Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2009 Volume IV: How We Learn about the Brain

Brain Buzz: Effects of Caffeine, Nicotine, Alcohol and Drugs on Learning

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Introduction

I teach third grade at Vincent E. Mauro Magnet school in New Haven, Connecticut. Vincent Mauro is an interdistrict elementary school with a Science, Mathematics and Technology focus. My third grade classroom is in an urban district and is composed of a diverse, multicultural community of learners that encompass a wide spectrum of achievements, interests, learning and social needs. Students come not only from New Haven but from surrounding suburban communities as well. Since this classroom is a part of a science, mathematics and technology magnet school the students are provided with the means to explore their multiple intelligences and interests and utilize different learning styles to strive to reach their goals. Students are given opportunities to choose how they respond and how they are assessed on various integrated curricular tasks throughout the year. Assessment is done via a project driven rubric and students are not limited as to how much they can achieve.

As mentors and role models for children it is extremely important that we not only teach academics but help students understand who they are and why certain things happen to them. This unit is designed to help students piece together the fundamental elements of the brain, how we learn about it and how stimulants like caffeine, alcohol, nicotine and other recreational drugs affect how the brain works.

Objectives

This unit will give students the ability to take responsibility for their own learning and well being at a critical time in their lives. Students are beginning to question themselves and having the approval of their peers seems to be most important. Students at this age often make decisions based on how it will affect their friendships rather than thinking about the consequences of their actions on their lives. Too often, teachers and parents simply tell students to say no to drugs and tell that stimulants like caffeine, alcohol and nicotine are bad for them. Students however receive mixed messages when they see adults around them smoking and drinking and partaking in bad habits. This can cause them to think that it can't be that bad if others are doing

it and it doesn't appear as though anything bad is happening to them. This unit will teach students why they should "Just Say No!" when faced with peer pressure. It is not often that students will blindly do as their parents and teachers say unless they can see and experience its applicability to them and their world. Students will understand why their parents tell them to stay away from stimulants like caffeine, drugs, alcohol and nicotine. Understanding the "why" often is what will sway students to make positive choices when faced with peer pressure. Students need to take more responsibility in their decisions and in their learning. Students will formulate a better understanding of how the brain works as well as what stimulants may affect their learning negatively. Students will also learn about addiction and how it attacks a brain like a disease. Students will get to know the functions of the brain and how they can take responsibility for keeping it healthy in order to be better learners, promote healthy lifestyles and make informed decisions. As a result, students will make smarter decisions because they learned that the brain is the control center of their body, which is directly affected by their actions.

Our brain not only tells us who we are, what we are doing and what we have done, but it also controls critical body functions like heart rate, breathing and blood pressure. Drugs strongly affect these functions that are critical to our survival. The human brain is a complex structure with thousands of different sites for drug action on just as many different kinds of nerve cells. Because of its complexity, different people have different experiences with the same drug. The central nervous system has a great capacity to change in response to experiences like learning and memory. Change in response to experience and influence in known as "plasticity". Plasticity can be modified by chemicals whether taken for medical benefit or for recreational purposes. This unit will address these differences and allow students to understand basic brain functions and the changes that occur when stimulants or sedatives are used and abused.

Activities

Week 1

This first week will provide the students with an overview of the human brain, including its size and function from infant to adult. Students will learn that different regions of the brain serve different functions. This week students will conduct a series of activities including mapping the geography of the brain and taking an inside peek at the inner workings of the human brain. Students will keep a daily log of their activities from which they will then have to find out what part of their brain controls those actions. Students will use what they learned about the brain by creating their own three dimensional model.

Week 2

The second week will focus on the brains' inner connections or synapses and how stimulants like caffeine, nicotine, alcohol and other drugs affect these connections. Students will also investigate how addiction affects the brain and the long term behavioral consequences associated with it. Through this, students will understand the chronic effects of stimulant use on learning and memory. The students will watch an animation of neurotransmission. The students will study the effects of stimulants on the brain and how they disrupt natural brain chemistry. Activities will include integrating literacy as the students write and perform a class play about the brain that demonstrates how nerve cells talk to each other.

Week 3

This week the students will learn about interventions and treatments for addictions to stimulants. They will focus on keeping the brain healthy through a balanced diet, exercise, maintaining a positive attitude and getting adequate sleep. They will plan "brain healthy" menus based on what is learned about a balanced diet complete with fruits, vegetables, antioxidants, vitamins and minerals.

Background Knowledge: This is Your Brain

The Human Brain: Form and Function

The brain is what makes each of us different human beings. It controls everything we do from breathing to playing an instrument or catching a ball. Not only that, but the brain controls everything that we feel and how we think. Our brain gives us the ability to make choices in our lives, it makes decisions, plans and imagines. The brain is what makes humans different from other animals. When an infant is born their brain weighs about 400 grams and grows to be about 1400 grams. The adult human brain consists of three main parts: the cerebrum, cerebellum and the brain stem. The cerebrum is the largest part of the brain that controls and integrates thinking, memory and five senses. It is divided into two hemispheres, the right and the left. The left hemisphere directs the right side of the body while the right hemisphere guides the left side of the body. This is due to the axons that cross over to the opposite side of the body in the spinal cord.

