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The Developing Mind: How Relationships and the Brain Interact to Shape Who We Are, Second Edition. By Daniel J. Siegel.
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CHAPTER 1

Mind, Brain, and Relationships

The Interpersonal Neurobiology Perspective

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The "mind" is rarely defined in fields that focus on mental experience. This avoidance may be due to any of several well-considered reasons. There is the understandable philosophical stance that definitions may restrict a full understanding, or the notion that the mystery of the mind makes us unable to characterize its defining features. Sometimes the word "mind" is used as a placeholder for the unknown, a marker of this mysterious source of our subjective inner life. In this book, I honor these positions while taking the risky step of exploring a working definition of the mind that has been of great value in understanding how our lives develop and what a healthy mind may actually be. After all, if we do not attempt to define at least a core aspect of the mind itself, how can we state what might constitute a healthy mind?

This book explores how recent findings from a range of sciences can bring us to a new understanding of the developing mind. The sciences give us many views of how the mind functions, providing in-depth but distinct perspectives on human experience. For example, neuroscience can inform us about how the brain gives rise to mental processes such as memory and perception. Developmental psychology offers us a view of how children's minds grow within families across time. Anthropology gives us insights into how relational experiences and communication patterns within different cultures directly shape the development of the mind. Psychiatry gives us a clinical view of how individuals may suffer from emotional and behavioral disturbances that profoundly alter the course of their lives. Often these disciplines function in isolation from one another. Yet when one attempts to synthesize their recent findings, an incredible convergence of many independent fields of study is revealed. This convergence can be called "consilience"—the discovery of common findings from independent disciplines.[1] These findings shed light on how the mind emerges from the substance of the brain and is

shaped by our communication within interpersonal relationships. My aim is to provide an overview and integration of some of these scientific perspectives, which serve as a foundation for a neurobiology of interpersonal experience.

More specifically, to help you to understand the developing mind, I provide an integration of mental processes (such as memory and emotion) with both neurobiology (such as neural activity in specific circuits) and interpersonal relationships (such as patterns of communication). This integration is indeed the challenge of the book, both in the writing and in the reading. My concern is with those who, like many of my past students, are new to neurobiology; the unfamiliar ideas and vocabulary may initially feel too overwhelming to continue. Numerous teaching experiences, however, have demonstrated that the outcome is worth the effort. I have tried to include enough of a background as the chapters evolve that each topic can be understood by those who may be totally unfamiliar with a given area. No prior expertise is required. New concepts and vocabulary are inevitable, but I have tried to incorporate information throughout the book in a "user-friendly" manner, summarizing the significance of certain findings and including reminders of certain trends as they recur in the book. Whatever your personal, scholarly, or professional pursuits, you will have a better understanding of unpredictable experiences after having studied this material. Learning this approach will support the scientific view that "chance favors the prepared mind," in that your own mind will be prepared with this integrative perspective to understand and respond to what arises in life. There are many readily accessible concepts and much useful information just below the surface of these sometimes new names and ideas. A shared understanding from the beginning will help you in making sense of the intricate and exciting findings about interpersonal relationships and the developing mind. For those who are charting new waters, I welcome you to the exciting world of interdisciplinary study!

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DEFINING THE MIND

Here is a definition of the mind that enabled dozens of scientists to communicate with one another about the mind: *"A core aspect of the mind is an embodied and relational process that regulates the flow of energy and information*." In the beginning of the Decade of the Brain, the 1990s, I offered this working definition to a group of over forty scientists in order to find a common starting place for us to address the connection between the mind and the brain. With this view, all of the researchers—from anthropologists to neuroscientists—could find a common way of describing each discipline's way of exploring the nature

of reality. Energy and information flow is what is shared among people within a culture, and this flow is what is measured in subjects within a brain scanner. In this working definition, we also found a way to meet for over four years, sharing our various perspectives on the nature of what it means to be human. It was in the fertile soil of this gathering that the seeds of the interdisciplinary field that ultimately became interpersonal neurobiology (IPNB) were first sown. IPNB embraces everything from our deepest relational connections with one another to the synaptic connections we have within our extended nervous systems. It encompasses the interpersonal power of cultures and families, as well as insights into molecular mechanisms; each contributes to the reality of our subjective mental lives. IPNB is not a branch of neuroscience, but a broad field drawing on the findings from a wide range of disciplines that explore the nature of what it means to be human. Based on science, IPNB seeks to create an understanding of the interconnections among the brain, the mind, and our interpersonal relationships. IPNB can also be used to understand our relatedness beyond the interpersonal, to other living creatures and to our whole planet. With this approach, new strategies for both understanding and promoting well-being are possible. We can both define the mind and outline practical steps for how to cultivate a healthy mind as it develops across the lifespan.

The mind is an embodied and relational process that regulates the flow of energy and information.

The ideas of this framework are organized around three fundamental principles:

1. A core aspect of the human mind is an embodied and relational process that regulates the flow of energy and information within the brain and between brains.
2. The mind as an emergent property of the body and relationships is created within internal neurophysiological processes and relational experiences. In other words, the mind is a process that emerges from the distributed nervous system extending throughout the entire body, and also from the communication patterns that occur within relationships.
3. The structure and function of the developing brain are determined by how experiences, especially within interpersonal relationships, shape the genetically programmed maturation of the nervous system.

To put it simply, human connections shape neural connections, and each contributes to mind. Relationships and neural linkages together shape the mind. It is more than the sum of its parts; this is the essence of emergence.

