The Brain that Changes Itself

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When I turned on my computer the other day, a notification greeted me to update my software. I clicked “okay” and marveled at the computer’s capacity to improve itself. An hour or so later, my computer had improved its programs to run faster, cleaned up its layout to appear more modern, and deleted several useless programs. On many occasions, the brain has been compared to a computer in its vast functionality. Norman Doidge, MD, a psychoanalyst and researcher at Columbia University and psychiatrist at the University of Toronto, discusses in his novel, “The Brain that Changes Itself” (ISBN-10: 0143113100, Penguin Books reprint edition December 2007) the brain’s ability to improve or “update” from a previous level of functioning is no exception to the brain/computer comparison. The novel is available for $11.51 on Amazon.com.

Neuroplasticity, as Doidge explores throughout his novel, is the brain’s capacity to change itself, or, a phenomenon in which, “one part of [the brain] fails, another can often substitute; that if brain cells die, they can at times be replaced,” (Doidge, xix) as is often the case in certain birth defects or accidents. For example, Doidge introduces his readers to a woman named Michelle who lives with only the right hemisphere of her brain. Doidge explains that Michelle was born without the left hemisphere, and her right hemisphere “took over” (Doidge, 259) for essential functions of the left hemisphere, such as speech and language. This “take-over” likely occurred during Michelle’s childhood because the brain shows the most plasticity in early years of life. Although healthy tissue can naturally compensate for deficits, the process can be initiated with certain thoughts and actions depending on the individual’s specific issue. Through exploring the brain’s, “plastic,” or dynamic capabilities, Doidge brilliantly depicts neuroplasticians’ research, including his own, to highlight the future of neuroplasticity-based treatments that utilize the thoughts and actions of individuals.

Research on neuroplasticity challenges the previous dogma of the brain, which argued that the brain consisted of localized regions hardwired to perform a specific function. Doidge illustrates the research of neuroplastician Michael Merzenich, whose research fundamentally depicts the dynamic properties of the brain. In his experiment, Merzenich compared the brain map, or the processing area for specific sensory or motor functions, of a monkey normally moving his fingers to a monkey moving fingers that were sewn together. Since the monkey with his fingers sewn together had stopped using his fingers independently, the two brain map regions for the two fingers that were normally activated independently had merged together and showed activation in a brain scan if either of the fingers was stimulated. Although areas of the brain are specialized to perform certain functions, they are not statically inclined to only perform said functions. Carla Shatz appropriately summarized the phenomenon of the brain maps merge as, “neurons that fire together wire together” (Doidge, 63). When stimulated appropriately, neurons form a strong connection in the brain. This mantra forms the basis of the approaches to treatment that Doidge explores throughout the novel.

Doidge first introduces his readers to Cheryl Schiltz. As a result of an antibiotic from a post-operation infection, Cheryl's vestibular apparatus functions at 2% of normal function, resulting in balance impairment. Normally, canals in the inner ear detect movement of a person's head and signal the vestibular nuclei to signal the muscles to adjust the body, but Cheryl's system is damaged and cannot initiate the signaling cascade. Doidge describes meeting Paul Bach-y-Rita, a pioneer neuroplastician who invented a machine that he believed could help Cheryl using the plasticity of the senses. Bach-y-Rita put a strip of plastic with electrodes in Cheryl’s mouth that is connected to a hat that can sense movement. When Cheryl moved, the plastic strip became activated to “bubble” on her tongue. This “bubbling” told Cheryl that her head is bending and she must adjust her body to avoid falling. The machine was able to improve Cheryl’s impaired vestibular apparatus while she wore the plastic piece. Remarkably, Cheryl felt an additional residual effect: she was able to balance after removing the hat and plastic. With practice, the residual effect increased from 40 seconds to eventually 3 hours and 20 minutes. Bach-y-Rita’s machine uses the perception in Cheryl’s tongue to induce not only healthy tissue from the vestibular system to fire its neurons, but also helps recruit other neural pathways to fire in response to Cheryl’s moving head. By revitalizing her vestibular system, Bach-y-Rita’s machine formed a new “wire” in her brain. Bach-y-Rita has had similar success in other balance-impaired subjects and is working on a similar device to develop new pathways that will allow the blind to recognize objects and movement.