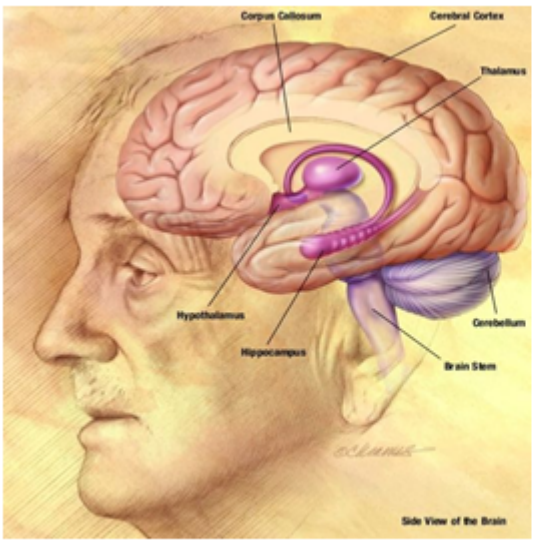

Figure 1: Courtesy of Wikipedia

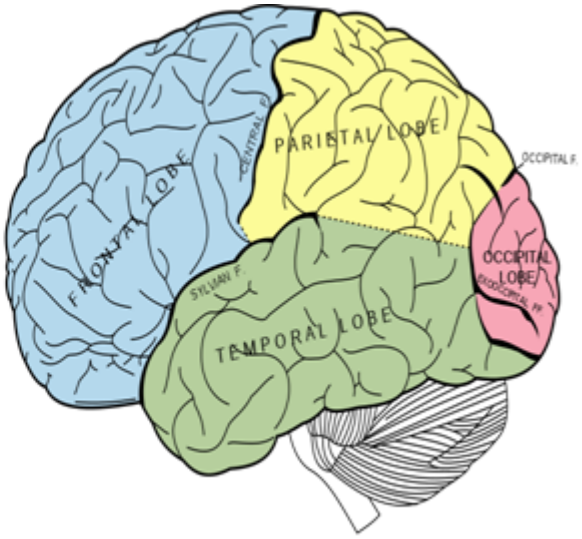

Figure 2: Courtesy of: Wikipedia

Although most brain activity involves both hemispheres, the left side primarily governs logical, objective and analytical thinking such as speaking, reading, writing and problem solving. The right hemisphere controls the abstract, intuitive and subjective part of us, such as imagination, appreciation and creativity. These two halves however are connected by a band of nerve fibers, the corpus callosum that allows the two halves to communicate (Freidman, 1990).

The cortex is the outer layer of the cerebrum that collects information via our five senses. It is made up of four sections called lobes: frontal (reasoning, planning, parts of speech, movement, emotions and problem

solving), parietal (somatosensory functions), temporal (hearing and memory) and occipital (vision).The cerebellum is located at the lower back part of the cerebrum and controls movement, balance and posture. The brain stem connects the cerebrum, the cerebellum and the spinal cord. It controls breathing, heart rate, digestion and blood pressure. At the top part of our brain stem lies the pleasure center (Freidman, 1990). Things like food, drink and sleep make us feel good by activating the pleasure center. Near the pleasure center at the top of the brain stem is the hypothalamus. It regulates body temperature, appetite and sleep patterns (Freidman, 1990).

In addition, the hippocampus and amygdala are vital in the anatomy of the brain. These regions are affected directly by many stimulants. The hippocampus plays a major role in long term memory and spatial navigation. It is also involved in the formation of new memories. The amygdala are almond-shaped groups of nuclei located deep within the medial temporal lobes of the brain. The amygdala performs a primary role in the processing and memory of emotional reactions (Freidman, 1990).

Lesson 1 - Geography of the Brain

Objectives: Students will learn the three main parts of the brain: the cerebrum, cerebellum and the brain stem. Students will recognize that the brain has two hemispheres, each which control different moods and cognitive function.

Materials: Oatmeal, Cardstock, Zippered bags, Model of a brain and or diagrams/ photos of the brain

Prior Preparation: Cook oatmeal as instructed and place in 4 zippered bags. Allow the bags to sit for at least 15 minutes in order to become firm. Cut a diagram of the brain into its three main parts and paste on card stock. Be sure each piece fits together like a puzzle. Be sure to have 1 set per student of these three puzzle pieces.

Procedure:

1) Pass around the bags of oatmeal and allow students to observe and feel its contents.
2) Have students' hypothesize what body part they think this represents and share their thoughts with the class.
3) Tell students that they are feeling oatmeal. Have them describe what they are feeling. Tell them that oatmeal is very much like the human brain. Although we may think the brain is hard, what we are actually feeling when we touch our head is our skull. The skull is made of bones that protect the brain. The brain itself however is mushy.
4) Administer a pre- assessment of the structure of the brain. It can be later given as a post assessment following the completion of the unit.
5) After completing the pre-assessment, pass around a model of the brain or a few labeled diagrams of the brain. Ask students to guess how much they think the brain weighs (3 pounds).
6) Explain that the brain is divided into many parts, but today you will learn the three main parts: the cerebrum, cerebellum and the brain stem.
7) Display on an overhead the three main parts of the brain and pass out one envelope holding the brain puzzle to each group (4 groups).
The students can remove the three pieces from the envelope and place on their desks. Ask them to find the largest part. This is the cerebrum. It is the largest part of the brain and contains many bumps and grooves. Explain that it contributes to your thinking, your fives senses and your

memory.
8) The students can then label the back of their puzzle piece and write the facts that they just learned about it.
9) The cerebrum is divided into two hemispheres, the right and the left. It is divided down the middle from the top of your head to the bottom.
10) Next have the students locate the second largest puzzle piece which is the cerebellum. It is located at the lower back of the cerebrum and controls movement, balance and posture,
11) Have the students label and write what they have learned on the back of their puzzle piece.
12) The students should now look at the last piece, known as the brain stem. The brain stem connects the other two parts to the spinal cord. Mention also that it controls breathing, heart rate, digestion and blood pressure.
13) Students will now label and write what they have learned on the back of the puzzle piece.

Closure: Have students share what they learned about the brain today. On chart paper have students formulate questions about what they have learned and what they want to learn about the brain as we begin our study. Based on what they have learned about the brains' function, ask students why they think its important to keep their brain healthy and what may happen if they impose unhealthy habits on it, like, smoking, alcohol or drugs (Science Teacher Education Partnership Program, 2005).

Lesson 2- Daily Log

This lesson will allow students to better understand the role that the brain plays in their life. It will also help them to later understand that when stimulants then affect these parts of the brain, how their actions and bodily functions are altered.

Objective: Students will recognize how their daily activities are controlled by their brain function.

