The Mind and the Brain: Neuroplasticity and the Power of Mental Force - Jeffrey M. Schwartz, Sharon Begley (2003)

INTRODUCTION

Hamlet: My father, methinks I see my father.
Horatio: O! where, my lord?
Hamlet: In my mind's eye, Horatio.

—***William Shakespeare***

Every Tuesday, with the regularity of traffic jams on I-405, the UCLA Department of Psychiatry holds grand rounds, at which an invited researcher presents an hour-long seminar on a "topic of clinical relevance." One afternoon in the late 1980s, I saw, posted on a bulletin board at the Neuropsychiatric Institute, an announcement that stopped me cold. One of the nation's leading behavior therapists was scheduled to discuss her high-profile and hugely influential work with obsessive-compulsive disorder (OCD), the subject of my own research as a neuropsychiatrist. OCD is a condition marked by a constant barrage of intrusive thoughts and powerful urges, most typically to wash (because patients are often bombarded with thoughts about being dirty and contaminated with deadly pathogens) and to check (because of irresistible urges to make sure an appliance has not been left on, or a door left unlocked, or to satisfy oneself that something else is not amiss). I had a pretty good idea of what to expect—the speaker was widely known in medical circles for her application of rigorous behaviorist principles to psychological illnesses. "Rigorous," actually, hardly did the behaviorist approach justice. The very first paragraph of the very first paper that formally announced the behaviorist creed—John B. Watson's 1913 classic, "Psychology as the Behaviorist Views It"—managed, in a single throw-down-the-gauntlet statement, to deny man's humanity, to dismiss the significance of a mind capable of reflection, and to deny implicitly the existence of free will: "The behaviorist," declared Watson, "recognizes no dividing line between man and brute."

Rarely in the seventy-five years since Watson has a secular discipline adhered so faithfully to a core principle of its founder. Behaviorists, ignoring the gains of the cognitive revolution that had been building momentum and winning converts throughout the 1980s, continued to believe that there is no need for a therapist to acknowledge a patient's inner experiences while attempting to treat, say, a psychological illness such as a phobia; rather, this school holds that all desired changes in behavior can be accomplished by systematically controlling relevant aspects of a patient's environment, much as one would train a pigeon to peck particular keys on a keyboard by offering it rewards to reinforce correct behavior and punishments to reverse incorrect behavior. The grand rounds speaker, faithfully following the principles of behaviorist theory, had championed a particular method to treat obsessive-compulsive disorder known as "exposure and response prevention."

Exposure and response prevention, or ERP, was a perfect expression of behaviorist tenets. In ERP therapy sessions as routinely practiced, the OCD patient is almost completely passive. The therapist presents the patient with "triggers" of varying intensity. If, for instance, an OCD patient is terrified of bodily secretions and feels so perpetually contaminated by them that he washes himself compulsively, then the therapist exposes him to those very bodily products. The patient first ranks the level of distress various objects cause. Touching a doorknob in the therapist's office (which the patients believes is covered with germs spread by people who haven't washed after using the bathroom) might rate a 50. Touching a paper towel dropped in the sink of a public rest room might rate a 65; a sweaty T-shirt, 75; toilet seats at a gym, 90; a dollop of feces or urine, 100. Presenting one of these triggers constitutes the "exposure," the first half of the process. In the second half, the "response prevention," the therapist keeps the patient from reacting to the trigger with compulsive behaviors—in this example, washing. Instead of allowing him to run to a sink, the therapist waits for the intensity of the patient's distress to return to preexposure levels. During this waiting period, the patient is typically quite passive, but hardly calm or relaxed. Quite the contrary: patients suffer unpleasant, painful, intense anxiety in the face of the triggers—anxiety that can take hours to dissipate.

The theoretical basis of the approach, to the extent that there is one, involves the rather vague notion that the intense discomfort will somehow cause the symptoms to "habituate," much as the intense feeling of cold one feels after jumping into the ocean fades in a few minutes. During these treatment sessions, if a patient asks about the possible risks of exposure and response prevention he is usually rebuffed for "seeking reassurance," which supposedly undermines the efficacy of the treatment. And yet examples abound in which the risks endured by patients were only too real. In the United States, therapists in the forefront of developing these techniques have had patients rub public toilet seats with their hands and then spread—well, then spread whatever they touched all over their hair, face, and clothes. They have had patients rub urine over themselves. They have had patients bring in a piece of toilet paper soiled with a minuscule amount of their fecal material and rub it on their face and through their hair during the therapy session—and then, at home, contaminate objects around the house with it. In other cases, patients are prevented from washing their hands for days at a time, even after using the bathroom.

To me, this all seemed cruel and distasteful in the extreme—but it also seemed unnecessary. At the time, my UCLA colleague Lewis Baxter and I had recently begun recruiting patients into what was probably one of the first organized, ongoing behavior-therapy groups in the United States dedicated solely to the study and treatment of OCD. The study would examine, through the then-revolutionary brain imaging technique of positron emission tomography (PET), the neurological mechanisms underlying the disease. The group therapy sessions held in conjunction with the study would allow us to offer treatment to the study participants, of

course. But the therapy sessions also presented what, to me, was an intriguing opportunity: the patients whom Baxter and I would study for clues to the causes of OCD might also tell us something about the relative efficacy of different treatments and treatment combinations. Our UCLA group had decided to study the effects of both drug and behavior therapy. I wasn't interested in doing research on the first of these, but I was extremely curious about the effects of psychologically oriented drug-free treatments on brain function. I didn't have much competition: by the late 1980s drugs were where the glamour was in major academic research centers. My offer to lead the behavior-therapy research group was accepted gladly.

I was becoming increasingly convinced of what was then a heresy in the eyes of mainstream behaviorists: that a patient undergoing behavior therapy need *never* do anything that a normal, healthy person would object to doing. I believed, too, on the basis of preliminary clinical research, that OCD might be better treated by systematically activating healthy brain circuits, rather than merely letting the pathological behaviors and their associated circuits burn themselves out, as it were, while the patient's distress eventually dissipated in a miasma of pain and anxiety.

My quest for an alternative treatment grew in part from my discomfort with exposure and response prevention treatment, which is based on principles gleaned almost solely from research on animal behavior. The difference between the techniques used in animal training and those applied to humans was negligible, and I had come to suspect that, in failing to engage a patient's mental faculties, behavior therapy was missing the boat. Treatments based on the principles of behaviorism denied the need to recognize and exploit the uniquely human qualities that differentiate humans from animals. If anything, such treatments are imbued with an obstinate machismo about not doing so; the behaviorists seemed to take a perverse pride in translating their work directly from animals to humans, allowing their theoretical preconceptions to displace common sense.

But exposure and response prevention, with its visits to public toilets and patients' wiping urine-impregnated paper over themselves, was claiming success rates of 60 to 70 percent. (Only years later would I discover that that percentage excluded the 20 to 30 percent of patients who refused to undergo the procedure once they saw what it entailed, as well as the 20 percent or so who dropped out.) Clearly, any alternative would face an uphill battle.

When I walked alone into the grand rounds auditorium that afternoon, I had a pretty clear idea of the techniques the speaker had applied to her OCD patients. Still, it was a welcome opportunity to hear directly from an established behaviorist about her methods, her theories, and her results. The audience settled down, the lights dimmed, and the speaker began. She had the tone and demeanor of someone on a mission. After explaining her diagnostic techniques—she was well known for a detailed questionnaire she had developed to pinpoint patients' fears, obsessions, and compulsions—she launched into a description of the behavioral

treatment she used in the case of one not-atypical OCD sufferer. When this patient hits a bump in the road while driving, she explained, he feels he has run over someone and so looks obsessively in the rearview mirror. He frequently stops the car and gets out or drives around for hours looking desperately for a body he anxiously worries must be lying, bleeding and dying, on the pavement. She reported, with what I would come to recognize as her trademark self-assurance, that the key to her treatment of this case was…removing the rearview mirror from the car! Just as she made germ-obsessed patients touch toilet seats until their distress evaporated, she had this hit-and-run-obsessed patient drive without his mirror until his urge to check for bodies in the road behind him "habituated."

I was aghast. The potential danger she put the patient in was astonishing—but this apparently made not a whit of difference. The prevailing view among behaviorists was that normal standards of judgment and taste could be set aside during behavioral interventions. I already had qualms about how mechanistic the treatment based on behaviorist principles was, how in thrall to problematic dogma and, indeed, to the cult of scientism itself, which has been described by Jacques Barzun as "the fallacy of believing that the method of science must be used on all forms of experience and, given time, will settle every issue." Imagining the implications of a mainstream treatment that called for a patient to drive around without a rearview mirror, I found it hard to focus on the rest of the talk.

But what I had heard had triggered an epiphany. From then on, I decided, I would commit myself to finding a way to spare OCD patients (as well as patients with other mental disorders) from unnecessary, irresponsible, even brutal treatment by experts who pride themselves on ignoring what patients are feeling, or indeed whether they are even conscious. Surely there is something deeply wrong, both morally and scientifically, with a school of psychology whose central tenet is that people's conscious life experience (the literal meaning of the word *psyche*) is irrelevant, and that the intrinsic difference between humans and "brutes" (as Watson had candidly put it) could be safely ignored. I became determined to show that OCD can be effectively treated without depriving patients of rearview mirrors, without forcing them to touch filthy toilets, without ordering them to use the bathroom without washing their hands afterward—without, in short, forcing them to do anything dangerous, unsanitary, or just plain ridiculous. There is no need to suspend common sense and simple old-fashioned decency to use behavioral interventions successfully, I reasoned, as I walked back to my office. By applying a new and scientifically testable method that would empower OCD patients actively and willfully to change the focus of their attention, I just might help them learn to overcome their disease. But I had a hunch that I might achieve something else, too: demonstrating, with the new brain imaging technology, that patients could systematically alter their own brain function. The will, I was starting to believe, generates a force. If that force could be harnessed to improve the lives of people with OCD, it might also teach them how to control the very brain chemistry underlying their disease.

What determines the question a scientist pursues? One side in the so-called science wars holds that the investigation of nature is a purely objective pursuit, walled off from the influences of the surrounding society and culture by built-in safeguards, such as the demand that scientific results be replicable and the requirement that scientific theories accord with nature. The gravitational force of a Marxist, in other words, is identical to the gravitational force of a fascist. Or, more starkly, if you're looking for proof that science is not a social construct, as so-called science critics contend, just step out the window and see whether the theory of gravity is a mere figment of a scientist's imagination.

That the findings of science are firmly grounded in empiricism is clear. But the *questions* of science are another matter. For the questions one might ask of nature are, for all intents and purposes, without end. Although the methods of science may be largely objective, the choice of what question to ask is not. This is not a shortcoming, much less a fault, of science. It is, rather, a reflection of the necessary fact that science is, at bottom, a human endeavor. Running through both psychiatry and neuroscience is a theme that seemed deeply disturbing to me almost from the moment I began reading in the field as a fifteen-year-old in Valley Stream, Long Island, when my conviction that the inner working of the mind was the only mystery worth pursuing made me vow to become a psychiatrist. What disturbed me was the idea that free will died with Freud—or even earlier, with the materialism of the triumphant scientific revolution. Freud elevated unconscious processes to the throne of the mind, imbuing them with the power to guide our every thought and deed, and to a significant extent writing free will out of the picture. Decades later, neuroscience has linked genetic mechanisms to neuronal circuits coursing with a multiplicity of neurotransmitters to argue that the brain is a machine whose behavior is predestined, or at least determined, in such a way as seemingly to leave no room for the will. It is not merely that the will is not free, in the modern scientific view; not merely that it is constrained, a captive of material forces. It is, more radically, that the will, a manifestation of mind, does not even exist, because a mind independent of brain does not exist.

