2 Articulatory Phonetics

SPEECH SOUND FORM

LEARNING OBJECTIVES

When you have finished this chapter, you should be able to:

- List the differences in production and function of vowels versus consonants.
- Identify the three descriptive parameters that are used for vowel articulations, and classify the vowels of American English using those three parameters.
- Differentiate between monophthong and diphthong vowels.
- Define centering diphthongs.
- Differentiate between a phonemic and a nonphonemic diphthong.
- Identify the four parameters that are used to describe the articulation of consonants.
- Define the various manners of articulation.
- Classify the consonants of American English according to their organ, place, manner, and voicing characteristics.
- Define coarticulation and assimilation, and describe the different types of assimilatory processes.
- Understand the importance of syllable structure in the assessment process.

Articulatory phonetics deals with the categorization and classification of the production features of speech sounds. A thorough knowledge of how vowels and consonants are generated remains essential for successful assessment and remediation of articulatory and phonological disorders. Although contemporary phonological theories have provided new ways of viewing assessment and treatment of these disorders, knowledge of the speech sounds' production features secures a firm basis for utilizing such procedures. Without this knowledge, phonological process analysis, for example, is impossible.

This chapter discusses articulatory-phonetic aspects of the speech sounds of General American English. The specific goals are

1. to provide a review of the production features of vowels and consonants;
2. to introduce the concepts of coarticulation and assimilation as a means of describing how sounds change within a given articulatory context; and
3. to examine the structure of syllables and their clinical applicability in the assessment and treatment of impaired articulation and phonology.

The production of vowels and consonants, and their subsequent language-specific arrangements into syllables and words, depends on articulatory motor processes. If these processes are impaired, speech sound production will be disordered. Articulatory motor processes depend in turn on many anatomical-physiological prerequisites, which include respiratory, phonatory, or resonatory processes. For example, the speech problems of children with cerebral palsy often originate in abnormal respiratory, resonatory, and/or phonatory prerequisites for articulation. The proper function of such prerequisites, therefore, must first be secured before any articulatory improvement can be expected. Articulatory motor ability is embedded in many different anatomical-physiological prerequisites, which are of fundamental importance to speech-language pathologists.

Basic knowledge in these areas is typically gained from courses and textbooks covering anatomy and physiology of the speech and hearing mechanisms rather than from those covering impaired articulation and phonology. This is because the clinical significance of anatomical-physiological knowledge and its application to articulatory and phonological disorders is not always recognized. The anatomical-physiological aspects of such disorders are not within the scope of this chapter. Box 2.1 offers references as an incentive for the reader to rediscover the wealth of information essential to the clinical assessment and remediation of articulatory and phonological impairments.

For more information about the respiratory, phonatory, resonatory, and articulatory characteristics of cerebral palsy, see Chapter 10.

BOX 2.1 Selected Readings in Anatomy and Physiology of the Speech and Hearing Mechanisms

Culbertson, W. R., Cotton, S. S., & Tanner, D. C. (2006). *Anatomy and physiology study guide for speech and hearing.* San Diego: Plural Publishing.

Kent, R. D. (1997). *The speech sciences.* San Diego: Singular Publishing.

Perkins, W., & Kent, R. (1986). *Functional anatomy of speech, language and hearing: A primer.* Boston: Allyn & Bacon.

Seikel, J. A., King, D. W., & Drumwright, D. G. (2005). *Anatomy and physiology for speech and language* (3rd ed.). Clifton Park, NY: Delmar.

Zemlin, W. R. (1997). *Speech and hearing science: Anatomy and physiology* (4th ed.). Boston: Allyn & Bacon.

VOWELS VERSUS CONSONANTS

Speech sounds are commonly divided into two groups: vowels and consonants. **Vowels** are produced with a relatively open vocal tract; *no significant constriction* of the oral (and pharyngeal) cavities exists. The airstream from

the vocal folds to the lips is relatively unimpeded. Therefore, vowels are considered to be *open sounds*. In contrast, **consonants** are produced with a *significant constriction* in the oral and/or pharyngeal cavities during their production. For consonants, the airstream from the vocal folds to the lips and nostrils encounters some type of articulatory obstacle along the way. Therefore, consonants are considered to be *constricted sounds*. For most consonants this constriction occurs along the sagittal midline of the vocal tract. This constriction for consonants can be exemplified by the first sound in *top,* [t], or *soap,* [s]. For [t] the contact of the front of the tongue with the alveolar ridge occurs along this midline while the characteristic s-quality is made by air flowing along this median plane as the tongue approximates the alveolar ridge. By contrast, during all vowel productions the sagittal midline remains free. In addition, under normal speech conditions, General American English vowels are always produced with vocal fold vibration; they are voiced speech sounds. Only during whispered speech are vowels unvoiced. Consonants, on the other hand, may be generated with or without simultaneous vocal fold vibration; they can be voiced or voiceless. Pairs of sounds such as [t] and [d] exemplify this relevant feature. Pairs of similar sounds, in this case differing only in their voicing feature, are referred to as **cognates.** Voicing features constitute the main linguistically relevant differences that separate the consonant cognates such as [s] from [z] or [f] from [v]. The transcription of various vowels and consonants together with examples of words in which these sounds can be heard are contained in Table 2.1.

The *sagittal midline of the vocal tract* refers to the median plane that divides the vocal tract into right and left halves.

Table 2.1 IPA Symbols (Wise, 1958)

Consonants		Vowels	
Symbol	*Commonly Realized In*	*Symbol*	*Commonly Realized In*
[p]	pay	[i]	eat
[b]	boy	[ɪ]	in
[t]	toy	[eɪ]	ape
[d]	doll	[ɛ]	egg
[k]	coat	[æ]	at
[g]	goat	[a]	father*
[m]	moon	[u]	moon
[n]	not	[ʊ]	wood
[ŋ]	sing	[oʊ]	boat
[θ]	think	[ɔ]	father*
[ð]	those	[ɑ]	hop
[f]	far	[aɪ]	tie
[v]	vase	[aʊ]	mouse
[s]	sun	[ɔɪ]	boy
[z]	zoo	[ɜ]	girl*
[ʃ]	shop	[ɝ]	bird
[ʒ]	beige	[ɚ]	winner
[tʃ]	chop	[ʌ]	cut
[dʒ]	job	[ə]	above
[j]	yes		
[w]	win		
[ʍ]	when*		
[l]	leap		
[r]	red		
[h]	hop		

*May be regional or individual pronunciations.