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One view of the mind parallels a dictionary definition of the psyche: "1. the human soul; 2. the intellect; 3. psychiatry—the mind considered as a subjectively perceived, functional entity, based ultimately upon physical processes but with complex processes of its own: it governs the total organism and its interaction with the environment."[2]

This book extends this notion of the mind's being more than "simply brain activity." It offers an IPNB perspective that draws on the full range of scientific disciplines to integrate everything from the societal to the synaptic. On the brain side of mental life, current neuroscience reveals the connection between brain structure and function, and provides us with new insights into how experience shapes mental processes.[3] By altering both the activity and the structure of the connections between neurons, experience directly shapes the circuits responsible for such processes as memory, emotion, and self-awareness. We now know, too, that experience and the firing of neurons can alter the regulatory molecules that control gene expression—a process called "epigenesis."[4] These epigenetic changes reveal the powerful ways in which experience modifies how the brain develops, sometimes across the lifespan. In fact, recent studies in neuroplasticity reveal how the brain continues to modify its structural connections with experience throughout life.[5] Moreover, studies of evolution suggest that our mammalian brains are profoundly social, and that relationships have a huge impact on neuronal function from the earliest days of our lives. On the relational side of our view of mind, we can draw upon a wide range of studies from development and family function to demonstrate the importance of patterns of communication between people to shape how the mind functions. We can use an understanding of the impact of experience on the mind to deepen our grasp of how the past continues to shape present experience and influence future actions. Insights into the mind, brain, relationships, and experience can provide a window into these connections across time, allowing us to see human development in a four-dimensional way.

This book synthesizes concepts and findings from a range of scientific disciplines, including those studying attachment, child development, communication, complex systems, cultural anthropology, emotion, evolution, information processing, memory, narrative, and neurobiology. I have attempted to provide enough of an introduction so that those totally unfamiliar with these domains can understand the material and apply the relevant findings in their professional work and personal lives. When we examine what is known about how the mind develops, we can gain important insights into the ways in which people can continue to grow throughout life. *The mind does not stop developing, even as we grow past childhood and adolescence.* Through understanding the connections between mental processes and brain functioning, we can build a neurobiological foundation for the ways in

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which interpersonal relationships—both early in life and throughout adulthood—continue to play a central role in shaping the emerging mind.

The mind does not stop developing, even as we grow past childhood and adolescence.

Energy and Information Flow

The mind—the regulatory process that creates patterns in the flow of energy and information—can be described as emanating in part from the activity of the neurons of the distributed nervous system.[6] Keep in mind that the "single-skull" view of mind as merely a product of the brain may be too limited. We have evolved to be social, and mental processes are a product of our inner neural connections as well as our interpersonal communicative connections with others. Without this reminder, it may be too easy to slip into the linear thinking that "mind is simply the brain's activity." The scientifically grounded view proposed in this text is that the mind arises from beyond the functioning of an isolated nervous system. Both our internal neural functions and our shared communicative processes give rise to the process defined here as mind.

It is important to underscore this issue right from the start. Sometimes neuroscience researchers or the popular media imply that the mind is simply the output of the brain. In this often-expressed view, mental life is equated with brain activity—an outcome of the firing of neurons within the brain. But in this book I take a broader view that perceives mental processes as emerging from neural functions throughout the whole body (not only the brain in the skull) *and* from relational processes (not only from one bodily self or nervous system). The mind is embodied, not just enskulled. And the mind is also relational, not a product created in isolation. These relationships include the communication an individual has with other entities in the world, especially other people. This book focuses especially on the important ways in which interpersonal relationships shape how the mind emerges in our human lives. But we also have a relationship with nature, with this planet, with the Earth upon which we live, that shapes our mental (and physical) lives as well. This is a vital form of relationship that sustains us in the air we breathe and the water we drink. But this book is focused primarily on the person-to-person aspect of our relationships. This is the social nature of the "embodied and relational process that regulates the flow of energy and information."

The implications of this definition are significant, as I hope you'll see in the journey through these pages. One implication is that we don't "own" our minds—that we, our individual "selves," are interdependent on others for the functioning of our minds. This relational part of the definition makes

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some people uncomfortable. Yet if you are in a family, or in a one-to-one relationship, you know that your subjective, inner mental life is profoundly influenced by others. On the scientific side, any anthrolopologist or sociologist knows from research how real this relational component of our mental lives truly is. And so what we need is a link that connects the social with the synaptic. To achieve the essential ability to move readily between these two levels of human reality, we will have to define the common ground that links them.

When one of us speaks to another, the voice box stimulates the movement of air molecules manifested as kinetic energy. The eardrum responds to this energy flow by creating electrochemical energy movement within the acoustic nerve and downstream neural circuits of the brain. Ions flow in and out of the neural membranes, and the release of chemical transmitters activates downstream neurons. When these patterns of neural firing match with prior learning, then this "energy flow" has informational value, and the listener can understand what the speaker has said.

Here we can see how "communication" is based on the *sharing* of energy and information. But what are these shared elements of mental life? Several different measures of *energy* can be used to study the different forms that energy flow takes. Brain imaging studies examine the metabolic, energy-consuming processes in specific neural regions, or the blood flow to certain areas that are thought to be a clustering of localized neuronal activity. Electroencephalograms (EEGs) assess the electrical activity across the surface of the brain as measured by electrodes on the head. These assessments of "energy flow" are not popularized, unscientific views of the flow of some mysterious substance through the universe. Neuroscience studies the way in which the brain functions through the energy-consuming activation of neurons. The degree and localization of this arousal and activation within the brain—this flow of energy—directly shape our mental processes.

But the mind is involved in more than the regulation of the flow of energy. The mind is also about regulating the flow of *information*.[7]

What is information? At the most basic level, "information" consists of swirls of energy that have symbolic meaning. If I say the term "glicanera," and you do not understand Greek, you will not derive information from that sound. Yes, the letters themselves have information; a "g" is pronounced "gee," and when it is combined with all the other letters, you can say the word "glicanera." In that way, the letters are bits of information—squiggles that stand for certain sounds. But the whole word may have no symbolic reference. If you speak Greek, you will "know" that this word means "sweet water," and that it is also the name of a magnificent beach

"Information" consists of swirls of energy that have symbolic meaning.

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on Crete. Now you know that the word "glicanera" stands for something more than the sounds of the letters. This information comes from the way the symbolic meanings are embedded in that set of sounds—the pattern of energy flow in "glee-kah-nehr-ah."

