How the Voice Works

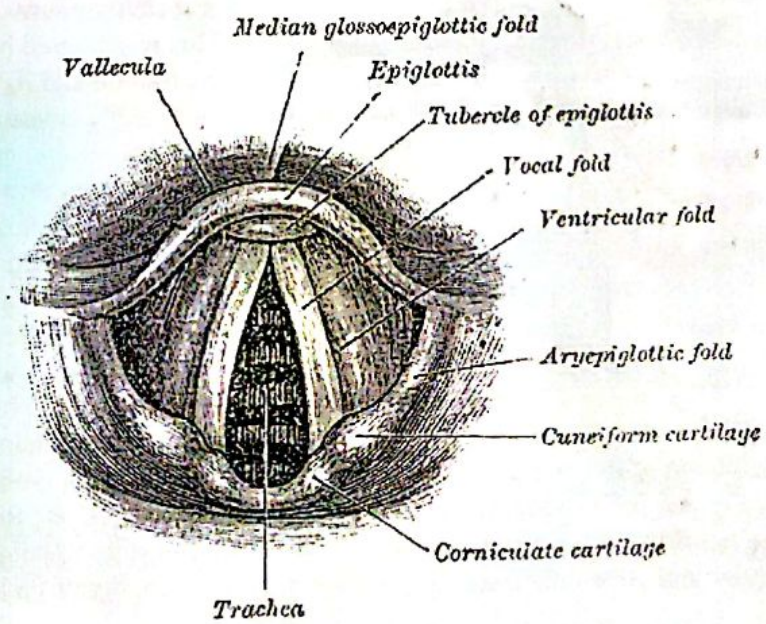
The larynx is the primary organ involved in voice production. However, phonation requires a complex interaction between many bodily systems to achieve the sound that we associate with the voice.

Mechanics of Voice Production

Production of the voice involves the same biophysics as the mechanics of sound production from any source. The production of sound requires four main components: airflow, an oscillator, a resonator, and an amplifier. In voice production, the source of airflow is the lungs. The abdominal muscles, chest, and back contribute to airflow in voice production. The oscillator is the vocal folds, housed within the larynx, which vibrate and place the air from the lungs into a wave-like motion. The resonance chamber is the whole pharynx area and includes the larynx, and the amplifier is composed of the remainder of the vocal tract: the oral cavity including the tongue and both the soft and the hard palate.

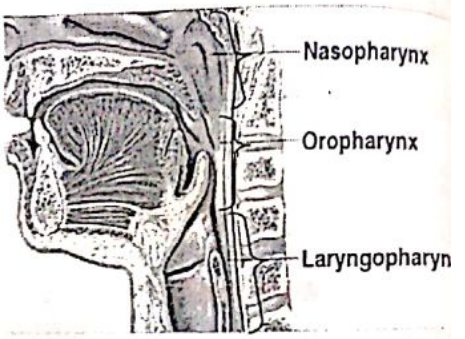
Sound Source

The sound source for voice production is the larynx and the vibrating vocal folds. When one makes the decision to talk or sing, the vocal folds come together in the midline. Air is forced from the lungs against the closed vocal folds, forcing them to separate. As they open, air travels past the vocal folds and into the upper parts of the larynx and into the pharynx. When the vocal folds snap shut, sound is produced in the form of a buzzing sound similar to blowing on a taut blade of grass. The frequency of opening and closing of the vocal folds determines the frequency of the sound waves, and, thus, the pitch of the voice. The frequency of vibration of the vocal folds is termed the fundamental frequency, and the character of the sound that is produced from the vocal folds is very similar to the sound that is produced from buzzing lips. This sound is then modified by the resonance chamber of the vocal tract and produces the voice that gives each person his or her characteristic vocal signature. A louder sound can be produced by one of two methods: by increasing the airflow from the lungs or by increasing glottal resistance. The preferred method of increasing volume utilizes a combination of both strategies. Greater force in the air stream from the lungs, exerted against somewhat increased closing force, causes the epithelium of the vocal folds to open wider as air is forced past them. A wider excursion produces a louder sound when the vocal folds clap together. When less airflow is used from the lungs, the vocal folds are blown apart to a lesser degree and a softer sound is produced. Clapping the hands can mimic this effect. When the hands are wide apart at the start of each clap, a louder sound is produced. When the hands are closer together at the start of each clap, a softer sound is produced. The vocal folds function in a similar fashion. However, if excessive force is used, and the vocal folds are snapped shut too tightly, firstly a glottal sound may be heard, and secondly, if folds are held together too tightly, a raspy/grinding sound may be heard (vocal fry). Such use of excess force is termed laryngeal hyperfunction, and the forceful closure of the vocal folds can cause vocal fold trauma and result in vocal fold tears, hemorrhages, edema (swelling), or masses such as nodules, polyps or cysts. So, optimal balance between airflow forces and glottal resistance is essential.



