

LET'S HEAR IT FOR THE EARS (1 Hour)

Addresses NGSS

Level of Difficulty: 4

Grade Range: 3-5

OVERVIEW

In this activity, students will explore the nature of human hearing by attempting to determine the location of coins dropping at different locations in a room. Then, they will design a hearing device to increase their sound-locating success.

Topic: Sound, hearing, and the human body

Real-World Science Topics

- An exploration of human ears and how they receive sound
- An exploration of scientific design and models

Objective

Students will gain an understanding of the benefits and limitations of the structure of the human ear. They will gain an understanding of the scientific design process.

Materials Needed for Teacher Demonstration

images of different animals

Materials Needed for Student Teams

- six pennies
- paper plates
- empty paper towel rolls
- tape
- scissors
- stapler
- paper cups

Materials Needed for extension Activity

coins of different denominations (penny, nickel, dime, quarter)

LET'S HEAR IT FOR THE EARS

STEPS FOR *LET'S HEAR IT FOR THE EARS*

- 1. warm-up Activity:** Introduce the lesson by showing your students several different images of animals. Ideally, the images should contain close-ups of the animals' faces, and specifically show the ears of each animal. A good example for this activity is the image of a deer. (A simple internet search should provide many suitable images.) As you view the images, ask students to make observations about the ears of each animal. Prompt student discussion by asking students to describe the shape of the animal's ear. Have them discuss how the ear looks similar to and different from a human's ear. Also, have them consider whether the shape of the ear might serve any purpose for that particular animal.

Point out any features of the animal's ear that your students may miss. For example, if you show students an image of a deer, students should note that the ears are quite large and pointed. Have students predict the advantages of these large, pointed ears and explain that students will continue this discussion at the end of the lesson. Explain that in this lesson, students will observe how the structure of our ears helps us hear things in our environments.
- 2.** Before dividing the class into groups, discuss the properties of sound and hearing. Make sure that your students know that sound is caused by vibrating particles. When sound travels through the air, it causes air particles to vibrate. Explain that these vibrating particles travel into our ears and make our eardrums vibrate. It may be helpful to have students think of the eardrum as a tiny trampoline in our ears. When the air molecules bump into it, they cause it to vibrate back and forth, similar to the way a trampoline moves up and down when people jump on it. The vibrations from the eardrum travel farther into the ear and are eventually converted into electrical signals that travel to our brains. Then, our brains recognize these electric signals as sound. You may deliver this information as a brief lecture, or you can ask questions of your students to understand what they already know about sound, the ear, and hearing.
- 3.** Divide the class into groups of 3-4 students. Give each group a small handful of coins. Instruct the groups to designate one member as the tester, another member as the observer, and a third member as the note keeper. If there are additional group members, tell them that these roles will rotate, and each student will play every part. Allow all groups to drop their coins on the ground a few times to listen to the sound and familiarize themselves with the sounds. If your classroom is carpeted, you may want to relocate students into an area with hardwood or tiled floors (such as the hallway, cafeteria, or gymnasium) so that the coin sounds will be more audible.
- 4.** Instruct the groups to complete all three parts of the following activity. It is best to space groups apart so that they cannot easily hear the coin drops from other groups.
 - **Part One:** The observer sits in a chair facing away from the other members of the group. The tester then stands behind the observer with the coins in his or her hands. Instruct the tester to stand in a location either to the right or left of the observer and drop one coin. The observer should then decide, without looking, if the coin was dropped on the right or left side. The note keeper should record where the drop occurred and where the observer believed the drop occurred. Explain that the tester can then remain in the same position or move quietly to the other side of the observer. Then, the group should repeat the coin-dropping, observing, and recording process for a total of six drops.
 - **Part Two:** Have the observer cover one ear with a hand to muffle the sounds in that ear. Then, have the tester repeat the coin-dropping process for a total of six drops.

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- **Part Three:** Have the observer hold a cardboard tube up to his or her ear. Again, have the tester repeat the coin-dropping process for a total of six drops. The same tester should drop the coins and the same note keeper should record the results for all three parts of the activity.
5. If time permits, repeat the process outlined in Step 4 so that each student has a chance to play each of the roles. Circulate as students work to make sure that groups repeat the same process. (Note: Students will need to create additional data tables in order to record data.)
 6. Allow students time to analyze their results and complete Question 2 on the **Student Handout**. Have students think about why they may have been more successful during one part than during another part of the investigation.
 7. Challenge students to make devices that will help increase their success at locating the source of the coin drops. Distribute the materials, shown to the right.

