

INTRODUCTORY

PHONETICS

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PHONOLOGY

A Workbook Approach

LINDA I. HOUSE

INTRODUCTORY PHONETICS AND PHONOLOGY
A Workbook Approach

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Linda I. House

*State University of New York
Geneseo, New York*



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In Dedication

To my husband, Tom, and my daughters, Amy and Alison—
You are the wind beneath my wings!!

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Preface

This workbook is designed to be practical with a goal of teaching a variety of audiences how to use phonetics as a viable link between the ever-changing spoken and written word. A course in phonetics for the speech/language pathologist has three main purposes. First, the course is designed to teach the normal processes of how sounds are formed and their relation to language development. Second, the course should look at the remediation process and how phonetics can be used for speech correction. Finally, the course should teach the importance of listening skills and how a cultivated ear is the key to success in the therapy process.

The International Phonetic Alphabet (IPA) is a superior tool for learning the correct pronunciation of a given word. For this reason, it is a necessary tool for not only speech/language pathologists but for linguists, media personnel, individuals learning English as a second language (ESL), and others interested in correct pronunciation.

This text focuses on the presentation of broad transcription for all audiences; however, because of the intricate nature of the English language, some narrow transcription symbols are introduced. In my opinion, the use of selected narrow transcription symbols in general transcription is necessary to accurately transcribe certain words in the English language.

This workbook is organized into two parts. The first part introduces the student to the IPA; the anatomical basis of phonemes; and the particular vowel, diphthong, and consonant phonemes. The second part enables the student to learn details about specific phonemes, the concepts of stress at the word and sentence levels, narrow transcription, pronunciation influences, and dialects. Finally, a series of appendixes explaining historical perspectives are included for reference.

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To my mother who instilled in me at an earlier age the idea that I could accomplish anything to which I set my mind.

To my sisters Jean, Teresa, and Alicia and their families who have consistently supported me in the past years.

To my husband Tom and daughters Amy and Alison—you are what life is all about!!!

—*Linda I. House*

PART I

UNDERSTANDING PHONETICS AND PHONOLOGY

Chapter 1

The Basis of Phonetics and Phonology

Success in mastering any language requires knowledge in speaking, reading, and writing the language. The speaking component requires the understanding and use of correct pronunciation, emphasis, and syntactic patterns. The written component requires mastery of the alphabet, spelling, and the ability to write, print, or type the pattern.

Very early in the learning process, English-language speakers become keenly aware of the language's lack of sound to symbol correspondence. Any young child studying the alphabet can point out that *cat* starts with the letter *c* that sounds like a /k/ and the word *race* ends in the letters *ce* but sounds like an /s/.

In order to help speech/language pathologists, linguists, media personnel, individuals learning English as a second language (ESL) and others interested in correct pronunciation the **International Phonetic Alphabet (IPA)** was devised.

INTERNATIONAL PHONETIC ALPHABET

In 1886, a group of phoneticians from France, Germany, Britain, and Denmark met to discuss the adoption of a universal system of pronunciation. The IPA based on an alphabet written by British phonetician Henry Sweet, represented the first successful attempt to systemize the pronunciation of speech sounds across most languages.

The IPA provides the user with a universally accepted symbol for each of the speech sounds. The IPA is phonetic, not phonemic in design. In other words, a particular symbol is used to represent the pronunciation of a speech sound, not to delineate a change in meaning. Linguistically significant, the IPA symbols summarize present linguistic theory. The IPA has been revised several times over the past century, the most recent changes taking place in 1996.

The International Phonetic Association, the agency governing the IPA, has a system of detailed principles applied to the formation and variation of the alphabet. In its present form, the IPA provides detailed information on vowels, consonants, other additional symbols, diacritics and suprasegmentals. (See Fig. 1.1 for a copy of the IPA.)

BASIC TERMINOLOGY

Allophone: The individual variation of the phoneme caused by such factors as position in the word, anatomical structure, and surrounding allophones. Allophones are nondistinctive variations of a phoneme. The use of an allophone does not change the meaning of a word.

Bisyllabic word: A word having two syllables.

Broad transcription: A general type of transcription using phonemes that appear in the vowel and consonant sections of the IPA. This type of transcription is used at the introductory level.

Coarticulation: The influence of the target phoneme on the surrounding phonemes.

Cognate: A pair of consonants produced with the same place and manner of articulation but one is voiced and one is voiceless. Examples: /p-b/, /s-z/.

Distinctive features: Articulatory or acoustic attributes of a phoneme necessary for distinguishing the difference between phonemes. Features are binary in nature meaning the feature is either present (+) or absent (-). Examples: the /n/ is (+) nasal and the /l/ is (+) lateral.

General American Phonetics (GAP): The use of the symbols and markings from the IPA that represent the physical and articulatory aspects of the General American dialect.

Homorganic: Phonemes produced in the same place of articulation that differ in one or more features. Examples: /t-s/ or /p-b-m/.

Loanword: A word that has entered the English language from another language, such as the word *ballet*.

Minimal pairs: Two words that are the same except for the one phoneme. Examples: *hit* and *hip* or *pat* and *bat*.

Monosyllabic word: A word having one syllable.

Morpheme: The smallest unit of meaning in the language. The two common types of morphemes are the **free morphemes** and the **bound morphemes**. The free morpheme provides meaning and stands alone. An example of a free morpheme is the word *boy*. The bound morpheme affixes to a free morpheme to convey meaning such as the plural "s" in boys.

Multisyllabic word: A word having more than two syllables.

Narrow transcription: A more specialized version of transcription using actual allophonic variations and specialized marking. Narrow transcription requires the use of the information from the other symbols, diacritics, and suprasegmental sections of the IPA.

Orthography: The part of the language that uses written symbols to represent the words in our language.

Phone: A single speech sound. Each symbol in the IPA represents a phone.

