Drug Addiction *Is a Disease*

Why the Teen Brain Is Vulnerable

- When Ryan Curry was 17, he woke each morning to find himself shaking, his sheets soaked in cold sweat. His body craved OxyContin, a prescription painkiller.
- When she was 16, Judy (who does not want her last name to be used) beat up her mother and spent her days breaking into houses and stealing. She was taking a powerful narcotic: heroin.
- Daniel Oerum was pale and skinny as a 17-year-old. "My teeth were rotting out," he says. Daniel was using MDMA, also known as Ecstasy.

These teens were featured in last year's edition of *Heads Up: Real News About Drugs and Your Body.* What do all these teens have in common?

HEADS UP REAL NEWS ABOUT DRUGS AND YOUR BODY

These teens were all suffering from *drug addiction*, a chronic relapsing disease that is characterized by compulsive drug-seeking and abuse and long-lasting chemical changes in the brain. No one knows how many times a person can use a drug before his or her brain is changed and the user is on the path to addiction. Everyone is different, but genetic makeup probably plays a role. Once a user becomes addicted to the drug, he or she craves it, even more than a person craves food or friendship. Without a dose of the drug, the natural chemical levels in a drug abuser's brain are low. The abuser then feels flat, lifeless, and depressed.

There have been many different approaches to the problem of drug abuse and many different beliefs about the causes of addiction. The scientists at the National Institute on Drug Abuse (NIDA) have been studying this for 30 years. Today, as a result of research studies, clinical trials, and new tools like neuroimaging, scientists know that drug addiction is a disease. With continuing advances in technology, such as fMRI and PET scans, and current research under way, scientists are learning that adolescent brains are more susceptible than adults' to the effects of drugs.

HEADS UP: TEENAGERS ARE MORE AT RISK

You know that as a teen you are at a different stage of development than at any other age, and that physiologically you are not yet an adult. Your brain is one reason why. During adolescence, the brain is still developing. Drugs interfere with that natural development. "Research indicates that exposure to drugs of abuse in adolescence may be a period of significantly increased vulnerability to drugs' effects because of all the changes occurring in the brain," says Nora D. Volkow, M.D., director of NIDA.

Your body and brain have been developing and maturing since you were born. Small children learn to balance and walk easily because the part of their brain called the *cerebellum* matures. You learned to talk, read, and write as your *parietal lobes* developed.

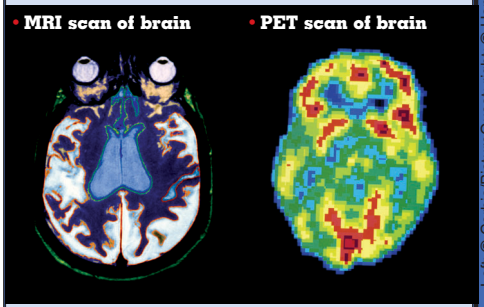
As teens, changes are still happening in your brain. Most important, the *prefrontal cortex* is rapidly changing; it will not be mature until your late teens or early 20s. When scientists look at scans of an adolescent brain, it looks much like an adult's, except for this section. The prefrontal cortex is the part of the brain that, when fully developed, you will use to make decisions that require judgment and consideration of long-term consequences. Because the prefrontal cortex is still maturing in teens, a brain system that matures earlier—the limbic system—influences their decisions more than it would influence an adult's decisions.

The limbic system is a group of linked brain structures that

Cutting Edge

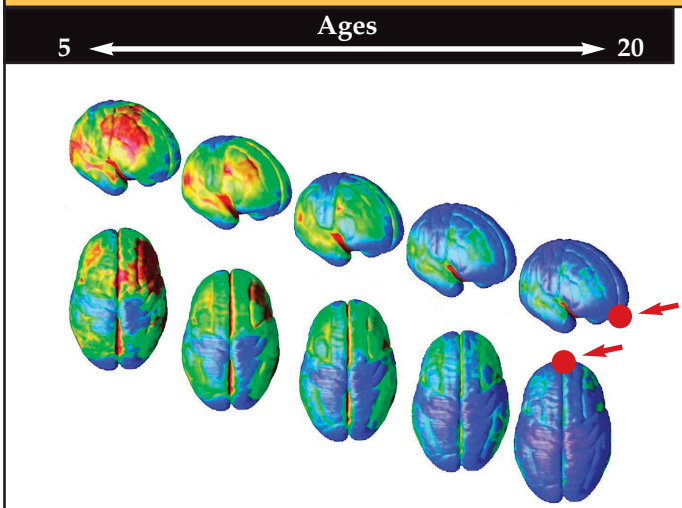
See the Brain in Action

How is it possible to watch the brain at work? With new brain scan technology, researchers can view a person's brain as he or she answers questions or plays games. One example of brain scan technology is functional magnetic resonance imaging, or fMRI. This type of scan shows where the brain is using oxygen. Brain cells need oxygen for energy; when cells are using oxygen, they're working. To create an image using fMRI, a force is set up between two powerful magnets; blood with oxygen changes the magnetic field differently than blood without oxygen. The contrast reveals the areas of the brain that are working. fMRI is very useful for studying how drugs change the structure of the brain.



Another window into the working brain is positron emission tomography, or PET scan. PET scans measure brain activity. To create a PET scan, scientists inject a slightly radioactive compound, a radiotracer, into the bloodstream. Through use of a computer, this radiotracer enables scientists to see where in the brain glucose (sugar) is being used. This indicates active areas of the brain. More glucose is used by more active areas of the brain, which means that the active areas are more visible than the less active areas. With PET, scientists can see which areas of the brain are active, and compare that level of activity to other areas of the brain.

