How Do You Make Sound?

Teacher Information

Background Information

Imagine being able to speak to someone without ever making a sound. That's the idea behind the subvocal speech project at NASA's Ames Research Center. Researchers have found that when people think of something to say, the brain sends out faint electrical signals with that same message – even if the person never speaks the words out loud. When researchers magnify those electrical signals and translate them into real words, people can think a message and the message will be turned into words. This is a form of voice recognition. It sends a message while cutting out the breath and sound vibration parts of speech. This technology is called subvocal speech. Subvocal means "below the spoken voice," referring to the nerve signals to the muscles that we use when we produce sounds.

Why would we want to speak to people without actually speaking? This technology would make it easier for people to communicate in loud environments, or when speech is not actually possible. For example, SCUBA divers working underwater cannot actually talk underwater. Using the subvocal speech technology, though, divers could easily communicate.

In this lesson, students will learn about how the vocal cords work to make us able to create sounds and speak. They will also learn how vibrations are what actually cause the sound when we speak.

Key Concepts and Student Information

- Vocal cords – structures that vibrate to create sound when we speak
- Subvocal speech – communicating without actually talking

Materials

NASAexplores 5-8 article, "Do You Hear What I'm Saying?" (1 copy per student)
Student Sheets (1 copy per student)
Thick rubber band (1 per pair/group)
Thin rubber band (1 per pair/group)
Plastic cup (1 per pair/group)
Drinking straw (1 per pair/group)

Procedure

1. Read the NASAexplores 5-8 article, "Do You Hear What I'm Saying?" Discuss the article and answer any questions the students may have.
1. Ask students if they know what makes sound when they speak. *Vocal cords.* Ask students to place their fingers on the front of their throat and hum. What do they feel? *Vibration.*
2. Explain that students will complete an activity to understand how vocal cords work.
3. Distribute Student Sheets and materials. Go over instructions; answer questions.
4. Allow time for students to complete activity and answer questions on the Student Sheets. Provide assistance as needed.

Teacher Information (Continued)

Enrichment Activities

- Have students experiment with various size and width rubber bands to see how the rubber band size affects the sound made by the vibrations.

Answers to Student Sheet Questions

a. When you blow across the rubber band, it starts to vibrate. You can feel this vibration when you hold the cup. If you blow on it just right, you can actually hear a sound made by the vibration. This happened because the air moving past the rubber band made it vibrate.
b. Just like the rubber band in the experiment, the vocal cords vibrate when air rushes past them. This vibration creates sound.
c. Yes, the sound made by the vibration was higher-pitched.
d. The thinner rubber band stretches more tightly across the top of the cup, so it vibrated more quickly. This caused it to make a higher-pitched sound. This is similar to the vocal cords because when they become more tightly stretched, your voice makes a higher-pitched sound.
e. A lower pitch could be made by a thicker rubber band, or one that is looser across the top of the cup. Higher pitches can be made by thinner, tighter rubber bands. Student explanations may vary.

Do You Hear What I'm Saying?
NASAexplores article, August 25, 2004
http://www.nasaexplores.com/show2_articlea.php?id=04-056

Have you ever noticed that when you concentrate on what you're reading, your lips sometimes move and silently speak the words? There's a reason for that. The brain sends out electrical signals that connect thinking and speech. We often avoid "reading with our lips" because it slows down the process, but it's a natural connection. Researchers at NASA are learning how that thought-speech connection can be used for better communication.

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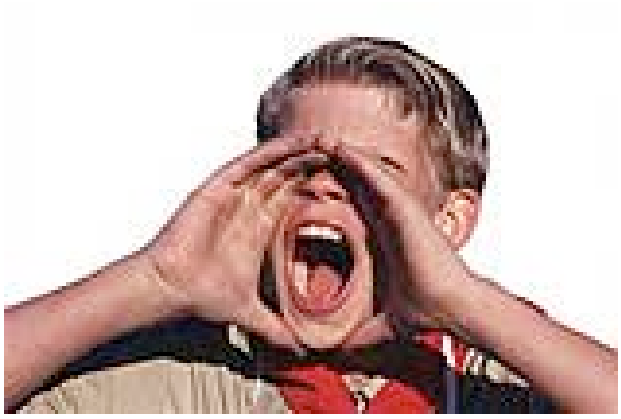
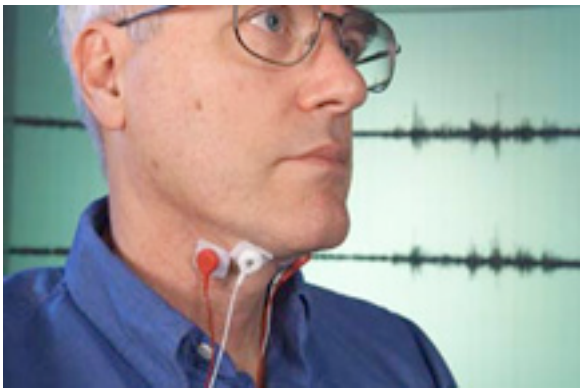