Phoneme: A family or group of sounds with distinctive acoustic characteristics. The phoneme is used to represent the target or ideal sound. A symbol from the phonetic alphabet is used for each phoneme.

Phonetics: The study of speech sounds in terms of physical and articulatory aspects.

Phonological rules: Rules that dictate how phonemes and allophones are used in the language. In addition, these rules dictate how phonemes and allophones are patterned into allowable syllable structures.

Phonology: The study of the rules and organization of sound units in the language.

Syllable: Unit of the speech consisting of a vowel. Consonants may or may not be present on one or both sides of the vowel.

Vocal tract: The area of the upper body inward from the lips to the lungs that is used in the production of speech. The vocal tract can be open or closed (occluded).

Voicing: The state of the vocal folds during the production of a phoneme or allophone. If the vocal folds are vibrating during the production, the subsequent sound is voiced. If the vocal folds are open or not vibrating during the production, the subsequent sound is voiceless or unvoiced.

Word: A part of language consisting of one or more phonemes and one or more syllables. The meaning of a word is dependent on the entire sequence of phonemes.

VOWELS

Vowels (see Table 1.1) are defined by the IPA using the three dimensions of **height**, **frontness**, and **rounding**. A quadrilateral space is used to visualize the relationships between the vowels. The **height** of a vowel refers to the position of the mandible (open or close) and the tongue in vertical relationship to the top or bottom of the mouth (low or high). The four variations of height are **open** (or low), **open-mid**, **close-mid**, and **close** (or high). **Frontness** refers to the horizontal position of the tongue in relation to the front or back of the mouth. The three variations of frontness are **front**, **central**, and **back**. **Rounding** pertains to the pucker or spread posture of the lips. The two lip positions are **rounded** and **unrounded**. It is important to note that all vowels are produced with an open vocal tract and are voiced.

TABLE 1.1
IPA-Vowels Summary Chart

<i>Dimensions</i>	<i>Delineations</i>
Height	Open, open-mid, close-mid, and close
Frontness	Front, central, back
Rounding	Rounded and unrounded

CONSONANTS

Consonants are delineated by the IPA in terms of manner of articulation, place of articulation, and voicing. **Manner of articulation** refers to how the air stream from the lungs is directed to the mouth and modified by the various structures to produce a consonant phoneme. **Place of articulation** refers to the location and constriction of the structures used in the production of a given consonant phoneme. **Voicing** refers to the presence or absence of the vibration of the vocal folds during the production of a phoneme.

The **manners of articulation** (see Table 1.2) in the IPA are **plosive** (the obstruction of the air stream from the lungs followed by a release of the air stream), **nasal** (the release of the sound through the nasal area), **trill** (the rapid fluttering of the lips, uvula, or tongue tip), **tap or flap** (a single tap of the tongue tip against the teeth), **fricative** (modification of a continued air stream from the lungs by the articulators), **lateral fricative** (frictionlike sound being emitted with a lateral airstream), **approximant** (proximity of two articulators without the presence of turbulence), **lateral approximant** (the air stream along the center of the oral cavity is obstructed forcing the emission of air laterally), **ejective stop** (an abrupt production of

TABLE 1.2
IPA Manner of Articulation Summary Chart

<i>Manner</i>	<i>Modification</i>
Plosive	Obstruction of air stream from the lungs followed by a release of the air stream
Nasal	Release of sound through the nasal area
Trill	Rapid fluttering of the lips, uvula, or the tongue
Tap or flap	Single tap of the tongue tip against the teeth
Fricative	Modification of a continued air stream from the lungs by the articulators
Lateral fricative	Frictionlike sound being emitted with a lateral air stream
Approximant	Proximity of two articulators without turbulence
Lateral approximant	Air stream along the center of the oral cavity is obstructed forcing lateral air emission
Ejective stop	Abrupt production of a plosive sound followed by a puff of air
Implosive	A plosive without a puff of air; a weakened version

a plosive sound followed by a puff of air), and **implosive** (a weakened production of a plosive sound without a puff of air). Using the consonant section of Fig. 1.1, manner of articulation can be found on the vertical axis.

The **places of articulation** (see Table 1.3) in the IPA are **bilabial** (using both lips), **labiodental** (using the lower lip and the upper central and lateral incisors), **dental** (placing the tongue between the upper and lower central and lateral incisors), **alveolar** (placing the tongue tip on the alveolar ridge), **postalveolar** (placing the tongue tip in the area directly behind the alveolar ridge), **retroflex** (curling the tongue so that the tip points toward the velum), **palatal** (placing the tongue tip on the hard palate), **velar** (moving the muscles of the velum), **uvular** (movement of the uvula), **pharyngeal** (movement of the muscles in the pharyngeal area) and **glottal** (movement of air through the glottis). Consonants are formed at each of the locations using the structures and functions outlined. Using the consonant section of Fig. 1.1, place of articulation can be found on the horizontal axis.

TABLE 1.3
IPA Place of Articulation Summary Chart

<i>Place</i>	<i>Structures</i>
Bilabial	Both lips
Labiodental	The lower lip and the upper and lateral incisors
Dental	The tongue placed between the upper and lower central and lateral incisors
Alveolar	The tongue tip on the alveolar ridge
Postalveolar	The tongue tip placed in the area directly behind the alveolar ridge
Retroflex	The tongue curled so that the tip points toward the velum
Palatal	The tongue tip placed on the hard palate
Velar	The movement of the muscles of the velum
Uvular	Movement of the uvula
Pharyngeal	Movement of the muscles in the pharyngeal area
Glottal	Movement of air through the glottis

The aspects of **voicing** (see Table 1.4) in the IPA are voiced consonants and voiceless or unvoiced consonants. Using the consonant section of Fig. 1.1, consonants appear as both paired and single entries. By convention, the symbol in the right half of the square is voiced, whereas the symbol in the left half of the square is voiceless or unvoiced. (Table 1.4 includes only the consonants found in GAP.)

