Jeffrey M. Schwartz, MD and Sharon Begley – The Mind & The Brain, Neuroplasticity and the Power of Mental Force– Quotes

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… matter is merely a concentrated form of energy. (35)

… mind and brain are independent entities … and they interact by quantum physics. (45)

… the ability of consciousness to transform the infinite possibilities for, say the position of a subatomic particle as describe by quantum mechanics into the single reality for that position as detected by an observer. (47)

[About OCD patients] giving in to the urge to wash or check or count or sort, which the patient does in the vain hope of making the dreadful feeling recede, backfires. […] the more you scratch it, the worse it gets. Someone with obsessive-compulsive disorder derives no joy from the actions she takes. (56)

OCD patients, who have an overactive inferior prefrontal cortex, get an excessive, intrusive feeling that something is wrong, even when they know that nothing is. In patients in the gambling study, these areas were damaged and therefore underactive; these patients failed to sense that something was wrong even when they knew, rationally, that something was. (67)

"Altering synaptic strength," means making the postsynaptic cell more likely to initiate an action potential, and keep the information transmission going, than it was before. (106)

… either the presynaptic neuron or the postsynaptic neuron (or both) changes in such a way that the activation of one cell becomes more likely to cause the other to fire. (107)

[G]enes may lead neurons to make their initial, tentative connections and control the order in which different regions of the brain (and thus physical and mental capacities) come on line, but it's the environmental inputs acting on the plasticity of the young nervous system that truly determine the circuits that will power the brain. […] Genetic signals play a large role in the initial structuring of the brain. The ultimate shape of the brain, however, is the outcome of an ongoing active process that occurs where lived experience meets both the inner and the outer environment. (117)

Between six and twelve months, […] babies' brains begin the "use if or loose it" process of pruning unused synapses. The auditory cortex loses its sensitivity to phonemes that it does not hear every day. (119)

… it is electrical activity generated by the very act of seeing that completes the wiring of the visual cortex. (121)

… the adult brain can change. It can grow new cells. It can change the function of old ones. It can rezone an area that originally executed one function and assign it another. It

can, in short, change the circuitry that weaves neurons into the networks that allow us to see and hear, into the networks that remember, feel, suffer, think, imagine, and dream. (131)

… the Silver Spring monkeys … changed forever the dogma that the adult primate brain has lost the plasticity of childhood. (162)

… muscles that move more receive a greater cortical representation than muscles that move less. … the more a creature makes a movement, the larger the cortical area given over to that movement. (166)

Human amputees, … experienced cortical reorganization similar to that found in the Silver Spring monkeys: stimulation of the face produced an electrical response in both the somatosensory representation of the face and the amputation zone representing the now-missing arm, as if facial nerves had invaded that region. (185)

The power of plasticity distinguishes the nervous system from every other system in the body. Although plasticity still seems to be greatest from infancy through early adolescence, it was now evident that the brain retains some plasticity throughout life, offering possibilities undreamed of just a few short years ago. (199)

If the brain is like a map of lived experience, then the mind can, with directed effort, function as its own internally directed mapmaker. (200)

Our brain is marked by the life we lead and retains the footprints of the experiences we have had and the behaviors we have engaged in. (212)

"[T]he cortical territory occupied by the representation of the digits [of the left hand] increased in string players as compared with that in controls" The brain recordings showed that the increase in cortical representation of the fingering digits was greater in those who began to play before the age of twelve than in people who took up an instrument at a later age. (214)

"[Even adult] cortex adapts to its environment, and respond to a changing environment – including the behavioral environment." (215)

… attention is a prerequisite for use-dependent brain changes (215)

In control animals whose fingers had been stimulated asynchronously, the brain represented each finger discretely. But when digits were stimulated synchronously, their representation in the brain fused, … [A] single region of somatosensory cortex responded to the touch of two or even three fingers. (216)

Motor circuits become active during pure mental imagery. Like actual, physical movements, imagined movements trigger synaptic change at the cortical level. Merely thinking about moving produced brain changes comparable to those triggered by actually moving. (217)

Physical changes in the brain depend for their creation on a mental state in the mind – the state called attention. Paying attention matters. It matters not only for the size of the brain's representation of this or that part of the body's surface, of this or that muscle. It matters for the dynamic structure of the very circuits of the brain and for the brain's ability to remake itself. (224)

… dysphoria, that down-in-the-dumps feeling that most of us experience at least once in a while, triggers "patterns of depressogenic thinking" powerful enough to trigger full-blown depression. (245)

[E]motional processing should focus primarily on changing emotional responses to internal affective events and thoughts, so that these responses are short-lived and self-limiting, rather than the first stages of an escalating process. (247)

