HEADS UP
REAL NEWS
ABOUT DRUGS
AND YOUR BODY
www.scholastic.com/HEADSUP

The Teen Brain: Under Construction

Brain

The teen brain is still developing, so it is particularly vulnerable to the effects of drugs. The prefrontal cortex, which an adult uses to make decisions, is still developing in a teen. Because of this, the teen brain relies on the limbic system to make decisions. **Drugs interfere with the** limbic system. Additionally, drugs interfere with the **teen brain's** natural development, affecting not only the brain, but the entire body.

Heart

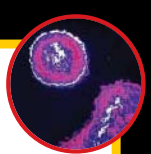
With effects that range from blocked blood flow to disrupted heart rhythms, the abuse of drugs such as inhalants, steroids, cocaine, or methamphetamine can result in a heart attack—even in a very fit athlete.

Lungs

From cancer to black lung, the impact that drugs have on the lungs is serious. Tobacco and marijuana users' lungs turn black from the effects of tar, one of thousands of chemicals in these drugs.

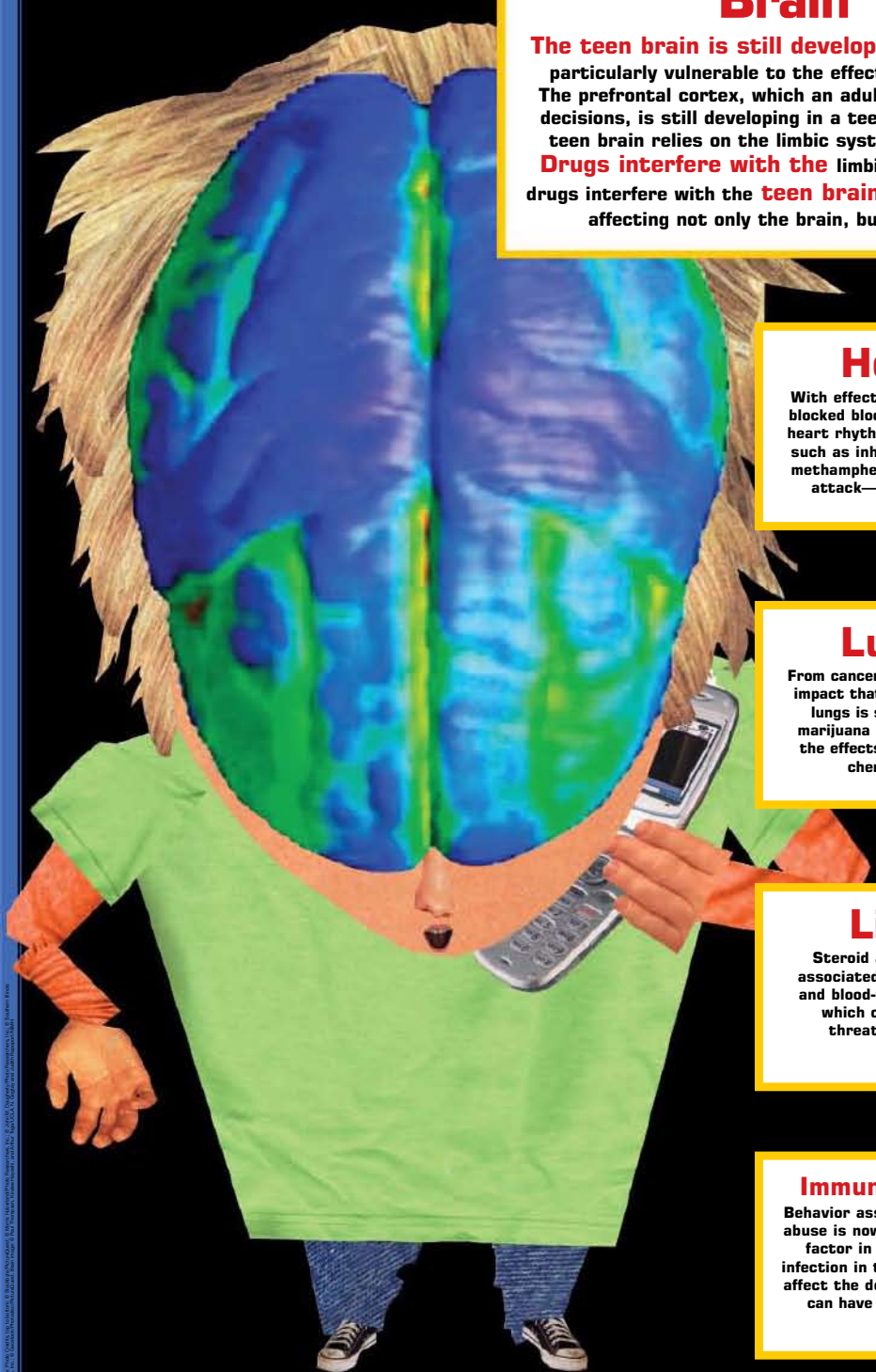
Liver

Steroid abuse has been associated with liver tumors and blood-filled cysts—either of which can rupture, causing life-threatening internal bleeding.



Immune System

Behavior associated with drug abuse is now the single largest factor in the spread of HIV infection in the United States. Drugs affect the decision-making process, which can have life-altering consequences.



SCHOLASTIC

FROM SCHOLASTIC AND THE SCIENTISTS OF THE NATIONAL INSTITUTE ON DRUG ABUSE, NATIONAL INSTITUTES OF HEALTH, U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES.

FREE TEACHING GUIDE & POSTER

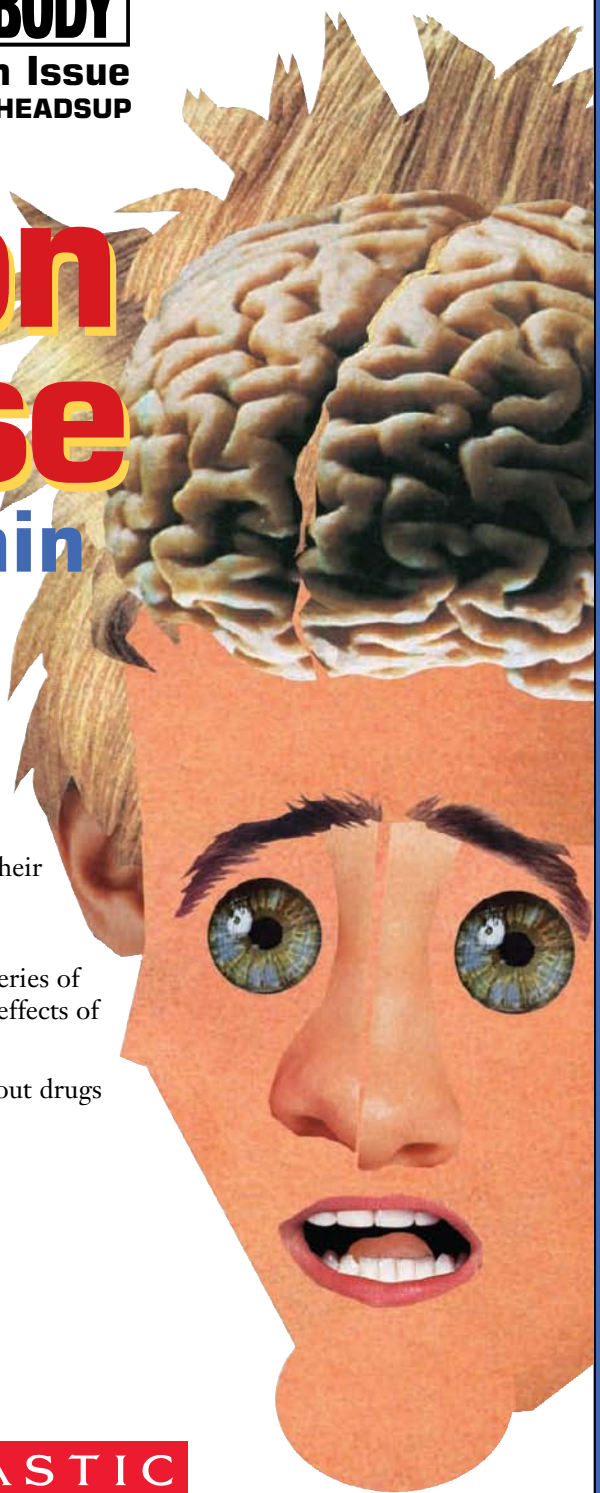
HEADS UP REAL NEWS ABOUT DRUGS AND YOUR BODY