TABLE 1.4
IPA-Voicing Summary Chart

<i>Voiceless Consonants</i>	<i>Voiced Consonants</i>
p, t, k	b, d, g
	m, n, ŋ
f, θ, s, ʃ, h	v, ð, z, ʒ
	ɹ, j
	l

OTHER SYMBOLS, DIACRITICS, AND SUPRASEGMENTALS

Other symbols, diacritics and suprasegmental are the three subsections of the IPA used to enhance and further delineate production. The **other symbols** category allows for the transcription of additional sounds not fully represented in the consonant and vowels categories. **Diacritics** are symbols designed to be added to consonant, vowel or other symbols to further describe the phoneme. **Suprasegmentals** provide information on stress, boundaries, timing and pitch. It is important to note that the IPA does not use capital letters for proper nouns, names, or to indicate the beginning of a sentence. Proper nouns and names receive no special delineation. Sentences are delineated through the use of suprasegmental double slash mark at the end.

DISTINCTIVE FEATURES

In addition to classifying phonemes into consonant and vowel categories, they can be classified by distinctive features. The purpose of a distinctive feature classification is to combine the articulatory and acoustic information in order to describe both vowels and consonants. Features are **binary** in nature meaning the feature is either present (+) or absent (-). Chomsky and Halle (1968) proposed the use of 17 features to describe phonemes. These features include: vocalic, consonantal, high, back, low, anterior, coronal, round, tense, voice, continuant, nasal, strident, sonorant, interrupted, distributed and lateral. Features are best thought of as theoretical and are not entirely useful in speech production process. It is important to note; however, the relationship between the IPA and distinctive features.

TABLE 1.5
Distinctive Feature Summary Chart

Vocalic: A voiced phoneme produced with an open vocal tract. The phonemes that are (+) vocalic are the vowels, the approximant /ɹ/, and the lateral approximant /l/.
Consonant: Phonemes produced with a constriction of the vocal tract. All consonants with the exception of the /h/ are (+) consonantal.
High: Phonemes made with an elevated tongue position. /k/ and /i/ are (+) high.
Back: Phonemes made with a retracted tongue position. /ɔ/ and /g/ are (+) back.
Low: Phonemes produced with a low tongue position. /æ/ and /h/ are (+) low.
Anterior: Phonemes produced when the point of constriction is anterior to the point of constriction for the /ʃ/, /l/, and /z/ are (+) anterior.
Coronal: Phonemes produced with the tongue blade in a raised position. /θ/ and /t/ are (+) coronal.
Round: Phonemes produced with the lips in a rounded position. /o/ and /w/ are (+) round.
Tense: Phonemes produced with tension in the muscles. /i/ and /u/ are (+) tense.
Voice: Phonemes produced with vibration of the vocal folds. /z/ and /v/ are (+) voice.
Continuant: Phonemes produced in a steady state. /θ/ and /s/ are (+) continuant.
Nasal: Phonemes produced when air is emitted directly through the nasal cavity. /n/ and /m/ are (+) nasal.
Strident: Phonemes produced when air is forced through a small opening causing friction. /f/ and /v/ are (+) strident.
Sonorant: Phonemes produced when the airstream is unimpeded by any structure in the nasal or oral cavity. /m/ and /l/ are (+) sonorant.
Interrupted: Phonemes produced when the airstream is completely occluded at some point during the production. /p/ and /b/ are (+) interrupted.
Distributed: Phonemes produced when the constriction is extended through the vocal tract. /θ/ and /ʃ/ are (+) distributed.
Lateral: A phoneme produced when the air stream is emitted laterally. /l/ is (+) lateral.

PHONOLOGY

The phone is the basic unit of phonology. This single speech sound can take the form of either a phoneme (the target) or the allophone (individual variations of the target). Phonological rules for a particular language dictate both the phonemes and allophones used by the language and the acceptable syllable structures (phoneme/allophone combinations).

Basic patterns used in monosyllabic words are consonant–vowel (CV) as in the word *tea* [ti], vowel–consonant (VC) as in the word *at* [æt], consonant–vowel–consonant (CVC) as in the word *sin* [sɪn], consonant–consonant–vowel–consonant (CCVC) as in the word *stop* [stɒp] and consonant–vowel–consonant–consonant (CVCC) in word *sand* [sænd]. The CVCC pattern is also commonly used to form plurals as in the word *tons* [tʌnz] and past tense as in the word *hopped* [hɒpt]. Other patterns and rules found are discussed in chapters 6 and 8.

PHONETICS AND PHONOLOGY

Phonetics and phonology are strongly interrelated. Phonetics provides the speaker with the sound differentiation necessary to imply linguistic meaning, whereas phonology helps the speaker understand sound patterns, sequences, and coarticulatory interrelationships. Both of these areas are presented in more detail in the subsequent chapters.

GENERAL AMERICAN PHONETICS

Because the IPA is universal in nature and includes symbols and markings for sounds in numerous languages, it is best for the beginning student to focus on a limited version of the alphabet. The primary focus of this text is to introduce the student to **General American Phonetics (GAP)**. Although dialectal variations and various standards of pronunciations are present within the United States, GAP represents the speech patterns used by the media, businesses, and for instruction purposes. The understanding of GAP will provide basic information that can be enhanced with additional study of the IPA.

Review Questions

1. What problem is faced by a speaker who uses the alphabet or the spelling of a word for pronunciation?
2. When was the IPA first used?
3. Who actually wrote the IPA?
4. When was the IPA last revised?
5. What are the five main sections of the IPA?
6. Define each of the following terms briefly.

phonetics, orthography, phone, phoneme, allophone, morpheme, minimal pairs, cognate, homorganic, distinctive features, broad transcription, narrow transcription, General American Phonetics, syllable, word, monosyllabic word, bisyllabic word, multisyllabic word, vocal tract, voicing, phonology, phonological rules, coarticulation, and loanword.