Within IPNB, we view mind, brain, and relationships as three aspects of energy and information flow. Brain is the embodied neural *mechanism* shaping that flow; relationships are the *sharing* of the flow; mind is the embodied and relational process that *regulates* the flow of energy and information. If we ask, "Where is the mind?", we can say that its regulatory functions are embodied in the nervous system and embedded in our interpersonal relationships. This emergent process of both the neural and the interpersonal locates the mind within both the physiological and relational frame of reality. The mind develops in the interaction of at least these two facets of our human lives.

Mind, brain, and relationships are not three separate elements. Instead, we are proposing that they are "three aspects of one reality"—that is, energy and information flow. Just as we have heads and tails of one coin, we can have many facets of one entity. This aspect of mind *regulates* the flow of energy and information as it is *shared* within relationships and moves through the physical *mechanisms* of the brain, the embodied neural connections within the extended nervous system distributed throughout the whole body. This "embodied brain" is simply referred to hereafter as the "brain," for ease of reference, reading, and writing. Please note, too, that a self-organizing process like the mind is an emergent property of a system. This process both *arises from* the interaction of the system's elements (energy and information flow within the body and are shared between people) and also *regulates* in a recursive way the very elements from which it arose. This recursive, reentry property of mind, typical of self-organizing emergent processes, means that relationships and brain shape mind and mind shapes relationships and brain. Mind, brain, and relationships are three aspects of one system: regulation, embodied mechanism, and sharing of energy and information flow. We'll be exploring these intricate and fascinating aspects of the mind throughout the pages of our journey together. Figure 1.1 shows this triangle of human experience, with mind, brain, and relationships representing aspects of energy and information flow.

This may be a new way for you to think, but embracing mental, neural, and relational processes as involving energy and information flow patterns is a powerful way to blend science with the subjective nature of our human lives. Naturally, our mental experience is far more than a regulatory process; it involves the subjective quality of our consciousness and the inner ways of knowing that enrich our sense of feeling, meaning, purpose, love, connection, and wholeness. However, learning about the regulatory aspect of mind

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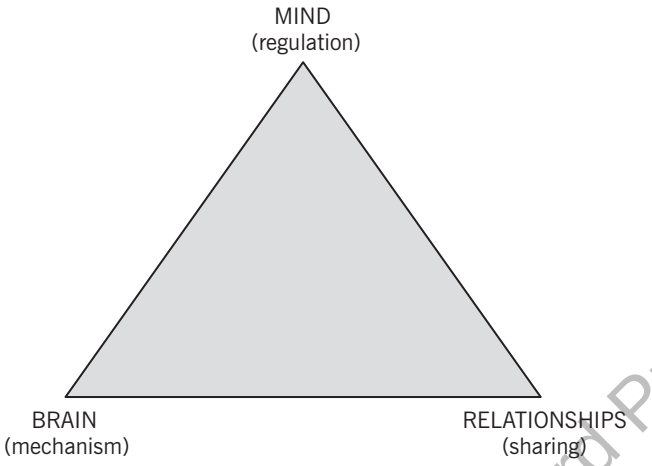

FIGURE 1.1. Three aspects of energy and information flow. Adapted from *The Mindful Therapist: A Clinician's Guide to Mindsight and Neural Integration* by Daniel J. Siegel. Copyright © 2010 by Mind Your Brain, Inc. Used by permission of W. W. Norton & Company, Inc.

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empowers us to see more deeply into the ways the mind develops as the brain changes and as relationships evolve over time. As you'll see, certain patterns of this flow involve a flexible and adaptive outcome; mind, brain, and relationships can be intentionally moved toward health. This pattern of healthy living involves the *integration of energy and information within the nervous system and between people*. Integration is the organizing principle that links the ways energy and information flow is shared (relationships), is shaped (the mechanisms of the embodied nervous system or, termed simply, the brain), and is regulated (the mind).

Integration

The mind has distinct modes of processing information. For example, our sensory systems can respond to stimuli from the outside world, such as sights or sounds, and can "represent" this information as patterns of neural firing that serve as mental symbols. The activity of the brain creates "representations" of various types of information about the outer and inner worlds. For example, we have representations of sensations in the body, of perceptions from our five senses, of ideas and concepts, and of words. Each of these forms of representation is thought to be created in different circuits of the brain. These information-processing modes can act independently, and they also have important interactions with one another that directly affect

their processing. We can have complex representations of sensations, perceptions, ideas, and linguistic symbols as we think, for example, of some time in the past. The weaving together of these distinct modes of information processing into a coherent whole may be a central goal for the developing mind across the lifespan. *This process of linking differentiated parts into a functional whole is called "integration."* As we'll see, integration is a unifying principle that will help us to understand the linkage of mind, brain, and relationships throughout our discussions. Furthermore, in IPNB, we propose that integration is the heart of health.

Linking differentiated parts into a functional whole is called "integration."

Interpersonal relationships may facilitate or inhibit this drive to integrate a coherent experience. Relationships early in life may shape the very neural structures that create representations of experience and allow a coherent view of the world: Interpersonal experiences directly influence how we mentally construct reality. This shaping process occurs throughout life, but is most crucial during the early years of childhood. Patterns of relationships and emotional communication directly affect the development of the brain. Studies in animals, for example, have demonstrated that even short episodes of maternal deprivation have powerful neuroendocrine and epigenetic effects on the ability to cope with future stressful events. Studies of human subjects reveal that different patterns of child–parent attachment are associated with differing physiological responses, ways of seeing the world, and interpersonal relationship patterns.[8] The communication of emotion may be the primary means by which these attachment experiences shape the developing mind. Research suggests that emotion serves as a central organizing process within the brain. In this way, an individual's abilities to organize emotions—a product, in part, of earlier attachment relationships—directly shapes the ability of the mind to integrate experience and to adapt to future stressors.