Encourage students to think about how sound travels and why the shape of our ears is important, and instruct them to think back on the activity as they design. Then, allow students to perform the coin-dropping process to test the efficiency of their hearing aids. If time permits, allow students to modify their designs and retest them.



8. **w rap-up Activity:** After students have designed and tested their devices, allow groups to share their designs and results with the class. As they share, ask questions to get them thinking about ear design, such as:

- What features are present in our ears? Are these same features present in your hearing device? Why or why not?
- What makes your hearing device different from a human ear?
- What features made the hearing device more or less successful than others? Why might this be the case?
- Do you think the human ear could be improved? Does your design improve the human ear?

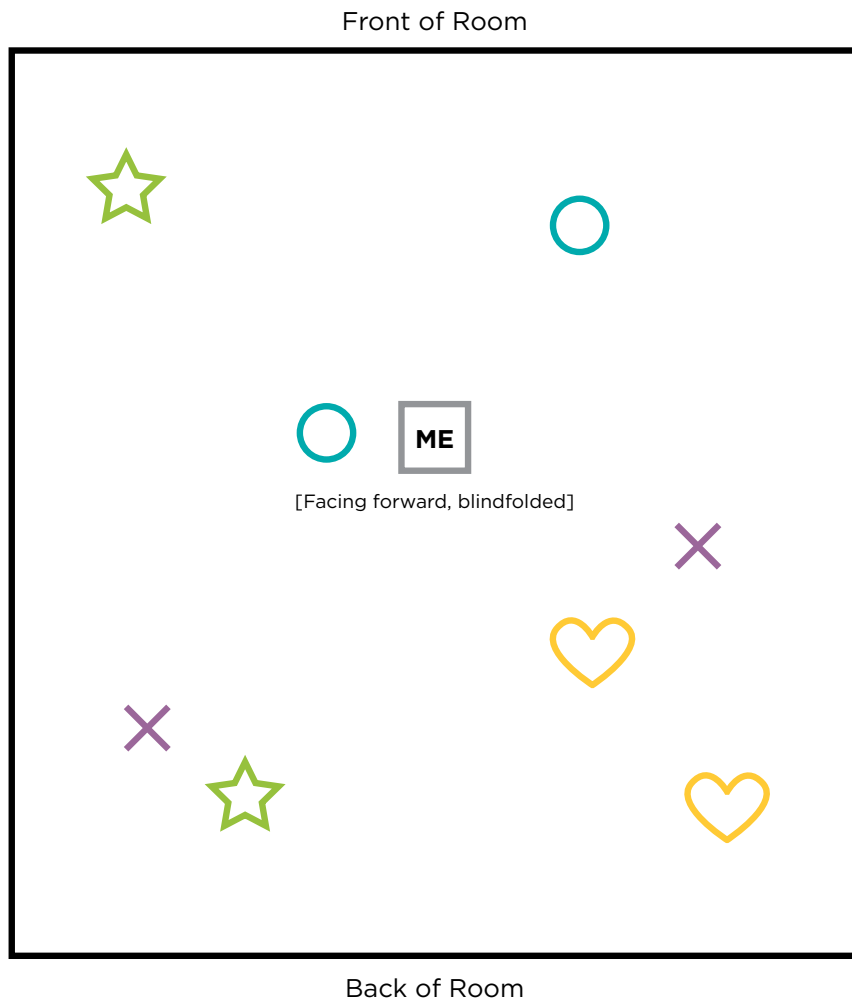
Have students think back to the design of the animal ears they observed at the beginning of the class. If you showed students the image of a deer, ask students if they can think of a reason why large, pointed ears would be helpful for a deer. (Prompt students by having them think about all of the predators of a deer.) Explain that deer must always be wary of predators, and large ears help alert them to dangers by funneling more sound from the environment into their ears.

