National Institute on Drug Abuse (NIDA)

Brain Power: Grades 4-5

Last Updated September 2012

https://www.drugabuse.gov

Table of Contents

Brain Power: Grades 4-5

Drugs in Society (Module 1)

Your Amazing Brain (Module 2)

Neurotransmission (Module 3)

Stimulants (Module 4)

Alcohol, Marijuana, and Inhalants (Module 5)

What is Addiction? (Module 6)

Materials/Contact

Drugs in Society (Module 1)

You can also download this entire module in PDF format by clicking the following link: Module 1 (PDF 5.2MB)

Introduction

This introductory Brain Power! mission is designed to encourage the students to think about drugs, and their impact on our society. They will be asked to think about the differences between legal and illegal drugs and to find examples in the media that show how drugs are presented. The students may be surprised to discover that drugs are mentioned often in all types of media. After making this observation, they will have a better understanding of why drug use is a pervasive problem in our society.

Learning Objectives

- Students understand the difference between legal and illegal drugs.
- Students find examples of how drugs are presented in the media.
- Students create a scrapbook identifying how drugs are presented in print media, movies, and electronic media.
- Students draw conclusions about why drug use is a pervasive problem in our culture.

Relationship to the National Science Education Standards

This mission aligns with one standard in the NSES: science in personal and social perspectives. The chart below shows how the mission aligns with this standard.

Levels K–4	How Mission Is Aligned
Personal health	The students develop an understanding of what drugs are and how they are used so that they can learn how to make decisions that affect their health.

Background

Drugs can be broadly defined as substances that change the way the brain and body function. One of the key messages that the students learn during this module is that some drugs are legal, while others are not. Legal drugs include medications when they are prescribed to you by a medical professional, caffeine, nicotine, and alcohol. Even though legal for adults, tobacco (which contains nicotine) and alcohol are illegal for children. Drugs that are illegal for everyone, all the time, include marijuana and cocaine. As this list shows, legal drugs can be helpful, but certain legal drugs, such as alcohol, can cause tremendous damage. All drugs can affect the brain and body, and children should only take medications that are given to them by a trusted adult.

During the second part of the activity, the students will look in magazines, newspapers, on the Internet, and in movies to find out how illegal and legal drugs are presented in our society. They will discover that often drugs are shown as being enticing and appealing. Both men and women shown using drugs are, in many cases, attractive, well dressed, and seem to be having a great time. The fact that drugs are paired with such positive qualities sends a confusing message to kids. Once the students learn how drugs are presented in the media, they will have a better understanding of why drugs are such a serious problem in our society.

This activity will lay the foundation for the remaining activities in the program, which focus on how drugs affect the brain and the nervous system. By the end of the program, the students will have a better idea

of why people are tempted to try drugs, but they will also know why—based on scientific fact—it is so important to resist that temptation.

Materials/Preparation

Materials

Materials

- Paper and pencils
- Markers
- DVD and DVD player
- Trading cards (PDF, 2.5MB)
- Old newspapers and magazines
- Computer with Internet access

Preparation

- Decide how you want to conduct this activity. You could have the students develop their scrapbooks individually or in groups of two or three.

Procedures/Discussion Questions

Procedures

Procedures

1. Begin the mission by discussing the difference between legal and illegal drugs. Ask the students if they can name some legal drugs. Write down their responses on a sheet of paper. Next, ask them to name some illegal drugs, and write down those responses as well. Examples of each are listed below:

    - **Legal Drugs**

    - Caffeine (in coffee, tea, and many soft drinks)
    - Medication for headaches, colds, and other illnesses
- **Legal for Adults**
    - Alcohol
    - Nicotine (in cigarettes)
- **Illegal Drugs**
    - Marijuana
    - Cocaine

2. After developing the lists, help the students understand the differences between legal and illegal drugs. Many legal drugs, such as medications, are helpful but must be taken carefully, in the right dosage, and under the right circumstances. Some legal drugs, such as cigarettes and alcohol, may be purchased only when individuals reach a certain age (e.g., an individual must be at least 21 to purchase alcohol in the United States). Illegal drugs are all harmful in some way, and illegal for everyone.
3. Have the students watch the DVD. Stop the DVD at the break.
4. Now that the students have an idea of the kinds of drugs commonly used, give them an opportunity to find examples of them in the popular media. First, decide if you want the students to work in pairs or in small groups. Then organize the class accordingly.
5. Tell the students that their mission is to create a scrapbook showing how drugs are presented in the media. The scrapbook should include examples from newspapers, magazines, the Internet, television, and movies. Be careful to select media that are appropriate for this age group. Some media may contain images that aren’t appropriate for children this age.
6. Give the students class time to work on their scrapbooks. Pass out the magazines and newspapers and have them look for pictures to

include in their scrapbooks. The students can also check on the Internet for examples. With their groups, they should brainstorm on how drugs are portrayed in the movies and on television.

7. After the students have completed their scrapbooks, watch the remainder of the DVD segment. At the conclusion of the DVD segment, have each group make a presentation to the class. During the presentations, ask the students questions, such as: Was it difficult to find pictures of drugs commonly used? Where did you find cigarette ads? Where did you find alcohol ads? Why do you think these kinds of media advertise these substances? Then conclude the activity by discussing the similarities and differences among the scrapbooks. What features do all the scrapbooks share? How are they different?

Tell the students to keep their scrapbooks to use in later modules.

Discussion Questions

1. Discuss with the class how drug use is portrayed in the media. For example, what do the people drinking or smoking look like? Are they well dressed and attractive? Are they engaged in an appealing activity, such as picnicking in the park, or laying on the beach? Ask the students if they think these images make drug use more attractive to young people. If so, do they think that the media contributes to drug use in our society?

2. After the students have watched the DVD, discuss the question that Corty has posed: Why do they think that people take illegal drugs, even when they know that they are bad for them?

3. Create a class diagram showing the similarities and differences between how drugs are portrayed in print versus other kinds of media. Does one kind of medium portray drugs more positively or negatively than another kind? What conclusions can the students draw by analyzing the diagram?

Extensions

The activities listed below provide a link to other areas in the curriculum.

1. Design a class mural showing how drugs are portrayed in society. Encourage the students to include as many different examples of drug use as they can.
2. Have each student write a summary of what they have learned about how drugs are portrayed in society. Ask for volunteers to read their essays to the class, and ask the students to note on what characteristics each student is focusing. What aspects of this issue have made an impression on the class?
3. Have the students write a short play showing how drugs are portrayed in society. Students can then perform the play for other classes in the school.

Assessment/Additional Activities

Assessment

1. View this module as a pre-assessment of what the students already know about drug use. Consider the following questions:
    - How much prior knowledge do the students have of the topic?
    - Do the students have misconceptions about drug use?
2. Keep a record of questions the students raised while working on the module to refer to as they work on subsequent modules in the program.

Additional Activities

Below are some additional activities that can be used after the students complete the first mission. These activities are extensions to many other areas of the curriculum.

1. Have the students make a list of the different contexts in which they find drugs mentioned. Possibilities include for medical use, as part of a criminal investigation, and in advertisements.
2. Ask the students to take a poll of the adults they know, asking them what their opinion is of both legal and illegal drugs. Have them ask the adults to consider when they think drugs are helpful and when they are harmful. Finally, have the students ask the adults about both legal and illegal drugs, and their impact on society.
3. Have the students write letters introducing themselves to the other group working on the activities in this program. Even though a competition is being set up between the two groups, encourage them to be polite and considerate in their letters.

Resources

The lists below include resources for teachers and students.

Resources for Teachers

- National Institute on Drug Abuse (NIDA)
  www.drugabuse.gov, 301-443-1124
  This Web site contains information about drug abuse and a section designed specifically for parents, teachers, and students. Publications and other materials are available free of charge at drugpubs.drugabuse.gov.
- National Clearinghouse for Alcohol and Drug Information (NCADI)
  store.samhsa.gov, 1-800-662-HELP (4357)
  NCADI provides information and materials on substance abuse. Many free publications are available here.

- ENC Learning Inc.
  http://www.goenc.com/
  This Web site provides useful information and products to improve mathematics and science teaching and learning.

- *Drugs and Society: Behavioral Medicines and Abusable Drugs*. [Leccese, A. P.] Saddle River, NJ: Prentice Hall College Division, 1991.
  Covering a range of drugs, this book addresses the societal views of medicines and abused drugs, and the motivation theories for their use and abuse.

Resources for Students

- Office of National Drug Control Policy (ONDCP): www.abovetheinfluence.com
  This Web site provides information directed at teens about drugs of abuse and how to resist pressure to use drugs.

- *Why Do People Take Drugs?* [Westcott, P.] Chicago, IL: Raintree Publishers, 2001.
  The students will find this book to be a good starting point when answering the question of why people take drugs. It covers the various cultural and individual perceptions people have about drug use and how laws governing it differ around the world.

- *Drugs and the Media.* [Lee, M. P.] New York, NY: The Rosen Publishers, 1994.
  In a straightforward, concise manner, this book presents a variety of propaganda techniques in the media, including advertising, entertainment, and news.

- National Institute on Drug Abuse (NIDA): NIDA for Teens teens.drugabuse.gov
  This site, developed specifically for teens, provides information on drugs.

Introductory Story for Module 1

Beth and Juan are members of the *Brain Power!* Club. They are hanging out in the clubhouse reading magazines. Beth is looking at an ad for alcohol, showing happy people drinking.

Beth says, "You know, Juan, I just can't believe magazines are allowed to run ads like this after all we've learned about how bad drinking alcohol is for you."

Juan says, "Let me see," and he takes a look at the ad. He replies, "Yeah, I've seen ads like that, too, with people drinking and looking all happy and smiling. Don't they know that alcohol can kill brain cells if they drink enough?"

Beth jokes, "And some of us need every brain cell we have!" as she bounces a large soft rubber ball off of Juan's head.

Juan rubs his head and says, "Speak for yourself."

"But it bugs me that the advertisers make it seem like drinking is cool," Beth says.

"Maybe they're a little short on brain cells!" Juan says.

They go back to thumbing through the magazines when Corty, the animated brain, pops out of the pages, startling the kids. "Hi, kids!" Corty says. "I brought some friends." Corty introduces Latisha and Jay from the *Spectacular Scientists Club.*

“Uh-oh, I feel a mission coming on!” Corty says all excited. “Mission alert! Mission alert!”

Jay and Latisha look at Corty like he’s crazy. “Wow! What’s wrong with him?!” asks Jay.

"Oh, he just loves missions," says Juan. "I'm Juan and this is my friend Beth. Ww're Junior Scientists and what we're studying is the problem of drugs in our society."

Juan chimes in, "And when we say "drugs," we mean things like alcohol and cigarettes, too."

"Hey, that's what we've been working on, too," says Jay. "Have you learned about the difference between legal and illegal drugs?"

Beth replies, "Yeah, medications for headaches and colds are legal, but they should only be given by a trusted adult."

Juan adds, "Cigarettes and alcohol are legal for adults, but they can still do a lot of damage. And they're always illegal for kids! But drugs like marijuana and cocaine are illegal for everyone."

Beth picks up the magazine that she and Juan were reading before and says, "Before you came in, we were talking about all the ads you see for liquor, wine, and beer, and how the people in the ads always seem so cool and happy."

Corty chimes in, "That has a lot to do with your mission. Your mission is to find out why people keep taking drugs that are bad for them. I hope you will all work together on this challenge."

The kids settle down to work. Juan says, "There are ads that make smoking and drinking look cool, but why do people use illegal drugs? And where do they find out about them, anyway?"

Latisha says, "We get information about drugs in newspapers, magazines, and on TV. I have an idea. Let's make a scrapbook showing all the different places you can get information on illegal drugs."

Stop here until students have completed their scrapbooks.

The kids get busy building a scrapbook. When they are done, they begin flipping through it. When they turn the page, there's Corty, flattened inside the plastic photo sleeve. The kids are surprised to see him in there.

Corty laughs, comes out of the scrapbook, and says, "Well, how did you do?"

Juan replies, "We've gathered a lot of information on how advertisers and the media sell things that really aren't very good for people."

Jay adds, “They make drinking and smoking look fun and cool, even though they can be harmful.”

Latisha says, “And in movies, you see people using illegal drugs, and sometimes it seems like they’re having a really good time, too. So that’s almost like an advertisement, although it’s not supposed to be.”

Beth says, “So in a way, we understand why people might start using them, but what we still don’t understand is why they keep using drugs.”

Juan says, “Yeah. They must know they can get really sick.”

“I’d also like to know why some TV commercials and advertisements make bad things look good,” says Juan.

Corty replies, “Those are really good points. So what can you do about it?”

Juan says, “Well, we can tell our friends about what we’ve learned: that just because& something looks good doesn’t mean it is.”

Jay says, “And we can control what we put in our bodies, so we can serve as good examples to others.”

Corty says, “Those are all really great ideas. Next time, we’re going to learn about how drugs and alcohol affect our brains—a subject near and dear to me.”

Brain Power News

Parent Newsletter
Volume 1, Number 1

Introducing the NIDA Junior Scientists Program

Your child is working on the first module of the *National Institute on Drug Abuse (NIDA) Junior Scientists Program*. NIDA is a component of the National Institutes of Health, the largest supporter of health research in the world. Geared to students in fourth and fifth grades, the program discusses the following topics:

- Impact of illegal and legal drugs on our society;
- Different functions of the brain;
- Process of neurotransmission;
- Effects of stimulants on the brain and body;
- Effects of alcohol, marijuana, and inhalants on the brain and body; and
- Addiction.

The overall purpose of the program is to lay a foundation for students to make better decisions about their own health in the future. This newsletter is designed to provide you with information so that you can reinforce at home what your child has been learning in school. Each

module has a parent newsletter that includes the following:

- The content of the module;
- Activities you can do at home with your child; and
- Additional resources for more information.

We hope that you and your child enjoy working on the program together and that the knowledge gained now will serve your family well in the future.

Drugs in Society

Module 1 is designed to encourage students to think about what drugs are, and the impact they have on our society. For this module, we define a drug as any substance that changes the way the body and brain work; examples include medicines, alcohol, caffeine, nicotine, and illegal drugs like marijuana and cocaine. Students will learn the differences between legal and illegal drugs and find examples in the media that show how information about drugs is presented. Students may be surprised to discover that drugs are mentioned often in all types of media. After making this observation, students will have a better understanding of why drug use is such a serious problem to our society.

During Module 1, students will look in magazines, newspapers, on the Internet, and in movies to find out how drugs are portrayed in our society. Students will discover that often drugs are shown as being enticing and appealing. Both men and women shown using drugs are, in some cases, attractive, well dressed, and look successful. The fact that drugs are paired with such positive qualities sends a confusing message to kids. Once the students learn how drugs are presented in the media, they will have a better understanding of why drugs pose such a serious problem to our society.

This activity aligns with a standard identified in the National Science

Education Standards, guidelines developed in 1996 by the National Academy of Sciences to help schools know what information should be covered in kindergarten through high school. This standard, science in personal and social perspectives, stresses the importance of understanding what drugs are and how they are used so that the students can learn how to make decisions that affect their health.

Science at Home

Ask your child to help you find examples in the media that show how drugs are portrayed. Watch TV or a movie with your child, look through magazines and newspaper articles, listen to music, or surf the Internet. Discuss how the drugs are portrayed, and how the people look who are using these drugs. Talk to your child about these drugs and the confusion that can happen when the media portrays them in a positive manner.

