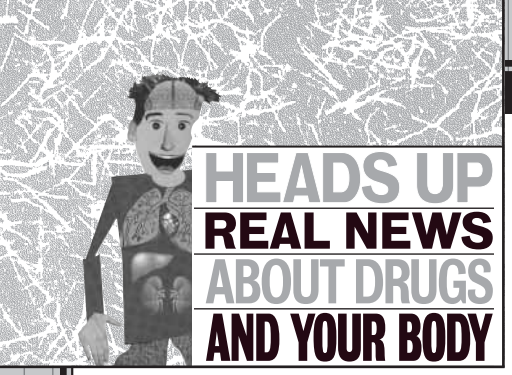


Methamphetamine: A Threatening Scourge on Teens, Families, and Communities

—A message from Dr. Nora D. Volkow, Director of NIDA

In This Installment

* Why methamphetamine is a threatening scourge
* How methamphetamine alters abusers' brains
* Toxic threats of chemicals used to manufacture methamphetamine
* Why teens need know the facts about methamphetamine
* Addiction to methamphetamine is a treatable disease

Coming Up in the Next Installment

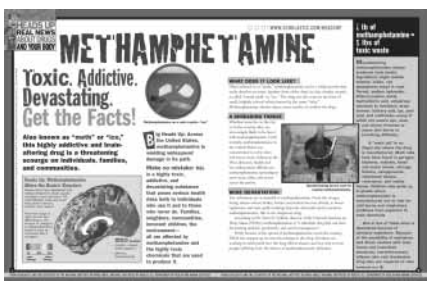
Dangers of Inhalants

Assessment Quiz

Use the Activity 1 Reproducible within as an Assessment Quiz to determine your students' core base of knowledge and to test what they've learned about drug abuse, addiction, and disease.

Dear Teacher:

The National Institute on Drug Abuse (NIDA) and Scholastic Inc. are dedicated to bringing students clear, science-based information about drugs and addiction. We are passionate about this mission because research has shown that when young people are armed with facts, they are more likely to make smart choices about their health and their futures.


METHAMPHETAMINE
Toxic. Addictive. Devastating. Get the Facts!

For those reasons, we are launching the fourth edition of *Heads Up: Real News About Drugs and Your Body.* Over the course of this school year, we will bring you a series of articles about drugs of abuse that NIDA researchers have determined to be of greatest risk to the teen community.

In this first installment of the series, we cover the scourge of methamphetamine, a devastating, addictive stimulant that can be snorted, swallowed, injected, or smoked, and which is increasingly available across the United States. We want to make sure that students understand the devastating effects of methamphetamine and how it poses serious health risks not only to individuals who use it but also to others who never do. We want them to also know the risks from the highly toxic chemicals that are used to make methamphetamine. Armed with these facts, they can make smart choices if ever faced with this drug.

Together with our partners, including classroom teachers like you, we at NIDA are working toward a day when young people everywhere understand the risks of drugs and the damage they can cause. Thank you for helping us come closer to that time, a time when every student in the U.S. will know that trying drugs is always the wrong choice.

Sincerely,

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

For printable past and current articles in the **HEADS UP** series, as well as activities and teaching support, go to **www.drugabuse.gov/parent-teacher.html** or **www.scholastic.com/HEADSUP.**

Lesson Plans for Student Activities

PREPARATION: Before beginning the lessons, make these photocopies: Two copies for each student of Activity 1 Reproducible to be used as a pre-text and post-text quiz, and one copy for each student of Activity 2 Reproducible.

Lesson 1 Heads Up: What Do You Know About the Dangers of Methamphetamine?

OBJECTIVE

To give students science-based facts about methamphetamine; to educate students about the ways in which methamphetamine can damage the brain and immune system; to help students understand that trying methamphetamine even once can be hazardous; and to assess students' knowledge of the topics before and after reading the article.

NATIONAL SCIENCE EDUCATION STANDARDS

Life Science; Science in Personal and Social Perspective

LESSON STRATEGY

Introducing the Topic

- Before the lesson begins, hold a class discussion based on these questions: What is methamphetamine? What do you know about it and how it affects the body and brain? What is the source of your information? How can you determine if your source is reliable?
- Tell students that they are going to see how much they know about methamphetamine and what the latest research is teaching us about it. Distribute copies of Activity 1 Reproducible. Tell students to write their names on the paper and label it No. 1. Then have them answer the questions. Collect and grade the papers.

