Understanding Addiction

Patient Education Module

Understanding Addiction *How Addiction Hijacks the Brain*

Scientific advances over the past 20 years have shown that drug addiction is a chronic, relapsing disease that results from the prolonged effects of drugs on the brain. As with many other brain diseases, addiction has embedded behavioral and social-context aspects that are important parts of the disorder itself. Therefore, the most effective treatment approaches will include biological, behavioral, and social-context components. Recognizing addiction as a chronic, relapsing brain disorder characterized by compulsive drug seeking and use can impact society's overall health and social policy strategies, reduce the "stigma" of addiction, and help diminish the health and social costs associated with drug abuse and addiction.

What Causes Addiction?

The word "addiction" is derived from a Latin term for "enslaved by" or "bound to." Anyone who has struggled to overcome an addiction or has tried to help someone else to do so understands why. Addiction exerts a long and powerful influence on the brain that manifests in three distinct ways: craving for the object of addiction, loss of control over its use, and continuing involvement with it despite adverse consequences.

For many years, experts believed that only alcohol and powerful drugs could cause addiction. Neuroimaging technologies and more recent research, however, have shown that certain pleasurable activities, such as gambling, shopping, and sex, can also co-opt the brain. Although a standard U.S. diagnostic manual (the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition or DSM-IV) describes multiple addictions, each tied to a specific substance or activity, consensus is emerging that these may represent multiple expressions of a common underlying brain process.

New Insights into A Common Problem

Nobody starts out intending to develop an addiction, but many people get caught in its snare. Consider the latest government statistics: nearly 23 million Americans—almost one in 10—are addicted to alcohol or other drugs; more than two-thirds of people with addiction abuse alcohol; and the top three drugs causing addiction are marijuana, opioid (narcotic) pain relievers, and cocaine.

In the 1930s, when researchers first began to investigate what caused addictive behavior, they believed that people who developed addictions were somehow morally flawed or lacking in willpower. Overcoming addiction, they thought, involved punishing miscreants or, alternately, encouraging them to muster the will to break a habit. *The scientific consensus has changed since then.* Today, *we recognize addiction as a chronic disease that changes both brain structure and function.* Just as cardiovascular disease damages the heart and diabetes impairs the pancreas, addiction hijacks the brain. This happens as the brain goes through a series of changes, beginning with recognition of pleasure and ending with a drive toward compulsive behavior.

Pleasure Principle

The brain registers all pleasures in the same way, whether they originate with a psychoactive drug, a monetary reward, a sexual encounter, or a satisfying meal. In the brain, pleasure has a distinct signature: the release of the neurotransmitter dopamine in the nucleus accumbens, a cluster of nerve cells lying underneath the cerebral cortex. Dopamine release in the nucleus accumbens is so consistently tied with pleasure that neuroscientists refer to the region as the brain's pleasure center.

All drugs of abuse, from nicotine to heroin, cause a particularly powerful surge of dopamine in the nucleus accumbens. The likelihood that the use of a drug or participation in a rewarding activity will lead to addiction is directly linked to the speed with which it promotes dopamine release, the intensity of that release, and the reliability of that release.

Even taking the same drug through different methods of administration can influence how likely it is to lead to addiction. Smoking a drug or injecting it intravenously, as opposed to swallowing it as a pill, for example, generally produces a faster, stronger dopamine signal and is more likely to lead to drug misuse.

Addictive drugs provide a shortcut to the brain's reward system by flooding the nucleus accumbens with dopamine. The hippocampus lays down memories of this rapid sense of satisfaction, and the amygdala creates a conditioned response to certain stimuli.

Learning Process

Scientists once believed that the experience of pleasure alone was enough to prompt people to continue seeking an addictive substance or activity. But more recent research suggests that the situation is more complicated. Dopamine not only contributes to the experience of pleasure, but also plays a role in learning and memory—two key elements in the transition from liking something to becoming addicted to it.

According to the current theory about addiction, dopamine interacts with another neurotransmitter, glutamate, to take over the brain's system of reward-related learning. This system has an important role in sustaining life because it links activities needed for human survival (such as eating and sex) with pleasure and reward. The reward circuit in the brain includes areas involved with motivation and memory as well as with pleasure. Addictive substances and behaviors stimulate the same circuit—and then overload it.

Repeated exposure to an addictive substance or behavior causes nerve cells in the nucleus accumbens and the prefrontal cortex (the area of the brain involved in planning and executing tasks) to communicate in a way that couples liking something with wanting it, in turn driving us to go after it. That is, this process motivates us to take action to seek out the source of pleasure.

Development of Tolerance

Over time, the brain adapts in a way that actually makes the sought-after substance or activity less pleasurable. In nature, rewards usually come only with time and effort. Addictive drugs and behaviors provide a shortcut, flooding the brain with dopamine and other neurotransmitters. Our brains do not have an easy way to withstand the onslaught.

Addictive drugs, for example, can release two to 1,000 times the amount of dopamine that natural rewards do, and they do it more quickly and more reliably. In a person who becomes addicted, brain receptors become overwhelmed. The brain responds by producing less dopamine or eliminating dopamine receptors—an adaptation similar to turning the volume down on a loudspeaker when noise becomes too loud.

As a result of these adaptations, dopamine has less impact on the brain's reward center. People who develop an addiction typically find that, *in time, the desired substance no longer gives them as much pleasure – if any at all.* They have to take more of it to obtain the same dopamine "high" because their brains have adapted - an effect known as tolerance. This is known as "chasing the high." An addict first starts by taking more and

more of the substance in order to recreate the “high.” Later, when this no longer works, the addict will start ingesting the drug in different ways to increase the amount of drug that reaches the brain. Typically and addict will start with taking substances by mouth, then when that no longer works will start snorting the substance. Finally, when snorting fails to bring pleasure – the addict will start injecting the substance into the vein.

Compulsion Takes Over

At this point, compulsion takes over. The pleasure associated with an addictive drug or behavior subsides - and yet the memory of the desired effect and the need to recreate it (the wanting) persists. It is as though the normal machinery of motivation is no longer functioning.

The learning process mentioned earlier also comes into play. The hippocampus and the amygdala store information about environmental cues associated with the desired substance, so that it can be located again. These memories help create a conditioned response - intense craving - whenever the person encounters those environmental cues.

Cravings contribute not only to addiction but to relapse after a hard-won sobriety. A person addicted to heroin may be in danger of relapse when he sees a hypodermic needle, for example, while another person might start to drink again after seeing a bottle of whiskey. Conditioned learning helps explain why people who develop an addiction risk relapse even after years of abstinence.

Avoiding The Pain of Withdrawal

Over time, one a person has developed enough tolerance, the ability to experience pleasure from addictive substances is no longer an option. This is due to the brain responds of producing less dopamine or eliminating dopamine receptors. At this point, the addicted individual becomes more concerned with avoiding the horrific pain of withdrawal. The addict is now caught in a never ending quest to “just feel normal.” Once this point is reached, the addict will require repeated doses of the addictive substance every 3 to 4 hours to prevent painful withdrawal. It is no longer about feeling good – that is not an option anymore – it is all about avoiding feeling bad. The mental and physical pain of withdrawal is what drives addicts to do things that they never thought they would in order to prevent being “pill sick.”