Vowels can also be distinguished from consonants according to the patterns of acoustic energy they display. Vowels are highly resonant, demonstrating at least two formant areas. Thus, vowels are more intense than consonants; in other words, they are typically louder than consonants. In this respect we can say that vowels have greater sonority than consonants. **Sonority** of a sound is its loudness relative to that of other sounds with the same length, stress, and pitch (Ladefoged, 2006). Due to the greater sonority of vowels

over consonants, vowels are also referred to as **sonorants.**

Due to the production features of a special group of consonants and their resulting sonority, certain consonants are also labeled sonorants. **Sonorant consonants** are produced with a relatively open expiratory passageway. When contrasted to other consonants, sonorant consonants demonstrate less obstruction of the airstream during their production. The sonorant consonants include the nasals, the liquids, and the glides. The sonorants are distinguished from the **obstruents**, which are characterized by a complete or narrow constriction between the articulators hindering the expiratory airstream. The obstruents include the stop-plosives, the fricatives, and the affricates.

There are also functional differences between vowels and consonants. In other words, vowels and consonants play different linguistic roles. This has often been referred to as the "phonological difference" between vowels and consonants (Crystal, 1987; Hyman, 1975). The term *consonant* actually indicates this: *con* meaning "together with" and *-sonant* reflecting the tonal qualities that characterize vowels. Thus, consonants are those speech sounds that function linguistically *together with* vowels. As such, vowels serve as the center of syllables, as syllable nuclei. Vowels can constitute syllables all by themselves, for example, in the first syllable of *a-go* or *e-lope*. Vowels can also appear together with one or more consonants, exemplified by *blue, bloom,* or *blooms*. Although there are many types of syllables, the vowel is always the center of the syllable, its nucleus. A small group of consonants can serve as the nuclei of syllables. A consonant that functions as a syllable nucleus is referred to as a **syllabic.** These form and functional differences are summarized in Table 2.2.

When transcribing, syllabic consonants need a special notation. This is discussed in Chapter 3.

Table 2.2 Features Differentiating Vowels and Consonants

Vowels	Consonants
No significant constriction of the vocal tract	Significant constriction of the vocal tract
Open sounds	Constricted sounds
Sagittal midline of vocal tract remains open	Constriction occurs along sagittal midline of the vocal tract
Voiced	Voiced or unvoiced
Acoustically more intense	Acoustically less intense
Demonstrate more sonority	Demonstrate less sonority
Function as syllable nuclei	Only specific consonants can function as syllable nuclei

American English Vowels

Vowels are commonly described according to certain parameters (Abercrombie, 1967; Crystal, 1987; Heffner, 1975; Kantner and West, 1960; Kent, 1998; Shriberg and Kent, 2003):

1. The portion of the tongue that is involved in the articulation. Example: front versus back vowels.
2. The tongue's position relative to the palate. Example: high versus low vowels.
3. The degree of lip rounding or unrounding.

The four-sided form called a vowel quadrilateral is often used to demonstrate schematically the front–back and high–low positions. The form roughly represents the tongue position in the oral cavity (see Figure 2.1).

The terms *tense/lax* and *open/close* are also used to describe vowels. *Tense* and *lax* refer to

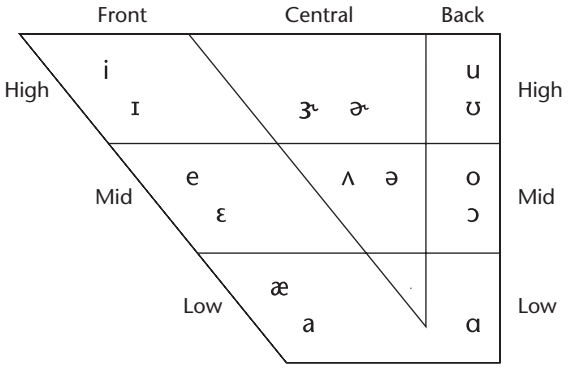

Figure 2.1 Vowel Quadrilateral of General American English Vowels

the degree of muscular activity involved in the articulation and to the length of the vowels in question (Shriberg and Kent, 2003). Therefore, tense vowels are considered to have relatively more muscle activity and are longer in duration than lax vowels. The vowel [i] is considered to be a tense vowel, whereas [ɪ] is lax. When contrasting tense versus lax, one has to keep in mind that these oppositions refer to pairs of vowels that are productionally similar, to vowel cognates. For example, [i] and [ɪ] are considered to be "ee" type vowels, and [u] and [ʊ] are "oo" type vowels.

The terms *close* and *open* refer to the relative closeness of the tongue to the roof of the mouth (Abercrombie, 1967). Again, only vowel cognates are usually characterized with these terms. Using the previous examples, [i] is more close and [ɪ] more open, [u] close and [ʊ] open.

There are two types of vowels: monophthongs and diphthongs. **Monophthongs** remain qualitatively the same throughout their entire production. They are pure vowels (Abercrombie, 1967; Shriberg and Kent, 2003). **Diphthongs** are vowels in which there is a change in quality during their duration (Ladefoged, 2006). The initial segment, the beginning portion of such a diphthong, is phonetically referred to as the **onglide**, its end portion as the **offglide.** Using this notation system, the following descriptions for the most common vowels of General American English are offered.

"It should be noted that although monophthongs are often referred to as 'pure' vowels, no special virtue attaches to them" (Abercrombie, 1967, p. 60).

Front Vowels

[i] a high-front vowel, unrounded, close and tense.