READING, DISCUSSION, AND ASSESSMENT

- Have students read the article "Methamphetamine: Toxic. Addictive. Devastating. Get the Facts!" Next, hold a discussion based on these questions: Why is it especially important today that teens understand the risks of using methamphetamine? What are the risks to users? To nonusers? What happens in the brain when a person takes methamphetamine? What does the article mean when it says that methamphetamine "tricks" the brain into releasing high and unnatural levels of dopamine? What are the dangers of the chemicals used to illegally make methamphetamine?
- Next, tell students it's time to see how much they've increased their knowledge. Give them a second copy of Activity 1 Reproducible. Tell them to write their names on the paper and label it No. 2. When students have finished, collect the papers, score them, and compare the results before and after the lesson.

WRAP-UP

- Conclude the lesson by asking students whether they think young people and adults in their community understand the risks of methamphetamine. Have students brainstorm ways of getting these messages across. If possible, put some of the best suggestions into action.

ANSWERS TO QUIZ QUESTIONS:

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

Lesson 2 Heads Up: What Methamphetamine Does to Your Brain

OBJECTIVE

Students use scientific data to draw conclusions about the effects of methamphetamine on brain chemistry, memory, and motor skills.

NATIONAL SCIENCE EDUCATION STANDARDS

Science as Inquiry; Science in Personal and Social Perspective

LESSON STRATEGY

Introducing the Topic

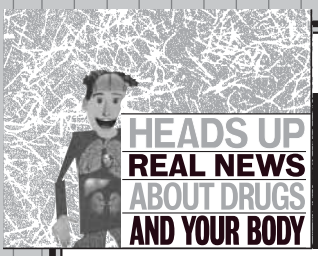
- Tell students that new advances in imaging are allowing scientists to study the living brain to understand how drugs affect its structure and chemistry. Ask students how they think this capability has changed research, and how it can work with other types of inquiry to increase our understanding of drugs and the harm they can cause.
- Explain to students that they are going to read about an experiment in which researchers used positron emission tomography (PET), a noninvasive imaging technique, to compare dopamine transporter (DAT) levels in the brains of methamphetamine abusers with those in non–drug users. (Methamphetamine produces pleasure by releasing extra dopamine in the brain.) The study subjects were also given memory and motor skill tests, because the researchers wanted to see if there was a relationship between DAT levels and performance on these tests.
- Ask students why they think it's important to learn about how particular drugs affect the brain. How is this information useful to scientists who study addiction? To teenagers?

READING, DISCUSSION, AND WRAP-UP

- Hand out Activity 2 Reproducible. Have students read the sheet and answer the questions at the end.
- Wrap up the lesson by discussing the following questions: Could spreading the news about how dramatically methamphetamine affects brain structure, memory skills, and motor skills help cut down the number of new users? Why or why not? What kinds of follow-up experiments would you conduct if you were on the research team? How could you set up an experiment to see whether the brain changes you detected are permanent?

ANSWERS TO ACTIVITY 2 REPRODUCIBLE:

1. Dopamine is a brain chemical that plays a key role in motor activity, motivation, and feelings of pleasure. DATs move dopamine around in the brain. **2.** They knew animals given high doses of methamphetamine had lowered DAT levels and wanted to see if the doses of methamphetamine abused by humans also resulted in lowered DAT levels; they suspected the loss of DATs might affect motor skills and memory because of the location in the brain where DAT levels were most reduced. **3.** By using PET scans. **4.** DAT reductions probably result in decreases in motor and memory skills; methamphetamine abuse can result in lower DAT levels. **5.** Athlete: using the drug may reduce chances of success by impairing motor skills. Lawyer: using the drug may reduce chances of success by impairing memory skills.



Heads Up: Methamphetamine—A Quiz

Test your knowledge of the drug methamphetamine by answering the questions below.

1. Methamphetamine is a

a. hallucinogen.
b. stimulant.
c. narcotic.
d. painkiller.

2. Which of the following does methamphetamine affect?

a. the brain
b. the body's immune system
c. the environment
d. all of the above

3. Dopamine is a brain chemical most important in regulating feelings of

a. anger.
b. jealousy.
c. pleasure.
d. déjà vu.

4. At first, methamphetamine causes

a. an unnaturally high level of dopamine in the brain.
b. a shortage of dopamine in the brain.
c. the destruction of all dopamine in the brain.
d. the destruction of some dopamine in the brain.

5. Methamphetamine can be responsible for

a. violent behavior.
b. burns.
c. explosions.
d. all of the above.

6. When methamphetamine abusers try to quit, they often experience

a. euphoria.
b. a lack of pleasure.
c. extreme violent impulses.
d. amnesia.

7. Methamphetamine can cause the body to heat up excessively, which can lead to

a. convulsions.
b. lung cancer.
c. heart attack.
d. brain tumor.

8. Methamphetamine causes alterations in the areas of the brain responsible for

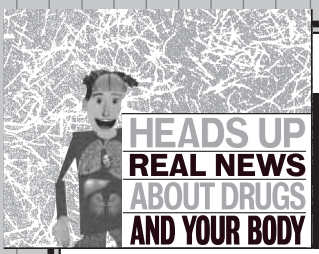
a. memory and motor skills.
b. breathing.
c. sleep regulation.
d. all of the above.

9. Which of the following technologies did scientists use to determine that methamphetamine abuse results in brain alterations?

a. X rays
b. CAT scan (Computerized Axial Tomography)
c. centrifuge
d. Magnetic Resonance Imagery (MRI)

10. Methamphetamine addiction is a disease that

a. can be treated with behavioral therapy.
b. is incurable.
c. can be easily cured with medication.
d. is contagious.



Heads Up: What Methamphetamine Does to Your Brain

With methamphetamine blazing a destructive path across the country, it has become urgent for young people to understand how the drug affects the brain. The NIDA-sponsored experiment described below does exactly that. The results are dramatic.

The Experiment: Dopamine Transporters, Methamphetamine, and Memory and Motor Problems

Background In 2000, when this experiment was conducted, scientists knew that animals given high doses of methamphetamine wound up with fewer dopamine nerve transporters, or terminals, in their brains. Dopamine is a brain chemical important for pleasure, motivation, and motor activity. Dopamine transporters, or DATs, are located on the dopamine terminal and are responsible for recycling dopamine back into the neuron that released it. This is a necessary step for proper communication between nerve cells.

Scientists can attach a radioactive compound to DATs in humans. Then, using imaging techniques, they can measure changes in the number of dopamine transporters to find out whether methamphetamine abusers have fewer dopamine transporters (and presumably fewer dopamine terminals) than nonusers.

This experiment was designed to determine not only whether methamphetamine abuse reduced DATs, but also whether changes in DATs could be linked to changes in abusers' behavior and performance. Problems with memory and motor skills have been associated with methamphetamine abuse, and these are both activities that involve dopamine.

Description Scientists attached radioactively labeled compounds to the DATs in the brains of 15 long-term methamphetamine abusers and 18 non–drug users. Then their brains were scanned using PET (positron emission tomography), which enabled scientists to see and measure DATs. The participants were then given four tests to assess their motor and memory abilities:

- **Timed Gait Test**: Walking a straight line as quickly as possible.
- **Grooved Pegboard Test**: Putting pegs into small, angled holes as quickly as possible.
- **Interference Recall Test**: Learning and recalling words after a distraction.
- **Delayed Recall Test**: Learning and recalling words after a delay.

Results When the experiment was complete, the researchers analyzed the results. They compared the test scores and DAT levels of methamphetamine abusers with those of the non-drug users. This is what they found:

DAT Levels The methamphetamine abusers, who had abstained from drug abuse for at least 2 weeks, all had fewer DATs than the non–drug users. The difference was most dramatic in the striatum, a part of the brain associated with motivation, attention, and control of movement, and was evident even in a former methamphetamine abuser who had abstained for 11 months.

Test Performance The researchers found that lower DAT levels corresponded to worse performance on all four motor and memory tests described above. The subjects with the lowest DAT levels performed worst on the tests.

You're the Scientist Now imagine that you're a scientist analyzing the data from this experiment, and answer these questions. Write your answers on the back of this page.

Understand

1. What is dopamine? What does a dopamine transporter (DAT) do?

2. Why were researchers interested in DAT levels in methamphetamine abusers? Why did they suspect a link between DAT levels and motor and memory skills?

3. How can you measure DAT levels in a human brain?

Analyze

4. What conclusion can you draw from the fact that the lower a methamphetamine abuser's DAT level, the lower his/her performance on the motor and memory tests? What does this tell you about how methamphetamine affects the brain?

5. Based on the experiment results, how would you predict methamphetamine abuse might affect the future career success of a teen who wanted to be a professional athlete? What about a teen who wanted to be a trial lawyer?

Study adapted from: Nora D. Volkow et al., "Association of dopamine transporter reduction with psychomotor impairment in methamphetamine abusers," *American Journal of Psychiatry* 158 (March 2001):377–82.