

UNIT THREE

COMMUNICATION IN THE NERVOUS SYSTEM

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SUMMARY	KEY POINTS	UNIFYING CONCEPTS*
<p>REACTION TIME</p> <p>Students work in pairs to measure their reaction time in a simple “ruler drop” experiment. The pathways through which messages are transmitted through the nervous system are illustrated with this experiment.</p>	<ul style="list-style-type: none"> • Students use the scientific method and do an experiment. • Several parts of the nervous system send messages with amazing speed to perform even the simplest tasks. • Catching a ruler involves a discreet neural circuit. 	<ul style="list-style-type: none"> • Students gain insight into Science as a Human Endeavor.* • Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.* • Explain how health is influenced by the interaction of body systems.**
<p>NEUROTRANSMISSION FELT KIT</p> <p>Students work with felt cutouts to create a model of a neuron. They use the model to illustrate the process of neurotransmission. The nerve circuits involved in the reaction time test are explained in the context of neurotransmission.</p>	<ul style="list-style-type: none"> • Communication within the nervous system occurs through the process of neurotransmission. • Neurotransmission is a sequence of events involving chemical & electrical processes. • All thoughts, feelings and movements involve communication among neural circuits. 	<ul style="list-style-type: none"> • In something that consists of many parts, the parts usually influence one another. • Specialized cells perform specialized functions in multicellular organisms.* • <i>Communication between neurons in the basis for thought and behavior.</i> • Describe the basic structure and functions of human body systems.**
<p>NEUROTRANSMISSION DANCE</p> <p>Students review neurotransmission by acting out the steps of the process in a dance. Percussion instruments provide sound effects for each step.</p>	<ul style="list-style-type: none"> • This lesson is an engaging reinforcement of the concepts introduced in the previous lesson. 	<ul style="list-style-type: none"> • Models are often used to think about processes that happen too slowly or too quickly to be observed.*
<p>ALCOHOL REACTION TIME DANCE</p> <p>Effects of alcohol on reaction time are illustrated with the neurotransmission dance. Students appreciate that brain chemistry is a delicate and powerful part of behavior.</p>	<ul style="list-style-type: none"> • There are excitatory and inhibitory neurotransmitters that affect the functioning of neurons. • Alcohol affects reaction time by altering neurotransmission. 	<ul style="list-style-type: none"> • Alcohol and other drugs are often abused substances. Such drugs change how the body functions and can lead to behavioral problems and addiction. • Tobacco, alcohol, other drugs, can harm human beings and other living things.* • Describe the relationship between personal health behaviors and individual well-being.**
<p>BRAIN DEVELOPMENT</p> <p>Students create neurons of different developmental stages using Scratch Lite™. Neurons are assembled into a network on a window or wall.</p>	<ul style="list-style-type: none"> • Dendritic structure gets more complex during development as more synaptic connections are formed. • The brain grows substantially from birth to adulthood. This growth involves increasing complexity of individual cells, not creating more cells. 	<ul style="list-style-type: none"> • Plant and animal life cycles include being born and developing into adults. (This includes the growth and development of the brain.) • Describe the basic structure and functions of human body systems.**

* Source: National Science Standards
 ** Source: National Health Standards

LESSON 7

Lesson Overview

Engage (5 minutes) Introduce Gravity

- With the help of a student volunteer, demonstrate to the class how a ruler can be dropped and caught. Ask students, “What made the ruler fall?”
- Get students to think critically about what draws objects toward the earth. What is gravity and how does it affect falling objects?

Explore: (10 minutes) Galileo’s Law of Free Fall

- Hold a book and a piece of paper (not crumpled) high above the floor. Ask students to make a hypothesis about which object will hit the floor faster. Do all objects fall at the same speed every time? Drop and retrieve the paper and book.
- Crumple the paper and then ask the students to guess which one will reach the floor first. Drop the book and paper again.
- Discuss air resistance. In the absence of air resistance, all objects fall at the same speed.
- At their desks, have students compare a heavy and a light object and make predictions about which object will fall faster.



Supplies: rulers for student pairs, class chart with milliseconds and handouts, one per student. Use side one for recording results. **Copy Experimental Procedure sheet of instructions to the back.** **Optional:** a stopwatch (For demonstration at the beginning. Attempt to record how fast the ruler is caught using a stopwatch and observe that we cannot hit the stopwatch fast enough.)

REACTION TIME

Explain: (20 minutes) Reaction Time Sequence

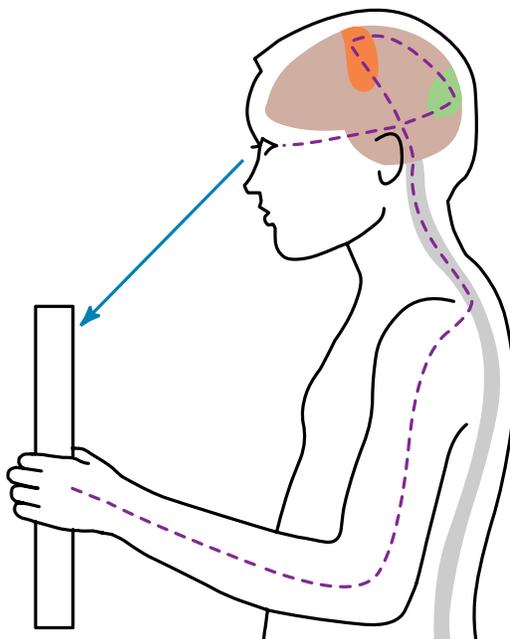
- Introduce Galileo's Law, which states that all objects fall at the same speed despite their mass (neglecting air resistance).
- Bring out the ruler again and ask a student volunteer to come up to the front of the class. Instruct the student to catch the ruler as it is dropped.
- After the ruler is caught, ask the student:
 - “Why was the ruler caught in the middle (after a lag period) rather than at the end (instantaneously)?
 - “What causes this hesitation?”
 - “What had to happen in my body for me to catch the ruler?”
- Have students predict the sequence of events involved in the reaction time pathway.
- Ask students what had to happen for you to grab the ruler after it dropped.
- Demonstrate visually the process using the REACTION TIME POSTER. Use the dry erase marker to draw the reaction pathway:
 - The eye sees the ruler drop.
 - The eye sends a message to the visual cortex.
 - The visual cortex sends a message to the motor cortex.
 - The motor cortex sends a message to the spinal cord.
 - The spinal cord sends a message to the hand/finger muscle.
 - The finger muscle contracts to catch the ruler.

Evaluate: (5 minutes) Reaction Time Sequence Worksheet

- Distribute the worksheet and have students complete the top portion by writing the 5 key words from the word box in the correct order.
- Have students complete the lower portion of the worksheet. They must write a short paragraph detailing the reaction 6 components of the sequence listed above.
- Collect student work and select students to share their paragraphs during the following lesson.

Vocabulary:

Gravity
Constant
Rate (distance/time)
Galileo
Visual Cortex
Motor Corte
Nervous System
Reaction Time



Background

Reaction Time

The first lesson of this unit introduces a process that we will look at in greater and greater detail throughout the course of the unit. How someone catches a ruler involves a significant sequence of events that involves the sending and receiving of messages through the nervous system.

Galileo deduced that bodies falling freely in a vertical direction have uniform acceleration, and in the absence of air resistance, all bodies fall with the same constant acceleration regardless of their mass. Reaction times can be calculated manually, but because they can occur in milliseconds, it is easier to use a mathematical formula developed by scientists to calculate reaction times based on the distance that an object is dropped before it is caught. The reaction times can be measured in this manner because an object falls at a predetermined rate.

