

ADHD – A Focus on the Brain

Laurie Hayes
Center for Advanced Research and Technology
Clovis, California

Carrie Newdigger
Macksville High School
Macksville, Kansas

In collaboration with Susanna Visser¹ and Alina Flores¹

¹National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

ADHD – A Focus on the Brain

Laurie Hayes
Center for Advanced Research and Technology
Clovis, California

Carrie Newdigger
Macksville High School
Macksville, Kansas

Summary

This lesson is designed to be a supplemental activity for brain anatomy for a mid-level high school biology class. It allows students to apply their knowledge of the brain in understanding how neurochemical imbalances are thought to affect behavior and how different medications are used to treat the symptoms of ADHD. At the conclusion of this lesson, students will be able to discuss differences in brain anatomy and resulting behavior among youth with ADHD, and the different treatment options available for individuals with ADHD.

Learning Outcomes

- Students will be able to identify myths and misconceptions of ADHD.
- Students will be able to describe the treatment options available to a person with ADHD.
- Students will be able to apply their knowledge of brain anatomy and physiology to predict how changes in neurotransmitter levels can cause symptoms of ADHD.
- Students will be able to describe how ADHD medication changes neurotransmission.

Materials

1. Fact or Fiction Pretest (class set)
2. Attention-Deficit/Hyperactivity Disorder - Diagnostic Criteria fact sheet
3. ADHD Posttest (class set)
4. White paper
5. Computer with Internet

Total Duration

3 hours, 35 minutes

Procedures

Teacher Preparation

If needed, review the web resources that follow to familiarize yourself with ADHD.

Make photocopies for the class of the ADHD Fact or Fiction Pretest and the ADHD Posttest.

Web Resources

Title: Attention-Deficit/Hyperactivity Disorder Home Page

URL: www.cdc.gov/ncbddd/adhd/default.htm

Description: This CDC resource provides a wide variety of information about ADHD. This website has links to other government agencies and organizations that are conducting ongoing research and/or provide resources to support the study and treatment of ADHD.

Title: National Resource Center on ADHD

URL: www.help4adhd.org/

Description: The National Resource Center on ADHD is a program of CHADD (Children and Adults with Attention Deficit/Hyperactivity Disorder) and CDC. This resource provides a wide variety of information on ADHD for teachers and students about the myths and misconceptions of ADHD.

Title: Neurotransmission

URL: www.utexas.edu/research/asrec/synapse_m.html

Description: This website provides a visual review of brain anatomy, neurotransmission, and the impact of drug interference on neurotransmission.

Introduction

Duration: 45 minutes

Begin the lesson by asking students to do a 2-minute quick write on their knowledge of ADHD. After the quick write, ask students to share their ideas with the class and write the students' responses on the board. Then divide students into groups of three to five and generate questions about ADHD. Give each group 10 minutes for this activity. At the end of this time period, have students read their questions aloud and write them on the board. After all questions have been written on the board, give each student a copy of the "Fact or Fiction" to assess students' knowledge about ADHD. Give students 5-10 minutes to complete the pretest and then review answers aloud with the students.

Supplemental Documents

Title: ADHD Fact or Fiction Pre-test

Description: This pretest gives students the opportunity to answer questions about ADHD and will allow students to identify the myths and misconceptions surrounding ADHD.

Title: ADHD Fact or Fiction Pretest: Answer Key

Description: This is the answer key for the pretest. It provides in-depth background information for each response.

Step 2

Duration: 45 minutes

After students have discussed the answers to the pretest, begin the lesson by reviewing brain anatomy and function, including neurotransmission. Have students use the web "Neurotransmission" which includes moving images to show how neurotransmission works.

Explain that some drugs alter the neurotransmission process. The "Neurotransmission" website also demonstrates this.

Finish this step by discussing how some medications have positive effects for individuals with ADHD. Medications given to people with ADHD help to increase the amount of certain neurotransmitters released from one neuron into the synaptic cleft or slow the reuptake of these neurotransmitters to allow the dendrites of other neurons more time to receive the neurotransmitters.

Web Resources

Title: Neurotransmission

URL: www.utexas.edu/research/asrec/synapse_m.html

Description: This website provides students with a visual review of brain anatomy, neurotransmission, and the impact of drug interference on neurotransmission.

Step 3

Duration: 20 minutes

In the Introduction, students learned about some of the myths associated with ADHD and in Step 2, gained an understanding of brain activity and neurotransmission function. This step focuses on treatments available for individuals with ADHD. Introduce one possible treatment option for individuals with ADHD; medications. Students can use their previous knowledge of neurotransmission to hypothesize how medications might work in treating people with ADHD.

