Addiction and the Brain

It is frequently said that addiction occurs when drugs "hijack" the brain. It's hard to nail down what that means, but it does rightly suggest that there is an involuntary takeover of the brain that compromises decision-making and diminishes freedom of choice, making quitting difficult even in the face of desire to do so. What happens in addiction is that, through completely natural processes involved in all learning, the brain prunes nerve pathways of attention and motivation to preferentially notice, focus on, desire, and seek the substance. What starts out as a choice becomes, in a sense, a prison. Because drugs of abuse act directly on the brain's reward circuitry to induce a surge of dopamine, addiction functions as an artificial shortcut to satisfaction. Over time, however, this neurological bypass results in significant long-term costs to an individual's overall health. Overcoming addiction usually entails not just stopping use of a substance but also discovering or rediscovering meaningful activities and goals, the pursuit of which provide the brain with rewards more naturally (and more gradually). And because they require effort, they contribute to growth of many facets of personality and personhood.

The brain plays a leading role in addiction, just as it plays a role in all human behavior. The choice to try a drug is a decision that that is centered in the executive portion of the brain, the prefrontal cortex. Once consumed, the drug delivers a powerful stimulus to the nucleus accumbens, a cluster of nerve cells below the cerebral cortex, which responds quickly by releasing a flood of dopamine. The neurotransmitter dopamine is often called "the pleasure molecule," but it is more correctly defined as a chemical that underlies motivation. It focuses attention on and drives people to pursue specific goals. The sensation of pleasure orchestrated by dopamine likely arose to encourage repetition of behaviors that support individual and species survival—eating, interacting with others, having sex. The high level of direct stimulation by drugs of abuse powerfully encourages repetition. Addiction can be seen as hacking the brain by drugs—a way to create a direct path to feeling good.

Repeated use of a drug changes the wiring of the brain in a number of ways. It stimulates the nucleus accumbens, and overactivity of the nucleus accumbens progressively weakens its connectivity to the prefrontal cortex, seat of executive functioning. One result is impaired judgment, decision-making, and impulse control, a hallmark of addiction. Neuroscience research supports the idea that addiction is a habit that becomes quickly and deeply **entrenched** and **self-perpetuating**, rapidly rewiring the circuitry of the brain because it is aided and abetted by the power of dopamine. Under the unrestrained influence of dopamine, the brain becomes highly efficient in wanting the drug; it focuses attention on anything drug-related and prunes away nerve connections that respond to other inputs. The biological weakening of decision-making areas in the brain suggests why addicts pursue and consume drugs even in the face of negative consequences or the knowledge of positive outcomes that might come from quitting the drugs.

Calling addiction a brain disorder means, for one thing, that the machinery of addiction is complex and subtle, because the brain is complex and often subtle. Addiction comes about through the brain's normal pathways of pleasure. It is known that addiction changes the circuitry of the brain in ways that make it increasingly difficult for people to regulate the allure of an intense chemical rush of reward.

In response to repeated use of a highly pleasurable experience—drugs, gambling—neurons adjust their wiring to become increasingly efficient at relaying the underlying signals. They prune away their capacity to respond to other sources of reward. And neural connection to the brain centers of impulse control and decision-making is weakened. The brain is set to stay stuck in its habit. But, unlike in disease, the brain changes that occur in addiction are not a malfunction of biology. Rather, the changes reflect the brain's normal processes of changeability—called neuroplasticity—its capacity to change in response to every-day experience, which is the basis of all learning. Unlike other organs, the brain is designed to change, because its mission is to keep us alive, and in order to safeguard us, it needs to be able to detect and respond to the ever-changing dynamics of the real world. It is important to know that recovery from addiction also relies on neuroplasticity. Changing behavior rewires the brain.

The disease model of addiction, which arose in the 1950s to counteract the view of addiction as a moral failing, is based on the observation that addiction involves biological changes in the brain. The brain alterations change the way the brain works—notably in the dopamine system—to create the craving, the progressive inability to exert control, and other dysfunctions associated with substance use. The view of addiction as a disease is consonant with some facts about the condition. It suggests that drug use is difficult to quit. It has prompted the development of pharmaceuticals that can ease withdrawal symptoms. The disease model of addiction, studies show, also fosters more compassionate attitudes towards those who are addicted and more human treatment. Addiction is also viewed as a disease in order to facilitate insurance coverage of any treatment.

