



# Vibration and Hearing

NC Standard 6.P.1.2

Grade 6 Physical Science

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## Activity Description & Estimated Class Time

**Throughout the guide, teaching tips are in red.**

In this 50-minute activity, students begin by discussing sound and problems with hearing. Pairs of students then assemble a model of the ear from components, using only prior knowledge. Afterward, the teacher leads the class through the functions of each component of the ear, and students reassemble their model of the ear. The teacher then introduces a diagram of the ear and a series of hearing maladies. The class uses these to discuss the path of sound from the ear to the brain.

## Objectives

Students will develop an understanding of the relationship between vibration and hearing.

Note: Rate of vibration and variations in medium are covered in the activity “6.P.1.1 Properties of Waves,” in this unit. The teacher can connect longitudinal waves taught in that lesson to hearing and the ear in this lesson.

## Correlations to NC Science Standards

6.P.1.3 Explain the relationship among the rate of vibration, the medium through which vibrations travel, sound, and hearing.

## Brief Science Background

Physical vibrations in materials can produce sounds, and sounds can produce physical vibrations in materials. Plucking a guitar causes the string to vibrate, producing sound. Likewise, sound striking a guitar can cause its strings to vibrate. Vibrations travel from place to place through solids, liquids, and gases. A person with an ear pressed to a solid door can hear sounds on the other side. Whales hear each other under water. Vibrations from a thunder-clap move through miles of air to rattle windows. No matter what material sound moves through, it causes tiny movements (vibration) all along its path. The ear uses these vibrating movements that sound produces. The ear funnels the vibrations to a small drum attached to tiny bones. The drum moves in response, and moves the bones. The bones transmit the movement to a tube filled with liquid, causing the liquid to move. Sensitive hairs in the liquid respond to movement by sending a signal to the brain. To become the nerve impulses that we hear as sound, vibrations travel through air, solid bone, and a liquid.



**Materials**

**Materials for the Whole Class**

- BLM 1 Ear Component Functions
- BLM 2 Ear Diagram
- BLM 3 Ear Problems

**Materials for Pairs of Students**

- one set of ear component cards
- 1 science notebook per student
- removable tape

**Preparation**

Punch out the ear component puzzle piece sheets and place one complete set of randomly-numbered (unlabeled) ear component puzzle pieces in an envelope. Be ready to give these out, one per pair of students, but withhold them until step 2 of the procedure.

**Procedure**

1. Ask for a show of hands responding to the following questions:
  - Who had or knows someone who has had “tubes” in their ears when they were younger?
  - Who had or knows someone who has had “swimmer’s ear?”
  - Who has had people tell them not to turn up their earbuds too loud?
2. Explain that we will explore the ear to make sense of some of the things that happen to the ear. Point out that sound comes in the ear and then somehow gets to the brain. If that pathway is clear, there is no problem. However, lots of things can go wrong with that pathway.
3. Give each pair of students the puzzle pieces and 12 inches of removable tape. Ask each team to spread out the puzzle pieces so that they can see them all and say that these are components of the ear. Say that all of these are necessary for people to hear sounds. Ask teams to tape the pieces together the way they think they are arranged inside the ear. They will have to explain how they think sound gets into the ear, through each component, and to the brain. Allow 5 minutes.
4. As teams finish, ask them to meet with another team and compare models. Ask them to justify to each other why they have put the pieces where they have them. If class discussion seems reasonable at this time, it could be useful to get a lot of ideas out.
5. After teams finish comparing models, say that you have information that explains what each part of the ear does, and names each part. Tell the class that they have exactly 10 minutes to get as much of this information from you as they can. Tell them that when you finish giving this information, each team will use what they learned in this 10 minutes to reassemble the ear model.



