Your Brain: Memory and Multitasking

IN THE WORKSHOP YOUR BRAIN: MEMORY AND MULTITASKING, YOUR STUDENTS EXPLORED SOME OF THE TESTS COGNITIVE SCIENTISTS USE TO PROVIDE CLUES TO HOW THE HUMAN BRAIN PROCESSES INFORMATION. CONTINUE THEIR INVESTIGATIONS INTO THE BRAIN’S SYSTEMS FOR ATTENTION AND MEMORY WITH THE FOLLOWING DISCUSSIONS AND ACTIVITIES.

DISCUSSION 1: WHAT DID YOU LEARN ABOUT THE BRAIN?
TIME: 10–20 minutes
GOAL: Review and discuss concepts encountered during the field trip.

Revisit the lists of facts and questions the class generated before the field trip.

- To which questions were students able to find answers? What did they find out?
- Which of the facts were confirmed—or contradicted—in the workshop or exhibit?
- What new questions do they have about how the brain works?
- What could they do to find out more information?

DISCUSSION 2: LEARNING, ATTENTION, AND MEMORY
TIME: 10–20 minutes
GOAL: Apply understanding of attention and memory to situations in students’ learning environment.

Ask students to reflect on their experiences in the workshop and in the exhibit.

- What things did they find out about how the brain pays attention, remembers, and learns?
- In what ways might these ideas be helpful in things they do every day?
- What do these ideas say about the best ways to study and do homework?
- How do they think teachers could use these ideas to improve learning in the classroom?

EXTENSION: Challenge students to create a list of “Homework Tips” for other students, and/or a list of “Classroom Tips” for teachers, based on what they’ve learned about how the brain works.
In the workshop, students tested their ability to recall objects seen for a short period of time. This activity explores the recall of spoken words and introduces the concept of short-term and long-term memory.

**MATERIALS:**
- Word List #1 (see below)
- Pencils & paper
- Large paper / whiteboard
- Graph paper
- Calculators (optional)

**PROCEDURE:**
1. Instruct students that you will be reading a list of words, to which they should listen carefully and attempt to remember as many of the words as possible.
2. Read the words from List 1A at a rate of about one word per second. Read the list only once, without repeating any words.
3. After all the words have been read out loud, ask students to write down as many of the words as they can remember.
4. Read the words again one at a time, and ask students to raise their hands if they correctly remembered the word. Record on chart paper or whiteboard each word’s position in the list (word 1, word 2, etc.) and how many students remembered it.
5. Instruct students to calculate the “percent recall” for each word (# of students recalling it/total number of students x 100%) and create a graph of word position vs. percent recall.

**REFLECTION:**
- What strategies did students use to help them recall the words? How were they similar to or different from the methods they used to recall the objects in the workshop?
- What trends do they notice from the graph? What might it say about how word position affects ability to recall it? What do they think might be causing this pattern?
- In general, people are more likely to remember the words at the beginning and end of the list, but less likely to remember the words in the middle, a pattern known as the **serial position effect**. The words at the end of the list are still stored in the brain’s **short-term memory**. The words at the beginning of the list have been rehearsed long enough to have entered **long-term memory**. We tend to forget words in the middle of the list because of **displacement**: they are forced out of short-term memory as new words are said, but they haven’t been in the memory long enough to have been converted into long-term memory.
EXTENSIONS:
1. Using List 1B, carry out the experiment again. This time, after reading the word list, ask students to count backwards from 100 by threes for 15 to 30 seconds. Then ask them to recall the words from the list. How do these results compare to the first test? Graph the serial position curve (position vs. percent recall) again and notice any changes.

2. Brainstorm what other factors might affect ability to remember words in a list. How might the effects of these factors be tested?

Challenge students to design and carry out an experiment to test one of the possible variables, working individually or in groups. They might use the following questions as guidelines:

- What question do we want to answer? How could we answer it?
- What variable(s) will we change? What needs to stay the same?
- What will we measure? How will we record the results?
- What materials will we need?

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WORD LIST #1 — SERIAL POSITION EFFECT

**LIST 1A**
- Cat
- Apple
- Ball
- Tree
- Square
- Head
- House
- Door
- Box
- Car
- King
- Hammer
- Milk
- Fish
- Book
- Tape
- Flower
- Arrow
- Key
- Shoe

**LIST 1B**
- Mind
- Lawn
- Length
- Palace
- Knowledge
- Broom
- Series
- Flood
- Jelly
- Pudding
- Joke
- Contest
- Girl
- Winter
- Square
- Bat
- Robot
- Sock
- Pizza
- Truck
In the workshop, the memory box activity illustrated the idea that memory of objects can be influenced by context and past experience. This activity explores the idea that some contexts can create false memories: hearing a group of thematically-related words may cause people to remember hearing a related word that was not in the group.

**MATERIALS:**
- Word List #2 (see below)
- Pencils and paper

**PROCEDURE:**
- Explain that you will be reading a list of words, to which they should listen carefully and attempt to remember as many of the words as possible.
- Read the words from List #2 slowly, pausing for about one second between each word.
- Ask, one at a time, if each of the following words was on the list, and instruct students to write down “yes” or “no” for each:
  - candy (YES)
  - bread (NO)
  - sweet (NO)
  - eye (YES)
  - lamp (NO)
  - needle (NO)
- Compile the class’s results.

