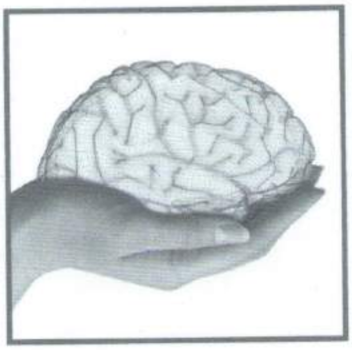
BEING A BRAIN-WISE THERAPIST



A Practical Guide to Interpersonal Neurobiology

BONNIE BADENOCH

FOREWORD BY DANIEL J. SIEGEL

Chapter 2

The Brain's Building Blocks

As we start to build our knowledge of the brain, we'll be talking about the brain as a more or less static thing—something it never is in life. In fact, neural firing patterns change from 4 to 100 times per second, and axons extend through the brain and body, connecting distinct and sometimes distant regions. It turns out that even in the brain and body, relationship is everything—what parts are connected with each other, and what messages delivered. However, if we are going to understand the flow of brain, mind, body, and relationship, it will be helpful to first picture something about the building blocks and architecture of the individual domains in the brain and nervous system.

Building Blocks of the Brain and Nervous System

The brains of adult human beings have about 100 billion *neurons* that, on average, have 7,000–10,000 synaptic connections to other neurons, creating 2 million miles of neural highways in our brains (Siegel, 1999). The connecting *synapse* is actually a very small space between sending and receiving neurons, called the *synaptic cleft*. Communication between neurons is facilitated by a large number of neurotransmitters produced in the presynaptic neuron, carrying messages that increase (excite) or decrease (inhibit) electrical activity in the postsynaptic neuron. Increases and decreases in these neurotransmitters can have a dramatic impact on thought, mood, behavior, and relational style. An army of *glia* (Greek for *glue*), tiny cells outnumbering neurons at least 10 to 1, have long been known to wrap axons in *myelin* to provide stability and speed connection between neurons, act as the cleanup crew for neural debris, and provide nutrition.

The traditional picture of the neural communication network says that neurons are composed of a cell body, with a forest of hefty *dendrites* at one end and one long, willowy *axon* (often with branches) at the other. We used to believe that the electrical impulse moved down the axon, releasing neurotransmitters into the synaptic cleft, where they made the short trip to a receiving dendrite on another neuron. Now we know that the electricity occasionally flows the other way, with dendrites sometimes sending and axons receiving, that a whole class of neurons communicates very rapidly without neurotransmitters, and that the ubiquitous glial cells are not limited to a maintenance role, but are also implicated in the communication network by influencing the way neurons fire (Fields, 2006). In addition, collections of neural and glial cells in the heart and gut function as little brains, sending information that influences regulation of the autonomic nervous system, as well as our higher cognitive and emotional processes (Armour & Ardell, 2004). The brain is not so neat, orderly, or head-centered as our former pictures suggested. Varied as these processes are, they may still sound mechanistic and remote from our daily lives. However, becoming aware that this tango of rapidly firing, ever-changing electrical impulses produces the rich subjective experience of our lives can instead bring on a sense of awe.

Pruning

Researchers estimate that the brain of a 3-year-old child has about 1,000 trillion synapses (Chang et al., 2004). This number declines with age (a good thing—simplification leads to efficiency) through a process of cell death called *pruning*. Some of those cells that have not been incorporated into the developing structure of the brain are eliminated. As we will see, chronic stress may lead to excess pruning in certain brain regions as well—and this is not a good thing. At the beginning of adolescence, there is another developmental burst of overproduction, followed by dramatic pruning (particularly in certain parts of the brain), reaching stability by the mid-20s (Giedd et al., 1999). By then, we have "only" 100 to 500 trillion synapses, creating web-like networks that integrate experience throughout the brain (Chang et al., 2004). If we consider all the *potential* activation patterns among neurons, we arrive at the figure of *10 to the millionth power*, yielding a number larger than the quantity of known particles in the universe (Siegel, 1999, 2007).

