Teacher Guide

Motor Learning and Memory

adapted from "Neuroscience Laboratory and Classroom Activities" created by the National Association of Biology Teachers and the Society for Neuroscience; and "The Senses, Behavior, and Learning" by Dr. Roger Johnson

Grade Level 4-12

Lesson Length
1 class period

Lesson Summary: Students will measure reaction time during tasks of increasing complexity.

Standards Alignment

Next Generation Science Standards

- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- 4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
- MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
- MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
- MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
- MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
- **Framework for K-12 Science Education**: Science & Engineering Practices 3,5,6,8

National Science Standards – Project 2061: Atlas of Science Literacy reference

a) Behavior/Heredity and experience shape behavior – learning from experience (p.97, Atlas Vol. 1)

Research on student learning: "No relevant research available in Benchmarks." (p.97, Atlas Vol. 1)

Objectives—Students will

- experience activities that involve reaction time.
- investigate how reaction time can be altered.
- discuss brain regions that mediate reaction time.
- discuss how information is sent from the senses to brain regions involved in this activity.

Assessment Options

- Collect and graph data, then discuss results.
- Discuss what is going on in the nervous system when the activity is performed.
- Brainstorm ideas on different ways to investigate reaction time.

Materials

- decks of playing cards
- time clocks or stopwatches

Procedures

Engage

- Ask students what makes a task hard to do.
- Generate ideas with the class about what makes an activity hard to do.
- Ask what might happen in the brain when a task gets harder to do.

Explore

1. Instruct students to work in pairs. Assign the roles of Card Sorter and Recorder to each pair. Ask the students to shuffle the cards.
2. **Activity 0**
   The card sorter deals the cards into one pile. The recorder times how long it takes to simply deal the cards.

   Activity 1
   The card sorter deals the cards into two piles. The recorder starts the time clock or stopwatch as soon as the card sorter begins to put the cards into two piles. The recorder times how long the cards are randomly sorted and records the time.

   Activity 2
   The card sorter places the cards into two piles **based on the color** of the suits: one pile for red (hearts and hiamonds) and another pile for black (spades and clubs). Again, the recorder writes down the time it took the card sorter to put the cards into two piles.

   Activity 3
   The card sorter puts the cards into **four random piles**. The recorder writes down the time the card sorter took to finish this task.

   Activity 4
   The card sorter puts the cards into **four piles based on the suits**: hearts, spades, clubs, diamonds. The recorder writes down the time the task was completed.
3. Ask students to create a graph of the data they collected. Discuss with students different ways to graph the data (e.g. create a bar graph of time versus activity). You can also make a graph of the data from the class.

Develop Questions

- Ask students if they observed any patterns in their graphs? If they observed a pattern, ask the students what they thought of the pattern.
- Talk about what happens when the task becomes more complex.
- Challenge the students to calculate how long it takes to make a decision when sorting cards.

  Hint: Subtract the time of Activity 0 (just the motor actions) from the other times.

  Problem: What does the difference between the times for Activity 0 and Activity 1 represent?

Explain

Discuss how information is translated.

- Information about the card is received through the eyes and travels to the **visual cortex** (**occipital lobe**) then to the **association cortex** (**parietal lobe area**) where the visual information is related to memory of where to place the card.

  As the task gets more complex, it takes a longer time for the cerebral cortex to evaluate and decide where to place the card.
- The information (decision on where to place the card) travels to the **motor cortex** (**frontal lobe**) and from there it is sent down through the **spinal cord** to the muscles that control the arm movement.

Expand and Evaluate

- Ask students how one could become more efficient with card sorting. Discuss how repetition can be a strategy for performing a complex task faster.
- If anyone cut the deck of cards into 2 or 4 piles, discuss with the class where this idea may have come from (frontal lobe, cerebral cortex) and if this is a fair way to do the task. What do students think of this solution?
- Students can develop their own experiments to investigate reaction time. For example:

  Ask students to pair up. One student holds the tip of a ruler just above the hand of the second student. The first student lets go of the ruler. As quickly as possible, the second student catches the ruler. Note the ruler markings just below the the student's hand to determine how many inches or centimeters passed through the catcher's grasp. Record the inches/centimeters. Try the activity again three times and record the measurement of each attempt.