The neural pathway involved in the reaction time experiment involves a series of neural processes. Catching the ruler begins with the eye watching the ruler in anticipation of it falling. After the ruler is dropped, the eye sends a message to the visual cortex, which perceives that the ruler has fallen. The visual cortex sends a message to the motor cortex to initiate catching the ruler. The motor cortex sends a message to the spinal cord, which then sends a message to the muscle in the hand/fingers. The final process is the contraction of the muscles as the hand grasps the ruler. All of these processes involve individual neurons that transmit electrochemical messages to other neurons. The details of neurotransmission will be discussed in later lessons. When comparing hands, students will usually find that their dominant hand is faster. The increased speed is evidence that one hand has greater dexterity than the other. Or, simply put, one hand is more skilled. Because the dominant hand is used more often, the neurons that carry messages between that hand and the brain are faster at transmitting electro-chemical signals. They are communicating along well-worn pathways. By running the same messages along the same pathway repeatedly, students can improve their motor skills. The phrase “practice makes perfect” is scientifically accurate! Go ahead and encourage your students to practice skills they wish to hone.

Name _____

Class _____

EXPERIMENTAL PROCEDURE

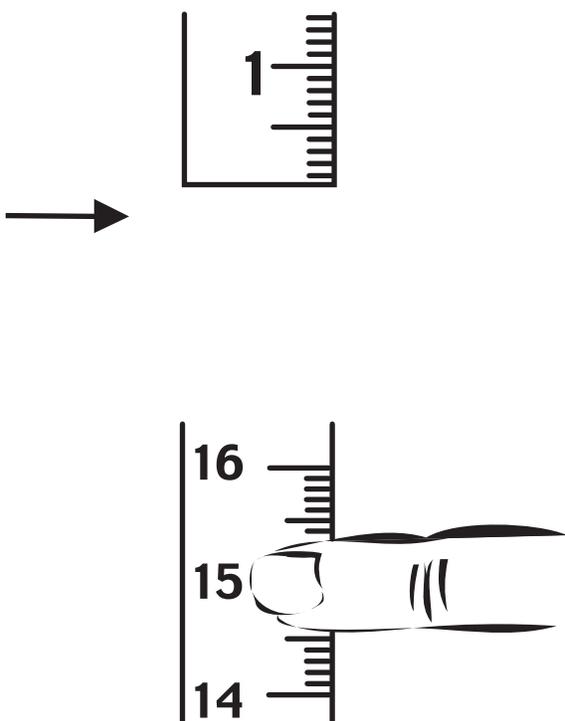
Instructions:

Be sure to start at Zero.
Rest the ruler just above the
thumb and forefinger of the person
catching, and do not tell them-
when you will drop the ruler.

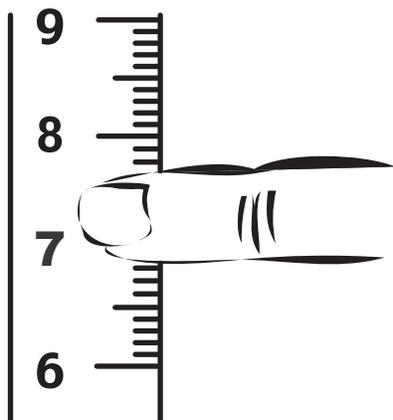
It is important that everyone use
the same **method** if you are to
compare results.

When reading where you caught
the ruler, either:
1) round to the nearest whole
number, or
2) Choose the nearest whole num-
ber above your finger.

Again, it is important that every-
one use the same **method** if you
are to **compare results**.



EXAMPLE: What would be the result for the catch below? Take a guess, then read the answer.



For example, if rounding to the
nearest whole number, then this
person would record that they
caught the ruler at 7 centimeters.

If using the nearest number *above*
the finger, then they would record
8 centimeters.

Reaction Time Experiment: Summary



Step 1: Describe experiment and decide on procedures as a class.

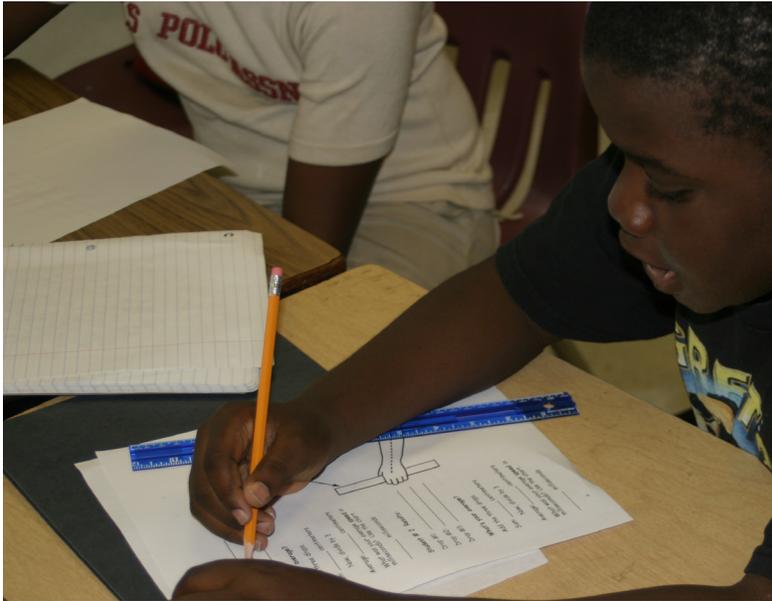
Step 2: Student pairs take turns dropping and catching the ruler.



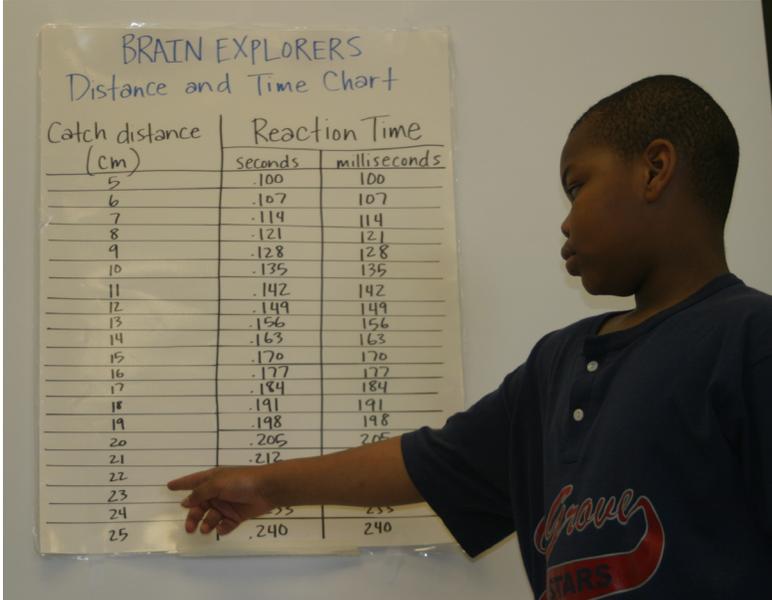
Step 3: Students read and record results of three consecutive drops.



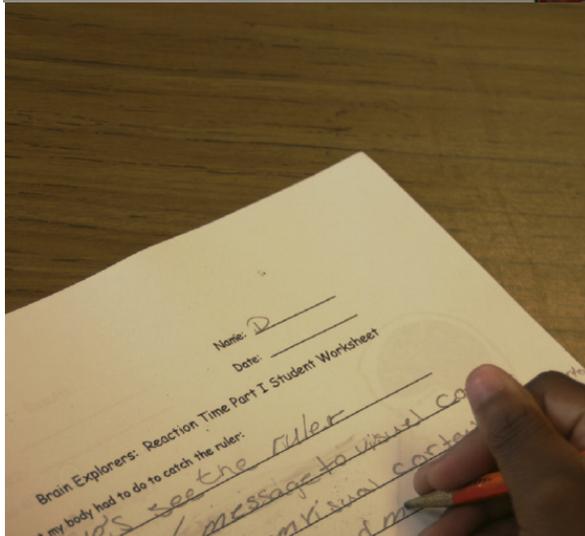
Step 4: Second student then repeats the catch process and records results.



Step 5:
Students complete the data collection hand-out. After adding the three catch times and finding the average catch distance, they refer to the distance and time chart to determine their reaction time.



Step 5:
Students find the speed of their reaction time using the distance and time chart. They find their catch distance and read the time in milliseconds.



Assessment:

Students record what steps had to happen in their body for them to catch the ruler.

Lesson Overview

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Engage (10 minutes) Student Inquiry

- Review neuron structure with students.
- Ask: “How can these neurons send messages to each other and to the muscle cell?” Students hypothesize as to what structures might be involved in neurotransmission, which is the process of communication between nerve cells and other cells in the body.

Explore (10 minutes) Neurotransmission - Spinal Cord to Hand

- Review the reaction process required to catch the ruler on the board: the eye, the visual cortex, the motor cortex, the spinal cord, and the muscle.
- Tell students, “Let’s focus on the neuron that carries the message from the spinal cord to the muscles in the hand.” This nerve cell body is in the spinal cord and its axon stretches out to the hand muscles.
- Students may enjoy estimating the length of their axons by measuring the distance from the spinal cord to the hand with a meter stick.
- Tell students that they will next learn all the details about how the message gets from the nerve cell to the muscle cell.

Explain (10 minutes) Introduction to Neurotransmission

- Explain the sequence of events detailed in **Background** section.

Expand: (25 minutes) Reaction Time Felt Kit

- Explain to students that they now will put together and narrate the steps of neuromuscular transmission using a felt kit.
- Introduce the felt kit parts and labels: placemat (white felt), neuron cell body with dendrites (blue felt), axon and axon terminal (gold bead chain), action potential (lightening bolt), neurotransmitters (fuzzy balls), neurotransmitter receptors(y-shaped felt), and muscle cell (arm, hand, and muscle felt shape).
- Demonstrate the process once for the class, setting up and moving the various parts. Repeat the sequence of events for the students.
- Students work in groups to put together the “neurotransmission scheme” on the placemat.
- Encourage students to use the labels for each part of the kit and to practice narrating the process to each other using the labels.
- Come together as a class and have a few student volunteers narrate the process for the class.
- Be sure to remind students to use the materials carefully and make sure all the pieces get back in the bag for the next class.

FELT KIT



Evaluate: (15 minutes) Synapse Worksheet

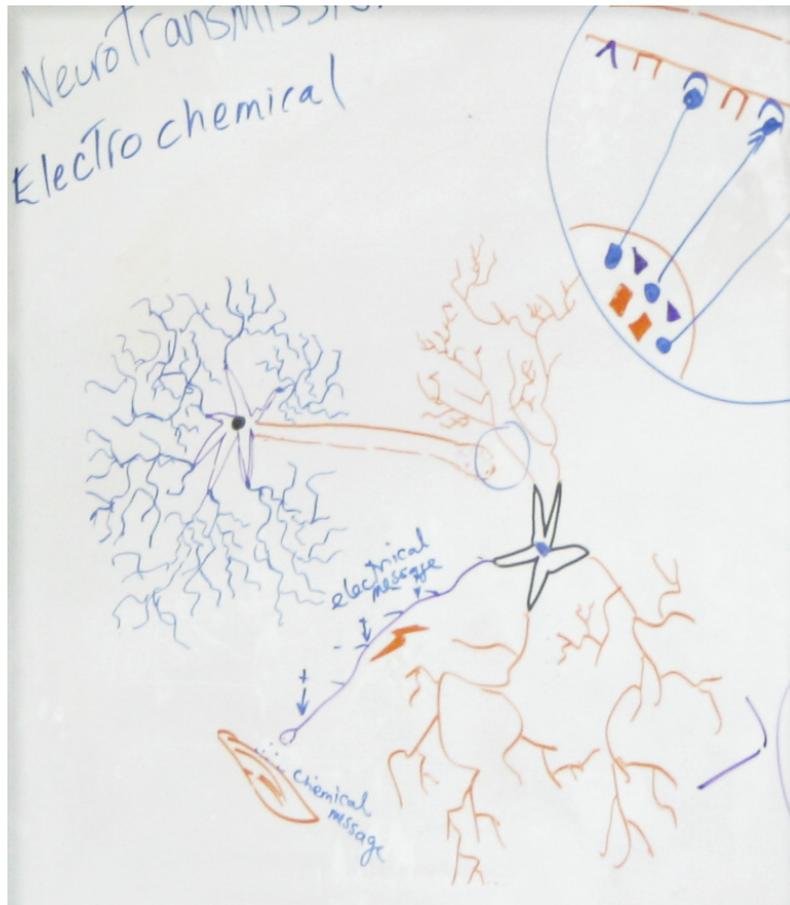
- Students draw and label the synapse using all the words listed
- Students number the steps of neurotransmission from 1-6 beginning with # 1 (the nerve cell in the spinal cord receives a message from the nerve cell in the motor cortex).

Background

Neurotransmission is a process that follows specific steps. The student use the felt kit to learn and review the process. The steps are as follows:

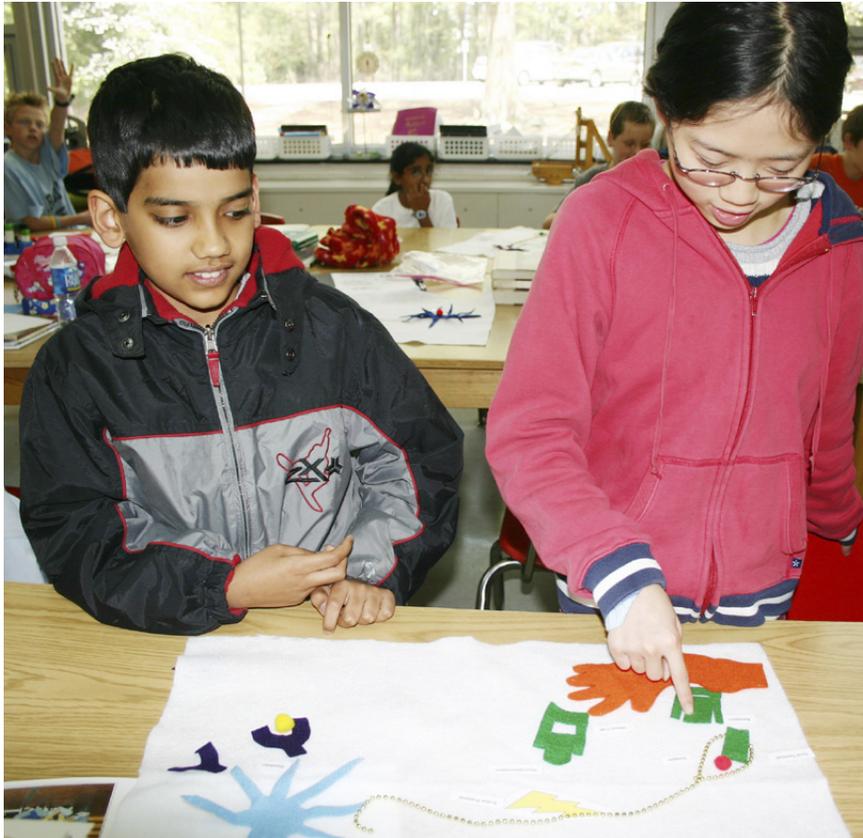
1. The dendrites of the nerve cell in the spinal cord get a message from the nerve cell in the motor cortex.
2. The nerve cell in the spinal cord gets excited which causes an electrical signal, or action potential, to move down the axon of the nerve cell (ie. the axon that travels down the arm from the spinal cord).
3. Once the action potential reaches the axon terminal, neurotransmitters are released and travel through the synaptic cleft (the space between the axon terminal of the nerve cell in the spinal cord and the receptors on the muscle cell) to neurotransmitter receptors on the muscle cell. Use the neuron and synapse posters to clarify the process.
4. The neurotransmitters and neurotransmitter receptors bind, which causes the muscle cell to get very excited.
5. Once the muscle cell is excited then the muscle contracts (or moves).

There are different levels of excitation in the receiving muscle cell. Excitation is increased with the the increase in neurotransmitters that are released and recieved. The cell must be excited to a certain state before the muscle is able to contract.



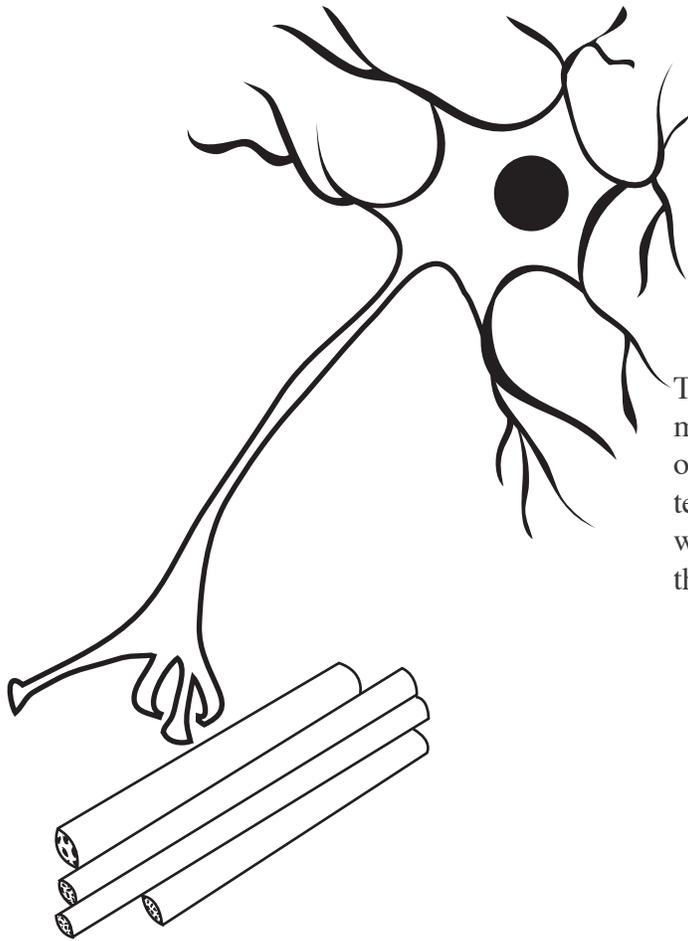
Vocabulary:

Neuron/nerve cell
Neurotransmitters
Nucleus
Action potential
Axon terminal
Neurotransmitter receptors
Synapse
Synaptic cleft

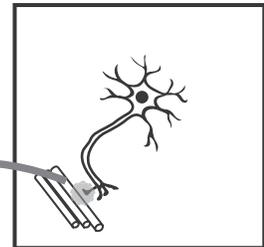


***Assessment:** Students take turns talking through the process and reviewing the parts of the neuron. They could also draw the felt kit, label the parts, and write a paragraph describing the process.*

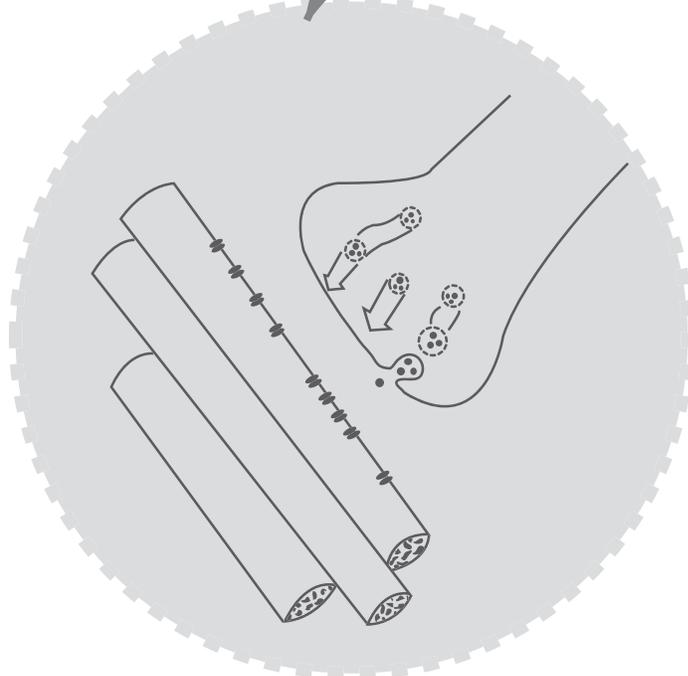
FELT KIT

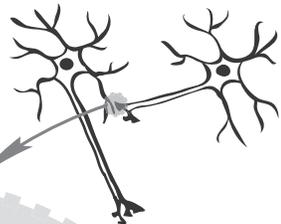
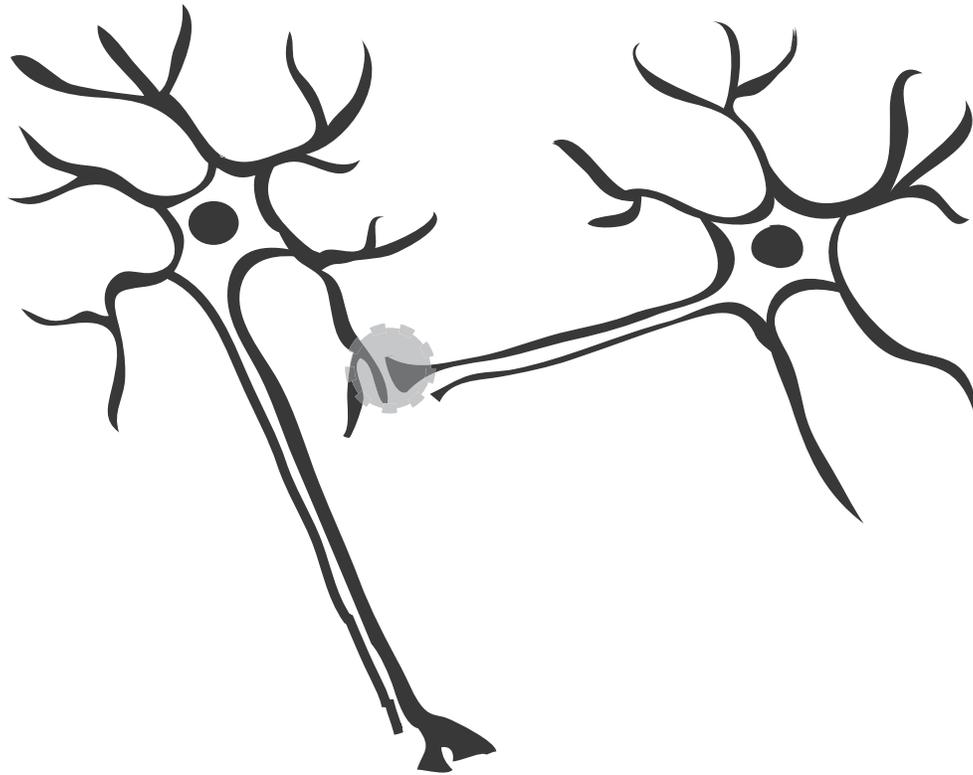


This is the neuron next to a set of striated muscle cells. Below is an up-close view of the synapse - the place where the axon terminal of the neuron communicates with the muscle cell. The space between the two cells is called the synaptic cleft.

