

## CHAPTER 1

# The Embodied Brain, Awareness, and the Nature of Energy

In this chapter we will explore aspects of both the body and consciousness in order to highlight the intricate origins and manifestations of the mind. Though since the time of Hippocrates twenty-five hundred years ago, the mind has often been equated with the functioning of the brain alone, this ancient perspective may, in fact, be one important but limited part of a much larger and more in-depth story about the human mind and how it emerges from both an embodied origin beyond the skull and a relational origin beyond the single body alone.

Let's begin with an exploration of some basic ideas about the body and its brain, and then move to the fundamental experience of being aware, our capacity for consciousness.

### The Embodied Brain

#### The Organization of the Brain

The body and its head-located brain are a complex system of interconnected parts. In fact, we have neural networks around both the intestines and the heart, which preceded, in our evolutionary history, the emergence of the extensive networks of interlinked neurons inside the skull, what we usually refer to simply as the “brain.” At its most basic level, this skull-based portion of the nervous system consists of about one hundred billion “neurons” and trillions of supportive “glia” cells—our Schwann cells, astrocytes, oligodendrocytes, and microglia. Collectively, if laid out end to end, our neurons would be over two million miles long. Each neuron has an average of ten thousand connections that directly link it to other neurons.<sup>1</sup> Thus there are thought to be about one million billion of these connections, making it “the most complex structure, natural or artificial, on earth.”<sup>2</sup> A “neuron” is one of the basic

types of cells in the nervous system; it consists of a cell body, receiving ends called “dendrites,” and a long axonal length that reaches out to other neurons. The neuron sends an electrical impulse, called an “action potential,” down its long axons; this releases a neurotransmitter at the space at the end, called a “synapse,” which then excites or inhibits the downstream neuron. This process is an example of electrochemical energy flow. A synapse is the connection that functionally links neurons to one another, involving electrical, chemical, and possibly even other forms of energy field influences on information transmission among neuronal networks, called “aptic coupling.”<sup>3</sup> These synaptic connections and other mechanisms of energy flow in the brain help form the linkages that are the foundation for the intricate structural and functional architecture of the brain. Because of the spiderweb-like interconnections, activation of one neuron can influence an average of ten thousand other neurons. In this way, an energy flow pattern within massively intricate networks is thought to be the correlate of our mental life.<sup>4</sup> The resulting set of neurons that fire together can be called a “neural net profile,” which signifies a pattern of neural activity clustered into a functional whole. Such a neural net profile, for example, could be a neural representation activated when we think of the Golden Gate Bridge or the Eiffel Tower. Each time we think of that particular structure, a similar neural net profile will become activated. The vast numbers of neural connections are not static; the brain continually changes its synaptic interconnections in response to experience.<sup>5</sup> This means that the number of firing patterns possible across a lifespan is virtually infinite. The number of possible “on-off” patterns of neuronal firing, even in a given moment of time, is immense, estimated at a staggering ten times ten one million times (i.e., ten to the millionth power). The brain is obviously capable of an imponderably huge variety of activity; the fact that it is often organized and functional is quite an accomplishment!

Neurons and glia are organized in various levels of complexity, from small clusters called “nuclei” to larger assemblies called “circuits,” “regions,” and “hemispheres.” These various groupings have internal interconnections that enable neural firing to cluster into specialized patterns limited to that specific area; the output of these differentiated areas then links with the output of other regions by way of intergroup fibers that enable cross-group communication to occur. The result of such differentiation and linkage within the brain yields a range of networks that appear to function via waves of oscillating patterns.

As Tognoli and Kelso suggest<sup>6</sup>: “A truly integrated spatiotemporal account is attained through a thorough embrace of brain coordination dynamics: how neurons and neural ensembles ‘act in concert’ requires the systematic unfolding of dwell–escape choreography in space–time to identify the dynamic signatures of healthy, adaptive brain function and its less adaptive counterparts.” The notion of a spatial distribution of neural assemblies that are coordinated in time suggests that to understand the brain and its functioning, we need to begin to think in four-dimensional ways, including both the spatial location

of which neurons are engaged and the timing of their activation. The “dwell-escape” process involves a temporary coalescing of neural assemblies as they “dwell” in that configuration, and then escape those associations.

In neural studies, as mentioned in the Introduction, the term “segregation” is used in the manner that we are using the general term “differentiation” to indicate the specialization or unique function and structure of a given set of neural assemblies. In the neural nomenclature of these studies, too, the term “integration” is sometimes used as we are using the general term “linkage.” Why the difference in terminology? Decades ago when these notions were emerging from the inspirations occurring in the field of mathematics, indicating that complex systems differentiate and link their functions, it seemed natural to use these accessible terms. As mentioned earlier, there was no global term to summarize the balance of differentiation and linkage, and so I chose to use the familiar term “integration” as a word to simply indicate a state in which differentiation and linkage were dynamically shifting in a complex system as it moved toward emerging layers of self-organization.

To expand this use of varied terms a bit further, depending on the field in question the words “criticality” in mathematics and “metastability” in neuroscience are sometimes used to refer to processes related to this balance that we are calling a state of “integration.” Here we can see how such metastable states are described, as Hellyer and colleagues suggest<sup>7</sup>: “Current theory proposes that healthy neural dynamics operate in a metastable regime, where brain regions interact to simultaneously maximize integration and segregation.” The research terminology here would be stated in an IPNB perspective/vocabulary as “maximizing linkage and differentiation.” In other words, integration creates metastability. The authors go on to state:

Metastability may confer important behavioral properties, such as cognitive flexibility. It is increasingly recognized that neural dynamics are constrained by the underlying structural connections between brain regions. An important challenge is, therefore, to relate structural connectivity, neural dynamics, and behavior. . . . Decreased metastability was associated with reduced cognitive flexibility and information processing. A computational model, defined by empirically derived connectivity data, demonstrates how behaviorally relevant changes in neural dynamics result from structural disconnection. Our findings suggest that metastable dynamics are important for normal brain function and contingent on the structure of the human connectome.<sup>8</sup>

We would call such processes “integrative” in that they would create the metastable dynamics from balancing the differentiation and linkage of aspects of the connectome. In connectome language, such states might be referred to as revealing the “interconnectivity of the connectome.”

Further support for the importance of this balance of linkage and differentiation comes in studies of executive functions (EFs) from Jason Nomi and colleagues:

Metastable brain states allow for the flexible reconfiguration of neural networks while avoiding extreme integrative or segregative brain configurations. . . . The current study supports the notion that metastability and cognitive flexibility may arise from similar brain configurations. . . . The current study demonstrates a relationship between EF abilities and the brain's propensity to occupy a specific functional connectivity configuration, or state. Thus, performance on a cognitive task may not be based entirely on the changes occurring during the specific task itself, or the dynamic functional coupling of any single brain area, but it may also depend on the intrinsic organization of dynamic shifts between entire brain states or systems.<sup>9</sup>

Here, the notion of extremes of linkage or of differentiation would be simply stated in IPNB terminology as “compromises to integration.” Too much linkage or too much differentiation without the balance of these two ends of a kind of “integrative spectrum” would result in the chaos and/or rigidity of nonintegrative flows.

The term for whole-brain interconnectivity is the “connectome.” Researchers can study both the structural and functional interconnections of the connectome. As mentioned earlier, for example, Smith and colleagues found that the functional interconnectivity of the connectome was the best predictor of well-being across a wide array of assessments, which were then correlated with a range of neural measures.<sup>10</sup> There are many ways to study how this functional linkage of the differentiated areas of the connectome arises. When studied across time, the term “chronnectomic systems” has been offered to creatively embed time (chrono) with connectome (-nectomic); when studying the oscillating waves that link the various regions of the connectome, the term “connectome harmonics” has also been used.<sup>11</sup> Other terms you may come across in this exciting new way of envisioning and studying the functions of neural networks that assemble and integrate massively interconnected regions across time are “connectomics” and “connectome dynamics.”

The term “criticality,” which was introduced earlier from the mathematical field of complex systems, has some fascinating conceptual and empirical overlaps with the neural science term “metastability.” In personal discussions with researcher Morten Kringelbach on this topic, we explored how future research will need to clarify the ways in which the neural study of these dynamics of metastability and the complexity theory's view of self-organization arising with the balance of linkage and differentiation and the ensuing states of criticality may possibly overlap.

For our work and discussions going forward, please keep in mind, too, that we will continue to use the time-tested terms of *linkage* (parallel to the neural science view using the terms connection or “integration”) and *differentiation* (parallel to the neural science view of specialization or segregation). And as emphasized earlier and reinforced here, we will also use the accessible term “*integration*” to indicate the balance of linkage and differentiation that is at the heart of the creation of a metastable state in the brain and a state of criticality in any complex system that enables optimal self-organization to emerge.

With the contemporary emphasis on neural networks within the connectome, is there any need to become familiar with the individually named specific regions of the brain? In not-so-distant times, the question would often be posed, “*Where in the brain* does this or that mental function *reside* or *come from?*” Knowing the *where* in the brain seemed, in those days, to be crucial to understanding how mind and brain might be connected. In more recent times, however, we have come instead to ask the question not so much *where* but *how* brain functions correlate with mental states. It is helpful to remember that the brain seems to function through *global brain states*, unfolding in *oscillating waves* across the whole brain, which link widely differentiated areas—in fact, often whole networks—to one another.

Yet knowing the basics about the specific regions actually can be quite useful. Why? Because when some regions are damaged or underdeveloped, the impediments to functioning that arise from this blockage to differentiation can be helpful in understanding the overall functioning of an individual.<sup>12</sup> Likewise, blockages to linkages can lead to impediments in network connectivity and hence function. Furthermore, interventions can be targeted to develop under-differentiated areas so that they can be induced to grow and become active participants in the now potentially more differentiated networks that contribute to the newly linked and more integrated global state. In other words, when we can focus on balancing differentiation when impeded or on linkage when ruptured or not established, it is possible to intentionally create a more integrated brain state. This integrated state, in our very specific use of this terminology as carefully defined here, is the basis for optimal self-organization, potentially creating the criticality and metastability at the heart of adaptive functioning.

As Tognoli and Kelso further state:

Neural ensembles oscillate across a broad range of frequencies and are transiently coupled or “bound” together when people attend to a stimulus, perceive, think, and act. This is a dynamic, self-assembling process, with parts of the brain engaging and disengaging in time. But how is it done? The theory of Coordination Dynamics proposes a mechanism called metastability, a subtle blend of integration and segregation. Tendencies for brain regions to express their individual autonomy and specialized functions (segregation, modularity) coexist with tendencies to couple and coordinate globally for multiple functions (integration). . . . We discuss theory and experiments at multiple scales, suggesting that metastable dynamics underlie the real-time coordination necessary for the brain’s dynamic cognitive, behavioral, and social functions.<sup>13</sup>

As we’ll soon see, studies of the “neural correlates” of consciousness, the neural firing patterns associated with being aware, reveal how understanding these neural dynamics beyond simply identifying individual areas that are activated is essential for a broader insight into brain and mind. As Atasoy, Deco, Kringelbach, and Pearson suggest, “dynamical systems such as the

brain maximize their state repertoire when they approach criticality; that is, transition between order and chaos, which has also been proposed to be the neural mechanism underlying conscious wakefulness.”<sup>14</sup> They go on to note that these states of metastability emerge from harmonic oscillations within the connectome as a whole:

The framework of elementary harmonic brain modes offers a unifying perspective and explanatory framework revealing the link between various seemingly unrelated findings on neural correlates of consciousness. The proposed framework links the spatial patterns of correlated neural activity, not only to temporal oscillations characteristic of mammalian brain activity but also to brain anatomy and neurophysiology. Hence, this framework goes beyond enabling a new dimension of tools for decomposing complex patterns of neural activity into their elementary building blocks, by also providing a fundamental principle linking space and time in neural dynamics through harmonic waves—a phenomenon ubiquitous in nature.<sup>15</sup>

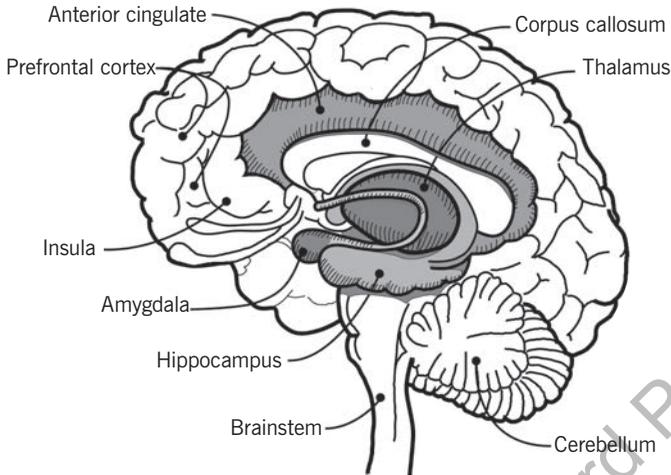
As we move forward from single neurons to clusters of neurons and then interconnected networks, it will be helpful to keep in the front of our minds that the flow of energy and information passes through the brain in the head and is interconnected with the whole of the body. This embodied flow takes various forms and oscillates in various frequencies, sweeping into a state in the moment in a varied set of bodily regions. At the same time, this flow can also be seen to involve the sharing of energy patterns from outside the body: from other people and the surrounding environment, what we might simply call nature or the planet. We are connected to people and the planet, not separate from these sources of sharing energy and information flow. This energy flow is *not* “metaphysical” in the sense of being beyond (*meta*) the physical world; energy is a fundamental aspect of our common reality—and energy flow is simply not limited to an inner bodily location. How are you reading these words right now? With the energy of light to your eyes enabling sight? Or through the energy of sound waves, the movement of air molecules, which is the energy we use to enable us to hear? As we move from head to body to other individuals and the larger world, let’s keep this primary view of energy, in all its varied forms in our physical world, in mind as we move along. Energy is a part of our universe—perhaps the essential aspect of the universe—a scientifically established aspect of our reality, and we are simply proposing that the mind is deeply and fundamentally related to its flow. That flow happens between our bodily self and the world around us, and that flow happens inside the body. Neither skull nor skin are impermeable barriers to the flow of energy in our lives. When we consider where this flow happens, we can perhaps begin to “see” the mind more clearly.

Let’s start up in the head. The brain in the head is one embodied mechanism through which energy and the subset of energy called “information”—a symbolic pattern of energy that represents something other than itself—flow.

“Flow,” in our usage, simply means *change*. Energy in the brain is primarily in the form of electrochemical energy flow as ions move in and out of membranes of neurons during an *action potential*. There is also the influence of chemicals such as neurohormones and neurotransmitters on the functioning of cells in the brain. When an action potential’s *flow of electrical charge* reaches the end of the neuron, a chemical is released, and the neurotransmitter, which can be either excitatory or inhibitory, increases or decreases the likelihood of the firing of the synaptically linked downstream neuron. The molecule that is released interacts with the receptor of the postsynaptic neuron with *chemical energy* flowing at this level of neuronal activation. Other chemicals bathing the neuron may influence its functioning as well. This sequence of the action potential illustrates how the flow of a charge (electrical) and the receptor interfacing with the neurotransmitter (chemical) result in *electrochemical energy flow*. Nothing fantastical. Simply fantastic. Energy flow.

When we consider the “brain” and its functions, we really mean an “embodied brain” in that the energy and information flow that streams through the interconnected connectome up in the head is influenced by streams of energy throughout the body and the information those streams confer. This term, “embodied brain,” also reminds us that the spiderweb-like configuration of interconnected neurons that processes energy flow into information exists not only in the head’s brain, but is also extensively interconnected with the intrinsic nervous system of the heart and with the intestines. Researchers such as Antonio Damasio suggest that the gut is actually the first brain, with the head-brain coming much later in evolution.<sup>16</sup> We can also use the term “social brain” for how the electrochemical energy patterns in the head-brain are profoundly shaped by, and also shape, our interpersonal relationships.<sup>17</sup> Although the simpler term, “brain,” is so commonly used, let’s simply try to recall that this head-brain is fully embodied and fully social. Its functions are profoundly shaped by energy patterns emerging from the other brains in the heart and gut, from the body as a whole, and from the environment—from other people and the natural world surrounding the body. And this is why we can suggest that the brain in the head is fully embodied and fully relational. This is also why we can sense that the mind—who we are—is fully embodied and relational. Yes, some excessive differentiation can occur, and a given individual can learn to become disconnected from both the body and the relational world (examples of impaired integration), but generally these non-head sources of energy and information flow are fundamental to the brain’s functioning and influence how the mind works.

What are these differentiated areas of the brain, the interconnected sets of neurons in our head? These neural clusters can be classified in a number of ways, including their anatomical placement in the lower, central, and upper areas of the brain. Figure 1.1 is a schematic drawing of the basic structure of the brain.