Materials: Mini journals 1 per student, Resources for Research: access to a library/ computer

Procedure: Have students complete a daily list of activities from the time they wake up until they go to bed. Students should do this for 1 week. Next, students should research what part of the brain controls the

functions necessary for each activity.

Closure: Students can share what they have learned about the brain as the main control center and how it affects their daily life (Science Teacher Education Partnership Program, 2005).

(Example of a table to be completed by students.)

Activity	What part of the brain controls this action?
Wake- Up	Circadian Rhythm in the Hypothalamus
Shower	Motor Cortex and the Cerebellum
Eat Breakfast	Cerebrum (5 senses) Brain Stem (digestion) Hypothalamus (appetite)
Walk to School	Motor Cortex, Parietal, Frontal and Temporal Lobes, Cerebellum
Sleep	Cortex and Circadian Rhythm in the Hypothalamus
Talking	Frontal and Temporal Lobes

Lesson 3- Build A Brain

Objective: Students will better understand the structure of the brain as they create their own model.

Materials: (the following recipe will make one brain, be sure to have enough that each student can create his/her own)

- 1.5 cups instant potato flakes
- 2.5 cup hot water
- 2 cups clean sand
- 1 gallon zippered bag

Procedure: Combine all of the ingredients in the zippered bag and mix thoroughly. It should weigh about 3 lbs. and have the consistency of a real brain

Closure: Have students share about what they learned about the brain, its weight, color, texture and size through making the model (Chudler, 2009).

Lesson 4 -Thinking Cap

Objective: The students will cover their brain with a thinking cap created from paper mache.

Materials: Newspaper, Plastic Bowl that fits the size of the students' head and Paste: White glue and water (about 2 parts glue to 1 part water), White flour, salt and water (1 to 1 consistency with a few tablespoons of salt), Liquid starch

Procedure: You will build your cap around the bowl. Cut strips of newspaper and glue them to the form using paper mache paste. Coat the newspaper strips with the paste, and place them on the bowl. Let each newspaper layer dry before you add a new layer. Add enough layers to give a strong structure. When the structure is dry, remove the underlying bowl. Finally, decorate the thinking cap by labeling the parts of the

brain in their appropriate space.

Closure: Students can share their thinking caps and in doing so explain the various parts of the brain and what each part controls. Students can use their tables to discuss as well (Chudler, 2009).

In order to truly appreciate this miraculous structure we must look at how the brain can function so well under difficult conditions that we impose on it. There is a tremendous balance of both excitation and inhibition forces running through it at all times. The inhibitory chemicals suppress the activity of nerve cells while excitation receptors accelerate the firing of nerve cells. In order to understand the necessity for this delicate balance and how drugs disrupt it, it's vital to understand the building blocks of the central nervous system (Kuhn, Swartzwelder and Wilson, 1998).

A Peak Inside

Twenty-four hours a day the brain is busy sending and receiving messages. These messages travel along a network of nerve cells that make up the nervous system (Freidman, 1990). The human brain is composed of billions of cells. Estimates suggest that there are between 100 billion and one trillion neurons in a single human brain. It sends and receives an immense number of messages every day along neurons. (Dupont, 1997). "A nerve cell, or neuron, is a cell that receives information from other nerve cells or from the sensory organs and then projects that information to other nerve cells, while still other neurons project it back to the parts of the body that interact with the environment, such as the muscles." (Bransford, Brown, and Cocking, 1999). Neurons are designed to receive, examine and send information to other neurons. The neuron is the fundamental building block of the nervous tissue in the brain and consists of three major parts: the cell body, the axon and the dendrites. The cell body houses genetic information in its nucleus. The axon extends from the neuron to make contact with other neurons and send messages. The dendrites are the neuron extensions that form a tree-like structure which is the input side of the neuron that receive messages from other nerve cells. Most of the excitatory information is passed into the cell through projections on the dendrites called spines. These neurons send messages to each other over a very small space between the axon and dendrite. This space between the neurons or gap is known as a synapse (Dupont, 1997). Synapses can be excitatory or inhibitory. The neuron then integrates the received information from the synapse and the output is determined.

Special chemicals send messages across these gaps. The chemicals, called transmitters, take messages from the axon of one nerve cell and send it to the receptors of another nerve cell. When the transmitters bind with the receptor the message is communicated. A cell may receive thousands of such messages in just a few seconds. For example, your eyes are composed of millions of nerve cells, yet the eyes don't really see pictures. They simply send electrical signals to the brain. The brain then receives the information from the nerve cells, examines it, and compares it to other information it already has, decides whether or not it's important enough to store in its memory and then uses the information to help us react to the outside world. This is one aspect of learning.

At birth the brain has only a small proportion of the trillions of synapses it will have. The rest of the synapses are formed after birth. A portion of this is guided through experiences. Synaptic connections are added in two ways. Some synapses are overproduced and then selectively lost. The brain does this in order to incorporate

information from experience, usually during the early periods of development. Another method is through the addition of new synapses. Synapse addition continues throughout life and is very important in later life. This process is driven by experience. After the cycle of synapse overproduction and selection runs its course, additional changes occur in the brain. This includes the modification of existing synapses and the addition of new synapses. Activity in the nervous system associated with learning experiences somehow causes nerve cells to create new synapses. This is unlike the process of synapse overproduction and loss. Synapse addition and modification are lifelong processes and they are driven by experience. "In essence, the quality of information to which one is exposed and the amount of information one acquires is reflected throughout one's life in the structure of the brain. This process is probably not the only way that information is stored in the brain, but it is a very important way that provides insight into how people learn" (Bransford...et all ,1999).

The neurons can not do this alone. They need a support group. The structures inside the brain are made up of about 100 billion neurons and trillions of support cells known as glia. Although the neurons are responsible for sending the messages they couldn't do it without the help of the glia cells. There are different types of glia cells that optimize brain function. The oligodendrocytes speed up the electrical signal that is traveling down the axon. Microglias are immune cells that detect damaged neurons and infections. The astrocytes keep the neurons in place, and assist in the transport of nutrients. They also communicate and modify signals between the neurons. Each astrocyte can interact with several neurons and thousands of synapses to properly integrate information (National Institute of Health, 2009).