But the disease model also wrongly suggests that the brain changes in addiction are permanent and that addiction is a chronic condition, that those who are addicted are unable to overcome it by themselves, and that relapse is an ever-present danger even to the recovered. For those reasons and others, the disease model of addiction, while well-intentioned, is highly controversial. Experts point to the fact that many with substance use disorders quit for life, with or without treatment. They also observe that age 18 to 25 is the peak period of illicit drug use, indicating it is often a developmental disorder, a temporary form of disengagement from life for any number of possible reasons. In addition, mounting evidence suggests that the brain changes of addiction do not reflect abnormal processes—they are the same processes involved in all learning. And the addicted brain returns to normal, gradually rewiring itself after substance use stops.

Addiction corrupts the ability to make choices. Addiction brings about changes in the brain, but those changes do not reflect a pathological process. The pathways to addiction can be difficult to understand, because substance abuse, as a result of the intense burst of pleasure it brings, rapidly rewires the circuitry of the brain to become highly efficient at drug wanting and seeking. At first glance, the fact that addiction shifts the way the brain works lends credibility to the idea of a disease. However, the brain alterations reflect the normal capacity of the brain to change in response to experience. That capacity is called neuroplasticity, and it is the basis of all learning and change. Unlike other organs, the brain is designed to change.

Addiction is a learned response involving several key areas of the brain and changes to the neural circuitry connecting them. Through the actions of the neurotransmitter dopamine, the brain become extremely efficient in wanting the drug effects, and eventually becomes imprisoned in the wanting. Nevertheless, the ability of the brain to adapt to changed circumstances always keeps the door open for the possibility of recovery.

(Source: Psychology Today)

A. Read the text and answer the questions below.

1. What does it mean when addiction is described as "hijacking" the brain, and how does this affect freedom of choice?
2. How do drugs of abuse act as an "artificial shortcut" to satisfaction in the brain?
3. What role does dopamine play in motivation, learning, and addiction according to the passage?
4. How does repeated drug use change the relationship between the nucleus accumbens and the prefrontal cortex?
5. Why does the author argue that the brain changes seen in addiction are not a biological malfunction?
6. In what ways does overcoming addiction involve more than simply stopping drug use?
7. What are the main strengths of the disease model of addiction described in the text?
8. Why is the disease model of addiction considered controversial, and what evidence challenges it?

B. Read the text and say if the following statements are True or False.

1. Addiction begins as a voluntary choice but can become involuntary over time.
2. Dopamine is best described as a chemical responsible only for pleasure. F
3. Drugs of abuse directly stimulate the brain's reward circuitry.
4. The nucleus accumbens is part of the prefrontal cortex. F
5. Repeated drug use strengthens the brain's impulse control systems. F
6. Addiction encourages the brain to focus attention on drug-related cues while ignoring other rewards.
7. The brain changes involved in addiction are caused by abnormal biological processes. F
8. Neuroplasticity refers to the brain's ability to change in response to experience.
9. The same brain mechanisms involved in addiction are also involved in normal learning.
10. According to the disease model, addiction is a chronic and permanent condition.
11. Research shows that most people with substance use disorders are unable to quit without treatment. F
12. The peak period of illicit drug use typically occurs between ages 18 and 25.
13. Recovery from addiction depends in part on the brain's capacity to rewire itself.
14. Addiction completely eliminates a person's ability to make choices. F
15. The brain returns to normal immediately after substance use stops. F

What part of the brain is responsible for addiction?

There are several parts of the brain involved in addiction. They are:

• the nucleus accumbens, a cluster of cells below the cortex in the basal forebrain that produces the urge to pursue a goal. Sometimes called the "pleasure center" of the brain, it is a key player in the reward circuitry of the brain and releases dopamine in response to positive experiences and the anticipation of such experiences.

