5. BODY-BRAIN CONNECTIONS

You are being provided with a book chapter by chapter. I will request you to read the book for me after each chapter. After reading the chapter, 1. shorten the chapter to no less than 300 words and no more than 400 words. 2. Do not change the name, address, or any important nouns in the chapter. 3. Do not translate the original language. 4. Keep the same style as the original chapter, keep it consistent throughout the chapter. Your reply must comply with all four requirements, or it's invalid.
I will provide the chapter now.

T
CHAPTER 5
BODY-BRAIN CONNECTIONS
Life is about rhythm. We vibrate, our hearts are pumping blood.
We are a rhythm machine, that's what we are.
—Mickey Hart
oward the end of his career, in 1872, Charles Darwin published The Expression of the Emotions in Man and Animals.1 Until recently most scientific discussion of Darwin's theories has focused on On the Origin of Species (1859) and The Descent of Man (1871). But The Expression of the Emotions turns out to be an extraordinary exploration of the foundations of emotional life, filled with observations and anecdotes drawn from decades of inquiry, as well as close-to-home stories of Darwin's children and household pets. It's also a landmark in book illustration—one of the first books ever to include photographs. (Photography was still a relatively new technology and, like most scientists, Darwin wanted to make use of the latest techniques to make his points.) It's still in print today, readily available in a recent edition with a terrific introduction and commentaries by Paul Ekman, a modern pioneer in the study of emotions.
Darwin starts his discussion by noting the physical organization common to all mammals, including human beings—the lungs, kidneys, brains, digestive organs, and sexual organs that sustain and continue life. Although many scientists today would accuse him of anthropomorphism, Darwin stands with animal lovers when he proclaims: "Man and the higher animals . . . [also] have instincts in common. All have the same senses, intuition, sensation, passions, affections, and emotions, even the more complex ones such as jealousy, suspicion, emulation, gratitude, and magnanimity."2 He observes that we humans share some of the physical signs of animal emotion. Feeling the hair on the back of your neck stand up when you're frightened or baring your teeth when you're enraged can only be understood as vestiges of a long evolutionary process.
"When a man sneers or snarls at another, is the corner of the canine or eye tooth raised on the side facing the man whom he addresses?" —Charles Darwin, 1872
For Darwin mammalian emotions are fundamentally rooted in biology: They are the indispensable source of motivation to initiate action. Emotions (from the Latin emovere—to move out) give shape and direction to whatever we do, and their primary expression is through the muscles of the face and body. These facial and physical movements communicate our mental state and intention to others: Angry expressions and threatening postures caution them to back off. Sadness attracts care and attention. Fear signals helplessness or alerts us to danger.

We instinctively read the dynamic between two people simply from their tension or relaxation, their postures and tone of voice, their changing facial expressions. Watch a movie in a language you don't know, and you can still guess the quality of the relationship between the characters. We often can read other mammals (monkeys, dogs, horses) in the same way. Darwin goes on to observe that the fundamental purpose of emotions is to initiate movement that will restore the organism to safety and physical equilibrium. Here is his comment on the origin of what today we would call PTSD:

Behaviors to avoid or escape from danger have clearly evolved to render each organism competitive in terms of survival. But inappropriately prolonged escape or avoidance behavior would put the animal at a disadvantage in that successful species preservation demands reproduction which, in turn, depends upon feeding, shelter and mating activities all of which are reciprocals of avoidance and escape.3

In other words: If an organism is stuck in survival mode, its energies are focused on fighting off unseen enemies, which leaves no room for nurture, care, and love. For us humans, it means that as long as the mind is defending itself against invisible assaults, our closest bonds are threatened, along with our ability to imagine, plan, play, learn, and pay attention to other people's needs.

Darwin also wrote about body-brain connections that we are still exploring today. Intense emotions involve not only the mind but also the gut and the heart: "Heart, guts, and brain communicate intimately via the 'pneumogastric' nerve, the critical nerve involved in the expression and management of emotions in both humans and animals. When the mind is strongly excited, it instantly affects the state of the viscera; so that under excitement there will be much mutual action and reaction between these, the two most important organs of the body."4

The first time I encountered this passage, I reread it with growing excitement. Of course we experience our most devastating emotions as gut-wrenching feelings and heartbreak. As long as we register emotions primarily in our heads, we can remain pretty much in control, but feeling as if our chest is caving in or we've been punched in the gut is unbearable. We'll do anything to make these awful visceral sensations go away, whether it is clinging desperately to another human being, rendering ourselves insensible with drugs or alcohol, or taking a knife to the skin to replace overwhelming emotions with definable sensations. How many mental health problems, from drug addiction to self-injurious behavior, start as attempts to cope with the unbearable physical pain of our emotions? If Darwin was right, the solution requires finding ways to help people alter the inner sensory landscape of their bodies.

