Part 1: Sight

Why Do NASCAR Drivers Need To React Fast?

Grade Level | Topic | NGSS
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3-5 | Properties of Materials | LS1.D

**Phenomenon**

Students try to figure out why other students can’t catch a dollar bill when it’s dropped.

**Materials**

- Video Reaction time lab + Dollar Bill challenge from 1:08 to 1:38
- Video 2021 NASCAR All-Star Race/ NASCAR on Fox Highlights from 0:15 to 0:55
  - Meter sticks
  - Dollar bill or photocopy of dollar bill
  - Measuring tape (the longer, the better)
  - Lab Handout: Reaction Time
  - Reference: Time and Distance

**Material Management Tips**

- Have videos queued up at the proper timestamp.
- Gather materials for investigation:
  - 1 Meter stick
  - Lab Handout
  - Lab reference for each lab group
- Pre-measured distances for the reflection section of the lesson
Why Do NASCAR Drivers Need To React Fast? (Part 1: Sight)

SCIENE AND ENGINEERING PRACTICE(S)
Developing and Using Models
Develop and/or use models to describe and/or predict phenomena.

DISCIPLINARY CORE IDEAS
LS1.D—Information Processing
Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain.

CROSSCUTTING CONCEPTS
A system is a group of related parts that make up a whole and can carry out functions that its individual parts cannot. They can also describe a system in terms of its components and their interactions.

SUPPORTING EQUITABLE PARTICIPATION

Interactions

Modalities
How students communicate their ideas
Talk • Text • Visual: Drawing, Symbols, Table, Graph, Chart, and Gesture

Safety
NSTA encourages K–12 teachers and school leaders to promote and support the use of science activities in science instruction and work to avoid and reduce injury. Additionally, NSTA recommends teachers and school leaders visit the NSTA Safety Resource page for up-to-date information on safety issues and guidelines.

EXPERIENCE PHENOMENON
Students experience the phenomenon or problem. The teacher creates an opportunity for students to connect with this specific event or problem (through prior experience, interests, and curiosities) and raise or identify a student question to investigate.

1. Introduce the Phenomenon
Gather students and introduce NASCAR racing to students to elicit excitement and experience the phenomenon together.
### Demonstration and Video Observation

Show them a dollar bill, and demonstrate how you would drop it and how they would catch it. Hold a dollar bill in one hand, and place your other hand just the way the students in the video did. Drop the dollar to let kids see it fall, but don’t try to catch it. **Play the video** from 1:08 to 1:38 of students trying to catch a dollar.

Students watch the demonstration and video to observe the phenomena.

Invite students to share their reactions to the video. Expect lots of student enthusiasm and disbelief. Encourage them to share their curiosities and disbelief out loud to motivate the next steps: figuring out the question, “**Why is it so hard to catch a dropped dollar bill?**”

Students share noticings and wonderings. Students share initial ideas. Lead to lesson question “**Why is it so hard to catch a dropped dollar bill?**”

Next, ask students to individually brainstorm ideas about why they think the challenge is hard for many of the students. Have students turn and do a quick share with a partner. Next, ask students to share their ideas with the whole class. Student ideas will vary but listen for ideas around body systems and gravity.

Individual think time to begin thinking about why the dollar bill challenge might be hard. During this time, students will likely begin to think about the body systems and gravity.

Acknowledge students’ ideas, then say, “It seems like many of you have pointed out the connection that needs to happen between the eyes and the fingers. Take a minute to think about all the things that need to happen in the body.”

In groups, have students develop an initial model to explain what they think needs to happen in the body to catch a dollar. Provide each group with a whiteboard or large sheet of paper.

Student groups develop an initial model of or the first attempt at explaining the phenomena.

Students models will vary, but ideas to include are these:

- Our eyes have to see it.
- Our hands have to move to catch it.
- Our brain has to tell our hands what to do.
- There is a path from the eyes to brain to arm to hand.

As student groups develop their models, circulate around the class to formatively assess students’ prior learning around body systems.
Bring the class back together, and say, “As I walked around, I noticed many of your models were similar, but not exactly the same. To make sure we all have the same information, we are going to create a class model.” As a whole class, guide a discussion to create a class consensus model. Use prompts such as the following:

- What is something we all had in our models?
- Did anyone have anything else in their models? What do we think about that component? Should it be added?
- Did anyone have how these components interacted with one another?
- Can we agree that these components have to work together?