Sometimes it can be good to just sit with numbers this large and processes this complex to see if we can intuitively grasp the wonder of what is happening in our skulls, along the channels of our nervous systems, and in the heart and the gut. Through such reflection, it may seem miraculous that all this activity produces a coherent experience of conscious life.

Neural Nets

Genes and *experience* guide this symphony of interconnection. Our genetic inheritance directs overall brain organization, while experience influences how and when which genes become expressed (Siegel, 1999). Throughout life, as we have inner and outer experiences, neurons form synaptic connections with one another, carrying *energy* (the actual electrical firing) and *information* (the mental representations that emerge with the firing) throughout the brain. As we will see later, the *mind directs, emerges from, and rides on* these firing patterns (Siegel, 1999, 2006). Hebb's axiom (Hebb, 1949) roughly says that *what fires together, wires together*, and now we might add, *survives together* (Post et al., 1998). This concept means that all aspects of an experience tend to gather into a *neural net* that encodes a representation of that event. When one strand of that net is touched by current experience, there is some probability that the whole net will be activated. This is called *remembering*. As we sit with patients, we watch this process unfold during every session. Recalling the image of her mother's face, a young woman feels warmth fill her body with the memory of loving connection, or her eyes turn down and away when seeing the inner face of her shaming grandfather. Thoughts, images, feelings, body sensations, and the relational valence of any experience tend to flow together.

It is very important for us to understand that *every act of recall is also potentially an act of modification* (Siegel, 1999). The very process of directing attention toward a particular memory adds, at a minimum, the energy and information of the present moment to that memory. This process is one way that our comforting presence actually may alter our patients' painful past experiences. If we are able to stay in connection with one another, the feeling of comfort—often communicated through the sound of our voice, the position of our body, the look on our face as it reflects our inner experience of compassion—will initiate new neural firings that will now become associated with, and ameliorate, the suffering contained in the neural nets of frightening and repeated childhood events. This is an immensely hopeful bit of knowledge for patient and therapist alike.

We might ask why some memories carry such power to disrupt us in the present, whereas others seem quite manageable. One factor is that *the stronger the linkages within the net, the greater the probability of it being reactivated at a later date* (Siegel, 1999). *Repetition, the emotional intensity of the encoding experience,* and *myelination* all strengthen the synaptic connections making up these neural nets. We can imagine how both repetition and intensity of an experience would cause strengthened firing of neural nets, creating greater likelihood of being accessed at a later date. If someone we don't know well hurts our feelings one time, the pinprick of pain may be barely encoded. On the other hand, if someone close to us regularly misreads our intentions, both repetition and emotional significance can create a "super highway" to painful and powerful reexperiencing. The story of myelin is about speed and stability of connection and is largely under the direction of our genes. However, research (Bartzokis, 2005) reveals that certain experiences (e.g., teen drinking and drug use) that occur during the brain's vulnerable developmental stages can disrupt the ongoing myelination process and thereby worsen any underlying difficulties, such as hyperactivity or addictive tendencies, and perhaps create new challenges. Under normal circumstances, this process begins in infancy as axons are wrapped in many layers by sheets of myelin, extending from our ubiquitous glial cells in a spectacular display of cell-to-cell coordination (ffrench-Constant, Colognato, & Franklin, 2004). Whereas myelination is complete in certain brain areas within the first 3 years, other areas continue to be wrapped throughout life, peaking in our 40s and declining thereafter (Bartzokis, 2005; Paus et al., 1999). This sheath serves to speed the electrical impulse along the axonal fiber 100 times faster than without this wrapping, leading to immensely more efficient coordination between parts of the brain. The sheath also adds strength to the axon, stabilizing connections, while reducing flexibility. As we build a more complete picture of the complexity and speed of neural firing, we may also begin to appreciate how much is going on in our brains beneath the level of conscious awareness.

Neuroplasticity

After we reach maturity, how much does brain structure change? The answer lies in the process of *neuroplasticity,* which is the brain's capacity to change the patterns of energy and information (neural connectivity) in response to new experience (Siegel, 2006). As therapists, we will pay particular attention to how the power of the relationship between us and our patients resides in the capacity for ongoing neuroplasticity. The foundation for the hope of healing lies in the brain's ability to modify wired-in painful or frightening experiences by activity both *within* the mind and *between* minds. One way of thinking about psychotherapy is as a process of mutual engagement that will change both structure and function in the brain and nervous system in the direction of *neural integration*, as discussed in detail below. Such increases in neural integration are the basis for personal and interpersonal well-being.

It is helpful to become acquainted with two of the processes that mediate neural change: synaptogenesis and neurogenesis. *Synaptogenesis*, as one would guess, refers to the formation of new synaptic connections, but also includes modification of previously established circuits. This process is continual; each moment brings internal and external experiences that change the connections within the brain. Research has shown that *structure* changes in response to the increased density of synapses that fire repeatedly (Lazar et al., 2005). These synapses often represent new associations within established circuits. For changes in structure to be detectable on a scanner, a great many new connections would have to be made (Siegel, 2007). *Function* can also change as the result of certain kinds of experience. Recently developed functional magnetic resonance imaging (fMRI) technology lets us see where blood is flowing in the brain, so we can detect changes in the way brain areas are working together as a system. In one study, people's brains were scanned while they looked at pictures of angry and frightened faces. Both left and right amygdalae (the brain's primary fear centers) showed increased blood flow. That is, exposure to the pictures altered functioning. When asked to state the sex of the person in each picture, no change was detected in blood flow. However, when asked to name the emotion on the face, the amygdalae calmed down (i.e., less blood flowing there) if the emotion was named accurately. At the same time, blood flow increased in the right prefrontal cortex, a part of the brain that contributes to emotion regulation (Hariri, Bookheimer, & Mazziotta, 2000).

We can imagine that if the change of flow were repeated, an accumulating modification of brain structure would occur as synaptic connections strengthened with repetition. In this way, a new state of mind can gradually become an enduring trait. This kind of evidence for the brain's capacity to change can give us a healthy respect for how much impact therapeutic experiences may have on minds struggling with the fear and sadness of painful histories. When the recall of such experiences is met with empathy and kindness, new synapses carry that particular information throughout the brain, and blood flow changes course to more soothing paths. Over time, our patients may engrain an expectation of kind treatment, enabling them to develop much more fulfilling relationships.

Turning to the relatively new discovery of *neurogenesis*, in 2002 Fred H. Gage (Song, Stevens, & Gage, 2002) of the Salk Institute for Biological Studies and his team reported their ability to observe the results of "daughter cells" differentiating from their stem cell "parents" in the brain. They could see that by 1 month, newborn neural cells in the hippocampus (a crucial part of our memory system) had developed "long axons for transmitting electrical messages," and by 4 months had "thick forests of complex dendrites" for receiving signals from the environment ("Neural stem cells," 2002, p. 1). At that point, they were fully integrated with the hippocampus (in the limbic region) and cortex, possibly carrying the energy and information that initiated new cell birth. Gage and his colleagues had previously discovered that exercise and new experience (among other stimuli) induce stem cells to split, creating a new cell while leaving the stem cell in place to split again, providing a possibly endless supply of new neurons (Song et al.). Therapy certainly falls into the category of "new experience" for most people, and so may turn out to be an excellent source of stimulating the growth of new neurons.

This research is in its infancy, so we don't know how many parts of the brain contain stem cells, or if these cells, once generated, can migrate to other regions of the brain. If you want to look into the latest research, putting "neural stem cells" into your search engine will give you access to the unfolding story. We have found that sharing the idea of neuroplasticity with our patients gives hope. Creating your own simple way of helping your patients feel their brain's ongoing capacity for change may be a valuable resource.

