Lesson Summary: This lesson explores the relationship between motor response time and cognitive load, using a simple deck of playing cards. It offers opportunity to explore data analysis and critique experimental design.

Grade Level 9-12

**Lesson Length
1 class period**

Standards Alignment

Next Generation Science Standards
- **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.
- **HS-LS1-3.** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- **Framework for K-12 Science Education**: Science & Engineering Practices 3,4,5,6,7,8

Objectives—Students will be able to

- Understand the relationship between cognitive load and reaction time.
- Collect data and display it graphically.
- Design and carry out their own experiment illustrating the underlying concept (optional).

Assessment Options

- Assess students during follow-up discussion of activity.
- Evaluate student data and analysis page.
- Evaluate students' experimental design and write-up (expand).
- Evaluate students' presentations of designed inquiry (expand).

Note: This may have meaningful context in discussion about distracted driving and the impact of increased cognitive load (ex. texting, talking on phone) on reaction time while driving.

Materials for each group

- One deck of playing cards
- One stopwatch
- Student Guide instruction and data table pages

Procedure

Engage

1. Ask which students think they have pretty quick hands or reflexes, especially related to dealing cards.
2. Invite two students to come forward and hand them a deck of cards.
3. Tell them they will compete to see who can deal out the cards faster.
4. The class will cheer on their competing peers as they carry out their task.
5. Ask the class what they think puts limits on how fast this task can actually be done.

Explore

1. Divide students up into groups of two or three, having each group gather necessary materials.

2. Be sure each group has accompanying student procedure, data table, and question sheets.

3. Set the students to work through procedures, collect data, and answer questions.

   Part II of the procedure requires special instructions from the teacher to one member of each group. This is to be done at the teacher's discretion. *SEE SPECIAL NOTE ON PG 3*

4. Direct students to develop a graphic representation of the data they collected, as well as a summary conclusion of what this data means and what implications it could have for daily decision making.

Explain

1. Allow students to share their graphic representation, interpretations of meaning, and implications for daily decision making.

2. Ask students why they chose to represent the data the way that they did.

3. Ask students to discuss how accurate they think their data is, and possible limitations.

4. Explain the limitations of our nervous system to react in time, particularly as more and more synapses and parts of the brain are being recruited for an increasingly complex task.

5. Use this opportunity to reinforce the physiology of neurons and transmission of action potentials

6. (Optional) Model simple statistical tests that could tell you if there are significant differences between groups of card-sorting tasks of varied complexity.

Elaborate

1. Ask students to pool data and run statistical tests with the larger sample size.

2. Allow students to gather more data if they'd like to do so and if time permits.

Evaluate

1. Look at student work.

2. Assess students' understanding based on discussion and presentation.

3. (Optional) Student experimental design, implementation and presentation from (expand) open inquiry.

Expand (Optional)

Option 1: Ask students to develop an experiment to challenge or support their findings. They should develop a task in which they can alter the complexity and against which they can measure time. They should be prepared to share their procedure, display their data, and draw evidence-based conclusions.

Option 2: Ask students to research studies on distracted driving and draw conclusions from their findings to share with the class.

Take Home Points

- As more synapses and areas of the brain are recruited to carry out tasks of increasing complexity, motor output is delayed due to processing time.

- Processing time increases even more when task complexity is related to external feedback. Processing time grows even more if rules directing the task change unexpectedly.

*SPECIAL NOTE ON PART II OF STUDENT PROCEDURES

In each group: One student sorts the cards. Another student is the feedback person or rule-maker/changer for the card sorter. A third student serves as timer. The timer's role is unchanged from Part I. One of these students or another student can serve as data recorder.

The rule-maker chooses **one of 3 rules** for sorting the cards (sorting by color, suit, or numbered card vs. face card) and *does not tell* the card sorter which rule is in effect.

When the timer says "Go!" the card sorter begins sorting. As each pair of cards is placed, the rule-maker will say "Yes" or "No."

When the rule-maker/changer determines that the sorter has successfully figured out the rule - after 5 correct sorts - the rule-maker will then change the rule (again, not telling the card sorter what the new rule is), thereby forcing the sorter to figure out the new rule.

If the sorter is not catching on, the rule-maker/changer can tell the sorter that there are 3 possible sorting rules being used.

Repeat this pattern until all the cards are sorted.