6. Ask: “Which number part do you want to know about?” When someone gives you a part number, read the description of the function and the name of the part. Repeat this until you have gone through all of the parts of the ear.
7. Give students another 5 minutes to reassemble their ear models based on what they have learned. As teams finish, again ask them to meet with another team to compare models. **The path of sound from the air to the brain is k, t, x, d, r, b, m, i.**

### **Wrap-Up**

1. Project BLM 2, Ear Diagram. Give the class a minute or so to reassemble their models according to the diagram. Together with the class, trace the path of sound through the ear. Try to get students to do as much explaining as possible. Point out where sound travels as a vibration in air, in a solid **bone** and in a liquid **fluid in the cochlea**. Point out the outer, middle, and inner ear.
2. Project BLM 3, Ear Problems. Discuss with the class how each problem interferes with the path of sound from the ear to the brain. As you go through ear problems, give the following symptoms and ask students to “diagnose” the problems and relate them to the models of the ear.
  - Ringing in the ear
  - Muffled hearing



### Guided Practice

Guided Practices are similar to typical tests, but require students to reveal their thinking about content. They serve as a practice before a test and should not be graded. They are intended to expose misconceptions *before* an assessment and to provide opportunities for discussion, re-teaching, and for students to justify answers. They are best given as individual assignments without the manipulatives used in the activity. In that context, pose the following “test items” to the class. Ask them to write responses in notebooks.

1. Complete the following sentence with the correct response: To be heard, sound travels...
  - a. ...as a ray that passes through the eardrum and excites nerves in bones of the skull.
  - b. ...as movements in air that vibrate the outer ear, which is connected to the eardrum, causing it to emit nerve impulses.
  - c. ...as vibrations in air that are channeled down the ear canal and strike the eardrum, which transfers vibration to a set of tiny bones that move fluid in a canal that triggers nerve impulses to the brain.
  - d. ...as a ray that travels into the ear canal through the cochlea, then through bones connected to nerves that send impulses to the brain.

Ask students to explain why the wrong answers are wrong.

2. Complete the following sentence with the correct response: Sound travels...
  - a. ...as a vibration through many different kinds of materials, including, solids, liquids, gases.
  - b. ...through a vacuum or through air, but it cannot travel through solids or liquids.
  - c. ...as very fast vibrations through solids, slower vibrations through liquids, and the slowest vibrations through gases such as air.
  - d. ...through air, and because of this, the ear must transmit the signal to the brain through air.

Ask students to explain why the wrong answers are wrong.

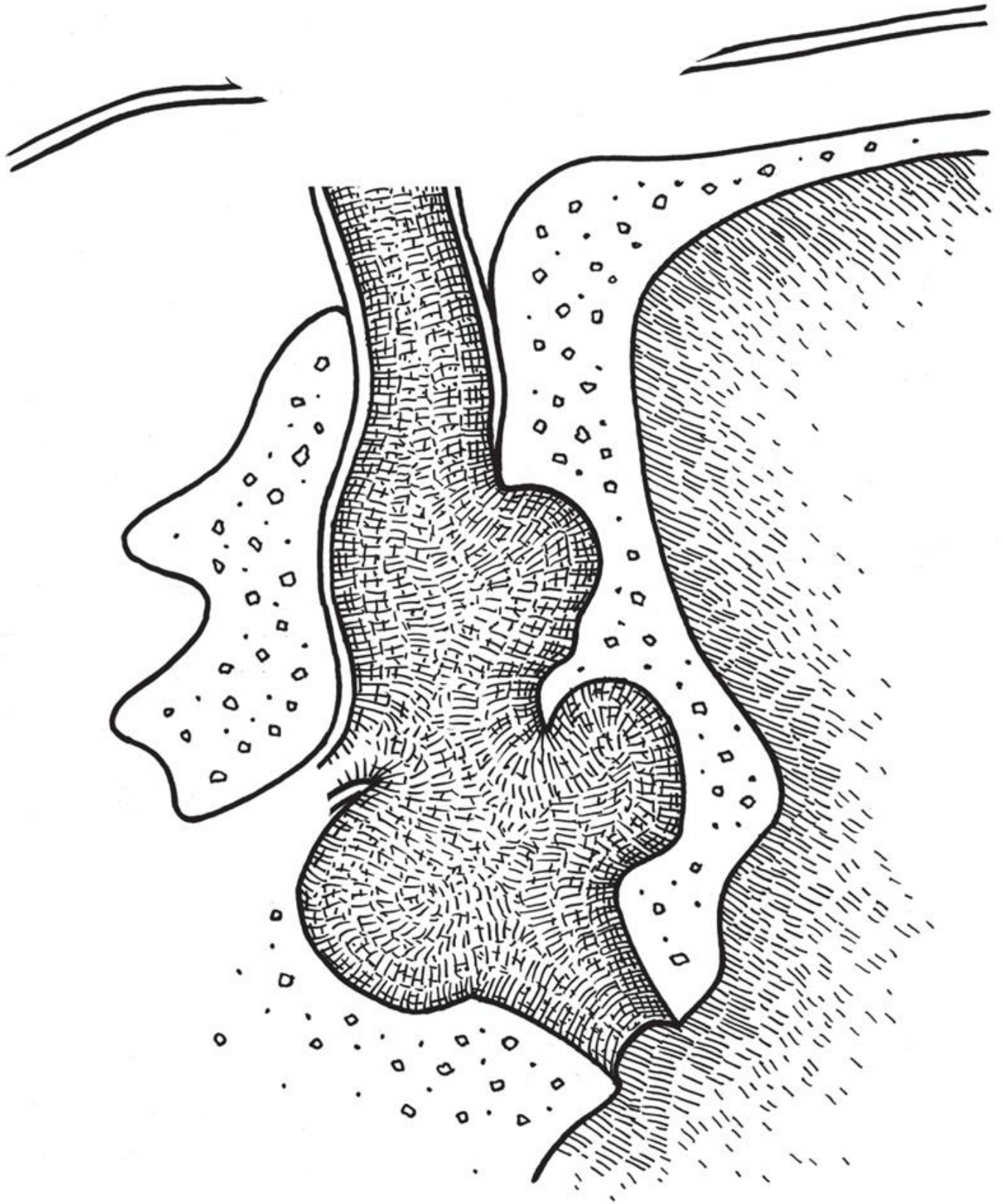
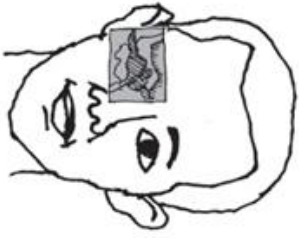
### Answer Key

- #1 b. is correct. Sound travels as a vibration in air that is channeled down the ear canal and strikes the eardrum, which transfers the vibration to tiny bones that move fluid in a canal, triggering nerve impulses to the brain.  
**Explanations of wrong answers should touch upon the chain of events as sound travels through the ear.**
- #2 a. is correct. Sound travels as a vibration through many different kinds of materials, including, solids, liquids, gases.

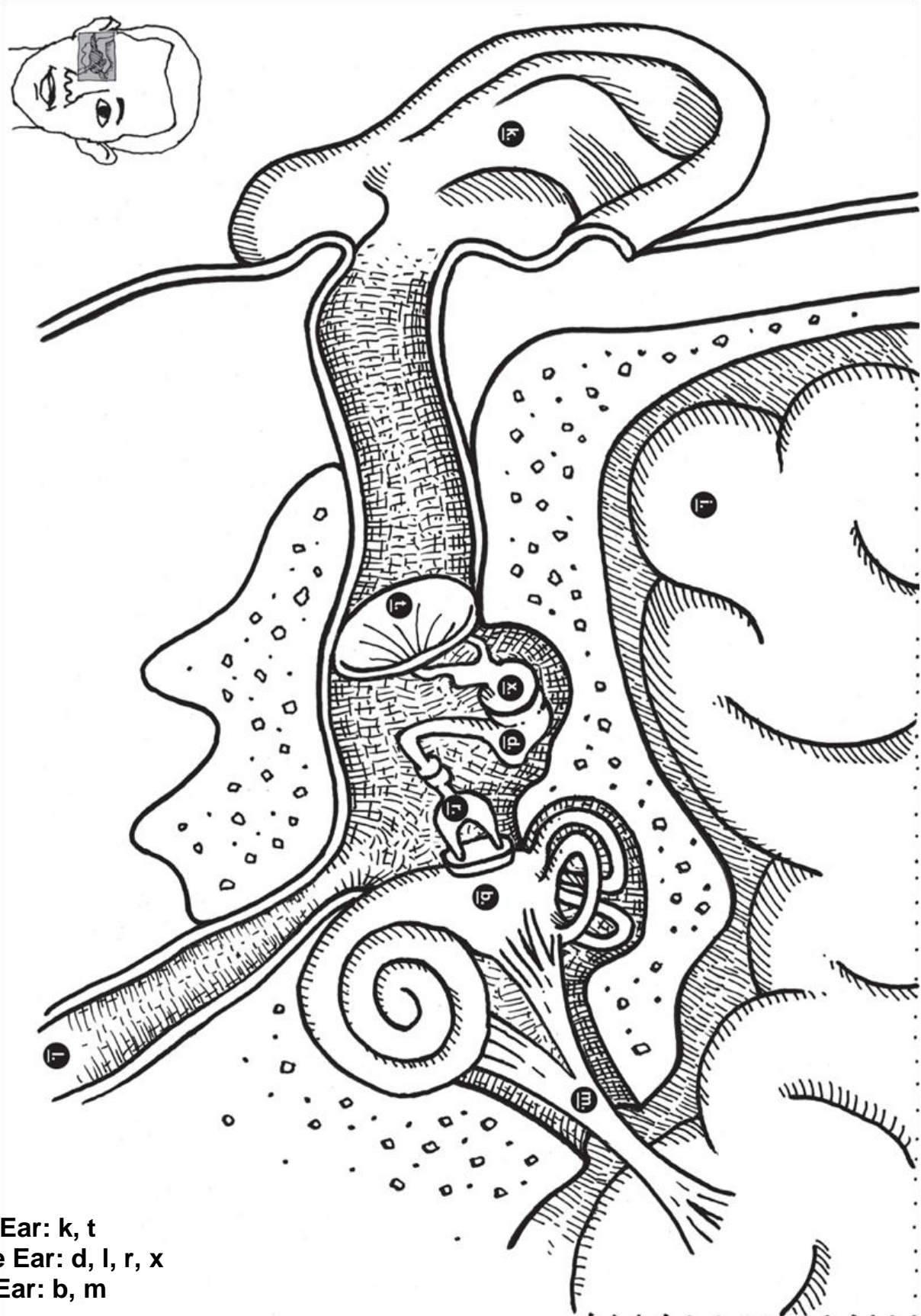
Sound cannot travel in a vacuum, but it can travel through solids, liquids, and gases. The ear transmits the signal to the brain through solids and liquids.

**BLM 1**

- b. This fluid-filled snail-shaped sack in the inner ear contains hair cells attached to nerves, which transmit sound information to the brain. Attached to it are three fluid-filled tubes containing hairs that sense movement to provide the sense of balance: **Cochlea**
- d. One of three tiny bones in the middle part of the ear between two other tiny bones, receiving vibration from one and transmitting it to the other: **Anvil Bone**
- i. This part receives nerve signals and makes sense of them as sound: **The Brain**
- k. This part gathers sound from the air and channels vibrations through a canal to the eardrum: **Outer Ear and Ear Canal**
- l. This tube connects the middle ear and the back of the nose. It allows fluids to drain from the middle ear and lets air pass to equalize pressure between the middle ear and the atmosphere: **Eustachian Tube**
- m. This nerve sends all of the information from the nerves in the cochlea to the brain: **Auditory Nerve**
- r. One of three tiny bones in the middle ear, the smallest bone in the body, this bone receives vibrations from the other small bones and transmits them to the inner ear: **Stirrup Bone**
- t. This thin, sensitive membrane stretched over the entrance to the middle ear vibrates when sound strikes it. It passes vibrations on to the tiny bones in the middle ear : **Ear Drum**
- x. One of three tiny bones in the middle ear, attached to the eardrum and to another bone. When the eardrum vibrates, it passes vibration to the other bone, which passes it to another bone attached to the inner ear: **Hammer Bone**