GRADES 6–10

Special Launch Issue
www.scholastic.com/HEADSUP

Addiction is a Disease

Why the Teen Brain Is Vulnerable



Dear Teacher:

The National Institute on Drug Abuse and Scholastic Inc. are deeply committed to bringing students the real, science-based facts about drugs so they can make smart decisions regarding their health. Toward that end, we are launching the third edition of *Heads Up: Real News About Drugs and Your Body*.

Over the course of the next four months, we will bring you a series of articles about addiction that will help students understand the effects of addiction on teen brains and bodies.

Thank you for helping your students get the scientific facts about drugs and their bodies.

Sincerely,

Nora D. Volkow, M.D.
Director of NIDA

SCHOLASTIC

Lesson Plans for Student Activities

Preparation: Before displaying the poster, make two photocopies for each student of Student Activity Reproducible 1 (see "Your Students' Assessment Results" below for more information). Then make one photocopy for each student of the four-page article in this Teaching Guide ("Drug Addiction Is a Disease") and of Student Activity Reproducible 2.

Lesson 1: Heads Up: How Much Do You Know About Drug Addiction?

OBJECTIVE To test students' self-knowledge about drug addiction before and after reading the article

NATIONAL SCIENCE EDUCATION STANDARDS

Life Science; Science in Personal and Social Perspective

WHAT YOU WILL DO

- Before the lesson begins, ask students, "What do you know about drug addiction?" and "What do you think happens to a person's brain when they are addicted to drugs?" Give students time for discussion.
- Tell students you are going to find out what they really know about drug addiction. Distribute copies of Student Activity Reproducible 1. Tell students to write their name on the paper, date it, label the paper #1, and answer the questions. Collect the papers when they are done.
- Have students silently read the article, "Drug Addiction Is a Disease." When they have finished, begin a discussion by asking the following: How would you define addiction? Why is addiction a disease? What do drugs do to the teen brain?
- After the discussion, tell students you are going to find out if they know more about drug addiction and their bodies than they did before. Distribute a second copy of Student Activity Reproducible 1. Tell students to write their name on the paper, date it, label the paper #2, and answer the questions. After students are done, collect the papers, score their answers, and record your data in the Assessment Guide below.
- Wrap up the lesson by asking students: "Why are drugs dangerous?" and "What can you do to prevent drug abuse?"

ANSWERS TO REPRODUCIBLE:

1. d; 2. d; 3. d; 4. a; 5. b; 6. c; 7. a; 8. a; 9. c; 10. b.

Lesson 2: Heads Up: Drug Abuse Affects Decision Making

OBJECTIVE Students use scientific data to draw their own conclusions about the effects of drug use on the brain

NATIONAL SCIENCE EDUCATION STANDARDS

Science as Inquiry; Science in Personal and Social Perspective

WHAT YOU WILL DO

- Tell students that scientists have long known that drugs damage the brain's limbic system. Now, scientists are discovering that drug abuse also harms other parts of the brain. Ask students what parts of the brain they know about and what might happen if these parts were damaged.
- Have students define the word *hypothesis*. If necessary, explain that a hypothesis is a scientific word for an assumption. Scientists come up with a hypothesis, then do experiments to prove the hypothesis true or false.
- Tell students they are going to look at a real scientific study. The study tests the hypothesis that drug abusers make poor decisions because the drugs have damaged their prefrontal cortex.
- Distribute Student Activity Reproducible 2. Have students complete it.
- Wrap up the lesson by asking students: "Why do you think it is important to do research studies?" and "What kind of study about drugs and the body would you do?"

ANSWERS TO REPRODUCIBLE:

1. Group A (drug abusers) and Group B (brain damaged) were most alike. The most different were Group B (brain damaged) and Group C (healthy). 2. People who abused drugs made decisions similar to those of people with brain damage. 3. Yes.