Differentiation and Linkage

To understand integration, we must unpack its two fundamental components: "differentiation" and "linkage." Differentiation is how parts of a system can become specialized, unique in their growth, individualized in their development. Linkage involves the connection of separate areas to each other, often involving the sharing of energy and information flow. When differentiated areas become linked, they retain some of their essential qualities while also becoming a part of a functional whole. Here we see how integration makes the whole greater than the sum of its parts. In mathematics, we use terms such as "complexity" and "coherence" to describe such linkage of differentiated parts. In biological terms, we can see how individuals develop, growing

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ever more differentiated and interconnected over a lifetime and across the generations. In day-to-day terms, vitality and harmony emerge from integration. From simple, less integrated stages of development, differentiation and linkage can create more sophisticated and intricate functions. Such integration gives rise to flexible and adaptive functions. This is the essence of health.

There are important scientific implications for systems that link differentiated parts to one another. Like a choir, they move toward harmony in an integrated state. Yet if such integration is impaired, the result is chaos, rigidity, or both. Chaos and rigidity can then be seen as the "red flags" of blocked integration and impaired development of a mind. Taking note of this pattern has profoundly useful implications for understanding impediments to health and for promoting health through integrative development. For example, attachment can be understood as how parents have come to integrate their own inner self-awareness with their relationship with their children—honoring differences, cultivating compassionate linkages. An integrated relationship is a healthy relationship.

Here is a fabulous finding verified by studies in neuroplasticity: How we learn to focus the mind can change the brain. If we learn the basic approach of linking differentiated parts of our lives—our nervous systems and our social connections with others—we can move internally and interpersonally toward integration and health. Lack of integration can help explain otherwise mysterious patterns underlying how some individuals become stuck in their growth and development.[9] Given that the focus of the mind can change brain activity and structure, knowing something about brain anatomy and function can empower us to transform our lives and intentionally move our development toward health. This book creates a view of the developing mind by examining the interdependent mental, relational, and neural processes that are the foundational aspects of energy and information flow within and among people.

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THE ORGANIZATION OF THE BOOK

This book is composed of two general forms of information. First, scientific findings from a range of disciplines are summarized and synthesized to construct a conceptual foundation for an "interpersonal neurobiology" of the developing mind. This scientific foundation creates a new, interdisciplinary view of established knowledge. Second, conceptual implications and new proposals derived from data, clinical experience, and synthetic reasoning across disciplines can then be drawn from this framework. Here we are "moving beyond the data" with caution and intention, but doing so out of

necessity. Much as in the old Indian fable of the blind men and the elephant, we need to fill in the gaps in our knowledge to create a "whole-elephant" view of reality. I have tried my best to clarify where we are synthesizing established views from science and where we are making hypotheses from this existing data.

Each chapter explores a major aspect of human experience: awareness, memory, attachment, emotion, states of mind, representations, self-regulation, interpersonal connection, and integration.

Brain Anatomy and Awareness

In the remainder of this first chapter, we will dive into the basics of brain anatomy and function so that we start with a common understanding of this point on our triangle. Much remains unknown about neural processes, but having a basic scaffold of shared knowledge will be of great benefit. We will also begin to explore the wonderful and mysterious world of consciousness, examining some aspects of its subjective nature and its neural correlates. The fact is, we don't really know how the physical property of neural firing and the subjective experience of being aware of something create each other. I raise this issue from the start because it is a fundamental unanswered question. Conscious awareness is a useful modality for examining this fascinating question, and we will explore the science of how neural function may be correlated with the subjective experience of being aware.

We don't really know how the physical property of neural firing and the subjective experience of being aware of something create each other.

Memory

In Chapter 2, I summarize research on various forms of memory to help us understand how our earliest experiences shape not only what we remember, but also how we remember and how we shape the narrative of our lives. Memory can be seen as the way the mind encodes elements of experience into various forms of representation. As a child develops, the mind begins to create a sense of continuity across time, linking past experiences with present perceptions and anticipations of the future. Within these representational processes, generalizations or mental models of the self and the self with others are created; these form an essential scaffold for the growing mind's interactions with the world.

The narrative process is one way that the mind attempts to integrate these varied representations and mental models. Autobiographical narratives are reviewed to explore how the mind creates coherence within its own

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processes and how this central integrative function influences the nature of interpersonal relationships.

Attachment

Awareness, memory, and autobiographical narrative set the stage for Chapter 3, which examines attachment in children and adults. Repeated patterns of children's interactions with their caregivers become "remembered" in the various modalities of memory and directly shape not just what children recall, but how the representational processes develop. Behavior, emotion, perceptions, sensations, and models of others are engrained by experiences that occur before children have autobiographical memory processes available to them.

A profound finding from attachment research is that the most robust predictor of a child's attachment to parents is the way parents narrate their own recollections of childhood during the Adult Attachment Interview. This implies that the structure of an adult's narrative process—not merely *what* the adult recalls, but *how* it is recalled—is the most powerful feature in predicting how an adult will relate to a child. These attachment studies provide a framework for understanding how communication within relationships facilitates the development of the mind.

Emotion

The primary ingredient of secure attachment experiences is the pattern of "emotional communication" between child and caregiver. This finding raises the fundamental question of why emotion is so important for the evolving identity and functioning of a child, as well as in the establishment of adult relationships. It also raises the question as to what exactly is "emotion." Why does a child require emotional communication and the alignment of emotional states for healthy development? To attempt to answer these questions fully, we need to synthesize a number of independent perspectives. The way the mind establishes meaning is closely linked to social interactions and both meaning making and relationships appear to be mediated via the same neural circuits responsible for initiating emotional processes. Emotion can thus be seen as an integrating process that links the internal and interpersonal worlds of the human mind.

States of Mind

Chapter 5 examines how different mental processes are organized within a state of mind. These states allow disparate activities of the brain to become linked at a given moment in time. A single brain functions as a system that

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can be understood by examining the "theory of nonlinear dynamics of complex systems," or, more briefly, "complexity theory." Chapter 5 proposes how the laws of complex systems that deal with emergent processes and self-organization can be applied not only to the single mind, but also to the functioning of two or more minds acting as a single system. This new application allows us to deepen our discussion of states of mind and their fundamental importance in creating internal subjective experience and shaping the nature of human relationships.