Challenge students to find a mechanism for increasing the efficiency of neurotransmission for dopamine and norepinephrine as a means of treating the symptoms of ADHD. Hand out white paper to students and ask them to draw a diagram of how their hypothetical “medication” would work. Refer students to the “Neurotransmission” website for more information.

Web Resources:

Title: Neurotransmission

URL: www.utexas.edu/research/asrec/synapse_m.html

Description: This website provides students with a visual review of brain anatomy, neurotransmission, and the impact of drug interference on neurotransmission.

Step 4

Duration: 60 minutes

Students will now look at alternative treatments available for individuals with ADHD. Divide the class into five groups. Each group will investigate one of the following treatments:

- Medication alone
- Intensive Behavioral Therapy
- Medication combined with Behavioral Therapy
- Educational modifications/adaptations
- Alternative medications

Have students conduct individual research using the Internet, write information on note cards, and report back to group. Instruct groups to develop a presentation on their findings, and to elect a representative to present group findings to the class. Presentations should include a description and pros and cons for each treatment discussed, along with the resources used in the group’s research. Use the “Research Presentation Rubric” to assess completeness of presentations.

Web Resources

Title: Attention-Deficit / Hyperactivity Disorder Home Page

URL: www.cdc.gov/ncbddd/adhd/default.htm

Description: This CDC resource provides a wide variety of information about ADHD. It also has links to other government agencies and organizations that are conducting research and/or provide resources to support the study and treatment of ADHD.

Title: National Resource Center on ADHD

URL: www.help4adhd.org/

Description: The National Resource Center on ADHD is a program of CHADD (Children and Adults with Attention Deficit/Hyperactivity Disorder) and CDC. This resource provides a wide variety of information on ADHD for teachers and students on the myths and misunderstandings of ADHD.

Supplemental Document

Title: Research Presentation Rubric

Description: This rubric can be used to assess student presentations on the different types of treatment.

Conclusion

Duration: 45 minutes

Now that students have a better understanding of what ADHD is, and how it impacts brain development and function, conclude the activity by putting this information into a larger context. Discuss the prevalence of ADHD with students, and how the rates of ADHD vary across states. For this activity, refer to the figure and table *“Percent of Youth 4-17 ever diagnosed and currently medicated for Attention-Deficit/Hyperactivity Disorder: National Survey of Children’s Health, 2003”*. Also discuss with students how the medication rates for ADHD treatment vary across states. For this activity, refer to the figure and table found in the *“Percent of Youth 4-17 ever diagnosed and currently medicated for Attention-Deficit/Hyperactivity Disorder: National Survey of Children’s Health, 2003”*.

Ask students to interpret the figures and tables.

- What do the figures and tables about prevalence of ADHD tell you? (high in many states, higher in some states than others, higher in the southeast, varies geographically)
- Does the prevalence of ADHD vary across states? (yes)
 - If yes, why might that be? (physicians diagnosing differently, differences in what is “acceptable” behavior”, socio-economic, cultural, racial, and ethnic differences)
- What do the figures and tables about medication use tell you? (high in many states, higher in some states than others, higher in the southeast, varies geographically)
- Does the rate of medication use vary among states? (yes)
 - If so, why might that be? (different views on medications, differences in how medications should be used, parents may not want to use medication for child, socioeconomic differences)

Tell students that prevalence may be affected by level of diagnosis, awareness of ADHD in certain areas, culture and gender biases (“boys will be boys” mentality), etc. Allow students to generate other ideas as to why prevalence might vary geographically.

At the conclusion of this lesson, give students the ADHD posttest to determine change in level of understanding about ADHD.

Web Resources

Title: Percent of Youth 4–17 Ever Diagnosed with Attention-Deficit/Hyperactivity Disorder: National Survey of Children’s Health, 2003

URL: www.cdc.gov/ncbddd/adhd/adhdprevalence.htm

Description: Figure and table showing percent of children and adolescents diagnosed with ADHD.

Title: Percent of Youth 4–17 Ever Diagnosed and Currently Medicated for Attention-Deficit/Hyperactivity Disorder: National Survey of Children's Health, 2003.

URL: www.cdc.gov/ncbddd/adhd/adhdmedicated.htm

Description: Figure and table showing percent of children and adolescents currently on medication for ADHD.

Supplemental Document(s)

Title: ADHD Posttest

Description: Posttest will be used to assess student learning on ADHD.

Title: ADHD Posttest Answer Sheet

Description: Answer key for the ADHD Posttest.