You regard your thoughts and feelings as passing, ephemeral "mental events" rather than as accurate reflections of reality. Instead of reacting to negative thoughts and feelings as "these are me," you come to regard them as "events in the mind that can be considered and examined." Yu recognize that thoughts are not facts … but are instead "events that come and go though the mind. (248)

[D]irect attention to specific regions of the body. The goal is to become acutely aware of whatever sensations an arm, a cheek, a knee is experiencing at the moment. … Focus on the breathing. If the mind wanders, acknowledge the distraction with "friendly awareness" and learn to return calmly to a focus on the breath. Repeat until you learn to use the inhalations and exhalations as an anchor to pull you back to a mindful awareness of the present moment. (249)

The will … has the power to change the brain … by activating adaptive circuitry. How someone thinks about thoughts can effect plastic changes in the brain. (250)

By the new millennium it was clear that new neurons arise from stem cells, immature cells capable of differentiating into virtually any type of cell. There is now abundant evidence that neural stem cells persist in the adult brain and support ongoing neurogenesis (the creation of new neurons). (253)

The brain may not be limited to working with existing neurons, fitting them together in new networks. It may, in addition, add fresh neurons to the mix. The neural electrician is not restricted to working with existing wiring, … he can run whole new cables through the brain. (253)

… conscious experience is inherently and forever irreducible to anything more "basic" – including anything material. … conscious experience is an irreducible entity, like space, or time, or mass. (256)

… materialism as a worldview, a view that holds that the physical is all that exists, and that transcendent human mental experiences and emotions, no matter what grandeur they seem – from within – to possess, are in reality nothing but the expressions of electrical pulses zipping along neurons. (258)

Behaviorism denies the reality of thoughts and emotions – indeed, or any sort of inner life. Instead of being afraid of something, it claims, we exhibit "a conditioned fear response"; instead of loving someone, we show "conditioned love response." (259)

Classical physics held that the reality of the physical world is constituted of infinitesimal particles in a sea of space. Causation, in this scheme, reflects, at bottom one particle's acting on its immediate neighbor, which in turn acts on its neighbor, until – well, until something happens. Wholly deterministic natural laws govern the behavior of matter. Furthermore, reality consists of material objects forever separated, by the chasm of Cartesian dualism, from the immaterial mind. (260)

Planck viewed his quanta as mere mathematical devices, something he invoked in "an act of desperation" to explain why heated, glowing objects emit the frequencies of energy that they do (an exasperating puzzle known as the black-body radiation problem). (261)

It is quantum physics, … that explains the burning of stars, accounts for the structure of elementary particles, predicts the order of elements in the periodic table, and describes the physics of the newborn universe. (262)

In place of the tidy cause-and-effect universe of classical physics, quantum physics describes a world of uncertainties, or indeterminism: of limits of our knowledge. (263)

Integral to quantum physics is the fundamental role played by the observer in choosing which of a plenitude of possible realities will leave the realm of possible and become actual. (263)

Quantum physics makes the seemingly preposterous claim … that there is no "is" until an observer makes an observation (263)

In quantum physics, … only through an act of observation does a physical quantity come to have an actual value. (264)

Before the observation, the system had a range of possibilities; afterward, it has a single actuality. This is the infamous *collapse of the wave function*. (269)

There are at least three ways to account for the shift from a microworld of probabilities defined by the Schrodinger wave equations to a macroworld of definite states that we measure. Each interpretation implies a different view of the essential nature of the world. One view, preferred by Einstein, holds that the world is governed by what are called *hidden variables*. … They are supposed to be the certainties of which that wave function of quantum physics describes the probabilities. … A second interpretation of quantum physics holds that superposed waves exist for quantum phenomena, … but never really collapse. … no single possibility is ever selected. Rather the wave function continues evolving, never collapsing at all. Every one of the experiential possibilities inherent in the wave function is realized in some superrealm. … A third view of the change from superposition to a single definite state is the one advanced by Niels Bohr. … the abrupt change from superpositions to single state arises from the act of observation. … it would

become known as the Copenhagen Interpretation of quantum mechanics, after the city where Bohr,… worked. … Quantum theory is about our knowledge of a system and about predictions based on that knowledge; it is not about reality "out there." … It is the observer who both decides which aspect of nature is to be probed and reads the answer nature gives. … The mental event collapses the wave function. (271)

Science is what we know, and what we know is only what our observation tells us. (273)

"In quantum theory, experience is the essential reality, and matter is viewed as a representation of the primary reality, which is experience." (278)

[The observer] experiences the output of the measuring device. … He chooses which question to pose to nature. (282)

This point is key: once the brain of observers are included in the quantum system, the wave function describing the state of the brain of any observer collapses to the form corresponding to his new knowledge. The quantum state of the brain must collapse when an observer experiences the outcome of a measurement. The collapse occurs in conjunction with the conscious act of experiencing the outcome of the observation. And it occurs in the brain of the observer – the observer who has learned something about the system. (285)