Representations

Chapter 6 reviews in detail how the mind creates representations—mental symbols—of experience. Our internal experiences are constructive processes. That is, our emotions, states of mind, and interpersonal relationships help shape the ways in which these representational processes develop.

This chapter also looks at how differences in the hemispheres of the brain shape the creation of representations. The brain has an asymmetry in its circuitry, which leads to the specialization of functions on each side of the brain. The capacities to sense another person's emotions, to understand others' minds, and even to express one's own emotions via facial expressions and tone of voice are all mediated predominantly by the right side of the brain. In certain insecure attachment patterns, communication between parent and child may lack these aspects of emotions and mental experience. In contrast, secure attachments seem to involve the sharing of a wide range of representational processes from both sides of the brain. In essence, balanced interpersonal communication allows the activity of one mind to sense and respond to the activity of another. The ways we connect with each other directly shape how we "regulate" our emotions and alter our states of mind. In other words, dyadic regulation directly shapes "self-regulation," the topic of the next chapter.

Our internal experiences are constructive processes.

Self-Regulation

Chapter 7 explores self-regulation—the way the mind organizes its own functioning. Self-regulation is fundamentally related to the modulation of emotion and self-organization. As we'll see, this process involves the regulation of energy and information flow via the modulation of arousal and the appraisal of meaning. Emotion regulation is initially developed from within interpersonal experiences in a process that establishes self-organizational abilities.

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Interpersonal Connection

Chapter 8 examines the nature of the connections between minds. Interpersonal relationships shape the mind by allowing new states to emerge within interactions with others. Early in development, patterns of communication between parent and child help determine the ways in which self-regulation emerges. Self-organization thus emerges out of self–other interactions. These patterns can help us to understand how relationships throughout life may facilitate emotional well-being. Examples from families and individual patients in psychotherapy are offered to illustrate these ideas.

Integration

How the self creates a sense of coherence across time is reflected in the concept of integration, the central topic of Chapter 9. As noted earlier, "integration" refers to the way the mind links differentiated parts. The mind establishes a sense of coherence by linking states of mind across time.

By organizing the self across past, present, and future, the integrating mind creates a sense of coherence and continuity. Integration can be assessed by examining the structure of autobiographical narratives. Narrative coherence is reflected in the way a life story is told and the manner in which life is lived. In this way, an attachment history revealed in an adult attachment narrative reflects the individual's capacity to integrate a coherent sense of self. Various forms of mental dysfunction may signal that integration is impaired, leading to a sense of paralysis or chaos. From the perspective of interpersonal neurobiology, the signs, symptoms, and syndromes described in the *Diagnostic and Statistical Manual of Mental Disorders* (the DSM-IV-TR)[10] can be interpreted as actually describing chaos, rigidity, or both. However, human relationships can foster resilience and emotional well-being by facilitating an integrative capacity.

Throughout our journey together, we'll be exploring new ways to understand established findings that move us further in understanding human development. My overall goal is to create a scientifically grounded, interdisciplinary view that deepens our grasp of the developing mind and helps create stronger minds, healthier relationships, and more integrated brains for the generations ahead.

Let us now turn to look at the "brain" aspect of energy and information flow—but please keep in mind the complete triangle of mind, brain, and relationships as it reveals the interdependent nature of these three aspects of one reality. What are the mechanisms by which human relationships shape brain structure and function? How is it possible for the interactions between people to affect something so inherently different as the activity of neurons?

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Exploring insights from neurobiology—the study of the way neurons work and how the brain functions—will greatly enhance our ability to address these basic questions. We'll then turn to some basic ideas about how we can use awareness, the mental experience of consciousness, to intentionally alter the structure of the brain. The very focus of our attention can create neural firing patterns that can change the brain's physical connections. Given that interpersonal relationships guide how we focus our attention and therefore how our neural firing patterns emerge, our social experiences can directly shape our neural architecture. Put simply, our relational connections shape our neural connections. This interactive process occurs throughout the lifespan.

Our social experiences can directly shape our neural architecture.

THE EMBODIED BRAIN

The Organization of the Brain

The brain is a complex system of interconnected parts. At its most basic level, the skull-based portion of the nervous system consists of over one hundred billion "neurons" and trillions of supportive "glia" cells. Collectively, these neurons are over two million miles long. Each neuron has an average of ten thousand connections that directly link it to other neurons.[11] Thus there are thought to be about one million billion of these connections, making it "the most complex structure, natural or artificial, on earth."[12] 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 is an example of electrochemical energy flow. A synapse is the connection that functionally links neurons to one another. These synaptic connections help form the linkages that are the foundation for the intricate architecture of the brain. Because of the spider-web-like interconnections, activation of one neuron can influence an average of ten thousand other neurons. The resulting set of neurons that are firing together is called a "neural net profile," which signifies a pattern of neural activity clustered into a functional whole. Such a neural net profile, for example, can 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.[13] This means that the number of firing patterns possible across a lifespan is virtually

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infinite. The number of possible "on–off" patterns of neuronal firing even in a given moment of time is immense, estimated as a staggering ten times ten one million times (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. 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 1.2 is a schematic drawing of the basic structure of the brain.