[ɪ] a high-front vowel, unrounded, open and lax.

[e] a mid-front vowel, unrounded, close and tense. In General American English, this vowel is typically produced as a diphthong, especially in stressed syllables or when articulated slowly.

[ɛ] a mid-front vowel, unrounded, open and lax.

[æ] a low-front vowel, unrounded, open and lax.

[a] a low-front vowel, unrounded, close and tense. In General American English, the use of this vowel depends on the particular regional dialect of the speaker. In the New England dialect of the Northeast, one might often hear it.

All front vowels show various degrees of unrounding (lip spreading), with the high-front vowels showing the most. The lip spreading becomes less as one moves from the high-front vowels to the mid-front vowels, finally becoming practically nonexistent in the low-front vowels.

Back Vowels

[u] a high-back vowel, rounded, close and tense.

[ʊ] a high-back vowel, rounded, open and lax.

[o] a mid-back vowel, rounded, close and tense. This vowel is typically produced

There are differences of opinion as to whether certain vowels (specifically [ɔ] and [ɑ]) are tense or lax. This is based partially on definitional differences. Heffner (1975) and Kantner and West (1960) define tense and lax according to the degree of muscular activity. Shriberg and Kent (2003) point out that this has not been verified by experimental studies (e.g., Neary, 1978; Raphael and Bell-Berti, 1975), and they add the dimension of length: Tense vowels are longer in duration than lax ones. Ladefoged (2006) defines tense and lax according to the type of syllable in which the vowel can occur. Only tense vowels can occur in open syllables, that is, in those without a consonant following the vowel (as in the words *bee* and *do*); all other vowels must be considered lax.

as a diphthong, especially in stressed syllables or when articulated slowly.

[ɔ] a low mid-back vowel, rounded, open and lax (Heffner, 1975). The use of this vowel depends on regional pronunciation.

[ɑ] a low-back vowel, unrounded, open and lax (Kantner and West, 1960). There seems to be some confusion in transcribing [ɔ] and [ɑ], although acoustic differences certainly exist. One distinguishing feature: the [ɔ] shows some degree of lip rounding, whereas [ɑ] does not.

Back vowels display different degrees of lip rounding in General American English. The high-back vowels [u] and [ʊ] often show a fairly high degree of lip rounding, whereas the low-back vowel [ɑ] is commonly articulated as an unrounded vowel.

Central Vowels

[ɝ] a central vowel, rounded, tense with r-coloring. Rounding may vary, however, from speaker to speaker. [ɝ] is a stressed vowel. It is typically acoustically more intense, has a higher fundamental frequency, and has a longer duration when it is compared to a similar unstressed vowel such as [ɚ].

[ɚ] a central vowel, rounded, lax with r-coloring. Again, lip rounding may vary from speaker to speaker. This lax vowel is an unstressed vowel.

[ɜ] a central vowel, rounded, tense. [ɜ] is very similar in pronunciation to [ɝ], but it lacks any r-coloring. This vowel is heard in certain dialects. [ɜ] might be found in a Southern dialect pronunciation of *bird* or *worth,* for example. Also, it could be heard in the speech of children having difficulties producing the "r" sound.

[ʌ] a lax, unrounded central vowel. It is a stressed vowel.

[ə] a lax, unrounded central vowel. It is an unstressed vowel.

CLINICAL APPLICATION

Do Children Have Difficulties Producing Vowels?

Vowel errors in children developing phonological skills in a normal manner are relatively uncommon. However, children with phonological disorders may show deviant vowel patterns. Several studies (e.g., Gibbon, Shockey, and Reid, 1992; Penney, Fee, and Dowdle, 1994; Pollock, 2002; Pollock and Keiser, 1990; Reynolds, 1990; Robb, Bleile, and Yee, 1999; Stoel-Gammon and Herrington, 1990) have documented the presence of specific vowel problems in phonologically disordered children. Although certain vowel substitutions seem to be articulatory simplifications that could also occur in normal development, other errors appear to be idiosyncratic. Assessment of vowel qualities should be a portion of every diagnostic protocol. This can easily be achieved with any formal articulation test by transcribing the entire word rather than just the sound being tested.

Diphthongs. As previously defined, a diphthong is a vowel sound that demonstrates articulatory movement during its production. Its initial portion, the onglide, is acoustically more prominent and usually longer than the offglide. Common diphthongs in General American English are **rising diphthongs.** This means that in producing these diphthongs, essential portions of the tongue move from a lower onglide to a higher offglide position; thus, relative to the palate, the tongue moves in a rising motion. This can be demonstrated on the vowel quadrilateral as well (see Figure 2.2).

Certain diphthongs are referred to as **centering diphthongs.** In this case, the offglide, or less prominent element of the diphthong, is a central vowel. In British English, and in some dialects of General American English, this may be a schwa vowel [ə]. Thus, *fear* may be pronounced as [fɪə] or *far* as [fɑə]. More common in General American English is the use of the central vowel with r-coloring [ɚ] as the offglide. Thus, *fear* is often pronounced as [fɪɚ], *far* as [fɑɚ], and *bear* as [bɛɚ] (Ball and Rahilly, 1999; Heffner, 1975). Theoretically, any vowel may be combined with [ə] or [ɚ] to form a centering diphthong; however, in General American English certain centering diphthongs are more common than others. Thus, [ɪɚ], [ɛɚ], and [ɑɚ], which can be heard in *dear* [dɪɚ], *bear* [bɛɚ], or *farm* [fɑɚm], are far more prevalent than [iɚ] or [uɚ]. Lowe (1994) refers to the diphthongs which are paired with [ɚ] as **rhotic diphthongs.** Centering diphthongs are also seen transcribed with [r]. Thus, *dear* is transcribed as [dɪr], *bear* as [bɛr], or *farm* as [farm].