Structures and Regions of the Brain

Now let's consider the collections of neurons that form various structures and regions. The brain is sometimes described as triune—brainstem, limbic, and cortex—or as two hemispheres, right and left, that are so distinct that some researchers think of us as having two brains. Since therapy is a process that helps remove blockages to the natural flow of linkage between differentiated regions, it will be helpful to have at least a working knowledge of these basic areas, always keeping in mind the pathways that connect the parts.

To understand the triune brain, we're going to borrow the hand model, the "brain in the palm of your hand," imagined by Daniel Siegel (see Figure 2.1; Siegel, 1999, 2007; Siegel & Hartzell, 2003). Open both hands with the thumbs extended, palms toward you. Now, place your thumbs against your palms and fold your fingers over the thumbs. Turn your folded hands with knuckles facing away from you, and bring your hands together, side by side, thumbs and forefingers meeting. If you

Figure 2.1 The brain in the palms of our hands: This portable representation of the brain is useful for making the brain visible and tangible. Roughly, the wrist is the spinal cord, the lower palm is the brainstem, the thumb is the limbic region, and the back of the hand from wrist to fingertips is the cortex. If we picture an eye in front of the middle two fingernails of each hand, our brains would be gazing at us. Art by Ron Estrine.

visualize an eye in front of the middle two fingernails of each hand, the two hemispheres of your brain would be looking out on the world. We have found this visual and tactile image to be extremely useful in helping patients understand what's going on inside their skulls.

Since a great deal of brain conversation in therapy revolves around what is happening in the right hemipshere, we can switch to the single-hand version at this point. Roughly, your wrist and forearm represent your *spinal cord*, the lower part of your palm contains your *brainstem* (including the medulla oblongata, the pons, and the midbrain), and, at the back near your wrist, your *cerebellum*. The brainstem is the only area of the brain that is fully wired up and ready for action before birth in full-term babies. It is genetically primed to control many aspects of body functioning that happen without our having to attend to them: respiration, vessel constriction, sleep cycles, and some aspects of the fight–flight–freeze responses, for example. Being closest to the spinal cord, the brainstem is also a major relay station for information coming from the body to the brain. With signals passed continually back and forth between body and brain, we may usefully picture body–brain as a single entity spread throughout the body.

In contrast to how much we understand about the brainstem, research is just beginning to reveal the complex functions of the cerebellum. Once thought to be responsible only for coordinating movements in time and space, studies are beginning to find that the massive streams of information pouring into the cerebellum from the cortex are processed and then redirected to many areas of the brain, appearing to coordinate complex mental as well as motor processes, including the allocation of attention and problem-solving functions (Allen, Buxton, Wong, & Courchesne, 1997). Largely undeveloped at birth, the cerebellum may accumulate information throughout childhood and adolescence, building its capacity for continual prediction and preparation in response to changing internal and external conditions (Courchesne & Allen, 1997).

Tucked away in the center of your brain (the thumb in your hand model) is the *limbic region* (including the amygdala, hippocampus, hypothalamus, and interfacing with the middle prefrontal structures; see Figure 2.2). Because the medial (middle), ventral (front/belly), and orbitofrontal (behind the eyes) portions of the prefrontal cortex, together with the anterior cingulate, work in such close association, it makes sense to gather these into a single term, the *middle prefrontal region*