My deep doubts that human actions can be explained away through materialist determinism simmered just below the surface throughout my years of medical school. But by the time I completed my psychiatric residency at Cedars-Sinai Medical Center in 1984, my research interests had converged on the question of the role of the brain in mental life. After two years conducting brain research under the mentorship of Floyd Bloom at the Salk Institute in La Jolla from 1980 to 1982—investigating a possible role for the endogenous opiate beta-endorphin in manic depression, as well as doing basic research on the functional neuroanatomy of changes in mood states—I was growing ever more curious about the mysterious connection between mental events and the activity of discrete brain structures. The timing was perfect: even then, that area of neuroscience, broadly known as functional neuroanatomy, was achieving gains few even dreamed of. Brain imaging techniques such as PET (and, later, functional magnetic resonance imaging, or

fMRI) were, for the first time, allowing neuroscientists to observe the living, working human brain in action. Ordering a forefinger to lift, reading silently, matching verbs to nouns, cogitating on faces, conjuring up a mental image of a childhood event, mentally manipulating blocks to solve the game Tetris—scans were mapping the parts of the brain responsible for each of these activities, and for many more.

But even as Congress declared the 1990s the Decade of the Brain, a nagging doubt plagued some neuroscientists. Although learning which regions of the brain become metabolically active during various tasks is crucial to any understanding of brain function, this mental cartography seemed ultimately unsatisfying. Being able to trace brain activity on an imaging scan is all well and good. But what does it *mean* to see that the front of the brain is underactive in people with schizophrenia? Or that there is a quieting of the frontal "executive attention network" when experienced practitioners of the ancient technique of *yoga nidra* attain meditative relaxation? Or even that a particular spot in the visual cortex becomes active when we see green? In other words, what kind of internal experience is generated by the neuronal activity captured on a brain scan? Even more important, how can we use scientific discoveries linking inner experience with brain function to effect constructive changes in everyday life? Soon after I joined the UCLA faculty in 1985, I realized that obsessive-compulsive disorder might offer a model for these very questions of mind and brain.

At the same time, I was regaining an interest in Buddhist philosophy that I had developed a decade earlier, when a poet friend (who later perished on that ill-fated KAL flight that ran into the wrong end of the cold war) became deeply involved in Buddhist meditation. As a premed philosophy major I always had a healthy dose of skepticism about what my poet friends were into, but I was nevertheless intrigued. The first Noble Truth, Dukkha—or, as it is generally translated, "Suffering"—had an immense intuitive sensibility to me. Life, I already felt, was not an easy undertaking. In addition, Buddhist philosophy's emphasis on the critical importance of observing the Basic Characteristic of Anicca, or Impermanence, appealed to me. As an aspiring psychiatrist in self-directed training, I was drawn to the practical aspect of Buddhist philosophy: the systematic development and application of a clear-minded observational power, known in the Buddhist lexicon as Mindfulness.

I had first pursued this new direction in earnest during my first year of medical school. I added two self-taught extracurricular courses to my required studies: introductory training in Yoga as expounded in the classic text *Light on Yoga*, by B. K. S. Iyengar, and regular reading of the *Archives of General Psychiatry*, which, of all the leading journals, seemed most focused on the newly developing field of neuropsychiatry (I had already decided that I would specialize in the brain-related aspects of psychiatry). During that first year I arranged to continue these pursuits by setting up a summer clerkship in neuropsychiatry research and enrolling, at the end of the summer, in an intensive retreat in the practice of Buddhist mindfulness meditation. When the second year of medical school began in September 1975, I

knew I was setting off on what would become a lifelong quest, to develop and integrate these two fields.