Additional Resources

National Institute on Drug Abuse (NIDA)
www.drugabuse.gov, 301-443-1124
This Web site contains information about drug abuse and a section designed specifically for parents, teachers, and students. Publications and other materials are available free of charge at drugpubs.drugabuse.gov

National Clearinghouse for Alcohol and Drug Information (NCADI)
http://store.samhsa.gov, 1-800-662-HELP (4357)
NCADI provides information and materials on substance abuse. Many free publications are available here.

Why Do People Take Drugs? [Westcott, P.] Chicago, IL: Raintree Publishers, 2001. Students will find this book to be a good starting point when beginning to answer the question of why people take drugs. It covers the various cultural and individual perceptions people have about drug use and how laws governing it differ around the world.

Drugs and the Media. [Lee, M. P.] New York: The Rosen Publishers, 1994. In a straightforward, concise manner, this book presents a variety of propaganda techniques in the media, including advertising, entertainment, and news.

Your Amazing Brain (Module 2)

You can also download this entire module in PDF format by clicking the following link: Module 2 (PDF, 4.9MB)

Introduction

During the second *Brain Power!* mission, the students learn about the major parts of the brain and their functions. They learn about different techniques used to study the brain—Positron Emission Tomography (PET) scan, Single Photon Emission Computed Tomography (SPECT), and Magnetic Resonance Imaging (MRI)—and discuss what each can tell us about the brain and its functioning. The students also learn about the work of brain researchers.

Learning Objectives

- Students learn about different parts of the brain and the function of each part.
- Students discuss three different techniques used to study the brain.
- Students analyze pictures taken with each device and figure out what information can be obtained from each kind of picture.
- Students learn about the work of different brain researchers.

Relationship to the National Science Education Standards

The activities in this lesson align with two standards identified in the NSES: history and nature of science and science as inquiry.

Unifying Concepts and Processes

Levels K–4	How Mission Is Aligned
Systems, order, and organization	The mission explains the key concept that the brain is part of a larger system—the human body—and that both systems work together to make all human behavior possible.

Standards for Science and Technology

Levels 5-8	How Mission is Aligned
Understanding science and technology	Students learn about three devices and how they are used to further knowledge about the brain.

Background

Module 2 provides the students with important information about the structure of the brain. They will refer to this information later in the program, when learning about the effects that drugs have on different parts of the brain.

In the *Brain Power!* program for the students in grades 2 and 3, they learned about four parts of the brain—the cerebral cortex, composed of the right and left hemispheres; the cerebellum; the brain stem; and the limbic system. In this program, they will learn more detail about the different functions localized in each area. If they haven't already completed the second- and third-grade curriculum, review the basics about the brain in more detail.

Cerebral cortex: right and left hemispheres

In people, the *cerebral cortex* is the brain's largest part, making up more than 3/4 of the brain. It is considered to be the most highly

developed part of the brain and controls thinking, perceiving, and understanding language.

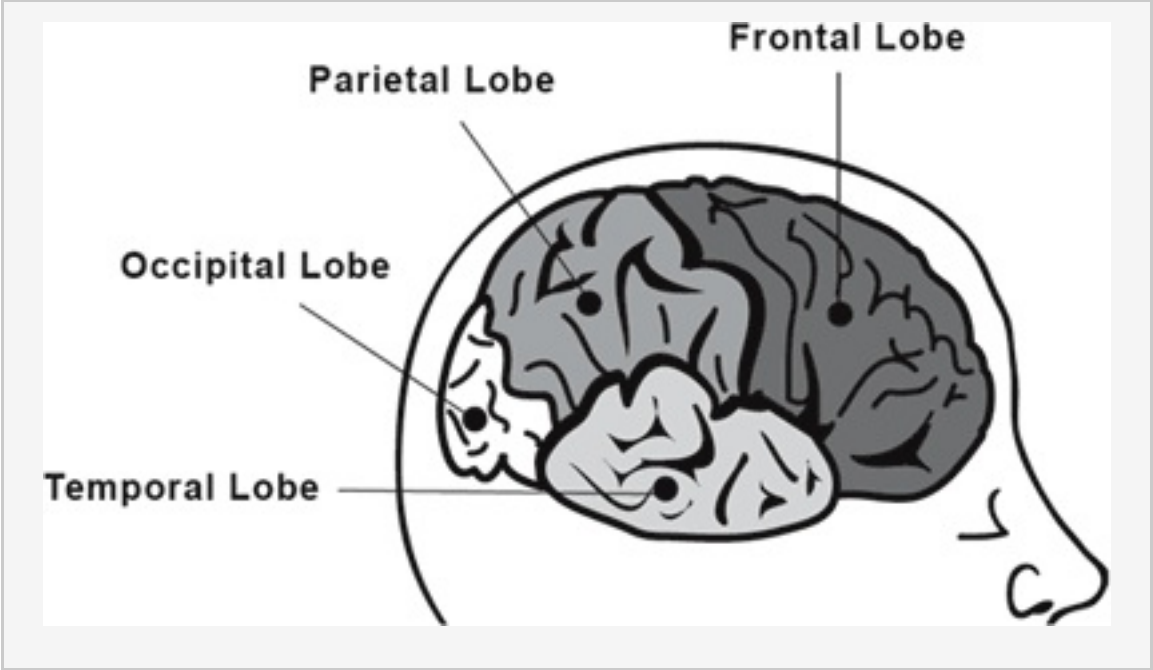
The cerebral cortex is divided into two hemispheres—the *right hemisphere* and the *left hemisphere*. The right hemisphere controls the left side of the body and is largely responsible for artistic expression and understanding relationships in space.

The left hemisphere, which controls the right side of the body, is largely responsible for mathematical ability, problem solving, and comparing information needed to make decisions. It is also the brain's center of language.

The two hemispheres can communicate with one another because of a bundle of fibers called the *corpus callosum*. The corpus callosum serves as the bridge between the two hemispheres.

The cortex is specialized—specific areas of the cortex, called lobes, are responsible for different tasks, such as the following:

- The *frontal lobe* is responsible for initiating and coordinating motor movements and higher cognitive skills like problem solving and thinking.
- The job of the *parietal lobe* is to process sensory information from the whole body—like information about pain, touch, and pressure.
- The *occipital lobe* processes all the visual information coming into the brain.
- The *temporal lobe* is in charge of making sense of the auditory information from the environment. It is also involved in integrating sensory information from various senses, such as smell and vision.



Cerebellum

The *cerebellum* controls posture, movement, and the sense of balance. Playing ball, picking up objects, and playing musical instruments are just a few of the activities that fall under its control.

Brain Stem

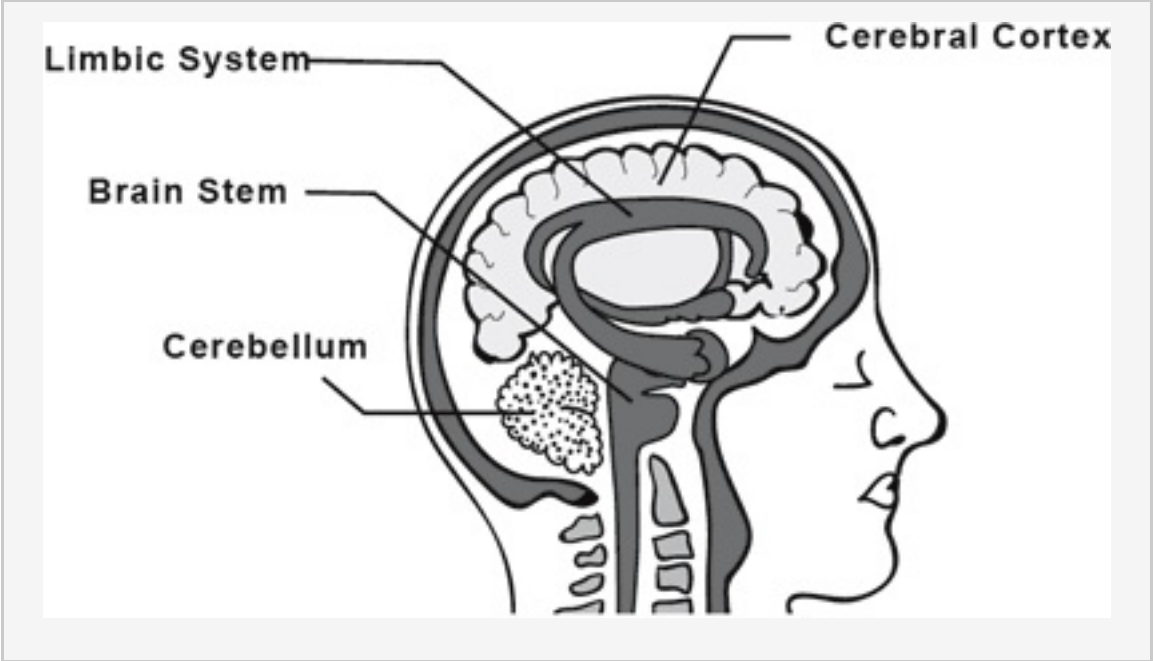
The *brain stem* is the brain's most primitive part. Its two main parts are the *pons* and the *medulla*. The pons contains fibers that connect the cerebral cortex with the cerebellum and the spinal cord. The pons also controls sleeping, awakening, and dreaming.

The medulla controls heart rate, respiration, and blood pressure. The brain stem also controls simple reflexes, such as coughing, sneezing, and digestion.

Limbic System

The *limbic system* has many parts, but two of the most important are the *hippocampus* and the *amygdala*. The hippocampus is mainly

responsible for learning and memory. The amygdala plays an important role in emotional behavior. The limbic system is greatly affected by drugs such as nicotine, alcohol, and illegal drugs.



New Tools for Studying the Brain

Scientists now have very sophisticated techniques for studying the brain. Three important tools that are used are PET, SPECT, and MRI. Each of these tools is described below.

Positron Emission Tomography (PET) scans. Radioactive glucose is injected into the bloodstream; the radioactive glucose is then taken up by parts of the brain that are active and using energy. These areas, which are using either radioactive oxygen or glucose, show up on the image. The advantage of this technique is that it can actually show what parts of the brain are more active than others. The disadvantages are that it is expensive to use and involves radioactive material, which has the potential to be dangerous.

Single-Photon Emission Computed Tomography (SPECT) scans. Similar to PET scans, radioactive material is injected into the bloodstream and travels to the brain and body. Scientists and doctors can view the

material on computerized images, which helps them identify brain activity. The radioactive substances used in SPECT are different from those used in PET scans, and the SPECT images are less detailed than those of PET. On the other hand, SPECT is less expensive than PET, and SPECT centers are more accessible than PET centers because they have fewer equipment requirements.

Magnetic Resonance Imaging (MRI). MRI uses radio frequency signals produced in a strong magnetic field to create an image of the brain and show what it looks like. MRIs show the structure of the entire brain, as opposed to the other types of imaging, which show the specific parts that are working. While MRIs produce clear images, they are expensive to use and can be uncomfortable for the patient, who must lie still in a very small space for a relatively long period of time. However, a big advantage is that MRI is noninvasive and doesn't use injections or radioactivity.

During the activity, the students will have an opportunity to look at images produced from these three different tools to see what each shows and how the images can be used to learn more about the brain.

Materials/Preparation

Materials

- Paper and markers
- DVD and DVD player
- Computer with Internet access
- Brain Instruction and Fact Sheets (PDF, 142KB)

Preparation

1. Review the Background material about the parts of the brain and

the tools used to study the brain.

2. Preview the DVD before starting the activity. Decide which sections you want to use with the class.
3. Use the Brain Instruction Sheet to make an overhead transparency of the brain.
4. Make enough copies of the Brain Instruction and Brain Fact Sheets (PDF, 142KB) for each student in the class.

Procedure/Discussion Questions

Procedure

1. Begin the mission by asking the students what they know about the brain. Do they know the names of any of its parts? Do they know what the different parts do? Write down their ideas on a sheet of newsprint. It might be helpful to create a chart for this information. The chart can hang on the wall in the classroom.
2. Project the transparency of the brain. Go over each part and describe its function. After discussing all the parts, ask the students to think of examples of different activities that each part controls. For example, they may say that the cerebral cortex enables them to play card games, and the cerebellum is involved in their ability to play soccer.
3. To make sure the students know the parts of the brain, pass out the Brain Instruction Sheets and Brain Fact Sheets from the guide. After splitting the class into pairs, ask the students to label each part of the brain and jot down some activities for each part. After they have completed the sheet, tell them to keep it for reference during the second part of the activity. The students can practice sharing what they learned by teaching someone else the information (e.g., parent, sibling, or friend).
4. Tell the students that during the second part of the mission, they will be learning about some different tools available to scientists

for studying the brain. For this activity, it would be preferable for them to work in the computer lab, if possible.

5. Have the students watch the DVD. Stop the DVD at the break.
6. Divide the students into pairs. Have them visit the following Web site: faculty.washington.edu/chudler/image.html. Give the students a few moments to look at the images on the Web site developed from each brain imaging tool. Using their Brain Instruction Sheets, have them identify the different parts of the brain. They can write their responses on a separate piece of paper. Tell them to make sure to indicate to which image their labels are referring.
7. Have the students watch the remainder of the DVD. Conclude the lesson by asking them what they think of the different machines used to study the brain. How do they all work together to give scientists a more complete picture of the brain?

Discussion Questions

1. Tell the students to use the information they learned in the DVD to fill in the following chart. They can watch the part showing the researchers again if they need to.

Name of Researcher	Brain Part Studied	Machines Used to Study the Brain	Drugs Studied That Affect the Brain

2. Discuss the findings with the students. What role do the different tools play in allowing the scientists to study the brain? What do they learn from the images produced from these tools?

3. Tell the students to keep this chart for further reference. They may need it when they start studying different drugs and how they affect the brain.

Extensions

The following activities provide a link to other areas in the curriculum.

1. Have the students look through newspapers and magazines. Tell them to cut out any articles that relate to the brain or brain research. They can compile their articles into a scrapbook.
2. Have the students write a story based on what they learned about the brain and brain research. The story could be about a child who needed to undergo a test because of an illness, a scientific breakthrough, or what brain research will be like 50 years from now. Encourage them to use their imaginations as well as their knowledge to write a creative, interesting story.
3. Have the students draw a cartoon strip illustrating a day in the life of a brain researcher. Suggest that they base their comic strips on the DVD they watched.
4. Have the students take a brain dominance self-assessment to find out if they are left or right brained. These tests can easily be found on the Internet.

Assessment/Additional Activities

Assessment

1. As the students work on these activities, look for evidence of the following:

- Are the students grasping the concept that the brain is a complex organ made up of different parts that perform different functions?
- Do the students understand how the different tools work that researchers use? Do they understand that each tool is used for a specific purpose?
- Can the students apply what they have learned to new situations? For example, can they use the information to write a story?

2. Put each student's Brain Instruction Sheet in his or her student portfolio.

Additional Activities

Below are some additional activities that can be used after the students complete the second mission. These activities are extensions to many other areas of the curriculum.

1. Draw a class illustration of the brain. Be sure to label all of the parts the students studied during the mission. Include the functions of each part.
2. Write a class play about the brain or brain research. The play could focus on the work of the brain researchers that the students learned about, how each device is used to study the brain, or the function of each part of the brain.
3. Make a class chart with ideas on how to protect the brain. Some suggestions include wearing a helmet when bike riding or rollerblading, eating a nutritious diet, and wearing a seatbelt when in a car. After developing the list, discuss specifically how each idea could protect the brain.