7. What three aspects are used to delineate consonants?
8. List and define briefly the places of articulation.
9. List and define briefly the manners of articulation.
10. What determines the presence or absence of voicing?
11. List and define briefly the three dimensions used to define vowels.
12. What is vowel height and what are the four variations used by the IPA?
13. What is frontness and what are the three variations used by the IPA?
14. What is rounding and what are the two variations used by the IPA?
15. When are the other symbols or diacritics categories in transcription used?
16. What are suprasegmentals?
17. How are proper nouns, names, and sentences delineated in the IPA?
18. Distinctive features are binary in nature. What does this mean?
19. List and describe briefly the 17 distinctive features according to Chomsky and Halle.
20. What do the phonological rules dictate to the language?
21. What are the five basic phonological patterns found in monosyllabic words in GAP?
22. Are phonetics and phonology interrelated?
23. What do the initials GAP represent?

Exercises

1. Using the IPA chart as a reference, write 10 symbols that you are not familiar with and try to pronounce them using manner and place of articulation information.
2. Considering pronunciation, which of these words do not have direct sound to symbol correspondence?
 psalm, though, hat, ballet, scare, pea, wrist, gnome, tomb, knight
3. List 20 words (not including those listed in Exercise 2) that do not have a direct sound to symbol correspondence.
4. Can you identify the number of sounds and the phonological patterns in the following words?
 (Remember to say the word aloud and ignore the spelling!)

run	vase
feed	bee
me	key
if	wheat
it	knee
eight	zoo
up	loot

5. At the library, find a phonetics textbook written prior to 1996. Using this text, compare the IPA and GAP symbols. Note changes.

Chapter 2

Anatomical and Physiological Correlates

In order to better understand the IPA some basic information in the areas of anatomy and physiology is needed. The information presented in this chapter is brief and intended to provide the beginning phonetic student with an understanding of the intricate relationships of structure, function, and the production of speech sounds. These relationships form interdependent processes necessary for the production of speech. The four processes are respiration, phonation, resonance, and articulation.

Respiration is the process of modifying the air from the lungs for use in breathing and speaking. **Phonation** is the modification of the airstream from the lungs by the movement of the structures in the laryngeal area. **Resonance** is the shading and modification of the airstream from the lungs by the size, shape, and movement of the structures of the nasal, oral, and pharyngeal areas. **Articulation** is the modification of the air stream from the lungs by the various articulators.

The processes of respiration, phonation, and resonance work together to produce the various vowels and diphthongs. These processes are also instrumental in determining the voicing or voiceless aspect of consonants. The process of articulation facilitates the production of consonant sounds. It is important to remember that in addition to their singular functions just stated, each of these four processes have an interactive component effecting the entire vocal tract. The structures creating these processes overlap for maximal efficiency in the production of connected speech.

In the remainder of the chapter, each of the processes is discussed from the anatomical and the physiological perspective. The material is presented in both narrative and outline form for easy reference.

RESPIRATION: THE STRUCTURES

The structures of respiration include the **pulmonary system**, the **chest wall**, the **major and minor thoracic muscle groups**, and the **abdominal muscles**. Respiration depends on the nasal, oral, and pharyngeal cavities for air intake.

The Pulmonary System

The pulmonary system is composed of the **trachea**, the **bronchi**, and the **lungs**, working together to bring oxygen to the body. The trachea is a tube of cartilage that connects the larynx and the bronchi and is lined with a mucous membrane. The bronchi are two cartilaginous tubes that are continuous with the trachea and are lined with mucous membrane. These two bronchi subdivide several times forming the secondary bronchi, bronchioles, alveolar ducts, and the alveoli (see Fig. 2.1). The lungs are elastic structures that expand and contract in relation to air supply.

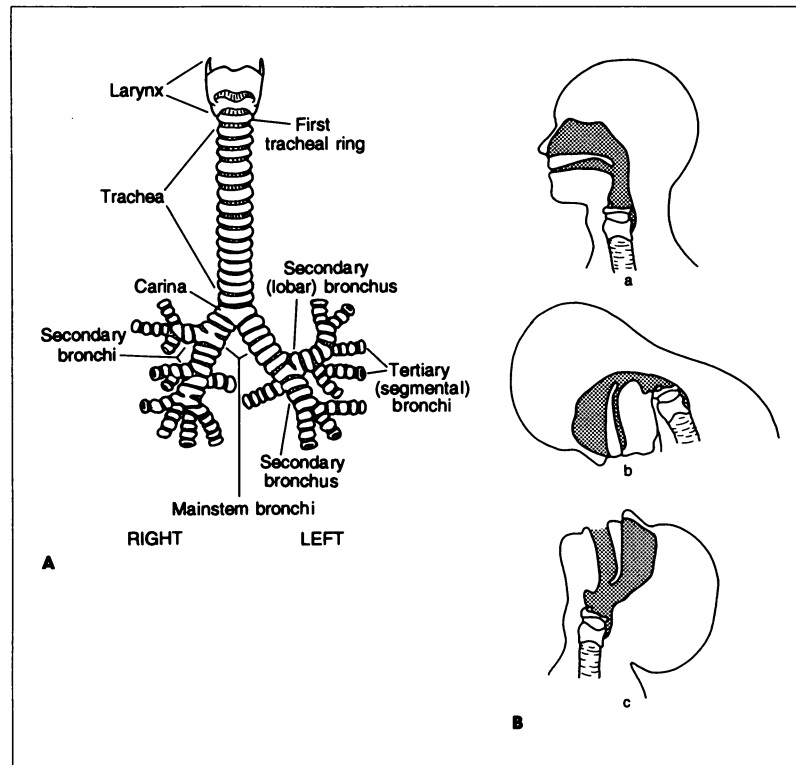


FIG. 2.1. Schematic of the respiratory passage. The upper respiratory tract is shown as the shaded area (from Seikel, King, and Drumright, *Anatomy and Physiology for Speech and Language*, copyright © 1997. Reprinted with permission by Singular Publishing Group, Inc.).