Newton connected celestial motions with terrestrial motion. Maxwell unified light and electromagnetism. Einstein did it for space and time. Quantum theory makes exactly this kind of connection, between the objective physical world and subjective experience. (289)

… It is because of volition that consciousness keeps arising throughout endless world cycles. (294)

"free won't" refers to the mind's veto power over brain-generated urges. (296)

"Mental effort can, within contemporary physical theory, have, via the effect of willful focus of attention, large dynamical consequences that are not automatic consequences of physically describable brain mechanisms acting alone." (298)

It is hard to date precisely the moment when biological determinism turned free will into a "myth" or a mere "metaphor." Perhaps it was in 1996, with the discovery of the first gene associated with a common behavior – risk taking. Perhaps it was in 1995, with the discovery of leptin, the hormone associated with a loss of appetite control. Or perhaps it was even earlier, with the avalanche of discoveries in neuroscience linking a serotonin deficit with depression, and dopamine imbalances with addiction. Each connection that neuroscientists forged between a neurochemical and a behavior, or at least a propensity toward a behavior, seemed to deal another blow to the notion of an efficacious will. (299)

… Although the physical sensation of an urge to move is initiated unconsciously, - will can still control the outcome by vetoing the action. (307)

… Free will operates not to initiate a voluntary act but to allow or suppress it. (307)

"Since the volitional process is initiated in the brain unconsciously, one cannot be held to feel guilty or sinful for simply having an urge or with to do something asocial. But conscious control over the possible act is available, making people responsible for their actions. The unconscious initiation of a voluntary act provides direct evidence for the brain's role in unconscious mental processes. I (Benjamin Libet) as an experimental scientist am led to suggest that true free will is a [more accurate scientific description] that determinism." (308)

Mental force affects the brain by altering the wave functions of the atoms that make up the brain's ions, neurotransmitters, and synaptic vesicles. (318)

Mental force is the causal bridge between conscious effort and the observed metabolic and neuronal changes. (318)

… Quantum physics offers a mechanism that validates the intuitive sense that our conscious thoughts have the power to affect our actions. (319)

[Quantum mechanics] allows conscious experience to act back on the physical brain by influencing its activities. It describes a way in which our conscious thoughts and volitions enter into the causal structure of nature and focus our thoughts, choose from among competing possible courses of action, and even override the mechanical aspects of cerebral processes. (319)

… Drawing on mental force, should be able to change other circuitry that underlies an aspect of personality, behavior, even thought. (320)

Sometimes the power of … passive, unbidden, and unwanted brain processes – the voiced the schizophrenic hears, the despair a depressive feels – is simply too great for mental force to overcome. And although directed mental force allows will to change the brain in both the stoke patients, … it is not will alone. It is knowledge, training, support from the community and loved ones, and appropriate medical input. (321)

… The act of focusing attention so that one thought, one possible action, prevails over all the other possible ones competing for dominance in consciousness – this is the true moral act, the point where volition enters into … "the cerebral conditions" and, moreover, "contribute[s] coequally" to them in determining which of those competing thoughts and actions will be chosen. It is this power of attention – to select one possibility over all others – that invests us with an efficacious will. (325)

… Volition acts through attention, which magnifies, stabilizes, clarifies, and otherwise makes predominant one thought out of many. The essential achievement of the will is to attend to one object and hold it clear and strong before the mind, letting all others – its rivals for attention and subsequent action – fade away like starlight swamped by the radiance of the Sun. (325)

We go through our lives "seeing" countless objects that we do not pay attention to. Without attention, the image (or the sound, or the feel – attention plays a role in every

sense) does not register in the mind and may not be stored even briefly in memory. I can guarantee that if you were to scan every square centimeter of a crowd scene in a photograph, visual information about every person depicted would reach your visual cortex. But if I asked you, after you had scanned the photo of the crowd, where the man in the fedora and vest was, you would doubtless be flummoxed. Our minds have a limited ability to process information about multiple objects at any given time. "Because of limited processing resources," … "multiple objects present at the same time in the visual field compete for neural representation. … Two stimuli present at the same time within a neuron's receptive field are not processed independently. [R]ather, … they interact with each other in a mutually suppressive way." They compete for neural representation. They key question for attention is, What determines the winner? (327)

According to our best understanding, the images of scores of people … sped from … retina and into … visual cortex, in parallel. But then competition set in. The winner was determined by the strength of the stimulus, … by its novelty … by its strong associations … or, most interestingly, by the demand of the task. Selectively focusing attention on target images significantly enhances neuronal responses to them. … In general, when two images are presented simultaneously, each suppresses the neuronal activity that the other triggers. But selective focusing of attention can override this effect and thereby filter our distractions. (328)

… Selective attention can strengthen or weaken neural processing in the visual cortex. (329)

