

English Phonetics Speech Anatomy & Physiology

What is Phonetics?

- Phonetics is the study of speech sounds
- we are interested in how they are made (speech) and how they are perceived (hearing)
- in order to understand the nature of sound systems, it is important to first understand the apparatus employed to produce the sounds

Speech Anatomy and Physiology

- in the case of human speech production, these involve the various elements of human anatomy and physiology
- the sound-generating aspects of human anatomy share the physical system with other functions: air movement in lungs; shut off valves as protective devices for the nose, windpipe, and esophagus; tongue and teeth for the ingestion of food, etc.

Sound Production

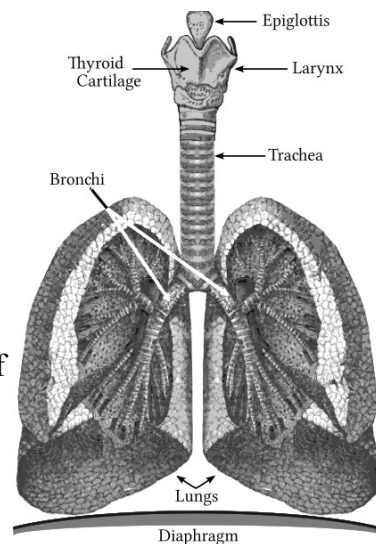
- Speech can be seen as a secondary system, dependent on anatomy originally intended for more basic functions such as respiration and ingestion.
- there are limitations on the kinds of sounds possible due to the anatomical and physiological constraints on the system
- the various kinds of sounds can be viewed as due to mechanisms intended to serve other functions
- we break up the human sound production system into three parts: the sub-glottal region, the larynx and the supra-laryngeal region

The Subglottal Region

- this is the area below the glottis
- the diaphragm is a large muscle that can raise or lower
- this compresses and expands the lungs, pushing the air out or pulling it in

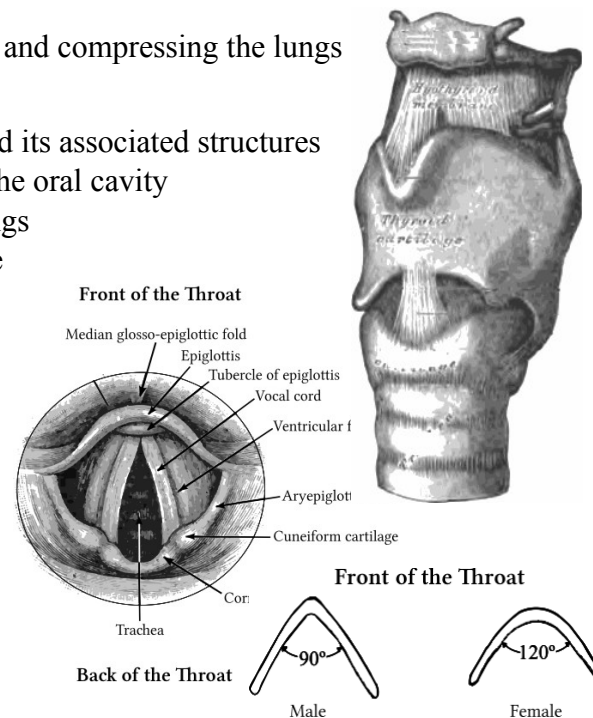
The Lungs

- The lungs are connected to the rest of the respiratory system via tubes or bronchi
- they are attached to the trachea and thereby to the larynx, which controls the flow of air in and out
- air can move out (exhalation) or in (inhalation)
- the primary task of the lungs is the exchange of oxygen
- The raising and lowering of the diaphragm produces a result much like a bellows or air pump, as shown below for the inhalation phase
- Exhalation involves the opposite direction, raising the diaphragm and compressing the lungs