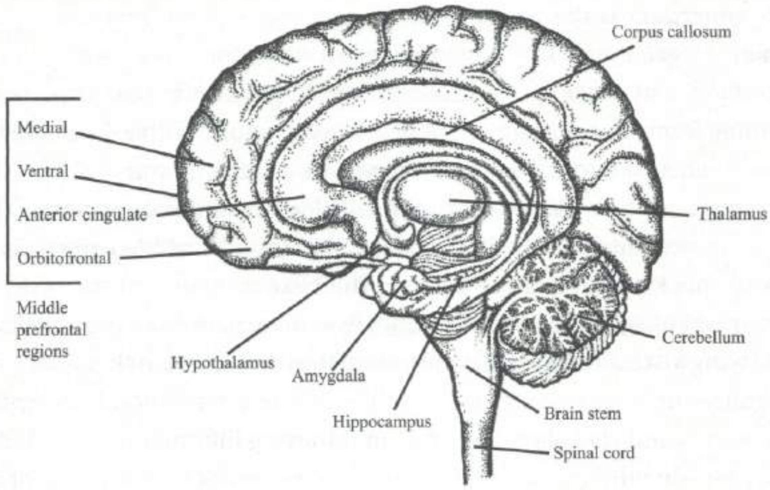


Figure 2.2 Right-hemisphere limbic and middle prefrontal regions: Fostering neural integration of these two regions is the foundation for effective psychotherapy. The corpus callosum (bands of fibers carrying information between the two hemispheres of the brain) and the thalamus (a central relay station for incoming sensory information) are also shown, together with the spinal cord, brainstem, and cerebellum. Art by Ron Estrine.

(Siegel, 2007). Taken together, we could call these regions the *social brain* (Cozolino, 2006; Siegel, 2007).

These regions, working with the brainstem, are dedicated to our motivational, emotional, and relational life, as well as the processes of memory. When we are born, this part of the brain is largely comprised of neurons that are not yet connected to each other (although it is likely that some connecting has happened in utero, based on the mother's physiological and emotional state; Field, Diego, & Hernandez-Reif, 2006). However, these neurons are genetically primed to *form connections through the relational experiences* we have with those closest to us. The patterns of energy and information laid down in these early moments of meeting develop the actual *structure* of these limbic regions. This means that the very foundation of perception, particularly in regard to relationships, relies on the quality of these earliest interactions with our parents. These three sentences are essential for understanding the crucial importance of early attachment experiences.

Limbic Region

In very brief outline, emphasizing only those functions that are most important for therapy, let's look at the components of the limbic area.

The *amygdala* is the home of initial *meaning-making processes* in the brain (Siegel, 1999). This almond-shaped structure tells us when to pay attention and makes a preliminary evaluation of whether experience coming from the environment or within us is "good" or "bad"—not in the moral sense, but in the sense of whether it is safe and warm or not. It is also the seat of *implicit memory*, the only form of remembering available to us during approximately the first 12–18 months of life (much more about this kind of memory below). The next structure, in the order of eventual linkage, is the *hippocampus*, extending back from the amygdala and lying just inside the temporal lobe of the cortex. Researchers call it the cognitive mapper because it assembles bits of information into *explicit memories*, and also plays a key role in retrieving information encoded in the past—in other words, in the process of remembering. Bundles of axonal fibers, called the *fornix*, begin at the hippocampus and arch around below the anterior cingulate, ending in the region of the *hypothalamus*. Together with the pituitary, the hypothalamus controls the neuroendocrine system, releasing neurotransmitters and hormones throughout the body–brain in the service of maintaining homeostasis. Clearly, these three components form a team that interact strongly with one another.

Above the corpus callosum lies the *cingulate gyrus*, with the part toward the front (to the left in Figure 2.2) being the *anterior cingulate*. This large region has many functions, but for our purposes, two of the most important are its involvement in the attentional processes that are central to regulation, and its capacity to assemble cognitive and affective information to make decisions that will be positive for our future. Because focused attention is a crucial component of encouraging the mind to reshape the brain, this circuitry becomes central in the therapeutic endeavor. Because streams of information, containing rational and emotional cognitions, converge here, it is one of the primary areas supporting neural integration. Finally, the *medial, ventral, and orbitofrontal parts of the prefrontal cortex* are near the end of the frontal lobe, where your fingertips contact both the brainstem and the limbic regions in the hand model. These regions are part of the cortex. However, the orbitofrontal region lies so close to the limbic proper that some researchers say it is neither fully cortex nor fully limbic. Taking these four regions together, we will follow Siegel (2007) in collectively calling them the *middle prefrontal region*. The neurons here are *specialized for integration*, and, as we will see below, play a key role in facilitating recovery from all kinds of attachment and traumatic difficulties.