At the core of Buddhist philosophy lies this concept of mindfulness, or mindful awareness: the capacity to observe one's inner experience in what the ancient texts call a "fully aware and non-clinging" way. Perhaps the most lucid modern description of the process comes from the German monk Nyanaponika Thera (his name means "inclined toward knowledge," and *thera* is a title roughly analogous to "teacher"). A major figure of twentieth-century Buddhist scholarship, he coined the term *Bare Attention* to explain to Westerners the type of mental activity required to attain mindful awareness. In his landmark book *The Heart of Buddhist Meditation*, Nyanaponika wrote, "Bare Attention is the clear and single-minded awareness of what actually happens *to* us and *in* us at the successive moments of perception. It is called 'Bare' because it attends just to the bare facts of a perception as presented either through the five physical senses or through the mind…without reacting to them." One Buddhist scholar captured the difference between mindfulness and the usual mode of mind this way: "You're walking in the woods and your attention is drawn to a beautiful tree or a flower. The usual human reaction is to set the mind working, 'What a beautiful tree, I wonder how long it's been here, I wonder how often people notice it, I should really write a poem.'…The way of mindfulness would be just to see the tree…as you gaze at the tree there is nothing between you and it." There is full awareness without running commentary. You are just watching, observing all facts, both inner and outer, very closely.

The most noteworthy result of mindfulness, which requires directed willful effort, is the ability it affords those practicing it to observe their sensations and thoughts with the calm clarity of an external witness: through mindful awareness, you can stand outside your own mind as if you are watching what is happening to another rather than experiencing it yourself. In Buddhist philosophy, the ability to sustain Bare Attention over time is the heart of meditation. The meditator views his thoughts, feelings, and expectations much as a scientist views experimental data—that is, as natural phenomena to be noted, investigated, reflected on, and learned from. Viewing one's own inner experience as data allows the meditator to become, in essence, his own experimental subject. (This kind of directed mental activity, as it happens, was critical to the psychological and philosophical work of William James, though as far as we know he had no more than a passing acquaintance with Buddhist meditation.)

Through the centuries, the idea of mindfulness has appeared, under various names, in other branches of philosophy. Adam Smith, one of the leading philosophers of the eighteenth-century Scottish Enlightenment, developed the idea of "the impartial and well-informed spectator." This is "the man within," Smith wrote in 1759 in *The Theory of Moral Sentiments*, an observing power we all have access to, which allows us to observe our internal feelings as if from without. This distancing allows us to witness our actions, thoughts, and emotions not as an involved participant but as a disinterested observer. In Smith's words:

When I endeavor to examine my own conduct…I divide myself as it were into two persons; and that I, the examiner and judge, represent a different character from the other I, the person whose conduct is examined into and judged of. The first is the spectator…. The second is the agent, the person whom I properly call myself, and of whose conduct, under the character of a spectator, I was endeavoring to form some opinion.

It was in this way, Smith concluded, that "we suppose ourselves the spectators of our own behaviour." The change of perspective accomplished by the impartial spectator is far from easy, however: Smith clearly recognized the "fatiguing exertions" it required.

For years I had wondered what psychiatric ailment might best lend itself to a study of the effects of mindfulness on brain function. So within a few days of beginning to study the literature on obsessive-compulsive disorder at UCLA, I suspected that the disease might offer an entrée into some of the most profound questions of mind and brain, and an ideal model in which to examine the interface between the two. And soon after I began working intensively with people who had the condition and looked at the PET data being collected on them, I realized I'd stumbled onto a neuropsychiatrist's gold mine.

The obsessions that besiege the patient seemed quite clearly to be caused by pathological, mechanical brain processes—mechanical in the sense that we can, with reasonable confidence, trace their origins and the brain pathways involved in their transmission. OCD's clear and discrete presentation of symptoms, and reasonably well-understood pathophysiology, suggested that the brain side of the equation could, with enough effort, be nailed down.