Next, Doidge depicts a remarkable young woman named Barbara Arrowsmith Young. Through exploring her own mental deficits, Barbara developed a program building on existing neuropsychology research to help improve cognitive function. Barbara’s frontal lobes are extremely developed, giving her brilliant auditory and visual memory, but she has neuropsychological deficits including trouble pronouncing words, spatial reasoning, simple logic (such as the difference between left and right, the concept of a father’s brother vs. a brother’s father, etc.), and difficulty writing. Barbara’s father declared that she would never be a “normal child” (31), and Barbara was offered little treatment. As an adult, Barbara read “Problems of Neurolinguistics” written by neuropsychologist Aleksander Luria and recognized that many problems that follow strokes or neurological defects were similar to her own (particularly her difficulty with logic). Luria described the logic difficulties of his patient Comrade Zazetsky, a Russian Lieutenant who had been shot in his head, as a difficulty associating information perceived from the temporal (sound and language), occipital (visual), and parietal (spatial and sensory) lobes. Although the information was perceived well, it was not cohesively synthesized in his patient’s mind. Building on neuropsychology research, Barbara wanted to find a treatment for this deficit in synthesizing perceptions. Barbara and her husband founded the Arrowsmith School to help children by first zoning in on the child’s specific deficit, and then using specifically designed exercises to strengthen the weak areas of functioning. For children with problems similar to Barbara’s and Comrade Zazetsky’s, exercises would focus on logic and problem solving to help strengthen the connection between information perceived from the three lobes. Children with difficulty reading and writing who may skip words, lose their places, etc. would complete exercises in tracing complex lines to help neurons in the premotor area and to increase their attention span.

Doidge next discusses one of his own patients, to whom he refers as “A.” A, a handsome young man, was depressed. A described to Doidge a past relationship in which he and his partner engaged in consensual, yet aggressive sexual encounters, and A found that he enjoyed this aggressiveness. Doidge explains the concept of sexual plasticity as the reason behind the variance between human sexual preferences and attractions, as well as humans’ abilities to change that what they find sexually attractive. This shift in arousal indicates that the brain is capable of changing sexual preferences, further showing the dynamic properties of the brain. Because of sexual plasticity, Doidge knew he could treat A by separating his thoughts of sex from his thoughts of aggression by training his brain to fire for the stimulus separately. To do this, Doidge first psychoanalyzed A to find the roots of his fused sex and aggression maps. Using Freudian theories, he found that as a result of negative experience with A’s drunken mother, A had fused the maps that allowed him to perceive sex and aggression, which lead to A sexually enjoying aggression, reinforcing the neural connection. Next, Doidge trained A to focus on instances of aggression in which he did not have sexual feelings. By focusing intently on these instances, Doidge was able to “depress” (Doidge, 117) or weaken the neural connection between sex and aggression. Because neurons that “fire apart wire apart” (Doidge, 117), A was able to experience healthier and more fulfilling relationships. Doidge has also found that he can rewire the sex maps of pornography addicts who no longer enjoy sex with their partners in a similar treatment. Since the pleasure of perceiving pornography simultaneously increase dopamine levels, Doidge can differentiate the two maps in pornography addicts, which allows them to once again enjoy sex with their partners.

Doidge next explores obsessive-compulsive disorder (OCD), which has been difficult to treat in the past. OCD patients’ frontal lobes show higher activation compared to people without the condition. The difference in activation is due to the hyperactivity of the orbital frontal cortex in the frontal lobe, which detects mistakes, in signaling the cingulate gyrus, which induces anxiety about what will happen if the mistake is not corrected. In “regular” people, some anxiety is healthy to cause the person to correct his or her mistake. An individual with OCD has an obsession, such
as germs, and is extremely anxious about their obsession as a result of his or her hyperactive cingulate gyrus. He or she engages in compulsive behavior to ease the anxiety, such as washing his or her hands. Jeffrey M. Schwartz, a psychiatrist, normalized the link between the orbital frontal cortex and the cingulate gyrus using neuroplastic properties of the brain. He believed that past treatments of OCD, such as exposure-response prevention, focused too heavily on the content of the obsession; patients who obsessed over germs would be forced to come in contact with the germs and then were not allowed to wash their hands. Instead, Schwartz encouraged the patients to distinguish between the content of the obsession and the nature of the disorder. Patients would remind themselves that, for example, germs are not the problem, but the OCD is (Doidge, 171). Then, patients would focus on a pleasurable activity, such as a hobby or music. This would cause neurons to fire in response to the new thoughts, stimulating relaxation in the person. Because the neurons would no longer fire in response to the obsession and the compulsion simultaneously, that connection/wire would be broken, and a neural wire for relaxation paired with the (usually) anxiety provoking stimuli would be formed. Brain scans showed normal firing in improved patients’ brains.