**FIGURE 1.1.** Diagram of the right hemisphere of the human brain. The lower areas include the cerebellum and the brainstem; the central areas include the limbic regions (amygdala, hippocampus) and thalamus; the upper areas include the cortical regions. The insula is beneath this medial surface. Copyright © 2012 Mind Your Brain, Inc.

### Lower Brain Structures

The “lower structures” of the head-brain include those circuits of the brainstem deep within the skull that mediate basic elements of energy flow, such as states of arousal and alertness and the physiological state of the body (temperature, respiration, heart rate). Clusters of neurons in this region are also responsible for the survival reactions of fight–flight–freeze–faint and are fundamental to the “polyvagal theory” of self-regulation.<sup>18</sup> This theory suggests that our interactions with others directly shape how these deep structures in the brain respond with a sense of safety and receptivity or with a sense of danger or life threat. At the top of the brainstem is the thalamus, an area that serves as a gateway for incoming sensory information. It has extensive connections to other regions of the brain, including the neocortex, just above it. As we shall see, one theory of awareness considers the activity of a thalamocortical circuit to be a central process for the mediation of conscious experience.<sup>19</sup> Other proposals suggest that various regions contribute to different elements of consciousness, and to a wide range of senses of a self.<sup>20</sup>

The lower regions of the brain also house the hypothalamus and the pituitary, which are responsible for “physiological homeostasis,” or bodily equilibrium, established by way of neuroendocrine activity (neuronal firing and hormonal release).<sup>21</sup> The body proper is intimately integrated with skull-based neural tissue by way of these hormonal and other regulatory processes, such as the immune and musculoskeletal systems. When we use the term “brain,” we can now see that it makes no sense in our conceptualizations to separate

this skull-based structure from the body as a whole. Hence the origin of the term “embodied brain.” The hypothalamic–pituitary–adrenocortical (HPA) axis often responds to stress, and this system can be adversely affected by trauma. Studies reveal that early childhood stress can even negatively affect the ways in which gene expression is regulated in these important areas of the brain’s stress response system. Such alterations in gene regulation in response to experience are a part of a process called “epigenesis.”<sup>22</sup> This HPA neuroendocrine axis, along with the autonomic nervous system (regulating such things as heart rate and respiration) and the neuroimmune system (regulating the body’s immunological defense system), are ways in which the function of the brain and body are intricately intertwined. When we see that social interactions directly shape the ways in which these integrative processes function, we can see how relationships and the embodied brain are really part of one larger system. As we’ll soon discuss, too, the subjective states experienced in awareness, such as an open, receptive state of presence versus a reactive state of fight–flight–freeze–faint, can have direct impacts on the overall health of body and relationships.

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Relationships and the embodied brain are really part of one larger system.

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### Central Brain Structures

The more centrally located areas, which traditionally have been called “limbic regions”—including the clusters of neurons called the “hippocampus” and “amygdala”—are thought to play an important role in mediating emotion, motivation, and goal-directed behavior, as well as in the integration of memory and the engagement of an attachment system that enables mammalian young to depend on their parents for safety and security. Limbic structures permit the integration of a wide range of basic mental processes, such as the appraisal of meaning, the processing of social signals, and the activation of emotion. This region houses the medial temporal lobe (toward the middle of the brain, just to the sides of the temples), including the hippocampus, which is thought to play a central role in flexible forms of memory (e.g., in the recall of facts and autobiographical details) and in identifying the context of an ongoing experience.

### Upper Brain Structures

The “upper structures” toward the top of the brain, such as the cerebral cortex (sometimes called the “neocortex”), mediate more complex information-processing functions such as perception, thinking, and reasoning. While we can use the term “mediate” to indicate that these areas play a crucial role in this process, it is important to recall the preliminary comments we discussed, that the networks of the brain function as whole to create global brain states of activation that have a connectome harmonic of oscillations. So although we sometimes state that cortical structures may mediate these brain states, this

does not mean that they carry out this function in isolation.<sup>23</sup> There are many interconnecting linkages between the cortex and other regions of the brain, as well as essential inputs from the body and the relational world—our interconnections with other people and the environment.

This “outer bark” of the brain consists of highly folded layers, usually about six cellular layers deep, that are filled with “cortical columns” of highly linked neuronal clusters. The grouped columns process information, and their communication with other columnar areas allows increasingly complex functions to emerge. In general, the cortex matures from back to front, with the frontal regions continuing active growth well into young adulthood. These frontal neocortical areas are considered to be the most evolutionarily “advanced” in humans; they mediate the complex perceptual and abstract representations that constitute our associational thought processes.

The frontmost part of the frontal neocortical region—the “prefrontal cortex”—has two important aspects: the ventral and medial zones, and the lateral prefrontal cortex (also known as the “dorsolateral prefrontal cortex”). The dorsolateral prefrontal cortex rests to the sides (thus “lateral”). It is thought to play a major role in working memory—placing something on the chalkboard of the mind to dial a phone number, for example—and the focusing of conscious attention. The middle portions of the prefrontal area include the orbitofrontal cortex (just behind and above the orbits of the eyes), the dorsal and ventral aspects of the medial prefrontal cortex, the ventrolateral prefrontal cortex, and the anterior cingulate cortex. Some authors consider the anterior cingulate and the orbitofrontal regions as part of the limbic area, whereas others recognize the interface role these regions play between the lower limbic and the higher cortical areas and refer to them at times as the “paralimbic cortex.” In this manner, the middle prefrontal regions can be seen, in fact, as the uppermost parts of the limbic system as well as a part of the frontal lobes of the neocortex. These bridging areas form a “team” of prefrontal regions that work together as a functional whole to link widely separated areas to one another. They have important integrative functions that help coordinate and balance cortical activity of thought and feeling with the functions of the lower limbic, brainstem, and bodily areas. As we’ll soon see, the medial prefrontal region is connected to the posterior cingulate cortex to form the central or midline hubs of something called the “default mode network,” or DMN.<sup>24</sup> Participating in many functions, this primarily midline network, front to back, is active while an individual rests in a scanner before given any instructions, and so this is the “default mode” of neural activity. It turns out that our brains are quite active even when “at rest.” One set of processes carried out by the DMN is to make maps of mental states. The DMN makes it possible for us to map the mental states of others in a process called “empathy” and to map our own mental state with insight. When this DMN is excessively differentiated, as in a state of anxiety or depression, it may be conceptualized as an example of impaired integration with this loss of balance between differentiation and linkage. But when integrated well into the overall

system of the individual, the DMN plays a flexible role in considering the mental states of other individuals and the inner self, without excessive preoccupation and with insight and empathic understanding and concern. Overall, these mostly midline default mode regions link the perception of communication signals from other people to the internally mediated neural firing patterns, creating a wide spectrum of integration ranging from the somatic to the social.

## Neural Integration

The brain as a whole functions as an interconnected and integrating system of subsystems that can be described as circuits or networks. “Interconnected” means that the long axonal fibers link widely separated clusters of neurons to each other in a spiderweb-like configuration. “Integrated,” as we’ve discussed, used in this very specific way means that these separate, differentiated areas maintain their unique features while also becoming linked. It’s crucial to keep in mind that integration, used in this way as a term, does not mean becoming blended or “all one,” but rather involves the *maintenance of differences while facilitating connection*. This balance is truly the means by which the whole is greater than the sum of the parts. The linkage of differentiated parts of a system is the meaning of integration, as we have defined it, and when it occurs in the brain, we call this “neural integration.” The outcome of neural integration is optimal self-regulation with the balancing and coordination of disparate regions into a functional whole. One perspective is that this neural integration creates the complexity of criticality between chaos and rigidity; it creates the metastability at the heart of flexible executive functions mediated by the brain. Although each element of such a system contributes to the functioning of the whole and the interaction of networks distributed across a wide range of neural clusters, certain regions can be seen to play an important role in integrating brain activity. These include the classically named “limbic” areas (especially the hippocampus), the prefrontal regions, the corpus callosum (which links the left and right sides of the brain to each other), and the cerebellum (which plays a role in linking bodily motion, mental states, and cognitive processing). All of these areas have unique and extensive input and output pathways linking widely distributed areas in the brain. Studies of the connectome can also be carried out to assess the “interconnectivity of the connectome,” a state of the linkage of differentiated areas at the heart of neural integration. When we look to understand how the mind develops, we need to examine how the brain comes to regulate its own processes. Such self-regulation appears to be carried out in large part by the process of neural integration that may depend on these and other integrative circuits.

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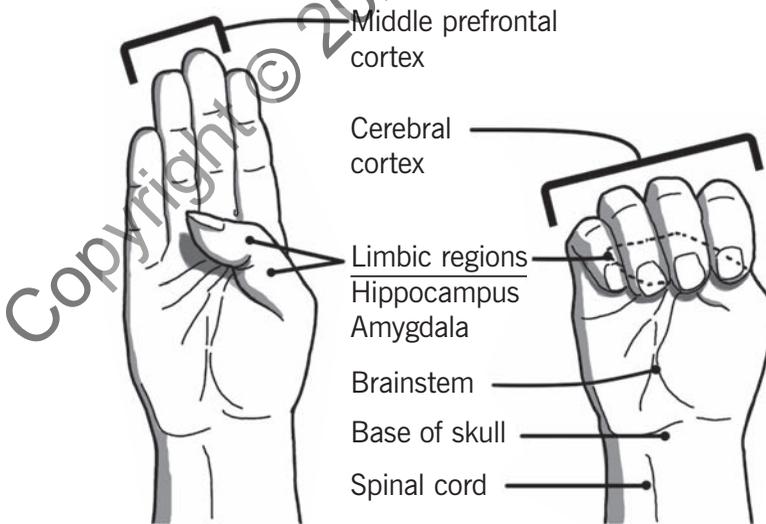
Self-regulation appears to depend upon neural integration.

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To summarize this point succinctly, self-regulation, in the form of a range of executive functions, appears to depend upon neural integration. Such

primacy of this state of integration in the brain is revealed in the discovery that a vast set of measures of well-being was correlated with one common finding in the brain: a more interconnected connectome.<sup>25</sup> As we'll see, in IPNB we note the consistent finding that optimal relationships that honor differences and promote compassionate, respectful linkages—relationships that are integrative—are likely to stimulate the growth of integrative fibers in the brain of the young child, whereas adverse childhood experiences, including neglectful and abusive relationships—ones that lack differentiation and linkage—specifically inhibit the healthy growth of the brain in the form of neural integration and may negatively influence the capacity to deal effectively with stressors in the future.<sup>26</sup> Even impairments to health that are not experientially derived, such as with individuals with autism, bipolar disorder, or schizophrenia, have now been shown to reveal impairments to neural integration.<sup>27</sup>

To gain a visual grasp of some of this brain structure, it may be helpful to use a readily available three-dimensional model. It will enable you to have neuroanatomy in the palm of your hand, so to speak (see Figure 1.2). If you make a fist with your thumb bent toward the center of your palm, and your fingers curled around it and resting on the lower part of your hand, you'll have a model of the brain. Your lower arm represents the location of the spinal cord inside the backbone, and your wrist is at the base of the skull. The various parts of your hand represent the three major regions discussed above: brainstem, limbic (central), and neocortical (upper) areas.



**FIGURE 1.2.** Hand model of the brain. Adapted from Siegel (2010a, p. 15). Adapted with permission from Bantam Books. Copyright © 2012 Mind Your Brain, Inc.

Although the old three-part model of the brain is no longer considered complete or accurate, it does provide a useful initial way of diving into the anatomy of the brain if the model's limitations are acknowledged from the outset. Please keep in mind that the dynamic functioning of this ever-changing organ is far more complex than a simple model made by your hand. Nevertheless, having a "handy" starting place can be quite useful if seen as just a model. If you look directly at your fist from the palmar side, the orbits of the eyes emerge around the areas of the fingernails of your third and fourth fingers. The ears extend from either side of your fist. Your fingers represent the neocortex. Facing you are its frontal lobes; at the top are the neocortical areas that mediate motor control and somatosensory representations; to the sides and back of your hand are the posterior parts, such as the temporal lobe of the cortex, which generally mediate perceptual processing of the outside world but also play important roles in social perception. The lower parts of the brain are represented by the midline portion of your lower palm. Just below your knuckles, deep inside your fist where the end of your thumb rests, is the limbic region. Most of the brain is split into the left and right hemispheres, which are connected with bands of tissue called the "corpus callosum" and the "anterior commissures," thought to serve as direct sources of information transfer between the two sides of the brain. The cerebellum, located at the back of your hand near its connection to your wrist, may also indirectly transfer information across the division that separates the two halves of the brain. The cerebellum itself may carry out a number of informational and integrating processes.

The areas of your fist jutting out from the front of your palm are the frontal lobes, beginning from your second knuckles forward to your fingernail areas. The very front of this anterior region, in front of the last knuckles, is the prefrontal cortex—an area we will be exploring throughout the book. The lateral prefrontal cortex rests to the sides and is represented by your index finger on one side and your fifth finger on the other. On your fist model, the more centrally located orbitofrontal area lies, as you may have guessed, just behind and above the orbits of the eyes, especially where your last knuckles bend and the tips of your fingers push inward toward your palm. These middle two fingernail areas in your hand model also symbolically represent the related ventral and medial zones of this midline prefrontal region. Notice on your hand model that these middle two fingernail areas, representing the position of the middle portion of the prefrontal region, are adjacent to a number of areas from which they receive and to which they send information: the deeper structures of the brain that process sensory and bodily data, the limbic areas, and the neocortex just above it. This three-dimensional hand model thus gives you a direct experiential/visual example of neural interconnections and the relevance of anatomy for coordinated function.

The brain is highly interconnected, and controversy exists in academic circles about how distinct these regions actually are in anatomy and function.<sup>28</sup> The notion of a limbic "system," for example, has been challenged,

because defining its limits (where it starts and where it ends) has been scientifically difficult to accomplish. Nevertheless, the limbic and paralimbic regions appear to utilize specific neurotransmitters, to have highly interconnected circuitry, to carry out complementary functions, and to have similarities in their evolutionary history. For example, the middle areas of the prefrontal regions, sitting at the top of the limbic area and anatomically connected to a wide array of circuits in the neocortex and the deeper structures of the brain, carry out a vital role in the coordination of the activity from all three regions.<sup>29</sup> As we shall see, recent studies from neuroscience suggest that this prefrontal region may play a major role in many of the integrating processes we will be examining, such as self-awareness, empathy, memory, emotion regulation, and attachment.

### Brain Development

The activation of neural pathways directly influences how connections are made within the brain and how the regulation of genes is altered. Though experience shapes the activity of the brain and the strength of neuronal connections throughout life, experience early in life may be especially crucial in organizing the way the basic regulatory structures of the brain develop. These include, as suggested earlier, the integrative fibers of the brain. For example, traumatic experiences at the beginning of life may have profound effects on the integrative structures of the brain, which are responsible for basic regulatory capacities and enable the mind to respond later to stress.<sup>30</sup> Thus we see that abused children have abnormal responses of their stress hormone levels, which are in part due to changes in the regulation of the genes in these areas of the brain responsible for reacting to stress—and may be also associated with alterations in the regulation of telomere length, the caps of the chromosomes that protect the integrity of the DNA during cellular replication.<sup>31</sup> Cortisol in sustained and elevated levels can become toxic to the brain.<sup>32</sup>

As the Adverse Childhood Experiences (ACEs) study reveals, early adversity has long-lasting impacts on the individual, leading to effects not only on mental functioning, but on medical health as well.<sup>33</sup> The essential take-home messages here are that early experience shapes the regulation of synaptic growth and survival, the regulation of response to stress, the regulation of

Early experience shapes the regulation of synaptic growth and survival.

telomere length to protect cellular health, and even the regulation of gene expression that might impact inflammation as

well as the future growth of the brain. Adverse interactions with others negatively impact these regulatory features of the body. Experience directly shapes regulation.

As journalist Donna Jackson Nakazawa suggests in her book *The Angel and the Assassin*, focusing on one type of glia cell, the microglia,<sup>34</sup> research has shown that the microglial cells function as part of the immune system and have both an inflammatory role and a constructive function in the brain:

These tiny little cells have a bright side too. When the brain is in a state of homeostasis—in other words, when microglia aren't being triggered to misbehave—they get active in a completely different, positive way. In a healthy brain, microglia secrete nutrients to stimulate new, healthy neurons to grow and create brand-new synapses, wherever they might be needed, to help mend the brain. They even release neuroprotective factors involved in repairing sick neurons.

In fact, microglia can directly help neurons to reach out and form new neuronal projections—a little like growing a new appendage—and these new growths can then clamp on to other neurons, thus increasing and strengthening brain connectivity.