**REFLECTION:**
- What percentage of the class remembered a word that wasn’t on the list?
- Why do they think this happened? What might it say about how our memories work?
- What are some real-life situations where this could occur?
- Groups of related ideas and concepts are connected into networks in the brain. Activating one part of a network makes it easier for the brain to activate other parts of the same network, an effect called **priming**. People will often remember hearing “sweet” or “needle” because they are primed by hearing other words that are related to those ideas.
EXTENSION:
• Challenge students to create their own word lists designed to give a false memory response. (You may want to have the original list and questions available for reference.) What topic or idea will they group their words around? Which words will they ask about? Encourage them to try their lists out on a partner or small group.

WORD LIST #2 — PRIMING AND FALSE MEMORY

- Sour
- Chocolate
- Point
- Candy
- Heart
- Prick
- Sugar
- Cake
- Thimble
- Bitter
- Eat
- Haystack
- Good
- Pie
- Thorny
- Taste
- Thread
- Hurt
- Tooth
- Pin
- Injection
- Nice
- Eye
- Syringe
- Honey
- Sewing
- Cloth
- Soda
- Sharp
- Knitting
In the workshop, students participated in a demonstration of the effects of multitasking. In this experiment, the class will collect and analyze data on a different dual-task test and investigate other variables that might influence the outcomes.

**MATERIALS:**
- Masking or painter's tape
- Stopwatches or other timekeeping devices
- Chart paper or laptop/screen
- Data recording sheets (see below) and pencils
- Calculators

**PROCEDURE:**
1. Set up one or more testing stations with the following:
   - A straight line of tape on the floor, approximately 10' long
   - On separate sheets of chart paper or computer slides, positioned at one end of the tape line, two multi-step addition/subtraction problems, such as
     - $7 + 15 + 3 - 11 + 8 - 2 + 36$
     - $6 + 18 + 5 - 23 + 9 - 4 + 37$
   - Calculator
   - Stopwatch or timer

2. Remind students of the multitasking test they performed during the workshop. Explain that they will be trying a different type of multitasking test and looking for patterns in the whole group's results.

3. Introduce the two tasks and the procedure (you may want to have printed copies of these directions available at each station):
   - Walk the line beginning to end, tightrope style (heel-to-toe). If heel and toe are more than an inch or two apart, or if more than half of the foot is off the line (front, back, or side), it will be considered a mistake.
   - Type the arithmetic problem into the calculator to find the answer. Using the clear button/starting over or getting the wrong answer at the end will be considered mistakes.
   - One at a time: Participant walks the line, stops at the end, and enters the arithmetic problem into the calculator. Record time and number of mistakes.
   - Multitasking: Switch to second arithmetic problem. Participant walks and types simultaneously. Record time and number of mistakes.
4. Divide students among the testing stations; while one student performs the test, others should be responsible for keeping time and watching for mistakes. Each student should record their own data on their data sheet.

5. Provide a place (whiteboard, chart paper, computer spreadsheet, etc.) for collecting the whole group’s data and have students add their individual data.

6. (Optional) Once everyone’s data have been collected, instruct students to calculate the average time and number of mistakes for the “single-tasking” and multitasking trials.

**REFLECTION:**
- What trends or patterns do they see in the class’s results?
- Based on their own experience, can they think of any other factors that might influence the results? How might they test the effects of some of those factors?
- What other questions do they have about multitasking?

**EXTENSION:**
Divide the class into small groups and challenge them to design an experiment testing one of the other variables or answering one of the questions the class brainstormed. They might use the questions from the Serial Position Effect Activity, Extension 2 (above) to guide the process. If possible, provide opportunities for the groups to test their experiments with the class.
## Online Resources:
### General Neuroscience:
- **Neuroscience for Kids**: games, experiments, and information designed for students: [http://faculty.washington.edu/chudler/neurok.html](http://faculty.washington.edu/chudler/neurok.html)

### Attention and Change Blindness:
- A video clip from the PBS series Nova about a classic change blindness experiment: [https://www.youtube.com/watch?v=VkrrVozZR2c](https://www.youtube.com/watch?v=VkrrVozZR2c)

## Standards
The workshop *Your Brain: Memory and Multitasking* and these accompanying resources support the following elements of the Next Generation Science Standards ([http://www.nextgenscience.org/](http://www.nextgenscience.org/)):

### Core Ideas
- **Life Sciences, Information Processing (LS.D-1)**:
  How do organisms detect, process, and use information about the environment?
- **(MS-LS1-3)** In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues or organs that are specialized for particular body functions.
- **(MS-LS1-8)** Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. Changes in the structure and functioning of many millions of interconnected nerve cells allow combined inputs to be stored as memories for long periods of time.

### Science and Engineering Practices
- **Asking Questions and Defining Problems**: Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.
• Planning and Carrying Out Investigations: Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

• Analyzing and Interpreting Data: Analyze and interpret data to determine similarities and differences in findings, or to provide evidence for phenomena.

CrossCutting Concepts
• Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural or designed systems.
• Patterns: Graphs and charts may be used to find patterns in data.
• Structure and function: Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts.