Chapter 2

NORMAL ASPECTS OF COMMUNICATION

To better understand the communication disorders reviewed in the following chapters, it is helpful first to understand some basic aspects of normal communication. Human communication is a very complex process, many aspects of which are not yet fully understood. It is not even possible to talk about "normal" communication without specifying for whom it is normal. The ability to communicate is a developmental skill. People do not expect an infant to be able to communicate as well as a first-grader, and they do not expect a first-grader to communicate as well as an adult. Children exhibit different levels of communication skills at various stages of their development. Parents, teachers, and speech-language pathologists (SLPs) who deal with young children on a regular basis should be aware of these different levels of communication skills because expecting too much can lead to frustration on the part of the child and expecting too little can result in a failure to identify early signs of a communication disorder.

Several terms used throughout this book are important for you to understand. These terms are **communication**, **language**, and **speech**. Many people use these terms interchangeably, which can lead to confusion. SLPs must understand the specific skill described by each term and use the terms correctly as must others who work with people with communication disorders.

COMMUNICATION

Communication is the broadest of the three terms and refers to an exchange of ideas or feelings. Speech and language are means of communicating, but human beings communicate in many other ways too. Artists communicate through art. A painting or a sculpture can communicate feelings or ideas in a very effective manner. Others with less artistic skill can communicate through gestures, body positions, or facial expressions. A tight jaw and a clenched fist communicate one meaning, while a smile and a wink communicate quite another. The most common way for human beings to communicate, however, is the way we are communicating now, through language.

LANGUAGE

Language can be defined in many ways. Perhaps the best definition of language for the purposes of this chapter comes from Bloom. She defines language as: "A code whereby ideas . . . are represented through a conventional system of arbitrary signals for communication" (Bloom, 1988, p. 2). According to this definition, to communicate through language, a person must first have an idea, and then arrange some symbol system in such a way that another person can process those symbols and draw from them the intended meaning.

Several conditions must be met to communicate using language. First, the person sending the message must have an idea to communicate. For example, if you are asked to discuss agricultural practices in Estonia prior to World War I, you probably would have some difficulty because you may not have much of an idea on that topic to communicate. As children grow, their knowledge and understanding of the world also grow. As a result, they have more ideas to express and more topics to communicate. A second condition is that the communicator must be familiar with the symbol system used to express ideas. If you have studied a foreign language, you know that it is easier to say what you want to say in your native language than in the new language, even though your idea is the same. It takes time and practice to master a new symbol system. As you will see in Chapter 3, children master their language symbol systems in developmental stages.

It is important to remember that language is not only expressed, but for communication to occur, language must also be received. When people send a message, they are using **expressive language**; when they receive a message, they are using **receptive language**. We are communicating with you (we hope) through language right now. We are using expressive language, putting our ideas into symbols. You are using receptive language, processing those symbols so that you can understand our ideas. If you understand our ideas, we have communicated. The process involved in expressive language is **encoding**, putting ideas into code, and the process involved in receptive language is **decoding**, taking ideas out of code.

To communicate through language, both the encoder and the decoder must know the same code. If you speak only English and you try to explain something to someone who speaks only Mandarin Chinese, any communication would probably result from gestures and facial expressions rather than from language because you do not share a common linguistic code with your listener. It does not matter how slowly or how loudly you say the words. The other person will not be able to understand you because she does not have knowledge of your code. Even if the person to whom you are trying to communicate speaks English, if that person does not have knowledge of the words you are using, you will not communicate your idea to the listener. For example, if someone told you that he wanted you to "defenestrate my guzmania," you might not know that he wanted you to take a plant (a guzmani) and throw it out a window (defenestration). If you did not have the confidence to admit that you did not understand the direction, you might do nothing or do something completely unrelated to the instruction. Now imagine a child in an educational setting who does not have sufficient vocabulary to understand the teacher's instruction. That child is in the same situation of not knowing what to do, and her inappropriate response might be misinterpreted by the teacher as disobedience or failure to pay attention.

Because language is such a broad topic, it is sometimes helpful to specify certain aspects or subcomponents of language. Five subcomponents are typically identified: semantics, syntax, phonology, morphology, and pragmatics.

Semantics is the component of language having to do with meaning. The words and sentences people use must have meaning if they are to communicate. If a speaker uses an incorrect word to express an idea or if a listener does not understand the meaning of a word, information may not be conveyed accurately. Certainly one of the more observable aspects of a person's semantic ability is vocabulary. Individuals' vocabularies expand throughout their lives. Hopefully, you are adding to your vocabulary as you read this chapter. During childhood, however, vocabulary grows rapidly. Between the ages of 2 and 4 years, it seems as if children learn a new word every day.

As with all components of language, the semantic component has both an expressive and receptive aspect. Like adults, children usually understand more words than they use. It is not correct to assume that a child does not understand a word simply because he never uses it. On the other hand, because a child uses a word in one context does not mean that he understands all of the possible meanings associated with that word or even is aware that the word has other meanings. The phrases a "loud" jacket, a "sharp" student, or a "school" of fish might not convey the same meaning to a child that they do to an adult. In the same way, idiomatic expressions such as "You're pulling my leg" or "She went to pieces" may suggest some unusual images to a child who knows all the words but on a less abstract level. Additionally, some of a child's first words may be applied more broadly than they are in the adult form of the language. For example a child might call all women "Mommy" or all animals "kitty." This is called overgeneralization. As children's language skills increase, they apply labels more specifically.

Syntax is the component of language that has to do with the way words are put together to form sentences. This includes rules regarding the acceptable order of words in sentences. Syntax is related to those skills referred to as grammar. As children develop, their skills in the area of syntax improve. Children begin with single words and move to two- and three-word utterances. Gradually, they are able to use questions, tenses, different forms of the verb "to be," compound and complex sentences, and other advanced syntactic structures. Consider the complexity of the following sentence: "By this time next year, you will have been in first grade for three months." A student who is not yet able to deal with such complex sentence structure will not be able to decode the message adequately. Just as SLPs see overgeneralization in semantic development, they sometimes see overgeneralization of basic syntactic rules to irregular forms. For example, a child might apply the rule of adding *s* to form a plural to a word such as *foot*, resulting in a sentence such as "I have two foots." Or a child may apply the rule of adding *ed* to indicate past tense and say, "I drawed a picture."