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Lower Brain Structures

The "lower structures" include those circuits of the brainstem deep within the skull that mediate basic elements of energy flow, such as states of arousal

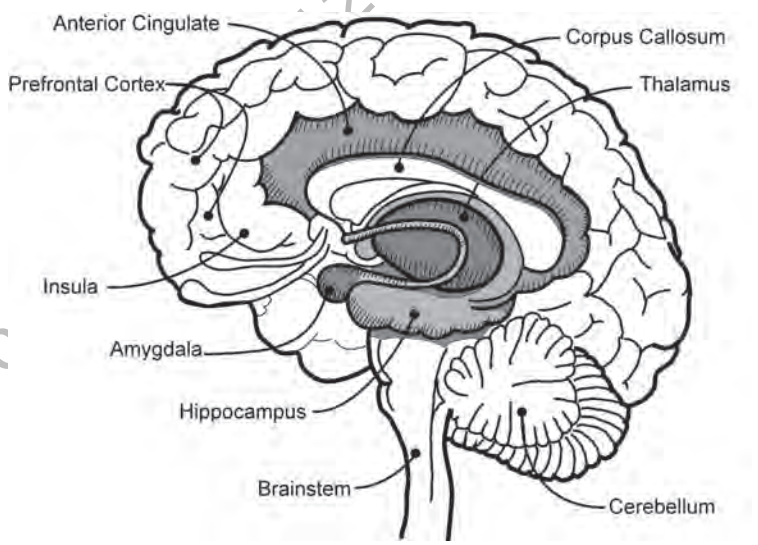

FIGURE 1.2. Diagram of the right hemisphere of the human brain. The lower areas include the cerebellum and the brainstem; the central areas include the limbic regions (amygdala, hippocampus) and thalamus; the upper areas include the cortical regions. Copyright 2012 by Mind Your Brain, Inc.

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 and are fundamental to the "polyvagal theory" of self-regulation.[14] 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.[15] Other proposals suggest that various regions contribute to different elements of consciousness, and to a wide range of senses of a self.[16]

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). 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. Stress is often responded to by the "hypothalamic–pituitary–adrenocortical (HPA) axis," 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 gene regulation alterations in response to experience are a part of a process called "epigenesis."[17] 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.

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

Central Brain Structures

The more centrally located "limbic regions"—including the clusters of neurons called the "hippocampus" and "amygdala"—play a central role in coordinating the activity of various regions. The limbic regions are thought to

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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 upon 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 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. This "outer bark" of the brain consists of highly folded layers, usually about six cells 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 in the chalkboard of the mind to dial a phone number, for example—and the focusing of conscious attention. The middle prefrontal area includes 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, while others recognize the interface role these regions play between the lower limbic and the higher cortical areas and refer to them at times as "paralimbic cortex." In this manner, the middle prefrontal region can be seen, in fact, as the uppermost part of the limbic system as well as a part of the frontal lobes of the neocortex. These bridging areas are part of a "team" of middle prefrontal regions that work together as a functional whole to link widely

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separated areas to one another. They have important integrative functions that help coordinate and balance cortical activity of thought and feeling with the lower limbic, brainstem, and bodily areas' functions. As we'll soon see, this region also links the perception of communication signals from other people to these 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. "Interconnected" means that the long axonal fibers link widely separated clusters of neurons to each other in a spider-web-like configuration. "Integrated," as we've seen, means that these separate, differentiated areas maintain their unique features while also becoming linked. It's crucial to keep in mind that integration is not becoming blended or "all one," but rather involves the maintenance of differences while facilitating connection. This is truly how the whole is greater than the sum of the parts. The linkage of differentiated parts of a system is the definition of integration, 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. Although each element of such a system contributes to the functioning of the whole, certain regions play an important role in integrating brain activity. These include the 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. 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 integration that may depend on these and other integrative circuits.

To summarize this point succinctly, self-regulation appears to depend upon neural integration. As we'll see, optimal relationships are likely to stimulate the growth of integrative fibers in the brain, whereas neglectful and abusive relationships specifically inhibit the healthy growth of neural integration in the young child.[18] Even impairments to health that are not experientially derived, such as autism, bipolar disorder, and schizophrenia, have now been shown to reveal impairments to neural integration.[19]

Self-regulation appears to depend upon neural integration.

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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 1.3.) 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. 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 that generally mediate perceptual processing of the outside world but also play important roles in social perception, such as the temporal lobe of the cortex. 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

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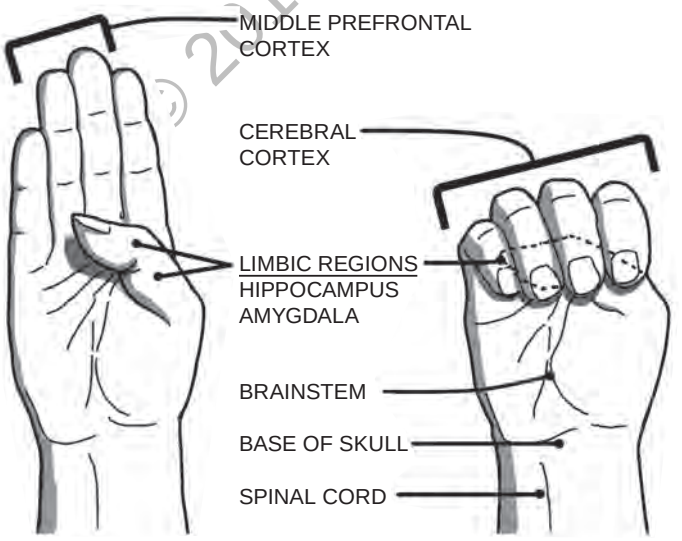

FIGURE 1.3. Hand model of the brain. Adapted from Siegel (2010a, p. 15). Adapted with permission from Bantam Books. Copyright 2012 by Mind Your Brain, Inc.

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 prefrontal region, and so let us refer to this cluster of horizontally and vertically "middle" regions simply by the term "middle prefrontal" cortex. Notice on your hand model that these middle two fingernail areas representing the position of the middle 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.[20] 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 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.[21] As we shall see, recent studies from neuroscience suggest that this middle 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.

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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.[22] 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.[23] Cortisol in sustained and elevated levels can become toxic to the brain.[24]

The essential take-home message here is that early experience shapes the regulation of synaptic growth and survival, the regulation of response to stress, and even the regulation of gene expression. Experience directly shapes regulation.

More common, everyday experiences also shape brain structure. 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. 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. Lack of experience for these circuits can lead to cell death in a process called "apoptosis," or to the diminution of synaptic connections in a process called "parcellation" or "pruning." This is sometimes called a "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 with experience.

Early experience shapes the regulation of synaptic growth and survival.

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.