When it comes to determining what the brain will process, the mind (through the mechanism of selective attention) is at least as strong as the novelty or relevance of the stimulus itself. In fact, attention can even work its magic in the total absence of sensory stimuli. (330)

"… In attention without a visual stimulus, you get activation in the same cells that would respond to that stimulus, as if the cells are primed. You also get activation in the prefrontal cortex and parietal lobes. That seems like strong evidence that these lobes exert top-down control on what the sensory system processes." … Selective attention – reflecting willful activation of one circuit over another – can nudge the brain into processing one signal and not another. (331)

… Not only do mental states matter to the physical activity of the brain, but they can contribute to the final perception even more powerfully than the stimulus itself. (337)

… When stimuli identical to those that induce plastic changes in an attending brain are instead delivered to a nonattending brain, there is no induction of cortical plasticity. Attention, in other words, must be paid. (338)

… Introspection, willed attention, subjective state … can redraw the contours of the mind, and in so doing can rewire the circuits of the brain, for it is attention that makes neuroplasticity possible. The role of attention throws into start relief the power of mind over brain, for it is a mental state (attention) that has the ability to direct neuroplasticity. (339)

In stoke patients who sustain damage to the prefrontal cortex, and whose attention systems are therefore impaired, recovery is much less likely. (340)

… In Quantum Zeno, the questions one puts to nature have the power of influence the dynamic evolution of a system. In particular, repeated and closely spaced observation s of a quantum property can freeze that property in place forever, or at least much longer than it would otherwise stay if unwatched. (351)

… Quantum Zeno might allow repeated acts of attention – which are, after all, observations by the mind of one strand of thought among the many competing for prominence in the brain - to affect quantum aspects of the brain. (353)

"The mere choice of which question is asked can influence the behavior of a system … [O]ne's [own] behavior could be influenced in this way by focusing one's attention, if focusing attention corresponds to specifying which question is posed." (354)

… Attention offered an avenue into a scientific understanding of the origin of physics-based mechanism of mental force. (355)

In a quantum brain, all the constituents that make up a thought – the diffusion of calcium ions, the propagation of electrons, the release of neurotransmitters – exists as quantum superpositions. Thus the brain itself is characterized by a whole slew of quantum superpositions of possible brain events. The result is a buzzing confusion of alternatives, a more complex version of Schroedinger's alternative (alive of dead) cats. The alternative that persists longer in attention is the one that is caught by a sequence of rapid consents that activates the Quantum Zeno Effect. (356)

In the brain, the flow of calcium ions within nerve terminals is subject to the Heisenberg Uncertainty Principle. There is a probability associated with whether the calcium ions will trigger the release of neurotransmitter from a terminal vesicle – a probability, that is, and not a certainty. There is then, also a probability but not a certainty that this neuron will transmit the signal to the next one in the circuit, without which the signal dies without leading to an action. Quantum theory represents these probabilities by means of a superposition of states. Just as an excited atom exists as a superposition of the states "Decay" and "Don't decay," so a synapse exists as a superposition of the states "Release neurotransmitter and "Don't release neurotransmitter." This superposition corresponds to a superposition of different possible courses of action: if the "Release neurotransmitter" state comes out on top, then neuronal transmission takes place and the thought that this neuron helps generate is born. If the "Don't release neurotransmitter" state wins, then the thought dies before it is even born. By choosing whether and/or how to focus on the various possible states, the mind influences which one of them comes into being. (357)

… Mind, by consenting to the rapid re-posing of the question already constructed and briefly presented by brain, can influence brain activity by causing this activity to stay focused on a particular course of action. Let's take the example of a person suffering from OCD. In this case one possible brain state corresponds to "Wash your hands again." Another is, "Don't wash – go to the garden." By expending mental effort – or, as I think

of it, unleashing mental force – the person can focus attention on this second idea. Doing so, as we saw, brings into play the Quantum Zeno Effect. As a result, the idea – whose physical embodiment is a physical brain state – "Go to the garden" is held in place longer than classical theory predicts. The triumphant idea can then make the body move, and through associated neuroplastic changes, alter the brain's circuitry. This will change the brain in ways that will increase the probability of the "Go to the garden" brain state arising again. (359)

For the stroke victim, the OCD patient, and the depressive, intense effort is required to bring about the requisite Refocusing of attention – a refocusing that will, in turn, sculpt anew the ever-changing brain. The patient generates the mental energy necessary to sustain mindfulness and so activate, strengthen, and stabilize the healthy circuitry through the exertion of willful effort. This effort generates mental force. This force, in its turn, produces plastic and enduring changes in the brain and hence the mind. Intention is made causally efficacious through attention. (360)

Whereas the contents of a consciousness are largely determined by passive processes, the amount and type of attention we pay to those contents are subject to active input via willful mental effort. (370)