Microglia, along with other types of glial cells, also foster the growth of myelin, which insulates fibers in the brain, helping to speed up synaptic connections. And one of the most active areas where microglia do such repair work is in the brain's hippocampus.<sup>35</sup>

In her interview of neuroscientist Beth Stevens, Jackson Nakazawa reports:

“Microglia have so many good roles if they are balanced just right,” Beth underscores. “When they are in a state of homeostasis, they release signals that spew out all these different proteins and good chemicals that are protective. They actually try to stop the process of synapse loss.

“But the minute that microglia perceive a change, or somewhere that something tiny goes wrong, or a big thing goes wrong, they can stop emitting good, protective neurochemicals and spit out neuroinflammatory chemicals that harm the brain. And that can cause another kind of damage, in addition to synapse loss: runaway inflammation. If something shifts, microglia can get pushed into a pro-inflammatory state and begin releasing a lot of cytokines, making them one of the biggest producers of inflammatory chemicals in the brain.”<sup>36</sup>

New discoveries in the role of our microglia cells will undoubtedly shed light on many dysfunctions of the brain and the developing mind that before were mysteries. The central role of glia in the larger function of inflammation in the body invites us to consider the whole of an individual's life, including both the biome composition of the intestine and the role of cultural factors, such as exclusion, that cause profound stress in our individual and collective lives. Inflammation, and the stress and other factors that may cause it, need to be assessed in relation to the impact of neurons and glia in the flow of energy and information of the embodied brain.

More common, everyday experiences also shape brain structure.<sup>37</sup> The brain's development is in part an “experience-dependent” process, in which experience activates certain pathways in the brain, strengthening existing connections and creating new ones.<sup>38</sup> Development is also in part “experience-expectant,” in that genes instruct specific circuits to be created, such as the visual system, but that maintenance of those synaptic linkages requires stimulation from species-general experiences, such as receiving light to the retina

of the eyes and activating the visual cortex or hearing sound to stimulate the acoustic nerve and auditory centers in the brain. Lack of sensory experience can lead to cell death for these circuits in a process called “apoptosis,” or to the diminution of synaptic connections in a process called “parcellation” or “pruning.” This is sometimes referred to as the “use-it-or-lose-it” principle of brain development. Whether experience-expectant or experience-dependent development is occurring, synaptic connections are maintained by ongoing neural firing that is created through experience. When considering what “experience” means, then, thinking of neural activation is one simple perspective that can help us understand how “experience is biology” in that it shapes the activity and structure of the embodied brain.

For this reason, I often remind adoptive and foster parents who often state that they “are not the biological parents” to consider a different viewpoint: They may not be the *birth* parents who provided gametes and carried the child in the womb, but they are in fact the biological parents in that the relationship they provide creates the interactive *experiences* that are the biological foundation for the developing mind.

An infant is born with a genetically programmed excess of neurons, and the postnatal establishment of synaptic connections is determined by both genes and experience. Genes contain the information for the general organization of the brain’s structure, but experience plays an important role in determining which genes become expressed, how they will be activated, and the timing of that activation. The expression of genes leads to the production of proteins that enable neuronal growth and the formation of new synapses. Experience—the activation of specific neural pathways—therefore directly shapes gene expression (i.e., “epigenesis”), and leads to the maintenance, creation, and strengthening of the connections that form the neural substrate of the embodied brain’s contribution to the energy flow of the mind. In epigenesis, the sequence of DNA in a chromosome does not change, but the molecules that control gene expression do. Early in life, interpersonal relationships are a primary source of the experience that shapes how genes express themselves within the brain. Changes in epigenetic regulation of gene expression induced by experience can be long-lasting and may even be passed on to the next generation by way of the alterations of epigenetic regulatory molecules in the sperm or egg.<sup>39</sup>

It may be helpful to briefly outline the origins of the nervous system in our embryological history. Sperm and egg combine to form the conceptus, the single cell origin of life. With cell division, the one cell becomes two, two become four, four into eight, eight into sixteen—until soon a special moment occurs in which differentiation of these cells anatomically occurs when some cells in this growing spherical being are on the outside, some on the inside. This outer layer, the ectoderm, will become our skin encasing. One zone of the ectoderm invaginates to form the neural tube, folding inward, and becoming the origins of our nervous system. The fundamental role of the skin as the interface of the inner and outer world, can be seen also as the key function of the nervous system. In fact, neural cells can be considered “fancy skin

cells” whose job as a system is to link the inner world of the body with the outer world of our relationships with people and the environment around us. When we consider the brain in the head as part of this interconnecting system of inner bodily processes with outer relational connections, we can see how relationships and the brain shape who we become. We can also see here how the dynamic of differentiation of cellular function and structure and the linkage of these fundamental elements into a larger system—the integration of the body—is at the very start of our lives the foundation for how we emerge into being. Integration is at the heart of our origins.

At birth, the cortex of the infant’s brain is the most undifferentiated part of the body. Genes and early experience shape the way neurons connect to one another and thus form the specialized circuits that give rise to mental processes. The basic architecture in the brain is laid down in these early years. The differentiation of circuits within the brain involves a number of processes, including these:

1. The growth of axons into local areas, and the development of axonal connections among widely distributed regions.
2. The establishment of new and more extensive synaptic connections between neurons in certain regions, and the possible growth of new neurons in areas such as the hippocampus.
3. The growth of myelin along the lengths of neurons, which increases the speed of nerve conduction by one hundred times and reduces the refractory period, during which a just-fired neuron must rest before firing again, by thirty times. Thus myelin functionally enhances the linkage among synaptically connected nerve cells by three thousand times.
4. The modification of receptor density and sensitivity at the postsynaptic “receiving” cells, making connections more efficient with either excitatory or inhibitory effects.
5. The balance of all these factors with the dying away or pruning of neurons and synapses resulting from disuse or toxic conditions such as chronic stress.

In experimental animals, enriched environments and exercise have been shown to lead to increased density of synaptic connections, and especially to an increased number of neurons and actual volume of the hippocampus, a region important for learning and memory.<sup>40</sup> Experiences also lead to increased activity of neurons, which enhances the creation of new neurons and the growth of new synaptic connections or the strengthening of existing synapses. This experience-dependent brain growth and differentiation is thus referred to as an “activity-dependent” process.

One way of remembering this process is with a saying that captures the connection between the mind’s focus and the brain’s response: “Where attention goes, neural firing flows, and neural connection grows.”<sup>41</sup> In this way, the mental focus of attention stimulates the activation of particular circuits in the

brain that, under the proper circumstances, can lead to protein production, the growth of synaptic connections, and myelin production, enhancing the effective connectivity of neurons. Here we can see how the internally motivated focus of attention or the externally driven focus of attention can each directly impact the structure and function of the brain. Attention is a mental process—one that is both embodied and relational—and has been shown to impact the anatomy of our neural structures.<sup>42</sup>

Studies suggest, too, how gene expression is altered following experiences.<sup>43</sup> The fundamental mechanism of epigenesis is that neural firing can lead to the “turning on” or “expression” of genes that enable protein production. Protein production in turn creates structural changes, allowing neurons, for example, to form new synaptic linkages or to strengthen existing ones. Experience can also induce changes in the molecules on the chromosome that do not code for protein synthesis, but instead function to regulate the expression of the adjacent gene. Epigenetic changes induced by experience alter how and when genes are expressed, and thus have a powerful impact on neural connections. Studies are now beginning to reveal the important means by which we may have embedded in our own nuclear material the ways in which our parents—and even our grandparents—experienced stress, underwent alterations in their epigenetic control mechanisms, and then passed these changes on to us via the gametes from which we were formed.<sup>44</sup> There are profound implications of these new findings for our understanding of development and the emergence of patterns of growth, temperament, and other inborn qualities of nervous system functioning, and the intergenerational transmission of stress and trauma.

Interpersonal experiences continue to influence how our minds function throughout life, but the major structures—especially those that are responsible for self-regulation—are initially formed in the early years. As proposed

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earlier, *regulation emerges from integration*. And for this reason, it will be helpful to keep a close eye on unfolding research that may continue to reveal how

interpersonal experience shapes the growth of the integrative regulatory circuits of the brain. The essential proposal is that integrative communication stimulates the healthy growth of integrative fibers in the brain. Given the view that integration enables regulation, we will look closely at the early years of life to understand the ways in which the mind develops and comes to regulate its own processes through interactions with important caregivers. This notion helps us see the importance of viewing the mind as having both an embodied and a relational aspect; each influences the other as part of one self-organizing mind. These interactions of the embodied and relational mind do not end in childhood. New findings on the study of neuroplasticity reveal that the brain is open to further development throughout the lifespan.<sup>45</sup> From studies of early interpersonal experience, we can try to understand how relationships may continue to foster the development of the mind throughout life.

## Mind and Brain: Information Processing and Neurobiology

We've proposed that mind has at least four facets: subjective experience, consciousness, information processing, and self-organization. If the broad proposal that what we mean by "mind" is an emergent phenomena of the complex system of energy flow—emergence being a mathematically established, empirically supported property associated with complex systems as their elements interact with one another—then we might consider that each of these four facets of mind may arise from the flow of energy. In this view, "*information*" is a *pattern of energy with symbolic value*. In a way, this is "energy in formation" that *re*-presents the world in a new form, a representation that can serve as the underlying mechanism beneath a category, concept, or linguistic symbol. The word "knowledge," for example, means more than just the squiggles of letters comprising the linguistic symbol. There is a concept and a category or "stuff" beneath that linguistic term. And this set of photons, this pattern of energy of "k-n-o-w-l-e-d-g-e," stands for something more than the pattern of light energy, with those letters strung one after the other, or the pattern of sound spoken aloud, by themselves. This is how *energy in formation* is what we mean by "information."

Information processing or "cognition" can be seen as an embodied, enacted, extended, and embedded process.<sup>46</sup> While energy is generally not named or discussed in this perspective, from this philosophical view, mental processes and the mind in general, whatever they might be, are seen broadly as being more than just brain activity. "Embodied" means that we live in a body and, from an IPNB perspective, can be seen to have flows of energy within us. "Enacted" means that we carry out actions that contain information and influence it, such as using terms like "grasping" something or "understanding"—meaning, reaching for something and holding it, or standing under something. We also "extend" information beyond our body and its actions; we read a book like this one and hear or see its information arising from another mind outside our bodily identity. And we live in a culture in we are "embedded" in information processing. Within interpersonal neurobiology, we would take this consilient perspective and suggest that this information processing is emerging from energy flow patterns. In these important ways articulated by this philosophical view, the information-processing facet of the mind is not just in our heads. We can simply describe it as being fully embodied as well as fully relational. With this in mind, let's focus on how we can think about information processing and its relationship to one important aspect of mind: the energy and information flow within the brains in our heads.

From an information-processing perspective, brain anatomy and neural circuit functioning can be understood as follows. Signals consisting of electrochemical energy flow patterns from the brain's deep structures represent physiological data from the body. They are received and processed by what have traditionally been called the centrally located "limbic" structures. More elaborately processed data from the activities of the limbic region itself are

integrated by the adjacent paralimbic areas, including the orbitofrontal cortex and anterior cingulate. Another prefrontal circuit, the “anterior insula” (which is considered to be a portion of the ventrolateral prefrontal cortex), receives direct input from the body as well. These areas send emotional and somatosensory input to the neocortex, which also processes perceptual representations via the thalamus and the sensory cortices, conceptual representations from the associational cortices, and linguistic representations from the language-processing centers. In one view, information processing links input from various regions by way of integrative circuits, such as the associational cortices and prefrontal cortex, which take in the different neural “codes,” coordinate the information contained within these signals, and “translate” them into transformed neural activity. The transformed information is then sent as output to the various regions. Such neural translation of the various forms of representations allows for information to be both processed and then communicated in different codes to the relevant regions. This translation process allows for a type of neural integration of complex information within the brain and yields highly complex neural output and mental capacities.<sup>47</sup>

Here is an analogy: We can transmit information in an electronic mail message containing the twenty-six letters of the alphabet, spacing, and a handful of punctuation marks. This email is transmitted as energy flow through cables or the air. The energy flow is then translated back into information—its symbolic value as letters, spacing, and punctuation marks. Through the same wires, we can send an entire photograph or even a video. Though the message contains different information (note, photo, video), the fundamental medium in which the data are transmitted is identical—electrical impulses flowing as patterns of energy through a wire of a cable, or through the air for WiFi. The information contained within the different messages varies in its patterns and its complexity. Without the proper receiving device to translate these electrical impulses into words, pictures, or video, the complex representation has no meaning. This mishmash will happen if you open a .pdf file with a word-processing program. You will find symbols that make no sense. Energy will abound on your computer screen, but the pattern of that energy will be indecipherable. It will have no informational value; it will not be symbolic of something other than being a mess of squiggles on a screen. If I spoke to you in Greek and you did not know that language, you would receive the energy, but it would not have informational value for you. Information is in the eye and ear of the beholder.

The same principle is true with the brain. Neural activity is the fundamental form in which energy flows and then information can be transmitted. This electrochemical energy flow consists of action potentials with ions moving in and out of the membrane, release of the chemical neurotransmitters, and chemical activation of the downstream receptors. The sending area is capable of transmitting a certain kind of information as neural codes. The receiving circuits or systems must be capable of processing such signals for them to have any meaning; in other words, they need to stand for something

that is useful beyond just the neural firing itself. The brain is genetically programmed to be able to differentiate its regions, which carry different forms of sending and receiving information—swirls of energy flow that stand for something other than merely neural firing patterns. These forms vary in pattern and complexity from the most “simple” signals of the deeper structures (such as heart rate) to the more complex ones of the neocortex (such as ideas about freedom or about the mind itself).

Experience serves not only to activate the energy flow to these regions; it is also necessary for the proper development of the brain itself. Experience-expectant and experience-dependent maturation are a part of even the basic sensory systems of our brains. The brain must “use it or lose it” in many cases of brain specialization. For example, studies in animals reveal that the lack of exposure to certain types of visual information, such as vertical lines, during a critical period early in life leads to loss of the capacity for perceiving such lines later in life. Specific forms of experience are necessary for the normal development of information-processing circuits in the visual cortex.<sup>48</sup> As discussed earlier, this has been called “activity-expectant” development, in that genetically created circuits “expect” exposure to minimal inputs (light or sound) to maintain those pathways. The same process may occur for other systems in the brain, such as the attachment system. Children who have had no experience with an attachment figure (not merely suboptimal attachment, but a lack of attachment) for the first several years of life may suffer a significant loss of the capacity to establish intimate interpersonal relationships later on.<sup>49</sup> Even the ability to perceive the mental side of life may require interactions with caregivers in order to develop properly.<sup>50</sup>

In this way, we can reexamine one of our initial questions: How does experience shape the mind? A general principle can be proposed here: *Experiences can shape not only what energy and information enter the mind, but also how the mind processes that information.* To “process” here means to make meaning out of energy flow patterns, to create symbolic value out of swirls of neural firing patterns. How this meaning-making occurs can be seen as the modification of the actual circuits of the brain responsible for processing that particular type of information. If you don’t speak Greek, you won’t know what “*glicanera*” means. Experience creates representations, as well as stimulating the capacity for specific forms of information processing. This is how learning occurs.

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### The Brain as a System and as Part of a Larger System

The brain can be considered as a living system that is open and dynamic. It is also a part of a larger system. Its integrated, component subsystems interact in a patterned and changing way to create an irreducible quality of the system as a whole.<sup>51</sup> Furthermore, the brain is a complex system, meaning that

there are multiple layers of component parts that are open, capable of chaotic behavior, and nonlinear—meaning small inputs at one point in time can lead to large and difficult-to-predict outcomes of those inputs.<sup>52</sup> These parts can be conceptualized at various levels of analysis and include the single neuron and its sending and receiving functions, neuronal groups, circuits, systems, regions, hemispheres, and the whole brain within the skull. This skull-based neural collection is also intricately interconnected with an array of neural, immune, endocrine, metabolic, cardiovascular, gastrointestinal, and musculoskeletal processes in the rest of the body. When we add to this that the brain is a “social organ” and takes in the neural signals from other brains, we can see that viewing the “brain” as limited to the skull makes no biological sense. It is “bio-illogical” to view component elements of a whole as isolated from one another.