Deep within the brain lies one area that is not technically part of the limbic region but that acts as a relay station for communication between body (via the spinal cord and brainstem), limbic region, and cortex: the *insular cortex* (or *insula*). Researchers believe that the streams of information converging here provide an emotionally relevant context for sensory information. Working with the middle prefrontal regions, the insula is thought to serve as one vital conduit for the flow of information that allows us to form pictures of the state of our own bodies and of one another's minds (Siegel, 2007). Taking a moment to mentally review the locations and functions of these structures may help us begin to visualize how they work together.

Cerebral Cortex

Returning to the hand model, the third group of regions is represented by the back of your hand from above the wrist down to the fingertips, wrapping around the limbic regions—the *cerebral cortex* (also called the *neocortex*), which is comprised of four lobes (see Figure 2.3). These regions, particularly those toward the front of the brain that are devoted to reasoning and relationship, are most extensively developed in human beings.

Moving from back to front (and roughly in order of increasingly integrative processing), the *occipital lobe* at the back of the head integrates bits of visual information into whole images. The *parietal lobes* process information about touch, pressure, temperature, pain, where we are in

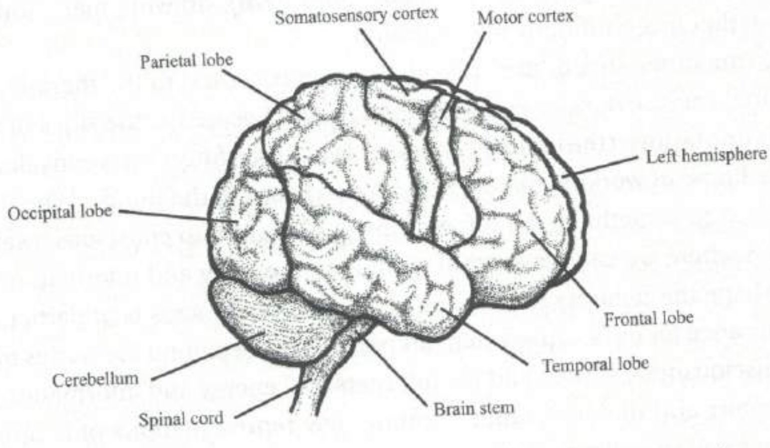


Figure 2.3 The cerebral cortex: We are looking at the right hemisphere, with the back of the brain at the left. This cortex, particularly the frontal lobe, is most extensively developed in human beings. Art by Ron Estrine.

space, sensory comprehension, understanding speech, reading, and visual functions; the somatosensory strip at the front of this lobe receives information from the spinal cord about touch, position of the body, and other matters. You can begin to sense the streams of energy and information gathering.

The *temporal lobes* at the side of the head process complex information about smells and sounds, and have many integrative functions relating to memory. Just inside the temporal lobes, in the medial temporal cortex, we find the hippocampus, the limbic structure most involved in explicit memory creation and retrieval. As an example of the temporal lobe's integrative power, the functions of the left lobe are not limited to simple perception but extend to comprehension, naming, verbal memory, and other language functions. The ventral (front/belly) part of the temporal cortices appear to be involved in integrative visual processing of complex stimuli such as faces (fusiform gyrus) and scenes (parahippocampal gyrus).