Until recently, this bidirectional communication between body and mind was largely ignored by Western science, even as it had long been central to traditional healing practices in many other parts of the world, notably in India and China. Today it is transforming our understanding of trauma and recovery.

A WINDOW INTO THE NERVOUS SYSTEM

All of the little signs we instinctively register during a conversation—the muscle shifts and tensions in the other person's face, eye movements and pupil dilation, pitch and speed of the voice—as well as the fluctuations in our own inner landscape—salivation, swallowing, breathing, and heart rate

—are linked by a single regulatory system.5 All are a product of the synchrony between the two branches of the autonomic nervous system (ANS): the sympathetic, which acts as the body's accelerator, and the parasympathetic, which serves as its brake.6 These are the "reciprocals" Darwin spoke of, and working together they play an important role in managing the body's energy flow, one preparing for its expenditure, the other for its conservation.

The sympathetic nervous system (SNS) is responsible for arousal, including the fight-or-flight response (Darwin's "escape or avoidance behavior"). Almost two thousand years ago the Roman physician Galen gave it the name "sympathetic" because he observed that it functioned with the emotions (sym pathos). The SNS moves blood to the muscles for quick action, partly by triggering the adrenal glands to squirt out adrenaline, which speeds up the heart rate and increases blood pressure.

The second branch of the ANS is the parasympathetic ("against emotions") nervous system (PNS), which promotes self-preservative functions like digestion and wound healing. It triggers the release of acetylcholine to put a brake on arousal, slowing the heart down, relaxing muscles, and returning breathing to normal. As Darwin pointed out, "feeding, shelter, and mating activities" depend on the PNS.

There is a simple way to experience these two systems for yourself. Whenever you take a deep breath, you activate the SNS. The resulting burst of adrenaline speeds up your heart, which explains why many athletes take a few short, deep breaths before starting competition. Exhaling, in turn, activates the PNS, which slows down the heart. If you take a yoga or a meditation class, your instructor will probably urge you to pay particular attention to the exhalation, since deep, long breaths out help calm you down. As we breathe, we continually speed up and slow down the heart, and because of that the interval between two successive heartbeats is never precisely the same. A measurement called heart rate variability (HRV) can be used to test the flexibility of this system, and good HRV—the more fluctuation, the better—is a sign that the brake and accelerator in your arousal system are both functioning properly and in balance. We had a breakthrough when we acquired an instrument to measure HRV, and I will explain in chapter 16 how we can use HRV to help treat PTSD.

THE NEURAL LOVE CODE7

In 1994 Stephen Porges, who was a researcher at the University of Maryland at the time we started our investigation of HRV, and who is now at the University of North Carolina, introduced the Polyvagal Theory, which built on Darwin's observations and added another 140 years of scientific discoveries to those early insights. (Polyvagal refers to the many branches of the vagus nerve—Darwin's "pneumogastric nerve"—which connects numerous organs, including the brain, lungs, heart, stomach, and intestines.) The Polyvagal Theory provided us with a more sophisticated understanding of the biology of safety and danger, one based on the subtle interplay between the visceral experiences of our own bodies and the voices and faces of the people around us. It explained why a kind face or a soothing tone of voice can dramatically alter the way we feel. It clarified why knowing that we are seen and heard by the important people in our lives can make us feel calm and safe, and why being ignored or dismissed can precipitate rage reactions or mental collapse. It helped us understand why focused attunement with another person can shift us out of disorganized and fearful states.8

In short, Porges's theory made us look beyond the effects of fight or flight and put social relationships front and center in our understanding of trauma. It also suggested new approaches to healing that focus on strengthening the body's system for regulating arousal.

Human beings are astoundingly attuned to subtle emotional shifts in the people (and animals) around them. Slight changes in the tension of the brow, wrinkles around the eyes, curvature of the lips, and angle of the neck quickly signal to us how comfortable, suspicious, relaxed, or frightened someone is.9 Our mirror neurons register their inner experience, and our own bodies make internal adjustments to whatever we notice. Just so, the muscles of our own faces give others clues about how calm or excited we feel, whether our heart is racing or quiet, and whether we're ready to pounce on them or run away. When the message we receive from another person is "You're safe with me," we relax. If we're lucky in our relationships, we also feel nourished, supported, and restored as we look into the face and eyes of the other.