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***Let's Hear It For the Ears!* extension Activities**

1. Once all students have completed the activity, take a moment to drop each coin (quarter, dime, nickel, and penny) in front of the class, instructing students to listen carefully to the different sounds each coin produces. Then, repeat the activity. This time, students should not only attempt to identify where the coins are falling, but they should also try to identify which coin is falling. Students can create a new chart to show both the location and the denomination of the coins dropping. Finish by having students discuss why they believe the ear is able to distinguish between very similar sounds.
2. Work with your students to create a sound map. To do this, each student needs a blank piece of paper. The paper represents the entire classroom. Students should mark their approximate location in the room on the paper. Instruct students to create a simple symbol for each coin (such as an "X" to represent a quarter, a "heart" to represent a penny, and so on). Then, blindfold students or instruct them to close their eyes. Quietly move about the room and drop different denominations of coins. After each drop, allow students to take off their blindfolds and mark the location at which they believe the coin was dropped as well as the denomination of the coin. (For more advanced classes, have students create a grid of the classroom on their sound maps.) When you have finished, students may take off their blindfolds. Show them the location of each dropped coin, and allow students to share their results. The image on the next page shows a sample sound map. This activity can be repeated, allowing students to use their "hearing devices" from Part Three of the activity.

SOUND MAP



KEY	
×	Quarter
○	Dime
☆	Nickel
♡	Penny

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BACKGROUND INFORMATION

How does sound travel to the ear?

Sound is a vibration of particles in a medium caused by an initial disturbance, such as a plucked guitar string. The guitar string vibrates and causes the particles of air around it to vibrate as well. The vibrating air particles, in turn, bump into other air particles, which causes them to vibrate, and so on. This is how sound waves are transmitted through any medium. The sound waves move away from the source of sound in all directions. When sound waves enter our ears, we are capable of perceiving the sound.

What happens once sound hits our ears?

When sound waves enter our ears, the sound is funneled inward toward the eardrum. The eardrum is a thin elastic membrane that is stretched over the base of the ear canal, similar to the head of a real musical drum. The vibrating particles of a sound wave cause the eardrum to vibrate. The vibration of the eardrum then vibrates the small bones in the ear, called the ossicles. The ossicles, which include the anvil, hammer, and stirrup, are the tiniest, most delicate bones in our bodies. From there, sound enters the cochlea, which is a small, liquid-filled tube in the inner ear. The vibrations of the ossicles cause the fluid in the cochlea to vibrate. When the cochlea vibrates, it causes small hairs in the inner ear to move. The movement of these hairs is transformed into nerve impulses, which travel to the brain. Once these nerve impulses reach the brain, the brain translates the impulses into sound messages. Our brain is able to recognize and identify thousands of different sounds.

What are the parts of the ear that make hearing possible and efficient

The first important part of the ear is the outer ear. The design of our outer ear helps funnel sound inward, focusing the sound waves onto our eardrums. The outer ear, the part that we can see, is called the auricle. Another part of the outer ear is the ear canal. The ear canal also helps funnel sound inward toward the eardrum.

The middle ear contains the eardrum and the ossicles. The eardrum is a small piece of skin that vibrates with the sound waves. The eardrum causes the ossicles to vibrate, which amplifies the sound and sends the vibrations deeper into the ear.

The inner ear is where vibrations are converted into nerve impulses. Sound enters the cochlea, which is a hollow bone, shaped like a spiral. The fluid within the cochlea moves much like water waves, causing the thin hairs surrounding it to sway and move. Most hearing loss is the result of damage to these sensitive hair cells in the ear. These hairs then turn sound into nerve impulses that travel to the brain. The entire process happens in a fraction of a second.

Key vocabulary

eardrum: tightly stretched skin in the middle ear that vibrates in response to sound

sound: vibrations that travel through a medium such as air

vibration: the back-and-forth movement of particles

STUDENT HANDOUT FOR *LET'S HEAR IT FOR THE EARS*

Name:

Date:

1. Fill in the following table for each coin drop.

Dr OP #	PAr T ONe		PAr T Tw O		PAr T THree	
	Guess	Correct?	Guess	Correct?	Guess	Correct?
1						
2						
3						
4						
5						
6						
Fr Ac TiON cOrrec T						

2. Now, represent the times you were correct (for all three parts of the activity) with a fraction and a percentage. Add your answers to the chart above.

STUDENT HANDOUT *FOR LET'S HEAR IT FOR THE EARS*

3. In which part of the activity were you most successful and why?

4. In which part of the activity were you least successful? Why do you think this was the case?

STUDENT HANDOUT *FOR LET'S HEAR IT FOR THE EARS*

5. Draw a quick sketch to show the ear device your team created. Label all of the parts and important features of your model.

6. Do you think the human ear is an efficient design? Why or why not? In your answer, refer back to this activity.