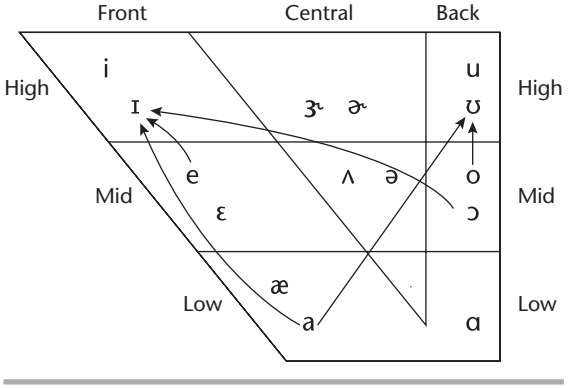

Figure 2.2 Vowel Quadrilateral with Rising Diphthongs

There are several different ways to characterize diphthongs as single phonemic units in contrast to two separate vowels. Some transcribers use a bar or bow either above or below the two vowel symbols—[e͞ɪ], [e͡ɪ], or [e͜ɪ], for example. The author has chosen to use the transcription that elevates the offglide portion of the diphthong to indicate its typically lesser intensity and length.

Discrepancies may be noted between the transcriptions of diphthongs offered in this text and the ones in other books. Because phonetic transcription is purely *de*scriptive, never *pre*scriptive, any transcription will, of course, vary according to the actual pronunciation. See Shriberg and Kent (2003) for a thorough discussion of the various ways diphthongs have been transcribed.

[eᴵ] a **nonphonemic diphthong**

It is nonphonemic in the sense that the meaning would *not* change in a particular word if the vowel were to be pronounced as a monophthong [e] versus a diphthong [eᴵ]. Therefore, the meaning would not change if just the onglide was realized. Words pronounced [beᴵk] or [bek], for example, would be recognized as the same word.

[oᵚ] a nonphonemic diphthong

[aᴵ] a **phonemic diphthong**

It is phonemic in the sense that the meaning *would* change in a particular word if only the vowel onglide was produced. Therefore, the vowel was realized as a monophthong. A realization of

[a] instead of [aᴵ] will change the meaning in General American English as the words *sod* [sad] versus *sighed* [saᴵd] demonstrate.

[ɔᴵ] a phonemic diphthong

The opposition [ʤɔ], *jaw,* versus [ʤɔᴵ], *joy,* exemplifies its phonemic value as a meaning-differentiating sound feature of English.

[aʊ] a phonemic diphthong

Oppositions such as [mas], *moss,* versus [maʊs], *mouse,* exemplify its phonemic value.

CLINICAL APPLICATION

Analyzing the Vowel System of a Child

Occasionally, the vowel system of a client may be restricted or show deviant patterns. In this case, a more in-depth analysis of the vowels produced may be necessary. Vowel systems can be analyzed using the vowel quadrilateral and knowledge of the diphthongs as guiding principles. Front, back, and central vowels as well as diphthongs can be checked in relationship to their accuracy and their occurrence in the appropriate contexts. George, age 5;3, is an example of a child with a deviant vowel system.

George was being seen in the clinic for his phonological disorder. He was a gregarious child who loved to talk and would try to engage anyone in conversation who would listen. The only problem was that George was almost unintelligible. This made dialogue difficult, possibly more so for those who would patiently and diligently try to understand his continuing attempts to interact.

In addition to his many consonant problems, the following vowel deviations were noted:

VOWEL ERRORS

Norm Production	→	Actual Production	Word Examples	Transcriptions		
[eᴵ]	→	[ɛ]	grapes	[greᴵps]	→	[dɛ]
			table	[teᴵbl̩]	→	[tɛboʊ]
[i]	→	[ɪ]	feet	[fit]	→	[fɪ]
			teeth	[tiθ]	→	[tɪ]
			three	[θri]	→	[dɪ]
[ɛ]	→	[æ]	bed	[bɛd]	→	[bæt]
			feather	[fɛðɚ]	→	[fævə]
[u]	correct	[u]	shoe	[ʃu]	→	[tu]
			spoon	[spun]	→	[mun]
[ʊ]	correct	[ʊ]	book	[bʊk]	→	[bʊ]
[oʊ]	correct	[oʊ]	stove	[stoʊv]	→	[doʊ]
			nose	[noʊz]	→	[noʊ]
[ɑ]	correct	[ɑ]	mop	[mɑp]	→	[mɑ]
			blocks	[blɑks]	→	[bɑ]

George's productions of the back vowels [u], [ʊ], [oʊ], and [ɑ] are on target. The front vowels do show a deviant pattern, however. Not only is the diphthong [eɪ] produced as a monophthong, but also the articulatory position of the vowel substitution for [e] is realized lower as [ɛ]. This tendency to lower vowels is also noted in the other productions with front vowels, in which [i] becomes [ɪ] and [ɛ] becomes [æ].

American English Consonants

Four phonetic categories are used to transcribe consonants: (1) organ of articulation, (2) place of articulation, (3) manner of articulation, and (4) voicing features. Most textbooks state that only place, manner, and voicing are used to characterize individual consonants (Edwards, 2003; Lowe, 1994; Shriberg and Kent, 2003). However, they nevertheless often include the organ of articulation. For example, the term *lingual* as in *lingua-dental* or *lingua-palatal,* designates the active organ of articulation. However, when contrasting the lingua-dental sounds [θ] and [ð] to the lingua-palatal sounds [ʃ] and [ʒ], it becomes clear that different portions of the tongue are actively involved in the articulation. The term *lingual* alone does not specify these differences. This text emphasizes the detailed knowledge of production features for specific therapy goals. By adding a category specifically designating the active articulator, the organ of articulation, valuable clarification of consonant articulation is achieved.

Organ of Articulation. Consonants are sounds characterized by the articulators creating a partial or total obstruction of the expiratory airstream. There are active and passive articulators. Active articulators, the so-called **organs of articulation,** are the parts within the vocal tract that actually move to achieve the articulatory result (Crystal, 1987). In describing the consonants of General American English, we are referring specifically to the movements of the lower lip and portions of the tongue. The structures actively involved in the articulation of the consonants of General American English and the resulting phonetic descriptors are contained in Table 2.3. Figure 2.3 displays the divisions of the tongue.

