Vocal Fold Straws

Demonstration

Participants will learn about vocal folds and how vocal fold vibration is responsible for human voice.

Number of Participants: 2-10

Audience: Middle school and General Public (ages 11-13) and up

Duration: 5-10 mins

Difficulty: Level 1

Materials Required:

- Straws (1 for each participant)
- Scissors (regular or safety scissors)
- Computer or other device with a screen
- Videos of vocal folds

Setup:

1. Flatten 3-5 inches of the straw.
2. Cut two lines to create a triangle wedge as shown in figure.

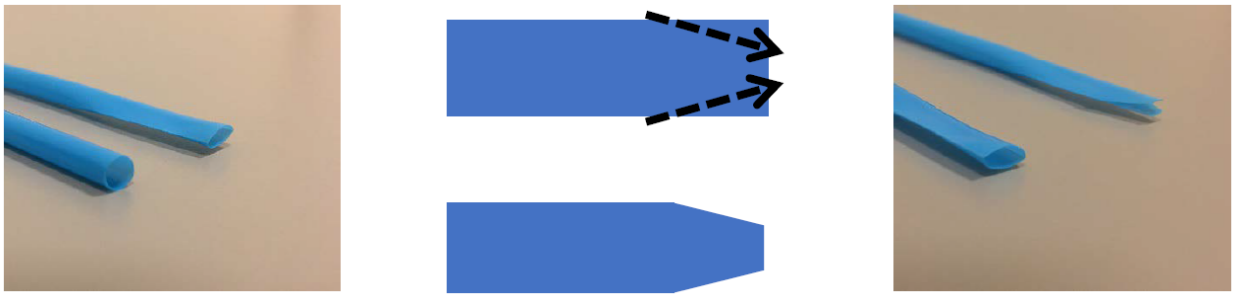

Figure 1: The process of creating the vocal fold straw (Source: SPS Straw Oboe Demo)

3. To create a buzzing, purse your lips and some pressure from your lips or teeth, then blow. A few attempts may be necessary.

Presenter Brief:

General knowledge of sound waves is required. The presenter should be able to distinguish between a longitudinal and transverse wave and understand how we hear sound. In addition, the presenter should be familiar with the basic mechanisms for human speech, particularly the vocal folds. Understand that air passing through the

vocal folds causes sustained oscillation via pressure gradients and the Bernoulli principle. The vocal folds produce a buzzing sound, which is the basis for most human speech and singing. This same principle is how reed instruments work.

Vocabulary:

- Wave - A disturbance that can transmit energy and information while not transporting the medium.
- Frequency - How many cycles per time an oscillation happens, measured in Hz or cycles/second.
- Wavelength - The distance between two corresponding points, such as peak to peak, on sequential waves.
- Vocal Folds - Two small bands of muscle within the larynx that vibrate to produce the voice.
- Larynx - Commonly known as the voice-box, a hollow muscular organ that forms an air passage to the lungs and holds the vocal folds.
- Bernoulli Principle - An increase in the velocity of a fluid (typically air) causes a drop in pressure.

Physics & Explanation:

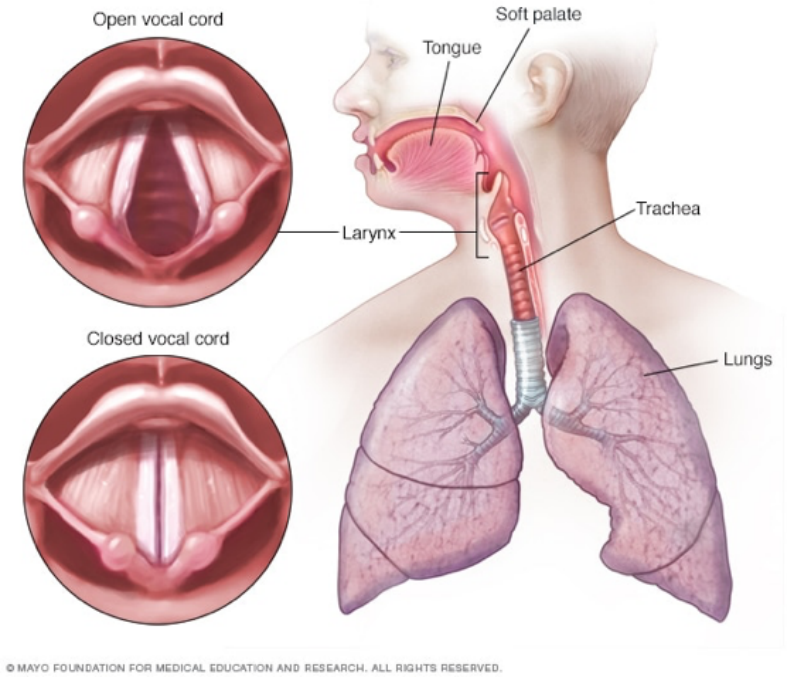

Figure 2: a diagram of the vocal folds and the location on the neck (Source: Pulmonary Performance Institute[1])

Middle (ages 11-13) and general public:

Sounds are vibrations in the air and are also waves. To create these vibrations, objects need to vibrate very fast and collide. That's why when something drops on the floor a sound is created, or why you can feel a speaker vibrating.

When you blow air through the slits on the straw, you will notice there is a buzzing noise. This is caused by the two flaps hitting each other repeatedly. The reason why blowing through the flaps causes the buzz is due to a principle called Bournoulli's Principle. It states that fast moving air creates a lower pressure, and high pressure wants to go to low pressure. This means that we are creating a low pressure area in between the straw flaps, and the higher pressure is pushing the flaps together.

