

# Introduction to Linguistic Phonetics

## Physiology and Aerodynamics

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# Recap and Reflection

## Reflection

- Spend ~3 minutes reviewing your notes from last lecture and from R&J ch. 2.
- Look for questions you have or clarifications you need.

# The International Phonetic Alphabet

- A transcription system with the goal of describing the sounds found in all the world's languages
- While the human vocal tract can produce an amazing array of sounds, the ones used in languages are more limited ( 200)
- Any individual language has a much smaller number of sounds in its inventory (all the speech sounds used in that language)
  - Rotokas ( 11)
  - !Xóõ ( 122)



# Speech articulators

- Most of these body parts have other essential functions—primarily breathing and eating
- They have been co-opted and adapted to speech through evolutionary processes
- In this class we're mostly talking about **descriptive articulation** (i.e., only a minimal examination of physiology and motor control)

# Chimpanzee (*Pan troglodytes*) vs. Human Vocal Tracts

(A)

Nasal cavity  
Soft palate  
Hard palate  
Tongue  
Epiglottis  
Vocal fold  
Oesophagus

(B)

Nasal cavity  
Hard palate  
Tongue  
Pharynx  
Hyoid bone  
Larynx (voice box)  
Trachea  
Soft palate  
Epiglottis  
Vocal fold  
Oesophagus

# Human development

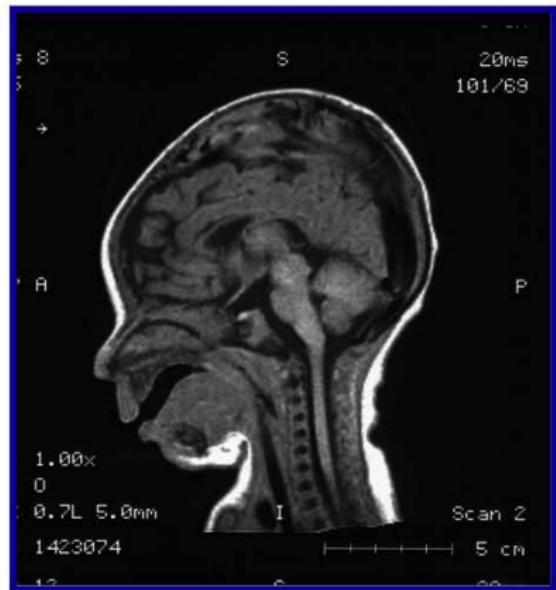


Figure 1. Male 2 week old infant MRI



Figure 2. Adult male MRI

# What does speech look like?

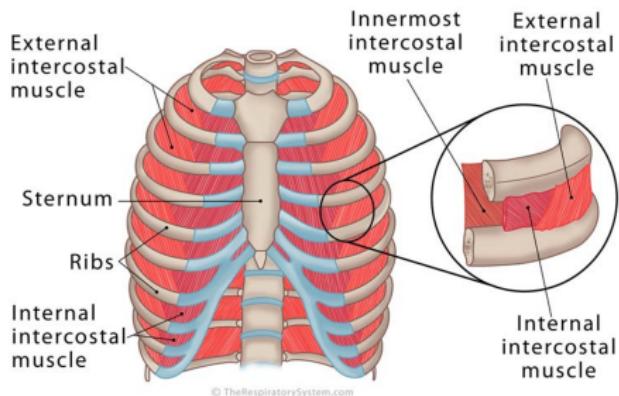
- To begin, we need to understand the basic articulators for speech
- Ken Steven's X-ray
- Vocal tract MRI during speech

# Breathing apparatus

- The basic source of power in speech is the respiratory system pushing air out of the lungs
- In most instances, we superimpose speech on an outgoing breath
- Humans have considerable control over breathing, especially compared to other primates

# Breathing

## Intercostal Muscles



- **Inhalation:** the ribs are pulled up by the external intercostal muscles
- **Exhalation:** rib cage is deflated by pulling the ribs down by the internal intercostals
- Exhalation is a more passive activity in during **tidal breathing**—elastic tension on the ribs naturally compresses them

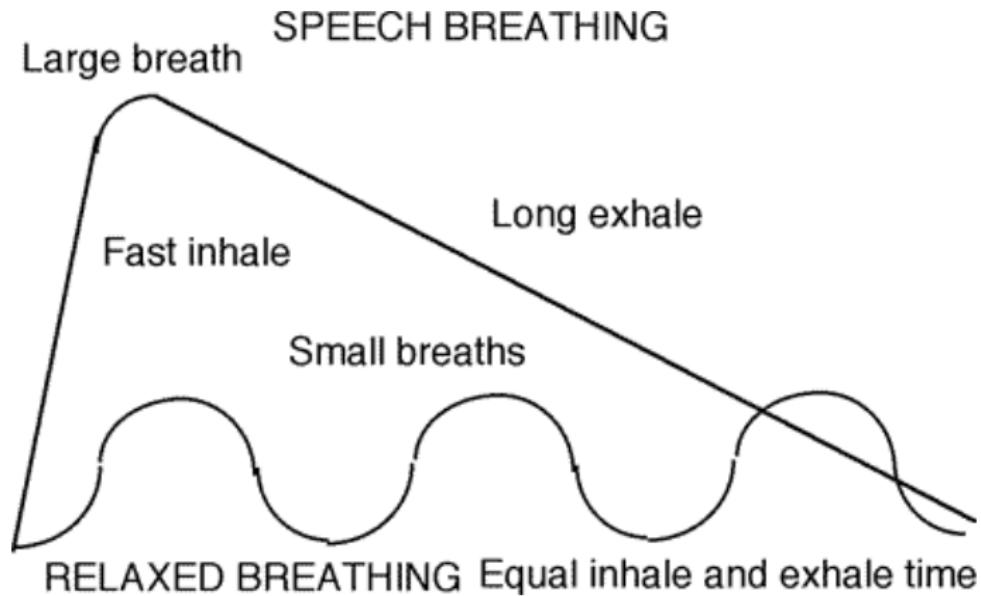
# Breathing for staying alive vs. speech