• dopamine neurons, which are concentrated in the nucleus accumbent and form pathways of connection to other parts of the brain when activated by positive experiences.

• the prefrontal cortex, which is the seat of such executive functions as judgment, decision-making, impulse control; it gradually weakens in response to overactivation of the reward circuits by drugs of abuse.

• the amygdala, which registers emotional significance of perceptions, is highly responsive to drug-related cues and sets in motion the rise and fall of craving.

• the hippocampus, seat of memory; under the influence of dopamine, the memory of an expected reward results in overactivation of the reward and motivation circuits and decreased activity in the cognitive control centers of the prefrontal cortex.

Which brain chemical is associated with addiction?

The brain chemical that plays a starring role in addiction is the neurotransmitter dopamine. Addictive drugs such as cocaine, heroin, and many others—and eventually, just the anticipation of consuming those agents—cause a flood of dopamine to be released in the nucleus accumbens of the brain, creating an intensely pleasurable sensation. That pleasurable reward reinforces the behavior, motivating the user to seek the experience again and again. Dopamine is released in response to sex, accomplishment, winning, and other positive experiences, creating the sensation of reward and motivating the desire for repetition of the experience, but the dopamine response to drugs like heroin and cocaine is especially fast and intense.

The neurotransmitter glutamate is also involved in addiction. Widely distributed in the brain, its general role is to activate the firing of neurons; it's called an excitatory neurotransmitter. Glutamate helps mediate the rewarding effects of drugs of abuse and speeds the hard-wiring of substance response into the brain.

How does addiction hijack the brain?

The very fast and very intense flood of dopamine generated by taking a drug of abuse motivates repetition of the drug-taking. Under the influence of dopamine, that repetition changes the wiring of the brain in ways to increase the drug-wanting and decrease the ability to regulate the drug usage. What starts as a choice becomes so deeply wired into the brain that the machinery of desire operates automatically, and the machinery of attention narrows focus to the drug and getting it. The brain loses the capacity to respond to other potentially rewarding activities. The desire for reward ultimately becomes a prison from which it is difficult—but not impossible—to escape.

What is neuroplasticity and what role does it play in addiction?

Neuroplasticity is the brain's natural ability to change its wiring patterns in response to life experience. When stimulated, nerve cells generate new tendrils of connection to other nerve cells, called synapses. All learning hinges on the brain's capacity to form new nerve cell connections, and mental and behavioral flexibility is the hallmark of that capacity.

While neuroplasticity is the great liberator of the mind, allows people to learn languages and remember birthdays, and fuels the imagination, it has a dark side. The same process rewires the brain in response to using drugs of abuse—but, under the influence of the unnaturally fast and large flood of dopamine released, the rewiring strengthens the desire for the drug, weakens judgment and control, and prunes away the capacity to be interested in other, more natural rewards. The capacity for neuroplasticity, however, also enables the brain to rewire itself more normally once drug usage is stopped.

What do brain imaging studies show about addiction?

Brain imaging studies reveal which structures of the brain are involved in addiction, the intensity of their involvement, the networks of connectivity between them, how connectivity is configured and reconfigured in response to stimuli, and how the structures and circuitry influence addiction-related behavior. One of the most notable findings of brain imaging studies of addiction is the degree to which, through dopamine pathways, the prefrontal cortex is consistently dyregulated, disempowered in response to activation of the nucleus accumbens by drug cues. Brain imaging studies help explain how drug cues biologically narrow focus on the substance of abuse, motivate the drive to get it, and impair rational decision-making—brain changes that make addiction a self-perpetuating condition.

Imaging studies also reveal that many substances of abuse are related to reduction in volume of specific areas of the cerebral cortex, reflecting a pruning of synapses to make the brain highly efficient in drug-seeking. The loss of synaptic density underlies a biologically based inability to respond to the wide range of other, more natural rewards. Ongoing research suggests that imaging studies measuring cortical thickness and brain response to a decision-making task may reveal who is most susceptible to relapse and could benefit from particular types of supportive treatment, such as cognitive therapies that strengthen executive control.