The Chest Wall

The chest wall consists of **vertebra**, **clavicles**, **scapulas**, **ribs**, **sternum**, and the **hip bones**. These bony structures create a framework for the respiratory system. The basic framework of the chest wall includes the vertebral column, the rib cage, the pectoral girdle, and the pelvic girdle.

The vertebral column is composed of five groups of vertebrae including the 7 cervical, 12 thoracic, 5 lumbar, 5 fused sacral, and 4 or 5 fused coccygeal. The thoracic vertebra are particularly important in the process of respiration due to the posterior connection of the ribs at this level of the vertebral column. The rib cage is formed by the thoracic vertebra, the sternum bone, and the 12 pair of ribs. The clavicles or the collarbones form the front section of the pectoral girdle, and the scapula or the shoulder blades form its back section. The hip bones or the pelvic girdle form the bottom of the bony framework (see Fig. 2.2a and 2.2b).

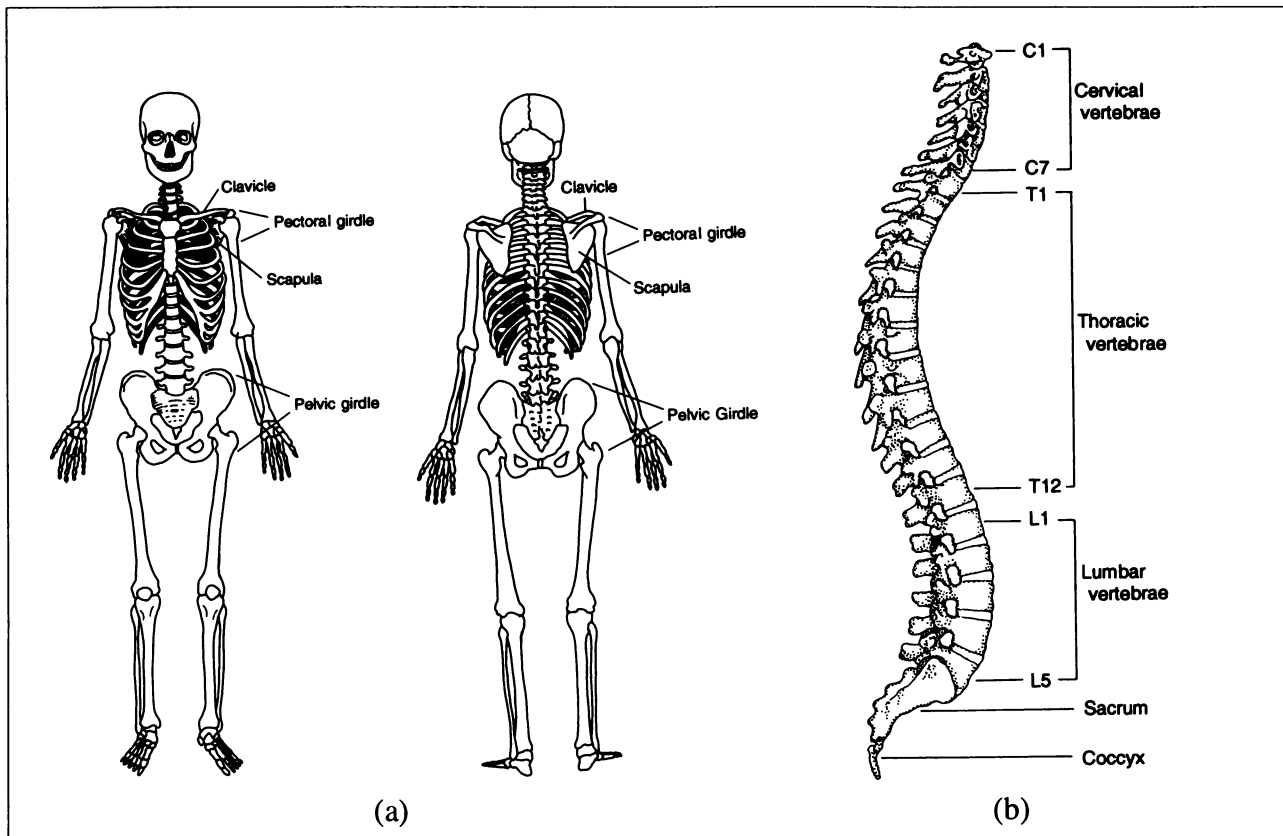


FIG. 2.2. (a) A rib cage and pectoral girdle seen from the front and a scapula in situ as seen from behind. (b) The vertebral column (from Seikel, King, and Drumright, *Anatomy and Physiology for Speech and Language*, copyright © 1997. Reprinted with permission by Singular Publishing Group, Inc.).

The Muscles

The major muscles include the **diaphragm**, the **external intercostals**, and **internal intercostals**. The minor muscles are the **scalenes**, the **transverse thoracic**, **quadratus lumborum**, **pectoralis major**, and the **pectoralis minor**. The abdominal muscles include **rectus abdominis**, **external oblique**, **internal oblique**, and **transverse abdominis**.

The diaphragm is the chief muscle of inspiration, and the external intercostals aid in inspiration and the internal intercostals aid in expiration. The minor muscles serve to elevate or depress the ribs as support for respiration. The abdominal muscles serve the function of compressing the viscera and affecting the size of the thorax (see Fig. 2.3).