Place of Articulation. The **place of articulation** denotes the area within the vocal tract that remains motionless during consonant articulation, that is, the passive articulator; it is the part that the organ of articulation as active articulator approaches or contacts directly (Crystal, 1987). The upper lip and teeth, the palate, and the velum are the main places of articulation when describing the consonants of General American English. The passive structures of articulation and their resulting phonetic descriptors are contained in Table 2.4. Figure 2.4 displays the structures of the oral cavity as organs and places of articulation.

Manner of Articulation. The **manner of articulation** refers to the type of constriction the organ and place of articulation produce for the realization of a particular consonant. There are various manners of articulation, ranging from complete closure for the production of stop-plosives to a very limited constriction of the vocal tract for the production of glides. The following manners of articulation are used to account phonetically for the consonants of General American English.

Stop-Plosives. During the production of stop-plosives, complete occlusion is secured at specific points in the vocal tract. Simultaneously,

Table 2.3 Phonetic Description: Organ of Articulation

Organ of Articulation	Phonetic Descriptor	Examples
Lower lip	Labial	[p], [b], [m], [f], [v], [w], [ʍ]
Tip of tongue	Apical	[s], [z], [θ], [ð], [r],[1] [l]
Lateral rims of tongue[2]	Coronal	[t], [d], [n], [ʃ], [ʒ]
Surface of tongue	Dorsum	
anterior portion	predorsal	[s], [z]
central portion	mediodorsal	[j], [r]
posterior portion	postdorsal	[k], [g], [ŋ]

1. The transcription used officially by the International Phonetic Association for the American English "r" is [ɹ]. See explanation under rhotics.

2. The term *coronal* designates the apex and the lateral rims of the tongue. While the term *blade* of the tongue also includes its apex, it characterizes an extension into predorsal areas as well. In order to delineate the action of the organ of articulation as closely as possible, the terms *coronal* and *predorsal* will be used instead of *blade.*

the velum is raised so that no air can escape through the nose. The expiratory air pressure builds up naturally behind this closure (stop); compression results, which is then suddenly released (plosive). Examples of stop-plosives are [p] and [b].

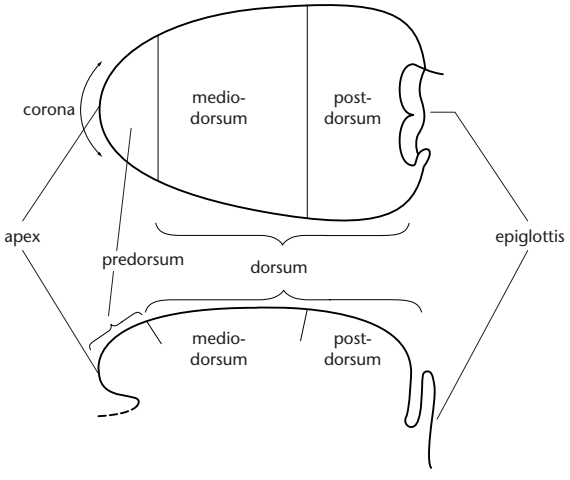

Figure 2.3 Divisions of the Tongue

Fricatives. Fricatives result when organ and place of articulation approximate each other so closely that the escaping expiratory airstream causes an audible friction. As with the stops, the velum is raised for all fricative sounds. Two examples of fricatives are [f] and [v]. Some fricatives, referred to as **sibilants,** have a sharper sound than others due to the presence of high-frequency components. In General American English [s], [z], [ʃ], and [ʒ] belong to the sibilants.

Nasals. These consonants are produced with the velum lowered so that the air can pass freely through the nasal cavity. However, there is complete occlusion within the oral cavity between organ and place of articulation. These sounds have been called nasal stops due to the closure in the oral cavity and the ensuing free air passage through the nasal cavity (Ball and Rahilly, 1999). [m], [n], and [ŋ] are the nasal speech sounds of General American English.

Table 2.4 Phonetic Description: Place of Articulation

Place of Articulation	Phonetic Descriptor	Examples
Upper lip	Labial	[p], [b], [m], [w], [ʍ]
Upper teeth	Dental	[f], [v], [θ], [ð]
Alveolar ridge	Alveolar	[t], [d], [n], [s], [z], [l]
Surface of hard palate	Palatal	
anterior portion	prepalatal	[ʃ], [ʒ],[1] [r]
central portion	mediopalatal	[j], [r]
posterior portion	postpalatal	(does not normally occur in General American English)
Soft palate	Velar	[k], [g], [ŋ]

1. [ʃ] and [ʒ] are also referred to as postalveolar sounds, indicating a place of articulation just posterior to the highest point of the alveolar ridge. This text will include both of these places of articulation to describe [ʃ] and [ʒ].

Affricates. For affricate sounds, two phases can be noted. First, the velum is raised as a complete closure is formed between organ and place of articulation. As a consequence of these articulatory conditions, expiratory air pressure builds up behind the blockage formed by the organ and place of articulation, the stop phase. Second the stop is then slowly (in comparison to the plosives) released orally, resulting in the friction portion of the speech sound. Affricates should not be viewed as a stop plus fricative combination similar to consonant blends or clusters, such as [ks], in which the stop portion is formed by a different organ and at a different place of articulation than the fricative portion. Rather, affricates are single uniform speech sounds characterized by a slow release of a stopping phase into a homorganic (*hom* = same) friction element. The two most prominent affricates of General American English are [ʧ] and [ʤ].

