Chapter 3

Anatomy and Physiology of Speech
Speech Process

- Respiration
- Phonation
- Articulation
- Resonance
Respiratory System

1. Nasal cavity
2. Oral cavity
3. Pharynx
4. Larynx
5. Trachea
   16-20 incomplete rings
6. Lungs
   Bronchi
   alveoli
Alveoli

300 million minute pits per lung
70 square meters (size of tennis court)
Exchange between blood and oxygen-rich air in lungs
Diaphragm

- Primary muscle of respiration

The diaphragm is shaped like a parachute

whyfiles.org/204endurance_training2.html
• not talking
  – 12 times per minute
  – 2.5 second phase (both)

• talking
  – 2 to 3 second inspiration
  – up to 15 second expiration
Respiratory Physiology

- 500 to 750 cubic centimeters per cycle (tidal air/volume)
- 3500 to 5000 cubic centimeters (vital capacity)
  - spirometer
  - 1000 less for adult females over adult males
- 1000 to 1500 cubic centimeters (residual capacity)
Phonation

- Hyoid bone
- Thyroid cartilage
- Arytenoid cartilages
- Cricoid cartilage
- Trachea
Phonation - Larynx

http://ww2.med.jhu.edu/voice/larynx.html
Phonation - Larynx

http://ww2.med.jhu.edu/voice/larynx.html
Phonation - Larynx

- Pitch (frequency)
  - Length
  - Thickness
  - Degree of tension
- Loudness (volume)
  - Duration of closed phase

http://www.aos-jax.com/nrml_lar.htm
Vocal Tract

- Mandible
- Lips
- Alveolar ridge
- Teeth
- Hard palate
- Soft palate
- Uvula
- Tonsils
- Tongue
Articulation

Articulators
- lips
- teeth (central and lateral incisors), canine/cuspid, 1st premolar (bicuspid), 2nd premolar (Bicuspid), 1st, 2nd and 3rd molar.
- hard palate
- soft palate
- tongue

Other landmarks
- uvula
- tonsils
Resonance - Oral Cavity

- Oral cavity
  - Tongue Musculature
    - Intrinsic muscles - changes shape of tongue
    - Extrinsic - changes in tongue position
  - Mandibular Movement
    - Elevators
    - Depressors
    - Protractor
Resonance - Nasal Cavity

- nasal cavity
  - soft palate or velum
  - raises to close off nasal cavity
  - muscles to elevate and depress

www.ghorayeb.com/CleftPalate.html
Resonance - Pharynx

- Nasopharynx
- Oropharynx
- Laryngopharynx
Resonance - Larynx

[Diagram of the larynx with labels for epiglottis, vocal folds, and trachea]

www.phon.ox.ac.uk/~jcoleman/phonation.htm
Articulatory Physiology

- Vowels
  - Shape of cavity
- Consonants
  - Voicing
  - Place of production
  - Manner of production
The Nervous System and Speech Production
composed of billions of individual cells (neurons) and their supportive tissue

cell body
dendrites - short extensions around cell body
axon - long extension
end brushes - numerous branches which allow a synapse
Nervous System

- central nervous system (CNS)
  - brain
  - spinal cord
- peripheral nervous system (PNS)
  - voluntary
    - cranial nerves
    - spinal nerves
  - involuntary
    - autonomic nervous system

http://medicalimages.allrefer.com/large/central-nervous-system.jpg
Major Regions of the Brain

http://w3.aces.uiuc.edu/ArSci/HSE/Figures/CNS_parts_85_rgb.jpg
The Brain

Figure 19.1  Embryonic development of the human brain. (a) The neural tube becomes subdivided into (b) the primary brain vesicles, which subsequently form (c) the secondary brain vesicles, which differentiate into (d) the adult brain structures. (e) The adult structures derived from the neural canal.

Major embryonic areas of the brain.

• Forebrain
• Midbrain
• Hindbrain
The Forebrain - Cerebrum

- cerebral hemispheres
  - cortex
    - outermost few millimeters
    - dark in color (gray matter)
  - nerve tracts (white matter)
    - projection fibers (from cortex down)
    - association fibers (front to back)
    - commissural (between hemispheres)
- basal nuclei or ganglia
  - gray matter deep within the hemisphere
  - role in coordination
    - athetosis (slow, writhing, snakelike movements)
    - chorea (jerky purposeless movements)
- thalamus (walnut shaped)
  - synthesizer and relay center
  - regulates water balance, sleep and consciousness, body temperature and food intake
- olfaction center
Hemispheric Specialization

Left Brain Functions
- Written expression
- Reasoning
- Critical thinking
- Scientific skills
- Right-handed control

Right Brain Functions
- Insight
- 3-D forms
- Art
- Creativity
- Musical awareness
- Left-handed control

http://images.encarta.msn.com/erfmedia/encymed/targets/illus/bib/08T012861A.gif
Landmarks

- Frontal Lobe
- Parietal Lobe
- Occipital Lobe
- Temporal Lobe
- Lateral Fissure (deep)
- Central Sulcus (shallow)
- Precentral Gyrus (motor cortex)
- Postcentral Gyrus (sensory cortex)
Specialization for Speech

1. Auditory area
2. Visual cortex
3. Wernicke’s Area
4. Broca’s Area
5. Motor cortex
Midbrain (mesencephalon)

- cerebral peduncles (paired, short thick stalks)
- descending and ascending fiber tracts
- connect cerebrum with hindbrain
- centers for motor coordination
The Hindbrain

• cerebellum (little brain)
  – integrating and coordinating center
  • maintains muscle tone
  • posture
  • equilibrium
  • muscle coordination
  – ataxia
• pons (bridge)
  – tranverse white fibers (cerebellum)
  – longitudinal white fibers (medulla and cerebrum)
• medulla oblongata
  – continuous with spinal cord
  – all ascending and descending nerve tracts of spinal cord
Cranial Nerves

I. Olfactory
II. Optic
III. Oculomotor
IV. Trochlear
V. Trigeminal
VI. Abducens
VII. Facial
VIII. Acoustic
IX. Glossopharyngeal
X. Vagus
XI. Accessory
XII. Hypoglossal
Spinal Cord and Nerves

- Gray matter in center (H)
- Ventral (motor) horns
- Dorsal (sensory) horns
- Reflex arc