BLM 3 Ear Diagram



Outer Ear: k, t  
Middle Ear: d, l, r, x  
Inner Ear: b, m

## **BLM 4 Ear Problems**

### **Tubes in Ears**

Young children who have colds, allergies, or small ear canals can have a middle ear blocked with mucus, leading to infections and muffled hearing. Normally, a passage between the middle ear and back of the nose, called the eustachian tube, equalizes air pressure with the outside world, but the tube can be closed for many reasons, and pressure builds up. To relieve all of these problems, doctors can insert spool-shaped plastic tubes through the ear drum to equalize air pressure in the middle ear, reduce pressure, and allow fluid to flow out. The tubes generally reduce pain in the ear.

### **Swimmer's Ear**

Sometimes, the outer part of the ear and ear canal can become infected because the ear canal has been compromised. Normally, the ear canal is lined with antibacterial ear wax and fine hairs to trap debris, but extra moisture from showering or swimming can alter the antibacterial qualities of ear wax, allowing bacteria and fungi to invade. Ear plugs, ear buds, hair dyes, bleaches, and shampoos in the ear canal can also disrupt the protective lining. The result is a red ear (usually just one), painful when touched. In severe cases, the ear canal may swell shut and drain clear, white, or yellow fluid that can crust over the ear. Severe cases can result in some temporary hearing loss, ringing in the ear, and dizziness.

### **The Problem With Ear Buds**

Damage to the cochlea can reduce hearing impulses to the brain. When tiny hair cells in the cochlea are damaged or degenerate as we grow older, people notice a loss of high-pitched sounds, then difficulty understanding speech in noisy surroundings. About half of people over 70 have impaired hearing for this reason. Young people get it when loud noises damage hair cells in the cochlea. Playing music through ear buds at high volume can damage these cells. As of now, damaged hair cells cannot be replaced. Sometimes, hearing loss is accompanied by a ringing sound with no external cause, called tinnitus. About 1 in 5 people between 55 and 65 report tinnitus.

### **Conductive Hearing Impairments**

Sometimes malformation or malfunction of bones in the middle ear can reduce the vibrations that are conducted to the cochlea. Injuries such as a severe blow or infection to the ear can damage the hammer, anvil, and stirrup bones so that they transmit less vibration. Sometimes, the hammer and anvil are separated, or the anvil bone is broken or eroded from recurrent ear infections. Some injuries or infections can also separate the anvil from the stirrup or erode the stirrup so that it no longer connects with the inner ear. Any of these conditions greatly reduce hearing.

### **Ruptured Eardrum**

The eardrum is a thin membrane separating the outer and middle ear. A blow to the ear, foreign objects in the ear (often a cotton swab used to clean the ear), or pressure from infection inside the ear can break the eardrum or put a hole in it. When the eardrum is damaged, hearing decreases because the middle and inner ears receive less vibration coming from the outer ear.





## Appendix

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### Common Student Preconceptions About This Topic

When young children are asked how they hear a clock ticking, they often say something like, “I hear the clock because I am listening,” or “I hear the clock because it is ticking.” About half of 11-12 year-olds give descriptions of this kind, but by age 16, most children can refer to vibrations traveling through air and the eardrum. However, a significant number of 12-16 year-olds also give explanations involving an active ear that “picks up sound” by tapping into and seeking out the source of sounds around it. Some children in this age range also view light and sound as similar, traveling in “rays.”