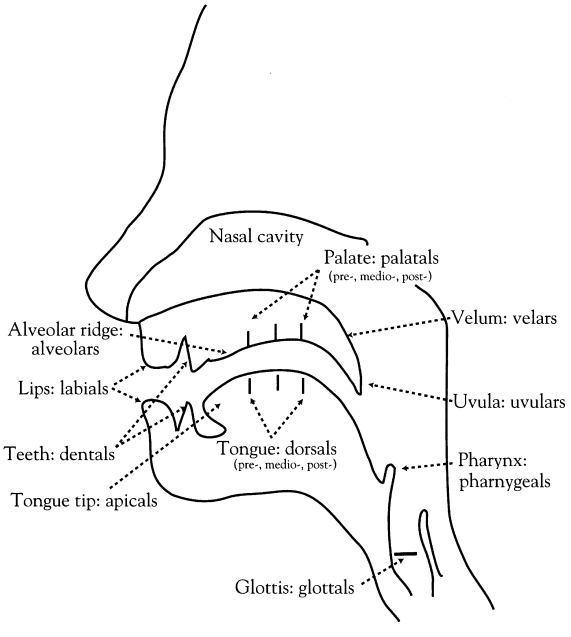

Figure 2.4 Structures of the Oral Cavity as Organs and Places of Articulation

Glides. For the realization of glides, the constriction between organ and place of articulation is not as narrow as for fricatives. In addition to this relatively wide articulatory posture, glides are also characterized by a gliding movement of the articulators from a rela-

Stop-plosives are sometimes referred to as stops and sometimes as plosives, depending on the phase of production one wants to draw attention to. Such a division appears at first glance rather academic. There are situations, however, when this distinction becomes important. For example, a client has difficulties realizing a complete occlusion of the lips. This can occur in cases of paralysis of the facial nerve, such as in myasthenia gravis (Thiele, 1980). Such a client has trouble with the stop portion of the production. Other clients—for example, children with developmental verbal dyspraxia—have difficulties with rapid movement patterns of speech. These children can realize the static articulatory postures of the occlusion, but they cannot necessarily release it suddenly enough (Velleman and Strand, 1994). They, therefore, have problems with the plosive phase of the realization and need to be treated quite differently.

tively constricted into a more open position. The sounds [w] and [j] are considered glides. According to the classification of the International Phonetic Alphabet (IPA), [w] and [j] are considered approximants. **Approximants** are consonants in which there is a much wider passage of air resulting in a smooth (as opposed to turbulent) airflow for these voiced sounds (Ball and Rahilly, 1999).

According to the symbols used by the International Phonetic Association (IPA), the American English rhotics are officially transcribed as [ɹ], an upside down *r,* while the retroflexed is characterized by [ɻ], an upside-down *r* with a retroflexed diacritic. According to the IPA, the [r] symbol is officially reserved for the alveolar trilled "r" sound, which can be heard in Spanish, for example. Because trilled "r" sounds do not exist in General American English, and in order not to complicate matters unnecessarily, it is customary to use the [r] symbol for both the bunched and the retroflexed "r" sounds.

Laterals. These sounds are established by a midline closure but lateral openings within the oral cavity. Consequently, the expiratory airstream can pass only around one or both sides of the tongue. [l] is the only lateral consonant of General American English. The laterals together with the rhotics are collectively referred to as **liquids.** According to the classification system of the International Phonetic Alphabet [l] is considered a lateral approximant.

Rhotics. The phonetic characteristics of the rhotics are especially difficult to describe. First, there are at least two types of rhotic productions: *retroflexed* and *bunched* (Shriberg and Kent, 2003). Second, the actual forming of rhotics is highly context dependent. Thus, the production easily changes depending on the features of the surrounding sounds (Kantner and West, 1960). In addition, the positioning of the tongue for individual speakers is highly variable (Shriberg and Kent, 2003). Generally, the *retroflexed* rhotics are produced with the tongue tip in a retroflexed position (*retro* = back, *flex* = turn). The bunched rhotics, on the other hand, show an elevation of the whole corpus of the tongue toward the palate. Perhaps a better classification for [r] is the term *approximant,* which is used within the International Phonetic Alphabet. In this case, [r] is a central approximant. According to the International Phonetic Alphabet, there are two symbols used for the central rhotic approximants. The [ɹ] is a postalveolar approximant in which the tongue tip is raised and points directly upward toward the rear of the alveolar ridge. The [ɻ] is a retroflex production characterized by the tongue tip elevated and bent backward in a more retroflexed position. Officially, there is no IPA symbol for the bunched r-production (Ball and Rahilly, 1999). Table 2.5 contains the various manners

Table 2.5 Phonetic Description: Manner of Articulation

Manner of Articulation	Phonetic Descriptor	Examples
Complete blockage	Stop-plosive	[p], [b], [t], [d], [k], [g]
Partial blockage	Fricative	[f], [v], [s], [z], [ʃ], [ʒ], [θ], [ð]
Nasal emission	Nasal	[m], [n], [ŋ]
Release of stop portion to a homorganic fricative portion	Affricate	[tʃ], [dʒ]
Gliding motion from a more closed to a more open position	Glide	[w], [ʍ], [j]
Lateral airflow	Lateral	[l]
Retroflex blade or bunched dorsum	Rhotic	[r]

of articulation with examples of the consonants of General American English.

Voicing. **Voicing** is the term used to denote the presence or absence of simultaneous vibration of the vocal cords resulting in voiced or voiceless consonants. The voiced and voiceless consonants of General American English are summarized in Table 2.6.

Far more precision may often be necessary to describe how specific consonants are produced. However, this framework of organ of articulation, place of articulation, manner of articulation, and voicing provides a fairly accurate description of General American English consonants.

CLINICAL APPLICATION

When Organ, Place, Manner, and Voicing Are Not Enough

In analyzing the articulatory requisites for the realization of [ʃ], we find that it can be described—according to voicing, articulatory organ, place, and manner—as a voiceless coronal-prepalatal fricative. Although that is a generally satisfactory phonetic description, another production characteristic is lip rounding. Describing such an additional feature becomes necessary because some children with "sh" problems do not realize the rounding. In fact, the resulting aberrant production may be due entirely to the absence of this lip-rounding feature.