Examining the brain in context, we can temporarily tease apart its many layers of input and output to get a glimpse of how the parts make up the whole. The basic components, the neurons, are the simplest. While the four types of supportive glia cells are smaller and more numerous, their important role in neural systems is often not highlighted when focusing directly on the structural and functional architecture of the brain itself. Instead, the basic neuron serves as the fundamental “building block” or unit of brain structure and function. As we move up the levels, the units become more and more elaborate. Some authors use the terms “lower-order” to refer to the basic level of organizational unit and “higher-order” to refer to the more intricate level of organization. For the most part, each subsystem can be considered to have both lower and higher orders of systems with which it relates. For example, the activity of the visual cortex is made up of the lower-level input from the eyes, but itself contributes to the higher-level processing of the entire perceptual system.<sup>53</sup>

A living system must be open to the influences of the environment in order to survive, and the brain is no exception. The system of the brain becomes functionally linked to other systems, especially to other brains. The brain is also dynamic, meaning that it is forever in a state of change. An open, dynamic system is one that is in continual emergence with a changing environment and the changing state of its own activity. From the point of view of the brain as an open system, each region may take in unique input from outside itself. Certainly we have input from outside our bodies as we receive signals from other people and engage in interactions with the world. Within the body, the nervous system receives input from the many physiological processes mentioned above. As Antonio Damasio has noted, the purpose of the nervous system is to regulate the complex processes of the body.<sup>54</sup> As discussed above, the embryonic origin of the nervous system itself, as coming from what initially were ectodermal cells—the layer destined to become the skin that encases the body and forms the boundary of inner and outer—reveals that our neural tissue is always about linking this inner bodily world with the outer world.

It is quite natural, from this developmental perspective, to see the brain as part of both a fully embodied *and* relational “system.” A system is simply

a collection of interacting elements. In this way, we need to keep in mind that the brain is a node—an important interconnecting part of a complex system—that links input from the relational and the embodied world. The world of what? The world of energy flow: energy flows within the body, and within our connections to other people and the world around us. We are connected “internally” to energy flow *inside* our skin-encased bodies; we are interconnected “externally,” outside of these bodies, to people and the planet. To isolate one element of that larger system from the others loses sight of the larger whole in which we—who we are and how we develop—emerge throughout our lives. Knowing how the various components of this larger embodied and relational system that comprise who we are interact with each other helps us deepen our understanding of the self and the mind from which it arises.

The deeper structures of the skull-based brain receive sensory input from the body and from the external world; the limbic region receives input from the deeper structures and from the neocortex; and the neocortex receives data from the limbic area, the brainstem, and the body itself. Neuroanatomic studies reveal that the neocortical regions are also intricately interwoven with the “lower” levels of the system, and thus that our “higher thinking” is actually directly dependent upon activity of the entire brain, and indeed the entire body.<sup>55</sup> The regions that balance and coordinate the states of activation of the brain’s subcomponents play an important role in the regulation of the body and emotions. It is an important and fascinating finding that those regions, such as areas of the prefrontal cortex, that serve to regulate internal states are also integrative in their functions and in their structural connections. As stated earlier, this integrative linkage of differentiated areas of the nervous system may be the fundamental mechanism underlying regulation. Integration is how the nervous system becomes coordinated and balanced. This is the outcome of the integrative circuits of the brain that perform such a regulatory function.

The field of complex systems theory derives from the probability field of mathematics.<sup>56</sup> From this perspective, as we’ve mentioned earlier, a complex system is said to have a “self-organizing” property that emerges in the interaction of elements of the system. *I am proposing in this book that the emergent process of energy and information flow within bodies and within relationships is one important facet of “the mind.”* This embodied and relationally embedded process is regulatory, in that it self-organizes the movement of energy and information flow within bodies and among people interacting with one another. Given that the system of mind we are proposing is not limited by skull or skin, the potential conclusion that there is a “dual” nature of divided, separate locations of mind—within the body and between the body and the world around it—is actually an illusion, an inaccurate perception. Mind can be one entity, and the “within-ness” and “between-ness” of energy and information flow enable us to see how one process can be both inner and inter.

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The emergent process of energy and information flow within bodies and within relationships is one important aspect of “the mind.”

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Does the self-organizing emergent property that derives from complexity theory overlap with “self-regulation,” a primary focus in the field of psychopathology? If so, this may be a conceptual bridge linking two independent fields. One implication of this possible overlap is that “impairments to self-regulation” suggested by the field of developmental psychopathology as central to mental dysfunction may be fundamentally “impairments to self-organization.” And if self-organization moves the system to the most flexible, adaptive, and harmonious states with integration, then perhaps self-regulation, too, is dependent on integration. This is the basis of the proposal being made here that regulation comes from integration. And now we can state the notion that dysregulation comes from nonintegrated functioning. Given that integration produces harmonious and flexible functioning and that impairments to integration yield chaos, rigidity, or both, we can predict that dysregulation will result in this pattern of dysfunction. Indeed, the DSM-5’s entire listing of psychiatric disorders, however meaningful or not those classifications might be as they are categorized, can be reframed within this perspective as revealing chaos and/or rigidity, and so as reflecting impaired integration. Recent studies in trauma<sup>57</sup> and in neural functioning in the non-task-performing default mode or “resting state”<sup>58</sup> support this proposal that impaired integration is the common mechanism among disorders of health, whether they have primarily experiential or nonexperiential (e.g., genetic, toxic, infectious, or random) origins. And as we’ve mentioned earlier, studies of the connectome reveal that an interconnected connectome is the most robust predictor of well-being.<sup>59</sup>

Another implication is that the basic process we call “emotion” is actually an aspect of this self-organizing emergent property reflecting *changes in states of integration*. If this is true, it makes our emotional lives fundamental to our minds. For example, some suggest that emotions, generated and regulated by the activity of the subcortical areas—those beneath the cortex—are integral parts of our neocortically derived “rational thoughts” as well as the overall functioning of our minds.<sup>60</sup> The cortex, though, plays a major role in how we construct meaning from the experience of emotion.<sup>61</sup> Furthermore, the “regulation of emotion” may be dependent on large-scale integrative processes—ones that emerge from throughout the embodied brain, including the integrative role of the prefrontal cortex in coordination and balance of homeostatic processes; as well as from interpersonal experiences within one-on-one relationships, families, communities; and even the larger culture and our connections with nature. Emotion and meaning emerge from both inner and inter influences on the flow of energy and information in our lives. Relationships that are attuned—ones that honor differences and cultivate compassionate connections—are integrative relationships that promote health. We even sometimes call these “emotional relationships” and make comments about “an emotionally healthy connection” between two people. We can propose that this phrase is referring to the patterns of communication in that relationship that are promoting integration.

These issues also suggest that specific circuits within the brain may function as somewhat distinct “subsystems” that create their own predominant states of processing. For example, the left and right sides of the brain have distinct circuits that become predominant early in life, even in the embryo. Each of these pathways has its dominant neurotransmitters and involves distinct evaluative components that serve to direct each hemisphere to process information in distinct manners. How each hemisphere is activated directly shapes our subjective sensations and the ways in which we communicate with others. Naturally, we need to be skeptical about oversimplifying reality and also to remain cautious of overgeneralizations, but (as we’ll see) distinct patterns that have emerged through millions of years of evolution support the notion that the two sides of the brain are specialized in their neural functions even if many of the networks on both sides of the brain interact with one another.<sup>62</sup> Again, integrating the two differentiated sides of the nervous system appears to support healthy growth and development.

The broader “system” view is of energy and information flow; we can detect its integrative quality by the presence of harmony or its impediments via chaos and/or rigidity. Integration, in relationships and in the embodied brain, is the substrate for well-being from this perspective. Integration can be seen as a deep mechanism that enables us to gain insight into both synaptic and societal connections and how they impede or promote the development of a healthy mind. The principles of integration become our guiding framework, whatever level of micro- or macroanalysis we utilize.

In examining issues of health and the unhealth of the mind, it may be a useful place to start in considering integration as an underlying mechanism of well-being. Impediments to health would be revealed as chaos and/or rigidity in various manifestations and combinations. Such “unhealthy” states would emerge when differentiation and/or linkage were out of balance, with too much or too little of either one. Therapeutic interventions would focus on “domains of integration”<sup>63</sup> (discussed in detail in Chapter 10) that can help identify which area in a person’s life may be nonintegrated and then how to promote the growth of a balance in differentiation and linkage. Outcome measures, too, might examine reduction in chaotic and rigid states in subjective experience and relational connections; brain studies would look for both structural and functional ways of assessing differentiation and linkage in the brain. In these ways, the mind’s subjective experience as well as its relational and embodied sources would be the focus of evaluation, treatment, and assessment of the emergence of integrative states of well-being.

## **Genes, Epigenetic Regulation, and Experience**

In an era when science is enabling us to understand human experience in new ways, it is important to examine the common debate about how much of development and personality can be attributed to “nature” or genetics, as opposed to “nurture” or experience. Misinterpretations of genetic studies

have led to beliefs such as “parents have no effect on their children’s development.” It is certainly true that temperament and other constitutional variables play a huge, and perhaps previously under-recognized, role in child development.<sup>64</sup> However, riding the pendulum swing of “What shapes development?” to either the genetics end or the experience end can lead to erroneous conclusions.<sup>65</sup>

A wide range of studies<sup>66</sup> has in fact clarified that development is a product of the effects of experience on the unfolding of genetic potential. Genes encode the information for how neurons are to grow, make connections with each other, and die back as the brain attains differentiation of its circuitry. These processes are genetically preprogrammed as *experience-expectant* as well as experience-dependent and initiated by interactive experience. Genes have two major functions.<sup>67</sup> First, they act as “templates” for information that is to be passed on to the next generation; second, they have a “transcription” function based on the information encoded within their DNA, which determines which proteins will be synthesized. The non-DNA epigenetic molecules on the chromosome—such as methyl groups or histones—directly affect when, which, and how genes are expressed. Transcription is directly influenced by experience. Experience alters the molecular mechanisms that regulate gene expression (i.e., the process of epigenesis) and determines when genes express themselves via the process of protein synthesis. For the brain, this means that experience directly influences how neurons will connect to one another—creating new synaptic connections, altering their strengths, and allowing others to die away.<sup>68</sup>

In other words, genes do not act in isolation from experience. Experience has a long-lasting impact on how we learn, and it directly involves gene expression. In turn, the nature of our genes and of their regulation directly affects how we respond to experience. Genes and experience interact in such a way that certain biological tendencies can create characteristic experiences. For example, certain temperaments may produce characteristic parental responses and may shape how each child responds to parents.<sup>69</sup> These responses, in turn, shape the way in which neuronal growth, interconnections, and pruning (dying back) occur.

The development of the mind has been described as having “recursive” features.<sup>70</sup> That is, what an individual’s mind presents to the world can reinforce the very things that are presented. A typical environmental/parental response to a child’s behavioral output may reinforce that behavior. Therefore, the child plays a part in shaping the experiences to which the child’s mind then must adapt. In this way, behavior itself alters genetic expression and regulation, which then shapes neural connections and their firing patterns, ultimately influencing behavior. In the end, changes in the organization of brain function, emotional regulation, and long-term memory are mediated by alterations in neural structure. These structural changes are due to the activation or deactivation of genes encoding information for protein synthesis. Experience, gene expression and gene regulation, mental activity,

behavior, and continued interactions with the environment (experience) are tightly linked in a transactional set of processes.<sup>71</sup> Such is the recursive nature of development and the way in which nature and nurture, genes and experience, are inextricably part of the same process. Embracing this approach to the nature–nurture issue allows us to stand on scientifically solid ground as we try to understand human development and the growth of the mind. The question isn't “Is it heredity *or* experience?” but “How do heredity, epigenetic changes, *and* experience interact in the development of an individual?”

Genetic studies of behavior commonly note that fifty percent of each personality feature measured is attributable to heredity. The majority of the other half of the variability is thought to be due to “nonshared” aspects of the environment, such as school experiences and peer relationships.<sup>72</sup> But siblings—even identical twins, who are raised by the same parents at the same time—actually have a “nonshared” environment, in that parental behavior is not identical for each child.<sup>73</sup> The recursive quality of mental development magnifies initial individual differences and creates a challenge to the sometimes held opinion that growing up in the same family is a shared (statistically identical) experience. This reminds us that each individual's history reflects an inseparable blend of how the environment, random events, gender, and temperament all contribute to the creation of experiences in which adaptation and learning recursively shape the development of the mind.

Gender-based differences in brain development, in conjunction with cultural expectations, may be a factor in moving development in a certain direction that reinforces itself across the lifespan.<sup>74</sup> However, it is important to avoid conclusions drawn from adult differences that may be due to cultural factors experienced throughout childhood and adolescence. It is essential *not* to assume innate, inborn neural differences between individuals of any status or gender. Excessive judgments about these gender differences can cause an observer to miss the reality that there is a wide spectrum of characteristics beyond the oversimplified male–female terms that tend to categorize our thinking into rigid groupings and limit our perception of what is real. Individuals across the range of gender identity and sexual orientation may have far more variations in their unique life characteristics than the distinctions of “male” and “female” tend to imply without a basis in biological reality.<sup>75</sup>

The intricate interaction of genes, experience, and epigenetic regulation is also revealed in the inheritance patterns of certain psychiatric disorders, such as schizophrenia.<sup>76</sup> In identical twins, who share all of their genetic information, there is slightly less than fifty percent concordance in the behavioral expression of the illness. This implies that many factors determine how a “genotype” (genetic template of information) becomes expressed as a “phenotype” (genetic transcription function leading to protein synthesis and external manifestation as physical or behavioral features). *In utero* factors such as infections and exposure to toxins can influence the early development of the embryonic nervous system in ways that are not dependent upon the genes themselves. Genetic variables may influence vulnerability to a condition such

as schizophrenia, but they may require exposure to such an agent for disease to be induced. Studies of individuals with certain atypical neurotransmitter variants, called “alleles,” reveal observable differences in those individuals only when they are exposed to a severe developmental challenge such as abuse early in life.<sup>77</sup> Those with the atypical variants do extremely poorly in their lives, whereas those with the typical variants are less severely affected. Without the experience of the abuse, the individuals may have no phenotypic difference discernible to an observer. On the other hand, psychosocial stressors of exclusion and maltreatment, poverty and disempowerment in a society within a given culture may create profoundly stressful conditions, making certain individuals at risk, even in the absence of intrafamilial abuse or neglect, for the development of compromises to well-being.<sup>78</sup> Being open to these ways in which stressful experience may impair the growth of integration with or without genetic vulnerability is important in understanding the unique developmental pathways for each individual within the personal and cultural history in which they are developing.

The epigenetic regulation of gene expression may vary even in individuals who share the same genes. Our epigenetic regulation can be inherited through sperm and egg, and we can acquire it through direct impacts of experience.<sup>79</sup> Such regulatory shifts in gene expression can impact how sensitive we may be to stressors. Adolescence, found throughout the animal kingdom<sup>80</sup> and in humans, is a period of intense pruning of the nervous system, and vulnerable brains may be especially at risk following this period of development.<sup>81</sup> This parcellation, also called pruning or “apoptosis,” can unmask latent vulnerabilities. The timing of this parcellation process can help us explain the unfolding of serious psychiatric disturbances during and immediately following adolescence. For these reasons, too, how the child’s environment offers support or intensifies stress can directly influence the occurrence and progression of psychiatric illness. Children who are exposed to significant trauma early in life, for example, have epigenetic changes that make the HPA axis less adaptive in ways that appear to last a lifetime.<sup>82</sup> The ACEs study and other investigations into the impact of early adversity on the developing individual suggest that without intervention, long-term impacts on mental and medical health may ensue.<sup>83</sup> Given that interventions may be able to alter at least some of the neural and physiological mechanisms by which adversity makes its impact on health, there is reason to explore avenues of healing for those exposed to developmental stressors. Future studies will need to investigate whether clinical interventions with such individuals may be able to reverse these structural and epigenetic impacts of trauma on the developing brain.

For the growing brain of a young child, the social world supplies the most important experiences influencing the expression and regulation of genes. This period, in turn, determines how neurons connect to one another in creating the neuronal pathways that give rise to mental activity. The function of these pathways is determined by their structure; thus alteration in genetic expression changes brain structure and shapes the developing mind.

The functioning of the mind—derived in part from neural activity—in turn alters the physiological environment of the brain, and thus itself can produce changes in gene expression. These interdependent processes are all a part of the complex systems of our mental lives.<sup>84</sup> This is clearly seen in the production of corticosteroids as a response to stress, which directly influences gene function.<sup>85</sup> In children with shy temperaments, for example, there is a huge physiological response to even mild environmental changes. Such individuals create their own internal world of stress responses that heighten their brains' reactivity to novelty.<sup>86</sup> Likewise, a child traumatized early in life will have an alteration in physiological response, such that small stressors lead to large hormonal responses.<sup>87</sup> Thus both constitutional as well as experientially “acquired” reactivity can lead to further physiological features that maintain the hypervigilant response over time. Jerome Kagan and his colleagues have demonstrated that parenting behavior makes a large difference for the trajectory of development.<sup>88</sup> In their research, those parents who supportively encouraged their shy children to explore new situations enabled the children to develop more outgoing behaviors than those parents who did not help their children with their fears. These and other studies clearly demonstrate that parenting has a direct effect on developmental outcome, even in the face of significant inherited features of physiological reactivity.<sup>89</sup> Throughout this book, we will return to discussions of shy and traumatized children as examples of the interactions between constitutional and experiential variables in development.