Resources

The lists below include resources for teachers and students.

Resources for Teachers

- National Institute on Drug Abuse (NIDA)
  www.drugabuse.gov, 301-443-1124
  This Web site contains information about drug abuse and a section designed specifically for parents, teachers, and students.
- National Clearinghouse for Alcohol and Drug Information (NCADI)
  store.samhsa.gov, 1-800-662-HELP (4357)
  NCADI provides information and materials on substance abuse. Many free publications are available here.
- *The Human Brain: A Guided Tour.* [Greenfield, S. A.] New York, NY: Basic Books, 1998.
  Written for a lay audience, it provides a holistic view of the brain as an integral part of the body; part of the Science Masters Series.
- *A Celebration of Neurons: An Educator's Guide to the Human Brain.* [Sylwester, R.] Alexandria, VA: Association for Supervision and Curriculum Development, 1995.
  The book discusses the structure and function of the brain, and explains how we think, dream, digest food, and much more.

Resources for Students

- Neuroscience for Kids
  faculty.washington.edu/chudler/neurok.html
  Contains information on the brain and neurotransmission, activities, experiments, pictures, and other resources for students and educators.
- *Focus on Drugs and the Brain.* [Friedman, D.] Frederick, MD: Twenty-First Century Books, 1990.
  This book, part of the "Drug-Alert Book" series, gives a good overview of the brain, neurotransmission, effects of drugs on the brain, and addiction.

- *Phineas Gage: A Gruesome but True Story About Brain Science.* [Fleischman, J.] Boston, MA: Houghton Mifflin Co., 2002.
  Written for ages 9 through 12, this book tells the story of a railroad employee who experienced personality changes after a 13-pound iron rod shot through his brain.
- *The Brain: Our Nervous System.* [Simon, S.] New York, NY: William Morrow, 1997.
  This book offers simple, yet comprehensive, information on the brain and the nervous system.
- *Big Head! A Book About Your Brain and Your Head.* [Rowan, P.] New York, NY: Alfred A. Knopf, 1998.
  Gives an overview of the different parts of the brain; includes detailed color pictures and transparencies.

Introductory Story for Module 2

Beth and Juan are sitting at a table in the *Brain Power!* Clubhouse looking at model brains. Beth says, “The brain is really so cool. You don’t have to think about it, but it still does all your thinking for you.”

Juan picks up one of the brains and looks it over. He says, “We couldn’t even breathe if we didn’t have a brain.”

Juan then squeezes the brain a little as he looks at it. He puts it back and goes for another brain. It leaps out of his hands – it’s Corty! Juan jumps back.

Corty looks at Beth and Juan who are still holding the brain models and winces saying, “Hey, you’re giving me a headache playing with those things.”

Beth says, “But Corty, we’re really interested in brains. They’re very important, and we want to learn more about them.”

Corty says, “Now that’s food for thought! So, what do you want to know?”

Juan replies, “We want to learn how scientists know so much about brains. I mean, how do they study brains? You’d need to have x-ray vision to look inside someone’s head.”

Corty says, “OK! I have the perfect mission for you. How about teaming up with the other club again so you can help out each other?”

“We don’t need any help. I mean, we’re Junior Scientists,” Beth says.

“You’re right. But you know what would be fun?” asks Juan. “What?” says Beth.

“What about if we compete with them?” Juan says. “That’s a great idea!” says Beth.

Corty says, “You’re wasting brainpower by splitting up!”

The kids just stare at him. There’s no way they’re working together.

Corty says, “Okay, okay. I’ll tell the *Spectacular Scientists Club* members the plan. Now listen up. How do scientists know so much about brains? How do they learn about brains? And what can we learn from them?”

Beth says, “It seems like we’d have to talk to some scientists to learn the answers to those questions.”

Corty says, “You’re right! And I’m going to introduce you to some of my scientist friends who study drug abuse research.”

Corty snaps his fingers, and scientists show up on the computer

monitor who explain different imaging techniques that can be used to see the effects of drugs on the brain. These techniques include MRI, PET, and SPECT. Anna Rose Childress explains that MRI uses radio frequency signals produced by magnets to create an image of the brain. Bob Malison and Nora Volkow explain that in PET and SPECT scans, radioactive material is injected into the bloodstream, which allows scientists to view computerized images of the brain.

Juan says, “Wow! They sure said a mouthful! I didn’t realize there’s so much for scientists to do and learn.”

Beth says, “That’s the truth! I have got to organize this information so I can study it better. Let’s make a chart.”

Juan goes off to get markers and rulers. Then, they begin to make their chart of the scientists—what they do and what machines they use. When they finish, they pin up their chart.

Stop here until students have completed procedure #6.

Corty says, “Very nice! You’ve really been paying attention! Great job, but I can’t stick around. I’ve got to give a mission to the kids in the *Spectacular Scientists Club*.”

“What’s their mission?” asks Juan.

Corty replies, “Can’t tell you. It’s top secret. If you’d cooperated instead of competing, you’d be in on it, too, but... see ya!” Corty starts to leave, but both kids yell for him to help them out.

Corty responds, “You wanted to compete.”

Beth says, “Just a hint?”

Corty can’t resist responding. He says, “Okay, okay, I’ll give you a hint: neurotransmitters.”

Beth and Juan look at each other, confused.

Corty continues, “The brain’s no good without them. They go together like PB and J, cereal and milk, synapses and neurons.” The kids just stare at him blankly. Corty says, “So, you could say neurotransmission is another example of teamwork.”

Beth says, “Corty, you’re a brain with a one-track mind!”

Brain Power News

Parent Newsletter
Volume 1, Number 2

Your Amazing Brain

Your child is learning about the most important part of the body—the brain! The brain is the control center for the entire body. It controls everything a person does. This module teaches children about the five major parts of the brain and their functions.

Part of the Brain	Function
Cerebral Cortex: right and left hemispheres	The cerebral cortex, comprised of the right and left hemispheres, is responsible for artistic expression, understanding relationships in space, mathematical ability, problem solving, and comparing information needed to make decisions. It is also the brain's center of language.
Cerebellum	The cerebellum controls posture, movement, and the sense of balance. Playing ball, picking up objects, and playing musical instruments are just a few of the activities that fall under its domain.
Brain Stem	The brain stem controls sleep, awakening, dreaming, heart rate,respiration, and blood pressure. The brain stem also controls body temperature; simple reflexes, such as coughing and sneezing; and digestion.
Limbic System	The limbic system is responsible for learning, memory, and emotional behavior. The limbic system is greatly affected by drugs.

In Module 2 the students are learning about different methods researchers use to study the brain. Scientists now have very sophisticated imaging tools for studying the brain. The three main tools used are:

- Positron Emission Tomography (PET) – uses radioactive substances linked to sugar to show which parts of the brain are using the most energy. These are the brain areas that are most active. Areas of the brain with the highest radioactivity will look bright red, and therefore are working hard. Areas that have little activity will be dark blue.
- Single Photon Emission Computed Tomography (SPECT) – uses

radioactive material to show which parts of the brain are using energy and are most active. SPECT produces images that are less detailed than PET, but SPECT techniques are less expensive and more accessible than PET.

- Magnetic Resonance Imaging (MRI) – uses radio frequency signals produced in a strong magnetic field to create an image of the brain. These images provide more details about brain structure, but they don't show specific functions like SPECT and PET scans.

This activity aligns with two standards identified in the National Science Education Standards: unifying concepts and processes, and science and technology. The activity explains the key concept that the brain is part of a larger system—the human body—and that both systems work together to enable people to function. Students also learn about PET, SPECT, and MRI and how they are used to further knowledge about the brain.

Science at Home

Ask your child what he or she learned about the brain. See how many parts he or she remembers and can identify. Act out different activities and have your child guess which part of the brain is being used. Then ask your child to draw a picture of the brain and label it.

Additional Resources

National Institute on Drug Abuse (NIDA)
www.drugabuse.gov, 301-443-1124
This Web site contains information about drug abuse and a section designed specifically for parents, teachers, and students. Publications and other materials are available free of charge at drugpubs.drugabuse.gov.

National Clearinghouse for Alcohol and Drug Information (NCADI)
http://store.samhsa.gov, 1-800-662-HELP (4357)
NCADI provides information and materials on substance abuse. Many

free publications are available here.

Neuroscience for Kids
http://faculty.washington.edu/chudler/neurok.html
This Web site contains information on the brain and neurotransmission, activities, experiments, pictures, and other resources for students and educators.

Phineas Gage: A Gruesome but True Story About Brain Science. [Fleischman, J.] Boston, MA: Houghton Mifflin Co., 2002. Written for ages 9 through 12, this book tells the story of a railroad employee who experienced personality changes after a 13-pound iron rod shot through his brain.

Focus on Drugs and the Brain. [Friedman, D.] Frederick, MD: Twenty-First Century Books, 1990. Part of the "Drug-Alert Book" series; gives a good overview of the brain, neurotransmission, effects of drugs on the brain, and addiction.

Big Head! A Book About Your Brain and Your Head. [Rowan, P.] New York: Alfred A. Knopf, 1998. Gives an overview of the different parts of the brain; includes detailed color pictures and transparencies.

Neurotransmission (Module 3)

You can also download this entire module in PDF format by clicking the following link: Module 3 (PDF 5.5MB)

Introduction

In the second mission, the students learned about the parts of the brain and what each part does. During this mission, they learn about neurotransmission—the process by which information travels to and from the brain—by playing a board game and then devising their own original way to explain this process.

Learning Objectives

- Students learn about neurons and what they do.
- Students find out how neurons communicate with each other.
- Students explore the relationship between the brain and the rest of the central nervous system.
- Students learn more about neurotransmission by playing a board game.
- Students apply what they have learned by figuring out a unique way to explain the topic.

Relationship to the National Science Education Standards

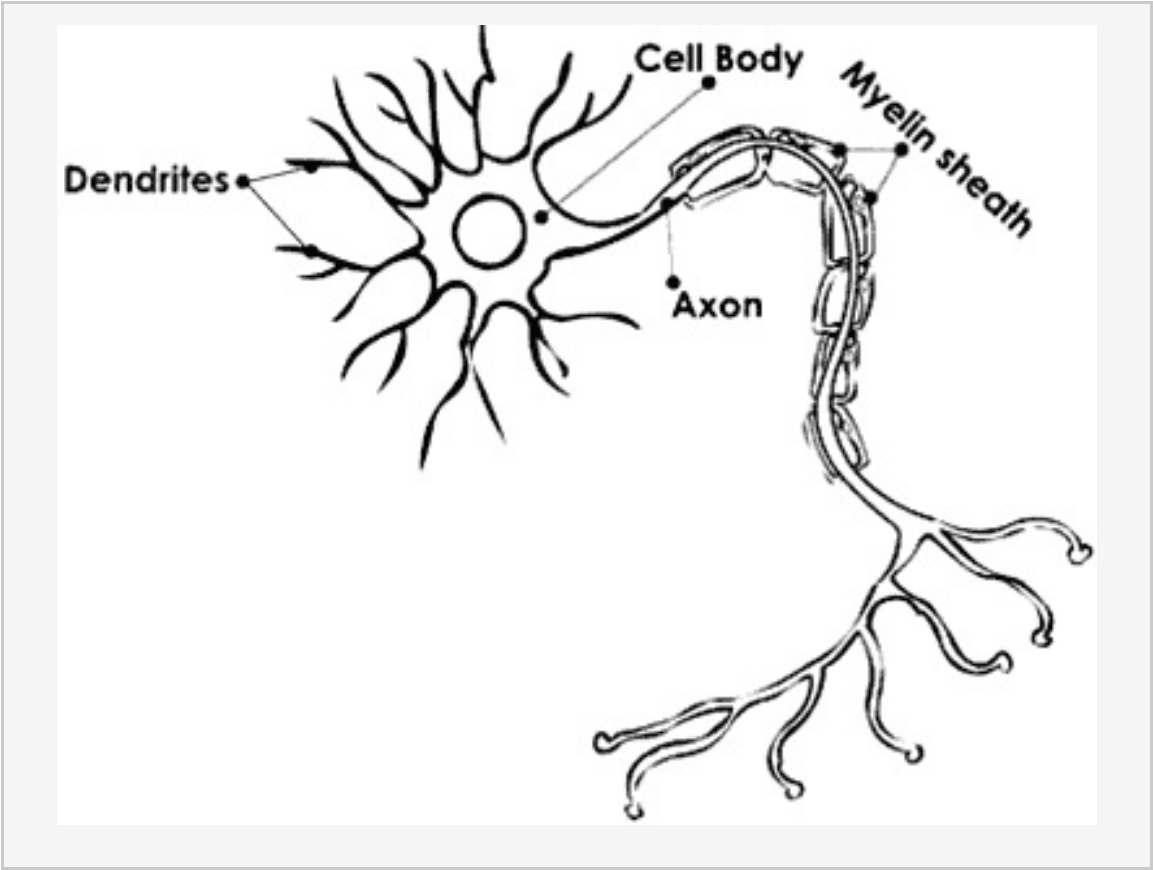
This mission aligns with the following standard in the NSES: unifying concepts and processes. The chart below shows how the mission aligns with this standard.

Levels 5-8	How Mission Is Aligned
Systems, order, and organization	This mission adds key knowledge to what was learned in Module 2 by showing how neurotransmission is part of the nervous system. Students develop an understanding of how the brain works with other parts of the nervous system to keep the entire human body functioning.

Background

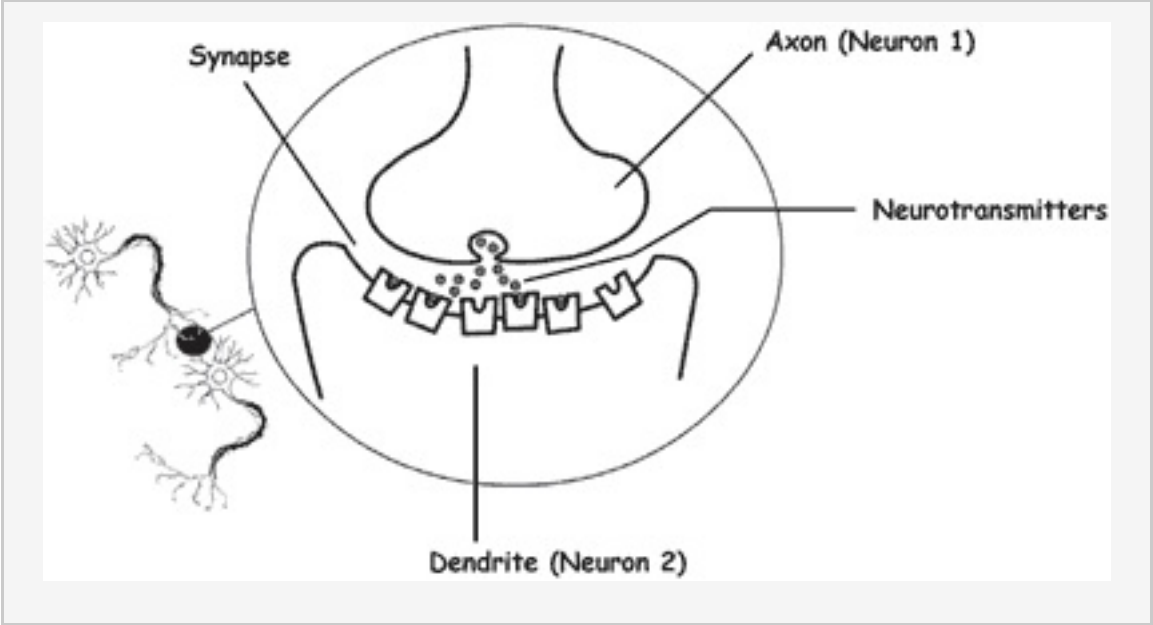
Information is constantly exchanged between the brain and other parts of the body by both electrical and chemical impulses. A cell called a neuron is responsible for carrying this information. The human brain is made up of 100 billion neurons.