Your Students' Assessment Results: Student Activity Reproducible 1 is a quiz that can be used as a pre- and post-assessment of student knowledge. Record the results of your students' quizzes below so that you can see what they have learned about the science and facts of drugs and addiction. Share your results and you could be eligible to win your choice of a $150 Scholastic gift certificate or a classroom magazine subscription. Send this chart (a photocopy is fine), and your name, telephone number, mailing address, and name of school to: Heads Up #1-CH, c/o Scholastic Inc., Space CN-562, 557 Broadway, 5th Floor, New York, NY 10012.

Activity Reproducible 1	QUESTION 1	QUESTION 2	QUESTION 3	QUESTION 4	QUESTION 5	QUESTION 6	QUESTION 7	QUESTION 8	QUESTION 9	QUESTION 10
Pre-Lesson Quiz: Percentage of students with correct answer										
Post-Lesson Quiz: Percentage of students with correct answer										
Percentage change										

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?

Illustration: © Stephen Kroninger

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.

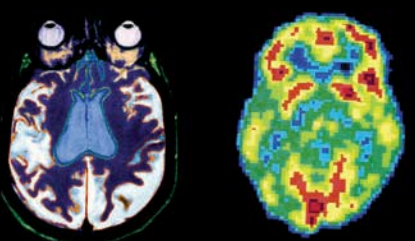
The limbic system is a group of linked brain structures that

Cutting Edge

See the Brain in Action

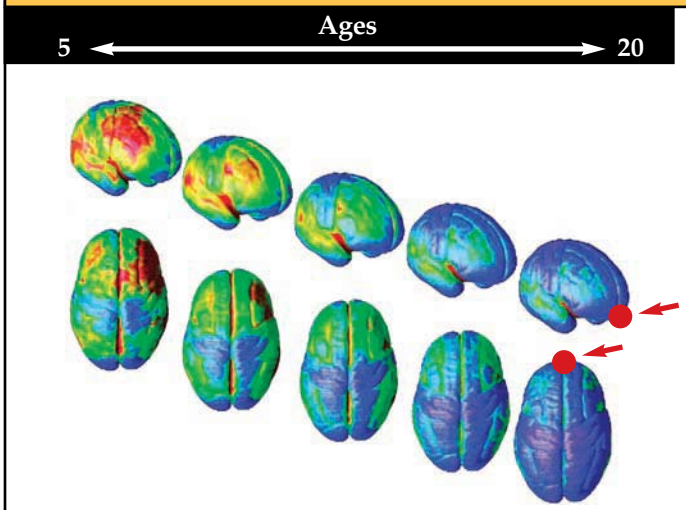
How is it possible to watch the brain at work? With new brain scan technology, researchers can view a person's brain as he or she answers questions or plays games. One example of brain scan technology is functional magnetic resonance imaging, or fMRI. This type of scan shows where the brain is using 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.

• MRI scan of brain • PET scan of 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.

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.

Name _____ Date _____

How Much Do You Know About Drug Addiction?

Answer the questions below to find out what you know about drugs and drug addiction.

1. Drug addiction is best defined as:

a. a bad habit.

b. a disease that is characterized by occasional drug use that temporarily changes a person's behavior.

c. a disease that is characterized by the controlled use of drugs.

d. a disease that is characterized by an uncontrollable, compulsive urge to seek and use drugs.

2. Teenagers' brains are:

a. the same as adult brains.

b. the same as adult brains with the exception of the parietal lobes, which are still forming.

c. completely formed.

d. different from adult brains.

3. The part of the brain in which emotional reactions are created is called:

a. the cerebellum.

b. the parietal lobes.

c. the prefrontal cortex.

d. the limbic system.

4. The part of the brain that adults use to make long-term plans and decisions is called:

a. the prefrontal cortex.

b. the parietal lobes.

c. the cerebellum.

d. the limbic system.

5. Most drugs of abuse act on:

a. the parietal lobes.

b. the limbic system.

c. the cerebellum.

d. the prefrontal cortex.