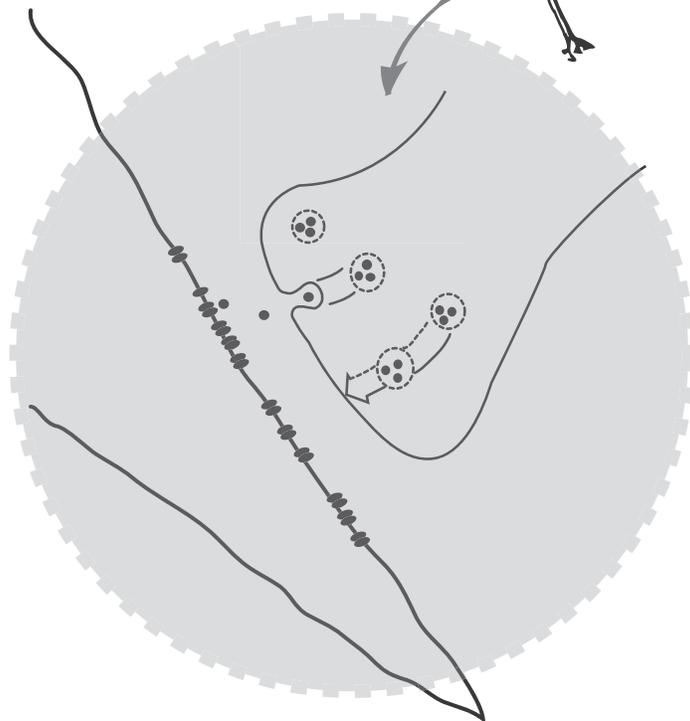


In neuron to muscle communication, the chemical neurotransmitters cross the synaptic cleft and bind to receptors on the muscle cell, telling it to contract.



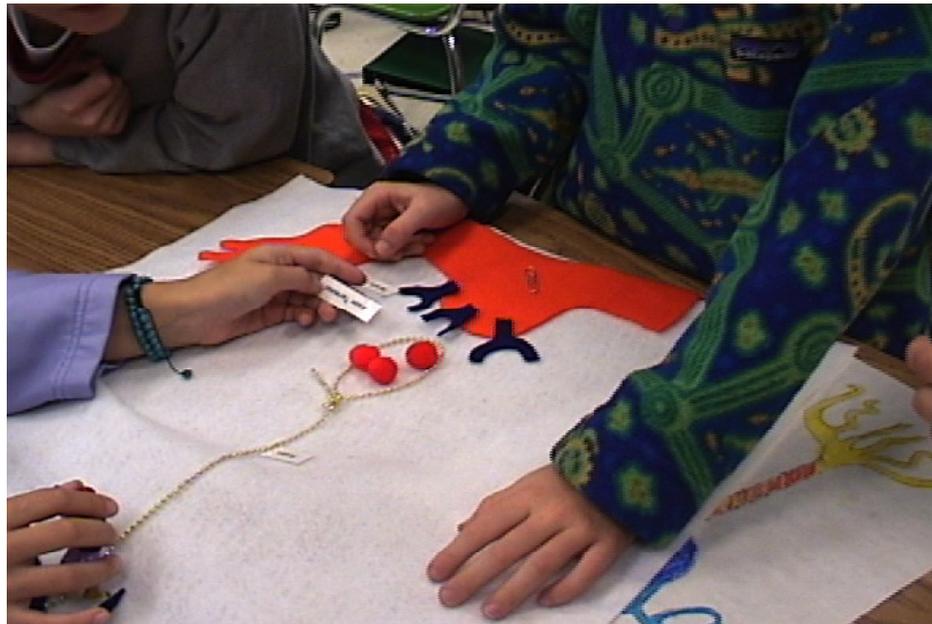


In neuron to neuron communication, the neurotransmitters cross the synaptic cleft and bind to receptors on the next dendrite.