A neuron has three main parts. The cell body directs all of the neuron's activities. Dendrites, short branches that extend out from the cell body, receive messages from other neurons and pass them on to the cell body. An axon is a long, single fiber that transmits messages from the cell body to the dendrites of other neurons or to other tissues in the body, such as muscles. A protective covering called the myelin sheath covers the axons of many neurons. Myelin insulates the axon and helps messages from nerve signals travel faster, farther, and more efficiently.



The exchange of information from the axon of one neuron to the dendrites of another is called neurotransmission. Neurotransmission takes place through the release of chemicals into the space between the axon of the first neuron and the dendrites of the second neuron. These chemicals are called neurotransmitters. The space between the axon and the dendrites is called the synapse.

When neurons communicate, an electrical impulse traveling down the axon causes neurotransmitters to be released from the end of the axon into the synapse. The neurotransmitters cross the synapse and bind to special molecules on the other side, called receptors. Receptors are found on the dendrites and cell bodies of all neurons. These receptors convert the information into chemical and/or electrical signals for processing in the neuron.



Our body produces many different types of neurotransmitters. Each neurotransmitter has a specific role to play in the functioning of the brain. A neurotransmitter binds to a receptor in much the same way that a key fits into a lock. A specific neurotransmitter only binds to certain receptors. Once the neurotransmitter has bound to a receptor, a series of events follow. First, the message carried by the neurotransmitter is received and passed on to the receiving nerve cell. Second, the neurotransmitter is inactivated and either broken down by an enzyme or reabsorbed from where it was released. The reabsorption is completed by other molecules called transporter molecules. These molecules are located in the cell membranes of the axon that releases the neurotransmitters. They pick up specific neurotransmitters from the synapse and carry them back across the cell membrane into the axon. The neurotransmitters are then recycled for use at a later time. Note that this process is true for most neurotransmitters, but not for all of them.

Materials/Preparation

Materials

- Board Game, with spinner and playing pieces (PDF, 279KB) (for each group)

- Set of 10-15 blank cards for each group (use index cards or scratch paper)
- Paper and pencils
- Black Line Master (PDF, 111KB)
- DVD and DVD player

Preparation

1. Familiarize yourself with the topic of neurotransmission by reading the background section of the guide.
2. Create an overhead transparency showing neurotransmission by using the Black Line Master (PDF, 111KB) at the back of this guide.
3. Decide how you want to group the students for this activity. Each group should consist of three to four students.
4. Make enough copies of the board and the cards so that each group receives one set.

> You may want to have parent volunteers or instructional assistants help make copies of the materials needed for this activity.

Procedures/Discussion Questions

Procedures

1. Begin the activity by asking the students if they have ever learned about neurotransmission. The students who worked on other modules in the *Brain Power!* program may remember something about this process.
2. Show the students the overhead transparency of neurotransmission. Explain the steps in the process.

3. Watch the Module 3 DVD. Stop the DVD at the break.
4. Tell students that to better understand this complex process, they are going to design a board game explaining how neurotransmission works and how information is communicated between the brain and other parts of the body.
5. Pass out a board game set to each group. Tell students that the game works like this: The spaces on the board will tell students what to do when they are playing the game. The students must fill in these spaces before playing the game. Ideas are listed below. Once the students have filled in the spaces, have them play. Each student should spin, move a certain number of spaces, and follow the instructions on the space. If they answer the question correctly, they spin again. The player who returns to the starting place first wins the game.

   Ideas for the Board

   - Neurotransmitters were just released into the synapse. Move two spaces.
   - A message didn't go through. Go back three spaces.
   - You just had a brilliant idea! Move ahead four spaces.
   - Brain overload! Go back three spaces.
   - Pick a card and follow the instructions.

   Ideas for the Cards

   - Name the parts of a neuron.
   - Explain how your brain "knows" that your arm hurts.
   - What is the myelin sheath? Why is it important?
   - What are neurotransmitters?
   - What are receptors?
   - What are transporter molecules?

- What parts of a neuron communicate with each other?
- Where does communication take place?

6. Resume the DVD. When the DVD is finished, give students class time to play the game. It may be a good idea to leave the overhead transparency on while students are playing. That way, they can refer to it if they have questions while playing the game.
7. After the students are finished playing the game, have them clean up and come back together as a class. Conclude the activity by asking them what they learned about neurons and how they communicate (neurotransmission).

Discussion Questions

1. Show the DVD to the students. Discuss what new neurotransmission information they learned from the DVD.
2. Challenge the students to develop their own way to explain neurotransmission. It could be by developing another board game, a simulation, or a play.
3. Ask the students if they think it would be better if the *Junior Scientists* collaborated with the *Spectacular Scientists Club* kids instead of competing with them. Tell them that they will be asked later in the program about the value of competition versus collaboration.

Extensions

The activities listed below provide a link to other areas in the curriculum.

1. Have the students share their ideas about how to explain neurotransmission. Keep a list of all of their ideas.
2. Develop a class play explaining how neurotransmission works. The

students may have the characters be the parts of the neuron, or kids showing what happens if neurotransmission works—and if it doesn't.

3. Draw a class poster showing the different parts of a neuron. Students could also draw the steps of neurotransmission.

Assessment/Additional Activities

Assessment

1. If students worked on the *Brain Power!* program for grades 2 and 3, they may have some knowledge of neurotransmission. For those learning about it for the first time, expect some difficulties in understanding it. Neurotransmission is a very difficult topic for elementary school students. Our goal is for the students to have a basic understanding of the process by the end of the module.
2. Look for the following indicators of understanding of key concepts:
    - Did they have a working knowledge of the key terms learned during the mission?
    - Were the students able to play the game?
    - Were they able to apply what they learned to a new situation, such as developing a new way to explain this process?

Additional Activities

Below are some additional activities that can be done after completion of the third mission. These activities are extensions to many areas of the curriculum.

1. Working in pairs, have students make a comic strip explaining neurotransmission. Make sure they include information about neurons, how messages are received, and what chemicals are

involved in the process.

2. Have the students find out how many neurons are in the human body at different life stages. At which stage do people have the most neurons? Ask students why the number varies. The best ways for the students to find this information would be on the Internet or in library books.

3. Have students look in newspapers, magazines, and on the Web for information about the latest developments in brain research. What information do we have now that we didn't have 10 or 15 years ago?

4. Working in small groups, have the students make a timeline showing major findings in brain research beginning in 1900 and going to the present. They can use reference books and the Internet to complete their research. The Neuroscience for Kids Web site contains information on brain research.

Resources

The lists below include resources for teachers and students.

Resources for Teachers

- National Institute on Drug Abuse (NIDA)
  www.drugabuse.gov, 301-443-1124
  This Web site contains information about drug abuse and a section designed specifically for parents, teachers, and students. Publications and other materials are available free of charge at drugpubs.drugabuse.gov.

- National Clearinghouse for Alcohol and Drug Information (NCADI)
  store.samhsa.gov, 1-800-662-HELP (4357)
  NCADI provides information and materials on substance abuse. Many free publications are available here.

- *From Neuron to Brain*. [Nicholls, J. G., Wallace, B. G., Fuchs, P. A., & Martin, A. R.] Sunderland, MA: Sinauer Associates, 2001.
  Developed for readers with an interest in the human nervous system with little or no background in the biological sciences; describes how nerve cells transmit signals and messages.

- *The Brain Atlas: A Visual Guide to the Human Central Nervous System*, 3rd Edition. [Woolsey, T. A., Hanaway, J., Gado, M.H.] Hoboken, NJ: John Wiley & Sons, Inc., 2007.
  This book is a comprehensive and accurate atlas of the brain. It includes nearly 400 images of the brain and its pathways.

Resources for Students

- Neuroscience for Kids
  faculty.washington.edu/chudler/neurok.html
  This site contains information on the brain and neurotransmission, activities, experiments, pictures, and other resources for the students and educators.

- *Phineas Gage: A Gruesome but True Story About Brain Science*. [Fleischman, J.] Boston, MA: Houghton Mifflin Co., 2002.
  Written for ages 9 through 12, this book tells the story of a railroad employee who experienced personality changes after a 13-pound iron rod shot through his brain.

- *Focus on Drugs and the Brain*. [Friedman, D.] Frederick, MD: Twenty-First Century Books, 1990.
  This book, part of the "Drug-Alert Book" series, gives a good overview of the brain, neurotransmission, effects of drugs on the brain, and addiction.

- *Understanding Your Brain (Science for Beginners Series)*. [Treays, R.] Newton, MA: EDC Publications, 1996.
  This book describes the parts of the brain and the process of neurotransmission.

- *The Brain: Our Nervous System*. [Simon, S.] New York, NY: Collins Publishers, 2006.

This book presents a simple, yet detailed, overview of the brain and neurotransmission.

Introductory Story for Module 3

Jay and Latisha are sitting in the chairs in the *Brain Power!* Club house. They're taking turns checking each other's reflexes using the rubber hammer doctors use on patients' knees.

Latisha says, "You have good reflexes, Jay."

Jay responds, "A sign of someone ready to kick off a serious campaign to become a future Junior Scientist!"

"It would be fun to be Junior Scientists like the *Brain Power!* Club kids, wouldn't it?" Latisha says. "I like it here in their club house. And I think that if we do a good job with our next mission, we might get promoted!"

Corty appears, emerging from a nearby computer monitor. He says, "Oh, wow, that's just what I have for you, a mission! You are going to compete with the Junior Scientists to see who can solve more missions."

Latisha and Jay are both really excited.

Corty says, "The Junior Scientists solved the last one, so this is up to you. Your mission, should you choose to accept it, is learning about neurotransmission. It's the process that takes information to and from the brain."

Latisha and Jay look at each other confused and a little concerned. Latisha says, "I must be having a neurotransmission breakdown because I don't get it." Jay agrees.

Corty asks them for examples on how to send information.

The kids respond, “By telephone, e-mail, instant message, letters…”

Corty says, “Right. But brains don’t have telephones or computers. Well, I mean, I do, but I’m…different.” The kids totally agree.

Corty says, “Typical brains have to find another way to communicate with the rest of their bodies. And they do it by using the synapses between neurons—or brain cells—as a kind of Internet, like when you send Instant Messages.”

The kids are still confused. Corty says, “Maybe it’s time to call in an expert.”

A scientist named Elliot Stein appears on the computer screen and explains neurotransmission. The kids see a 3-D animation showing neurotransmitters being released from one neuron into the space between neurons, called the synapse. The neurotransmitters cross the synapse between the neurons and then attach to the receptors on the next neuron. Then the computer screen goes blank.

Corty says, “There you go! Your mission is to design a board game to teach other kids about neurotransmission.”

Latisha says, “Whoa!” Jay says, “Cool! Hard, but cool.”

Corty says, “Of course, board games are best when played in teams.” He looks at the kids and clears his throat meaningfully. The kids look at each other and roll their eyes.

Stop here until students have designed a game.

Jay and Latisha work hard on their board game. They put the finishing touches on it and draw a picture of Corty on the board. Jay makes the final stroke and says, “Ta-dah – finished!”

Latisha explains how to play the game, “Each player is a neuron, a brain cell. See how the pieces are shaped like neurons? The goal is to be the first to get an important piece of information to the brain.”

Jay chimes in, “At the beginning of the game, each player finds out, from a booklet, what that piece of information is. Mine is that I’m being chased by a hungry lion. I need to let my brain know, so it can tell my body what to do—Ruuuun!”

Latisha says, “Mine is that I’m hungry for pizza, and I have to get that information to my brain so that my body knows how to get a slice—hold the anchovies, please.”

Jay picks up two stacks of cards and says, “There are two sets of cards.” He points to one stack and takes a card from it. “This set tells the players how many spaces to move their pieces. This one says ‘Neurotransmitters were just released into the synapse. Move ahead two spaces’.

Latisha points to the other stack of cards and says, “Then there’s another set of cards called “Challenge Cards,” with questions to test the players’ knowledge of neurotransmitters. This one asks you to name the parts of a neuron. If you get it right, you spin again.”

Corty says, “Well, I have a question for you: What part of the brain would help you if we’re taking a test in math class?” Jay and Latisha look at each other and shrug.

Corty says, “Which part of the brain helped you make up this game?” They shake their heads because they don’t know. Corty says, “Don’t know? Well, this is a good game, but it only tells half the story. You

know where you'd find the other half?"

Latisha says, "I know. The *Brain Power!* kids had a mission that taught them about the brain."

Corty says, "Now your synapses are firing. You need to work together to make this game a real brain teaser."

Jay says, "Well, it would be more fun to play with four."

Corty says, "Maybe you can do your next mission together. You'll need to know about the brain and neurotransmission to solve it."

Brain Power News

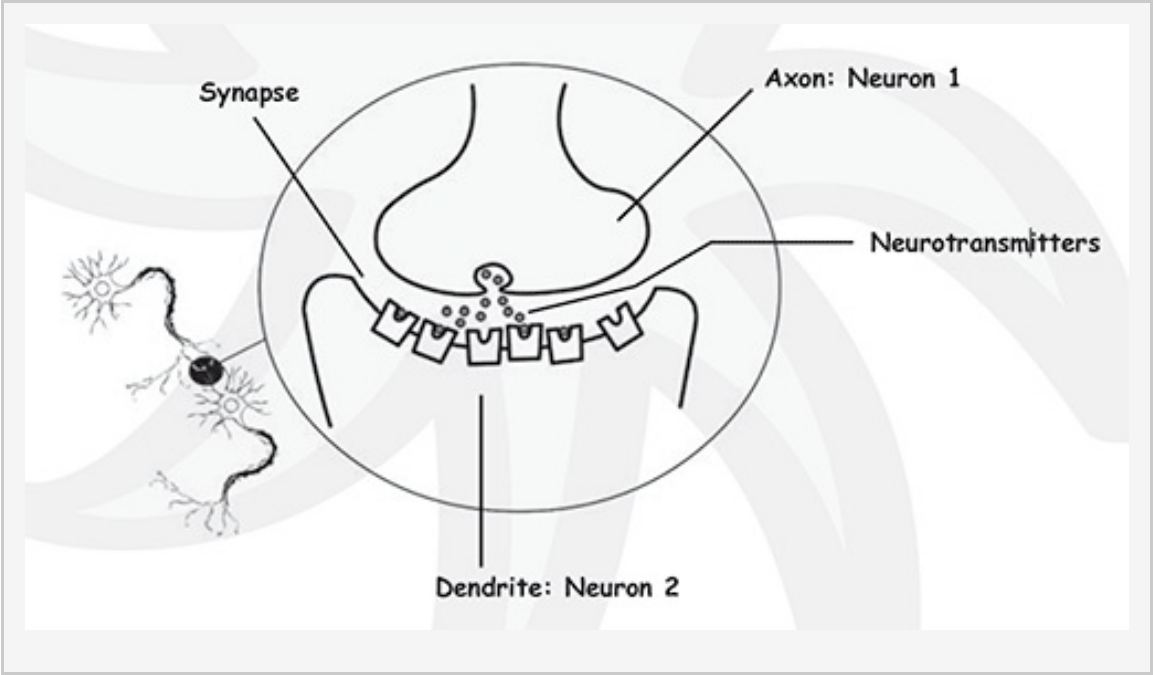
Parent Newsletter
Volume 1, Number 3

Neurotransmission

Module 3 focuses on neurotransmission. In Module 2, your child learned all about the brain and the functions of the brain. In this module, your child will learn more about the brain and how messages are sent and received. Neurotransmission is part of the process where information is transported to, from, and within the brain. A cell called a neuron is responsible for carrying information. The human brain is made up of 100 billion neurons. Neurons have different parts that carry out different functions.