Table 2.6 Phonetic Description: Voicing

Voicing	Phonetic Descriptor	Examples
With vocal fold vibration	Voiced	[b], [d], [g], [m], [n], [ŋ], [v], [z], [ʒ], [ð], [w], [j], [l], [r]
Without vocal fold vibration	Voiceless	[p], [t], [k], [f], [s], [ʃ], [θ], [ʍ], [h]

The following phonetic descriptions classify the consonants of General American English according to the parameters of voicing, organ, place, and manner.[1]

[p] voiceless bilabial stop-plosive

(Because both organ and place of articulation are the lower and upper lips, respectively, one should actually say labio-labial. However, the term *bilabial* is usually preferred.)

[b] voiced bilabial stop-plosive

[t] voiceless coronal-alveolar stop-plosive

[d] voiced coronal-alveolar stop-plosive

[k] voiceless postdorsal-velar stop-plosive

[g] voiced postdorsal-velar stop-plosive

[f] voiceless labio-dental fricative

[v] voiced labio-dental fricative

[s] voiceless apico-alveolar or predorsal-alveolar fricative

[s] (and [z]) can be produced in one of two ways: with the tongue tip up (i.e., as apico-alveolar fricative [sibilant]) or with the tongue tip resting behind the lower incisors (i.e., predorsal-alveolar fricative [sibilant]).

[z] voiced apico-alveolar or predorsal-alveolar fricative

[ʃ] voiceless coronal-prepalatal or coronal-postalveolar fricative with lip rounding

[ʒ] voiced coronal-prepalatal or coronal-postalveolar fricative with lip rounding

[θ] voiceless apico-dental or interdental fricative

The [θ] and [ð] are typically produced with either the tongue tip resting behind the upper incisors (i.e., apico-dental) or with the tongue tip between the upper and lower incisors (i.e., interdental).

[ð] voiced apico-dental or interdental fricative

[m] voiced bilabial nasal

[n] voiced coronal-alveolar nasal

[ŋ] voiced postdorsal-velar nasal

[w] voiced labial-velar glide or approximant

[ʍ] voiceless labial-velar fricative (IPA, 1996)

[j] voiced mediodorsal-mediopalatal glide or approximant

[l] voiced apico-alveolar lateral or lateral approximant

[r] voiced mediodorsal-mediopalatal rhotic approximant (bunched) or voiced apico-prepalatal rhotic approximant (retroflexed), officially [ɹ]

Here, the term *apico* refers to the underside of the apex of the tongue.

[h] voiceless unlocalized open consonant that is, an aspirate

Although this sound is sometimes classified as a laryngeal or glottal fricative, in General American English, there is normally no constriction at the laryngeal, pharyngeal, or oral levels. See Heffner (1975) for a discussion of the [h] production in General American English.

[ʧ] voiceless coronal-alveolar stop portion followed by a voiceless coronal-prepalatal fricative portion

[ʤ] voiced coronal-alveolar stop portion followed by a voiced coronal-prepalatal fricative portion

1. The organ, place, manner, and voicing features are based on the phonetic descriptions provided by Bronstein (1960) and Kantner and West (1960). These features are seen as descriptive and may, therefore, vary somewhat from speaker to speaker.

CLINICAL APPLICATION

Rhotic Errors versus Central Vowels with R-Coloring

Children with "r" problems, thus, rhotic consonant difficulties, often produce the central vowels with r- coloring ([ɝ] and [ɚ]) in error as well. However, that is not always the case. Note the following patterns seen in Latoria's speech from the Word Articulation Subtest of the Test of Language Development, Primary, Second edition (Newcomer and Hammill, 1988).

Norm Production	→	Actual Production	Word Example	Transcriptions
Rhotics				
[tr]	→	[tw]	tree	[tri] → [twi]
[br]	→	[bw]	bridge	[brɪʤ] → [bwɪʒ]
[r]	→	[w]	ring	[rɪŋ] → [wɪŋ]
[br]	→	[bw]	zebra	[zibrə] → [zibwə]
[r]	→	[w]	garage	[gərɑʒ] → [ʤəwɑ]
[θr]	→	[θw]	thread	[θrɛd] → [θwɛd]
[tr]	→	[tw]	treasure	[trɛʒɚ] → [twɛʒɚ]
Central Vowels with R-Coloring				
[ɚ]	correct	[ɚ]	feather	[fɛðɚ] → [fɛdɚ]
[ɚ]	correct	[ɚ]	soldier	[soʊldʒɚ] → [soʊʒɚ]
[ɚz]	correct	[ɚz]	scissors	[sɪzɚz] → [sɪzɚz]
[ɝ]	correct	[ɝ]	birthday	[bɝθdeɪ] → [bɝdeɪ]

On the one hand, Latoria has a [w] for [r] substitution ([r] → [w]) for the rhotic consonant [r]. On the other, she can produce the central vowels with r-coloring accurately.

SOUNDS IN CONTEXT: COARTICULATION AND ASSIMILATION

Until now, this textbook has discussed articulatory characteristics of General American English speech sounds as discrete units. However, the articulators do not move from sound to sound in a series of separate steps. Speech consists of highly variable and overlapping motor movements. Sounds within a given phonetic context influence one another. For example, if the [s] production in *see* is contrasted to the one in *Sue,* it can be seen that [s] in *see* is produced with some spreading of the lips, whereas there is lip rounding in *Sue*. This difference is due to the influence of the following vowel articulations: [i], a vowel with lip spreading, facilitates this feature in the [s] production in *see,* whereas the lip rounding of [u] influences the production of [s] in *Sue*. These types of modifications are grouped together under the term *coarticulation*. **Coarticulation** describes the concept that the articulators are continually moving into position for other segments over a stretch of speech (Fletcher, 1992). The result of coarticulation is referred to as assimilation. The term **assimilation** refers to adaptive articulatory changes by which

one speech sound becomes similar, sometimes identical, to a neighboring sound segment. Such a change may affect one, several, or all of a sound's phonetic constituents; that is, a sound may change its organ, place, manner, and/or voicing properties under the articulatory influence of another sound. Assimilation processes are perfectly natural consequences of normal speech production and are by no means restricted to developing speech in young children. Because the two segments become more alike, assimilatory processes are also referred to as *harmony processes*.