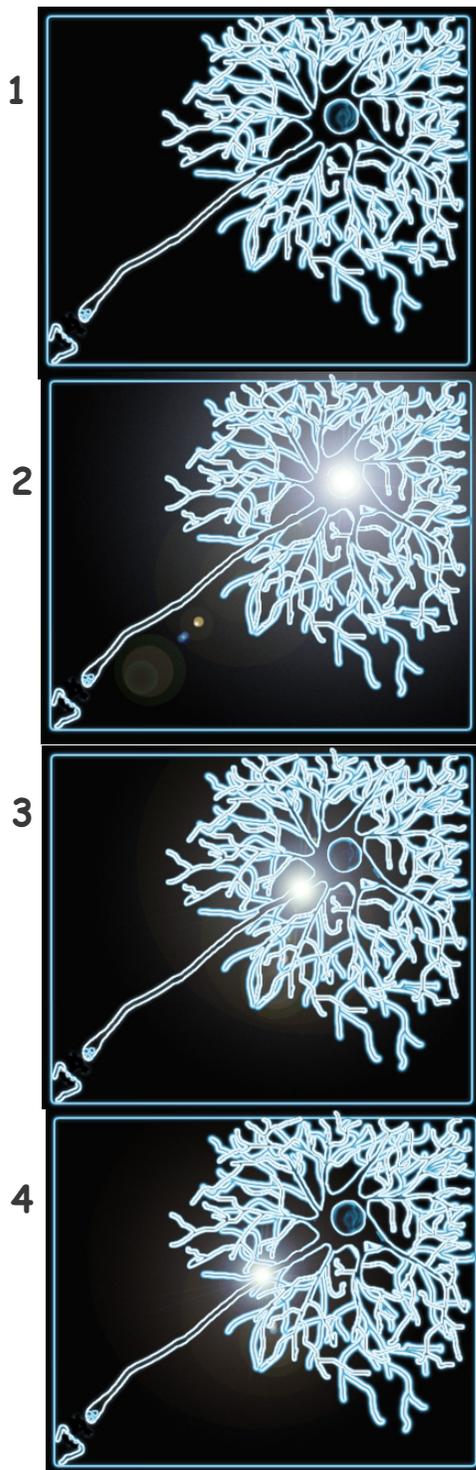
The Felt Kit: Summary

FELT KIT

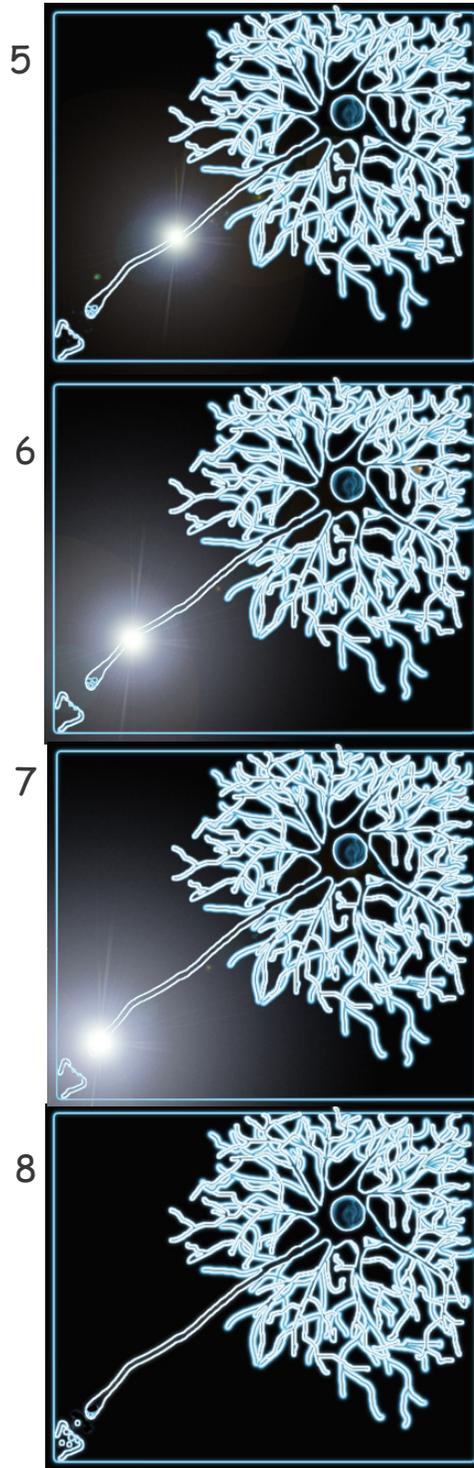


- Step 1: Show the kit. Talk through each part and its function in the process of catching the ruler, and in neurotransmission.
- Step 2: Hand out the kits to teams of 4-6 students. Have them try to arrange the parts in order.
- Step 3: Review the process as a class.
- Step 4: Rotate through the room to hear teams describe the process of catching the ruler, with emphasis on neurotransmission.

Optional Technology activity: Students import a neurotransmission animation into Hyperstudio or Powerpoint and create a presentation describing the process.



When viewing, let your eyes follow the pathway of the message, shown here as a bright light travelling through the neuron.



Idea: Make flip books!

FEELT KIT

Lesson Overview

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Note: There are two parts to this experience. They can be done in one lesson, or two, depending on attention span and time available. Part one teaches the process of neurotransmission. Part II teaches what happens when there is alcohol added to the system.

Lesson Plan: Neurotransmission Under Normal Conditions

Engage (5 minutes) Brainstorm

- Review the neurotransmission process with a poster, worksheet, or felt kit
- Ask students if there is any other way they could learn the neurotransmission process? Could they dance and act it out?

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Explore (5 minutes) Neurotransmission Dance - The Components

- Ask students what is needed to put on a play or musical.
- Students should respond: a cast, props, a set, musical instruments.
- Show students the labels cast members will be wearing and the props they will be using, and the musical instruments that will accompany the process. Ask students to guess which props will represent the different components involved in neurotransmission.

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Explain (10 minutes) Neurotransmission Dance - The Components

- Explain each aspect of the neurotransmission process to be acted out or danced and the sound effects that will accompany each step in the process.
 1. The neuron gets excited which causes an electrical signal, or action potential, to move down the axon of the nerve cell (ie. the axon that travels down the arm from the spinal cord). There are four cast members. There is one student acting as the neuron's cell body and another student acting as the neuron's axon terminal. They're connected by a cord or rope, which is the axon. A third student waits at the top of the axon for a message and then walks quickly down the axon as the action potential. There is a fourth student acting as the muscle cell that receives the message from the first neuron, who stands across from the student playing the axon terminal.
 2. Once the action potential reaches the axon terminal, neurotransmitters are released and travel through the synaptic cleft to neurotransmitter receptors on the muscle cell. The dance actually starts with the student who plays the nerve cell in the motor cortex throwing balls which are the neurotransmitters, to the student who is the cell body of the nerve cell in the spinal cord. This nerve cell gets excited, the action potential goes down the axon and the message is sent on to the muscle cell.

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SHOT OF INSTRUMENTS<
NAMETAGGS< SUNGLASSES
ETC>>>>>

DANCE!

3. The neurotransmitters and neurotransmitter receptors bind, which causes the muscle to get very excited. The student “catches” the neurotransmitters with two sticky mits they wear on their hands. These mits act as the neurotransmitter receptors.

4. Once the muscle cell is excited then the muscle contracts (or moves). The student who is the muscle cell should demonstrate contraction by contracting their own arm muscle.

- There are different levels of excitation in the receiving muscle cell. The cell must be excited to a certain state before the muscle is able to contract. The dance can demonstrate this concept if the person playing the nerve cell body and muscle cell move slowly when the first neurotransmitter is released and more quickly after each neurotransmitter until the third and last neurotransmitter creates enough energy for the message to be sent on. Also, the drums can get louder for each neurotransmitter.

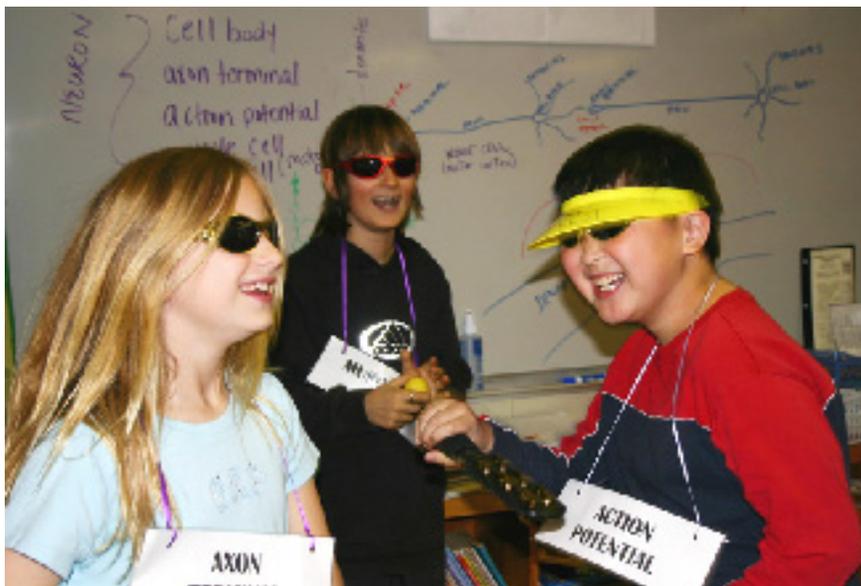
- Relate the cast members roles to the musical background so that students understand how the different components work together. Teachers can use instruments when available and as appropriate. Some suggestions: drums(electrical energy ad transfer of the message), xylophone(action potential), gong(neurotransmitters binding to receptors), cow bell and rattles.

Expand: (30 minutes) Neurotransmission Dance

- Students practice the neurotransmission dance, first in slow motion and then getting faster. All students get to participate by using the instruments or being a cast member.

Evaluate: (10 minutes) Neurotransmission Student Narration

- While continuing the dance, ask for student narrators.
- Keep in mind that there is a lot of noise; narrators will have to speak up.



DANCE!

Lesson Plan Part 2: Neurotransmission with Alcohol

Engage (5 minutes)

The last few lessons have dealt with neurons and neurotransmission. Neurotransmission is a long word that describes how neurons carry messages in our brains and bodies. Does anyone recall how neurotransmission works? Write the terms **spinal cord, dendrites, receptors, neurotransmitters, cell body, axon, action potential, axon terminal, synapse, and muscle cell** on the board. (Alternative, have a poster with the vocabulary already written on it.)