Why Are Teens Vulnerable?



The prefrontal cortex, indicated by the circles, is the last part of the brain to develop. It is involved in decision making in adult brains. In teens, the prefrontal cortex is rapidly developing. These images show 15 years of brain development for a healthy person.

together are responsible for feelings, emotional reactions, and drive or motivation. A well-developed limbic system is probably one reason why teens love new things and love them intensely. When you hear a song for the first time or taste a new kind of pizza, you'll remember the good feelings and seek out similar ones because your limbic system creates a memory. The limbic system is one of the oldest in the brain: you don't have to think about many of your emotional reactions—such as your heart beating faster when you see your crush in the hallway or your mouth watering at the thought of pizza—because your limbic system is directly wired to the *brain stem* and *cerebrum*.

HEADS UP: DRUGS CHANGE HOW THE TEEN BRAIN WORKS

Scientists have known for years that the limbic system is the primary system affected by drugs of abuse. Normally, brain cells in the limbic system respond to pleasurable experiences by using a natural brain chemical called *dopamine* to carry messages, which we experience as feelings. Dopamine is considered a neurotransmitter, or a chemical in the brain that acts as a messenger between two brain cells. Drugs of abuse interfere with this delicate communication system and create floods of dopamine and intense feelings. The limbic system adapts to drug use in two ways: First, the brain senses the excess neurotransmitters and begins to produce less of the chemical, so that without drugs, the abuser has a hard time creating natural feelings. He or she needs drugs just to feel normal. Second, the limbic system creates a memory of the drug and a drive for it. That drive to seek out drugs—an intense appetite for something the addict knows is unhealthy—is the disease we call addiction.

HEADS UP: DRUGS ALSO CHANGE HOW THE TEEN BRAIN DEVELOPS

Scientists recently discovered that drugs do more than change how the

Wake-Up Call Understanding the Science of Addiction Keeps Teens in the Know

The teen years have always been a time of growth and exploration. Now more than ever, teen years are also a time of stress. Overscheduling, performance pressure from parents and peers, and worries about the future can make adolescence a pressure cooker. You face these pressures every day. When you know the scientific facts of how you are growing and developing as a teen, you have the information you need to make smart choices. That means that you will understand the kinds of positive things you can do to relieve stress while not harming your body. You might cook a meal together with friends or spend time with friends at the beach or hiking. Relieving stress in a positive way will help protect you from becoming a victim of drugs.

HEADS UP REAL NEWS ABOUT DRUGS AND YOUR BODY

limbic system works. Taken during adolescence, drugs actually change how the brain develops. "Recent animal studies provide evidence that drugs affect the developing brain differently than they do the matured brain," says Dr. Volkow.

In studies sponsored by NIDA, scientists are learning why many adult addicts started using drugs in adolescence. For example, new studies show how vulnerable the teen brain is to nicotine, the highly addictive drug in cigarettes.

• **One example: Teen smokers are addicted more quickly than adults.** Animal studies have shown that teens crave cigarettes after smoking fewer cigarettes than adults. At Duke University in Durham, North Carolina, Dr. Edward Levin and his colleagues introduced nicotine to two groups of rats equivalent in ages to adolescent and adult humans. He found that adolescent rats wanted more nicotine more quickly than adult rats. "This finding suggests that those who begin smoking during adolescence are at greater risk for increased smoking over the long term," writes Dr. Levin.

• **And...teen smokers are more likely to be addicted as adults.** At Duke University, Dr. Levin also found that, compared to rats that never had nicotine, animals that had nicotine as adolescents wanted more as adults. "Self-administration of nicotine during teenage years, when the brain is still developing, may cause some of the developmental processes to proceed inappropriately, in effect sculpting the brains of these adolescents in ways that facilitate the addiction process," writes Dr. Levin.

• **What teens do when they are teens impacts the adult body.** At the University of Miami, researchers Dr. Sari Izenwasser and Dr. Stephanie Collins found that rats that had been exposed to nicotine as adolescents were more sensitive to cocaine as adults, putting them more at risk for cocaine abuse. "This suggests that early nicotine use may create an increased risk of addiction for young people who subsequently use cocaine," writes Dr. Izenwasser.

HEADS UP: KNOWLEDGE IS THE KEY TO PREVENTION

What stops kids from becoming drug users? NIDA research shows that education really works. As part of a recent experiment, a group of seventh-grade teachers taught their students a series of 45-minute lessons about the dangers of drugs, how to say no, and how to stand up for themselves. Over the next year, scientists compared the kids who got the lessons with similar kids who didn't. The educated kids had much lower rates of drug use than the others. This proves that when kids know the facts, they make smart decisions. Reliable Web sites such as **www.teens.drugabuse.gov, www.health.org,** and **www.scholastic.com/HEADSUP** have a wealth of information about drugs and their effects on the brain and body. For help with a drug problem, go to **www.findtreatment.samhsa.gov** to access information about a treatment center near you or call the National hotline at 1-800-662-HELP. Check out future issues of this magazine for more articles in the series **Heads Up: Real News About Drugs and Your Body.**

Facts for Real Life

Q: IF YOU BECOME ADDICTED TO DRUGS, IS IT HOPELESS, OR CAN YOUR BRAIN RECOVER?

A: It's tough to overcome addiction. Some of the brain changes caused by addiction to certain drugs are permanent. But drug addiction is treatable. People in treatment for drug addiction learn special techniques for controlling their behavior and sometimes take medications designed to compensate for the brain changes caused by addiction. Researchers have found that time is important when it comes to treating addiction. Patients who stay in treatment more than three months have better outcomes than those in short-term treatment.