How Alcohol Damages a Teen's Developing Brain, Part 1

Summary

This lesson will help students understand how the brain develops during adolescence and how alcohol affects the adolescent brain differently than an adult brain.

Main Core Tie

Health Education I (7-8)

Strand 4: SUBSTANCE ABUSE PREVENTION (SAP) Standard HI.SAP.4:

Materials

- Handouts and posters:
  "Brain Change," "How Brain Neurons Communicate," "Stronger Neural Connections," "Teens Choose How Their Brains Are Wired," "Peaks of Plasticity," "Brain Areas," "Alcohol Damages the Adolescent Brain," "Alcohol Damages Teen Brain Wiring!" "Under-age Drinking Is D.U.M.B," " Alcohol Stop Sign"
- Parent Share Sheets:
  "Alcohol Fact Sheet" from the American Medical Association
- Worksheet:
  "Our Amazing Brain -- The World's Most Powerful Computer!"

Intended Learning Outcomes

Understand the processes of neural and brain development during adolescence (approximately ages 12-21) that forms the basis of a future successful life.
Understand how alcohol affects an adolescent brain differently than an adult brain. It damages the neural wiring in both the prefrontal cortex (good judgment/impulse control center) and the hippocampus (memory/learning center), and can cause early addiction.

Instructional Procedures

Lesson at a Glance

Discuss the brain/computer metaphor.
Discuss various posters and ideas about youth and alcohol use.
Distribute parent share sheets.
Play "Pass the Neuron."

New Vocabulary

neurons
plasticity
neural connections
prefrontal cortex
neurotransmitter
hippocampus
myelin sheath

Introduction (Setting Focus)

Say: Let's pretend that today is your birthday, and when you woke up this morning there was a big, beautifully wrapped box with your name on it sitting right beside you on the bed. A note said that in the box was the best gift you could ever receive. What gift would you want it to be? When you tore open the package you found the most advanced high-tech computer that had ever been created. Once you opened your computer, what is the first thing you would do? (Accept all

answers; focus on: "read instruction book"; "find out what programs/software it had.")
Explain: This situation really did happen to each of you, for when you were born you received the most amazing "computer" ever created. Your computer has more than 150 billion nerve cells called "neurons" that communicate with each other -- and every other cell in your body -- at more than 200 mph. What is this computer? (brain) Our brain is more powerful than any computer ever made.
Explain: Like any new computer, we need to know how our brain works and how to care for it if we are to get the best use out of it. New scientific discoveries, made through MRI's, PET scans, and SPECT scans (which allow us to see the brain as it works), have given us valuable new information on how the brain works and what can harm it.
We used to think that the brain we were born with was the brain we'd have for life, but now we know that isn't true. Research shows that a young person's brain is still making the important neural wiring that is needed to be a responsible adult. What you think and do as a teen has a profound affect on how your brain develops. Adding brain wiring is like adding new software to your computer; with it you can become more competent and do more wonderful, exciting things. However, some things can harm your brain development.
Explain: New research shows that alcohol affects a teen's developing brain differently than an adult brain. Drinking alcohol before the age of 21 can actually harm brain development and can cause permanent damage.
Discuss the poster: "Brain Change."

The SPECT images show functional activity levels in the brain of a healthy nondrinker (left) and that of a sober 21-year-old with a 4-year history of heavy alcohol use (right).
The "holes" indicate areas of significantly reduced brain activity.
As a class, read aloud the quote on the poster: "The brain goes through dynamic change during adolescence (ages 12-21) and alcohol can seriously damage long- and short-term growth processes."
Why is it important for teens to know this new information?
We will have two important lessons on the latest brain research that explain what things harm or help your brain's development. You'll learn how to make smart decisions in caring for your high-tech brain, so it will work right to help you have a happy, successful life.

Students complete the worksheet: "Our Amazing Brain -- The World's Most Powerful Computer!" during the course of the discussion.
Discuss poster: "How Brain Neurons Communicate."

Our brain is made of more than 150 billion nerve cells called neurons which send electrical and chemical signals to communicate with other neurons. A neuron looks somewhat like a tree. It is made up of:

Soma -- The cell body where the neuron makes and stores electrical power that it uses to send signals.
Dendrites -- They look like branches, but are actually antennae which are covered in tiny "receptors" that sense/receive chemical messages from other neurons. Each neuron has many dendrites and hundreds of receptors.
Axon -- It looks like a tree trunk, but it is actually an information line that carries an electrical signal from the soma to the axon terminals.
Axon Terminals -- They look like roots or tentacles that have tiny sacks on each end which are filled with chemicals called "neurotransmitters." Our body makes over 100 different neurotransmitters; two are dopamine and serotonin.