Explore (15 minutes)

Give the students a piece of notebook paper and ask them to use the vocabulary words on the board to write a sequence of how neurotransmission occurs. When completed, their sequences should contain the following: The **receptors** on the **dendrites** catch **neurotransmitters** released from a **neuron** located in the **spinal cord**. When enough neurotransmitters are caught, the **cell body** gets excited, causing an **action potential** to travel down the **axon** to the **axon terminal**. The axon terminal then releases neurotransmitters across the **synapse** that land upon receptors on another neuron, or upon receptors on a **muscle cell**. If the students have trouble recalling this sequence, write it on the board.

Explain (10 minutes)

Recreate the Neurotransmission Dance. Assign roles to the students and distribute nametags. Designate a narrator to describe the sequence of neurotransmission. Repeat until the sequence is smoothly performed. Rotate the narrator role through the students not participating in the dance.



Expand (15 minutes)

What happens when you introduce alcohol to the brain? Ask the students what happens when people drink alcohol? Does it affect their how their brains work? Do their reaction times get faster or slower? What about muscle movement? Is it enhanced or diminished? When people drink alcohol, it quickly goes from the stomach into the bloodstream and on to the brain. When it gets to the central nervous system it can quickly affect neurotransmission. There are two main types of neurotransmitters, excitatory and inhibitory. Excitatory neurotransmitters stimulate the neurons and muscle cells. The neurons send messages that cause the muscles to move. Inhibitory neurotransmitters make the neurons less likely to carry messages. They inhibit the process. Alcohol stimulates the production of an inhibitory neurotransmitter called GABA (gamma-amino butyric acid). This slows down the neuron's ability to send the messages that make the muscles move. This difficulty in sending messages is what causes people under the influence of alcohol to slur their speech and have trouble moving normally. It makes it harder to think clearly as well. Your nervous system can't work like it normally does. To illustrate this, give a student a nametag that says "alcohol" and have them stand in the synapse between the nerve cell in the spinal cord and the next neuron in the sequence. When alcohol is present in the synapse, it is harder for the receptors on the dendrites to catch enough excitatory neurotransmitters. The end result is that the muscle cell isn't properly stimulated. Instead of flexing, the muscle cell actor should now just move feebly. Run this sequence once or twice, with the 'dendrites' just catching a few neurotransmitters, the action potential moseying down the axon, and the muscle cell shrugging their shoulders instead of flexing.

Next, demonstrate what happens after alcohol is removed from the synapse after long-term alcohol abuse. A depleted supply of inhibitory neurotransmitters couple with an overproduction of excitatory ones causes an over-stimulation of the muscle cell. Do the dance having the dendrites catching too many neurotransmitters, the action potential scurrying down the axon, the axon terminal again releasing too many neurotransmitters, and the muscle cell shaking violently. This shaking is called the delirium tremens (the D.T.'s), a symptom of withdrawal after long-term alcohol abuse.

Evaluate

If an evaluation is desired, have the students write a paragraph describing how alcohol can affect the nervous system.

Vocabulary:

spinal cord	axon, a
dendrites	action potential
receptors	axon terminal
neurotransmitters	synapse
cell body	muscle cell

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Background

Alcohol's Effects on the Brain

Alcohol is the most widely abused drug in the world. Although it is legal for adults to drink alcohol in most of the world, the price paid in both lives and resources is staggering. In the United States alone, around 16,000 people are killed every year in alcohol-related traffic accidents. When injuries and personal property losses are included, the cost of these accidents is about 50 billion dollars a year (data from the National Highway Safety Administration). However, these numbers are just the tip of the iceberg. It is estimated that nearly 14 million people in the U.S. abuse alcohol every year. (Society for Neuroscience "Brain Facts" p. 35) Everyone is aware of the costs of drinking when it comes to traffic fatalities and drunk driving arrests. What most people don't realize is that drinking alcohol can have a profound effect upon their brain.

Ethanol, the active ingredient in alcohol, is easily absorbed into the bloodstream. From there it quickly travels to the brain. In small amounts, alcohol can have a stimulating effect on people. In greater quantities it becomes a depressant, slowing down both cognitive and motor skills. Aside from the well-publicized toll on the liver, long-term alcohol abuse has also been shown to affect brain function long after the abuse has stopped. Chronic alcohol abuse can damage the prefrontal cortex of the brain, which we use to plan and organize actions and regulate behavior. It can also cause an overall reduction in brain size and an increase in the size of the ventricles, where cerebrospinal fluid is produced and stored. Alcohol abuse is associated with a deficiency in vitamin B-1 (thiamine). The cerebellum is especially sensitive to thiamine deficiencies. Chronic alcohol abuse interferes with the digestive system's ability to absorb thiamine, which can result in Wernicke's encephalopathy. The symptoms include impaired memory, disorientation, paralysis of the eye muscles, and problems with coordination. Eighty to ninety percent of alcoholics with Wernicke's encephalopathy go on to develop Korsakoff's syndrome, a psychosis featuring worsening symptoms of forgetfulness and an inability to perform simple motor functions (information from NIAAA bulletin number 63, October 2004).

Young people run an increased risk of brain damage from alcohol abuse. According to a recent study by the Substance Abuse and Mental Health Services Administration, over 9 and half million young people between the ages of 12 and 20 admitted to drinking alcohol. This is disturbing in light of recent research that indicates our brains develop slower than previously thought. While most important development is finished after the first few years of life, some brain regions continue to develop into the mid-twenties.

Neural circuits in both the prefrontal cortex and the hippocampal areas of the brain are still changing. Introducing alcohol into the brain can harm the ability to learn and remember. Studies have shown that people who start drinking during their teenage years have smaller hippocampal areas than non-drinkers, and perform more poorly on memory tests. Since the prefrontal cortex is involved in planning and decision-making, any damage caused by drinking can lead young people to make poor choices and decisions. This can also affect brain areas that reinforce pleasure-seeking activities, and can lead to addictive behaviors such as alcoholism.

Although scientists are not sure exactly how this ‘reward circuit’ works, studies of rodent and monkey brains along with brain imaging studies in humans have given us clues to the structures involved. Basically, neurons located in areas deep within the brain release chemical neurotransmitters that induce pleasurable sensations. Recreational drugs stimulate this reward circuit, making the user feel pleasure while under the influence of the drug. Unfortunately, artificial stimulation of the reward circuit causes a depletion of these chemicals. This in turn results in cravings to once again stimulate the reward circuit. Since the prefrontal cortex is part of this circuit, the ability to plan, organize, and control behavior is affected. The downward spiral of addiction inevitably leads to making more and more poor choices, based upon the compulsion to stimulate the reward circuit. Alcohol acts upon this circuit, as well as the learning and memory centers. (Society for Neuroscience, “Brain Facts” p. 34)

Perhaps the most serious effect of alcohol is when it is introduced during pregnancy. When a pregnant woman drinks, exposure to alcohol can result in her baby being born with Fetal Alcohol Syndrome (FAS). When alcohol is passed through a mother’s placenta to her unborn child, the baby’s brain can be seriously damaged. Brain structures affected include the corpus callosum, the cerebral cortex, and the cerebellum. Fetal Alcohol Syndrome is the leading preventable cause of mental retardation in the world. There is no safe time to drink when a woman is pregnant, nor is there a safe amount of alcohol to drink. Damage to the fetus can occur at any time, even before the mother is aware that she is pregnant.