As for the mind side, although the cardinal symptom of obsessive-compulsive disorder is the persistent, exhausting intrusion of an unwanted thought and an unwanted urge to act on that thought, the disease is also marked by something else: what is known as an ego-dystonic character. When someone with the disease experiences a typical OCD thought, some part of his mind knows quite clearly that his hands are not really dirty, for instance, or that the door is not really unlocked (especially since he has gone back and checked it four times already). Some part of his mind (even if, in serious cases, it is only a small part) is standing outside and apart from the OCD symptoms, observing and reflecting insightfully on their sheer bizarreness. The disease's intrinsic pathology is, in effect, replicating an aspect of meditation, affording the patient an impartial, detached perspective on his own thoughts. As far as I knew, the impartial spectator in the mind of an OCD patient—overwhelmed by the biochemical imbalances in the brain that the disease causes—remained only that, a mere spectator and not an actor, noting the symptoms that were laying siege to the patient's mind but powerless to intercede. The insistent thoughts and images of OCD, after all, are experienced passively: the patient's volition plays no role in their appearance.

But perhaps, I thought, the impartial spectator needn't remain a bystander. Perhaps it would be possible to use mindfulness training to empower the impartial spectator to become more than merely an effete observer. Maybe, just maybe, patients could learn a practical, self-directed approach to treatment that would give them the power to strengthen and utilize the healthy parts of their brain in order to resist their compulsions and quiet the anxieties and fears caused by their obsessions. And then, despite the painful intrusions into consciousness caused by the faulty brain mechanisms, the patient could exercise the power to make a choice about whether the next idea the brain attends to will be "I am going to work in the garden now," rather than "I am going to wash my hands again." Although the passive stream of the contents of consciousness may well be determined by brain mechanism, the mental and emotional response to that stream may not be. The OCD patient, in other words, may have the capacity to focus attention in a way that is not fixed or predestined by the (pathological) brain state.

To my way of thinking, the Buddhist concept of mindfulness offered a guide to what would be a radically new approach to OCD treatment. In what came to be called the Four Steps regimen of cognitive-behavioral therapy for OCD, patients gain insight into the true nature and origin of the bothersome OCD thoughts and urges. They *Relabel* their obsessions and compulsions as false signals, symptoms of a disease. They *Reattribute* those thoughts and urges to pathological brain circuitry ("This thought reflects a malfunction of my brain, not a real need to wash my hands yet again"). They *Refocus*, turning their attention away from the pathological thoughts and urges onto a constructive behavior. And, finally, they *Revalue* the OCD obsessions and compulsions, realizing that they have no intrinsic value, and no inherent power. If patients could systematically learn to reassess the significance of their OCD feelings and respond differently to them through sustained mindful awareness, I reasoned, they might, over time, substantially change the activity of the brain regions that underlie OCD. Their mind, that is, might change their brain.

At first, whenever I tried to discuss these ideas with colleagues, the reaction ranged from mere amusement to frank annoyance. Like all of modern science, the field of psychiatry, especially in its current biological incarnation, has become smitten with *materialist reductionism*, the idea that all phenomena can be explained by the interaction and movements of material particles. As a result, to suggest that anything other than brain mechanisms in and of themselves constitute the causal dynamics of a mental phenomenon is to risk being dismissed out of hand. But there was another problem. For decades, a key tenet of neuroscience held that although the organization and wiring of the infant brain are molded by its environment, the functional organization and structure of the adult brain are immutable. Experiments in rats, monkeys, ferrets, and people showing that the adult brain can indeed change, and change in profound ways, still lay in the future. Since I was arguing that the mind can change the brain, persuading the scientific community that I was right required that scientists accept an even more basic fact: that the adult brain can change at all.