Yelling is one way of sending a message to others. Why would it be useful to speak without using your voice? "People working in high-noise areas, such as construction sites or airports, could use subvocal communication to send commands and instruction for tasks when they otherwise couldn't be heard," says Chuck Jorgensen, chief scientist for neuroengineering at NASA Ames. "People who have suffered damage to their vocal cords could communicate by thinking, rather than speaking, their thoughts. Space explorers who may get injured while on Mars could use subvocal speech to call for help. And when sitting in a crowded room, people could ask each other a private question without bothering the rest of the people." Passwords could be entered without anyone else hearing the word. Deep sea divers could communicate to diving partners in an environment where words are impossible. Telephone calls could be conducted silently.

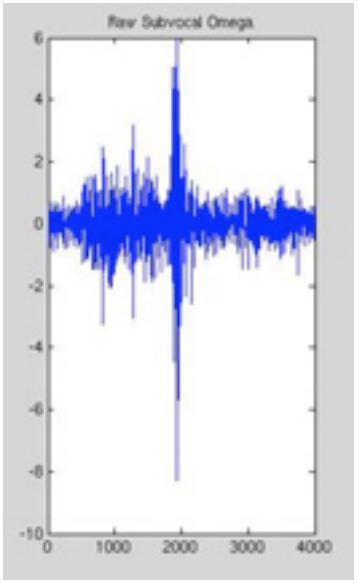
Do You Hear What I'm Saying? (Continued)

Don't get the wrong idea about subvocal speech, though. It's not mind reading. It's just like typing a word on a computer keyboard, but the message is sent by thinking the idea rather than by typing the words. Subvocal speech is totally voluntary; nobody forces anyone to think on demand.



To make this technology work, small electrodes are placed on the throat near the larynx. The signal that is created by thinking is captured and recorded. The list of recorded nerve patterns creates a type of dictionary that a computer remembers. So far, the system is able to recognize a few words, and only words spoken by a particular voice. As the system improves, it will be able to recognize more words and more speech patterns.

Researchers use numbers to code the alphabet into a matrix, so that 1,1 is the letter a, and 1,2 is b, and so on. They do this because subvocal speech technology cannot yet recognize the alphabet. In a demonstration, NASA researchers were able to control a small Mars rover by directing the rover without any audible sound to go to different locations. Commands such as right and left were thought, but not spoken, and the rover responded.



Everyone's voice creates a unique pattern.The electronic "signature" put out by your muscles is unique, just like fingerprints, Jorgensen says. Identifying the various signals that translate into different sounds and words is the challenge the researchers face now. Not only is every word different, but each person pronounces those words a bit differently, too. Regional accents and individual pronunciation create big differences in the signal.

Because English has so many different ways to pronounce the same letters, the researchers decided to use Latin when they first experimented with subvocal speech. English has diphthongs—combinations of vowels that create unique sounds, such as the word "voice"—and depending on how the letters are arranged, letters can have several different pronunciations. "Nasal languages, such as English and French, turned out to be much harder to develop into subvocal speech," says Jorgensen. "Languages with hard, guttural sounds, like German and Japanese, are easier. They are more consistent in how each letter is pronounced. And, Latin was the easiest tool for pulling out sounds and making consistent pronunciation. So, there's one more reason to know another language!"

How Do You Make Sound?

Student Sheet

Objective
To understand how the vibration of the vocal cords create sound.

Materials
Large plastic cup
2 Rubber bands – 1 Thick and 1 Thin
Drinking straw

Procedure
1. Read the "Do You Hear What I'm Saying?" article from NASAexplores.
2. Place the thick rubber band vertically around the cup so that it stretches over the top of the cup.
3. Make sure the rubber band is not twisted at any point around the cup. It should be flat completely around the cup.
4. Place the cup bottom flat on top of a hard surface, like your desktop.
5. Using the straw, blow a current of air across the rubber band at the center of the cup opening. What happens?
6. You may have to experiment with the angle at which you blow air at the rubber band to get it to work. Make sure you firmly hold the cup on the top of your desk.
7. Answer the questions below.

Questions

a. What happened when you blew air across the rubber band? Why did this happen?

_____
_____
_____

b. Compare what happened in this experiment to what happens to your vocal cords when you speak.

_____
_____

c. Try the experiment again with the thin rubber band. Did anything change?

_____

d. How was the experiment different with the thinner rubber band? How is this similar to what happens to your vocal cords when you speak?

_____
_____
_____

e. How could you make the sound created by the experiment have a lower pitch? Could you make it have an even higher pitch? Explain your answer.

_____
_____