Discuss that every thought you think, every emotion that you feel, every action that you do is made possible because your neurons communicate with each other. This process takes place in nanoseconds, so fast we are not even aware of it. Every time we have new

experiences or learn something new, our neurons form new connections between themselves. Neurons communicate by sending electrical and chemical messages:

The dendrites of a neuron receive a message from somewhere in the body and forward it to the soma.

The soma sends an electrical signal down the axon to the axon terminals.

This triggers the axon terminals to release a chemical neurotransmitter, which flows into the synapse.

The chemical message is picked up by the neighboring dendrite receptors. When a message is successfully sent and received, a "neural connection" is made.

Explain that neurons don't touch each other. There is a tiny gap between the dendrites of one neuron and the axon terminals of another. This gap is called a synapse. Neurotransmitters flow across the synapse from one neuron to another. Point to the gap, have students repeat "synapse."

Complete the activity "Make a Neuron" by instructing the students in the following exercise. Using the dialogue below, the teacher models and gives verbal instructions to students, instructing them to copy the teacher's actions and repeat the new words (in bold) aloud.

"Raise your right hand and pat the palm of your hand. Your palm is the soma or cell body of the neuron."

"Wiggle your fingers. Your fingers are like dendrites that receive messages."

"Touch your arm. Your arm is the axon or information line."

"Now, make the axon terminals by putting the back of your left hand against your elbow." (Compliment their fine neurons.)

"Now hold that position, and we are going to show our neuron in action." Students do the actions as you say and model the following.

"When your dendrites [wiggle your fingers] sense a message..."

"They tell the soma [slap your palm]..."

"Which sends an electrical impulse that travels down your axon (run your fingers down your arm) to your axon terminals.

"Your axon terminals [put your left hand at your elbow and wiggle your fingers] release chemical neurotransmitters into the synapse gap, and it is picked up by a neighboring neuron."

The concept of making a model of a neuron using our hand and arm comes from the MADD (Mothers Against Drunk Driving) "Protecting You-- Protecting Me" alcohol prevention education program. See http:// www.madd.org.

Discuss concepts on the poster "Stronger Neural Connections."

Every time we learn something new or have new experiences, our neurons form new connections between themselves. If we repeat a thought or action several times, the neuron begins sending a larger amount of neurotransmitter across the synapse, and the neighboring neuron makes more dendrite receptors to receive it. The neural connection then becomes stronger. Eventually, the connection becomes a dominant pathway for the brain to think, feel, or act. This process is called "wiring" your brain.

The axon eventually becomes coated with a fatty, waxy coating called a "myelin sheath." The myelin sheath acts like a type of insulation that protects brain wiring. The myelin sheath is not completely formed in the brain until about age 24. (NOTE: If the myelin sheath starts to deteriorate through a brain disease like Alzheimer's, a person will lose brain function.)

The myelin sheath increases the speed at which electrical signals travel through many of the axons (from 200 mph to up to 400 mph), so you can think and do those things faster and easier.

What are some of the things you can do that were hard at first, but now are easy for you to do? (Sports, musical instruments, dance, multiplication tables, video games, etc.) Why did it get easier? (Your neural connections were strengthened until your brain became "wired" for that activity.)

About 40 percent of our neurons are already communicating or "wired" at birth. The other 60 percent are waiting for outside stimulation to make their neural connections. Which brain neurons do you think are already wired at birth? (neurons that control breathing, eating, sleeping, crying, etc.)

What we choose to experience, think, feel or do becomes wired in our brain and becomes part of our character or identity -- who we are. While in our teens, we can help "wire" our brain with good choices and positive learning experiences to make our brain even more powerful and effective.

Discuss poster, "Teens Choose How Their Brains Are Wired."

A student reads quote by Dr. Jay Giedd, Chief of Brain Imaging at the National Institutes of Health: "Teens, through their choices and actions, have the power to direct the development of their own brains."

What activities can you do to help your brain make more positive neural connections? (reading, sports, music lessons, games, doing homework or chores, etc.)

As you learn and experience new, positive things, your brain develops more positive neural connections, and you become smarter and more capable.

What things do you think could harm our brain's neural connections? (alcohol, tobacco, drugs, inhalants, head injuries)

Discuss the poster, "Peaks of Brain Plasticity."

While our brain continues to learn things throughout life, there are important periods of time when our brain is pre-programmed to increase brain chemicals that allow us to make neural connections. During this time the brain has an increased level of "plasticity."

Plasticity refers to the brain's ability to reformat its internal structure when we have new learning and experiences. These times are called "peaks of plasticity." Our brain is also pre-programmed to wire specific areas of the brain at specific times in life.

An example of "brain-wiring timing" is our ability to see. Eyesight is not fully wired in the brain at birth, but continues to develop until the age of six months. On rare occasions a baby is born with a cataract covering an eye. The cataract must be removed during the first six months of life. If it is not, the time to wire the brain for sight passes, and even if the cataract is removed later, the child will always be blind in that eye.

What period of brain plasticity are you in now? (Ask a student to point to it.)

One of the key brain wiring times takes place during the ages of 12-21 years. This time is sometimes referred to as "adolescence." Research shows that drinking alcohol during this period of time can disrupt and harm brain wiring.

Discuss the poster, "Brain Areas."

The brain is divided into different specialized areas. Each brain area governs different parts of the body and has its own specific neural communication network.

We wire different brain areas at different times in life.

Two brain areas that must be wired during the teen years for a person to become a responsible, capable adult are the "prefrontal cortex" and the "hippocampus."

The prefrontal cortex is the director or boss of the brain and governs good judgment, planning, analyzing, decision-making, and impulse control. It helps us avoid antisocial behavior and become a thoughtful, capable adult.

The majority of prefrontal cortex brain wiring takes place during the ages of 12 to 16, and continues to develop until about age 24. By the time we reach adulthood, the ability to

wire our prefrontal cortex is much reduced.

The hippocampus is the part of the brain responsible for learning and memory. It goes through a developmental growth spurt during the ages of 12-21.

Discuss the poster, "Alcohol Damages the Adolescent Brain."

What do you think would happen to you if the prefrontal cortex area of your brain became damaged? (make bad decisions; lack impulse control; have relationship problems; do risky behaviors)

What do you think would happen if the hippocampus area of your brain were damaged? (have a bad memory; do poorly on tests; not be able to learn things as well)

What things can harm our brain's ability to form neural connections in our prefrontal cortex and our hippocampus? (alcohol, drugs, inhalants)

Discuss the poster, "Alcohol Harms a Teen Brain".

Alcohol is a chemical which, if consumed before our brains are fully developed, interferes with our own chemical neurotransmitters and damages our brain neuron wiring. Alcohol pretends to be a neurotransmitter and acts like a computer virus in our brain, garbling, changing, or deleting the messages we need to wire into our brains. It also slows or shuts down brain activity, thus keeping an adolescent brain from making proper connections. Drinking alcohol is like turning off the power when you are trying to download new software.

What would happen if you had a power outage right when you were trying to load some new software on your computer? (It wouldn't be there when the power came on.)

Alcohol acts the same way on a still-developing brain. Important neural connections that we need to be responsible, thoughtful adults may not be wired into our brains, making life more difficult for us and those who will depend on us. We may be harmed in ways we cannot predict, becoming less than we could be.

Most alcohol brain damage doesn't show up right away, not until your brain is needed to handle complex jobs or relationships, and then it's too late. Why is it important for teens to understand brain development and wiring?

Teen alcohol use not only harms brain wiring, it also:

Hijacks the brain's pleasure-reward system, causing the brain to crave alcohol pleasure and harming the brain's ability sense ordinary pleasure; and

Causes early addiction. 40 percent of kids who begin drinking at age 15 will become alcohol dependant as adults. We will discuss more about this in the next lesson.

Discuss the poster, "Underage Drinking Is D.U.M.B" but keep the words "Drinking Underage Maims the Brain" covered at first.

After reviewing all the latest scientific research on teen alcohol brain damage, the American Medical Association issued this slogan:

"Underage Drinking is a D.U.M.B. Decision"

What does "underage" mean? (Under the age of 21. It is illegal to drink alcohol before the age of 21.)

In pairs, students brainstorm an answer to what the initials D.U.M.B. stand for.

Share answers and then uncover the AMA definition of D.U.M.B. (Drinking Underage Maims the Brain).

After learning how alcohol harms a teen's brain, what will you do to make sure you're not pressured into drinking before age 21?

Distribute a copy of "American Medical Association Fact Sheet," "Alcohol Damages Teen Brain Wiring" including the poster "Drinking underage is a D.U.M.B. decision!" to each student to take home to parents.

Closure (Wrap-Up and Extension)

The winning team in the "Pass the Neural Message" contest stands up and shows how fast they can pass the "neural message" (piece of paper wadded up into a ball) from the neuron of the person in the front of the row to the person in the back.
This time, without warning, use the "Stop Sign" and try to block the passing of the neural message sent by the students.
Discuss how alcohol affects brain wiring -- it hinders messages from being sent and slows down brain development. It creates feeling of frustration and anger.

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