The chapters that follow explore the new vistas in neuroscience opened by the original UCLA work on obsessive-compulsive disorder. We'll survey both historical and current approaches to the mind-brain enigma surrounding how mental phenomena emerge from three pounds of grayish, gelatinous tissue encased in the human skull. We'll also explore the OCD research in further detail. My discovery that mental action can alter the brain chemistry of an OCD patient occurred when neuroscientists were reopening a question that most had thought long settled: can the adult brain change in ways that are significant for its function? Does it, in other words, display an attribute that researchers had thought lost with the final years of childhood—neuroplasticity? *Neuroplasticity* refers to the ability of neurons to forge new connections, to blaze new paths through the cortex, even to assume new roles. In shorthand, neuroplasticity means rewiring of the brain. After chronicling the ongoing discoveries of neuroplasticity in the brain of the developing child—from the first tentative neuronal synapses as they form in fetal life to the wiring of the visual, auditory, and somatosensory systems and higher cortical functions such as cognition and emotions—we will review the notorious tale of the Silver Spring monkeys. The mistreatment of these seventeen macaques at a behavioral psychology institute in the 1970s led to their seizure by federal agents, conviction of the lead researcher on six counts of animal cruelty, and, more than any other single event, the rise of the animal rights movement in the United States. But experiments on the Silver Spring monkeys also demonstrated, for the first time, the massive plasticity of the adult primate brain.

The heart of the book describes the burgeoning field of neuroplasticity—how plasticity is induced by changes in the amount of sensory stimulation reaching the brain. Neuroplasticity can result not only in one region of the brain colonizing another—with remarkable effects on mental and physical function—but also in the wholesale remodeling of neural networks, of which the changes in the brains of OCD patients are only one example. The discovery that neuroplasticity can be induced in people who have suffered a stroke demonstrated, more than any other finding, the clinical power of a brain that can rewire itself.

It was through my informal collaboration with the physicist Henry Stapp, a preeminent scholar of the interpretation of quantum mechanics, that my tentative musings on the causal efficacy of attention and will found a firm basis in physics. Stapp's youthful pursuit of the foundations of quantum physics evolved, in his later years, into an exploration of the mind's physical power to shape the brain. It has long been Stapp's contention that the connection between consciousness and the brain is (*pace*, philosophers) primarily a problem in physics and addressable by physics—but only the correct physics. Though you would hardly know it from the arguments of those who appeal to physics to assert that all mental phenomena can be reduced to the electrochemical activity of neurons, physics has progressed from its classical Newtonian form and found itself in the strange land of the quantum. Once, physics dealt only with tangible objects: planets, balls, molecules, and atoms. Today, in the form of quantum mechanics, it describes a very different

world, one built out of what Stapp calls "a new kind of stuff," with properties of both the physical and the mental. The physics that informs the neuroscience I describe is, I think, one of the features that make this book different from those that have come before, for it is in quantum mechanics that the hypotheses born of studies of OCD and the mind find their harmonizing voice. What we now know about quantum physics gives us reason to believe that conscious thoughts and volitions can, and do, play a powerful causal role in the world, including influencing the activity of the brain. Mind and matter, in other words, *can* interact.

One result of my collaboration with Stapp was a short paper we wrote for the *Journal of Consciousness Studies*. In it, we marshaled evidence from neuroscience and quantum physics to argue for the existence and causal efficacy of volition. In his 1890 masterpiece *The Principles of Psychology*, William James argued that the ability to fix one's attention on a stimulus or a thought and "hold it fast before the mind" was the act that constituted "the essential achievement of the will." If the effort to hold an object in one's attention is determined wholly by the properties of that object and its effects on the nervous system, then the case for free will is weak. If, however, one can make more or less effort, as one chooses, and so willfully "prolong the stay in consciousness of innumerable ideas which else would fade away more quickly," then free will remains a real scientific possibility.

James struggled throughout his life to find a rigorous alternative to the reductive determinism that ruled science in his day and has persisted down to ours. Although he rejected determinism on ethical grounds, as a working scientist he had to admit that "the utmost a believer in free-will can *ever* do will be to show that the deterministic arguments are not coercive. That they are seductive, I am the last to deny." But although determinism has indeed seduced both the scientifically sophisticated and the scientifically innocent for well over a century, its arguments are not "coercive." During the reign of classical physics one could be excused for thinking otherwise. But not anymore. Individuals choose what they will attend to, ignoring all other stimuli in order to focus on one conversation, one string of printed characters, or, in Buddhist mindfulness meditation, one breath in and one breath out.