Our culture teaches us to focus on personal uniqueness, but at a deeper level we barely exist as individual organisms. Our brains are built to help us function as members of a tribe. We are part of that tribe even when we are by ourselves, whether listening to music (that other people created), watching a basketball game on television (our own muscles tensing as the players run and jump), or preparing a spreadsheet for a sales meeting (anticipating the boss's reactions). Most of our energy is devoted to connecting with others.

If we look beyond the list of specific symptoms that entail formal psychiatric diagnoses, we find that almost all mental suffering involves either trouble in creating workable and satisfying relationships or difficulties in regulating arousal (as in the case of habitually becoming enraged, shut down, overexcited, or disorganized). Usually it's a combination of both. The standard medical focus on trying to discover the right drug to treat a particular "disorder" tends to distract us from grappling with how our problems interfere with our functioning as members of our tribe.

SAFETY AND RECIPROCITY

A few years ago I heard Jerome Kagan, a distinguished emeritus professor of child psychology at Harvard, say to the Dalai Lama that for every act of cruelty in this world there are hundreds of small acts of kindness and connection. His conclusion: "To be benevolent rather than malevolent is probably a true feature of our species." Being able to feel safe with other people is probably the single most important aspect of mental health; safe connections are fundamental to meaningful and satisfying lives. Numerous studies of disaster response around the globe have shown that social support is the most powerful protection against becoming overwhelmed by stress and trauma.

Social support is not the same as merely being in the presence of others. The critical issue is reciprocity: being truly heard and seen by the people around us, feeling that we are held in someone else's mind and heart. For our physiology to calm down, heal, and grow we need a visceral feeling of safety. No doctor can write a prescription for friendship and love: These are complex and hard-earned capacities. You don't need a history of trauma to feel self-conscious and even panicked at a party with strangers—but trauma can turn the whole world into a gathering of aliens.

Many traumatized people find themselves chronically out of sync with

the people around them. Some find comfort in groups where they can replay their combat experiences, rape, or torture with others who have similar backgrounds or experiences. Focusing on a shared history of trauma and victimization alleviates their searing sense of isolation, but usually at the price of having to deny their individual differences: Members can belong only if they conform to the common code.

Isolating oneself into a narrowly defined victim group promotes a view of others as irrelevant at best and dangerous at worst, which eventually only leads to further alienation. Gangs, extremist political parties, and religious cults may provide solace, but they rarely foster the mental flexibility needed to be fully open to what life has to offer and as such cannot liberate their members from their traumas. Well-functioning people are able to accept individual differences and acknowledge the humanity of others.

In the past two decades it has become widely recognized that when adults or children are too skittish or shut down to derive comfort from human beings, relationships with other mammals can help. Dogs and horses and even dolphins offer less complicated companionship while providing the necessary sense of safety. Dogs and horses, in particular, are now extensively used to treat some groups of trauma patients.10

THREE LEVELS OF SAFETY

After trauma the world is experienced with a different nervous system that has an altered perception of risk and safety. Porges coined the word "neuroception" to describe the capacity to evaluate relative danger and safety in one's environment. When we try to help people with faulty neuroception, the great challenge is finding ways to reset their physiology, so that their survival mechanisms stop working against them. This means helping them to respond appropriately to danger but, even more, to recover the capacity to experience safety, relaxation, and true reciprocity.

I have extensively interviewed and treated six people who survived plane crashes. Two reported having lost consciousness during the incident; even though they were not physically injured, they collapsed mentally. Two went into a panic and stayed frantic until well after we had started treatment. Two remained calm and resourceful and helped evacuate fellow passengers from the burning wreckage. I've found a similar range of responses in survivors of rape, car crashes, and torture. In the previous chapter we saw the radically different reactions of Stan and Ute as they relived the highway disaster they'd experienced side by side. What accounts for this spectrum of responses: focused, collapsed, or frantic?

Porges's theory provides an explanation: The autonomic nervous system regulates three fundamental physiological states. The level of safety determines which one of these is activated at any particular time. Whenever we feel threatened, we instinctively turn to the first level, social engagement. We call out for help, support, and comfort from the people around us. But if no one comes to our aid, or we're in immediate danger, the organism reverts to a more primitive way to survive: fight or flight. We fight off our attacker, or we run to a safe place. However, if this fails—we can't get away, we're held down or trapped—the organism tries to preserve itself by shutting down and expending as little energy as possible. We are then in a state of freeze or collapse.

This is where the many-branched vagus nerve comes in, and I'll describe its anatomy briefly because it's central to understanding how people deal with trauma. The social-engagement system depends on nerves that have their origin in the brain stem regulatory centers, primarily the

vagus—also known as the tenth cranial nerve—together with adjoining nerves that activate the muscles of the face, throat, middle ear, and voice box or larynx. When the "ventral vagal complex" (VVC) runs the show, we smile when others smile at us, we nod our heads when we agree, and we frown when friends tell us of their misfortunes. When the VVC is engaged, it also sends signals down to our heart and lungs, slowing down our heart rate and increasing the depth of breathing. As a result, we feel calm and relaxed, centered, or pleasurably aroused.

The many-branched vagus. The vagus nerve (which Darwin called the pneumogastric nerve) registers heartbreak and gut-wrenching feelings. When a person becomes upset, the throat gets dry, the voice becomes tense, the heart speeds up, and respiration becomes rapid and shallow.

COURTESY OF NED KALIN, MD

Three responses to threat.

1. The social engagement system: an alarmed monkey signals danger and calls for help. VVC.
2. Fight or flight: Teeth bared, the face of rage and terror. SNS.
3. Collapse: The body signals defeat and withdraws. DVC.

Any threat to our safety or social connections triggers changes in the areas innervated by the VVC. When something distressing happens, we automatically signal our upset in our facial expressions and tone of voice, changes meant to beckon others to come to our assistance.11 However, if no one responds to our call for help, the threat increases, and the older limbic brain jumps in. The sympathetic nervous system takes over, mobilizing muscles, heart, and lungs for fight or flight.12 Our voice becomes faster and more strident and our heart starts pumping faster. If a dog is in the room, she will stir and growl, because she can smell the activation of our sweat glands.

Finally, if there's no way out, and there's nothing we can do to stave off the inevitable, we will activate the ultimate emergency system: the dorsal vagal complex (DVC). This system reaches down below the diaphragm to the stomach, kidneys, and intestines and drastically reduces metabolism throughout the body. Heart rate plunges (we feel our heart "drop"), we can't breathe, and our gut stops working or empties (literally "scaring the shit out of" us). This is the point at which we disengage, collapse, and freeze.

FIGHT OR FLIGHT VERSUS COLLAPSE

As we saw in Stan's and Ute's brain scans, trauma is expressed not only as fight or flight but also as shutting down and failing to engage in the present. A different level of brain activity is involved for each response: the mammalian fight-or-flight system, which is protective and keeps us from shutting down, and the reptilian brain, which produces the collapse response. You can see the difference between these two systems at any big pet store. Kittens, puppies, mice and gerbils constantly play around, and when they're tired they huddle together, skin to skin, in a pile. In contrast, the snakes and lizards lie motionless in the corners of their cages, unresponsive to the environment.13 This sort of immobilization, generated by the reptilian brain, characterizes many chronically traumatized people, as opposed to the mammalian panic and rage that make more recent trauma survivors so frightened and frightening.

Almost everyone knows what that quintessential fight/flight response, road rage, feels like: A sudden threat precipitates an intense impulse to move and attack. Danger turns off our social-engagement system, decreases our responsiveness to the human voice, and increases our sensitivity to threatening sounds. Yet for many people panic and rage are preferable to the opposite: shutting down and becoming dead to the world. Activating

flight/flight at least makes them feel energized. That is why so many abused and traumatized people feel fully alive in the face of actual danger, while they go numb in situations that are more complex but objectively safe, like birthday parties or family dinners.

When fighting or running does not take care of the threat, we activate the last resort—the reptilian brain, the ultimate emergency system. This system is most likely to engage when we are physically immobilized, as when we are pinned down by an attacker or when a child has no escape from a terrifying caregiver. Collapse and disengagement are controlled by the DVC, an evolutionarily ancient part of the parasympathetic nervous system that is associated with digestive symptoms like diarrhea and nausea. It also slows down the heart and induces shallow breathing. Once this system takes over, other people, and we ourselves, cease to matter. Awareness is shut down, and we may no longer even register physical pain.

HOW WE BECOME HUMAN

In Porges's grand theory the VVC evolved in mammals to support an increasingly complex social life. All mammals, including human beings, band together to mate, nurture their young, defend against common enemies, and coordinate hunting and food acquisition. The more efficiently the VVC synchronizes the activity of the sympathetic and parasympathetic nervous systems, the better the physiology of each individual will be attuned to that of other members of the tribe.

Thinking about the VVC in this way illuminates how parents naturally help their kids to regulate themselves. Newborn babies are not very social; they sleep most of the time and wake up when they're hungry or wet. After having been fed they may spend a little time looking around, fussing, or staring, but they will soon be asleep again, following their own internal rhythms. Early in life they are pretty much at the mercy of the alternating tides of their sympathetic and parasympathetic nervous systems, and their reptilian brain runs most of the show.

But day by day, as we coo and smile and cluck at them, we stimulate the growth of synchronicity in the developing VVC. These interactions help to bring our babies' emotional arousal systems into sync with their surroundings. The VVC controls sucking, swallowing, facial expression, and the sounds produced by the larynx. When these functions are stimulated in an infant, they are accompanied by a sense of pleasure and safety, which helps create the foundation for all future social behavior.14 As my friend Ed Tronick taught me a long time ago, the brain is a cultural organ—experience shapes the brain.

Being in tune with other members of our species via the VVC is enormously rewarding. What begins as the attuned play of mother and child continues with the rhythmicity of a good basketball game, the synchrony of tango dancing, and the harmony of choral singing or playing a piece of jazz or chamber music—all of which foster a deep sense of pleasure and connection.

We can speak of trauma when that system fails: when you beg for your life, but the assailant ignores your pleas; when you are a terrified child lying in bed, hearing your mother scream as her boyfriend beats her up; when you see your buddy trapped under a piece of metal that you're not strong enough to lift; when you want to push away the priest who is abusing you, but you're afraid you'll be punished. Immobilization is at the root of most traumas. When that occurs the DVC is likely to take over: Your heart slows down, your breathing becomes shallow, and, zombielike, you lose touch

with yourself and your surroundings. You dissociate, faint and collapse.

DEFEND OR RELAX?

Steve Porges helped me realize that the natural state of mammals is to be somewhat on guard. However, in order to feel emotionally close to another human being, our defensive system must temporarily shut down. In order to play, mate, and nurture our young, the brain needs to turn off its natural vigilance.

Many traumatized individuals are too hypervigilant to enjoy the ordinary pleasures that life has to offer, while others are too numb to absorb new experiences—or to be alert to signs of real danger. When the smoke detectors of the brain malfunction, people no longer run when they should be trying to escape or fight back when they should be defending themselves. The landmark ACE (Adverse Childhood Experiences) study, which I'll discuss in more detail in chapter 9, showed that women who had an early history of abuse and neglect were seven times more likely to be raped in adulthood. Women who, as children, had witnessed their mothers being assaulted by their partners had a vastly increased chance to fall victim to domestic violence.15

Many people feel safe as long as they can limit their social contact to superficial conversations, but actual physical contact can trigger intense reactions. However, as Porges points out, achieving any sort of deep intimacy—a close embrace, sleeping with a mate, and sex—requires allowing oneself to experience immobilization without fear.16 It is especially challenging for traumatized people to discern when they are actually safe and to be able to activate their defenses when they are in danger. This requires having experiences that can restore the sense of physical safety, a topic to which we'll return many times in the chapters that follow.

NEW APPROACHES TO TREATMENT

If we understand that traumatized children and adults get stuck in fight/flight or in chronic shut-down, how do we help them to deactivate these defensive maneuvers that once ensured their survival?

Some gifted people who work with trauma survivors know how to do this intuitively. Steve Gross used to run the play program at the Trauma Center. Steve often walked around the clinic with a brightly colored beach ball, and when he saw angry or frozen kids in the waiting room, he would flash them a big smile. The kids rarely responded. Then, a little later, he would return and "accidentally" drop his ball close to where a kid was sitting. As Steve leaned over to pick it up, he'd nudge it gently toward the kid, who'd usually give a halfhearted push in return. Gradually Steve got a back-and-forth going, and before long you'd see smiles on both faces. From simple, rhythmically attuned movements, Steve had created a small, safe place where the social-engagement system could begin to reemerge. In the same way, severely traumatized people may get more out of simply helping to arrange chairs before a meeting or joining others in tapping out a musical rhythm on the chair seats than they would from sitting in those same chairs and discussing the failures in their life.

One thing is certain: Yelling at someone who is already out of control can only lead to further dysregulation. Just as your dog cowers if you shout and wags his tail when you speak in a high singsong, we humans respond to harsh voices with fear, anger, or shutdown and to playful tones by opening up and relaxing. We simply cannot help but respond to these indicators of safety or danger.

Sadly, our educational system, as well as many of the methods that profess to treat trauma, tend to bypass this emotional-engagement system and focus instead on recruiting the cognitive capacities of the mind. Despite the well-documented effects of anger, fear, and anxiety on the ability to reason, many programs continue to ignore the need to engage the safety system of the brain before trying to promote new ways of thinking. The last things that should be cut from school schedules are chorus, physical education, recess, and anything else involving movement, play, and joyful engagement. When children are oppositional, defensive, numbed out, or enraged, it's also important to recognize that such "bad behavior" may