The Laryngeal Component

- The second component of the vocal tract consists of the larynx and its associated structures
- it is responsible for the control of airflow between the lungs and the oral cavity
- the larynx is like a valve, which controls the air flow from the lungs
- the structure actually 'hangs' from the skeleton via the hyoid bone
- the structure of the larynx is primarily cartilage
- the internal structure of the larynx is important for understanding phonation
- the larynx is made up of several distinct cartilages
- these are the epiglottis, thyroid, cricoid and arytenoid cartilages
- they are connected by muscle and ligaments

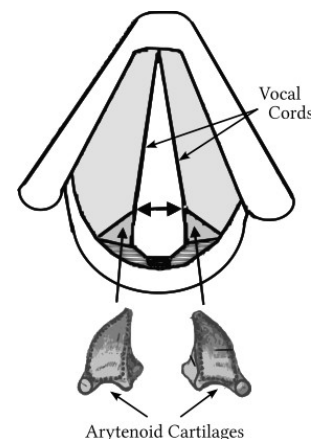


Thyroid Cartilage

- there are gender differences in the shape of the larynx
- greater protrusion of the so-called Adam's Apple in the male
- due to the more acute angle of the thyroid cartilage in the male

Arytenoid Cartilages

- The primary task of the cartilages which form the structure of the larynx is to act as a supporting frame for the vocal chords
- The vocal chords consist of bands of ligamentous tissue which can be spread or closed by the movement of the arytenoid cartilages
- arytenoid cartilages are two pyramid-shaped processes attached to the cricoid cartilage
- When the arytenoid cartilages are rotated they spread or close the vocal cords
- The gap between the vocal cords is referred to as the glottis



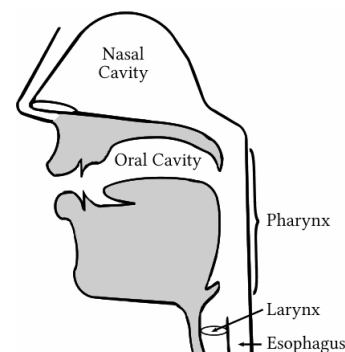
States of the Glottis

- If the vocal cords are held wide apart without vibration, the result is a voiceless sound
- If the vocal cords are held close together and the air is passed over them, then they will vibrate, creating a voiced sound
- a narrow space between the vocal cords, but no vibration, will produce a whisper
- if the cords are completely closed, the result will be glottalization or glottal closure
- if the cords are held open and are allowed to vibrate, this will produce breathy voice
- if the cords are moved closer together and kept vibrating, then the result will be creaky voice

Vocal Chords	Lax	Tight
Open	Breathy Voice	Voiceless
Partly Open	Voiced	Whisper
Closed	Laryngealization (Creaky Voice)	Glottalization

The Supra-glottal Component

- the supra-glottal vocal tract is the area *above* the glottis
- it is responsible for producing the variation in sounds that is necessary for language
- different sounds are made by changing the shape of the oral cavity
- the nasal cavity may also be involved, producing nasal sounds



The Vocal Tract

- The vocal tract consists of three parts: 1. Pharynx 2. Oral cavity 3. Nasal cavity

The Pharynx

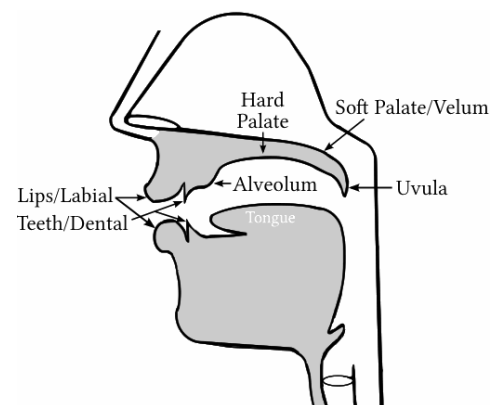
- Air moves through the pharynx up to the oral and nasal cavities
- The pharynx cannot move, but the tongue can move back towards the rear wall of the pharynx
- This makes pharyngeal sounds like ʕ and ʁ