Although alcohol is a socially accepted recreational drug, its regular use can have many negative ramifications. Beyond the well-documented dangers of drunken driving and liver cirrhosis lies an equally serious but more insidious danger to the brain. While young people and babies are the most vulnerable, everyone is susceptible to alcohol’s effect upon the brain

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LESSON 10

Lesson Overview

Engage (5 minutes)

- Ask students “What happens to your brain as you get older, say from birth to fourth grade?”
- Student responses should indicate some type of growth, which can lead to an explanation of brain development.
- Use the neuron and brain development posters to show dendrite formation from 0 to 2 years.

Explore (25 minutes)

- Students learn that brain volume increases with age as dendrite formation increases between cells.
- Students should also know that dendrite formation is crucial to learning and forming memories.
- Ask students to use 3 sheets of scratch light to show brain development in a newborn, six month old, and 2 year old.
- Students should draw more dendrites on a single neuron with each age increase, but should not draw more neurons.

Explain (10 minutes)

- As students are finishing refer back to the posters to show brain development
- Discuss developmental milestones for the ages for which students drew nerve cells and dendrites
- Highlight activities that require increased brain development with age

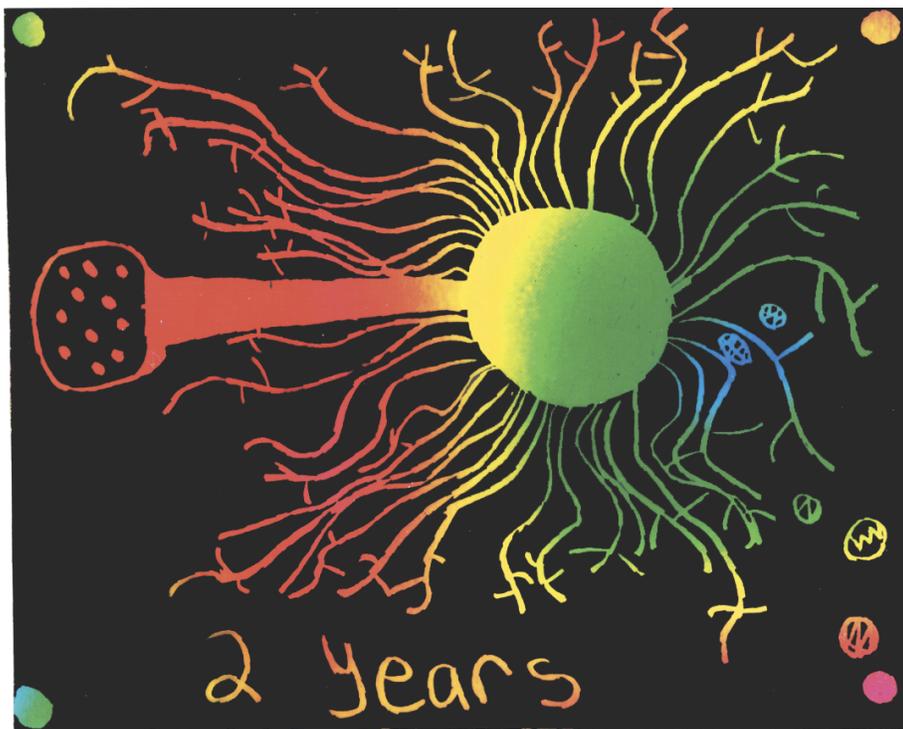
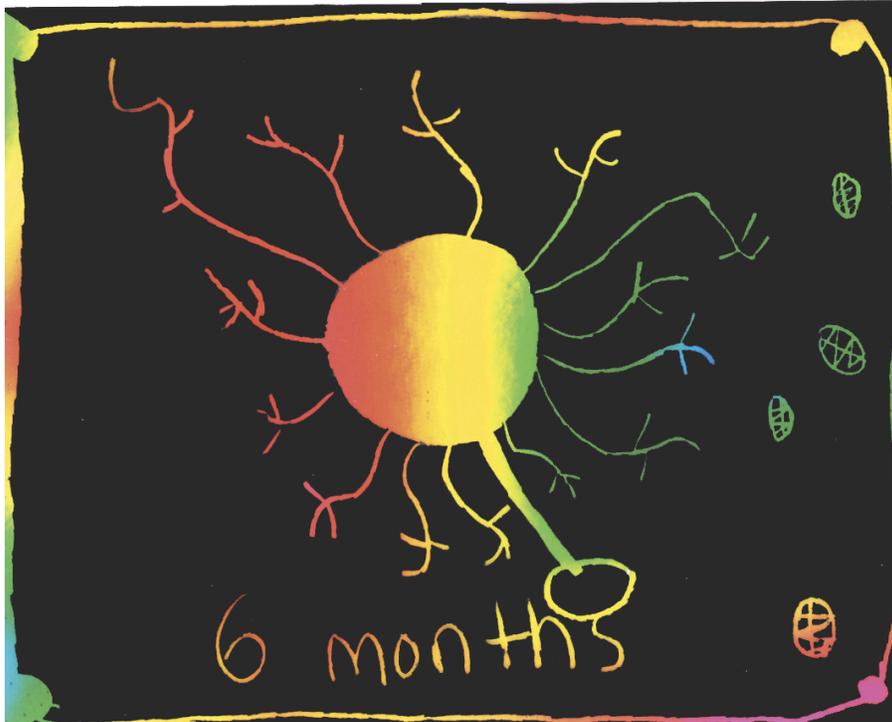
Expand (15 minutes)

- Students may help brainstorm activities that can be accomplished at specific ages
- Students should make the connection between early brain development and activities that enhance or facilitate dendrite formation as well as ways to protect the brain from damage to the nerve cells
- Discuss the myth that humans only use 10 % of their brain.

Evaluate (5 minute discussion, 10 minutes grading)

- Ask students, “Why might some nerve cells have different numbers of dendrites than others?”
- Students may discuss their hypotheses. Reveal that younger brains (0 to 2yrs) have fewer dendrites than adolescent or adult brains because as you learn and use new thought processes, you require more dendrites and connections between cells.
- Examine students work to see that students have drawn more dendrites with each age increase vs. more neurons.

DEVELOPMENT



Extension (artwork) Differences in Nerve Cells

- In the artwork extension, students use Scratch Light™ paper to depict the increasing complexity of neurons as a child grows. These can be assembled into a collage. Alternatively, they might be connected to create a neural network.

DEVELOPMENT

Background

The Brain: Learning and Growing

The human brain develops at a remarkable rate for the first five years of life. While we are born with all the nerve cells we will ever have, they are very simple cells. The cell body is there, and the axon, but there are very few branches and the cell lacks the complexity it will have later on. Nerve cells grow and become more complex as learning occurs. As we learn, new connections are made between and among the cells. These connections are made because of the growth of the cell. They are literal connections that can be seen in a high-powered microscope. Branches grow from the cells, moving out from the cell body, in ever-increasingly intricate patterns. The branches are called dendrites.

Brain-based Learning: a multi-sensory experience

The more multi-sensory stimuli the individual experiences, the greater the number of connections they form. This is the reason educators seek to create enriched environments and multi-sensory learning experiences for students. The more ways we approach a new piece of information, the more connections we can make. The more connections we make, the better and deeper the learning will be, and the greater the chances of retaining the information.

Inhibiting Brain Development: Fetal Alcohol Syndrome

Life for a baby in the womb is greatly affected by the lifestyle and nutrition of the mother. While the baby will gather the available nutrition it needs, and the mother's resources will be depleted if she does not maintain her supplies, the baby cannot filter out negative influences on growth and development such as nicotine or alcohol. Studies of infants born to alcoholic mothers, and of mice, reveal that the introduction to alcohol to the mother's bloodstream travels into the baby's bloodstream as well. The presence of the alcohol visibly slows and interrupts cell functions.