Finally, the *frontal cortex*, moving from back to front, contains regions for motor control of voluntary muscles and motor planning (motor and premotor strips), as well as for concentration, organization, reasoning, judgment, decision-making, creativity, personality, abstract thinking, emotion, and relational abilities (to name a few). If we move to the bottommost area of the frontal cortex, we have returned again to the highly integrative prefrontal region, a crucial area for healthy functioning in our relational universe. Again, you can notice how your fingertips touch both the thumb (limbic) and palm (brainstem), drawing many inputs together in a symphony of integration.

One other area of the prefrontal region is central to the therapeutic endeavor: the *dorsolateral prefrontal cortex*. Located at the sides of the prefrontal lobe (the topmost knuckle of your little finger), it is considered the home of working memory, the "chalkboard of the mind." When we attend to something, the information is brought into conscious awareness where we can play with it, adding new energy and information to reshape the memory before it is re-stored. This process is of particular relevance for us because when our patients bring painful memories into consciousness, we can add the interpersonal energy and information of comfort and understanding, creating new representations of a caring other and providing the impetus for increased integration. Then, when these memories are sent again to long-term or permanent storage, they will be both more integrated and more filled with soothing messages.

Differing Functions of the Two Hemispheres

Now let's turn briefly to the *differing functions of the two hemispheres*. In many pictures of the brain, if you look down from the top, it appears that it could be peeled into two halves like a ripe apricot. Were it not for the *corpus callosum* (the part right beneath the cingulate gyrus in Figure 2.2), a band of tissue that is the major highway for communication between the two halves, along with a few other smaller bands of fibers (all called *commissures*), this would be largely true in the anatomical and functional sense. Even though there are similar structures in both halves of the brain (e.g., two amygdalae, two hippocampi, two temporal lobes), the way they perceive experience as well as the information they process and their means of processing that information are quite different (Schore, 2007; Siegel, 1999).

The functions mostly mediated by the left, what we could call *left-mode processing* (LMP), conveniently begin with l's: logic, linearity, language, and literalness (Siegel & Hartzell, 2003). The left likes things to make sense in an "a, then b, then c" sort of way. It captures experience in words that give it a definable shape. LMP creates explanations of events and feelings, based on input from the right, producing the experience of things falling into predictable cause-and-effect patterns. Even the neocortex on the left side is wired in a way that supports such a sense of order, having more of a tendency to isolate information into neat packets that give the sensation of a yes/no and right/wrong binary system (Hawkins & Blakeslee, 2004).

Right-mode processing (RMP), happening for the most part in the right hemisphere, is more holistic and nonlinear, taking everything in at once in a receptive way (Siegel & Hartzell, 2003). It is specialized for perceiving and processing visual and spatial information—such as sending and receiving nonverbal signals, the centerpiece of social understanding. Mental models of the self, the world, and relationships are generated and experienced via the right mode. An integrated map of the body is assembled here, as well as the felt reality of our own story—our wordless autobiography as felt in and by our bodies. In short, the information necessary for understanding ourselves and others comes as direct experience through RMP. Interestingly, researchers have also discovered that there is some language on the right—the ambiguous, emotion- and image-laden words of poetry (Siegel, 1999). Even the neocortex on the right supports these ways of knowing; its neuronal columns have many more interconnections with each other than on the left (Hawkins & Blakeslee, 2004). All of this leads us to the inevitable conclusion that RMP is the indispensable bedrock of healing in therapy (Schore, 2007), and much of what follows offers ways to facilitate integrated RMP in ourselves so that we can provide regulating right-to-right connections with our patients.

What do we know about emotional processing in the two hemispheres? While there have been several hypotheses, the one with greatest research support at this point states that avoidance/withdrawal emotions (including turning inward to prepare to counteract a threat) are experienced, perceived, and expressed via RMP, whereas approach emotions are handled by LMP (Davidson, Jackson, & Kalin, 2000; Urry, Nitschke, Dolski, Jackson, Dalton, & Mueller, et al., 2004). This allocation makes sense given that researchers have discovered two motivational streams, tying the limbic regions to the cortex. In the right hemisphere, the stream that mediates avoidance/withdrawal is dominant, whereas in the left, the approach stream is stronger (Siegel, 1999). It is important to notice that both streams operate in both hemispheres, so the distinction is one of degree rather than indicating a complete separation.