Nasal Cavity

- air may pass through either the mouth or the nose
- for air to pass through the nose, the velum must be lowered, thereby opening the velo-pharyngeal port
- any sound produced by passing air through the nasal cavity will have a certain nasal timbre to it
- such sounds are referred to as nasalized sounds

The Oral Cavity

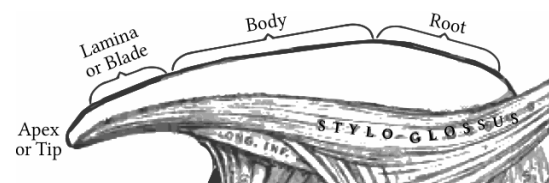
- The oral cavity is responsible for the majority of variation in sounds produced in any language
- An important aspect of this production is the use of various articulators, which make contact or come close to different parts of the oral cavity
- Depending on where the articulators make contact, different sounds are produced



The Tongue

- the final part of the anatomy to play a role in the sound system is also the most important: the tongue
- the tongue is basically a mass of muscle which can be constricted and stretched like any other muscle

- it consists of several parts: 1. the tip or apex of the tongue (= apical); 2. the tongue blade, sometimes referred to as the lamina (= laminal); 3. the tongue body or dorsum, (= dorsal); 4. the root of the tongue, used in making various sounds associated with the pharyngeal cavity



Articulators

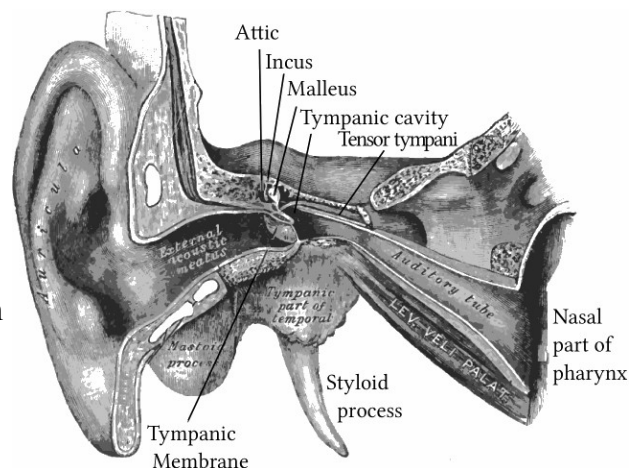
- the combination of tongue with various other parts of the oral cavity has led to the classification of articulators in terms of active versus passive
- this system may be employed to fine-tune the description of how a sound is made, e.g., *apico-dental* means ‘using the tip of the tongue to touch the teeth’
- this may be useful in languages where there are such differences or where one wishes to be precise about the nature of a sound

Active & Passive Articulators

Active	Passive
Lower lip	Upper lip
Tip of the tongue	Teeth
Blade of the tongue	Hard palate
Back of the tongue	Alveolar ridge
Root of the tongue	Velum
	etc.

Hearing

- the other end of the speech chain concerns the receiving of the speech signal
- this involves the basic anatomical structure of the ear:
- the external ear
- the eardrum (*Tympanic membrane*)
- the group of bones that relay the signal
- the organ that converts the physical signal to an electric one
- the nerves that pass the electric signal to the brain



The Process of Hearing

- the process of hearing involves sound waves traveling through the ear canal until they strike the eardrum
- when the sound waves contact the ear drum, they pass the vibrations on to three small bones in the middle ear:
 - the *malleus* (hammer) makes contact with the eardrum
 - it relays the vibrations to the *incus* (anvil)
 - the incus passes the vibrations to the third bone, the *stapes* (stirrup)

Inner Mechanism

- The combination of bones acts like a telegraph machine, relaying the sound to the cochlea
- It consists of several canals filled with liquid
- the cochlea contains a number of tiny hairs connected to nerves
- These convert the vibrations into nerve impulses that are relayed to the brain