Phonology is the component of language that deals with putting sounds together to make words. The sounds of a language are called **phonemes**, and there are certain ways in which phonemes can and cannot be combined to make words. For example, in English, certain consonants can be combined in a cluster at the beginning of words, such as fr in *from*, bl in *blue*, and scr in *scream*, but English speakers never begin a word with a pb or a dg combination. In the early stages of phonologic development, it is quite common for children to reduce consonant clusters to a single consonant, so a word such as *green* may be produced as "geen," and *stop* may be produced as "top." In very young children, this is part of the normal development of phonology.

Morphology deals with the use of morphemes. A morpheme is the smallest unit of language that conveys meaning. A word such as *boy* is a morpheme. When the phoneme s is added to the word *boy*, the s means more than one. In this case, because the s conveys meaning, it is also a morpheme. In addition to signifying a plural form, an s can also indicate a possessive form when it follows an apostrophe, but in either case, the s has to be attached to another morpheme to have meaning. Morphemes that have to be attached to other morphemes are called **bound morphemes** and include plural and tense markers, as well as prefixes and suffixes such as un in *undress* and ly in *quickly*. Morphemes such as *boy* that are meaningful when standing alone are called **unbound** or **free morphemes**. A child's language development is often reflected in the number of morphemes he or she uses in each utterance.

Pragmatics has to do with the effective use of language in various contexts. Skills such as appropriately initiating a conversation, taking turns during conversation, and assessing how much information your listener needs to be able to understand your message are all part of pragmatics. It is very common for children to think that everyone shares their knowledge of people, places, and things. When asked, "Where did you go on vacation?" a child might say something like, "Billy's house." It is then left to the listener to ask, "Who is Billy?" and, "Where does he live?" As pragmatic skills increase, the child can answer such a question by saying, "I went to visit my cousin Billy in Ohio."

There are two features of language that are important to point out. Language is **rule based**, and it is **generative**. By rule based, we mean that there are certain rules that all speakers of a language know and obey. These are not the rules you learn in junior high English class regarding split infinitives and dangling participles, but rules of which you may not even be aware. You simply know them as a speaker of your language. Some examples can help illustrate this point. You know that the prefix in means not. So, if something is not accurate, it is inaccurate, and if it is not tolerable, it is intolerable. But what if something is not possible? You do not say **in**possible; you say **im**possible. Why does the n become an m in this word? While you make the change somewhat automatically, you may not understand why you make the change. (It is simply more efficient to move from an m to a p than from an n to a p because the lips are together for m and p but apart for n.) Here is another example of a phonological rule: Each of the following are words in English, with one exception. Which one is not a word in English?

1. Monogenesis
2. Palpus
3. Rowel
4. Fugacious
5. Sssssseeeellpn

It shouldn't take very long for you to select number 5. Sssssseeeellpn is clearly not a word in English. It is likely that some readers might have difficulty defining words 1 through 4. But even if you do not know the meaning of the words (there is no semantic component to guide you), you can still identify the nonword. What is the phonologic rule that the first four terms obey but that the fifth violates? After some thought, you might be able to say something about the syllable structure or too many consonants together without a vowel, but you probably cannot state a rule that you memorized at some time in your educational history. As a speaker of English, you knew immediately that choice 5 was not a word. If you change the order of the letters so that "sssssseeeellpn" becomes *sleeplessness*, you now recognize it as a word all too familiar to most college students.

Here is an example of a syntactic rule. Which of the following is an acceptable sentence?

1. The old miles were lived clearly on a clean plate.
2. Plate on old the clearly lived miles a clean were.

As in the previous example, it should not be hard for you to choose. Number 1 is a sentence, whereas number 2 is simply a jumbled string of words. What makes number 1 a sentence and number 2 a nonsentence? Once again, although it might be very difficult to rattle off a rule, you know that the sequence of words in number 2 does not qualify as a sentence. The words in number 1, on the other hand, do form a sentence, even though the sentence is without meaning. As children develop their language skills, they must learn the rules of the language. During early stages of development, they do not know all of the adult rules, or they may operate under a different set of rules that allows them to communicate, but in a simpler fashion than adults. Consider the child who refers to his feet as "foots." Here is a child who has learned the rule: "If more than one, add s." Assuming normal language development, the child will learn the exceptions to that rule later.

The other characteristic of language is that it is generative. Once you learn the rules of the language, you can make and understand sentences that you have never heard before. You probably never before heard the preceding sentence, but you can understand it. The last time you took an essay test, you probably created sentences that you never used before (and in some cases may never use again). Children display this generative aspect of language very early in their development when they make sentences such as "all gone milk." Parents may repeat this utterance, but in most cases the sentence was first created by the child.

An example of how children use their knowledge of linguistic rules to generate novel sentences was proved by the son of one of the authors. After a request that he "behave," the boy responded, "But, Dad, I am being have." It is this generative aspect of language, the ability to create new sentences that makes language such a powerful tool for communication.

Language is most frequently expressed through two avenues: writing and speaking. The more common avenue for most people is speech.

SPEECH

Speech is the process of producing sound patterns to communicate. For most people, speech is a relatively effortless process. However, speech is a complicated action requiring the coordination of several processes. Five basic processes associated with speech are: **respiration**, **phonation**, **resonance**, **articulation**, and **cerebration**. Although these processes work together to produce speech, it is helpful to describe each separately.

RESPIRATION

Respiration is the inhalation and exhalation of air from the lungs. Quiet breathing, as you are probably doing now, is an automatic function. When your body senses the need for oxygen, your chest cavity expands by the contraction of chest muscles and the **diaphragm** (the muscle that separates the chest cavity from the abdominal cavity). Expanding the chest cavity causes the lungs to expand. The increased size of the lungs results in lower pressure inside the lungs than outside, and air rushes in to balance the pressure. When you exhale, you relax the diaphragm and chest muscles, allowing the lungs to return to their resting position. As the size of the lungs decreases, the pressure inside becomes greater than outside, and air is forced out until the pressure inside the lungs once again equals the pressure outside.

Beyond exchanging carbon dioxide and oxygen, respiration also serves as the driving force for speech. Breathing for speech is a much more complicated process than quiet breathing is. When using connected speech, speakers allow only brief pauses to "take a breath." Inhalation for connected speech then must be faster than inhalation for quiet breathing. Exhalation for speech is even more complex. Connected speech requires frequent changes in loudness and stress patterns. All of these changes require adjustments in the amount of air pressure provided by the respiratory system. Too much pressure results in speech that is too loud or in stress being placed on the wrong syllable. Too little pressure results in speech that is hard to hear or difficult to understand. Sometimes, speakers are almost "out of air," but they don't want to pause to take a breath. So, they force out air beyond the point where they would ordinarily stop to inhale. All of these adjustments must be done quickly enough to support rapid connected speech, and all must be coordinated with the activity of the other speech structures. Several abdominal, chest, and back muscles are used during exhalation for speech to provide just the right amount of air at just the right time to support a smooth flow of speech.

As air leaves the lungs, it travels through the trachea. Directly atop the trachea is a structure composed of cartilage and muscle, which some people call the voice box, but which we shall call the **larynx** (lar-ingks). The larynx has several functions. One function is to prevent food or liquids from entering the trachea and the lungs. The explosive coughing that you experience after swallowing something "the wrong way" is a result of the larynx fulfilling its role as protector of the lower airway. Another function of the larynx is the production of **voice**. The process of producing voice is called phonation and is the next basic process of speech to be discussed.

PHONATION

Phonation is the production of voice (be careful not to confuse *phonation* with *phonology*). Voice is produced in the larynx. **Figure 2–1** shows the position of the larynx in relation to the lungs and trachea. The larynx forms what many people refer to as the "Adam's apple."

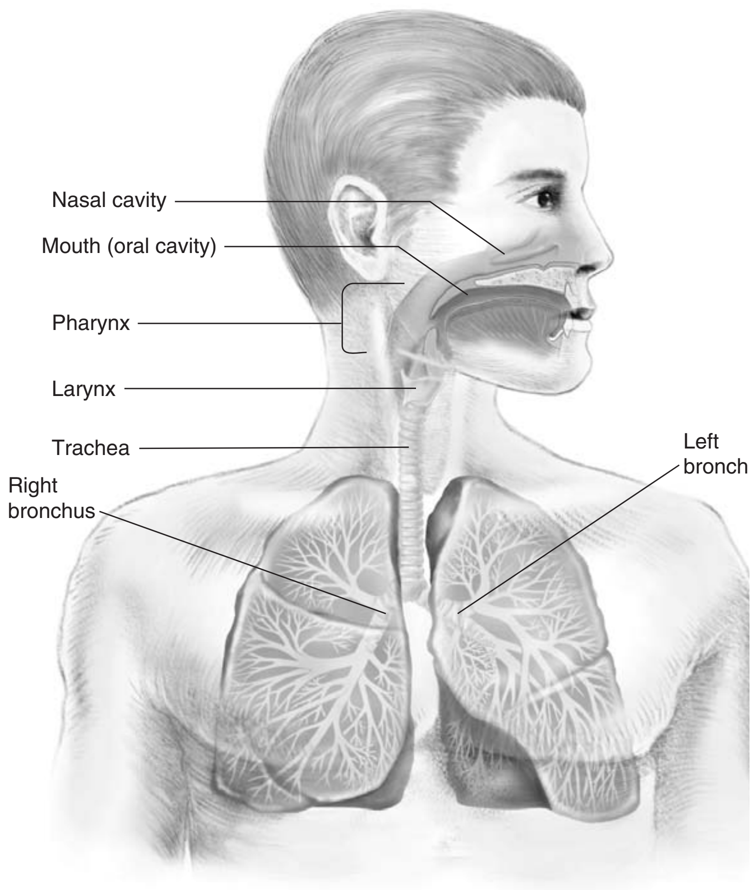

FIGURE 2–1 Relative position of the lungs, larynx, and pharynx.
Source: Chiras, D. (2008). *Human Biology* (6th ed., p. 153). Jones & Bartlett Learning. Reprinted by permission.

If you place your finger on the side of your Adam's apple and produce a prolonged "eeeeeee," you should feel some vibration. What you feel is the rapid vibration of the vocal cords, or more accurately the **vocal folds**. The vocal folds are two bands of muscle that run horizontally from the front to the rear of the larynx (see **Figure 2–2**). Air from the lungs sets these muscles into vibration. This vibration of the vocal folds produces voice.

The position and action of the vocal folds are sometimes difficult to visualize. It may be helpful to use the following hand analogy. With your index and middle fingers, make the letter *V*. Now hold your fingers in a horizontal plane so that you are looking at the fingernail side. You now have an analogy of the vocal folds. They are attached in a V shape in the front but are free to move together and apart at the rear. During quiet breathing, the vocal folds are apart, or **abducted**, allowing air to pass into and out of the trachea and lungs. To produce voice, the vocal folds must be brought together, or **adducted**, following inhalation. In this position, the vocal folds lie in the path of the exhaled air. The airflow from the lungs sets the adducted vocal folds into vibration, causing a buzzing sound that serves as the basis for what will eventually be heard as voice. The rate of vibration, or cycles per second, determines the **frequency** of the voice.

Listeners perceive frequency as **pitch**. A high-pitched voice is associated with faster vibratory rate (more cycles per second), and a low-pitched voice is associated with a slower rate of vibration (fewer cycles per second). Although a rubber band is not a perfect analogy for a vocal fold, it may help to clarify the pitch-changing mechanism of the larynx. As a child, or in an idle moment as an adult, you've probably plucked a rubber band, producing a sound. As you stretch the rubber band, it becomes longer, thinner, and tighter (or more tense), and the

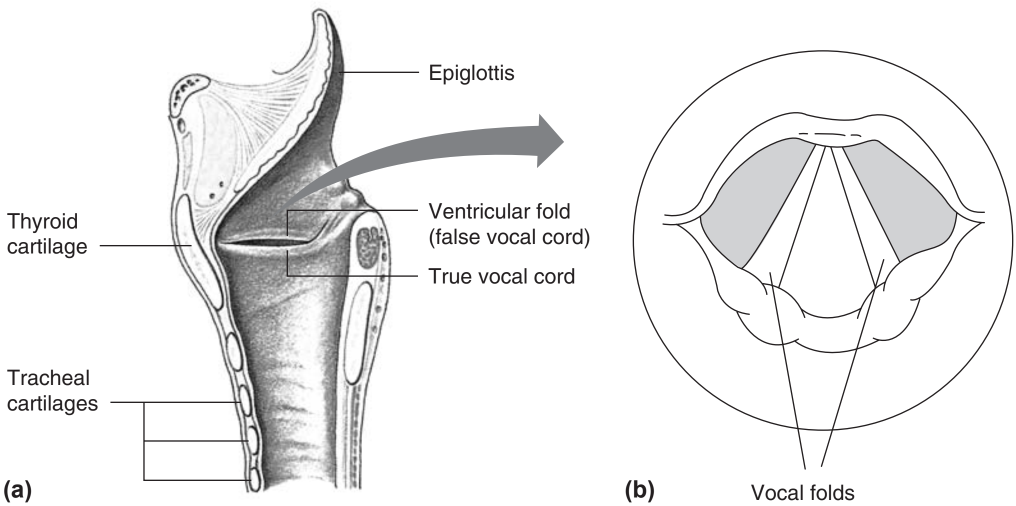

FIGURE 2–2 The larynx and vocal folds.
Source: (a) Chiras, D. (2008). *Human Biology* (6th ed., p. 154). Jones & Bartlett Learning. Reprinted by permission. (b) Illustration by Mark J. Moran.

sound produced by plucking it increases in pitch. That is roughly what happens to the vocal folds when a speaker increases vocal pitch. When you raises your pitch, you stretch the length of the vocal folds, which makes them thinner and increases the tension. A low pitch is associated with shorter, thicker, more lax vocal folds. Although there is no significant pitch difference in the voices of young boys and girls, adult males have a lower pitch than do adult females. The pitch difference between the sexes in adults is a result of the growth of the larynx during puberty. Chapter 3 contains more information about the changes in pitch across the life span.

In addition to pitch, another aspect of voice that speakers frequently alter is loudness. Just as pitch is the perceptual aspect of frequency, **loudness** is the perceptual aspect of **intensity**. Intensity is controlled primarily by the amount of air pressure with which the vocal folds are blown apart. Imagine that you are going to yell to a friend across a parking lot. Your friend is far away and the parking lot is noisy, so you have to yell loudly. What is the first thing you do as you prepare to yell? For most people, the answer is to take a deep breath. The large volume of air in the lungs resulting from the deep inhalation, along with forceful contraction of abdominal, chest, and possibly back muscles, provides the powerful exhalatory air stream needed for a loud voice.

Pitch and loudness by themselves do not completely describe a person's voice. Two people producing a sound at the same pitch with the same loudness still sound different from each other. The factor that gives each person's voice a certain uniqueness is the factor of **voice quality**. Voice quality is not as easy to define as pitch and loudness. Whereas pitch and loudness are each perceptual aspects of single physical characteristics (frequency and intensity), quality is the perceptual aspect of several physical characteristics. To complicate matters further, SLPs are not certain of all the physical characteristics that contribute to quality. Whereas pitch can be described as high or low and loudness can be described as loud or soft, a number of terms are used to describe quality. Terms such as *hoarse, harsh, breathy, rough, raspy, rich, mellow, flat*, and *throaty* all are attempts to describe voice quality. Although professionals do not understand all of the factors that affect voice quality, most authorities agree that voice quality is related to the process of phonation and the next process to be discussed, resonance.

RESONANCE

The sound that you hear as a person's voice is not the same sound that that person produces at the larynx. The sound has to pass through the **vocal tract**, which is the area from the larynx to the end of the lips or, sometimes, the end of the nostrils (see **Figure 2–3**). The size and shape of the vocal tract has an effect on the sound that listeners finally hear. The effect of the size and shape of the vocal tract on the sound that passes through it is resonance. A common childhood activity provides an example of resonance. Children often amuse themselves and others by talking into the cardboard tube from which paper towels or plastic wrap is dispensed. Holding the tube in front of the mouth results in a

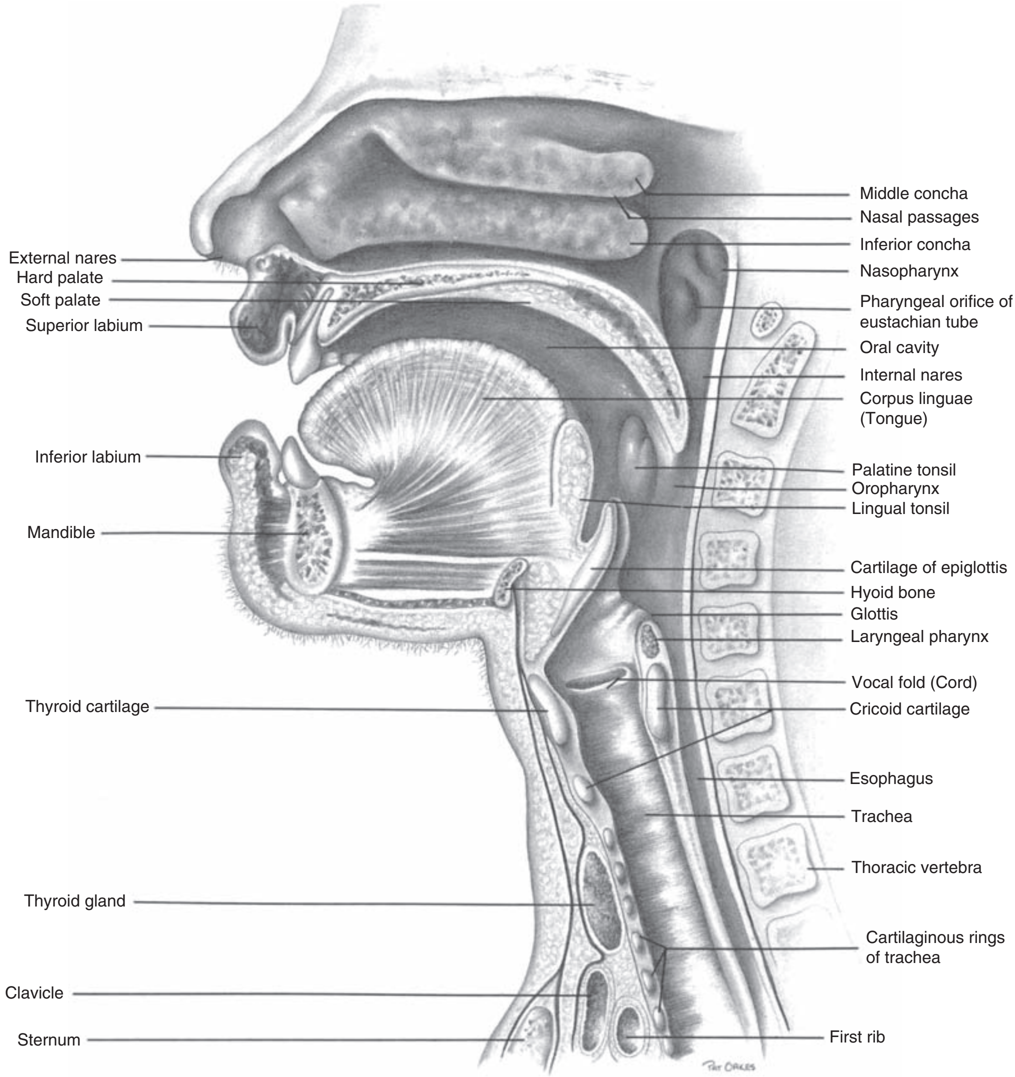

FIGURE 2–3 The vocal tract.
Source: Donnersberger, A., & Lesak, A. (2000). *A Laboratory Textbook of Anatomy and Physiology.* (7th ed., p. 332). Jones & Bartlett Learning. Reprinted by permission.

different sound than is produced without the tube. Holding the tube in front of the mouth effectively lengthens the vocal tract, and the sound that finally is released into the air is quite different from the sound that would have been released at the lips. Perhaps the most important aspect of resonance to understand is oral versus nasal resonance. For most speech sounds in English, the nasal cavity is closed off from the oral cavity by the upward and backward movement of the soft palate, or **velum**. Only the m, n, and ng sounds are produced with the velum down (open). If other sounds, especially vowels, are produced with the velum down, the voice has a nasal quality and the person sounds as if she is "talking through the nose." If an obstruction in the nasal cavity prevents the sound from passing through the nose on m, n, and ng, the person has a denasal quality and sounds as if she has a head cold. Problems of nasal resonance are discussed further in later chapters.

In the vocal tract, speech sounds, or phonemes, are produced by means of the next process to be discussed, articulation.

ARTICULATION

As mentioned in the previous discussion of language, phonology deals with the rules for putting speech sounds together to make words. Articulation is the physical production of the speech sounds. Speech sounds are produced by altering the flow of air from the lungs. The way in which the speaker alters the airflow and the place in which it is altered determines which sound is produced. The body structures speakers use to alter the flow of air through the vocal tract are called **articulators**. Some articulators are movable and some are immovable. The articulators are listed in **Table 2–1**.

Before we discuss individual speech sounds, we have a problem to solve. We are talking about speech sounds, but because we are communicating through written language, we must use a written symbol to represent each speech sound. Unfortunately, English is not a phonetic language. By that, we mean that the letters of the alphabet do not always represent the same sound. For example, the c in *Cindy* is produced as an s, but the c in *candy* is produced as a k, and the two c's together in *Gucci* are produced as a ch. In other cases, the same sound may be represented by several different letters. The f sound can be represented by the letter f, but it is also represented by the ph in *Philadelphia* and the gh in *enough*. In these examples, we have been able to identify the sound we mean by referring to another letter, but that is not always the case. What sound does the s represent in *vision*? How can we differentiate the th in *the* from the th in *think*?

It is difficult to describe the sound without producing it. That is one of the limitations of written language: We cannot make the sounds we wish to describe. In the field

TABLE 2–1 The Articulators

Movable Articulators	Immovable Articulators
Lips	Teeth
Mandible	Alveolar ridge
Tongue	Hard palate
Soft palate (velum)	
Larynx	
Pharynx	

of communication disorders, professionals solve this problem by using the International Phonetic Alphabet. In this alphabet, there is a symbol for each speech sound, and each symbol represents one and only one speech sound. It is beyond the scope of this text to discuss the International Phonetic Alphabet, so when the written letter does not represent clearly the sound we intend, we use a key word as an illustration (e.g., j as in *joy*). That way, we can use your speech to communicate our message.

There are two major categories of speech sounds, or phonemes: vowels and consonants. Consonants are produced with a greater degree of obstruction in the vocal tract than are vowels. To produce a consonant sound, speakers must use two articulators to obstruct the flow of air in just the right way to produce the sound that listeners recognize as a consonant. Consonant sounds are distinguished from each other on the basis of three production features (see **Table 2–2**). The **manner of articulation** describes *how* the airflow is altered. The air can be completely blocked and then suddenly released, as is the case for p, b, t, d, k, and g. Because these sounds often have an explosive quality to their production, they are sometimes called **plosive** consonants, but they are not always exploded. For example, in the word *hat*, the final t is rarely exploded, especially in connected speech such as "I wear a hat in the winter." The aspect that all of these consonants do have in common is the complete stoppage of air at the beginning of production. Therefore, we refer to these sounds as **stop consonants**.

Another way to alter airflow to produce a speech sound is to force it through a narrow opening. Forcing air through a narrow opening results in a friction noise, and consonant sounds made this way are called **fricatives**. Examples of fricatives are f, v, th (voiced as in *the* and unvoiced as in *thin*), s, z, sh and h, and the sound made by s in the word *vision*. Some sounds combine features of stops and fricatives and are called **affricates**. In English,

TABLE 2–2 Manner, Place, and Voice Characteristics of Consonants

	Manner				
Place	**Stop**	**Fricative**	**Affricate**	**Nasal**	**Semivowel**
Bilabial	p, b*			m*	w*
Labiodental		f, v*			
Linguadental		th (*thin*), th (*the*)*			
Lingua-alveolar	t, d*	s, z*		n*	l*
Linguapalatal		sh s (*vision*)*	ch, j (*joy*)*		r*, y*
Linguavelar	k, g*			ing*	
Glottal		h			

*Indicates voice.

there are two affricates: the ch sound as in *church*, and the dg sound at the end of the word *fudge*.

As mentioned earlier, most speech sounds in English are made with the nasal cavity closed off from the oral cavity by the velum. There are three sounds in English made with the velum open, allowing sound into the nasal cavity. These consonants, m, n, and ng, are called **nasals**. A group of consonants are made with the vocal tract too constricted to be vowels but not as constricted as the other consonants. These sounds are called **semi-vowels** because they are vowel-like but are still considered consonants. Semi-vowels are l, r, w, and y.

The second production feature used to distinguish among consonants is the **place of articulation**. The place of articulation indicates *where* in the vocal tract the alteration of the airstream occurs. Place of articulation is determined by the articulators used to produce the sound. For example, p, b, and m are made with both lips together and are therefore called **bilabial** (two-lip) sounds. Putting manner and place characteristics together, p and b are bilabial stops, while m is a bilabial nasal. The sounds f and v are made with the lower lip between the teeth, so these sounds are **labiodental**. The th sounds are made with the tongue between the teeth and are called **linguadental**. The ridge immediately behind the upper front teeth is the **alveolar ridge**. Several sounds are made with the tongue touching the alveolar ridge. These sounds, t, d, s, z, and l, are called **lingua-alveolar**. Moving back, the next place of articulation involves the tongue contacting the hard palate. Sounds made in this place, sh, ch, the s sound in *vision*, and the j sound in *joy*, are called **linguapalatal** sounds. The k and g are made with the tongue against the soft palate. We have already used *palatal* to mean hard palate, so for these sounds we use the term *velar* (referring to the velum). The k and g are **linguavelar** sounds. (Note the spelling difference between alveolar and velar). Finally, at least one sound, h, is made at the glottis (the space between the vocal folds), so it is known as a **glottal** sound.

The third production feature used to distinguish among consonants is **voicing**. Voicing indicates whether the vocal folds are together and vibrating or apart and not vibrating during the production of the sound. Some consonant sounds are voiced (vocal folds vibrating), while others are voiceless (vocal folds not vibrating). Voiceless consonants are p, t, k, s, th (as in *think*), sh, ch, and h. Voiced consonants are b, d, g, m, n, ng, v, z, th (as in *the*), j (as in *joy*), l, r, w, and y. Sounds that have the same manner and place of articulation but differ in voicing are called **cognates**. For example, s and z are both lingua-alveolar fricatives, but s is voiceless and z is voiced. Therefore, z is the voiced cognate of s. The phonemes are organized by manner, place, and voice characteristics in Table 2–2.

Vowels are not as easy to classify as are consonants. Vowels tend to be more continuous with each other, while consonants are more discrete. We cannot use the manner or voice features to distinguish among vowels because all vowels are made in the same manner (the manner of vowel production is called **vocalic**) and all vowels are voiced. That leaves only place. Although we have said that vowels are produced with a relatively unobstructed vocal tract, the articulators do assume certain positions to produce each vowel. Vowels are classified according to tongue position. To have a sense of the tongue positions for vowels, say the vowel ee as in *feet*, and then quickly change to oo as in *too*. Do this several times and note the direction in which your tongue moves. When you say ee your tongue should be toward the front of the mouth, and when you say oo it should move to the back. The ee is a **front vowel**, the oo is a **back vowel**. Now do the same thing with ee and a as in *at*. You should sense movement of the tongue from high in the mouth for ee to low in the mouth for a. Therefore, ee is a **high vowel** and a is a **low vowel**. It is on the basis of high–low and front–back that SLPs distinguish among vowels. Vowel classifications are presented in **Table 2–3**.

A **diphthong** is a sound produced by the joining of two adjacent vowel sounds in the same syllable. The sounds represented by the ow in *cow*, the oy in *boy*, and the i in *mine* are the three primary diphthongs in English.

The muscle movements required to make the speech sounds and the rules used to put the sounds together to make words are governed by the nervous system. The critical role of the nervous system is discussed as the process of cerebration.

CEREBRATION

Cerebration refers to the role of the nervous system in producing speech. The nervous system plays two distinct roles in speech. First, the cognitive-linguistic role involves supplying the ideas to be communicated and managing the rules that are to be used to communicate those ideas. The other role involves the motor aspect of speech. The impulses that move and control the muscles of respiration, phonation, and articulation originate in and are carried by the nervous system. The nervous system can be divided into two portions: the **central nervous system (CNS)** and the **peripheral nervous system (PNS)**. The CNS consists of those parts of the nervous system encased in a bony covering: the brain and spinal cord (see **Figure 2–4**). What is typically called the brain is actually several structures. The uppermost section is the cerebrum. The outer covering of the cerebrum, the **cerebral cortex**, is where most of the processing activity takes place. The cerebrum is divided into two halves, or hemispheres. It appears that these hemispheres have different functions. In most people, the left hemisphere is associated with intellectual functions including

TABLE 2–3 Vowel Classifications

	Front	Central	Back
	meet		too
	hit	but	foot
High to Low	made	her	no
	red		law
	hat		father

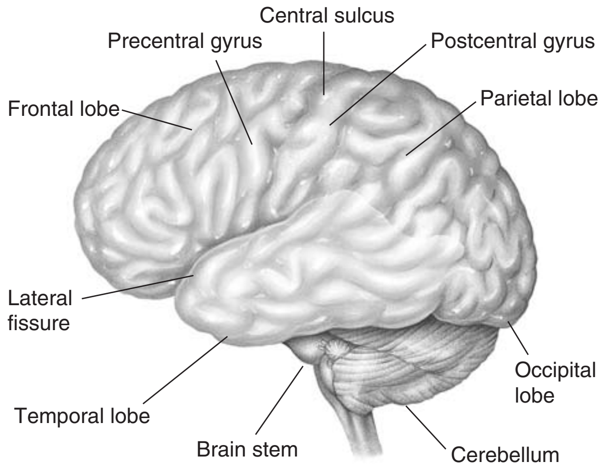

FIGURE 2–4 The brain.
Source: Chiras, D. (2008). *Human Biology* (6th ed., p. 199). Jones & Bartlett Learning. Reprinted by permission.

language and speech. The right hemisphere is associated more with spatial relations, musical patterns, and nonlanguage functions. Each hemisphere is further divided into four lobes: the frontal, parietal, occipital, and temporal lobes (see Figure 2–4). The frontal lobe is associated with speech, and the temporal lobe is associated with hearing. The cerebral cortex sends signals to and receives signals from the rest of the body via nerve fibers.

The PNS consists of the parts of the nervous system that exit the bony covering and carry signals to and from the muscles and organs. Fibers called **cranial nerves** carry signals to and from the muscles and organs of speech and hearing. The cranial nerves originate in the brainstem and innervate (i.e., carry signals to and from) most of the muscles above the shoulders. There are 12 pairs of cranial nerves (one member of each pair on each side of the body). The cranial nerves are quite complex and innervate nonspeech structures as well. These nerves serve as the connection between the nervous system and the speech structures.

The five processes of respiration, phonation, resonance, articulation, and cerebration allow human beings to put language into coded sound patterns. But communication cannot take place unless there is a way for others to decode those sound patterns. The way in which listeners usually decode the speech signal is through their sense of hearing.

HEARING

Recall from the earlier discussion that speech is a sound pattern. The sense used to receive sound is hearing. For listeners to hear a sound, three elements must be present. Small (1973) describes these elements in the following manner: First, there must be a sound source.

This could be a car horn, a falling tree, or the speech-production mechanism. Second, there must be a conducting medium to carry the sound away from the source. For speech, the medium is usually air, but if you've ever put your ear to a railroad track or lived in an apartment with thin walls, you know that sound can travel through materials other than air. Finally, there must be a mechanism to receive the sound. The mechanism that allows listeners to receive sound is the **auditory** system. The part of the auditory system with which you are most familiar is the ear. The ear changes the sound waves created by the speaker and carried through the air into nerve impulses. These nerve impulses are then sent to the brain to be interpreted or decoded.

We must mention two aspects of sound at this point: frequency and intensity. Recall from the earlier discussion of voice that frequency is the aspect of sound that listeners perceive as pitch. Frequency is measured in units called **hertz (Hz)**. Intensity is the aspect of sound listeners perceive as loudness. Intensity is measured in **decibels (dB)**.

The ear consists of three parts: the **outer ear**, the **middle ear**, and the **inner ear**. The parts of the ear are shown in **Figure 2–5**.

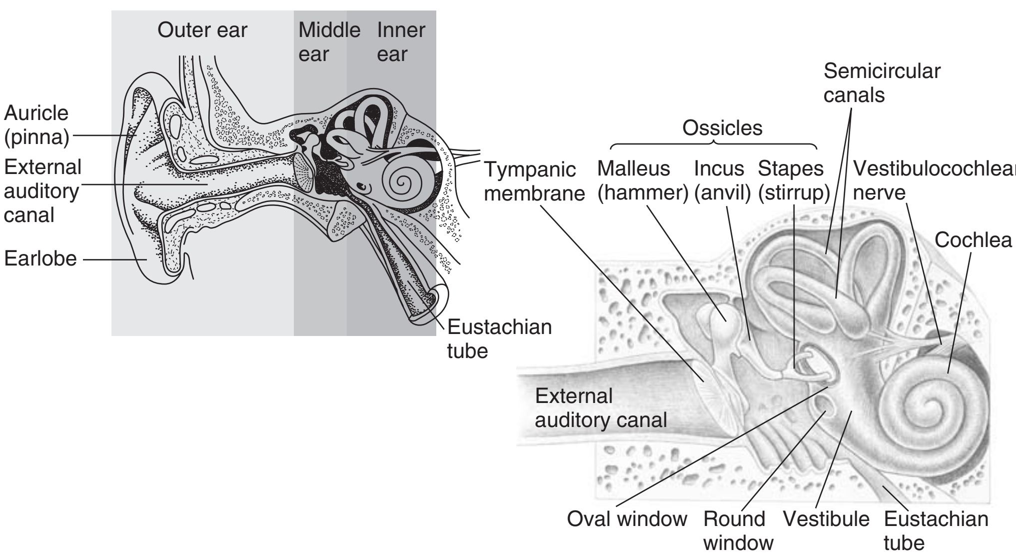

FIGURE 2–5 The outer, middle and inner ear
Source: Chiras, D. (2008). *Human Biology* (6th ed., p. 226). Jones & Bartlett Learning. Reprinted by permission.

THE OUTER EAR

The outer ear is made up of the part of the ear you see on the side of the head. This structure, made mostly of cartilage covered by flesh, is the **pinna**, also called the **auricle**. Inside each pinna, leading into the head, is a canal known as the **external auditory meatus**. Within the external auditory meatus are two structures that aid in protecting the ear from dust and other tiny particles. These structures are tiny hairs, which are visible upon close inspection of the ear, and tiny glands which secrete **cerumen**, a substance better known as ear wax. Cerumen serves an important function in protecting the ear from foreign particles. The outer ear does not play as important a role in hearing as the other parts of the ear. The pinna apparently serves to gather the sound waves from the air and funnel them down the canal to the middle ear.

THE MIDDLE EAR

At the end of the external auditory meatus is a thin membrane known as the ear drum, or, more properly, the **tympanic membrane**. The tympanic membrane separates the outer ear from the middle ear but is considered here as part of the middle ear. Behind the tympanic membrane is a cavity known as the middle ear space. There are several structures within the middle ear space, the two most important of which are the **Eustachian tube** and the **ossicles**. The middle ear space would be airtight except for the fact that it is ventilated by the Eustachian tube. The Eustachian tube leads from the middle ear to the **pharynx** (upper throat area) and allows air into and out of the middle ear space. This ventilation serves to balance pressure on each side of the tympanic membrane. You have probably experienced your ears "popping" in an airplane or as you drive up or down a mountain road. As altitude increases, the air pressure decreases. The result is more air pressure in the middle ear than on the outside. This can be painful and cause reduced hearing sensitivity. As you yawn, talk, or chew gum, the Eustachian tube opens, allowing air to escape from the middle ear until the pressure is balanced. With a decrease in altitude, the pressure outside becomes greater, and the Eustachian tube opens to allow more air into the middle ear. As discussed in Chapter 10 on hearing problems, Eustachian tube malfunction and resulting middle ear disorders are quite common among children.

The other major structure of the middle ear is a chain of tiny bones. As you no doubt learned in elementary school, there are three bones in the middle ear. These bones are sometimes called the hammer, anvil, and stirrup because of their appearance, but the true names of these bones are the **malleus**, **incus**, and **stapes**. Together, these bones are known as the ossicles, or the **ossicular chain**. The ossicles are attached to the tympanic membrane on one end and to a portion of the inner ear known as the **oval window** on the other end. As sound waves travel down the external auditory meatus, they hit the tympanic membrane, causing it to vibrate. The vibration of the tympanic membrane, in turn, sets the ossicular chain into motion, causing it to push in and out on the oval window, transmitting the pressure wave to the inner ear.

THE INNER EAR

The inner ear consists of two portions: the **vestibular** portion, which is related to balance, and the **cochlea**, which is associated with hearing. In the cochlea the pressure wave is changed to a nerve impulse by the action of a specialized structure called the **organ of Corti** (see **Figure 2–6**). The organ of Corti extends almost the entire length of the snail-shaped cochlea. The cochlea is filled with fluid in which the organ of Corti rides.

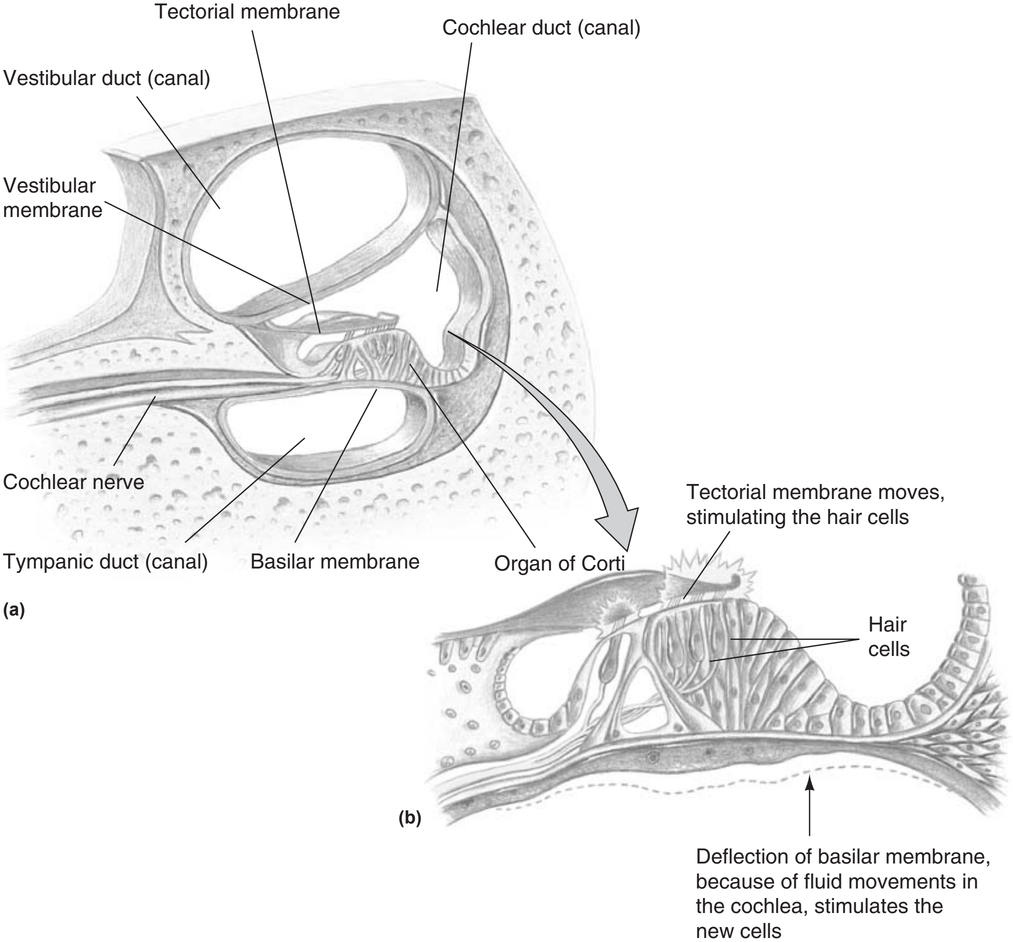

FIGURE 2–6 A cross section through the cochlea showing the position of the organ of Corti (a), and a closer view of the organ of Coti (b).
Source: Chiras, D. (2008). *Human Biology* (6th ed., p. 227). Jones & Bartlett Learning. Reprinted by permission.

When the ossicles of the middle ear move in response to sound, they create waves in the cochlear fluid. The waves cause **hair cells** in the organ of Corti to move in a shearing action. The shearing of the hair cells produces the nerve impulses that are carried along the auditory nerve and eventually to the brain. The organ of Corti is structured in such a way that different parts of the organ respond to different frequencies. The outer portion responds to high frequencies, and the inner portion responds to low frequencies. This is a very fortunate arrangement for receiving speech sounds. The frequency range of human hearing is approximately 20 to 20,000 Hz. Most speech sounds have the bulk of their energy between 500 and 2000 Hz. Because speech frequencies are closer to the low end of the range than to the high end, the portion of the organ of Corti that responds to these frequencies is near the inner, most well-protected portion. This arrangement provides maximum protection for the portion of the cochlea most important to speech.

After the organ of Corti converts the sound wave to a nerve impulse, that impulse is carried over nerve fibers up to the temporal lobe of the cerebral cortex. The right ear sends signals to the left temporal lobe, and the left ear sends signals to the right temporal lobe. Once the nerve impulse reaches the cortex, it can be processed so that meaning can be attached. What was once a pressure wave in the air, and then a series of nerve impulses, is perceived as poetry, humor, anger, obscenity, or any other message that can be conveyed through speech. What was once an idea in one person's mind becomes an idea in another's mind. Communication has occurred.

Even from this rather brief discussion you can see that the ability to communicate effectively through language and speech is a complex skill, requiring the coordination of several physical and intellectual functions. As with any complex process, there are many opportunities for things to go wrong. All listeners and speakers occasionally stumble over a sound or have difficulty finding the right word. Their voice sometimes deserts them, and they sometimes hear noises that exist only in their head. *Normal* does not mean perfect. There are, however, problems with communication that are outside the range of normal, problems that must be considered communication disorders. The rest of this book deals with those communication disorders.

Terms to Know

Communication
Language
Speech
Expressive language
Receptive language
Encoding
Decoding
Semantics
Syntax
Phonology
Phonemes
Morphology
Bound morphemes
Unbound or free morphemes
Pragmatics
Rule based
Generative
Respiration

Phonation
Resonance
Articulation
Cerebration
Diaphragm
Larynx
Voice
Vocal folds
Abducted
Adducted
Frequency
Pitch
Loudness
Intensity
Voice quality
Vocal tract
Velum
Articulators
Manner of articulation
Plosive
Stop consonants
Fricatives
Affricates
Nasals
Semivowels
Place of articulation
Bilabial
Labiodental
Linguadental
Alveolar ridge
Lingua-alveolar
Linguapalatal
Linguavelar
Glottal
Voicing
Cognates
Vocalic
Front vowel
Back vowel
High vowel
Low vowel
Diphthong
Central nervous system (CNS)
Peripheral nervous system (PNS)
Cerebral cortex
Cranial nerves
Auditory
Hertz (Hz)
Decibels (dB)
Outer ear
Middle ear
Inner ear
Pinna
Auricle
External auditory meatus
Cerumen
Tympanic membrane
Eustachian tube
Ossicles
Pharynx
Malleus
Incus
Stapes
Ossicular chain
Oval window
Vestibular
Cochlea
Organ of Corti
Hair cells

Study Questions

1. Identify and describe the five basic processes of speech.
2. Compare and contrast quiet breathing and breathing for speech.
3. Describe the mechanism by which a speaker increases vocal pitch, loudness.

4. How do vowels differ from consonants? How are consonants classified? How are vowels classified?
5. Provide several examples of words in which the same letter represents different sounds. Provide examples of words in which different letters represent the same sound.
6. Describe the cognitive and the motor function of the brain in spoken communication.
7. Identify the major structures of the ear and describe their role in normal hearing.

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