The exchange of information from one neuron to another is accomplished through neurotransmission. Neurotransmission takes place when one neuron releases chemicals into the space between neurons (called the synapse). The chemicals then cross the synapse and bind to specific molecules on the second neuron. The molecules on

the second neuron are called receptors. Once the chemicals attach to the receptors, they cause changes in the second neuron, and the message continues onward. This process is known as neurotransmission.



This activity aligns with the following standard identified in the *National Science Education Standards*: unifying concepts and processes. This mission adds key knowledge to what was learned in Module 2 by showing how neurotransmission is essential to the function of the nervous system. The students develop an understanding of how the brain works with other parts of the nervous system to keep the entire human body functioning.

Science at Home

Ask your child what he or she learned about neurotransmission. Discuss the parts of a neuron and the different steps of neurotransmission. Have your child draw neurons and label each part. Have your child draw or write down five activities that require the process of neurotransmission. (Hint: Everything you do requires neurotransmission to take place.)

Additional Resources

National Institute on Drug Abuse (NIDA)
www.drugabuse.gov, 301-443-1124
This Web site contains information about drug abuse and a section designed specifically for parents, teachers, and students. Publications and other materials are available free of charge at drugpubs.drugabuse.gov.

National Clearinghouse for Alcohol and Drug Information (NCADI)
http://store.samhsa.gov, 1-800-662-HELP (4357)
NCADI provides information and materials on substance abuse. Many free publications are available here.

Neuroscience for Kids
http://faculty.washington.edu/chudler/neurok.html
This site contains information on the brain and neurotransmission, activities, experiments, pictures, and other resources for students and educators.

Phineas Gage: A Gruesome but True Story About Brain Science. [Fleischman, J.] Boston, MA: Houghton Mifflin Co., 2002. Written for ages 9 through 12, this book tells the story of a railroad employee who experienced personality changes after a 13-pound iron rod shot through his brain.

Understanding Your Brain (Science for Beginners Series). [Treays, R.] Newton, MA: EDC Publications, 1996. This book describes the parts of the brain and the process of neurotransmission.

Focus on Drugs and the Brain. [Friedman, D.] Frederick, MD: Twenty-First Century Books, 1990. This book, part of the “Drug-Alert Book” series, gives a good overview of the brain, neurotransmission, effects of drugs on the brain, and addiction.

The Brain: Our Nervous System. [Simon, S.] New York: Collins, 2006. This book presents a simple, yet detailed, overview of the brain and neurotransmission.

Stimulants (Module 4)

You can also download this entire module in PDF format by clicking the following link: Module 4 (PDF 5.2MB)

Introduction

During the previous two modules, the students learned about the structures of the brain and what each does, and also about neurotransmission, the process through which information is exchanged between the brain and the rest of the body. In the next two modules, students learn about drugs—some legal with beneficial attributes, some legal with negative consequences, and some illegal. The first group of drugs is called stimulants. Stimulants change the functioning of the brain and body. Students will be learning about caffeine, nicotine, methylphenidate (Ritalin), amphetamine, and cocaine in this module.

Learning Objectives

- Students learn how certain stimulants affect the brain and the nervous system.
- Students study PET scans showing the difference between a normal brain and one exposed to stimulants.
- Students discuss the impact of drug use.

Relationship to the National Science Education Standards

This mission aligns with the following standard identified in the NSES: science in personal and social perspectives. The chart that follows identifies how the mission aligns with this standard.

Levels K–4	How Mission Is Aligned
Personal health	Students observe the effects that stimulants have on the brain and the nervous system. They discuss the impact this information has on their lives and how they can use it to make wise decisions about their own health.

Background

The kinds of drugs discussed in this module are known as stimulants. Stimulants cause accelerated heart rate, increased blood pressure, and an increase in the rate of the body's metabolism. Stimulants also raise levels of a neurotransmitter called dopamine in parts of the brain that control movement, attention, and reinforcement of pleasurable (rewarding) experiences. Dopamine activates the brain's reward system and is associated with reinforcing behaviors. Stimulants vary in the extent to which they boost dopamine, and in the effects they have on other neurotransmitters.

There are many different kinds of stimulants. The ones focused on here are nicotine, caffeine, cocaine and amphetamine, and methylphenidate (Ritalin). Each kind of drug is explained in the list below.

Nicotine

- ***Other Terms*** *- Tobacco; found in cigarettes, cigars, and smokeless tobacco*
- **How it is used**: Smoked, chewed or inhaled
- **Effects of the drug**: Reduces appetite, increases alertness

- **Negative effects on the body**: Can cause nausea and vomiting. Nicotine is addicting and use results in the harmful effects of tabacco use, such as lung cancer, emphysema, and bronchial disorders. Prenatal exposure to tabacco can impact the developing baby.
- **How it works**: A mild stimulant, nicotine reaches the brain just 8 seconds after being inhaled. It activates areas in the brain that control pleasure and reward. Causes increased heart rate and blood pressure by acting on the same receptor as the neurotransmitter, acetylcholine.

Caffeine

- ***Other Terms*** *- Found in coffee, tea, cocoa, soft drinks, and some medications*
- **How it is used**: Taken orally in pill form or consumed in food and drinks
- **Effects of the drug**: Increases alertness
- **Negative effects on the body**: Reduces fine motor coordination, alters sleep patterns, and can cause headaches, nervousness, and dizziness.
- **How it works**: Stimulates the central nervous system by increasing the metabolism inside neurons. Increases wakefulness by blocking the neurotransmitter, adenosine.

Cocaine and Amphetamines

- ***Other Terms*** *- Cocaine is also called crack; amphetamine is known as speed, uppers, meth, copilots, and crank*
- **How it is used**: Snorted, smoked, or injected
- **Effects of the drug**: Causes alertness, arousal, and euphoria
- **Negative effects on the body**: Cocaine causes dizziness,

headaches, anxiety, insomnia, and depression upon withdrawal in those who use it chronically. Amphetamine can cause increased heart rate, reduced appetite, and insomnia. These drugs also can make people feel anxious, raise blood pressure, cause dangerous and irregular heartbeats, chest pain, shortness of breath, nausea, vomiting, and diarrhea.

- **How it works**: Alters the actions of the brain's neurotransmitters — mostly dopamine. Over time, these drugs change how the dopamine neurons work. This, in part, is why users become addicted to the drugs. The user needs them to keep from feeling bad.

Methylphenidate*

- ***Other Terms*** *- Ritalin*
- **How it is used**: Taken orally in pill form, crushed up and snorted, or dissolved with water and injected
- **Effects of the drug**: When taken as prescribed helps with focus and learning. When abused causes increased wakefulness and euphoria
- **Negative effects on the body**: When abused, causes nervousness, loss of appetite, headache, increased blood pressure and heart rate, and the inability to fall or stay asleep; when injected, it can block small blood vessels causing damage to the lungs and retinas.
- **How it works**: Prescribed for attention-deficit hyperactivity disorder (ADHD). When taken in doses other than those prescribed, Ritalin can rapidly increase brain dopamine and disrupt normal communication between brain cells. This can lead to addiction.

* Several studies have shown that children who have ADHD and are treated with methylphenidate are less likely to abuse drugs and alcohol when they are older than those who were not, but more research needs

to be done. Methylphenidate taken without a doctor's prescription can cause addiction and other negative health effects.

Materials/Preparation

Materials

Materials

- Paper and pencils
- DVD and DVD player, or online video
- Computer with Internet access
- Brain Fact Sheets (PDF, 142KB) (from Module 2 - Parts of the Brain and Lobes of the Brain)
- Markers

Preparation

1. Read the Background material to familiarize yourself with specific stimulants and how they affect the brain, the body, and the nervous system.
2. Organize the students into small groups of three or four students.

Procedures/Discussion Questions

Procedures

Procedures

1. Begin the mission by watching the first segment of the DVD. Stop the DVD at the break and ask the students what stimulants are. Then go over the following key points:
    - Stimulants are drugs that cause the heart rate to increase, blood pressure to rise, and metabolism to increase.

- Stimulants include legal prescription drugs, such as methylphenidate (Ritalin); legal substances, such as nicotine and caffeine; and illegal drugs, such as cocaine and amphetamine.

2. Divide the students into small groups of three or four. Tell them that as a result of the tools available for studying the brain, which they learned about in Module 2, it is possible to see the difference between a brain that has been exposed to stimulants and one that has not. In particular, PET scans show brain activity and can show the effect that drugs have on the brain.

3. Direct students to the following Web site: http://faculty.washington.edu/chudler/coca.html. Have the groups look at the images of a brain that has not been exposed to drugs and one that has. It might be a good idea for students to refer to the Brain Fact Sheets.

4. Ask the students to answer the following questions:

   - Can you tell what parts of the brain are being shown on the scans?
   - What does it mean when certain parts of the brain have been activated?
   - Is it good or bad that different parts of the brain have been activated?
   - What do you think would happen to the brain if it is exposed to cocaine all the time?

5. Have each group write a couple of paragraphs or a list answering these questions. Then share some of their responses. What were some ideas expressed by the students?

6. Conclude the mission by watching the remainder of the DVD. Once the DVD is over, write a class statement about the effects of cocaine on the brain. Write the statement on a piece of newsprint and save it for further use.

Discussion Questions

1. Based on what the students have learned about the brain so far, ask them why they think people take drugs in the first place. Remind the students to think about the scrapbooks they created in the first module and the impact of drugs on our society.
2. Have the students discuss this question with their friends and family. What new ideas did people come up with?

Extensions

The activities listed below provide links to other areas in the curriculum.

1. Ask the students to brainstorm on how they think other stimulants, such as cocaine and nicotine, affect the brain. They may want to do some research on the Internet to find more information. The students can write up a short report and share their ideas. The Neuroscience for Kids Web site is a great place to start: http://faculty.washington.edu/chudler/neurok.html
2. Have the students look in books, newspapers, and magazines for examples of stories on how drugs have affected people's lives. The stories can be positive, describing how Ritalin made a person with ADHD function better, or negative, showing how drugs can cause tremendous damage in an individual's life. Ask the students to share their findings with the class.

Assessment/Additional Activities

Assessment

Consider the following questions as the students work on this activity:

- Can the students observe and understand the PET scans?
- Can the students answer the questions about the brain?
- Do the students participate in class discussions?
- Were the students able to generate new ideas about why people take drugs based on what they have learned so far?

Additional Activities

Below are some additional activities that can be done after completion of the fourth mission. These activities are extensions to many areas of the curriculum.

1. Play a “game show” using questions about drugs and how they affect the body. The students can take turns being the player, and the rest of the class can be the audience. If the player doesn’t know the answer, he or she has the option of asking the audience for help. Make sure that everyone has a chance to be the player.
2. As a class, go to the Library/Media Center and look for books or Web sites about one or more of the drugs studied during the module. Take the books back to the class and read them together. Discuss the books’ content and how they apply to what the students learned during the module.
3. Make up a class story about drugs. Have each student add a line to the story. Tell the students that the story could be about anything they have learned in the program to date.

Resources

Resources for Teachers

- National Institute on Drug Abuse (NIDA)
  www.drugabuse.gov, 301-443-1124
  This Web site contains information about drug abuse and a section

designed specifically for parents, teachers, and students. Publications and other materials are available free of charge at drugpubs.drugabuse.gov.

- National Institute on Drug Abuse (NIDA): Mind Over Matter
  teens.drugabuse.gov/MOM
  This Web site was developed to educate children about the biological effects of drug abuse on the body and brain.

- National Clearinghouse for Alcohol and Drug Information (NCADI)
  store.samhsa.gov, 1-800-662-HELP (4357)
  NCADI is operated by the Substance Abuse and Mental Health Services Administration (SAMHSA). Many free publications are available here.

- *Drug Abuse Sourcebook. Health Reference Series, Vol. 14*. [Shannon,JB, ed.] Detroit, MI: Omnigraphics, Inc., 2010.
  Basic health-related information about the abuse of legal and illegal substances, such as caffeine, cocaine, and amphetamine.

Resources for Students

- *Focus on Drugs and the Brain*. [Friedman, D. & Neuhaus, D.] Frederick, MD: Twenty-First Century Books, 1990.
  This book, part of the “Drug-Alert Book” series, describes the function of the brain and nervous system and how drugs affect the body.

- *Focus on Medicines*. [DeStefano, S. & Neuhaus, D.] Frederick, MD: Twenty-First Century Books, 1990.
  This book, part of the “Drug-Alert Book” series, gives a good overview of medicines and how various medicines work with the body and the brain to help healing.

- *Focus on Nicotine and Caffeine*. [Perry, R.] Frederick, MD: Twenty-First Century Books, 1997.
  This book, part of the “Drug Alert Book” series, gives a good overview of nicotine and caffeine, and how each of these drugs affects the body and brain.

- *The Encyclopedia of Drugs and Alcohol* (Reference). [Roza, G.] New York, NY: Franklin Watts, Inc., 2001.
  Written for ages 9 through 12, this book covers more than 250 commonly used and abused, legal and illegal drugs, including prescription, over-the-counter, and recreational drugs.
- National Institution Drug Abuse (NIDA): Mind Over Matter teens.drugabuse.gov/MOM.
  This series is designed to encourage students in grades 5-9 to learn about the effects of drug abuse on the brain and body.
- National Institute on Drug Abuse (NIDA): NIDA for Teens teens.drugabuse.gov
  This site is developed specifically for teens. It provides information on drugs.

Introductory Story for Module 4

Beth and Juan are hanging out in their club house, rolling a soccer ball between them as they talk. Beth asks, “So, how do you think the Spectacular Scientists Clubkids did on their mission?”

Juan replies, “I don’t know. They’re nice kids, but they’re not Junior Scientists like we are.”

Corty pops up on the soccer ball in Beth’s hands and says, “Why are you guys being so competitive? Scientists work together to solve problems. It’s called teamwork!”

“But we want to win, triumph, beat the other team. Be the best!” says Juan.

Corty replies, “Winning is about finding the right answers, and you can probably do that faster together. We’ll talk about that later. For now, we’re going to learn about drugs.

Juan, can you tell us about the different kinds of drugs?”

Juan can’t think of anything. “Um, I don’t think we covered that.”

“Well, drugs are categorized into classes, and one of the classes is stimulants,” says Corty.

“Oh, wait a second! We learned about stimulants, like cocaine and caffeine, like in coffee,” says Beth. “Nicotine in cigarettes is a stimulant, too, and so are amphetamines.”

Corty says, “Can you come up with one other?” The kids think for a moment but shake their heads. “Ritalin is a prescription drug that’s also a stimulant. Do you know what stimulants do?” asks Corty.

Beth answers quickly, “They make you more awake and active. They also make your heart beat faster, your blood pressure go up, and you get hyper and sometimes even angry and irritable.”

“Whoa! That can’t be good for you,” Juan comments.

“It isn’t! Your mission is to make a chart that lists each stimulant,” says Corty.