When the two halves are integrated, meaning that information flows smoothly between the differentiated hemispheres via the *commissures* (principally the *corpus callosum*), RMP provides the felt context for the making-sense activities in the left mode, and LMP provides what we might best describe as the calming reassurance of logic and predictability for the right mode. Later in these chapters, we will explore more about why this integration might be blocked, how partial integration can "cement in" hurtful stories about ourselves that impact relational patterns, as well as ways to help the highway reopen and become a conduit for the more complete and balanced narrative of a person's trajectory through life.

Autonomic Nervous System

The last piece of anatomical awareness involves the two branches of the *autonomic nervous system* (ANS)—the *sympathetic* (which acts like the accelerator in a car), and the *parasympathetic* (which acts like the brakes). With this, we move into the body proper. When we think of self-regulation, the ANS is one of the systems involved. The ANS certainly doesn't operate alone, and, in fact, the amygdala, regions of the prefrontal cortex, and hypothalamus play a large role in the regulation process. When there is balance between the sympathetic and parasympathetic functions, we stay within our *window of tolerance* (Siegel, 1999), being neither too excited nor too dampened. When the sympathetic branch is in ascendance, we may experience being overly stimulated (including fight–flight responses), and when the parasympathetic branch takes over, we may feel withdrawn. Interestingly, the word we use for this latter experience is *shame* (Schore, 2003a). If both systems are overly activated, a fairly intolerable, disorganizing sensation is created, akin to jamming accelerator and brakes to the floor at the same time. As therapists, we can often feel the ANS at work in our own bodies as well as observe its fluctuations in our patients. Later in these writings, we will talk about the interpersonal and internal influences that carry a person along the continuum from ANS dysregulation to balance.

To make the picture sufficiently complete, we need to consider one other brain structure: the body–brain–mind of every person with whom we interact. We are constantly shaping each others' brains through our interactions. Let's say that someone frowns at me for no reason I can discern. Circuits in my brain containing the experience of my father being critical flare into activity, affecting my body–brain–mind in a powerful way (momentary brain change), further strengthening those circuits containing the old memory (long-lasting brain change). A caring friend puts her hand gently on my arm when I am upset. My body–brain–mind resonates with the warmth and calmness she brings to me (momentary brain change), while my middle prefrontal region is empowered to establish new soothing connections to my amygdala (long-lasting change). At every moment, we are engaged in this brain-to-brain creative dance.

How much detail about brain structure do we need to feel comfortable enough to convey this information in ways that our patients can understand and absorb? That probably varies from person to person. This chapter certainly presents a bare-bones version of brain structure, but we have found that ease with this much information, well-internalized so that it is flexibly available depending on the need of the particular patient, provides a good foundation for conversation, even with patients who are curious about the details of brain function. Also, as you make your way through the book, much more detail about brain processes will be added to this basic structure.

When I first learned about the brain, I developed a fuzzy sense of the major sections—and that was somewhat helpful. However, when I discovered that I really wanted to be able to use this knowledge with patients, I reread my two sources with pen and paper in hand, taking notes and poring over the diagrams as though I were in school—because I was. Much like adjusting the focus on a camera, the brain swam into view with clarity, and my ability to be helpful with patients made a substantial leap as well. Getting this material somewhat engrained will make everything that follows easier, like putting a foundation under the house.

The main sense I hope you have gained from this very brief overview of the regions of the brain and components of the nervous system is how our neural equipment takes tiny bits of experience (information) and continuously weaves them together throughout the brain and body into our moment-to-moment subjective experience of life. Even though we're looking mainly at structures, a feeling of flow inevitably begins to emerge.