Next, Doidge visited the infamous Hindu neurologist, Ramachandran. Ramachandran’s current research focuses heavily on neuroplasticity, specifically in amputee patients who experience phantom limb pain, or pain in an organ that has been removed. Ramachandran believed the body part map of the amputees had merged. A patient referred by Doidge as Tom, had lost an arm in an automobile accident. When Ramachandran stroked his cheek, Tom said he felt it in his missing arm. Tom also said that when his missing arm itched, scratching his cheek could relieve the itch. Ramachandran believes the corresponding brain map “thirsts” (Doidge, 185) for stimulation. When it does not sense that stimulation, nerve growth is released invading nearby body part maps. When the body part map for one part is stimulated, such as the cheek, an amputee patient can feel the stimulation in the missing organ, such as the arm. Additionally, Ramachandran believes the pain amputees feel results from the lack of feedback to the brain following a command. For example, if the brain signals a missing arm to “clench” its hand but does not receive feedback, it may signal the hand to “clench harder,” which may cause the amputee to experience pain (Doidge, 185). To treat phantom limb patients, Ramachandran invented the mirror box. The box had no top, but included left and right compartments. There were two holes in the box for the patient to place his or her remaining arm. The patient is then instructed to imagine that both arms are in the box, and upon moving the remaining arm, the patient sees its mirror image. This process “tricks,” the brain into thinking that both arms are there. By moving the remaining arm, the patient perceives two arms moving, thus rewiring the brain to produce stimulation in the body map corresponding to the amputated arm, which, in turn, relieves the pain. Ramachandran reported improvement in many other phantom limb patients. Using this new insight to pain and plasticity, Ramachandran began similar treatment with patients suffering from “reflex sympathetic dystrophy,” which causes excruciating pain in response to even minor injuries.

Throughout the rest of the novel, Doidge similarly chronicles the treatments that utilize neuroplasticity in patients who had suffered strokes, received prosthetics, and suffered from depression. As demonstrated above, Doidge appropriately supported his beliefs outlined early in the novel that neuroplasticity can be utilized as therapy using repetitive thoughts and actions; neurons stimulated to fire create a wire or a more stable neural connection. In the cases of Bach-y-Rita’s sensory machine, Barbara’s Arrowhead school, and Ramachandran’s mirror box, an individual’s actions can lead to neuroplastic change. Doidge’s psychoanalysis/differentiation therapy and Schwartz’s OCD relaxation therapy demonstrated that an individual’s thoughts can also initiate neuroplastic developments.

Doidge’s “The Brain that Changes Itself” is strong in its clear scientific support for his statements and detailed background throughout each example. Furthermore, Doidge does not merely speculate on therapies that could potentially utilize neuroplasticity, but seeks professionals who have seen remarkable results in their patients and details their successes. The novel is interesting and cohesive in that it fully explores a vast array of neurological disorders while demonstrating the pattern in these concepts to explain theories (“neurons that fire together wire together” motif followed through each chapter). While the neuroplasticity-based therapies are fully explained from a scientific standpoint, one drawback of the novel is that Doidge consistently mentions Freudian theories that he believes support his statements, but does not always show scientific support for them. For example, Doidge states in “Acquiring Tastes and Loves” chapter that Freud explained how negative events during a child’s critical period can often reflect their sexual desires as adults, such as A’s negative relationship with his mother as a child and his sexual arousal in response to aggression. However, little scientific evidence can support this relationship, leaving a scientific/logical hole in Doidge’s explanation of how he psychoanalyzed his patient and separated the traumatic events in the patient’s childhood to his sexual practices. Regardless, because of Doidge’s phenomenal depiction of plasticity-based therapies for neurological disorders through action and thought, I recommend the novel to anyone who is interested in pursuing a career in neuroscience, as the future of various therapies will likely include neuroplasticity-based methods.

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