“That sounds like a great way to learn about stimulants. We can write down all the different stimulants, record the different names they have, how they’re used, and the effects on the body, the brain, and neurotransmission,” Juan suggests.

“But first, to help out, I’m going to show you a PET scan,” says Corty.

“Oh, that’s like when we took my dog to the vet to have x-rays. He ate one of my dad’s slippers,” Juan says, as Beth giggles.

Corty says, “No. PET stands for Positron Emission Tomography.” Corty leads them over to the computer and “wakes it up,” using the mouse. Two PET scans appear, one showing the normal brain and the other the brain on stimulants. “All you need to know is that these PET scans show a normal brain and a brain affected by stimulants.” The kids see how the PET scan affected by stimulants shows less activity than the PET scan of a normal brain.

The kids move away from the computer, and Juan says, “Let’s get started on those charts.” The kids gather their materials together and start working on the charts. Corty leaves while they are working.

Stop here until students have completed #5 in the procedure.

As the kids are finishing up, Corty jogs in holding a steaming cup of coffee. He sips the coffee. He gradually gets more hyper and jogs in place. Corty begins talking very fast, “That’s a very nice chart. Very impressive! Are you almost done? You do know a lot about stimulants. Tell me everything you know about stimulants.” Corty starts doing jumping jacks.

Juan and Beth look at each other, at Corty, then at the cup of coffee he’s now set aside.

Juan goes over, moves the coffee cup away, and says, “I think you’ve had enough coffee, Corty. It’s starting to go to your head.”

Corty continues to talk very fast. “Caffeine is legal; anyone can get it. It’s in coffee, tea, and soft drinks. But it’s not a good idea for kids to have caffeine, even in sodas, because it makes you hyper, and it can cause headaches and sleep problems.”

Beth walks over to Corty and says, “Corty, I think you’ve done enough research for the moment. You need to take your own advice and lay off the stuff.”

Corty is suddenly exhausted from all of his activity. He sprawls out on the table and says, “Maybe you’re right.”

“And that brings me to a question we had: If drugs are so bad for you, then why do people keep on taking them?” asks Beth.

Corty responds, “That’s a really good question. As Junior Scientists, did you come to any conclusions on that?”

Juan replies, “Well, some drugs are addictive, like nicotine and cocaine. So, once people start taking them, it can be very hard to stop. Even caffeine can be addictive.”

Corty says, “That’s what I need – a little more coffee. That’ll wake me up!” He reaches for his coffee cup, but Juan moves it away again and says, “I don’t think so.”

Corty gets up and shakes himself off and says, “Well, maybe you’re right. And anyway, I’m on to my next mission; gotta visit the Spectacular Science Clubkids. Later!”

Brain Power News

Parent Newsletter
Volume 1, Number 4

How Stimulants Affect the Nervous System

During the previous two modules, your child learned about the parts of the brain and what each does, as well as about neurotransmission. In the next two modules, he or she will learn about drugs—some legal with beneficial attributes and negative consequences, some legal with negative consequences, and some illegal. The group of drugs covered in module 4 is called stimulants. There are many different kinds of

stimulants. The ones focused on in this program are nicotine, caffeine, cocaine and amphetamine, and Ritalin (the prescription drug used legally to treat ADHD). Stimulants cause accelerated heart rate, increased blood pressure, and an increase in the rate of the body's metabolism.

Drug	Other Terms	How the Drug is Used	Negative Effects on the Body	How the Drug Works
Nicotine	Tobacco; found in cigarettes, cigars, and smokeless tobacco	Smoked, chewed, or inhaled	Can cause nausea and vomiting is. Nicotine is addicting and use results in the harmful effects of tobacco use such as lung cancer, emphysema and bronchial disorders. Prenatal exposure to tobacco use can impact the developing baby.	A mild stimu nicotine reac the brain jus seconds afte being inhale activates are the brain tha experience pleasure and reward by increasing th release of th neurotransm dopamine. Causes incre heart rate ar blood pressu acting on the same recept the neurotransm acetylcholin
Caffeine	Found in coffee, tea, cocoa, soft drinks, and some	Taken orally in pill form or consumed	Reduces fine motor coordination, alters sleep patterns, and	Stimulates th central nerv system by increasing th metabolism

	medications	in food and drinks	can cause headaches, nervousness, and dizziness.	inside neuro Increases wakefulness blocking the neurotransm adenosine.
Cocaine and Amphet-amine	Cocaine is also called crack; amphetamine is known as speed, uppers, meth, copilots, and crank	Snorted, smoked, or injected	Cocaine causes dizziness, headaches, anxiety, insomnia, and depression upon withdrawal in those who use it chronically. Amphetamine can cause increased heart rate, reduced appetite, and insomnia. These drugs also can make people feel anxious, raise blood pressure, cause dangerous and irregular heartbeats, chest pain, shortness of	Alters the ac of the brain' neurotransm —mostly dopamine. C time, these c change how dopamine neurons wor This, in part, why users become add to the drugs user needs t to keep from feeling bad.

			breath, nausea, vomiting, and diarrhea.	
Methyl-phenidate*	Ritalin	Taken orally in pill form, crushed up and snorted, or dissolved with water and injected	When taken as prescribed, helps with focus and learning. When abused, causes increased wakefulness and euphoria.	Prescribed fo attention de hyperactivity disorder (AD When taken doses other those prescr Ritalin can ra increase bra dopamine ar disrupt norm communicat between bra cells. This ca lead to addi
**Several studies have shown that children who have ADHD and are treated wit methylphenidate are less likely to abuse drugs and alcohol when they are olde than those who were not, but more research needs to be done. Methylphenida taken without a doctor's prescription can cause addiction and sometimes deat*				

This activity aligns with the following standard identified in the National Science Education Standards: science in personal and social perspectives. The students observe the effects that three drugs have on the brain and the nervous system. They discuss the impact this information has on their lives and how they can use it to make wise decisions about their own health.

Science at Home

Talk to your child about the different types of drugs and how they affect the brain and body. Have your child begin to think about the

reasons people would abuse drugs when they know how harmful they can be.

It is very important to discuss with your child the differences between taking Ritalin for ADHD in the dose and method prescribed by a doctor and abusing Ritalin. Inform your child that Ritalin will increase the attention and focus in people with ADHD, while it can cause serious side effects and addiction in those who inappropriately use it. Research has shown that people with ADHD do not develop addiction to Ritalin when used in the form and amount prescribed.

Additional Resources

National Institute on Drug Abuse (NIDA)
www.drugabuse.gov, 301-443-1124
This Web site contains information about drug abuse and a section designed specifically for parents, teachers, and students. Publications and other materials are available free of charge at drugpubs.drugabuse.gov.

National Institute on Drug Abuse (NIDA): Mind Over Matter
teens.drugabuse.gov/MOM
This Web site was developed to educate children about the biological effects of drug abuse on the brain and body.

National Clearinghouse for Alcohol and Drug Information (NCADI)
http://store.samhsa.gov, 1-800-662-HELP (4357)
NCADI provides information and materials on substance abuse. Many free publications are available here.

Alcohol, Marijuana, and Inhalants (Module 5)

You can also download this entire module in PDF format by clicking the following link: Module 5 (PDF, 4.3MB)

Introduction

In Module 4, students learned about stimulants, which make up one group of drugs. During this module, they focus on three other drugs—alcohol, marijuana, and inhalants. Students find out how these drugs affect the brain and the nervous system.

Learning Objectives

- Students learn about alcohol, marijuana, and inhalants.
- Students find out how alcohol, marijuana, and inhalants affect the brain and the nervous system.
- Students examine how alcohol, marijuana, and inhalants affect the body.

Relationship to the National Science Education Standards

This mission aligns with the following standard identified in the NSES: science in personal and social perspectives. The chart that follows identifies how the mission aligns with this standard.

Levels K–4	How Mission Is Aligned
Personal health	Students observe the effects that these three drugs have on the brain and the nervous system. They discuss the impact this information has on their lives and how they can use it to make wise decisions about their own health.

Background

Alcohol, marijuana, and inhalants are drugs that have a major impact on the brain and the nervous system. Alcohol and marijuana abuse can result in memory loss, impaired motor coordination, impaired thinking and problem solving, and changes in emotional behavior. Inhalant abuse can cause damage to nerves throughout the body and structural changes in the brain.

Below are descriptions of alcohol, marijuana, and inhalants.

Drug Name & *Other Terms*	How It Is Used	Effects of the Drug	Negative Effects on the Body	How It Wo
Alcohol *Ethyl alcohol or ethanol; found in beer, wine, and liquor*	Consumed by drinking	Causes relaxation and euphoria	Causes decreased coordination and attention, impaired concentration and reaction	Affects GABA which norma decreases th activity of otl neurons. Increases the level of dopamine in

			time, drowsiness, memory problems, and mood changes. Long-term use can result in diseases like alcoholism or Wernicke-Korsakoff Syndrome, which adversely affects memory. Also can severely damage the liver.	brain, reinfor the connectic between drug taking and reward, and leading the person to wa to repeat the behavior. Als affects brain structures th influence breathing an heart rate, w can make overdoses fat Depresses th central nervo system and c kill brain cells when used in excess.
Marijuana *Pot, weed, grass, and reefer*	Usually smoked like a cigarette (called a “joint”), but can be baked into brownies or cookies or brewed like tea	Causes euphoria	Can adversely affect the limbic system, impairing perception, learning and memory, as well as altering emotions. Can severely damage the lungs. Also	THC, the acti chemical in marijuana, attaches to neuron recep that are normally use by the neurotransm anandamide. Areas of the brain with hig concentration of these receptors are

			acts on receptors in the brain causing increased blood pressure, heart rate, and sleepiness.	affected, including the limbic systen basal ganglia and cerebellu
Inhalants *Turpentine, acetone, fluorinated hydrocarbons; some slang names include highball, hippie crack, and huff*	Fumes are sniffed or inhaled	Causes euphoria	Can decrease coordination, and cause hearing loss, nerve damage, hepatitis, liver failure, muscle weakness, and aplastic anemia, which is a result of decreased red blood cell production. Can adversely affect thinking, memory, and learning. Fumes can replace oxygen in the lungs,	Inhalants suppress ner action, kill neurons, and change the structure of t brain. They c damage mye the insulatior that covers neurons. The affect many areas of the brain, includi the frontal cortex, cerebellum, hippocampus and brain ste

			leading to suffocation (called “sudden sniffing death”), or interfere with normal heart rhythm, leading to cardiac arrest.	

Materials/Preparation

Materials

- DVD and DVD player, or online video
- Alcohol, Marijuana, and Inhalants Fact Sheet (PDF, 78KB)
- Web sites for brain images (listed below in Preparation section)
- Paper and pencils
- Poster board and markers

Preparation

1. Divide the class into groups of three for this activity.
2. Make one copy of each of the Fact Sheets for each student.
3. Make a list of the Web sites that show different brain images:
    - http://www.addictionrecoverycenteroftemecula.com/browse-20741/Brain-Scan-Images.html
    - https://www.amenclinics.com/spect-gallery/addictions/

- http://faculty.washington.edu/chudler/alco.html

4. Preview the DVD before showing it to the class.

Procedures/Discussion Questions

Procedures

1. Begin the mission by reviewing with students what they learned in the previous module about the effects of stimulants on the brain and the nervous system. Suggest that the students take a few moments to review their notes from Module 4.
2. Tell students that during this module, they are going to learn about the effects of alcohol, marijuana, and inhalants on the brain, the nervous system, and the body.
3. Pass out the Alcohol, Marijuana, and Inhalants Fact Sheet (PDF, 90KB). Give the students a few moments to read it over. Then divide them into their working groups.
4. Have the students watch the first segment of the DVD. Stop the DVD at the break.
5. Tell the students that their mission is to draw a picture of the human body and indicate how stimulants, alcohol, marijuana, and inhalants affect the brain, the nervous system, and the body. The challenge is to figure out how to show all the effects of these drugs on the multiple systems in the body. Before beginning this activity, spend some time brainstorming ways to show all the effects of these drugs on one poster. The students may want to develop a color-coded key to represent different drugs. They also may want to draw a close-up of the brain to highlight the parts of the brain and the neurotransmitters affected.
6. When the picture is completed, conduct a discussion on what the drawing shows.
7. Conclude the mission by watching the remainder of the video or

DVD. Discuss the many ways that drugs affect the body and the nervous system, resulting in major impairments.

Discussion Questions

1. Show the students the *Brain Power!* DVD. It depicts the other science club working on this activity, but they are having trouble. Ask the students why that is the case. Then ask them to consider whether the kids in the DVD have all the information they need to complete the activity.
2. Ask the students what collaboration is. Discuss what role collaboration plays in science. Ask them if they think there is any value to collaborating with the other science club working on this module.
3. Ask the students what the differences were between the SPECT brain image of a person with 12 years of marijuana use and the SPECT brain images of healthy people. Ask them if brain activity was increased or decreased in the brain of the person who had used marijuana.

Extensions

The activities listed below provide links to other areas in the curriculum.

1. Have the students make a series of posters illustrating why inhalants are dangerous. Suggest that they include as much information as possible. The students can hang up their posters in the halls at school if this is acceptable.

Assessment/Additional Activities

Assessment

As the students work on this activity, observe whether they have mastered the following:

1. Can the students explain the effects of alcohol on the brain, the nervous system, and the body?
2. Can the students explain the effects of marijuana on the brain, the nervous system, and the body?
3. Can the students explain the effects of inhalants on the brain, the nervous system, and the body?
4. Were the students able to develop accurate drawings that included the necessary information?
5. Were the students able to write explanations of their drawings that reflected what they learned?

Additional Activities

Below are some additional activities that can be done after completion of the third mission. These activities are extensions to many areas of the curriculum.

1. Suggest that the students write a play summarizing what they learned about drugs during these last two modules. They may want to perform for other students in the school.
2. Tell the students to write a poem explaining how drugs affect the brain and the body. They may want to include many drugs or just one specific type.

Resources

The lists below include resources for teachers and students.

Resources for Teachers

- National Institute on Drug Abuse (NIDA)
  www.drugabuse.gov, 301-443-1124
  This Web site contains information about drug abuse and a section designed specifically for parents, teachers, and students. Publications and other materials are available free of charge at drugpubs.drugabuse.com.

- National Institute on Drug Abuse (NIDA): Mind Over Matter
  teens.drugabuse.gov/MOM/TG_intro.php, 301-443-1124
  This Web site was developed to educate children about the biological effects of drug abuse on the body and brain.

- National Clearinghouse for Alcohol and Drug Information (NCADI)
  store.samhsa.gov, 1-800-662-HELP (4357)
  NCADI provides information and materials on substance abuse. Many free publications are available here.

- *Drug Abuse Sourcebook. Health Reference Series,* [Shannon, JB, ed.] Detroit, MI: Omnigraphics, Inc., 2010.
  Basic health-related information about the abuse of legal and illegal substances, such as alcohol, marijuana, and inhalants.

- National Institute on Drug Abuse (NIDA): NIDA for Teens
  teens.drugabuse.gov
  This site is developed specifically for teens. It provides information on drugs.

Resources for Students

- *Focus on Drugs and the Brain*. [Friedman, D. & Neuhaus, D.] Frederick, MD: Twenty-First Century Books, 1990.
  This book, part of the “Drug-Alert Book” series, describes the function of the brain and nervous system, and how drugs affect the body.