Now what about our voice? Where does our voice originate? Our voice actually originates from the neck from an organ called the vocal folds. They work very similarly to the flaps on the straws. When we push air from our lungs through the vocal folds, it causes them to vibrate creating a buzzing sound which is our voice. Our tongue is what allows us to create different vowels and articulate. Try putting your hand in the upper middle of your neck (see *Figure 2*) and when you talk you'll actually be able to feel your vocal folds buzzing.

🔑 Our voice is buzzing caused by the repeated collisions of vocal folds caused by the Bernoulli principle, which is similar to the flaps on the straws.

High School (ages 14+):

Sound waves are created by objects vibrating, and sound is simply air that is vibrating. Sound waves are longitudinal waves, meaning a difference in air pressure is how sound travels. It is akin to pushing a slinky back and forth rather than up and down. Objects vibrating can be caused by collisions as well, hence why dropping a pan on the floor makes a loud sound.

When you blow into the straw, you'll hear a buzzing sound. What would be causing that sound? Turns out it is the flaps on the straw that creates the buzzing. The two flaps are repeatedly slapping into each other at a high frequency, and thus creates the buzzing. The harder you blow, theoretically the higher the pitch can get as the frequency of the collisions increases. The way this works is via the Bernoulli Principle. The Bernoulli Principle states that when a liquid (in this case air) moves over a surface with a velocity, the air pressure decreases. Since high pressure wants to move to low pressure, there is a force applied on the object. The flow of air in between the flaps on the straw has a lower pressure than outside, causing the flaps to fold in. The constant blowing keeps pushing the flaps back open, causing the buzzing.

Now what about our voice? Where does that come from? It actually originates in our throat from an organ called the vocal folds. When you speak or say “ah”, put your hand on the middle of your throat and you’ll feel a vibration. The vocal folds work very similarly to the buzzing straw, but there are a few more mechanisms at work.

Rather than just slapping back and forth, the vocal folds move in a more wavelike motion. This is a result of not only the Bernoulli Principle, but also a pressure differential greater than Bernoulli. When the bottom of the folds open, air rushes in and forces the top open. Since above the vocal folds have lower pressure, as the air rushes in the top begins to close and the process repeats. It operates very quickly and we need slow-mo cameras to capture it. See *Figure 3* for a good diagram explaining the pressures and forces.

🔑 The primary source of human speech is the vocal folds which are located in the neck. These vibrate as a result of the Bernoulli principle and pressure differentials, similar to how the straw flaps vibrate.

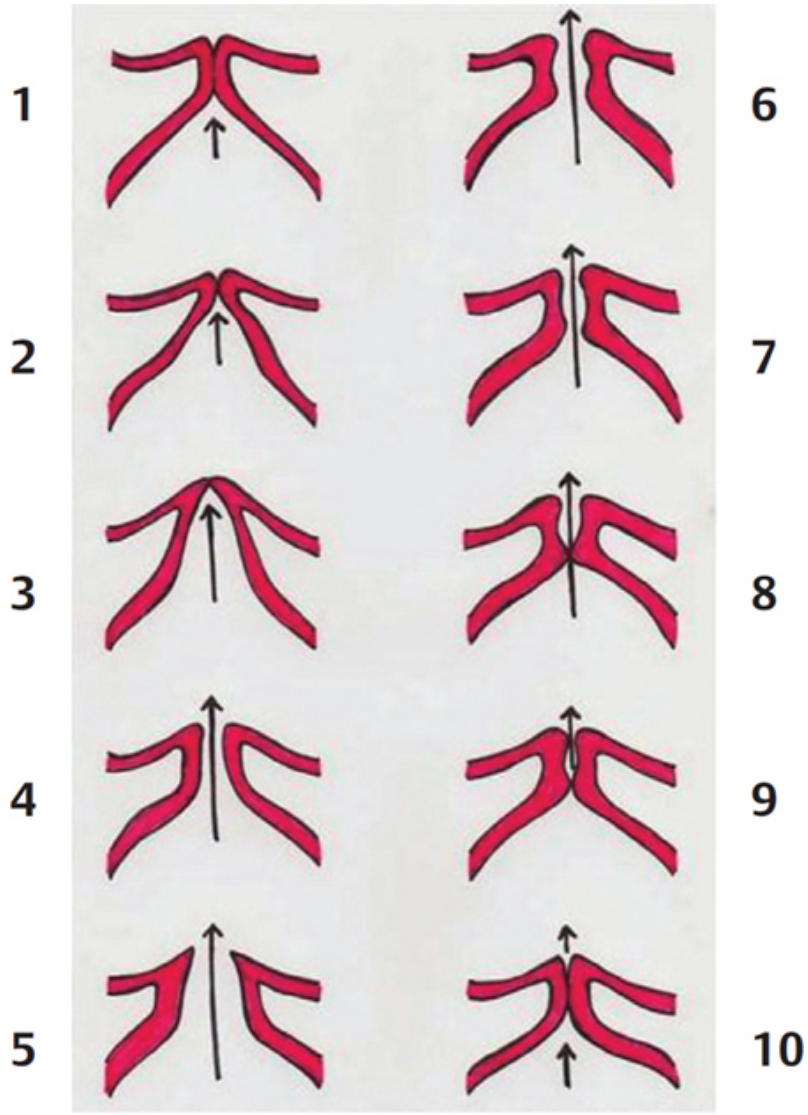

Figure 3: a diagram showing airflow and pressure in a step by step manner (Source: Ento Key[2])

Additional Resources:

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References:

1. https://pulmonary-performance.com/2020/03/15/protect-your-vocal-folds-the-little-muscles-that-give-you-a-voice/
2. https://entokey.com/physiology-of-phonation/

3. Article on Vocal Folds (Video Included): https://voice.weill.cornell.edu/voice-evaluation/normal-voice-function