Assessment

Students will be evaluated on the completeness of their “Diagnosis Report” in step 2, their neurotransmitter diagram in step 3, and the completeness of their research on treatment options in step 4. Final assessment will include the ADHD Posttest.

Modifications

Extension(s)

Side Effects of Using Stimulants

Give students an overview of the sympathetic nervous system and the effect of norepinephrine on that system. Ask students to generate ideas about how drugs that simulate norepinephrine might affect the nervous system. Have students work in teams to investigate and hypothesize what the impact would be on indicators of cardiovascular function (blood pressure and heart rate) of patients who are using medication to treat ADHD and taking one or more of the following stimulants: caffeine, ephedrine, cocaine, and methamphetamines.

Determining Prevalence Rates

The prevalence tables in the conclusion section can open the door for more in-depth discussion about epidemiology, how prevalence is determined, and epidemiology’s role in public health.

Web Resource

Title: Excellence in Curriculum Integration through Teaching Epidemiology

URL: www.cdc.gov/EXCITE/

Description: This CDC website introduces students to public health and epidemiology.

Education Standards

National Science Education Standards

SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES, CONTENT STANDARD F:

As a result of activities in grades 9-12, all students should develop understanding of

- **Personal and community health**
- Population growth
- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

LIFE SCIENCE, CONTENT STANDARD C

As a result of their activities in grades 9-12, all students should develop understanding of

- **The cell**
- Molecular basis of heredity
- Biological evolution
- Interdependence of organisms
- Matter, energy, and organization in living systems
- Behavior of organisms

ADHD Fact or Fiction Pretest

ADHD: A Focus on the Brain
Laurie Hayes and Carrie Newdigger, 2006 Science Ambassador Program

Name: _____

Class: _____

Directions: Determine if the following statements are Fact or Fiction.

1. All children with ADHD are hyperactive. _____
2. ADHD is more common in upper to middle class children. _____
3. ADHD has only been diagnosed in the last 20 years. _____
4. ADHD symptoms usually begin when children are in adolescence: _____
5. The exact cause of ADHD is known: _____
6. ADHD is a disorder of childhood: _____
7. More males than females have ADHD: _____
8. Stimulants are used to control ADHD: _____
9. Individuals with ADHD have a lower intelligence: _____
10. Individuals with ADHD have smaller frontal lobes than children without ADHD: _____
11. ADHD is caused by an increase in dopamine and norepinephrine (neurotransmitter in the brain): _____
12. Poor parenting causes ADHD: _____

ADHD Fact or Fiction Pretest: Teacher Answer Key

ADHD: A Focus on the Brain
Laurie Hayes and Carrie Newdigger, 2006 Science Ambassador Program

Directions: Determine if the following statements are Fact or Fiction.

1. All children with ADHD are hyperactive: **Fiction**
ADHD can be divided into 3 subtypes: ADHD predominately inattentive (ADHD-I). ADHD predominately hyperactive-impulsive type (ADHD-HI) and ADHD combined type (ADHD-C). (1)
2. ADHD is more common in children from upper to middle class homes: **Fiction**
Children from low income families are more likely to be diagnosed with ADHD. (2)
3. ADHD has only been diagnosed in the last 20 years. **Fiction**
ADHD was first described in 1902 by Sir George F. Still. He described a group of impulsive children with significant behavioral problems, caused by a genetic dysfunction and not by poor child rearing. This disorder has had various names since then, including: hyperkinetic disorder, minimal brain dysfunction, minimal brain damage, and attention deficit disorder. (1)
4. ADHD symptoms usually begin when children are in adolescence: **Fiction**
Symptoms arise during early childhood and criteria for diagnosis require that child shows signs of ADHD prior to age 7. (1)
5. The exact cause of ADHD is known: **Fiction**
Scientists are not sure of the exact cause of ADHD, however, there is some indication that there is a 50% genetic contribution and 50% environmental. Environmental exposures that may contribute to ADHD include lead, PCB, bromated flame retardants (found on carpet and upholstery) and fetal alcohol exposure. (2)
6. ADHD is a disorder of childhood: **Fiction**
Roughly 2-4% of adult population has ADHD. 70% of children diagnosed with ADHD show symptoms as an adult. (1, 2, 3)
7. More males than females are diagnosed with ADHD: **Fact**
There is a 3:1 ratio of boys to girls diagnosed with ADHD. However, this might be misleading in that the patterns of diagnosis might not mirror underlying morbidity and more girls who have ADHD might not be diagnosed. (2, 3)
8. Stimulants are used to control ADHD: **Fact**
Stimulants increase the movement of neurotransmitters into the synaptic cleft. The non-stimulant drugs used to treat ADHD inhibits the re-uptake of norepinephrine at the synaptic cleft. (2)
9. Individuals with ADHD have a lower intelligence: **Fiction**
Research suggests that, all other factors being equal, performance rather than intelligence is impaired. (2)