RESPIRATION: THE PROCESS

Respiration in the human body involves the flow of gas in outward (**expiratory**) and inward (**inspiratory**) cycles. The flow of gas is the result of pressure changes in the lungs related to the size of the thorax. Inspiration results in the increase in the size of the thorax. The lungs expand in volume and lung pressure is below atmospheric pressure. As a result, air rushes into the expanded lung. Expiration occurs when the size of the thorax is reduced and the lung is compressed causing air to be pushed out. The inspiratory cycle has three phases. The first phase is **ventilation** and involves the flow of air from the atmosphere to the lungs. The second is **external respiration** and is the gas exchange between the lungs and the blood. The third phase is **internal respiration** and involves the exchange of gas between the blood and the body cells.

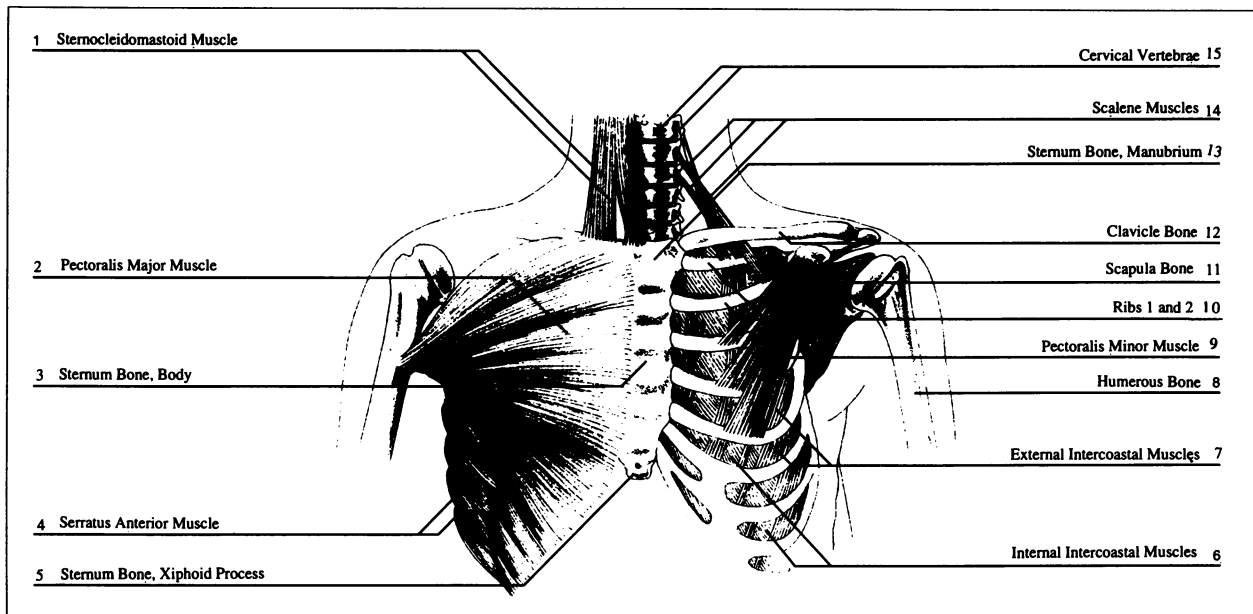


FIG. 2.3. Thoracic respiratory muscles (from Palmer, *Anatomy for Speech and Hearing*, 4th Edition. Reprinted with permission by Williams & Wilkins).

The two cycles vary slightly for quiet breathing, which uses little energy, and for active breathing, which uses considerable muscle support. Specialized respiration for speaking purposes involves the formation of air pressure below the vocal folds (subglottal). In speech breathing, the inspiratory cycle is short in duration and the expiratory cycle accounts for 80% to 90% of the speech breathing cycle. The way the air is released creates various manners of articulation.

Outline Summary of Respiration

A. Structures

1. Pulmonary system: brings oxygen to the body
 - a. Trachea
 - b. Bronchi
 - c. Lungs
2. Chest wall: framework of the respiratory system
 - a. Vertebra
 - b. Clavicles
 - c. Scapulas
 - d. Ribs
 - e. Sternum
 - f. Hip bones
3. Major muscles
 - a. Diaphragm: chief muscle of inspiration
 - b. External intercostals: aid in inspiration
 - c. Internal intercostals: aid in expiration
4. Minor muscles: elevate and depress ribs
 - a. Scalenes
 - b. Transverse thoracic
 - c. Quadratus lumborum

- d. Pectoralis major
- e. Pectoralis minor
- 5. Abdominal muscles: effect size of thorax
 - a. Rectus abdominis
 - b. External oblique
 - c. Internal oblique
 - d. Transverse abdominis
- B. Process
 - 1. Respiration: the process
 - a. Inspiration
 - 1.) Ventilation: air from atmosphere to the lungs
 - 2.) External respiration: gas exchange—lungs and blood
 - 3.) Internal respiration: gas exchange—blood and body cells
 - b. Expiration

PHONATION: THE STRUCTURES

The structures of phonation include the larynx and its membrane and muscles. The larynx is composed of four important cartilages and several minor cartilages. The thyroid cartilage is the largest cartilage and provides direct protection for the vocal folds. The cricoid cartilage forms the lower back section of the larynx and provides both a resting place for the arytenoid cartilages and a connection to the trachea. The two arytenoid cartilages are important in the movement of the vocal folds (see Fig. 2.4).