6. Drugs interfere with:

a. the ability of the brain to produce white matter.

b. the ability of the brain to use white blood cells.

c. the chemical communication between brain cells.

d. the ability of brain cells to use hemoglobin.

7. When teens smoke cigarettes, they:

a. become addicted to nicotine more quickly than adults.

b. are not affected by nicotine.

c. become addicted to nicotine at the same rate as adults.

d. become addicted to nicotine less quickly than adults.

8. Most adults who are addicted to drugs started using them:

a. when they were teenagers.

b. as adults at parties.

c. in their early twenties.

d. as adults, who use drugs to relax.

9. Dopamine is:

a. a type of white matter in the brain that receives messages in the cerebrum.

b. a natural chemical in the brain that carries messages in the parietal lobes.

c. a natural chemical in the brain that carries messages in the limbic system.

d. a type of gray matter in the brain that receives messages in the parietal lobes.

10. In teenagers, drug use interferes with:

a. bone formation.

b. normal brain development.

c. the ability to use the parietal lobes for decision making.

d. the quadriceps muscles.

Name _____ Date _____

Drug Abuse Affects Decision Making

One puzzling symptom displayed by individuals addicted to drugs is their decision to continue abusing drugs, even when there are harmful consequences to themselves and others. At the University of Iowa in 1999, Dr. Antoine Bechara and his fellow scientists created an experiment to find out more about why this happens. In the activity below, read about the experiment they conducted and its results, then draw conclusions about what was discovered.

The Bechara Card Task Experiment

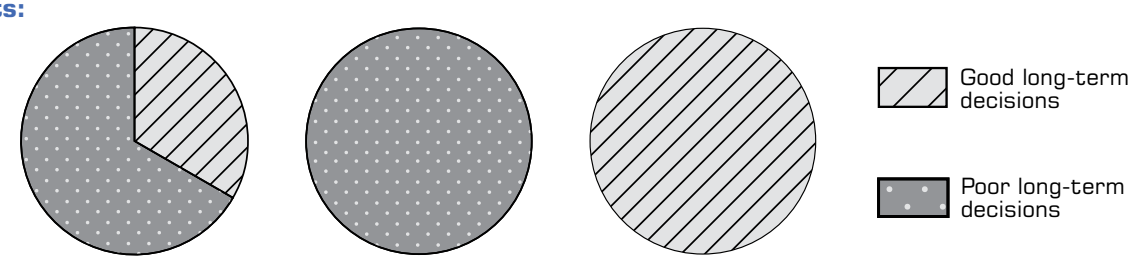
Question: Does drug use interfere with people's ability to make decisions that will benefit them in the long term?

Hypothesis: Some drug users make poor decisions because the drugs have damaged a part of their brain known as the *prefrontal cortex*.

Brief Description of Experiment: Three groups (A, B, and C) played a computerized card game three times. Group A consisted of 46 people who had abused drugs; Group B consisted of 10 people who had prefrontal cortex damage from an injury or a disease; Group C consisted of 49 healthy people who had never abused drugs or had a brain injury or disease.

The card game was designed so that participants had to make decisions involving short-term benefits and long-term consequences. Researchers assessed players' decisions as they made selections from four decks of cards. The object of the game was to accumulate the most points. Two decks of cards represented short-term benefits: the cards had high point value in the short term, but little or no value over the long term. The other two decks represented long-term benefits: the cards had low point value in the short term, but gained more points over the long term. For example, if a player chose a card from Deck A, getting a 100-point short-term gain, but a 200-point long-term loss, the player could decide to choose the next card from Deck B, which may have only a 10-point short-term gain, but a 100-point long-term gain. As players chose cards, it became apparent that to accumulate the highest possible number of points, players had to make decisions that benefited them in the long term. To accumulate the most points, players had to ignore the short-term benefit decks of cards, and choose cards from the long-term benefit decks.

Results:



Now that you have read the experiment and studied the results, answer these questions. Write your answers on the back of this page.

1. **Which groups were most alike? Which groups were least alike?**
2. **What conclusions can you draw from these results?**
3. **Does the hypothesis seem correct?**