Anatomy & Physiology of Speech Production
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Three systems of speech production

- Respiratory System
- Laryngeal System
- Articulatory system
A & P of Speech Production

Articulatory System

Laryngeal System

Respiratory System

Vocal Tract
Larynx
Esophagus
Lungs
Diaphram
Stomach
Articulatory System

Articulation refers to movement of one structure against another. In this case we are referring to “speech” structures.

Also referred to as the Supra-Laryngeal System (supra = above)

The system consists of a series of cavities, muscles, bones, and teeth.
The Vocal Tract

The vocal tract (not “track”) is an elongated assembly of tissue and organs that have a common origin and function. **THE** place where speech articulation occurs.

3 Cavities comprise the vocal tract:
- Nasal Cavity
- Oral Cavity
- Pharyngeal Cavity

Note that portions of the upper respiratory system are also included as part of the articulatory system.
Infant & Adult Vocal Tract

Fig. 1. Midsaggital sections of infant and adult vocal tracts. Note the differences in size, as well as configuration, between the two vocal tracts. Abbreviations: E, epiglottis; HP, hard palate; La, larynx; M, mandible; N, nasal cavity; SP, soft palate; T, tongue (reprinted with permission from R. Kent).
The Articulators

The structures involved in the articulation of speech can be classified into two categories:

- Movable
- Fixed
The Articulators: Movable

- Lips
- tongue
- Mandible/lower Jaw
- soft palate / velum
- uvula
- pharynx
The Articulators: Fixed

- Hard palate
- Alveolar ridge
- Nasal cavity
- Nostril
- Lip
- Tongue
- Teeth
- Oral (or buccal) cavity
- Jaw
- Trachea
- Lung
- Diaphragm

- Pharyngeal cavity
- Larynx
- Esophagus
- Soft palate (velum)
The Articulators

Movable:
- Lips
- Tongue
- Soft Palate
- Pharynx
- Mandible
The Articulators

Fixed:
- Incisors
- Hard Palate
- Aleolar Ridge
“Regulation” of the Respiratory, Laryngeal, and Articulatory Systems

- The three systems of speech production are controlled via the Nervous System.

- When the nervous system is “compromised” due to developmental abnormalities, acquired damage, or illness, communication is also compromised.
Nervous System

• Essentially divided into two parts:
  – Central Nervous System (CNS)
  – Peripheral Nervous System (PNS)
Central Nervous System

Consists of:
- Brain
- Brainstem
- Spinal cord
Landmarks of the Brain

**Hemispheres**

**Gyri/Gyrus**

**Sulci/Sulcus** (or Fissure)

**Lobes**

A schematic of a left cerebral hemisphere showing the major landmarks and lobes.
The Brain (continued)

• Frontal Lobe: Motor activity, attention, judgment, Speech production
  • Broca’s Area (left lobe only)

Paul Broca (1824-1880)
Frontal Lobe
(judgement)

Trans-orbital Lobotomy

Prefrontal Lobotomy

Electro-convulsive Therapy - ECT
The Brain (continued)

• Parietal Lobe: Sensation
The Brain (continued)

Temporal Lobe: hearing, speech comprehension
  • Wernicke’s Area (left lobe only)

Carl Wernicke
1848-1904
Broca’s & Wernicke’s Areas
The Brain (continued)

**Temporal Lobe**: hearing, speech comprehension
- Primary Auditory Area (Heschl’s Gyrus)
The Brain (continued)

- Occipital Lobe: vision
A diagram of the left cerebral hemisphere showing areas associated with various cerebral functions.
The Brain (continued)

- Cerebellum: balance, coordination
Peripheral Nervous System

• The remaining nerves which lie outside the brain, brainstem, and spinal cord.

• The PNS “connects” the brain to the outside world.

• Damage to the PNS can affect speech and hearing ability
How is speech produced?

- **S x T = P**
- **S = Source**
- **T = Transfer function (filter)**
- **P = Product**
$S \times T = P$ or *The Source-Filter Theory of Phonation*
Speech Examples

Vowels:
- **Source** = respiration & vocal fold vibration
- **Transfer Function** = tongue movement
- **Product** = specific vowels such as /ee/ vs /u/

Consonants:
- **Source** = respiration and *maybe* vf vibration
- **Transfer Function** = fixed/movable articulators
- **Product** = specific consonants such as /f/ vs /m/