A typical model here could include the following: the eye seeing the dollar bill and sending a signal to the brain; the brain deciding to catch the dollar, then sending a signal through the nerve (or nervous system) to the muscles of the hand; then muscles move the hand (fingers), catching the dollar. Expect some agreement and or disagreement on what’s important. The goal is not to get the process correct but to explicitly have all student ideas gathered in one place for the class to see. Use this discussion to develop the idea of a system. Use questions like these:

- We have different components (parts) in our model, but what else do we need to add to our model?
  - Leads to the need to include how the components of the system work together
- What do you think might happen if a part of the system model changed? For example, what if the person had to wear a blindfold?
  - Leads to the idea that body systems work together
- Thinking about body systems, what evidence do we have that supports the idea that systems work together?

The whole class works together to develop a consensus model that contains their ideas about how the body works to catch the dollar.

Students are prompted to think deeper about the relationships of the different parts of the body and how they work together.

Students develop a systems model through sensemaking around teacher prompts.
Use the model development as a way to formatively assess students’ prior learning and experiences around body systems. Also, watch for students to come in with misconceptions and/or incomplete ideas around body systems.

Last, ask students how they could investigate this challenge to figure out more. Many students will say they should try the dollar challenge or engage in some kind of investigation about reaction time. Agree with this idea and transition into the investigation.

INVESTIGATE

Students engage in the practices of scientists and engineers to build understanding of targeted science ideas (and engineering ideas) needed to explain the phenomenon or solve the problem.

Explain to the students that the dollar bill challenge is about reaction time. If you have a word wall in your classroom, consider adding this word to it using your student’s ideas for a definition.

Tell students you have a video clip you would like to share with them. Ask students to think about reaction time as they watch the clip. Show the video of NASCAR drivers driving in a pack around a track. 2021 NASCAR All-Star Race/NASCAR on Fox Highlights from 0:15 to 0:55. After the students have watched the video, say, “Wow, it seems like so many things could happen because they are going so fast. I wonder if NASCAR drivers have really fast reaction times? How fast can people react when they see something? Do you think a race car driver has the same reaction time as the kids trying to catch the dollar bill?” Have students share their thoughts about this question. Then say, “Many of you wanted to investigate reaction times, so that is what we are going to do now.”
Prepare for the investigation.

Show students a meter stick, yardstick, or other ruler. Solicit a volunteer to help demonstrate how to measure reaction time by dropping the ruler and seeing how far the ruler has moved by the time it is caught. If your rulers have both metric and customary measurements, decide as a class which you will use before they begin. This is important for having results you can compare. Some students may need guidance in reading a ruler. Distribute the lab handout with data table. Before beginning the activity, have students write or draw the process that must occur in their bodies for them to catch the ruler.

Do the investigation in small groups

In groups of 2 or 3 students, conduct the investigation and use the table provided or the online calculator to determine their reaction times.

Before they begin, take a few minutes to orient the students to the lab handout. Ask students why it might be important to repeat the experiment several times and take an average of their results. Expect responses like these:

- We might mess up the first time.
- We might get better over time.
- We could be really fast one time and really slow another time.
- It's important to know if our results are accurate.

Note that additional guidance about how to calculate an average may also be necessary. (Calculating average is a skill introduced in fifth grade. If you are working with younger students, consider modifying the investigation by having them circle the measurement that falls in the middle.)

Allow time for students to complete the investigation. Once students have been testing for several minutes, prompt them to discuss and try to answer the questions as a group by drawing or writing some ideas.

Students get ready for the investigation.

Students engage in data collection.

Students talk about their ideas to answer each of the questions. One or more students record(s) their ideas on the handout using drawings and/or writing.
REFLECT

Students use the new or revised science ideas they developed to help explain how or why the phenomenon occurs and/or to identify solutions to the problem.

**Making sense of the investigation.**

Visit a hallway/outdoor space. Say, “Now that we know our reaction times, let’s see how that translates into distances if we pretend we are NASCAR drivers going 200 mph.” Provide a pre-made chart with distances based on reaction times from 0.1 to 0.5 seconds. Have students walk off the distances while carrying their science notebooks with them. As they turn and look back at where they started, ask them to imagine what might happen during a NASCAR race in the distance they traveled and why having a fast reaction time would be important.