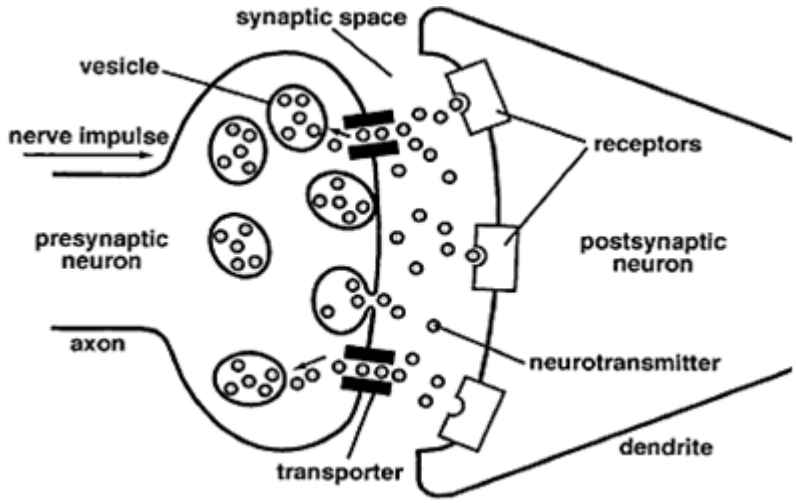

Figure 3: "Schematic diagram of a synapse. In response to an electrical impulse, neuro-transmitter molecules released from the presynaptic axon terminal bind to the specific receptors for that neurotransmitter on the postsynaptic neuron." Courtesy of National Institute of Health.

Lesson 5 - Build a Neuron

Objective: The students will understand the structure of a neuron by creating a model of one that can later be used to demonstrate a synapse.

Materials: 5 different colors of pipe cleaners: one color each for the dendrites, cell body, axon, myelin sheath and synaptic terminal. (1 set per student) scissors

Introduction: Show students the diagram of a neuron. Point out the main structures: axons, dendrites, cell body and myelin sheath. Emphasize the unique shape of the nerve cell - long and thin. Ask students what the

main job of a nerve cell is. (Receiving and transmitting messages.) What do we use in everyday life to communicate with people across town or across the country? (Telephone, People and Computers) How is the signal sent? (Over a long, thin wire.). Review that nerve cells do not actually touch one another, but that there are tiny gaps between nerve cells called synapses. Neurons produce powerful chemicals that are released into the synapse as a message is being sent from one cell to the next. The neurotransmitter is released by an axon. It crosses the synapse and attaches to a receptor on the other side. Dendrites sprout to make connections with other neurons. This is one of several mechanisms involved in learning.

Procedure:

1. Take one pipe cleaner and roll it into a ball. This is will be the cell body.
2. Take another pipe cleaner and attach it to the new "cell body" by pushing it through the ball so there are two halves sticking out. Take the two halves and twist them together into a single extension. This will be the axon.
3. Take other pipe cleaners and push them through the "cell body" on the side opposite the axon. These are dendrites. These can be shorter than your axon and you can twist more pipe cleaners to make more dendrites
4. Wrap small individual pipe cleaners along the length of the axon. These will represent the myelin sheath.
5. Wrap another pipe cleaner on the end of the axon. This will be the synaptic terminal (Chudler, 2009).

Closure: The students can share their creations with the class all the while explaining the parts of a neuron and how they communicate with each other. For further demonstration of a synapse check out this website and watch the animation with the class. It explains how neurons communicate as well as gives an animated visual to ensure comprehension. http://learn.genetics.utah.edu/content/addiction/reward/neurontalk.html

This Is Your Brain on Drugs

Both legal and illicit drugs may affect the ability of the brain to learn. There are three ways in which drugs affect memory. They first prevent learning by impairing the brain's ability to store information. Secondly, they cause distortions of reality that have such a powerful effect that they are stored and are either recalled as good or bad experiences. Third, there is slight evidence that shows small amounts of chemicals can actually increase learning. The most common effect of several common drugs is to suppress learning (Rankin, 1975).

Merriam Webster defines 'drug' as "a substance intended for use in the diagnosis, cure, mitigation, treatment, or prevention of disease, 2) a substance other than food intended to affect the structure or function of the

body and 3) often an illegal substance that causes addiction, habituation, or a marked change in consciousness" (Merriam Webster, 2009). In accordance with Webster's first definition, there are a few drugs that which alter the functions of our body and brain in a positive and necessary manner.

Aspirin

Aspirin is one of the most common over the counter drugs. It is in a group of drugs known as salicylates. It works by reducing fever, and inflammation. Aspirin often treats mild to moderate pain. It can also be used to prevent heart attacks, strokes and chest pain when under a physicians care. Side effects that may occur include nausea, swelling, and blood in stool or ringing in your ears. It is able to reduce fever and inflammation by attaching itself to an enzyme called cylooxygenase-2. This enzyme then makes chemicals called prostaglandins which send signals to the brain to tell it that there is pain in a certain area where damage to cells has occurred. It also creates a cushion around the damaged cells to prevent further damage which causes inflammation. When aspirin is attached the enzyme, it does not produce as many prostaglandins causing the brain to not register as much pain in that area which then reduces inflammation (Orwell, 2009).

Ritalin

Ritalin is a stimulant medication prescribed to treat attention deficit hyperactivity disorder. Its success is based on its ability to "fine-tune the functioning of neurons in the prefrontal cortex- a brain region involved in attention, decision making and impulse control" (Science Daily, 2008). By increasing dopamine levels in the brain, the user is given a feeling similar to a "high" in order to better help him/her focus on the task at hand. It also lessons the firing of neurons not associated with the task so to prevent the brain from becoming distracted and increasing the brains ability to transmit a clear signal.