### **Relationships and the Brain**

In this book I am proposing that the mind develops as relationships and the embodied brain change across time, and that the regulatory function of the mind emerges within the interactions of neurophysiological processes and interpersonal relationships. In other words, the mind is an emergent property that regulates the flow of energy and information within bodies and between the individual and other people and the environment—with our natural world. Relationship experiences have a dominant influence on the brain because the circuits responsible for social perception are the same as, or tightly linked to, those that integrate the important functions controlling the creation of meaning, the regulation of bodily states, the modulation of emotion, the organization of memory, and the capacity for interpersonal communication. Interpersonal experience plays a special organizing role in determining the development of brain structure early in life and the ongoing emergence of brain function throughout the lifespan.

One fundamental finding relevant for this IPNB view of the mind comes from numerous studies on attachment across a wide variety of cultures. Attachment is based on collaborative communication. Secure attachment involves contingent communication, in which the signals of one person are directly responded to by the other. Ultimately this is “integrative communication,”

in which the distinction between two people is honored, and compassionate, caring communication linking the two people is created. It sounds simple. But why is this type of reciprocal communication so important? Why do people with a common cold experience improved immune function and recover one day sooner when they see a physician who is empathic?<sup>90</sup> Why doesn't such integrative communication happen in all patient–clinician relationships? And why doesn't this contingent compassionate communication happen in all families?

During early development, a parent and child “tune in” to each other's feelings and intentions in a dance of connection that establishes the earliest form of communication. Mary Ainsworth's early studies suggest that healthy, secure attachment requires a caregiver to have the capacity to perceive and respond to the child's mental state.<sup>91</sup> This way of reflecting on the child's mental life—of seeing the mind beneath behavior and respecting the existence of an internal subjective world—has been identified as a possible core mechanism underlying secure attachment.<sup>92</sup> These studies propose that a “reflective function” enabling the parent to carry out “mentalization” may be at the heart of Mary Ainsworth's original notion that parental sensitivity is at the heart of attachment security.<sup>93</sup> This is essentially the extent to which a parent is “mind-minded” and has a “theory of mind”—that is, the extent to which the parent is able to conceptualize the real entity called “mind” both in the self and in others.<sup>94</sup> We'll see that this reflective function enables a parent to be sensitive to the child's signals and respond to the child's inner experience, not merely to the manifest behavior.

In Chapter 4, I review findings from neuroscience that can help us to understand what mechanisms underlie these early reciprocal communication experiences; how they are remembered; and how they allow a child's brain to develop a balanced capacity to regulate emotions, to feel connected to other people, to establish an autobiographical story, and to move out into the world with a sense of vitality. The capacity to reflect on mental states, both of the self and of others, emerges from within attachment relationships that foster such processes.<sup>95</sup> I call this capacity “mindsight”: the ability to see the internal world of self and others. It may be essential in healthy relationships of many kinds. *Mindsight permits integrative communication in which individuals are honored for their differences and compassionate connections are cultivated*

“Mindsight”—the ability to see the internal world of self and others.

*that link one mind to another. My proposal is that interpersonal integration promotes the growth of integrative fibers*

*in the brain.* These neural circuits linking differentiated areas to one another are the regulatory and social circuits of the brain. In this way, the concept of mindsight builds on the illuminating work of mentalization and extends the exploration further by embedding notions of neural integration and interpersonal relationships as interdependent aspects of the flow of energy and information. Mindsight can thus be conceptualized as the way we perceive energy and information flow within the neural and the relational systems from which

the mind emerges. When we see the flow of energy and information clearly, mindsight then enables us to intentionally move this flow toward integration and thus toward health.

These patterns of respectful, compassionate, interpersonal communication literally shape the structure of the child's developing brain toward integration. These important early interpersonal experiences are encoded within various forms of memory and shape the architecture of the brain. The integrative function of the brain is what permits flexible and adaptive neural regulation, and so interpersonal relationships that are integrative promote healthy self-regulation. It is important to keep in mind that development does not occur only during childhood or adolescence. The brain continues to change in response to experience throughout the lifespan. We are in a process of lifelong development, as reflected in the ever-changing structure of the brain throughout our lives. The need for integrative communication and connection does not end with childhood. As adults, we need not only to be understood and cared about, but also to have other individuals simultaneously experience a state of mind similar to our own. We need to be a part of a whole that is larger than our bodily defined selves. We are continually emerging within our connections with others. It is for this reason that healthy relationships are an important part of our health as we age.<sup>96</sup> With shared, collaborative experiences, life can be filled with an integrating sense of connection and meaning.

So far, the emphasis in this chapter has been on the embodied brain aspect of energy and information flow and how relationships interact with the nervous system to both shape and be shaped by that that flow. In the remainder of this chapter, emphasis shifts to the consciousness facet of mind and how it may emerge from the flow of energy in our lives, and also how awareness might be cultivated in an integrative way to promote well-being and flourishing as we create a healthy and resilient mind.

### **Mind: Regulation and Consciousness**

We do not know how the physical property of neurons firing and the subjective experience of our inner mental lives mutually create each other. Yes, neural function and structure influence mental life, and our mental life directly influences brain anatomy and firing. The point here is that exactly how neural tissue and mental experiences have mutual influence on each other is, at this time in our understanding, not known. No one knows how the scent of a rose is "created" when chemicals from the flower stimulate our olfactory nerves. And so with this humbling reality, we can propose that, for now, we can see the subjective side of mental life and the objective (measureable) side of neural life as representing two primes, or irreducible aspects, of our human existence.<sup>97</sup> Just as we do not struggle to resolve the primes of two sides and the edge of one coin, we can also consider that relational, neural, and subjective mental experiences are three aspects of one reality of energy and information flow.

That said, as we've seen, we can describe at least four facets of the mind that can help illuminate with more specificity the nature of our mental lives. One is the mind's regulatory function that governs the flow of energy and information, as described earlier in terms of self-organization. If we define this regulatory facet clearly, we can be in a scientifically grounded position to offer new and (let us hope) helpful ways of making our minds stronger, our mental lives healthier, our sense of well-being more robust. This is the facet of self-organization that leads to the proposal that optimal self-organization, arising from the linkage of differentiated parts of a complex system, may be the heart of health. We've named this process that optimizes self-organization as "integration."

A second core facet of mind is the phenomenon of being aware, of having an internal sense of knowing that is part of what we call "consciousness." A related and third facet of mind is our subjective internal texture of life. We know our subjective experience by way of being aware, and these states shape our sense of self and our felt connections to others in the world. Ultimately, this subjective aspect of mind is a wondrous mystery. The fourth facet of mind is perhaps more familiar: that of information processing. We've seen that this is the process whereby energy flow symbolizes something other than that energy pattern itself. This information processing, sometimes called "cognition," may be within awareness, or it may not involve that subjective sense of knowing, of being conscious. As we've seen, information processing can be enacted and embodied, as well as extended beyond our bodies and embedded in our culture.

But what does it really mean to be aware, and to have a subjective sense of being alive? What are these two facets of mind, truly: this sense of knowing within awareness and the subjective texture of that which is known? Although we may never truly "explain" awareness and this subjective facet of mind, we can actually come to practical insights that are quite useful. Even if these correlate with neural firing patterns in the brain, the reality of our subjectivity and our capacity to be aware are simply not the same as electrochemical energy transformations in the head. This point, as difficult as it may feel to some researchers, is important if we are to realize that what is included under the notion of "mind" is not reducible to brain activity, even if it were to turn out to be solely dependent upon that neural firing. In teasing apart these four core dimensions of mind—regulation, information processing, awareness, and subjective experience—I am not attempting to eliminate the magnificence and mystery of mind, but rather to illuminate its core and differentiable features so that we can improve our mental lives.

### **Regulating Energy and Information Flow**

When we regulate anything, we need to monitor and then modify that which is being regulated. *Monitoring* and *modifying* are two fundamental aspects of regulation. When you are driving a car, you must have your eyes open to

perceive where you are going and then to alter the direction and speed of the vehicle. When we regulate our emotions, we monitor our internal states and then modify our degrees of arousal and excitement to bring more balance into our lives. The outcome of healthy regulation is to coordinate and balance our functions so that we are adapting to our ever-changing environment.

The fascinating view that emerges from IPNB's consilient approach to the developing mind is that *regulation results from integration*. When our relationships are integrated, they are the most flexible and adaptive—and the most rewarding and meaningful. When the brain links its differentiated circuits to each other, the nervous system achieves homeostasis and develops new levels of intricacy in its functions. In this way, defining this aspect of the mind as a regulatory process can purposefully lead to the growth of a healthy brain and relationships. This is an empowering and practical definition of a core feature of mind that can improve the way we raise our children, teach, conduct therapy, and live our day-to-day lives.<sup>98</sup> Each of these developmental processes of parenting, education, and psychotherapy appear to benefit from, if not depend upon, consciousness. This suggests the underlying possibility that awareness can be used intentionally to cultivate integration in our relational and neural lives. For example, one way of viewing what these three ways of helping others grow and develop entail is through what can be simply called “presence.” The presence of a teacher, parent, or therapist can be seen as a key ingredient to optimal outcomes for classroom climates that promote learning, secure attachment, and positive clinical outcomes. “Presence” can be defined simply as state of mind, a way of being that is characterized by receptive awareness. If being aware in this way can transform lives, what do we know about the process of consciousness that underlies it? What does it mean to be *receptively aware*? As an educator, parent, and therapist, these questions about the nature of presence and being aware have organized my focus of attention and have preoccupied my conscious and likely nonconscious information processing for a long time. In other words, in every sense of the term as we've now defined it, these questions filled my mind.

### **Consciousness: Knowing and Subjective Experience**

Any exploration of the mind will be strengthened if we acknowledge that our mental lives cannot be fully measured in a quantitative or objective way. Even if we develop ways of measuring integration and the regulatory aspect of mind, we still have the qualia or felt texture of life and the inner subjective experience of being aware, which are not outwardly measureable. Even self-report measures, reliable as they may or may not be, are not the same as inner subjective awareness. *Your* internal mental experience—your sense of knowing and being aware, and the subjective nature of what is known in your conscious experience—cannot be fully known by me or anyone else. Our internal sea is a private world we can share only in communications that approximate

our internal world; we can never fully reveal to others its true nature. In science, for example, we can explore the “neural correlates” of consciousness and what we feel as “first-person” or “subjective” experience, but these and other measurements only describe physical changes at the time of the study participants’ subjective experience. Even more, it is important to keep in mind that these correlations are not necessarily revealing a linear causal influence. Systems often function in nonlinear ways, and we need to be scientifically cautious about drawing premature conclusions about the directionality of causation. Awareness may also influence the state of neural firing as much as neural firing influences awareness: Causality may be bidirectional, as often happens in emergent self-organizing processes.<sup>99</sup>

These important and fascinating studies of neural correlations do not solve what has been called the “hard problem” of how the physical property of neurons’ firing in the many complex ways they do “gives rise” to the subjective experience of being aware.<sup>100</sup> And they leave us with the important issue of how subjective awareness may shape the firing of neurons. Studies have also revealed that a wide array of specific brain regions and their interactions appear to play an important role in the emergence of conscious experience.<sup>101</sup> Physically interconnected circuits of the brain, from the brainstem up through the thalamus and connecting with the cortex, may weave a neural pattern of high degrees of integration that gives rise to consciousness.<sup>102</sup> But it is important to keep in mind that these proposals, even if true, do not answer the basic question, for example, of why neural integration would be “giving rise” to the experience of consciousness. Even if the physical and the mental occur simultaneously in time, we just don’t have a clear model for how the way we see the color red in our subjective lives and the firing of the areas of our brains responsible for vision work together. How a person is aware of vision relies on a complex array of neural firing patterns linking widely separated areas to one another.<sup>103</sup> Recent studies of imagery and its impact on how the brain changes raise important questions about how conscious mental experience (imagery) can alter the brain’s physical structure (synaptic connections). These studies of neuroplasticity reveal that focusing internal awareness on a self-generated image can alter the activity and the neural connections in specific regions of the brain. Imagining the playing of scales on a piano is associated with expansion in the motor areas of the brain responsible for the fingers and is similar to the change that occurs with actually playing the scales.<sup>104</sup> Although we certainly can propose that the neural firing is what creates the imagery in the first place, how does the person *initiate* this imagery-based neural change? What does it mean to have intention and will to carry out an action?<sup>105</sup>

These are important and challenging questions—and the point of this brief discussion is to invite us to embrace the possibility that the mind is more than simply the “output” of the brain.<sup>106</sup> At a minimum, energy and information flow between and among people in one-to-one relationships, families, communities, and societies. This flow directly activates our mental experience in ways that are beyond our own private neural firing pattern proclivities.

Anyone in a close, intimate relationship knows that our mental lives are shaped directly by our interactions with another. Even with the notion of a “social brain,” might it be possible that we can sense something happening in the between-ness of a relationship? Is that sense of something greater than just brain activity? Let’s try to keep an open mind to the possibility that the arrows of causality of the Triangle of Human Experience point in all directions: Embodied brain influences mind and relationships; relationships influence mind and embodied brain; mind influences embodied brain and relationships. If the mind is an emergent property of the system of energy and information flow that is fundamental to our neural nature and our relational connections with others, then viewing the causal processes as “emergent” and not merely linear (as in “Brain creates mind alone”) will be a useful starting place.<sup>107</sup> Being aware of our mental lives permits conscious choice. An aware mind can choose with intention how to shape neural and relational functioning. This empowering point of view has deep implications, as we shall see.<sup>108</sup>

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Being aware of our mental lives permits conscious choice.

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Some neuroscientists may propose that mind is “simply an outcome” of the activity of the brain. Brain is primary, and mind is an outcome of neural firing, a “secondary effect” of the nervous system’s function. Others suggest just the opposite, stating that our mental lives are in a different domain of reality that has little correlation with the physical world.<sup>109</sup> Our position in IPNB is to embrace the view that there are at least three “primes” of one reality: mind, embodied brain, and relationships, as mentioned earlier. In this framework, each is seen as a unique and irreducible aspect of energy and information flow. Our mental lives—awareness, subjectivity, information processing, and the regulatory facet of the mind—are emergent processes that arise from inner neural and inter relational processes and their interface with each other. Let us consider the subjective side of this mental experience a prime, an irreducible aspect of the emergent property we are calling “mind.” This stance will become clearer as we move forward through the ensuing chapters, with research-based data supporting this interdisciplinary perspective.

As a reminder, we are defining “mind” as an emergent process, part of which involves the regulation of energy and information flow, the “embodied brain” as an internal mechanism of that flow, and “relationships” as the “inter” sharing of that flow. These are not three separate elements, three different worlds, or three items to check off on a biopsychosocial model of the world. Instead, these are elements of “one reality” that is energy and information flow; mind, embodied brain, and relationships are three aspects of the one reality of patterns in the flow of energy and information. This, as we’ve seen earlier, can be called a “Triangle of Human Experience” (see Figure I.2, on page 11).

Much of what occurs within our mental life is not within the experience of awareness. And so I am not equating mind with consciousness. Mental life includes consciousness but is not limited to it; the regulation aspect of the

mind can occur with or without our awareness of it. Sigmund Freud made a major contribution to our understanding of mental life by pointing out that the processes outside our awareness have a significant influence on the quality of our lives.<sup>110</sup> In this text, however, I use the term “nonconscious” rather than Freud’s “unconscious” to refer to the processes of which we are not aware, in order to avoid the many historical and sometimes limiting non-conscious associations that arise with the “unconscious” term. I hope Freud would approve.

Information that enters consciousness is important because consciousness permits choice and change. Items within consciousness become temporarily more stable and thus available for mental and neural manipulation. “Consciousness” is not the same as “attention.”<sup>111</sup> Some forms of attention are within conscious awareness, and some forms are not. Attention itself can be defined as a process that directs the flow of energy and information—and that can proceed with or without awareness. “Nonfocal attention” is the term for the focus of energy and information that does not involve the experience of being aware. “Focal attention” is that form of guiding the flow of energy and information in the mind that involves our conscious awareness of that flow. Within our everyday lives—and within the developmental processes of parenting, education, and psychotherapy—using the conscious focus of attention, harnessing focal attention, can enable significant changes to occur within our scaffold of knowledge. Awareness stabilizes that of which we are aware. As we’ll see in Chapter 3, focal attention enables a form of flexible memory called “explicit processing” to be created in the brain. With conscious awareness, we also create purpose and plan and engage our lives intentionally as we deepen an understanding of ourselves and the world in which we live.