- Both an active and passive process
- **Respiration** is breathing to stay alive. It's mostly unconscious, controlled by the brainstem—regulated primarily by blood pH
- **Speech breathing** is a very different story

# Speech breathing

- Higher level motor control regions interact with the brainstem to control breathing
- Inhalations timed for major phrasal/sentence boundaries depending on overall utterance length
- Depth of inhalation and speed of exhalation controlled to utter the desired amount of speech per breath cycle
- A learned behavior—notice that children and very excited people often get out of breath while talking

# Speech breathing



# A small note

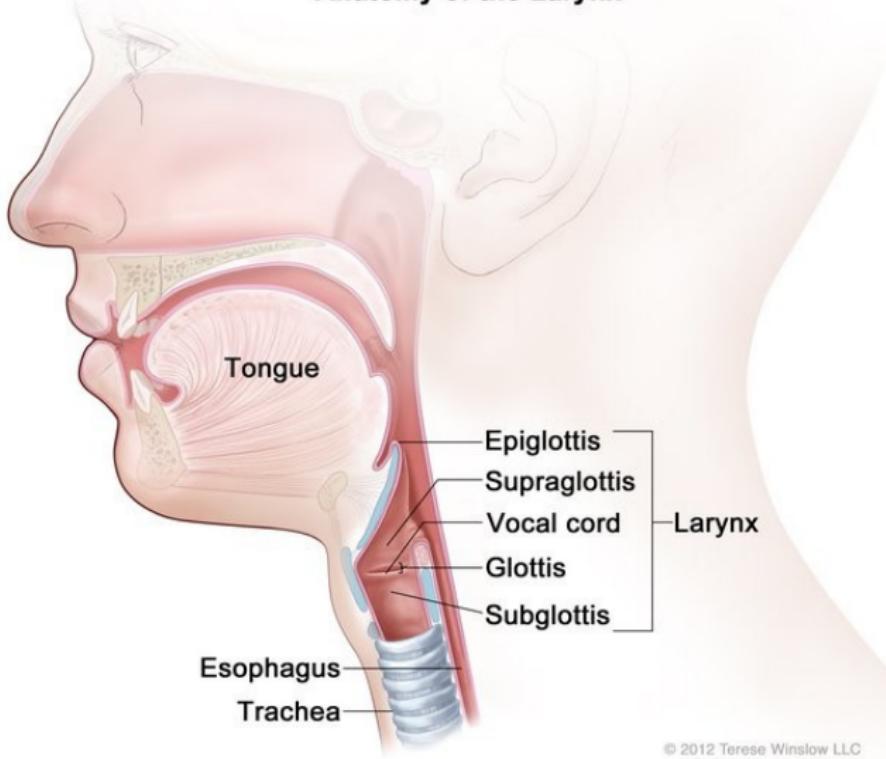
- We will be coming back to the physics in a few weeks.

# The larynx and glottis

- Reminder: the **larynx** is the entire structure that holds the vocal folds (plural is larynges)
  - Can also move up and down as a kind of articulator (e.g., ejective and implosive consonants)
  - Consonants made here are **laryngeal**
- Consonants articulated by opening and closing the vocal folds are **glottal**
  - Only if the opening or closing of the glottis the primary articulation (e.g., not just voicing)
- There's lots of confusion in the field between the terms