Ritalin has not been proven to be effective for children under the age of six years old. Ritalin use must be closely monitored since long term use can have significant side effects such as decreased appetite, vomiting, nervousness, insomnia, an increase in blood pressure, heart palpitations, dependence and depression upon withdrawal (Science Daily, 2008).

Penicillin

Penicillin is an antibiotic that destroys bacteria by attacking the cell well. It inactivates an enzyme called transpeptidase that is responsible for linking bacterial cell walls. Once the cell wall construction is ceased the bacteria dies. Despite high levels of penicillin in the blood, low concentrations of this drug are found in cerebrospinal fluid which implies that penicillin is blocked from entering the brain.

This is because of the blood-brain barrier. The brain is protected by a thin barrier that prevents certain toxic substances in the blood from reaching the brain. The blood-brain barrier "has transport systems that move substances the brain needs across the barrier to brain tissue" (Goldman, 2007). The cells that form the capillary walls in the brain are tightly sealed. Capillaries are small blood vessels where nutrients and oxygen are exchanged between the blood and tissues. This barrier limits the types of substances that can pass into the brain. Penicillin as well as many chemotherapy drugs, and most proteins cannot pass into the brain, unlike substances such as alcohol, caffeine, and nicotine that pass into the brain freely (Goldman, 2007).

Caffeine

Caffeine can be found in coffee, tea, chocolate and cola soft drinks. It can also be found in some medications.

It is naturally produced in the leaves and seeds of many plants. It can also be made artificially and is sometimes added to other foods. Caffeine is a stimulant. Stimulants are drugs that cause a sense of energy, alertness and well being that users find pleasurable. Simultaneously, the user will experience increased heart rate and blood pressure as well as dilation of the respiratory passages in the lungs. At low to moderate doses people will feel an increased alertness and ability to concentrate, while higher doses may result in nervousness and agitation. Some symptoms of overdose may include tremors, nausea, vomiting, irregular or rapid heart beat and confusion. Since caffeine is a stimulant, when it's combined with other medications it can increase their effect (Kuhn... et all, 1998).

In addition to these symptoms, caffeine affects the brain. At moderate doses about 200 milligrams which is equal to about two cups of coffee, electroencephalograph (EEG) studies indicate that the brain is aroused. Higher doses of 500 milligrams increase heart rate and breathing. When these centers are activated blood vessels in the brain are narrowed. Dependence on caffeine can develop and when users try to stop they generally suffer from fatigue and headaches.

In small children, toxic effects may be observed with consumption of 800 milligrams for a 50 pound child which is equivalent to 4 Caffeine pills or 7 cups of coffee. Although most parents do not let their children drink coffee, some don't realize the how much caffeine their children drink through soft drinks. Children should not consume more that 45 milligrams which is about the same amount found in a 12 oz cup of soda or a chocolate bar. It is necessary to limit the amount of caffeine that is consumed by children for other reasons, notably the high amounts of sugar in soda drinks. Because caffeine is a diuretic, it can contribute to dehydration which effects learning. Below is a chart with information about the amount of caffeine in common drinks, chocolate and pain relievers.

Items	Amount of Caffeine
Jolt soft drink (12 ounces)	71.2 mg
Mountain Dew (12 ounces)	55.0 mg
Coca-Cola (12 ounces)	34.0 mg
Diet Coke (12 ounces)	45.0 mg
Pepsi (12 ounces)	38.0 mg
7-Up (12 ounces)	0 mg
5 ounces of brewed coffee	115 mg
iced tea (12 ounces)	70 mg
dark chocolate	20 mg
milk chocolate (1 ounce)	6 mg
chocolate milk beverage (8 ounces)	5 mg
cold relief medication (1 tablet)	30 mg

(The Nemours Foundation, 2009)

Lesson 6 - How does caffeine affect you?

Objective: Students learn more about how a drug, caffeine, affects their body.

Materials

Preparation: Before beginning this investigation, be sure to have permission forms signed by parents or guardians for the students to drink either a caffeinated or caffeine-free soft drink. Those students who do not

have permission can participate in the investigation by drinking water, thereby providing a comparison or second control for the activity. Several days prior to conducting this activity decide which students will be in which group. Tell students which group they will be a part of if you are asking them to bring a can of soft drink to class. Approximately half of the class should be assigned to each group.

Introduction: Caffeine is a mild stimulant contained in coffee and some soft drinks. People often report that mild doses of caffeine increase their alertness and their ability to concentrate. Higher doses can cause a person to feel jittery or nervous. High doses can cause sleeplessness.

Procedure:

1) Teach students how to find their pulse, count their heartbeats, and calculate their resting heart rate. A student can find his or her pulse most easily by pressing two fingers against the artery in the neck or on the inside of the wrist. It is easiest to count for 15 seconds and then multiply that number by four to obtain the resting heart rate for one minute. Students should repeat the process several times until they get a consistent resting heart rate. . Students should record their data on chart paper.
2) Students can work in pairs. Distribute cans of the appropriate soft drink, one to each student. Instruct students to then drink their beverage. Students will then track their heartbeat in a table by taking their pulse 5 minutes after drinking the beverage, 15 minutes later and finally 45 minutes after drinking the beverage. This is because caffeine concentration is at its highest, 15-45 minutes after ingestion.

Closure: When all the students have filled in their data tables and calculated the difference between their resting heart rate and their heart rate after drinking a soft drink, discuss their findings by asking

- °¤ Did your heart rate go up, down, or stay the same after you drank a caffeinated soft drink?
- °¤ If you drank a caffeine-free soft drink, how did your heart rate change?
- °¤ What happened if you drank water?

On average, most students will see their heart rate go up after drinking the caffeinated soft drink 15- 45 minutes following ingestion. (National Institute of Health, 2000).