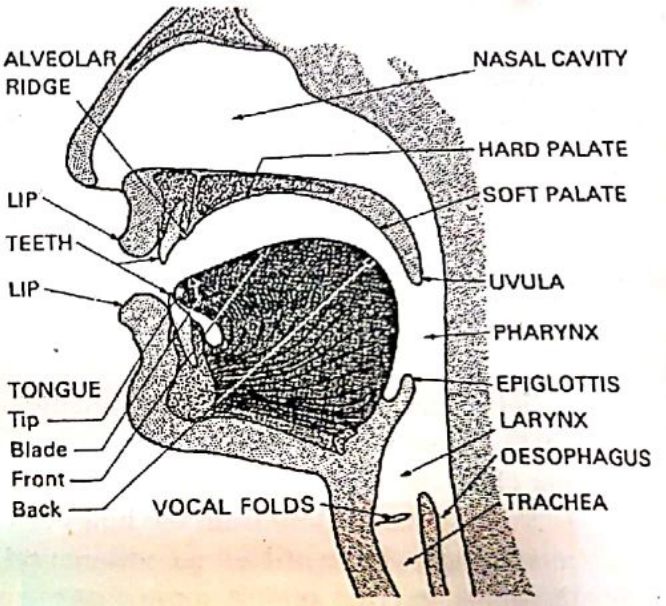
Magee Music

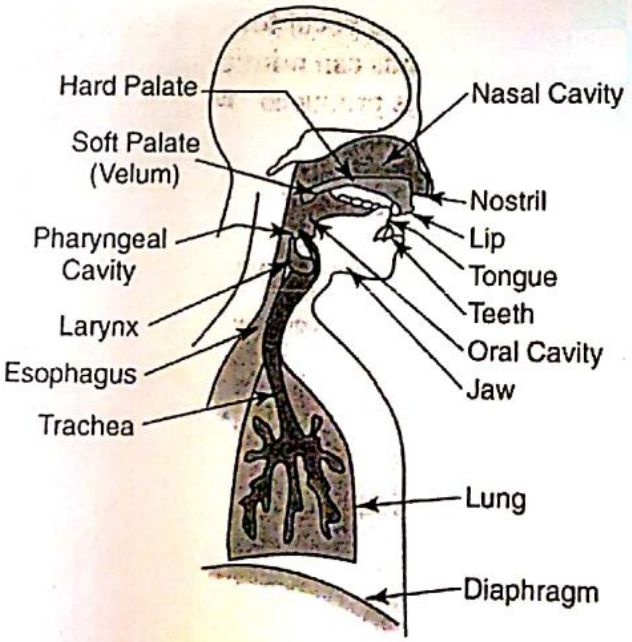
If there is a small space between the vocal folds, as can be caused by a mild vocal fold paresis (weakness), vocal fold masses (such as a polyp, nodule, or cyst), vocal fold scar, or vocal fold swelling, then there may be escape of air throughout the phonatory cycle, and the epithelium of the vocal folds may be unable to close completely.



Resonance and Amplification

The resonance chamber and amplifier of the voice is the vocal tract, which includes the back of the throat (pharynx), the tongue, the palate, the mouth, the back of the nose (nasopharynx), and to a lesser degree, the sinuses and the head. As sound leaves the vocal folds, the waves bounce back and forth against the walls of the vocal tract. As the sound resonates throughout the vocal tract, it gains energy in those areas that are amplified by the particular shape of the vocal tract and loses energy in those areas that are dampened by the shape of the vocal tract. Because everyone's pharynx, oral cavity, nasopharynx, and head are shaped differently, amplification of the fundamental frequency occurs at different sites and to different degrees from one person to another. The harmonic frequencies are responsible for giving each voice it's own "signature" sound that allows us to distinguish one individual from another. The highest energy harmonic frequencies give the voice its "ring", which allows the voice to be heard even in the presence of a significant degree of background noise. Changing the shape of the vocal tract by altering the position of the tongue, the shape of the pharynx, and the position of the uvula changes the characteristics of the harmonics and formants, and thus, the projection achieved.





Amplification of the voice occurs primarily in the oral cavity, which has a megaphone-like effect on vocal projection. In general, a more open mouth and oral cavity causes greater amplification of the voice. This is achieved best by optimizing the position of the tongue and its base, the palate, the mandible and the lips. Elongation and widening of the vocal tract includes several conscious mechanisms, including maintaining correct neck posture. If the neck is tilted back or the chin is lifted too high, a bend is created in the pharyngeal area, which effectively narrows the resonance and amplifying chamber at the region of the tongue base. Ideally, the head should be in the neutral position so that the spine is straight through the skull base. This produces a straighter vocal tract and usually enhances resonance and projection. Elevation of the uvula and the soft palate helps to open the vocal tract in the back of the oral cavity and seals the nasopharynx to minimize hypernasality. Relaxation of the tongue base, with the tip of the tongue placed in a more forward (but relaxed) position, helps to lengthen the oral cavity and widen the space at the tongue base which creates a longer, greater diameter amplifier.