- *Inhalant Drug Dangers (Drug Dangers Series)*. [Monroe, J.] Berkley Heights, NJ: Enslow Publishers, Inc., 2002.
  This book explains the serious risks associated with abusing chemical substances, including sections on how these chemicals

work on the human body and sections on societal pressures put on children that lead to abuse.

- *Bottled Up*. [Murray, J.] New York, NY: Dial Books for Young Readers, 2004
  This book is the story of a 16-year-old boy who has experienced problems with alcohol and marijuana. The book describes the issues he faces as a result of substance abuse.

- *The Encyclopedia of Drugs and Alcohol* (Reference). [Roza, G.] New York, NY: Franklin Watts, Inc., 2001.
  Written for ages 9 through 12, this book covers more than 250 commonly used and abused, legal and illegal drugs, including prescription, over-the-counter, and illegal drugs.

- National Institution Drug Abuse (NIDA): Mind over Matter teens.drugabuse.gov/MOM.
  This series is designed to encourage students in grades 5-9 to learn about the effects of drug abuse on the brain and body.

- National Institute on Drug Abuse (NIDA): NIDA for Teens teens.drugabuse.gov
  This site was developed specifically for teens. It provides information on drugs.

Introductory Story for Module 5

Jay and Latisha are snooping around the *Brain Power!* Clubhouse. Latisha asks Jay, “So, how do you think we’re doing in the competition, so far?”

Jay responds, “I think we’re doing really well. That board game we made up was way cool.” Latisha agrees.

“If we get one more good mission, we can pull ahead of the Brain Power!kids and win the competition. I know they think they’ll win, but I don’t think so,” says Jay. “Maybe we can even get to be Junior Scientists.”

“No doubt about it. In fact, we should probably go ahead and have the T-shirts made up right now: ‘Spectacular Scientists Rule!’” Latisha smiles and takes a book off a shelf and finds – Corty!

Corty is hiding behind the book she pulls out. Jay jumps back in surprise. Corty laughs. He’s wearing a T-shirt that says “Teamwork Rules!” Corty says, “Hi, kids! I’ve got the perfect mission for you to work on with the Junior Scientists. How ’bout it?” Jay says, “No way! We’re gonna beat them at their own game. We can solve this without any help from them.”

Corty sighs and says, “All right. Your mission today is to learn about drugs. The drugs we’re going to talk about affect a person’s brain and nervous system. They can even change the brain.”

Latisha asks, “Are they legal?”

“One is. Here’s a hint. It was in the ad you kids were looking at a few missions ago,” says Corty.

“Alcohol? But that’s only legal for adults, not for kids,” says Jay.

“Exactly. Another one is marijuana,” says Corty.

“That’s illegal for everyone,” says Latisha.

“Right. The third is inhalants – those are chemical fumes that people sniff or inhale. Inhalants can be very dangerous. Now, your mission is to learn more about the drugs we talked about. You’re going to draw a picture of the body and show how those drugs affect our brains, bodies, and nervous systems.”

Jay says, “Let’s see. So that’s alcohol, marijuana, and inhalants. Wow! That sounds like a challenge. But we’re up to it!” Corty leaves as

Latisha and Jay begin work on their drawings.

Stop here until the students have finished their drawings.

Corty comes back as the kids are putting the final touches on their body outlines, labeling them with the major effects of the drugs. Corty says, “Wow! Great job! Tell me about them.”

Latisha says, “Well, marijuana goes by a lot of names. It’s the most commonly used illegal drug in the United States.” As Latisha talks, she points to parts of the body outline. She continues, “In the brain, marijuana mostly affects the basal ganglia and cerebellum, which help us move, and the cerebral cortex, which helps us think and communicate. So when people smoke marijuana, they can seem uncoordinated, and they may not make much sense when they talk.”

Jay says, “Alcohol is found in beer, wine, and liquor. It affects your brain and almost every other organ of your body.” Jay also points to the body outline as he talks. He says, “In the brain, alcohol mostly affects the cerebral cortex, so heavy drinkers have slurred speech and sometimes they don’t make sense. It also affects the limbic system, which controls our emotions, and the brain stem, which is in charge of the basics—like breathing! But alcohol also interferes with the way messages are carried by neurotransmitters. So, basically, it affects everything a person does.”

Jay adds, “People who are dependent on alcohol may have a disease called alcoholism.”

“Inhalants are also really scary,” says Latisha. “They seem harmless because you can find them in everyday household items like paint thinner, nail polish remover, and rubber cement. They won’t hurt you if you use them for what they’re supposed to be used for, but some people breathe in inhalants on purpose. And when the chemicals enter the bloodstream directly through the lungs, they get to the brain fast and can do a lot of damage.”

Latisha points to the brain area of the body outline and continues, “Inhalants affect the structure of the brain, including the cerebral cortex, the cerebellum, and the brain stem. They also affect the frontal cortex, which is important for solving complex problems, and the hippocampus, which helps us remember things.” Latisha adds, “Inhalants can also cause nerve damage, hearing loss, and liver problems. They can even kill a person from a heart attack or suffocation.”

Corty says, “That is pretty scary stuff.”

Jay says, “It is, and it makes me wonder about something: If these drugs are so bad for you, then why do people try them at all? For those who do, why do they continue to use them after they cause problems?”

Corty says, “Great question!”

Latisha says, “Maybe people don’t know about the problems drugs can cause and by the time they find out for themselves, they’re hooked.”

“They get addicted,” says Jay.

“Good work!! That’s exactly what we’re going to cover in our next mission,” says Corty.

Brain Power News

Parent Newsletter
Volume 1, Number 5

Alcohol, Marijuana, and Inhalants

In Module 4, your child learned about stimulants, which make up one group of drugs. During this module, he or she will focus on three more

drugs—alcohol, marijuana, and inhalants. Students find out how alcohol, marijuana, and inhalants affect the brain and the nervous system. Alcohol and marijuana affect the nervous system in different ways, but both can result in memory loss, impaired motor coordination, impaired thinking and problem solving, and changes in emotional behavior. Inhalants are chemical fumes that are sniffed and have a powerful effect on the brain. They can result in decreases in coordination and alter thinking, memory, and the ability to learn.

Drug	**Source**	**How the Drug is Used**	**Negative Effects on the Body**	**How the Drug Works**
Alcohol	Found in beer, wine, and liquor	Consumed by drinking	Impairs concentration, slows reflexes (impaired reaction time), reduces coordination, and causes drowsiness when used in excess	Impacts many neurotransmitte in the brain. Alcohol increas turnover of som neurotransmitte and alters the function of others. Long-te use can lead to reduction in bra size and neurological problems.
Marijuana	From the dried leaves and flowers of the cannabis plant	Smoked, baked into brownies or cookies, or brewed like tea	Impairs memory, concentration, perception, and movement	Acts on recepto in the brain, causing increas blood pressure and heart rate, sleepiness, and disruption in attention.
Inhalants	Found in	Fumes are	Decrease	Inhalants

	rubber cement, paint thinner, fingernail polish remover, and pressurized cans of hair spray and whipped cream	either sniffed or inhaled	coordination and cause a kind of stupor; thinking, memory, and the ability to learn are affected. Can cause fatal heart failure within minutes of using. This is known as "sudden sniffing death."	suppress nerve action, kill neurons, and change the structure of the brain. They can damage myelin the insulation that covers neurons. They affect many are of the brain, including the frontal cortex, cerebellum, hippocampus, and brain stem

This activity aligns with the following standard identified in the NSES: science in personal and social perspectives. The students observe the effects that these three drugs have on the brain and the nervous system. They discuss the impact this information has on their lives and how they can use it to make wise decisions about their own health.

Science at Home

Talk to your child about the different types of drugs and how they affect the brain and body. Revisit the issue regarding the reasons people would use drugs when they know how harmful they can be.

Additional Resources

National Institute on Drug Abuse (NIDA)
www.drugabuse.gov, 301-443-1124
This Web site contains information about drug abuse and a section

designed specifically for parents, teachers, and students. Publications and other materials are available free of charge at drugpubs.drugabuse.gov.

National Institute on Drug Abuse (NIDA): Mind Over Matter
teens.drugabuse.gov/MOM
This Web site was developed to educate children about the biological effects of drug abuse on the brain and body.

National Clearinghouse for Alcohol and Drug Information (NCADI)
http://store.samhsa.gov, 1-800-662-HELP (4357)
NCADI provides information and materials on substance abuse. Many free publications are available here.

Drug Abuse Sourcebook. Health Reference Series, [Shannon, JB, ed.] Detroit, MI: Omnigraphics, Inc., 2010. Basic health-related information about the abuse of legal and illegal substances, such as alcohol, marijuana, and inhalants.

Focus on Drugs and the Brain. [Friedman, D. & Neuhaus, D.] Frederick, MD: Twenty-First Century Books, 1990. This book, part of the "Drug-Alert Book" series, describes the function of the brain and nervous system, and how drugs affect the body.

Inhalant Drug Dangers (Drug Dangers). [Monroe, J.] Berkley Heights, NJ: Enslow Publishers, Inc., 2002. This book explains the serious risks associated with abusing chemical substances, including sections on how these chemicals work on the human body and sections on societal pressures put on children that lead to abuse.

Bottled Up. [Murray, J.] New York: Dial Books for Young Readers, 2004. This book is the story of a 16-year-old boy that has come into problems with alcohol and marijuana. The book describes the issues he faces as a result of substance abuse.

The Encyclopedia of Drugs and Alcohol (Reference). [Roza, G.] New York: Franklin Watts, Inc., 2001. Written for ages 9 through 12, this book covers more than 250 commonly used and abused, legal and illegal drugs, including prescription and over-the-counter drugs.

What is Addiction? (Module 6)

You can also download this entire module in PDF format by clicking the following link: Module 6 (PDF, 7.5MB)

Introduction

This module is the last in the *Brain Power!* program. Over the past five modules, the students have thought about society's views toward drug use and have learned about the structure of the brain, how neurotransmission works, and how stimulants, alcohol, marijuana, and inhalants affect the brain, the nervous system, and the body. During this mission, students round out their knowledge of drugs by learning about addiction. Then they revisit their ideas about the impact of drug use on society and have the opportunity to modify their thinking based on new knowledge.

Learning Objectives

- Students learn about addiction.
- Students discuss how addiction relates to the drug abuse problem in this country.
- Students rethink the scrapbooks they developed during Module 1to reflect their new ideas about drugs.

Relationship to the National Science Education Standards

This mission aligns with the following two standards identified in the NSES: science as inquiry and science in personal and social perspectives. The charts that follow identify how the mission aligns with each of these standards.

Science as Inquiry

Levels K–5	How Mission Is Aligned
Abilities necessary to do scientific inquiry	Students experience some of the steps in the process of scientific inquiry: making observations, developing a hypothesis, completing an investigation to test the hypothesis, and drawing conclusions.

Science in Personal and Social Perspectives

Levels K–5	How Mission Is Aligned
Personal health	Students learn about the effects of several different drugs on the body, the brain, and the nervous system. They discuss the impact this information has on their lives and how they can use it to make wise decisions about their own health.

Background

Despite the negative consequences of drug use, some people who take drugs are unable to stop. Drugs change the way the brain works. Some of these changes are short term, while other changes can last a very long time.

In some people drug use can change the brain and its neurotransmitters so profoundly that addiction results. Addiction is characterized by the following:

- **Compulsive use:** A strong compulsion or drive to use drugs despite negative consequences. In other words, a person persists in using drugs even if he or she is having serious problems.

- **Tolerance:** Loss of control over the amount of the drug used—the person needs more of the drug to produce the same effect as before.
- **Withdrawal:** Intense craving for the drug when it is not available. The craving results from changes in the brain. Once a person is addicted, he or she must have the drug just to keep from feeling bad. This is because drugs can cause changes in the normal functioning of neurotransmitters in the brain.

Addiction is considered a disease because the drugs have changed the way the brain functions. Different drugs cause different changes in the brain, some more severe than others. Research in animals and humans suggests that some drugs may cause changes that last long after the individual has stopped taking drugs or even permanently.

Research

Addiction affects men and women of all ages and ethnicities. Because of the severity of the problem, scientists have been studying how drugs act in the brain to produce addiction using a range of methods, from brain imaging to psychological testing. These researchers are trying to identify causes and methods of effective treatment and prevention of drug abuse. As a result of this international attention and research, scientists and physicians now have a greater understanding of how drugs act in the brain. This has led to the development of new treatments for drug addiction.

Treatment

When a person becomes addicted to a drug, neurological, physiological, psychological, and social changes take place. These biopsychosocial changes must be addressed for the person to get better. The appropriate treatment is dependent on the individual, drug of abuse, and severity of addiction.

Often, detoxification is the first step in addiction treatment. Detoxification is the medically controlled withdrawal of the abused drug. However, this is only the first step in successful treatment, and many drugs, such as cocaine, do not cause the typical detoxification symptoms when their use is discontinued. After a person has gotten off of a drug, he or she still must deal with any changes that have occurred in his or her brain as a result of drug use. Often these changes are much harder to deal with than the initial detoxification from the drug use, and research has shown that some drugs can cause changes in the brain that last for a long time and may even be permanent.

For some abused drugs, medications are available that can be used in conjunction with psychological and social treatments. For other drugs, however, medications are not yet available, so successful treatment relies on psychological and social treatments. These treatments can help a person recovering from addiction deal with a range of emotions, including shame, denial, emotional distress, and neglect of family, friends, work, and school. They can also help them deal with a variety of social problems, such as trouble at school and hurt family members and friends. The person recovering from addiction must work to mend relationships with family and friends, reestablish a responsible role in school, and avoid situations that might lead to using drugs again. During treatment and recovery, people recovering from addiction and their families often have to learn how to communicate in new and healthy ways. This is typically accomplished during family therapy.

These treatments are offered in a variety of settings, such as hospitals and clinics, and recovery continues through the assistance of self-help and individual and group therapy. Addiction is a serious disease and, in some cases, those who misuse drugs start using drugs again after treatment and need to go back into treatment. Although addiction can be treated successfully, the best way to avoid addiction is to never start using drugs in the first place.

Materials/Preparation

Materials

- DVD and DVD player, or online video
- Fact Sheets from previous modules
- Notes from previous modules
- Scrapbooks from Module 1
- Old newspapers and magazines
- Paper and pencils

Preparation

1. Preview the DVD before showing it to the class.
2. Make sure the students have their scrapbooks from Module 1 as well as materials from other modules before beginning work on this activity.
3. Students will work in the same groups they worked in during Module 5.

> During this activity, keep in mind that some children may be trying to cope with an addicted loved one at home. It is recommended that the lines of communication be open between the teacher, students, and guidance counselor to handle any issues that may occur.

Procedures/Discussion Questions

Procedures

1. Tell the students that this is the final module in the program. Their

goal is to try to pull together material they learned in earlier modules to draw some conclusions about drug use.

2. Have the students watch the DVD. Stop the DVD at the break. Make sure that each student has all the Instruction Sheets, Fact Sheets, and notes from previous modules, as well as the scrapbooks from Module 1.

3. Tell students that their challenge is to add a page to their scrapbooks from Module 1 to reflect what they have learned during the program. These pages will serve as a before and after summary and will assess their growth and understanding over time about the brain and drugs. Based on what they know now, how would they depict people drinking and smoking in ads? How would they describe drug use to friends?

4. Give the students class time to modify their scrapbooks. They may choose to find new pictures to put in, or they may simply change what they say about the images.

5. Finish watching the DVD. When the DVD is over, bring the class back together to share their scrapbooks. What conclusions did the students come to? Did most students change their ideas about drugs and how they should be depicted in the media?