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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 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.[25]

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 early years are when basic architecture in the brain is laid down. 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 growth of new neurons and the establishment of new and more extensive synaptic connections between neurons in certain regions, 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.
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.[26] 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.

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Studies suggest, too, how gene expression is altered following experiences. 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 ways in which we may have embedded in our own nuclear material the ways in which our parents and even our grandparents experienced stress, had alterations in their epigenetic control mechanisms, and then passed these changes on to us via the gametes from which we were formed.[27] 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 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 the integrative communication stimulates the healthy growth of integrative fibers in the brain. Given the proposal 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. New findings on the study of neuroplasticity reveal that the brain is open to further development throughout the lifespan.[28] From studies of early interpersonal experience, we can try to understand how relationships may continue to foster the development of the mind throughout life.

Interpersonal experiences continue to influence how our minds function throughout life.

Information Processing and Neurobiology

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

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physiological data from the body. They are received and processed by 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 middle prefrontal area, the "insula" (which is 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 middle 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.[29]

An analogy is this: 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 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.

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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 not only serves to activate the energy flow to these regions; it is 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.[30] 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.[31] Even the ability to perceive the mental side of life may require interactions with caregivers in order to develop properly.[32]

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 enters 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 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

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creates representations, as well as stimulating the capacity for specific forms of information processing. This is how learning occurs.

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.[33] Furthermore, the brain is a complex system, meaning that there are multiple layers of component parts capable of chaotic behavior.[34] 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, 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. 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.[35]

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. Yet the embryonic origins of the nervous system itself as coming from what initially was ectodermal cells—the layer

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destined to become our skin, which 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 both embodied and relational. 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. The regions balancing and coordinating the state 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 the middle prefrontal cortex, that serve to regulate internal states are 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.[36] From this perspective, 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 aspect 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.

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

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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, DSM-IV-TR's entire listing of psychiatric disorders can be reframed within this perspective as revealing chaos and/or rigidity, and so as reflecting impaired integration. Recent studies in trauma[37] and in neural functioning in the nontask-performing default mode or "resting state"[38] support this proposal that impaired integration is the common mechanism among disorders of health, whether they have primarily experiential or non-experiential (e.g., genetic, toxic, infectious, or random) origins.

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.[39] Furthermore, the "regulation of emotion" may be dependent on large-scale integrative processes—ones that emerge from prefrontal coordination and balance, as well as from interpersonal experiences within one-on-one relationships, families, communities, and even the larger culture in which we live. Relationships that are attuned—ones that honor differences and cultivate compassionate connections—are integrative relationships that promote health. 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 will directly shape 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.[40] 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 with harmony or its impediments with chaos and rigidity. Integration, in relationships and in the brain, is the substrate for well-being from this perspective. Integration can be seen as a deep mechanism

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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 examine.

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 "What parents do has no effect on their children's development." It is certainly true that temperament and other constitutional variables play a huge, and perhaps previously underrecognized, role in child development.[41] However, riding the pendulum swing of "What shapes development?" to either the genetics end or the experience end can lead to erroneous conclusions.[42]

A wide range of studies[43] 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 *and* experience-dependent. Genes have two major functions.[44] 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. Molecules on the chromosome 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.[45]

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.[46] These responses in turn shape the way in which neuronal growth, interconnections, and pruning (dying back) occur.

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The development of the mind has been described as having "recursive" features.[47] 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 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.[48] 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 of the personality features 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.[49] 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.[50] 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.[51] However, it is important to avoid conclusions drawn from adult differences that may be due to cultural factors experienced throughout childhood and adolescence. I do not want to overstate the innate neural differences between individuals of either gender. (For various studies of how culture shapes neural development, please see the wide range of research projects described at our Foundation for Psychocultural

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Research–UCLA Center for Culture, Brain, and Development website, *cbd.ucla.edu*.) Excessive judgments about these gender differences can cause an observer to miss the reality that there is far more in common across the genders than there are neurally determined distinctions.

The complicated interaction of genes, experience, and epigenetic regulation is also revealed in the inheritance patterns of certain psychiatric disorders, such as schizophrenia.[52] 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 or 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 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.[53] 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.

The epigenetic regulation of gene expression may vary even in individuals who share the same genes. Adolescence is a period of intense pruning of the nervous system, and vulnerable brains may be especially at risk following this period of development. 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.[54] 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 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

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expression changes brain structure and shapes the developing mind. The functioning of the mind—derived 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.[55] This is clearly seen in the production of corticosteroids as a response to stress, which directly influences gene function.[56] 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.[57] Likewise, a child traumatized early in life will have an alteration in physiological response, such that small stressors lead to large hormonal responses.[58] Thus both constitutional and 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.[59] 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.[60] 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.

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Relationships and the Brain

I am proposing in this book that the mind develops as relationships and the 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 people. 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 even with a common cold have improved immune function and recover one day sooner when they see a physician who is empathic?[61] 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.[62] 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.[63] 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.[64] 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.[65] 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 3, 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.[66] 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 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

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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 enables us to then intentionally move this flow toward integration and thus toward health.

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

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 only occur during childhood or adolescence. The brain continues to change in response to experience throughout the lifespan. We are in 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 to have other individuals simultaneously experience a state of mind similar to our own. We need to be a part of a whole 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 health as we age.[67] 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. In the next section, emphasis shifts more directly to mind and how it emerges from the interface of relationships and neural function.

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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. 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.[68] Just as we do not struggle to resolve the primes of two sides of one coin, we can also consider that mental and neural are two aspects of one reality of energy and information flow.

That said, we can describe at least three dimensions of the mind. One is the mind's regulatory function that governs the flow of energy and information, as described earlier. If we define this first core feature, 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. The second core aspect of mind is the phenomenon of being aware, of having an internal sense of knowing that is part of what we call "consciousness." A third aspect of mind is our subjective internal life, which shapes our sense of self and our connections to others in the world. Ultimately, this subjective aspect of mind is a wondrous mystery. What are these aspects 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 side of mind, we can actually come to practical insights that are quite useful. In teasing apart these three core dimensions of mind—regulation, 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.