Share with students that NASCAR drivers have been measured to have reaction times about twice as quick as ordinary drivers/people. (See this website: [http://2012ojhsnascar.weebly.com/reaction-times.html](http://2012ojhsnascar.weebly.com/reaction-times.html).) This means that they react on average about 0.1 seconds faster than the rest of us.

Alternately, use the provided distance chart for a car moving at either 30 or 60 mph., and ask students to move those distances and imagine what might happen in their neighborhood or on a highway in that space. Students are unlikely to have a good sense of NASCAR speeds and distances but are more likely to relate to cars and drivers in their own neighborhoods. This also connects to the importance of watching for cars when crossing or playing near a street.

Students connect reaction time with distance. Students think about why reaction time would be important for a race car driver.

Students relate reaction time to distance using a more familiar measure. Students connect reaction time and distance to their community and life.
Return to the classroom and replay the dollar bill video clip for the students. Ask students to connect their experiences with reaction times to what they noticed about the students in the video. Pose the final question: How might reaction times help explain why it is so difficult for the students in the video to catch the dollar bill?

Have student revisit the class model about the body systems involved in reaction times. Ask students if they think they need to revise or add anything to the model that would better explain how different body systems work together. Answers will vary based on the original class model. However, if additional systems are added, prompt students to also include how these new components interact with the existing components.

Next, prompt students to think about their investigation and their reaction times and the reaction times of the NASCAR drivers. Ask students to brainstorm ideas about their reaction times and the reaction times of the drivers. Have students make predictions about why NASCAR drivers might have such fast reaction times. Expected predictions might include these:

• They see things faster.
• Their muscles work faster.
• Their nerves move things faster.
• Their brains process faster.
• They are used to it: They practice a lot, so that makes them faster.
• Maybe it’s a combination, and everything is a little bit better.

Revisiting and/or revising a class model is a core tenet of science. Models are constantly revised in science when new evidence comes to light.

As students share ideas, use some probing questions to motivate reasoning and class discussion. Some suggestions include these:

• Does everyone agree?
• Tell me more about what you mean about…
• Who had the same idea as…?
• Why did you think ___ was important?
• How might that work?

In this discussion, the class still won’t know what contributes to the improved reaction time, so the purpose of this discussion is to make predictions based on what they know so far about reaction times.
Optional Activity

Ask students to add a page in their notebooks and title it Reaction Time. Create a three-column chart under the title with the following headings:

<table>
<thead>
<tr>
<th>Situations that need fast reaction time</th>
<th>Factors that affect reaction time</th>
<th>People who have (or might need) fast reaction time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To build a deeper connection to the phenomena, encourage students to think of situations in which they needed fast reaction time and to expand their thinking to the world around them by also considering other people who might need fast reaction times. Students add their ideas to the chart. Invite a few students to share some of their ideas with the class. If students don’t include driving a car as a situation needing fast reaction time, suggest it now. Ask what kinds of things drivers need to look out for and what tools cars have now to help drivers keep track of the road around them.

Say, “Today, we only tested sight, one of our senses. NASCAR drivers have some extra helpers as they drive around the track called spotters, who talk to them about other cars and what’s happening around them that they might not see. Are our reaction times the same when we hear stimulus vs. when we see stimulus? How could we test that?”

Consider this a potential formative assessment moment to see if students are making progress on 4-LS1-2. Responses might include the following:

- It takes time for students to react to the dollar being dropped.
- When the dollar bill is dropped, it starts moving. By the time the person reacts, the dollar bill is out of reach.
- The eye-brain-muscles system takes time to work.

Navigate to future lessons by asking this:

What does our experiment today really mean? The times and distances we used today are how far the car would travel before we reacted and don’t include the time it takes to stop. What variables might influence how long it takes a car to stop after we react?
When you’re at the track and the race begins, notice the spacing between the cars. Think back to our investigation, and consider reaction time.

1. Some things to watch for on the track are the following:
   - How do the NASCAR drivers move with the other cars on the track?
   - When do they seem to decide to brake, accelerate, or turn?
   - What seems to be prompting their decisions?

2. As the race goes on, follow one car and driver. Can you anticipate when they will turn? Brake? Speed up?

3. In the space below, draw a model of what you think is happening in the body that allows the driver to move so fast around the track. What body systems is the driver using?