Nicotine

Unlike caffeine, as soon as nicotine enters the body, through the lungs, it immediately travels through the bloodstream to the brain where it is then delivered to the rest of the body. Nicotine is a chemical found in tobacco. Tobacco is a plant that can be smoked in cigarettes, pipes or cigars. It is also found in smokeless tobacco. Nicotine is a specific type of stimulant that increases attention, concentration and possible memory. It is reported that it sometimes has a calming or anti-anxiety affect. Nicotine stimulates the heart and circulation. When combined with other drugs it can cause problems with heart rate and blood pressure as well as reduce the amount of oxygen-carrying capacity in the blood. Combinations of these types of drugs can

cause heart attacks. Nicotine and other poisonous chemicals found in tobacco can cause heart disease and cancer. Overdose from nicotine, although rare is possible. Such symptoms would include tremors and convulsions that could paralyze muscles need for breathing. Other effects include dizziness, weakness and nausea. Nicotine is very harmful for women who are pregnant because it reaches the fetus and can cause permanent damage (Kuhn… et all, 1998).

Nicotine affects the brain by stimulating receptors that are widely distributed on nerve cells throughout the brain. Nicotine excites nerves cells which increases signaling from cell to cell. Some studies have shown that it increases the brain activity in regions associated with memory as well as physical movement, but he detrimental effects are far worse (Kuhn… et all, 1998).

When tobacco is smoked, nicotine is absorbed by the lungs and quickly moved into the bloodstream, where it is circulated throughout the brain. Nicotine reaches the brain within 8 seconds after someone inhales tobacco smoke. Nicotine can also enter the bloodstream through the mucous membranes that line the mouth, nose and even through the skin.

Nicotine affects the entire body. Nicotine acts directly on the heart to change heart rate and blood pressure. It also acts on the nerves that control respiration to change breathing patterns. In high concentrations, nicotine is deadly. The nicotine molecule is shaped like a neurotransmitter called acetylcholine. Acetylcholine and its receptors are involved in many functions, including muscle movement, breathing, heart rate, learning, and memory. They also cause the release of other neurotransmitters and hormones that affect your mood, appetite and memory. When nicotine gets into the brain, it attaches to acetylcholine receptors and mimics the actions of acetylcholine (National Institute on Drug Abuse, 2009).

Nicotine activates areas of the brain that are involved in producing feelings of pleasure and reward. Nicotine raises the levels of a neurotransmitter called dopamine in the parts of the brain that produce these feelings. Dopamine is the same neurotransmitter that is involved in addictions to other drugs such as cocaine and heroin (National Institute on Drug Abuse, 2009).

Alcohol

Alcohol is a hypnotic sedative. When alcohol is first consumed, most people feel pleasure or relaxation. After about an hour some become talkative but quickly turns drowsy as the alcohol is eliminated from the body. Some want to keep the feeling of pleasure so they continue to drink. People can become very sick and even die when too much alcohol is consumed too fast. After someone has fallen asleep, the alcohol consumed prior to losing consciousness will continue to be absorbed by the body. The amount of alcohol in their blood can reach dangerous levels and the person can die in their sleep. If a person becomes unconscious and vomits, their airway may become blocked which can cause them to suffocate and die. A person's body type can determine how the alcohol is distributed throughout the body. A heavier person would show a lower blood alcohol level in their blood but retains the alcohol longer than a leaner person. Both the alcohol concentration as well as the presence or absence of food will influence the effects of alcohol (Kuhn… et all, 1998).

Once alcohol has been absorbed and distributed, it has many effects on the brain and behavior. Alcohol changes the neurons' membrane and opens the potassium and chloride channels at synapse. It temporarily quiets the brain by reducing worry and tension. It can even suppress a panic attack until the level of alcohol begins to decline. This then causes an over stimulation of brain mechanisms. This over excited brain can then cause anxiety, sleeplessness delirium tremens and epileptic seizures. Alcohol also affects the dopamine, norepinephrine, and serotonin neurotransmitter systems in the brain (Dupont, 1997). Because alcohol is a

depressant, it first affects the higher functions of the brain including self observation and self criticism. Anger and irritability is often released after only a small amount of alcohol. In higher doses, alcohol; produces a lack of coordination and upsets the digestive process. Alcohol triggers the brains' vomiting mechanism and irritates the lining of the stomach. Alcohol can cause amnesia.

Ecstasy

Ecstasy also referred to as methylenedioxymethamphetamine (MDMA.) It typically produces drowsiness, a loss of inhibition and a distortion of sense, time and distance. It often intensifies a persons' mood from euphoria to anxiety. "Users often claim they feel uniquely connected to the world and an unusual muscular restlessness" (Dupont, 1997).

After effects like exhaustion, depression, fatigue nausea and numbness is a reflection of long term serotonin deficiencies in the users' brain. Ecstasy affects many of the brain neurotransmitter systems at the synapse, by its ability to increase levels of dopamine, norepinephrine and serotonin (Kuhn… et all, 1998). It's the increase of serotonin levels at the synapse that causes a unique positive feeling of empathy and a decrease in aggression. The range of neurotoxicity is based on how long and how much it has been used.

Marijuana

Marijuana is a green, brown, or gray mixture of dried, shredded leaves, stems, seeds, and flowers of the hemp plant. Marijuana first relaxes a person and then elevates their mood. This period is followed by drowsiness and sedation. Marijuana impairs judgment, coordination and increases the heart rate. THC (delta-9-tetrahydrocannabinol), is the main active chemical in marijuana as well as more than 400 other chemicals. Marijuana's effects on the user depend on the amount of THC it contains. Heavy or daily use of marijuana affects the parts of the brain that control memory, attention, and learning. It inhibits memory formation and the ability to store these memories due to its profound damage to the hippocampus (National Institute on Drug Abuse, 2009).

Lesson 7- Marijuana Activity 1

Objectives: The student will understand the effects of marijuana on the brain structures that control the five senses, emotions, memory, and judgment.

The student will use knowledge of brain-behavior relationships to determine the possible effects of marijuana on the ability to perform certain tasks and occupations.

Activity: Review the way marijuana use affects brain regions and structures that control the five senses, heart rate, emotions, memory, and judgment. Students will then randomly select (for example, draw from a hat) an occupation and be asked to act out, in front of the class, how marijuana use might specifically affect the performance of a person in that occupation. (airline pilot, professional basketball player, doctor, truck driver, construction worker, waiter/ waitress, politician.) Students will identify the brain regions and structures affected by marijuana use, and describe the link between these structures and behavior (National Institute on Drug Abuse, 2009).

Lesson 8- Marijuana Activity Two

Objective: The student will understand how marijuana interferes with information transfer and short-term memory.

Activity: Read aloud a list of 20 words to the class; then ask the students to write down as many words as they can remember. Next, have several students, stand in pairs around the room and carry on loud conversations while you read another list of 20 words to the remainder of the class. Ask students once again to write down as many of the words as they can remember. Compare the performance of the two trials. Tell the students that, like the disruptive pairs of students, marijuana interferes with normal information transfer and memory. Students will then identify the areas of the brain and structures responsible for these functions and will be reminded that marijuana alters neurotransmission in these areas. Students can also search the Internet and other sources for more research into the effects of marijuana on information transfer and memory, and then prepare a brief report summarizing their findings (National Institute on Drug Abuse, 2009).

Heroin

Heroin is in the drug class, opiate. People who inject opiates experience a rush of pleasure then enter a dreamy state and have little sensitivity to pain where all cares are forgotten. Some side effects include slowed breathing, constipation and pinpoint pupils. Opiates elicit their effects by activating opiate receptors that are widely distributed throughout the brain and body. When it reaches the brain, it activates the opiate receptors and produces an effect that correlates with the area of the brain involved. Two important effects produced by opiates, such as morphine, are pleasure and pain relief. The brain also produces substances known as endorphins that activate the opiate receptors. Endorphins are involved in respiration, nausea, vomiting, pain modulation, and hormonal regulation.

Opiates activate the brain's reward system. When a person injects, sniffs, or orally ingests heroin, it travels to the brain through the bloodstream. Heroin then activates opiate receptors in the brain which results in feelings of reward or pleasure (National Institute on Drug Abuse, 2009).

Opiates also act on the respiratory center in the brainstem. This causes a decrease in breathing rate. Excessive amounts of an opiate, like heroin, can cause the respiratory centers to shut down breathing. When someone overdoses on heroin, it is the action of heroin in the brainstem respiratory centers that can cause the person to stop breathing and die (National Institute on Drug Abuse, 2009).

Cocaine

Cocaine is considered a stimulant. It immediately causes a surge of energy and alertness, by stimulation of the nervous system. This results in increased heart rate, blood pressure and dilation of the breathing tubes in your lungs. It also causes an intense feeling of euphoria (Kuhn… et all, 1998).

Cocaine changes brain function by changing the way nerve cells communicate. One of the neurotransmitters affected by cocaine is dopamine. Once dopamine has attached to a nerve cell's receptor and caused a change in the cell, it's pumped back to the neuron that released it. But cocaine blocks the pump, called the dopamine transporter. Dopamine then builds up in the gap (synapse) between neurons. Dopamine will continue to affect a nerve cell after it should have stopped. Cocaine also causes the body's blood vessels to become narrow and constricts the flow of blood. The heart is then forced to work harder to pump blood through the body. The heart can even temporarily lose its natural rhythm, called fibrillation. Many of cocaine's effects on the heart are actually caused by cocaine's impact on the brain (Kuhn… et all, 1998).

Initially, cocaine may make someone feel pleasure. Later it can damage the ability to feel pleasure. Long-term cocaine use may reduce the amount of dopamine or the number of dopamine receptors in the brain. Nerve cells, then must have cocaine to communicate properly. Without the drug, the brain can not send enough

dopamine into the receptors to create the feeling of pleasure (Kuhn… et all, 1998).

Steroids

Anabolic steroids are artificial versions of the hormone testosterone. The body's testosterone production is controlled by a group of nerve cells at the base of the brain, in the hypothalamus. The hypothalamus helps control appetite, blood pressure, moods, and reproductive ability. While steroids are used to increase physical strength, they inhibit the immune system making you more susceptible to sickness. The ultimate problem lies in the mental damage that they create. Anabolic steroids can change the messages the hypothalamus sends to the body and can disrupt normal hormone function. They can also lead to liver damage or cancer. They can also permanently stop bones from growing. This means that a young steroid user may not grow to be his or her full adult height (National Institute on Drug Abuse, 2009).

Anabolic steroids also affect the part of the brain that influences mood, memory and learning. They cause feelings of irritability and depression. Often steroids will cause aggressive behavior. The effect may wear off, but it has long term consequences on the developing brain. This outward aggression is correlated with inner changes in the brain. This is because the neurotransmitter levels in the brain's aggression control region are activated. Neuroscientists have found that steroid use as a teenager can cause serious behavioral changes well into adulthood (American Psychological Association, 2009).

The Addict's Brain

"Addiction is the repetitive, compulsive use of a substance that occurs despite negative consequences to the user" (Kuhn… et all, 1998). Addictive drugs will activate circuits in the brain that usually respond to 'normal' pleasures such as food. Developing an addiction to drugs depends on many factors in the life of the user like, family history, personality, mental health and life experiences. The actual drug taking is maintained by factors including changes in the brain as well as the deep desire to experience pleasure from the drug and avoid the discomforts of withdrawal (Kuhn… et all, 1998).

Both psychological and physical dependence occurs in people who are addicted to drugs. Addiction is so powerful because it mobilizes basic brain functions that are necessary for survival. These neural circuits exist in all people. The neural circuit causes people to enjoy life sustaining activities. When a person experiences pleasure, he/ she is likely to repeat this activity. This neural circuit is often known as the reward pathway. When this pathway is destroyed a person loses interest or motivation in pleasurable life sustaining activities. Addictive drugs act as activators of the pleasure pathway in the brain. Stimulants like opiates, alcohol and nicotine may act as a substitute for natural pleasures like food (Kuhn… et all, 1998).

Addiction is considered a brain disease because it changes these structures in the brain as well as how it works. It does this by disrupting the normal, healthy functioning of the brain. Although harmful, addiction is both preventable and treatable. Drugs target the reward system or "pleasure pathway" by increasing the release of dopamine. An excess of dopamine produces a "high" that makes the user feel good. This feeling often leads to repetitive behavior. The reward pathway is responsible for making sure that you repeat a behavior whenever possible by connecting to regions of the brain that control memory and behavior. The reward pathway also signals the brains motor center and strengthens the "wiring" to help you achieve the

reward, i.e. repeat the pleasurable experience. Over time the brain begins to adjust so that it can no longer experience pleasure in natural ways, it needs the drug in order to feel good. The lack of being able to feel natural pleasure is often what makes it so hard for an addict to give it up (Scholastic, 2009).

The Brain and Nutrition - Keeping your Brain Healthy

We know that drugs and other substances alter the way neurons communicate with each other which in turn affects how we live via our learning, memories, experiences and physical well being. Just as it is important to know what not to put into our bodies, we should know what vital substances our bodies need for optimal functioning.

The brain requires twenty percent of our oxygen to operate properly. A person's nutritional intake can substantially affect brain function, mood and behavior. Brain chemistry and neural functioning is influenced by food intake, so deficiencies or excess amounts of vitamins and minerals also may impair function. The brain requires certain materials to function well, like sugar vitamins and minerals. Our brain produces essential proteins and fatty acids to grow and maintain connections between the neurons and to add myelin to axons (Brain Guide, 2007).

When it comes to energy consumption the human brain is very demanding. Energy is represented by the calories in food. The brain uses about 20 to 30% of a person's energy intake. When people don't consume enough calories in their diet they are more likely to experience changes in brain functioning. Simply by skipping breakfast, research shows a reduced verbal fluency, lower ability to solve problems and the lack of motivation.

Continual hunger via starvation, severely affects mental responsiveness. The body responds by slowing down most non-essential functions like hormonal levels, oxygen transportation and immune efficiency. People with a continual low energy feel apathetic, sad and depressed (Brain Guide, 2007).

Some fats are essential for proper brain function. Two lipids that are critical to the brain are the n-6 and n-3 fatty acids. Low levels of n-3 may cause visual problems by badly affecting the retina. Diets without n-3 fatty acids cause learning and motor disabilities and may damage systems that use the neurotransmitters dopamine and serotonin in the frontal cortex. The n-6 fatty acids affect neurotransmitter release and contribute to the ability of neurons to use glucose for energy (Brain Guide, 2007).

Diet and the Neurotransmitters

Certain foods contain starting materials for neurotransmitters. "If a diet is deficient in these precursors, the brain will not be able to produce some neurotransmitters. Neurological and mental disorders may then occur if the balance of neurotransmitters is upset" (Chudler, 2009). Examples of neurotransmitter precursors are aspartic acid which is found in peanuts, potatoes, eggs and grains, choline which is found in eggs, liver and soybeans, glutamic acid, as found in flour and potatoes, phenylalanine which is used to make dopamine and is found in beets, soybeans, almonds, eggs, meat and grains, tryptophan which is used to make serotonin; found in eggs, meat, skim milk, bananas, yogurt, milk, and cheese and tyrosine which is used to make norepinephrine and is found in milk, meat, fish and legumes (Chudler, 2009).

Diet and Brain Function

Including certain foods in your diet can help improve brain function. Foods like raisins, berries, apples, grapes, cherries, prunes, and spinach are high in antioxidants and can dramatically reverse memory loss, restore motor coordination and balance. Another healthy group of foods such as salmon, mackerel, sardines, herring, flax oil, and walnuts contain omega-3 fatty acids. Omega-3s help improve general brain functioning and restore memory. (Carper, 2000).

The body runs on carbohydrates, although too much simple carbohydrates can be harmful to the body and brain functioning because they create a sharp rise in blood sugar. Complex carbohydrates like peanuts, dried apricots, dried beans, yogurt, oat bran, and sourdough bread digest well and will not produce rapid increases followed by rapid decreases in blood sugar. (Carper, 2000).

Sugar needs to be taken in moderation. Eating too much sugar can lead to insulin resistance. This upsets the glucose level in the blood which may lead to permanent damage to brain cells (Carper, 2000).

There are some types of fat that are not good for the brain. Polyunsaturated fats of the kind found in safflower, sunflower and corn oils, set up chronic inflammatory responses in brain tissue and may foster blood damage. They are also harmful to blood vessels and ultimately blood circulation. These oils are also found in processed foods such as salad dressings, fried foods, doughnuts and most margarine (Carper, 2000).

A daily dose of a variety of vitamins and minerals is necessary for ideal brain functioning. Ideally it's best to consume these vitamins and minerals through diet. If the recommended dose is not met through diet it is recommended to take a supplement. "According to some research studies, between one third and one half of school children who took a multivitamin-mineral supplement raised their non-verbal IQ scores as much as 25 points" (Carper, 2000).

Implementing District Standards

This unit will be integrated directly through language arts and technology to meet CT Health and Science Standards such as: 1) Students will demonstrate the ability to use decision-making skills to enhance health. 2) Students will demonstrate the ability to advocate for personal, family and community health. 3) Students are provided with multiple opportunities to experience inquiry investigations that develop students' abilities to question, explore, observe, gather simple data, draw conclusions based on the data and build their understanding of natural phenomena. Additionally, this unit is aligned with New Haven Pubic Schools goals for students which say "What students learn in school must be relevant to the world in which they live. The learning that takes place in schools is not only academic, but also social and personal. It is profound and must be relevant to the world in which they live." This unit will therefore prepare me to better integrate subjects to fully develop one topic as well as help me to give students a "greater purpose" for learning about how and why it's important to keep the brain healthy because it directly affects their lives.

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