6. Divide the class again into two groups (A and B) and instruct each group to come up with four to six trivia questions about drugs and addiction to ask the other group. Give the students time to come up with questions and then play the game. If students have difficulty coming up with questions on their own, have them use these examples:

    - What is it called when a person needs more of a drug to produce the same effect? Answer: tolerance
    - What is it called when someone who is addicted to drugs feels bad when not using drugs? Answer: withdrawal

7. One member from Group A should read the question to be answered by Group B. Group B should discuss among themselves before agreeing on an answer. Group B has two options at this

point: (1) Group B members can agree on an answer that a group member will announce, or (2) they can ask for a clue from Group A. The point system is explained in the chart below.

How Question is Asked	Right or Wrong	Points Awarded
Group B with no help	Right Answer	2 points for Group B
Group B with a clue from Group A	Right Answer	2 points for Group B, and 1 point for Group A
Group B with no help	Wrong Answer	No points awarded
Group B with a clue from Group A	Wrong Answer	No points awarded

8. After all the questions have been asked to both groups, declare the group with the higher number of points the winner. Take the time now to emphasize how collaboration results in more points for both groups in this activity. Explain how scientists benefit from collaboration as well. When researchers work together, they make better progress.

Discussion Questions

1. Discuss what addiction means. Ask whether that piece of information changes their opinions about drug use.
2. Discuss what collaboration means. Ask whether scientists benefit more from competition or collaboration.

Extensions

The activities listed below provide links to other areas in the curriculum.

1. Have the students conduct research on the Internet or in newspapers and magazines about scientific research. For example, have them look up brain research and find out about a couple of different discoveries over the past 10 years. Ask students to determine whether progress was made through collaboration or competition. What does that say about the role of collaboration in scientific research?
2. Ask the students to look for examples in the media of how addiction affects people's lives. Then have them write a short summary of what they find out. In general, do they find that drug use usually has a positive or negative effect on people's lives? What does this tell them about drugs?
3. Go to the Library or Media Center and find books or articles about addiction. What additional information is available? Then tell the students to write or draw how addiction changes the brain and the functioning of neurotransmitters.

Assessment/Additional Activities

Assessment

This mission is an embedded assessment of what students have learned throughout the *Brain Power!* program. As the students work, observe whether they have mastered the following:

- Can the students clearly express their thinking about drugs?
- Can the students modify their work to reflect their new thinking?
- Do the students understand what addiction is?
- Are the students approaching the task logically and methodically?

- Are the students able to summarize their thinking and express their conclusions about the program?
- Do the students understand how drugs can change the brain?

Additional Activities

Below are some additional activities that can be done after completion of the sixth mission. These activities are extensions to many areas of the curriculum.

1. Have the students develop an awareness campaign about drugs in their school. As part of the campaign, they should develop posters, brochures, and flyers. They can include PET scans, diagrams of the brain, and illustrations of neurotransmission to develop compelling, persuasive pieces.
2. Challenge the students to develop a model of the brain. They can use clay or other materials to build an anatomically correct, detailed model.
3. Have the students make a list of aspects of their lives that involve competition and those that involve collaboration. For example, in baseball, you compete against another team, but you need to collaborate with your teammates to win each game. Do the students think that there is a place for both in their lives? When is one more appropriate than the other?

Resources

The lists below include resources for teachers and students.

Resources for Teachers

- National Institute on Drug Abuse (NIDA) www.drugabuse.gov, 301-443-1124

This Web site contains information about drug abuse and a section designed specifically for parents, teachers, and students. Publications and other materials are available free of charge at drugpubs.drugabuse.gov.

- National Institute on Drug Abuse (NIDA): Mind Over Matter
  teens.drugabuse.gov/MOM/TG_intro.php, 301-443-1124
  This Web site was developed to educate children about the biological effects of drug abuse on the body and brain.

- National Clearinghouse for Alcohol and Drug Information (NCADI)
  store.samhsa.gov, 1-800-662-HELP (4357)
  NCADI provides information and materials on substance abuse. Many free publications are available here.

- *Drugs, the Brain, and Behavior: The Pharmacology of Abuse and Dependence*. [Brick, J. & Erickson, C. K.] Binghamton, NY: Haworth Press, 1998.
  This book presents a good overview of the brain, major classifications of drugs, how drugs work in the brain, and addiction.

Resources for Students

- NIDA for Teens
  teens.drugabuse.gov
  This Web site created for teens provides information on the science of drug abuse and addiction, including personal stories from teens and activities for students.

- NIDA Partners with Scholastic Magazines
  headsup.scholastic.com
  This Web site provides science-based information about drug abuse to children.

- *Focus on Drugs and the Brain*. [Friedman, D.] Frederick, MD: Twenty-First Century Books, 1990.
  This book, part of the "Drug-Alert Book" series, includes a section on each drug of abuse and addiction.

- National Institution Drug Abuse (NIDA): Mind over Matter
  teens.drugabuse.gov/MOM
  This series is designed to encourage students in grades 5-9 to learn about the effects of drug abuse on the brain and body.
- National Institute on Drug Abuse (NIDA): NIDA for teens
  teens.drugabuse.gov
  This site, developed specifically for teens, provides information on drugs.

Introductory Story for Module 6

Beth, Juan, Jay, and Latisha sit in the *Brain Power!* club house. There is a sense of tension as the kids whisper to their teammates about who may be ahead in the game. Corty comes in and says, “Hi, kids! Glad to see you’re all sitting together – kind of. At least you’re in the same room. I’m here to bring you the final mission, and you’re all going to work on it together.”

“All right! Now we can have a neck and neck competition,” Juan says. “This is our chance to shine!” Latisha says.

Corty says, “I mean all together. Now, the mission is to learn more about addiction.”

“We already know about addiction,” says Beth. “That’s too easy.”

“I know you know a little about addiction. However, this mission will help you answer the question that’s been on all of our minds,” says Corty.

“Who’s going to win the competition?” suggests Juan.

“No! Forget about the competition for a minute. Learning about addiction will tell us why people continue to use harmful drugs even

though they know the drugs are bad for them," Corty says. "Now, who can describe addiction?"

Beth says, "Addiction is a disease of the brain that comes from drug use."

Corty asks, "How does addiction affect the brain?"

Jay replies, "It affects the neurotransmitters. It changes the way they function, so the messages aren't loud and clear like they should be. They're garbled, like a bad telephone connection."

Corty says, "What else do drugs do to the neurotransmitters – Brain Power!kids?" Beth and Juan exchange glances – they're not sure.

Beth says, "I guess we didn't do the mission on neurotransmission, so we're not sure."

Corty says, "Right. The other team did. But you aren't talking to them. Too bad. Now you do know how addiction affects the brain, right?"

"Yeah. Addiction changes the brain so that even if someone stops using a drug, it takes a while for the brain to get back to normal. And sometimes it never does," says Juan.

"Right. Spectacular Scientistskids, what can cocaine do to someone who uses it?" asks Corty. Latisha and Jay look at each other and shrug – they don't know.

Corty asks, "Do you know what class of drugs cocaine is in?" They look at each other again and shake their heads.

"Cocaine is a stimulant," Beth says. "We didn't learn about stimulants," says Jay.

“The *Brain Power!* kids did. Hmmm. Should have worked together. I’ll bet the *Brain Power!* kids can’t tell us what effects inhalants have on the brain,” says Corty. Beth and Jay look at each other and shake their heads.

Latisha says, “Inhalants affect the cerebral cortex, the cerebellum, and the brain stem.” “We didn’t learn about inhalants,” says Juan. The kids sigh and look unhappy, finally understanding that they should have worked together and feeling bad that they didn’t.

Beth says, “Um, I guess we kind of all missed out because we were so busy competing instead of working together. Is it too late to try being a team?”

“Let’s do it!” says Latisha.

Corty does a little victory dance. “Woo-hoo. Woo-hoo. It took you too long, but now I’m singin’ my song. You learned teamwork late, but it was well worth the wait!”

The kids pull out their charts and body outlines, and exchange notes on what they learned.

Corty says, “So now let’s answer the question we’re all asking.”

Beth says, “Why do people continue to use harmful drugs even when they know the drugs are bad for them? We haven’t figured that out yet.”

Corty says, “Well, let’s figure it out now. We’ll start by learning some more about addiction. Do you know some of the signs of addiction?” The kids look at each other, and then shake their heads. They don’t know.

Corty says, “One is called tolerance—the longer someone takes a drug, the more of the drug they need to get the same feeling from it. Of course, a person is supposed to continue taking drugs that a doctor prescribes for him or her for medical reasons. That person would not be considered addicted to those medicines.

Another sign is compulsive use—when someone needs to use a drug over and over again, even if bad things are happening, like with the people they love, or their job, or with the police!

And then, there’s withdrawal. Do you know what that is?” The kids shake their heads. Corty says, “That’s when people need the drug to keep from feeling bad. With cocaine, for instance, if a user can’t get it, they get depressed and nauseated, and they feel like they’ll do anything to get it.” The kids are listening closely.

Stop here until students have finished their scrapbooks.

When Corty gets back, all the kids are playing the game the Spectacular Scientists Club kids designed. Corty says, “Well, if you’re playing a game, that must mean you’ve figured out the answer to our question.”

Juan says, “I think we did!” Beth says, “Well, it seems people start using drugs for all different reasons…” Jay adds, “But the reason they keep using them is addiction.&rdquo

Latisha says, “Once someone is addicted to a drug, it’s very hard to stop using it because addiction makes the brain need the drug.” Beth says, “And addiction is very serious and very hard to overcome.”

“Very good! Excellent teamwork. So, can you sum up what you’ve learned in these six missions?” asks Corty. They go over to the blackboard and whisper together for a moment. Then Jay writes the answer on the blackboard, complete with happy and sad faces.

Jay writes, “Drugs and addiction mess up the way the brain is supposed to work! And teamwork helps us to understand things better than we could on our own!”

Corty applauds, and says, “Great work! And now the reward. Spectacular Scientists Club members, I now pronounce you Junior Scientists. Everyone, take your ‘Teamwork Rules’ T-shirts.”

The kids each grab a shirt from a pile Corty indicates. They put them on, and jump up and down in their excitement.

Brain Power News

Parent Newsletter
Volume 1, Number 6

What is Addiction?

This module is the last in the *Brain Power!* program. Over the past five modules, your child has thought about society’s views toward drug use and has learned about the structure of the brain, how neurotransmission works, and how stimulants, alcohol, marijuana, and inhalants affect the brain, the nervous system, and the body. During this module, your child will learn about addiction. He or she will then revisit the ideas about how society views drug use and modify his or her thinking based on new knowledge.

Most people know that many drugs are bad for them, yet some people use them anyway. Prolonged drug use can change the brain and its neurotransmitters so profoundly that addiction results. Addiction is a disease caused by changes in the brain. It is characterized by the following:

- **Compulsive use:** A strong compulsion or drive to use drugs despite negative consequences. A person persists in using drugs

even if he or she is having serious problems.

- **Tolerance:** The person needs more of the drug to produce the same effect as before.
- **Withdrawal:** Intense craving for the drug when it is not available. Once a person is addicted, he or she must have the drug just to keep from feeling bad. This is because drugs can cause changes in the functioning of neurotransmitters in the brain.

This activity aligns with the following standards identified in the NSES: science and inquiry and science in personal and social perspectives. The students experience some of the steps in the process of scientific inquiry: developing a hypothesis, completing an investigation to test the hypothesis, and drawing conclusions. Students also learn about the effects of several different drugs on the brain, the body, and the nervous system. They discuss the impact this information has on their lives and how they can use it to make wise decisions about their own health.

Science at Home

Talk to your child about addiction. Talk about the effects that addiction has on people's lives. Revisit the original question addressed during Module 1: If people know how bad drugs can be, why do they still use them and abuse them? Have your child use the space below to write down the answer.

Additional Resources

National Institute on Drug Abuse (NIDA)
www.drugabuse.gov, 301-443-1124
This Web site contains information about drug abuse and a section designed specifically for parents, teachers, and students. Publications and other materials are available free of charge at drugpubs.drugabuse.gov.

National Institute on Drug Abuse (NIDA): Mind Over Matter
This Web site was developed to educate children about the biological effects of drug abuse on the brain and body.

National Clearinghouse for Alcohol and Drug Information (NCADI)
http://store.samhsa.gov, 1-800-662-HELP (4357)
NCADI provides information and materials on substance abuse. Many free publications are available here.

NIDA for Teens
www.teens.drugabuse.gov
This Web site created for teens provides information on the science of drug abuse and addiction, including personal stories from teens and activities for students.

NIDA Partners With Scholastic Magazine
http://headsup.scholastic.com
This Web site provides science-based information about drug abuse to children.

Focus on Drugs and the Brain. [Friedman, D.] Frederick, MD: Twenty-First Century Books, 1990. This book, part of the "Drug-Alert Book" series, includes a section on each drug of abuse and addiction.

Materials/Contact

Contact Information

For questions regarding *NIDA's Science Education Program and Materials*, email NIDA Info.

Handouts

Module 1: Drugs in Society

- Trading Cards: Color (PDF, 2.5MB)
- Trading Cards: B&W (PDF, 1.1MB)
- Poster (PDF, 441KB)

Module 2: Your Amazing Brain

- Brain Instruction/Fact Sheets (PDF, 174KB)
- Trading Cards: Color (PDF, 3.1MB)
- Trading Cards: B&W (PDF, 427KB)
- Poster (PDF, 661KB)

Module 3: Neurotransmission

- Black Line Master (PDF, 115KB)
- Board Game Materials (PDF, 279KB)
- Trading Cards: Color (PDF, 2.8MB)
- Trading Cards: B&W (PDF, 634KB)

- Poster (PDF, 1.1MB)

Module 4: Stimulants

- Trading Cards: Color (PDF, 2.5MB)
- Trading Cards: B&W (PDF, 740KB)
- Poster (PDF, 1MB)

Module 5: Alcohol, Marijuana, and Inhalants

- Fact Sheets (PDF, 72KB)
- Trading Cards: Color (PDF, 1.9MB)
- Trading Cards: B&W (PDF, 728KB)
- Poster (PDF, 391KB)

Module 6: What is Addiction?

- Trading Cards: Color (PDF, 3.6MB)
- Trading Cards: B&W (PDF, 1.3MB)
- Poster (PDF, 664KB)
- Certificate (PDF, 600KB)

T-shirts, Stickers, and Buttons

How do I make a T-shirt?

Download PDF (2.5MB)

1. Ask children to have their parents find a plain white t-shirt or other cotton item that they can use for the iron-on.
2. Pick up iron-on ink-jet transfer paper at your local craft or office supply store. Choose opaque transfer paper for dark-colored items and transparent transfer paper for light-colored items. Transparent transfer paper may help avoid white outlines around artwork. Always read the instructions that come with the transfer paper.
3. Download the free artwork.
4. Use an inkjet printer to print the downloaded artwork onto the transfer paper. The artwork comes as a two-page PDF document. Page one is a flipped, mirror image (backwards) of the design. Page two is a regular (straightforward) non-flipped image.
5. Use an ordinary iron to transfer the design onto the item. Use caution, the iron will be very hot.

Download

How do I print the stickers?

1. Pick up some blank white labels paper at your local craft or office supply store.
2. Download the free artwork.
3. Place the downloaded artwork onto your labels and resize the art to fit your label.
4. Use an ink-jet printer to print your downloaded design onto the labels. Be sure to read the instructions that come with the labels.