### *Subjective Experience*

One aspect of consciousness is the quality of our internal subjective experience. This quality is sometimes called “phenomenal consciousness” or “first-person experience.” The quality of your internal subjective experience of seeing red and my experience of seeing the same red may not be exactly the same. No one’s unique subjective world is quantifiable, and comparing one’s own subjective mental life to another’s is limited by its internal nature. For this reason, the contemporary scientific field of psychology may have understandably moved away from introspective reports as a source of reliable data, seeking instead a more “objective” and often quantifiable way of measurement that can be statistically analyzed as self-reports, as observable behaviors, and as measureable scans of brain activations. Yet the subjective world is real, even if science cannot “prove it” with controlled forms of measurement. I was once in a debate with a fellow psychiatry trainee who took the position that psychiatrists should not learn psychotherapy, because there was no evidence from science that feelings were “real.” The only natural response I could muster was to say that I felt sad, and then to suggest that I wasn’t certain how we could

proceed with our conversation, because we didn't have the scientific evidence that he was "real."

One thing we do know is that when parents attune themselves to the internal subjective experience of a child, the child thrives. In fact, this is true with all close personal relationships. When a child is interested in a bug, for example, and has a caregiver who shares her interest and excitement, focusing their shared attention together on the insect, the child feels seen and enriched. That child will thrive in the moment. Repeated experiences in which caregivers attune themselves to children's internal worlds and join with the children at this subjective sharing level result in scientifically demonstrable positive outcomes for the children. In other words, although we cannot quantify a child's excitement or disappointment, we can in fact observe such joining experiences and then measure the various healthy ways in which such respect leads to positive developmental outcomes. As noted earlier, patients with a common cold who see an empathic physician have been shown to recover one day faster and to have better immune function than patients who see a nonempathic physician.<sup>112</sup> Again we see measureable scientific findings that the non-measureable subjective world is of vital importance. Researchers have viewed this intersubjective aspect of consciousness as a primary influence in how the experience of awareness develops.<sup>113</sup>

Our relationships directly influence our internal experience of being aware. Even the circuits of the brain that are directly involved in our awareness of others' mental states overlap with those circuits that participate in our own experience of being conscious.<sup>114</sup>

Consciousness can also involve a relationship with our own internal subjective lives; it can be a way of taking "time in" to focus our attention on our internal subjective states and let awareness become filled with what is happening inside of us, our inner mind. As children develop, their interactions with caregivers can influence how they become aware of and come to be able to regulate and express to others their own internal worlds: How we learn to pay conscious attention to our own bodily experiences, for example, can profoundly influence how consciousness arises.<sup>115</sup> This overlap between the bodily sense of self in the physical world and the relational sense of self within our interpersonal connections is exemplified by the finding that the same neural area (the anterior cingulate) is responsive both to physical pain and to social rejection.<sup>116</sup> Again and again, we'll be able to illuminate the ways the neural, relational, and mental aspects of our lives are intimately intertwined.

As Helen Keller, who became blind and deaf at the age of nineteen months, stated in her autobiography,<sup>117</sup> her "mind was born" at the moment she knew what her teacher *meant* by the sign for "water." Shared experience within interpersonal relationships, as Lev Vygotsky proposed,<sup>118</sup> is an important source of our mental lives and directly develops our thought processes and internal states. The mind is both embodied and relational. In other words, mental life is not just affected by synaptic connections in the brain, but extends

beyond the skull; it is both embodied and relational. The sharing of energy and information (relationship) occurs as you read this book. You remember the experience by altering the brain mechanism of that flow as synaptic connection. You can change the way you regulate energy and information flow (mind) within awareness and choose to move this flow with intention.

### *Knowing and the Awareness of Content*

A second aspect of consciousness is the sense of knowing its content, or the “known.” If conscious awareness is holding something “in the front of your mind,” making it more stable for a brief period of time, what exactly does this mean? Knowing—the *access* dimension of awareness, also known as “cognizance”—is how we subjectively sense knowledge or clarity about something. We can “pay attention” to the path in front of us as we walk, knowing that we are taking one step at a time. In this example, focal or conscious attention enables us to have a clear view of where we are walking. We have the phenomenal or qualitative aspect of our subjective experience within consciousness, and we have an access aspect of knowing the path ahead of us. With the knowing of such focal attention, we can choose to walk along a different path and change our direction with intention and awareness. With focal attention, with something known within awareness, the mind has the ability to choose and change its course of functioning with intention and purpose. With this “attentional flashlight,”<sup>119</sup> we can choose which part of our experience to illuminate and bring into cognizance. In this way, consciousness plays an important role in what are called “executive functions”; these include attentional control, cognitive flexibility, goal setting, impulse regulation, and complex information processing, and planning.<sup>120</sup> The unfolding of conscious awareness over children’s lives is influenced by a range of experiences from infancy onward that also shape the executive functions, which play an important role in how their lives unfold.<sup>121</sup> As the example of Helen Keller illustrates, our sense of awareness even of who we are is directly shaped by the relational experiences we have of sharing our sense of knowing, our mutually created sense of meaning and connection.

I use “consciousness” to include both the experience of being aware—the internal state of knowing that something is happening in the present moment—and that which is known. The term “cognition” can be used to signify the broad way in which energy flow patterns with symbolic value—what I have defined as “information”—move across time. This flow involves alterations in representation, the clustering of these symbolic energy patterns with related representations, and the performing of designated informational transformations

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*Consciousness* is the experience of being aware, the internal state of knowing that something is happening in the present moment.

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(such as comparing and contrasting, finding meaning, recalling similar elements, rhyming, and various other ways of shifting and recombining the symbolic representations of information).

“Cognition,” as the broad term referring to information processing in general, does not need awareness, as we’ve seen, and exists across a wide array of other species.

“Sentience” is a term that sometimes is used to refer to the “ability to perceive or to feel things” or a “state of elementary or undifferentiated consciousness.”<sup>122</sup> We have our sentient experience as the essence of our inner subjective lives. The feelings of sentience may be more akin to being aware of energy flow patterns that have no symbolic value, such as the smell of a rose, the exhilaration of an astonishing sunset, or the glorious feeling of the harmony of a choir in full voice. Perhaps this could also be called “conduction,” as the mind serves as a conduit of experience, like a hose directing water but not changing the water itself. In contrast, the mind can also be a constructor, as it alters the energy flow into patterns that are constructed to represent something. Sensing a rose’s scent would be as close to conduction as possible; naming that flower as a “rose” would be a construction. The mind can be both a conduit and a constructor. The awareness of these inner states of conduction and construction is a direct feeling and knowing that can include sentience and information; they are as close to the sense of “the thing itself” as we can get within our conscious experience as well as symbolizations that are attempting to construct information about that thing.

The ability to perceive and to understand other people’s minds, a form of “metacognition” sometimes called “mentalization,” begins within the first year of life<sup>123</sup> and is proposed to play a role in the unfolding of consciousness.<sup>124</sup> Other terms for this capacity are “theory of mind,” “mind-mindedness,” “mind perception,” and the IPNB term “mindsight.” While seeing the mind of another seems to catalyze the development of self-awareness, what more broadly do we understand about how consciousness develops? Some propose that intersubjective consciousness emerges during the first year of life,<sup>125</sup> whereas more internally based senses of awareness emerge during the second year of life.<sup>126</sup> Is the moment we share meaning via language use with another person, as Helen Keller experienced, a special form of the “mind [being] born”? When does this inner sense of being alive and being aware of that sense actually occur? And how would we even know? There are clearly many aspects of “self” that appear to emerge within our interpersonal worlds.<sup>127</sup> Some people remember clearly recognizing a sense of “self-awareness” as it emerged at a particular time in their lives, but these retrospective reports are constrained by the nature of recollection. Some studies of children before the age of two reveal that they can determine who shares their own particular likes and dislikes and that these preferences may be shaped by language and experience.<sup>128</sup> In other words, we may be aware and have a clear sense of “self” shaped by our experiences long before we can remember that we were aware. Clinically, some people have reported recollections of a kind of psychological birth of consciousness, in which such clear “beginnings” happened during their adolescence or beyond. Others recall a sense of self much earlier, during the earliest days of elementary school or prior. Innate

neural features and their interaction with family communication patterns may each contribute to the timing and nature of how awareness of the self develops across childhood and beyond.

What indeed is this awareness of this experience we've named "self"? When do you first realize that you are a person and occupy space and can think? Is it when you first realize that you are in the present moment remembering something from the past? How does awareness differ from self-awareness? And does the "self" need to be limited to the boundaries of the body? In other words, can a "sense of self" include a sense of "me" and of "you" and perhaps even a membership in a "we"? With all the ways in which life and the brain change over time, perhaps the self can be viewed as more of a verb than a noun—as a process that evolves as we grow and change. As we'll explore throughout the book, and in more depth in the final chapter, the experiences of identity and self seem to involve subjective experience, perspective, and agency that is profoundly influenced by relational experiences. The question is, can these fundamental aspects of the mind be expanded beyond a separate, solo-self; that solo-self that is so prevalent in modern culture and is associated with a sense of loneliness, social isolation, and disconnection in life? These are all intriguing questions that remain to be illuminated with future explorations.<sup>129</sup> The important point here is to consider these open questions so that we can imagine how mind, embodied brain, and relationships co-influence their own development across the lifespan.

### *Mindful Awareness and Compassion*

One form of awareness that has been a focus of contemporary research is an ancient contemplative practice of many variations called "mindfulness" or "mindful awareness." Though the specific scientific definitions of mindfulness vary, we can state here the general perspective that *being mindful* involves a way of paying attention, on purpose, to present experience as it emerges, moment by moment, without getting swept up by judgments.<sup>130</sup> Being mindful is the opposite of being on "automatic pilot" or being "mindless" in our actions. "Being mindful" means being receptively aware of, and present to, an experience as it is happening. When we speak of "awakening the mind," this term often refers to the way in which we can become alive and attend to the details of ordinary experience as if they were extraordinary.<sup>131</sup> Mindful awareness can enable our inner sense of knowing and subjective experience of being alive to attain a new vitality, level of detail, and clarity. Being present in this way has been scientifically demonstrated to support mental, physical, and social well-being.<sup>132</sup>

The study of mindfulness explores both inherent traits and intentionally created states. Mindful traits include being aware of what is happening as it is happening, being nonjudgmental (not being taken over by prior expectations) and nonreactive (coming back to emotional baseline readily), being able to label and describe the internal world, and being able to engage

in self-observation.<sup>133</sup> These traits may be related to some combination of temperament and a relationship history that has fostered this way of being grounded in the present moment-to-moment unfolding of experience.

With intention, it is also possible to engage in a training of the mind, which can be called “mindful awareness practice,” in that it creates a state of being alert and open to the novel way of experiencing in that moment. This form of awareness has the qualities described above, but also can be thought of as having the features of self-compassion and “other-directed” compassion.

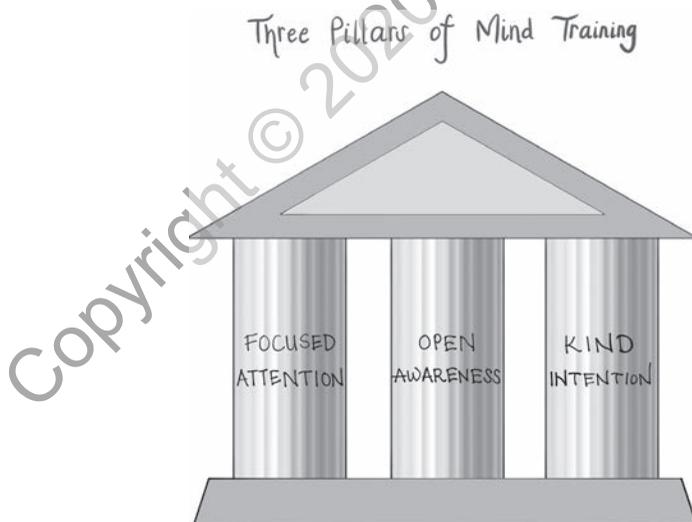
In this text, we can see the scientific basis for viewing the self as involving an embodied *and* relational origin, and so what is often called “self-compassion” could also be named “inner compassion,” and then the compassion we direct to another person is simply “inter compassion.” Such linguistic signifiers are more than mere semantics; if we begin to live life embracing the reality of our interconnected lives, then inter and inner become two aspects of our experience of mind, and being kind and compassionate can be directed to our inner and inter experience of self from our embodied and relational mind.

In other words, some consider that mindful awareness is a way of being aware of one’s own inner life and the surrounding world with kindness, a loving awareness or loving attention that is a form of positive regard for self and others.<sup>134</sup> When we “take time in” with positive regard for ourselves and others, when we have kind intentions, we cultivate mindfulness as a trait in our lives.

Mindful awareness exercises and other mind training practices may have origins in ancient or modern times, and may come from the East or West. They include mindfulness meditation, yoga, tai’chi, qigong, and centering prayer. I myself also do mindful dishwashing at home. Each dish, the sensations of the water, the movement of sponge over plate, the sound of the stream flowing from the faucet, the feel of the towel, and the circular motion of the towel as each dish is dried and put away—these all become the focus of moment-to-moment attention. The beauty of mindful awareness is that it can be applied to everyday life in a secular fashion. Research has clearly demonstrated that it can improve the health of the mind by increasing flexibility, concentration, and sense of well-being. Improved empathy and compassion enhance relationships, and a shift in the baseline activity of the brain occurs, which is associated with approaching, rather than withdrawing from, challenging situations.<sup>135</sup> This can be seen as a sign of “neural resilience.” Primary care physicians who are taught mindful awareness, for example, have less burnout from their work and enhanced empathy for their patients.<sup>136</sup> A study of intensive meditation training reveals that the cultivation of mindful awareness leads to increased telomerase, the enzyme that maintains the integrity of chromosomes by supporting the telomeres at their ends, and thus increasing cell life.<sup>137</sup> Patients listening to a mindfulness recording during the light treatment for psoriasis healed four times more quickly than other patients.<sup>138</sup>

Mind training practices that support the capacity to be present in these ways—of having the trait of being receptively aware—may involve three

foundations or “pillars” of strengthening the mind.<sup>139</sup> These three pillars of mind training include the cultivation of focused attention, open awareness, and kind intention (Figure 1.3). For some, the first two pillars would be considered aspects of “mindfulness practice,” and the third would be considered compassion or loving-kindness training. Others place all three under the term “mindfulness.” As there is no consensus yet among researchers or meditation practitioners on exactly what the terms “mindfulness” and “mindful awareness” imply, in this and other texts I use the term “three-pillar mind training” to avoid misunderstandings. Three-pillar mind training—practices that cultivate focused attention, open awareness, and kind intention—has been shown to create the following physiological outcomes supporting health and well-being: (1) reduced stress with the reduction of the stress hormone cortisol; (2) improved immune function; (3) enhanced cardiovascular health with reduction in blood pressure and cortisol and strengthening of vagal tone, with increased heart rate variability coherence revealing an integration of the parasympathetic and sympathetic branches of the autonomic nervous system—the brake and accelerator of the embodied brain; (4) reduction in systemic inflammation through modification of the epigenetic regulation of the gene regions that control the inflammatory response; and (5) the optimization of telomerase levels to repair and maintain the ends of the chromosomes. These factors, especially the latter, may all contribute to the suggestion that three-pillar practice—the ways we cultivate living with mental presence—actually



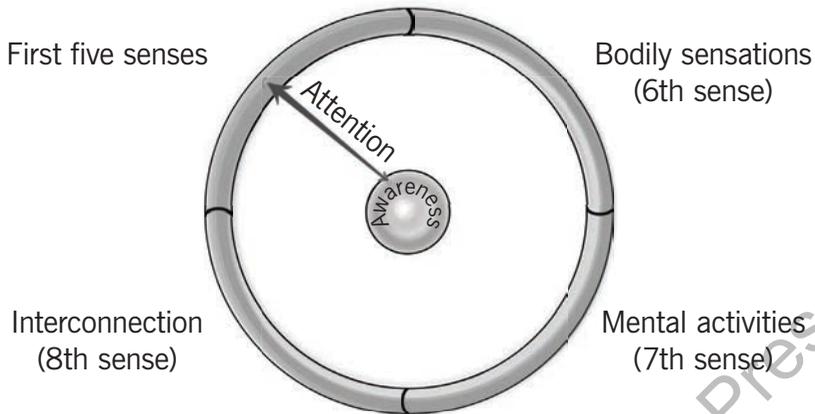
**FIGURE 1.3.** Three Pillars of Mind Training. Illustration by Madeleine Welch Siegel. From *Aware: The Science and Practice of Presence* by Daniel J. Siegel. Copyright © 2018 Mind Your Brain, Inc. Used by permission of TarcherPerigee/Penguin Random House.

slows the aging process.<sup>140</sup> In addition, a sixth bodily change has been documented with the three-pillar practice as well: The functional and structural findings that differentiation and linkage in the brain are enhanced—meaning that integration in the brain increases. Specific regions and networks that show growth in integration include (1) the corpus callosum, linking the differentiated left and right hemispheres; (2) the hippocampus, linking widely separated memory systems to each other; (3) areas of the prefrontal cortex, including the insula, which link body, brainstem, limbic regions, cortex, and the social world to each other; and (4) the interconnections of the connectome. What we do as we train the mind to become more mindful and compassionate alters the function and structure of the brain.<sup>141</sup> The overall idea is that the intentional creation of a mindful state is healthy for the body in that moment. With repeated practice, it can become a mindful trait—a way of being that shapes the ongoing health of the individual's life.