In the last section of the book, we explore this third rail of neuroscience: the existence, character, and causal efficacy of will. There, I propose that the time has come for science to confront the serious implications of the fact that directed, willed mental activity can clearly and systematically alter brain function; that the exertion of willful effort generates a *physical force* that has the power to change how the brain works and even its physical structure. The result is directed neuroplasticity. The cause is what I call directed mental force.

Mainstream philosophical and scientific discourse may remain strongly biased toward a materialist perspective. Yet the simple fact is that the materialism of classical physics offers no intuitively meaningful way of explaining the critical role played by the will in the brain changes seen in OCD patients. The striving of the

mind to be free of its inner compulsions—what Buddhists call Right Effort—is much more than just the play of electrochemical impulses within a material construct. In this book, I describe experimental data that support an alternative, offering evidence that the brain truly is the child of the mind.

How? Through the mental act of focusing attention, mental effort becomes directed mental force. "[T]he effort to attend," James believed, may well be a true and genuine "original force." Modern neuroscience is now demonstrating what James suspected more than a century ago: that attention is a mental state (with physically describable brain state correlates) that allows us, moment by moment, to "choose and sculpt how our ever-changing minds will work, [to] choose who we will be the next moment in a very real sense…. Those choices are left embossed in physical form on our material selves." If James was speaking metaphorically, he was also speaking with almost eerie prescience. For it is now clear that the attentional state of the brain produces physical change in its structure and future functioning. The seemingly simple act of "paying attention" produces real and powerful physical changes in the brain. In fact, Stapp's work suggests that there *is* no fully defined brain state until attention is focused. That physical activity within the brain follows the focus of attention offers the clearest explanation to date of how my hypothesized mental force can alter brain activity. The choice made by a patient—or, indeed, anyone—causes one physical brain state to be activated rather than another. A century after the birth of quantum mechanics, it may at last be time to take seriously its most unsettling idea: that the observer and the way he directs his attention are intrinsic and unavoidable parts of reality.

Finally, in the Epilogue, we attempt to come to terms with why any of this matters. One important answer is that the materialist-determinist model of the brain has profound implications for notions like moral responsibility and personal freedom. The interpretation of mind that dominates neuroscience is inimical to both. For if we truly believe, when the day is done, that our mind and all that term entails—the choices we make, the reactions we have, the emotions we feel—are nothing but the expression of a machine governed by the rules of classical physics and chemistry, and that our behavior follows ineluctably from the workings of our neurons, then we're forced to conclude that the subjective sense of freedom is a "user illusion." Our sense that we are free to make moral decisions is a cruel joke, and society's insistence that individuals (with exceptions for the very young and the mentally ill) be held responsible for their actions is no more firmly rooted in reason than a sand castle is rooted in the beach. In stark contrast to the current paradigm, however, the emerging research on neuroplasticity, attention, and the causal efficacy of will supports the opposite view—one that demands the recognition of moral responsibility.

And it does something more. The implications of directed neuroplasticity combined with quantum physics cast new light on the question of humankind's place, and role, in nature. At its core, the new physics combined with the emerging neuroscience suggests that the natural world evolves through an interplay between

two causal processes. The first includes the physical processes we are all familiar with—electricity streaming, gravity pulling. The second includes the contents of our consciousness, including volition. The importance of this second process cannot be overstated, for it allows human thoughts to make a difference in the evolution of physical events.

Because the question of mind—its existence and its causal efficacy—is central to our thesis, let us turn first to an exploration of a problem as ancient as philosophy and as modern as the latest discovery of genes that "cause" risk taking, or shyness, or happiness, or impulsivity—or any of the dozens of human behavioral traits that are now being correlated with the chemical messages encoded on our twisting strands of DNA.

Let us turn to the duality of mind and brain.