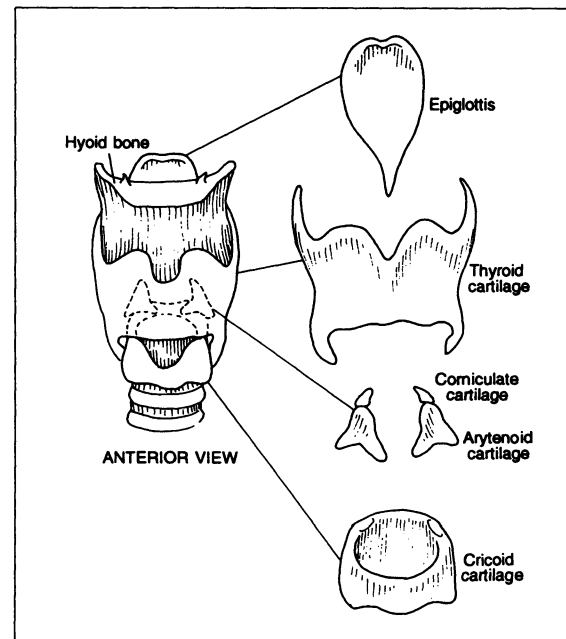


FIG. 2.4. Larynx (left) and cartilages making up the larynx (right) (from Seikel, King, and Drumright, *Anatomy and Physiology for Speech and Language*, copyright © 1997. Reprinted with permission by Singular Publishing Group, Inc.).

The Muscles

The muscles are divided into two main groups called the extrinsic muscles and the intrinsic muscles. The **extrinsic muscles** of the larynx are the **suprahyoids (stylohyoid, digastric, mylohyoid, and geniohyoid)** and the **infrahyoids (sternohyoid, sternothyroid, thyrohyoid, and the omohyoid)**. These muscles are

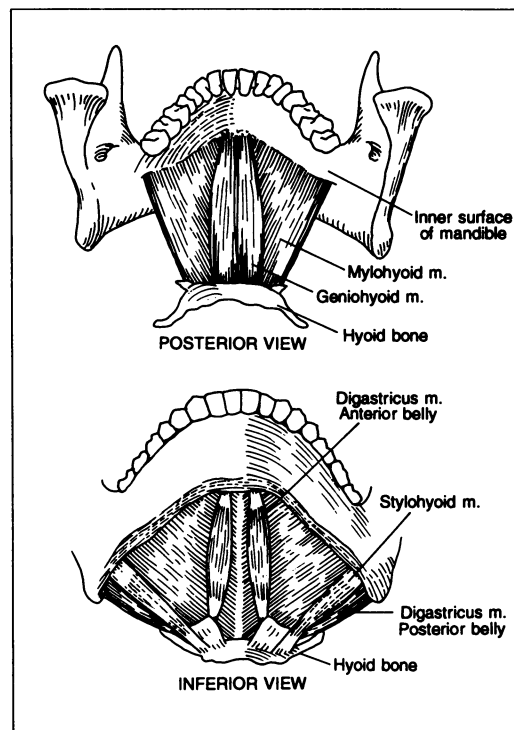


FIG. 2.5. Schematic of the relationship among geniohyoid, mylohyoid, digastric, and stylohyoid muscles (from Seikel, King, and Drumright, *Anatomy and Physiology for Speech and Language*, copyright © 1997. Reprinted with permission by Singular Publishing Group, Inc.).

responsible for movement of the larynx within the neck. The suprahyoids elevate the larynx and the infrahyoids depress the larynx (see Fig. 2.5). The **intrinsic muscles** of the larynx are the **cricothyroid**, **lateral cricoarytenoid**, **posterior cricoarytenoid**, **thyroarytenoid**, **vocalis**, **transverse interarytenoid**, and **oblique interarytenoid**. The intrinsic muscles are responsible for movement of the vocal folds and sound production (see Fig. 2.6).

The Vocal Folds

The **vocal folds** are comprised of a **vocal ligament** and the **thyroarytenoid muscle**. The **glottis** is the name given to the space between the vocal folds. There are numerous postures of the vocal folds including open and closed. When the vocal folds are open, air escapes through the glottis creating a friction type noise with no vibration. This posture allows for voiceless phonemes. When the vocal folds are closed, the air stream from the lungs creates pressure behind the closed glottis and causes the vocal folds to separate and vibrate. The open posture creates voiced phonemes.

PHONATION: THE PROCESS

Phonation is the production of sound at the level of the larynx. The process of phonation is not completely understood and researchers are still seeking answers to specific questions about laryngeal functioning. One of the most widely accepted theories of phonation is called the **myoelastic-aerodynamic theory**. The theory can best be explained through the following steps.

1. The glottis is constricted (not necessarily completely closed) by the contraction of the muscles of adduction.
2. Upon reaching the constriction, the air from the lungs increase the amount of pressure against the glottis and creates a negative pressure.

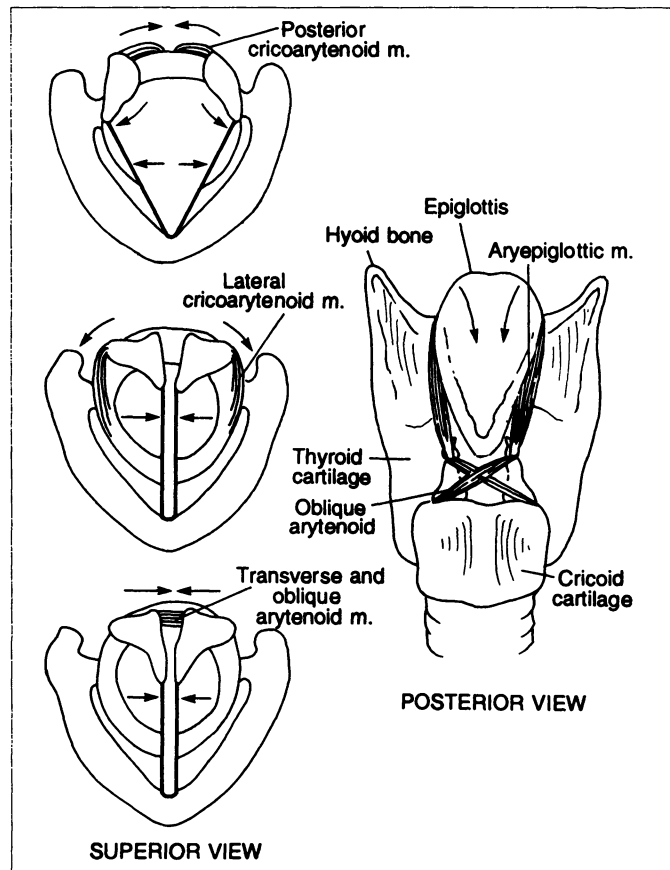


FIG. 2.6. The intrinsic muscles of the larynx (from Seikel, King, and Drumright, *Anatomy and Physiology for Speech and Language*, copyright © 1997. Reprinted with permission by Singular Publishing Group, Inc.).