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Regulating Energy and Information Flow

When we regulate anything, we need to monitor and then modify that which is being regulated. These 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 excitation 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

Regulation results from integration.

feature of mind that can improve the way we raise our children, teach, conduct therapy, and live our day-to-day lives.[69] The underlying possibility is that the power of awareness can be used intentionally to cultivate integration in our relational and neural lives. If being aware in this way can transform lives, what do we know about the process of consciousness? What does it mean to be consciously aware?

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 inner subjective experience of being aware, which is not 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, 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.[70]

These important and fascinating studies of neural correlations do not solve 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.[71] 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.[72] Physically interconnected circuits of the brain, from the brainstem up through the thalamus and connecting with the cortex, may weave a neural pattern that gives rise to consciousness.[73] But it is important to keep in mind that these proposals, even if true, do not answer the basic question. Even if the physical and the mental occur simultaneously in time, we just don't have a clear model for how the way you see the color red in your subjective life and the firing of

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the areas of your brain 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.[74] 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.[75] 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?[76]

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.[77] 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 how our mental lives are shaped directly by our interactions with others. Let's try to keep an open mind for the possibility that the arrows of causality of the triangle of human experience point in all directions: Brain influences mind and relationships; relationships influence mind and brain; mind influences 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.[78] Being aware in 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.

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.[79] Our position in IPNB is to embrace the view that there are at least three "primes" of one reality—mind, brain, and relationships, as mentioned

Being aware in our mental lives permits conscious choice.

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earlier. Each is a unique and irreducible aspect of energy and information flow. Our mental lives—awareness, subjectivity, and the regulatory facet of the mind—are emergent processes that arise from both neural and 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 "brain" as an embodied mechanism of that flow, and "relationships" as the 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, brain, and relationships are three aspects of the one reality of patterns in the flow of energy and information.

Much of what occurs within our neural, relational, and mental lives 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 be with or without our being aware. 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.[80] In this text, however, I use the term "nonconscious" rather than "unconscious" to refer to the processes of which we are not aware, in order to avoid the many historical and sometimes limiting nonconscious associations that arise with the "unconscious" term. I hope Freud would approve.

Information that enters consciousness is important because it 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."[81] 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 which we are aware of. As we'll see in Chapter 2, focal attention enables a form of flexible

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memory called "explicit processing" to be created in the brain. With conscious awareness, we also create purpose and can 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 is sometimes called "phenomenal consciousness." 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 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.[82] Again we see measureable scientific findings that the nonmeasureable subjective world is

Our relationships directly influence our internal experience of being aware.

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of vital importance. Researchers have viewed this intersubjective aspect of consciousness as a primary influence in how the experience of awareness develops.[83] Our relationships directly influence our internal experience of being aware.

Conscious awareness can also involve a relationship with our own internal subjective lives; it can be a way of taking "time-in" to focus on our internal subjective states. As children develop, their interactions with caregivers can influence how they become aware of their own internal worlds. How we pay conscious attention to our own bodily experiences can profoundly influence how consciousness arises.[84] 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 middle prefrontal area (the anterior cingulate) is responsive both to physical pain and to social rejection.[85] 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,[86] 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,[87] 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

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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,"[88] 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.[89] 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.[90] 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 signify the experience of being aware, the internal state of knowing that something is happening in the present moment. 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 it with related representations, and the performing of designated informational transformations (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 and exists across a wide array of other species.

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

"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."[91] 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. The awareness of these inner states is a direct feeling and knowing beyond information; they are as close to the sense of "the thing itself" as we can get within our conscious experience.

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[92] and is proposed to play a role in the unfolding of consciousness.[93] Other terms for this capacity are "theory of mind," "mind-mindedness,"

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"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,[94] whereas more internally based senses of awareness emerge during the second year of life.[95] 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.[96] 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. In other words, we may be aware 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 earlier. 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 the "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 "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. These are all intriguing questions that remain to be illuminated with future explorations.[97] The important point here is to consider these open questions so that we can imagine how mind, brain, and relationships co-influence their own development across the lifespan.

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Mindful Awareness

One form of awareness is the recently researched but ancient practice 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 being swept up by judgments.[98] This is the opposite of being on "automatic pilot" or being

"mindless" in our actions. When we speak of "awakening the mind," this often refers to the way in which we can become alive and attend to the details of ordinary experience as if it were extraordinary.[99] Mindful awareness can enable our inner sense of knowing and subjective experience of being alive to attain a new sense of vitality, detail, and clarity. Being present in this way has been scientifically demonstrated to support mental, physical, and social well-being.[100]

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 having self-observation.[101] 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 that 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 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 form of positive regard for self and others. When we "take time-in" with positive regard for ourselves and others, we cultivate mindfulness as a trait in our lives.

Mindful awareness 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 with increased 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.[102] This can be seen as a sign of "neural resilience." Primary care physicians who are taught mindful awareness, for example, have less burnout and enhanced empathy for their patients.[103] A study of intensive meditation training reveals that the cultivation of mindful awareness leads to increased telomerase, the

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enzyme that maintains the integrity of chromosomes by supporting the telomeres at their ends, and thus increasing cell life.[104] Patients listening to a mindfulness recording during the light treatment for psoriasis heal four times more quickly than other patients.[105] 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.

A recent study suggests that parents who have mindful traits may also have a state of mind called "secure with respect to attachment." This enables them to have children who themselves are securely attached to their parents and develop well.[106] As we'll see, this connection between mindfulness 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 self-compassion and kindness, we are in an internally integrated and mindful state.

Mindful awareness is a profoundly integrative internal process.[107] The observing self is open and receptive to the experiencing self, moment by moment. Research has demonstrated that being present with mindful awareness promotes health across the entire triangle of well-being, involving mind, brain, and relationships. Attachment relationships that promote well-being 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.

We return to the topic of attachment and how it influences the developing mind in Chapter 3. In the next chapter, we explore the nature of memory, the ways in which experiences shape its development, its neural basis, and its crucial role in the mind's creation of a coherent sense of self.

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