10. Individuals with ADHD have smaller frontal lobes than children without ADHD: **Fact**
According to a study done by Sowell and Peterson (<http://pn.psychiatryonline.org/cgi/content/full/39/1/26>), children with ADHD had smaller frontal and temporal lobe size. (2)
11. ADHD is caused by an increase in dopamine and norepinephrine. (neurotransmitter in the brain): **Fiction**
There is actually a decrease in the neurotransmission of these neurochemicals (dopamine and norepinephrine). (2)
12. Poor parenting causes ADHD: **Fiction**
ADHD does not discriminate between “good” and “bad” parenting. (1, 2, 3)

References

1. National Resource Center on AD/HD. The Disorder Named AD/HD [online]. 2006. [cited 2006 June 13]. Available from URL: <http://www.help4adhd.org/en/about/what/WWK1>
2. Visser S. Childhood Attention-Deficit/Hyperactivity Disorder. PowerPoint presentation, CDC Science Ambassador Program, June 2006.
3. Teeter P. Myths and Misconceptions About AD/HD: Science over Cynicism [online]. June 2003. [cited June 2006]. Available from URL: <http://www.help4adhd.org/en/about/myths>

Research Presentation Rubric

ADHD: A Focus on the Brain
Laurie Hayes and Carrie Newdigger, 2006 Science Ambassador Program

Name: _____

Class: _____

CATEGORY	4	3	2	1
Amount of Information	All topics are addressed and all questions answered with at least 2 sentences about each.	All topics are addressed and most questions answered with at least 2 sentences about each.	All topics are addressed, and most questions answered with 1 sentence about each.	One or more topics were not addressed.
Organization	Information is very organized with well-constructed headings and sub-headings.	Information is organized with well-constructed text.	Information is organized, but text is not well-constructed.	The information appears to be disorganized.
Quality of Information	Information clearly relates to the main topic. It includes several supporting details and/or examples.	Information clearly relates to the main topic. It provides 1-2 supporting details and/or examples.	Information clearly relates to the main topic. No details and/or examples are given.	Information has little or nothing to do with the main topic.
Mechanics	No grammatical, spelling or punctuation errors.	Almost no grammatical, spelling or punctuation errors	A few grammatical spelling, or punctuation errors.	Many grammatical, spelling, or punctuation errors.

Date Created:
Jun 16, 2006
08:21 am (CDT)

ADHD Post-Test

ADHD: A Focus on the Brain
Laurie Hayes and Carrie Newdigger, 2006 Science Ambassador Program

Name: _____

Class: _____

Determine if the following statements about ADHD are true or false.

1. More girls than boys receive medication treatment for ADHD.
True False

2. Stimulants may be used to treat ADHD.
True False

3. ADHD is always characterized by hyperactivity.
True False

4. ADHD usually occurs in upper middle class families.
True False

5. Prescription drugs are the only treatment for ADHD.
True False

6-7 Describe two ways in which drugs can increase the amount of neurotransmitters in the synapse.

8-10 List three treatment options for people with ADHD.

ADHD Posttest – Answer Key

ADHD: A Focus on the Brain
Laurie Hayes and Carrie Newdigger, 2006 Science Ambassador Program

Determine if the following statements about ADHD are true or false.

1. More girls than boys receive medication treatment for ADHD. **False (1)**
 2. Stimulants may be used to treat ADHD. **True (1)**
 3. ADHD is always characterized by hyperactivity. **False (2)**
 4. ADHD usually occurs in upper middle class families. **False (1)**
 5. Prescription drugs are the only treatment for ADHD. **False (1, 2)**
- 6-7 Describe two ways in which drugs can increase the amount of neurotransmitters in the synapse.
Answers may vary but could include:
- a. **Increase the amount of neurotransmitter released**
 - b. **Decrease the reuptake of the neurotransmitter**
- 8-10. List three treatment options for people with ADHD.
Answers can include:
- a. **Psychoactive medication**
 - b. **Behavioral therapy**
 - c. **Educational modification/adaptation**
 - c. **Alternative medications (herbal remedies, nutritional management, etc.)**

References

1. Visser, S. "Childhood Attention-Deficit/Hyperactivity Disorder" PowerPoint presentation, CDC Science Ambassador Program, June 2006.
2. National Resource Center on AD/HD. The Disorder Named AD/HD [online]. 2006 [cited 2006 June 13]. Available from URL: <http://www.help4adhd.org/en/about/what/WWK1>