3. The pressure at the glottis continues to increase as the folds close from negative pressure.
4. The folds are blown apart and air is emitted causing repeated open and closing automatically.

Outline Summary of Phonation

A. Structures

1. Larynx

- a. Thyroid cartilage
- b. Cricoid cartilage
- c. Arytenoid cartilage

2. Muscles

- a. Extrinsic: movement of the larynx within the neck
 - 1.) Suprahyoids: laryngeal elevators
 - a) Stylohyoid
 - b) Digastric
 - c) Mylohyoid
 - d) Geniohyoid
 - 2.) Infrahyoids: laryngeal depressors
 - a) Sternohyoid
 - b) Sternothyroid
 - c) Thyrohyoid
 - d) Omohyoid

- b. Intrinsic: production of sound
 - 1.) Cricothyroid
 - 2.) Lateral cricoarytenoid
 - 3.) Posterior cricoarytenoid
 - 4.) Thyroarytenoid
 - 5.) Vocalis
 - 6.) Transverse interarytenoid
 - 7.) Oblique interarytenoid
3. Vocal Folds
 - a. Vocal ligament
 - b. Thyroarytenoid muscle
 - c. Glottis
- B. Process
 1. Myoelastic–Aerodynamic Theory

RESONATION: THE STRUCTURES

The structures of resonance are the nasal, oral, and pharyngeal cavities.

Nasal Cavity

The nasal cavity (see Fig. 2.7) is composed of the nose and the nasal cavities. The nose is formed by cartilage and is supported by the two nasal bones and the vomer bone. The floor of the nasal cavity is formed by the maxilla and palatine bones. The roof of the nasal cavity is formed by part of the ethmoid bone. The nasal cavities consist of the inferior, medial, and superior nasal concha. The inferior concha is formed by the inferior turbinate bone. The medial and superior concha are part of the ethmoid bone.

Muscles

There are several small nasal muscles. These muscles serve a limited function in human beings. These are **procerus**, **nasalis**, **depressor septi**, **posterior nasal dilator**, and the **anterior nasal dilator**. The primary role of these muscles is to alter facial expression.

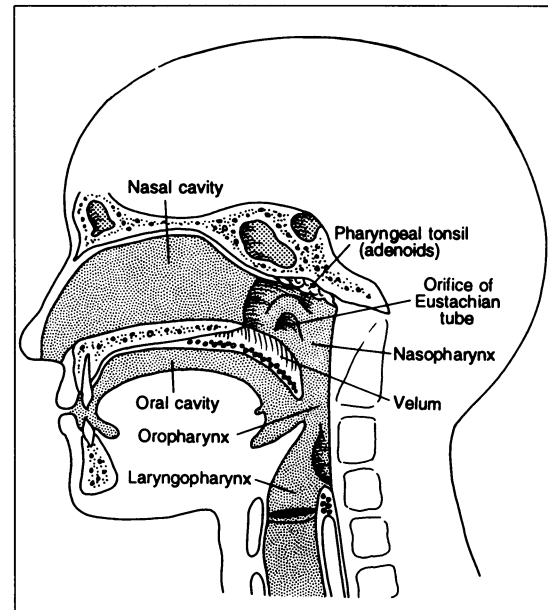
Oral Cavity

The oral cavity (see Fig. 2.7) consists of the **buccal** cavity and the **mouth** cavity. The buccal cavity is the area between the lips and the cheeks. The size of this cavity varies depending on the positions of the structures involved. The mouth cavity consists of the structures in the mouth inside the teeth, including the hard and soft palate. The mouth cavity is lined with a continuous mucous membrane. Although the oral cavity is important to both the processes of resonance and articulation, a detailed description is included in the articulation section.

Pharyngeal Cavity

The pharyngeal cavity (see Fig. 2.7) is a tube of muscle and mucous membrane connecting the larynx and the oral/nasal cavities. It can be subdivided into the laryngopharynx, the nasopharynx, and the oropharynx.

FIG. 2.7. Oral, nasal, and pharyngeal cavities (from Seikel, King, and Drumright, *Anatomy and Physiology for Speech and Language*, copyright © 1997. Reprinted with permission by Singular Publishing Group, Inc.).



The pharyngeal area is extremely important to the resonance of the voice. The actual size and shape of the anatomical structures and the capacity of the structures for variation are crucial to shaping an individual's voice. The pharynx also plays an important role in swallowing.

Muscles

The muscles of the pharyngeal area (see Fig. 2.8) the **superior, medial, and inferior constrictor muscles**, the **stylopharyngeal**, and **salpingopharyngeal muscles**. These muscles all serve to change the size and shape of the pharyngeal area. The **velopharyngeal sphincter** and **cricopharyngeal muscle** are subdivisions of the constrictor muscles that play a role in velopharyngeal closure and eliciting esophageal speech, respectively.

FIG. 2.8. Pharyngeal constrictor muscles (from Seikel, King, and Drumright, *Anatomy and Physiology for Speech and Language*, copyright © 1997. Reprinted with permission by Singular Publishing Group, Inc.).