One study suggests that parents who have mindful traits may also have a state of mind called “secure with respect to attachment.” This state enables them to raise children who themselves are securely attached to their parents and develop well.<sup>142</sup> As we'll see, this connection between mental presence as a way of being and the open, receptive way of participating in healthy relationships may rest within the process of integration. In other words, when we are loving of others, we are in an interpersonally integrated and mindful state, and when we are loving of ourselves with inner-compassion and kindness, we are in an internally integrated and mindful state of presence.

The trait of having presence, of living with receptive awareness, in these ways can be seen as a profoundly integrative internal process in which being present for life enables an individual to take in a wide array of differentiated streams of energy and information and link them in an open manner.<sup>143</sup> One approach that combines each of these three foundations of developing mindful awareness and compassion toward oneself and others with each of the three pillars is called the *Wheel of Awareness* (see Figure 1.4), a practice that cultivates an integration of consciousness by differentiating the knowns of awareness on the rim of a metaphorical wheel and placing the experience of awareness, of knowing, in the hub. The Wheel practice emerged from bringing together two fundamental consilient ideas: (1) Integration may be the basis of health; and (2) Consciousness may be needed for intentional change. What might happen if one could integrate consciousness? One way to do this is with the image and practice of differentiating knowing in the hub and the knowns on the rim of this idea of a wheel. The systematic movement of a spoke of attention permits the knowns to be differentiated from one another and the hub itself, and then linked. As an integrative and reflective practice, this exercise also offers a window into the nature of awareness itself.<sup>144</sup>

As we've seen, research on the three pillars of mind training has demonstrated that being present with mindful awareness and compassion promotes health across the entire triangle of well-being, involving mind, embodied brain, and relationships. Attachment relationships that promote well-being



**FIGURE 1.4.** Wheel of Awareness. Illustration by Madeleine Welch Siegel. From *Aware: The Science and Practice of Presence* by Daniel J. Siegel. Copyright © 2018 Mind Your Brain, Inc. Used by permission of TarcherPerigee/Penguin Random House.

involve interpersonal communication that honors the unique, differentiated qualities of each person, while also promoting the partners' linkages through compassionate and empathic communication. Having a mindful state enables a parent to take in the child's nature and attune to it without distorting perceptions or expectations. This secure relationship is based on the integration of the caregiver's and child's states of mind; the internal world of each person is encouraged to be differentiated and linked—to become integrated. In many ways, the integrative state of parental presence may foster the integrative relationship of secure parent-child attachment. It is fascinating that the outcomes of secure attachment parallel those found for three-pillar mind training practices.<sup>145</sup> It may be that what is shared between the internal attunement of mindful awareness and the interpersonal attunement of secure attachment is the integration of energy and information flow, one inner and the other inter.

#### *Awareness and the Nature of Energy: A New Framework for Conceptualizing the Mind*

In examining a survey of over ten thousand individuals taking part in the Wheel of Awareness practice, it became clear from the responses of those participants who shared their direct subjective immersion in the experience that this three-pillar mind training activity had similar descriptions offered of the first-person experience from individuals across the globe, independent of meditation history, educational background, or culture.

Before introducing the Wheel in workshop settings, I offered it to patients in psychotherapy who had a range of challenges to their mental well-being. When individuals I was treating, and those treated by psychotherapy students

studying with me, practiced the Wheel of Awareness and experienced improvement in their lives with a reduction in anxiety and stress, mild to moderate depression and post-traumatic symptoms, as a clinician I was moved to consider how this integration of consciousness might be helping their minds move toward health.

Clinical case reports are not the same as objective data obtained from randomized controlled trials. But the direct individual experiences of one person after another can accumulate, giving clarity that may, just may, be helpful in understanding the mind and how to promote well-being in new ways. Naturally in this situation there is an inherent bias: a belief that integration is health and that consciousness is crucial for change. So one could argue that this is the unreliable bias of a clinician, not the “unbiased” view of a researcher. Keeping this factor in mind, a scientist feels compelled to use scientific, consistent ideas in a potentially helpful clinical manner, doing one’s best to avoid distorting what one perceives with one’s patients. When a science-based integration of consciousness approach also seems to bring positive changes for the clients of another practitioner, it seems that the scientific reasoning has been useful in leading to a clinical intervention. This is what led to the creation of the Wheel of Awareness as a reflective practice to integrate consciousness in clinical work, and then, after these initial positive therapeutic responses, to its being offered in educational workshops.<sup>146</sup> As a scientist, I wanted to see if there might be any universal findings across demographic features of culture, nationality, education, meditation history, gender, age, and religion. Interestingly, the Wheel of Awareness seemed to bring up common experiences independent of any of these variables. That was fascinating. As a clinical intervention, the Wheel of Awareness contains each of the three pillars-of-mind training usually derived from wisdom tradition-based meditations that research has suggested creates these important changes toward well-being. As a window into the nature of the developing mind, the Wheel of Awareness enables us to gather information about the four facets of mind and ask some new questions about how they might, or might not, reveal aspects of energy flow.

Recall that in this text we have been suggesting that mind has four facets—subjective experience, consciousness, information processing, and self-organization—each of which may be an emergent aspect of energy flow. We have thus far been reviewing existing research that supports that proposal. What we will be exploring now takes us from our synthesis of mainstream research on established ways of investigating the mind to a more theoretical framework of what the mind might actually be. Let me suggest to you that keeping a skeptical mind for this framework, and for anything you might read, is a healthy way to approach taking in new knowledge. Yet for our fields, in the science of mind and mental health, to advance, we may need to take the risky step of proposing some new, and at first perhaps difficult to understand perspectives on mental life. What I’ll offer you here is a framework that might be totally wrong. It might be partially wrong. And it might just be mostly correct, even if naturally and unavoidably incomplete.

I'll now introduce you to a framework that we will be using at various moments in each of the subsequent chapters—a framework that hypothesizes one way of conceptualizing the nature of mind, a science-supported but not proven view that goes beyond established research findings. Researchers may find these ideas useful in developing novel approaches to studying mental processes in health and dysfunction; teachers and students of clinical practice and education may find these ideas of practical use in their studies and find new ways of applying them in their work. Even if we say that these ideas are of practical benefit, and that they are consistent with the findings from different disciplines of knowledge, this usefulness and consilience does not prove them to be correct. It simply means there is utility and consistency. Carefully controlled future research will be needed to verify the veridicality—the consistency with reality—of this proposed framework. So here we'll just highlight the phrase, “inspired and supported by science,” to avoid inadvertently misinterpreting the following ideas as proven or established or even widely accepted.

I'll propose it to you here, and I invite you to doubt it and challenge it while at the same time having an open mind to its details and its possible accuracy and usefulness. Having a willing suspension of disbelief may be helpful before you discard the proposed framework; that is, you should take in the framework and compare it to your actual direct, lived experience. Then, once you combine the first-person experience with learning about second-person reports and link those to potentially related third-person data, we can then discuss the merits, or lack of them, of this view of the mind. This is a suggestion for how we can move ahead in our fields. And for this reason, I've elected, in this third edition of this book, to include the invitation for you to explore your own mental life while also considering if any of the framework we're about to explore has value for those we may be trying to help.

This framework can be a useful way to consolidate and synthesize a range of scientific studies in order to extend our hypothesis that the mind might be an emergent aspect of energy. What this view offers is a proposal inspired by the survey of workshop participants and other individuals in clinical practice who have taken part in the Wheel of Awareness practice and have offered their own first-person, subjective reports on what the experience is like for them. Naturally, this immersion in deep subjective experience is before and beyond words; yet these first-person linguistic reports help us examine more fully the phenomenology—the detailed descriptions of inner, subjective life—of the nature of direct mental experience.

In this text, I encourage you to explore your own first-person immersions in life and in the various practices of mind training. If you choose to try the Wheel of Awareness, its instructions are readily available to you (see *DrDanSiegel.com* and search for “wheel of awareness”; also the book *Aware*). One benefit of this particular practice is that it includes all three of the research-supported pillars-of-mind training in one approach. Another benefit is that you have the opportunity to integrate consciousness directly by using the visual metaphor

of a wheel in which the rim contains the “knowns” and the hub represents the “knowing” of being aware. By exploring these elements of your own mental experience, you’ll combine the first-person immersion with the details of others’ experiences as second-person information with the third-person scientific discussions throughout this and any other texts on the mind—making the experience perhaps more experientially immersive and personally meaningful. What we would hope to construct is a perspective, a framework, that would enable first-, second-, and third-person data to be resonant with one another. Such overlap would support, not prove, the accuracy of the framework.

In the direct exploration of the Wheel, you’ll find that the rim can be divided into four segments: (1) the first five senses of hearing, seeing, smelling, tasting, and touching; (2) the interior signals of the body, what is called the sixth sense of interoception; (3) “mental activities” of emotion, thought, memory, belief, intention, hopes, dreams, and the like—what we can simply call our “seventh sense” to keep the numbers unfolding in sequence; and (4) our sense of interconnectedness, with other people and nature, the planet on which we live—our eighth, relational sense.

In an advanced step of the Wheel of Awareness practice, an opportunity arises between the third and fourth segments of the rim to explore the nature of pure awareness by a visualization of bending the spoke of attention to aim it into the hub itself. Some prefer the visual images of retracting the spoke, leaving the spoke in the hub, or having no spoke. Whatever visual image is most effective for you, the notion is the same: to “drop into awareness itself” and experience being *aware of awareness*, to rest in simply being aware, yet not aware of anything in particular.

Here we’ll discuss one set of findings from this “hub-in-hub” step that may help illuminate mechanisms of awareness that create a potential insight bridging a number of fields, including our exploration of the nature of mind and the science of energy. A common set of statements from around the world when attempting to describe what “being in the hub” of awareness feels like during the Wheel of Awareness practice includes descriptors of being empty-yet-full, joy, expansive, time disappeared, open, connected to everything, God, clarity, infinity, boundless, as deep as the ocean, tranquil, peaceful, and love.

These descriptions may seem to be elements of an altered state of consciousness, and in fact respondents doing the Wheel of Awareness do score high on features related to mystical states. Simply by differentiating hub from rim, the Wheel of Awareness seems to evoke this sense of joy, love, and awe, of being with something that is initially beyond understanding, something “larger than the self.”

Interestingly, these responses correspond in some ways to what the psychiatrist George Valliant has written about prosocial emotions and the experience of “spirituality,” as they both involve

eight positive emotions: awe, love (attachment), trust (faith), compassion, gratitude, forgiveness, joy and hope [that] constitute what we mean by

spirituality. These emotions have been grossly ignored by psychiatry. . . . Spirituality is not about ideas, sacred texts and theology; rather, spirituality is all about emotion and social connection. . . . Our whole concept of psychotherapy might change if clinicians set about enhancing positive emotions rather than focusing only on negative emotions.<sup>147</sup>

At a conference on science, spirituality, and education, I once held a workshop in which the participants each gave their definition of the term “spiritual.” What those responses shared were the two features of being a part of something larger than a private, separate self, and of life having meaning beyond survival. In this way, a “spiritual life” would be a life of meaning and connection. Some might also include a sense of a theistic notion of “god” as part of a religious belief, one that might overlap with the secular view of what the term spiritual might indicate.

As William James, the father of modern psychology, stated in his classic text, *Varieties of Religious Experience*:

Our normal waking consciousness, rational consciousness as we call it, is but one special type of consciousness, whilst all about it, parted from it by the filmiest of screens, there lie potential forms of consciousness entirely different. . . . We may go through life without suspecting their existence; but apply the requisite stimulus, and at a touch they are there in all their completeness, definite types of mentality which probably somewhere have their field of application and adaptation. No account of the universe in its totality can be final which leaves these other forms of consciousness quite disregarded.<sup>148</sup>

And so in *The Developing Mind*, we will not disregard these findings. Instead, we will offer as a hypothesis throughout the book a *potential* understanding of what pure awareness beyond our usual day-to-day ways of being aware of something, our waking or “rational consciousness,” may actually be.

As William James also once stated, the training of attention allows one to become a master of oneself. As James wrote:

The faculty of voluntarily bringing back a wandering attention, over and over again, is the very root of judgement, character, and will. No one is *compos sui* [master of himself] if he have it not. An education which should improve this faculty would be the education *par excellence*. But it is easier to define this ideal than to give practical instructions for bringing it about.<sup>149</sup>

Three-pillar practice might have pleased James, as it involves strengthening this essential capacity to focus attention and extends it to opening awareness and cultivating kind intention while integrating consciousness. And the Wheel of Awareness would likely have intrigued him as well, offering a direct access to the metaphoric hub that might just be a window to other ways of experiencing pure awareness as we distinguish the rim—perhaps the source of the “filmiest of screens”—from the hub of simply being aware.

Next I will briefly present a framework linking our proposal of the mind as an emergent aspect of energy to the experience of consciousness. Please bear in mind, here and throughout this text, that the following framework is only a *proposed model*. As stated above and repeated here for emphasis, please keep in mind that it may be wrong; some of it may be accurate, or it may be on the right track. As an academic mentor once advised, “In order to advance our knowledge and skills, we need to have the courage to be wrong.” See how this framework fits with your own first-person, directly lived subjective experience of life, of the Wheel practice, or of any other systematic ways you have of exploring the nature of your mind. Then see how this perspective may be useful at least as a visualization of the mind, as a possibly accurate framework, for how to understand the scientific studies and their suggested implications. For example, it may be that future brain studies will help illuminate how electrochemical energy flow within the neural connections inside our head operate by way of some of the features outlined in this framework. In other words, energy flow is what happens in our embodied brains, and this mapping of what “energy flow” may be helps us visualize the subjective and the neural aspects of mind in one single framework. It could be that future research that is just beginning, on the Wheel of Awareness, for example, may enable these ideas to be supported by empirical studies beyond the survey reports or your own first-person experience. The framework has been of practical utility in a range of settings—education, parenting, psychotherapy, organizational function, and in workshops on various topics—which supports its usefulness but does not prove its accuracy, by any means. It may just be that this framework has elements that, beyond a visual mapping of the mind, may actually reveal accurate mechanisms of how the mind works in its embodied, subjective, and relational aspects.

Here we will simply highlight the main points to get us started. As we move ahead in this text, we will elaborate on these fundamental ideas, realizing that this is a proposed framework in need of further research validation. Here are the essential features in outline form.

1. One view from physics is that *energy is the movement from possibility to actuality*.

2. If this scientific view of energy is accurate, we can visualize it on a diagram in which the vertical *y*-axis reveals the span from possible (near-zero% certainty) at the bottom to actual (100% certainty) at the top.

3. Though time may not be a “something” that flows, we do have an *Arrow of Time* that is a term indicating a directionality of change. We can use the terms “clocktime” or simply “time” to indicate this change, or what is sometimes called “flow.” Our awareness of this change may be what we mean by the common use of the term “time.” On our graph we will make this the horizontal, *x*-axis.

4. The number of unfoldings happening at a given moment of clocktime

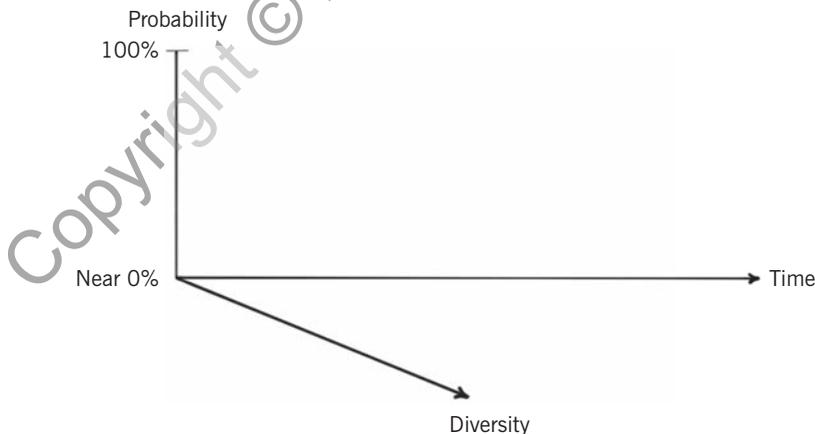
can be mapped out on our graph as the *z*-axis, one that goes in and out of the plane of the page. This would be the axis of diversity—the number and varieties of things happening at a given moment.

5. Figure 1.5 illustrates this basic diagram.

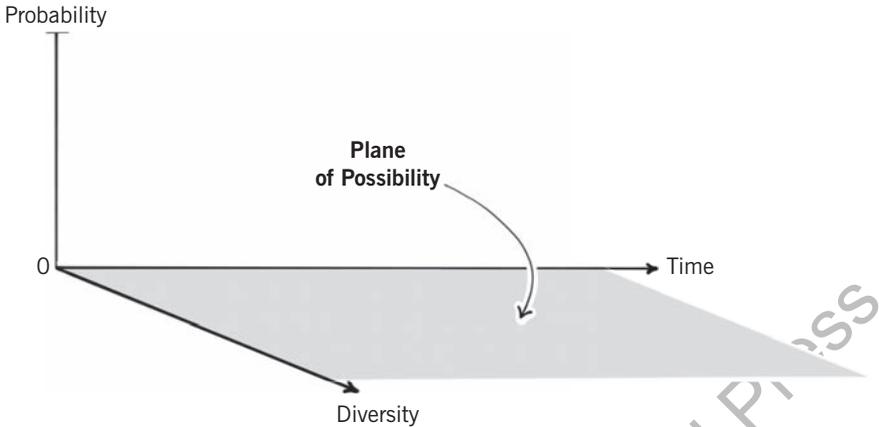
6. In physics terms, the mathematical space in which all possibilities rest is called the *quantum vacuum* or “sea of potential.” From the perspective of physics, this is the *formless source of all form*. It is full of potential energy, but not energy itself. Energy *arises from* this quantum vacuum on its way toward moving from possible to actual. This is one way of deeply sensing and imaging what “energy flow” may really be as the movement from possibility to actuality.

7. When we graph the lowest place of certainty on the diagram, it is in the shape of a plane. We can call this the “plane of possibility” (see Figure 1.6), as all possibilities rest in this location.

8. When energy arises, when it flows from the plane, it can be seen to move through a series of probabilities upward toward a peak. Sometimes actualization emerges not from this plane of maximal possibilities, but from a restricted subset of those possibilities. For example, if we share one million words, your chance of guessing it is one out of a million—the maximal possibilities available to us. Once I reveal the word “ocean,” you now know this word identity with one hundred percent certainty. This can be visualized as points A beforehand and A-1 once you know (see Figure 1.7). That is what energy flow means: the movement from possibility at A to actuality at A-1. However, if the choice is one out of the five oceans in the world, your chance



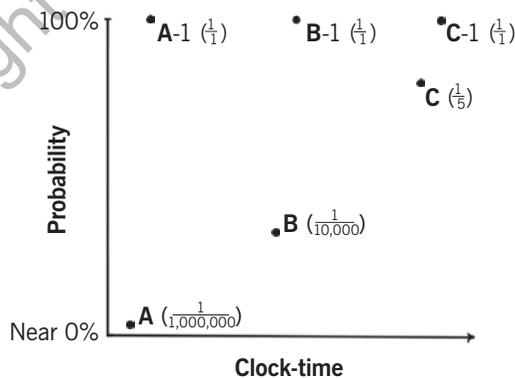
**FIGURE 1.5.** Three-P diagram: three axes. Illustration by Madeleine Welch Siegel. From *Aware: The Science and Practice of Presence* by Daniel J. Siegel. Copyright © 2018 Mind Your Brain, Inc. Used by permission of TarcherPerigee/Penguin Random House.



**FIGURE 1.6.** Three-P diagram: plane of possibility. Illustration by Madeleine Welch Siegel. From *Aware: The Science and Practice of Presence* by Daniel J. Siegel. Copyright © 2018 Mind Your Brain, Inc. Used by permission of TarcherPerigee/Penguin Random House.

is one out of five. This can be seen as point C at an elevated point of increased probability (one out of five is greater than one out of one million). Then once I indicate, Atlantic Ocean, we move to C-1 and the subset of five possible words at C has moved to actualization at C-1.

9. We can now label these three distinct positions as the maximal possibilities in the *plane*, the elevated probabilities in what we will call a *plateau*, and the actualization of possibility into actuality as a *peak*. Because of these



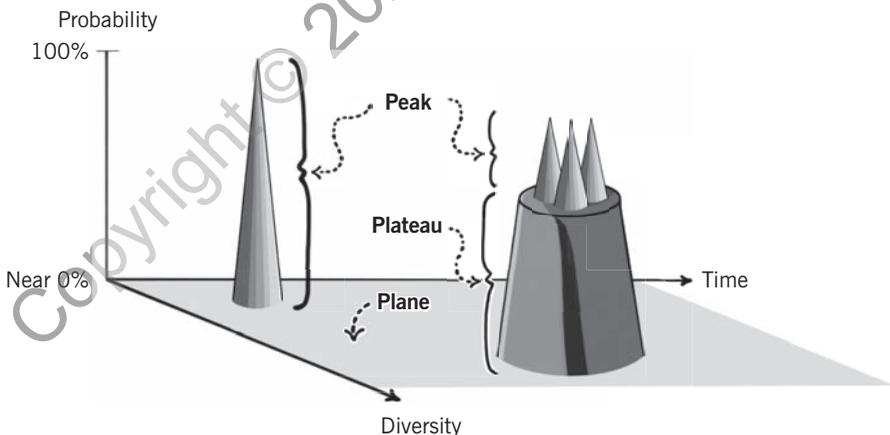
**FIGURE 1.7.** Graphing probability. Illustration by Madeleine Welch Siegel. From *Aware: The Science and Practice of Presence* by Daniel J. Siegel. Copyright © 2018 Mind Your Brain, Inc. Used by permission of TarcherPerigee/Penguin Random House.

three “p’s” on the figure, it is referred to as the *three-P diagram* (see Figure 1.8), and this overall proposal can be referred to as the *three-P framework*.

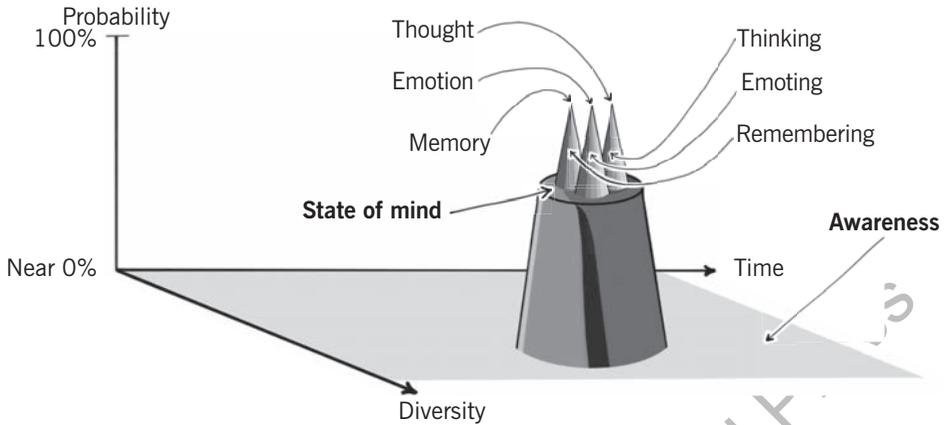
10. Through an attempt to make sense of the universal findings of the ten-thousand-person survey of the Wheel of Awareness practice, it appeared that mental life could be understood within the three-P framework and then visualized with the three-P diagram. Mental activities such as thought, emotion, and memory might be peaks; thinking, emoting, and remembering might be sub-peak energy probability positions. Mental states include intention, attitude, and mood, and these might be depicted as those elevated probability states that enable only certain peaks to arise, depicted on the diagram as a plateau. And then the experience of a vast number of individuals attempting to describe pure awareness of the hub-in-hub section of the Wheel of Awareness practice seemed to fit well with the idea that awareness, the knowing of consciousness, arises when the probability position has moved into the plane of possibility. Figure 1.9 illustrates these suggestions on our three-P diagram.

11. If this three-P framework is accurate, it has several implications, ones we will explore throughout this text. Here let me simply offer an outline of what this framework may imply:

- a. Why the subjective experience of being aware might arise from the plane of possibility is not clear, but this notion is consistent with the repeated first-person reports of several aspects of the Wheel practice, including the hub-in-hub component.



**FIGURE 1.8.** Three-P diagram: peaks, plateaus, and plane. Illustration by Madeleine Welch Siegel. From *Aware: The Science and Practice of Presence* by Daniel J. Siegel. Copyright © 2018 Mind Your Brain, Inc. Used by permission of TarcherPerigee/Penguin Random House.



**FIGURE 1.9.** Three-P diagram with state of mind. Illustration by Madeleine Welch Siegel. From *Aware: The Science and Practice of Presence* by Daniel J. Siegel. Copyright © 2018 Mind Your Brain, Inc. Used by permission of TarcherPerigee/Penguin Random House.

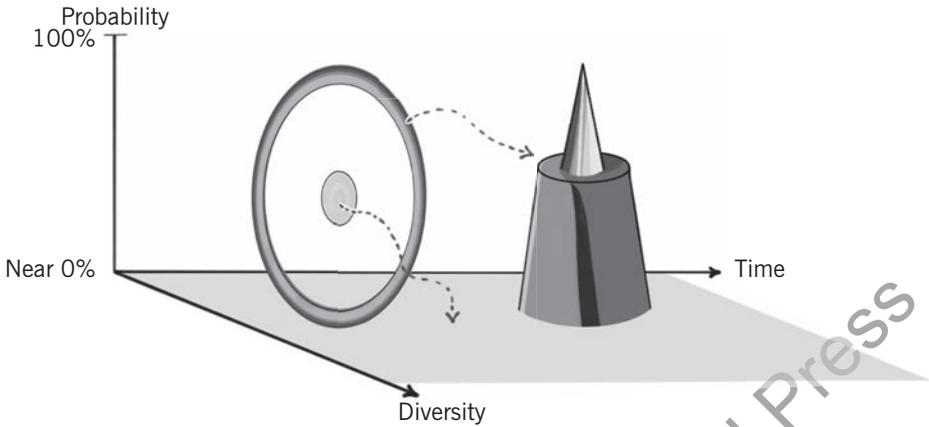
b. Awareness creates a mental space or pause between impulse and action.

c. Awareness arises in the mathematical space where all other options rest, perhaps revealing why being conscious facilitates choice and change. In other words, when we access awareness, we are accessing new options.

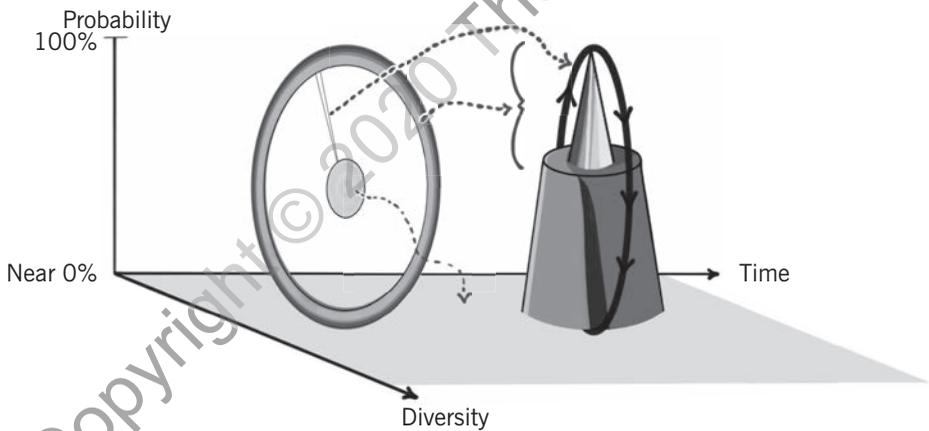
d. Pure awareness experienced in the hub may reveal what physicists call the “quantum” aspect of reality, arising from the quantum vacuum. This is a realm of our one reality in which the laws of quantum mechanics reveal distinct characteristics from the more classical or Newtonian laws of large objects. This distinction can emerge from what is called microstates of quanta of energy—what are considered “probability fields”—versus macrostates of large objects of matter, such as planets, planes, or our bodies.<sup>150</sup>

e. In this manner, the hub of the Wheel of Awareness corresponds to the plane, while the elements of the rim correspond to the above-plane plateaus and peaks (see Figure 1.10).

f. Being aware of something may involve linking the plane of possibility to plateaus and peaks. This may reflect an oscillating process of attention, one that may be revealed in the study of connectome harmonics, which, on the three-P diagram, would be visualized as a “loop” of attention that would correspond to the Wheel’s spoke (see Figure 1.11).



**FIGURE 1.10.** Three-P diagram meets the Wheel of Awareness. Illustration by Madeleine Welch Siegel. From *Aware: The Science and Practice of Presence* by Daniel J. Siegel. Copyright © 2018 Mind Your Brain, Inc. Used by permission of TarcherPerigee/Penguin Random House.



**FIGURE 1.11.** Three-P diagram and loop of attention. Illustration by Madeleine Welch Siegel. From *Aware: The Science and Practice of Presence* by Daniel J. Siegel. Copyright © 2018 Mind Your Brain, Inc. Used by permission of TarcherPerigee/Penguin Random House.

Overall, we can then summarize some of the implications of this proposed framework here in Table 1.1,<sup>151</sup> revealing the potential correspondences of mind as an emergent property of embodied and relational energy flow, juxtaposed with the neural findings of correlations with the experiences of attention and awareness. Please keep in mind the proposed nature of these correlations that future research can confirm or disconfirm.

The implications of this three-P framework for understanding the developing mind are fascinating and will be extended into the various topics ahead, as we move along on our journey together. Building on scientific findings of present conceptualizations with a proposed framework of what mind may truly be—an emergent property of energy and information flow—can help us not only make sense of the exciting new discoveries about mental experience, but they also offer us new windows into the nature of our own inner and interpersonal lives that can help promote well-being across the lifespan, as we'll come to see.

**TABLE 1.1. Correlates of Mind**

Mind as subjective experience	Wheel of Awareness metaphor	Three-P diagram and mechanism	Neural correlation/ brain activity	Other terms related to mental life
Awareness	Hub	Plane	High integration	Consciousness
Focal attention	Spoke of attention	Loop of sweep	40 Hz sweep from thalamus to cortex	Concentration
Sensation ( <i>first five</i> and the <i>sixth sense</i> of the body)	First two segments of rim	Peaks of activation with minimal filtering	Lateralized brain regions active, including sensory cortices and insula	Conduction
Mental activities ( <i>seventh sense</i> )	Third segment of rim	Peaks often arising from plateaus	Cortical regions, including midline default mode network (DMN)	Construction
Sense of interconnection: relational connections felt as conduction and construction ( <i>eighth sense</i> )	Fourth segment of rim	Peaks directly arising from plane and/or plateaus	Memory and/or resonance with energy states from other people and environment: the external inputs of an open system	Connection experienced as conduction and construction

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## Reflections: Energy, Awareness, and the Body

As we come to the conclusion of each chapter, we'll explore reflections on where we've come and prepare for where we are next to go on our explorations of the developing mind. In this chapter we've honored the reality of our lives having a rich complexity that directly shapes our experience of the feelings emerging in each moment. This subjective felt sense of being alive we know about through awareness, the wild and wondrous capacity to be conscious. Some information is processed within this awareness, much outside of it. As the mind's self-organizing functions arise to regulate the unfolding of energy and information, each of these processes—subjective experience, consciousness, and information processing—may be shaped moment-by-moment.

But what are these mental processes “made of”? In our approach in this book, we've taken the stance that the various aspects of energy flow can be examined as a possible “substrate” of mind. Energy flow, be it that of the electrochemical flow in our head's brain or the photons of light reflected from this book to your eyes, has certain properties we've seen that can be the stuff of mind. When in-formation to symbolize something, mind constructs information. When flowing in a relatively pure form, we have the mind as conduit. The optimal flow of this complex inner and inter system of mind arises when integration is allowed to naturally unfold—the linkage of differentiated parts of the system.

When we take a step back and examine direct first-person experience in integrating consciousness with a practice called the Wheel of Awareness, differentiating the knowing of consciousness in the hub from the knowns on the rim, we find a set of reports that seem to have a consilient overlap with the science of energy. That physics view suggests that energy can be conceptualized as the movement from possibility to actuality. Mapping this movement, we've seen that a “three-P framework” of the mind can be proposed as a working model for how the mind, as an emergent phenomenon of energy flow, might be visualized. This proposal enables us to have a shared way of considering how experience shapes our mind as we develop across the lifespan, seeing the continuity among awareness, states of mind, and emerging thought, emotion, and memory. Each of these will be explored in great detail as we move along in our journey.

In the next chapter, we explore the nature of states of mind, the ways in which experiences shape how the complex system of the mind unfolds, the neural basis of different states of mind, and the central role of those states in how the mind creates a coherent sense of self. As we move through each of the subsequent chapters step by step, we will occasionally return to and build upon these emerging ideas of the three-P framework and our basic proposal of mind as an embodied and relational process that arises from, and regulates the flow of, energy and information.