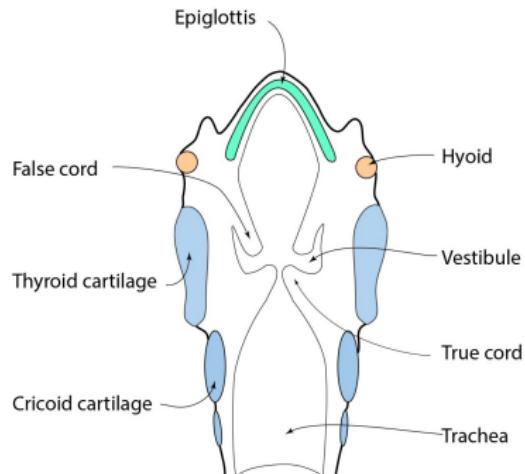
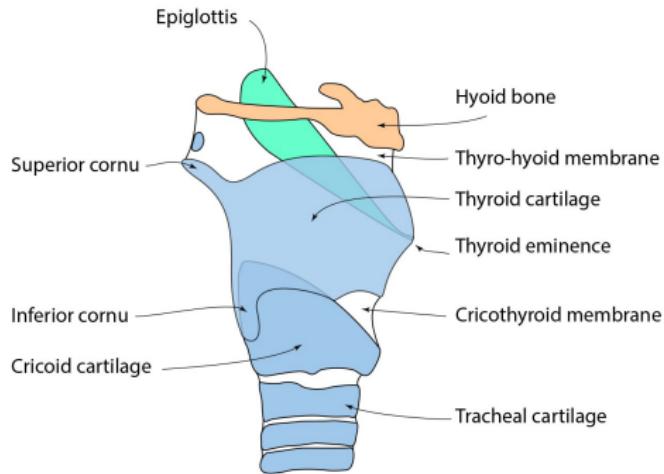
# The Larynx

## Anatomy of the Larynx



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# Major structures of the larynx

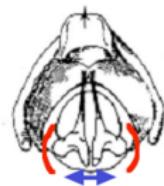


# How the larynx works

- The triangular-shaped **arytenoid cartilages** sit on the upper back of the **cricoid cartilage**
- They **rotate** and **slide** to *abduct* (move apart) and *adduct* (bring together) the vocal folds



View of the larynx  
from the back



View of the larynx  
from the top

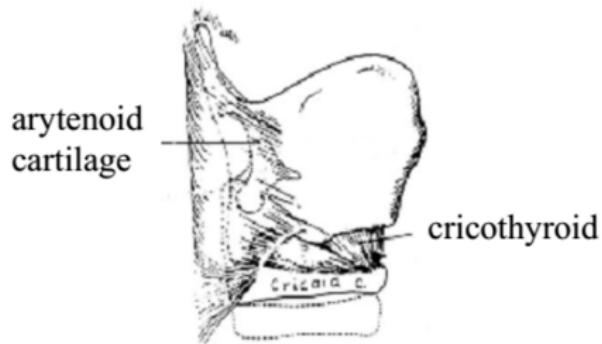
# How the larynx works

- The length of the vocal folds is correlated with the angle between the thyroid cartilage and the cricoid cartilage
- When the thyroid is tilted **forward** the vocal folds are longer and thinner
- When the thyroid is tilted **back** the vocal folds are shorter and thus thicker and vibrate at a lower rate



# Muscle in the larynx

- The main muscle in the larynx that controls the pitch of the voice is the **cricothyroid muscle**



# The vocal folds

- Tissue folds crucial to voicing
- Hormone changes at puberty stimulate enlarging in adolescents (roughly, more testosterone  $\rightarrow$  larger vocal folds)
  - Range from 12.5mm to 25mm in length, 3-5mm thick
  - The larynx also lowers for all people, with more lowering corresponding to (roughly) more testosterone
- More massive folds result in slower vibration (= lower pitch, on average)
- Most research has been with *WEIRD*<sup>1</sup> societies, so take a lot of this with grain of salt (maybe even a pound \*shrug\*)

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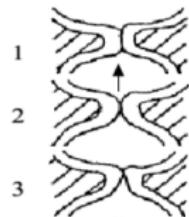
<sup>1</sup>Term coined in 2010 by Henrich, Heine, and Norenzayn to describe how 96% of psychological samples come from Western, Educated, Industrialized, Rich, and Democratic societies.

# Vocal folds during speech

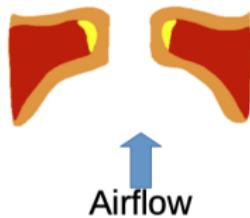
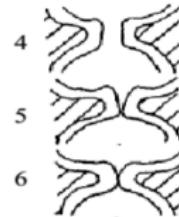
- Higher pressure air resulting from lung compression flows to the lower pressure (usually atmospheric) in the oral cavity
- We think of “pushing” air through the vocal tract, but it’s better to think about air flowing from higher to lower pressure (i.e., the Bernoulli effect)
- The lungs create pressure greater than atmospheric pressure when they compress
- Airflow passing through the adducted (= pulled together) vocal folds results in *voicing*

# The vocal folds during speech

Air pressure below the glottis forces the vocal folds open



Muscle elasticity and the Bernoulli force close the vocal folds



- **Phonation:** setting the vocal folds into vibration
- Broader definition: any active modification of airflow by the larynx (This make my research really difficult)
- Also called: **voice, voicing**
- Videos:
  - Movies of vocal folds in action
  - Synthesis
  - Mucosal wave

## Your tasks for next time

- Complete the exit ticket for today on Canvas by 12:30pm.
- Read Reetz & Jongman (2009) Chapter 2.
  - There will be a discussion post on Canvas for this reading (This counts as class participation)
- Complete Quiz 0 by Friday at 11:59pm.
- Complete Homework 1 by Tuesday at 8:30am.
- Be ready to dive into Articulation and the IPA next time!

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