There are different *types* and *degrees* of assimilatory processes. In regard to the different types of assimilatory processes, the following should be noted:

1. Assimilatory processes modifying directly adjacent sounds are called *contact* (or *contiguous*) *assimilations*. If at least one other segment separates the sounds in question, especially when the two sounds are in two different syllables, one speaks of *remote* (or *noncontiguous*) *assimilation* (Heffner, 1975).

The following assimilation processes were noted in the results of children's articulation tests:

Contact

"jumping" [ʤʌmpɪn] → [ʤʌmbɪn]

The voiced [m] impacts the normally voiceless [p].

"skunk" [skʌŋk] → [stʌŋk]

The organ and place of articulation for [s] influence the stop-plosive, changing it from a postdorsal-velar to a coronal-alveolar.

Remote

"yellow" [jɛloʊ] → [lɛloʊ]

Organ, place, and manner of articulation are impacted when the [j] at the beginning of the word becomes identical to the following [l].

"telephone" [tɛləfoʊn] → [tɛdəfoʊn]

Manner of articulation is impacted when the [l] is changed from a lateral to a stop-plosive, similar to the [t] at the beginning of the word.

2. Assimilations can be either *progressive* or *regressive*. In progressive assimilation, a sound segment influences a following sound. This is also referred to as *perseverative assimilation* (Crystal, 1987; Ladefoged, 2006). The previously noted contact assimilations for *jumping* and *skunk* and the remote assimilation for *telephone* are examples of progressive assimilation. A previously articulated sound influenced a following sound.

In regressive assimilation, a sound segment influences a preceding sound. If "is she" [ɪz ʃi] is pronounced [ɪʒ ʃi], changing [s] into [ʒ], regressive assimilation is noted. Regressive assimilations are also known as *anticipatory* assimilations (Crystal, 1987; Ladefoged, 2006).

The following are examples of progressive and regressive assimilation processes:

Progressive

"ice cream" [aɪskrim] → [aɪstrim]

Organ and place of articulation for [s] influence the following stop-plosive, changing it from a postdorsal-velar to a coronal-alveolar stop-plosive production: This is progressive contact assimilation.

"television" [tɛləvɪʒən] → [tɛdəvɪʒən]

Manner of articulation is impacted when the stop-plosive [t] impacts the following [l], changing it from a lateral to a stop-plosive: This is progressive remote assimilation.

Regressive

"pumpkin" [pʌmkɪn] → [pʌŋkɪn]

Organ and place of articulation of [k] influence [m], which is changed from the bilabial to the postdorsal-velar nasal [ŋ]: This is regressive contact assimilation.

"bathtub" [bæθtʌb] → [θæθtʌb]
Organ, place, and manner of articulation are impacted as [θ] influences the previous segment [b]: This is regressive remote assimilation.

In regard to the different degrees of assimilatory influence, one distinguishes between phonemic assimilation and phonetic similitude (Ball and Rahilly, 1999). If an altered segment is perceived to be a different phoneme altogether, this is termed *phonemic assimilation*. *Phonetic similitude* occurs when the change in the segment is such that it is still perceived by speakers of a language as nothing more than a variation or allophone of the original segment. A phonemic assimilation could be exemplified by the change in *ten girls* [tɛn gɝlz] to [tɛŋ gɝlz], the [n] changing to [ŋ] due to the influence of the following postdorsal-velar stop-plosive [g]. An example of a phonetic similitude would be the lip rounding of [s] in *soup* [sʷup] as the [s] is influenced by the lip rounding of the following [u].

Assimilation processes can also be total or partial. Total assimilation occurs when the changed segment and the source of the influence become identical. Partial assimilation exists when the changed segment is close to, but not identical with, the source segment.

The following are examples of total and partial assimilation processes:

Total	"window"	[wɪndoʊ]	→ [wɪnoʊ]
	"Pontiac"	[pɑntiæk]	→ [pɑniæk]
Partial	"handkerchief"	[hænkɚʧɪf]	→ [hæŋkɚʧɪf]

The term *coalescence* is used when two neighboring segments are merged into a new and different segment. An example of coalescence would be the realization of *sandwich* [sænwɪʧ] as [sæmɪʧ]. The bilabial features for the articulation of [w] have impacted the original coronal-alveolar nasal (regressive assimilation), which now is changed to a bilabial nasal [m].

Children at different stages of their speech-language development tend to utilize assimilation processes in systematic ways. This is of obvious interest to clinicians whose task is to separate normal from impaired phonological development. In normally developing children and those with disordered phonology, syllable structure can impact their production possibilities. This will be discussed in the next section.

Typical assimilation processes and the ages at which these processes occur in children are discussed in Chapter 5.

CLINICAL APPLICATION

Assimilation Processes and Articulation Testing

Assimilatory or harmony processes often occur during an articulation test. It is important to recognize these processes so that the test scoring will not be negatively impacted. The following assimilation processes have been frequently observed by the author:

Word	Expected Response	Child's Response	Impact on Scoring
Santa	[sæntə]	[sænə] total assimilation	Could be scored as an omission of [t]
sandwich	[sænwɪʧ]	[sæmɪʧ] total assimilation (coalescence)	Could be scored as an omission of [w] and an [m]/[n] substitution
presents	[prɛzənts]	[prɛzəns] total assimilation	Could be scored as an omission of [t]

Word	Expected Response	Child's Response	Impact on Scoring
A less common example was observed for Danny, age 4;3:			
bath	[bæθ]	[θæθ]	[θ]/[b] substitution
bathtub	[bæθtʌb]	[θæθtʌb]	[θ]/[b] substitution

However, Danny could produce [b] correctly in all other contexts. Note the correct production of [b] at the end of *bathtub.* This was an example of a regressive remote assimilation.

SYLLABLE STRUCTURE

If we are asked to break words down into component parts, syllables seem to be more natural than sounds. For example, speakers of unwritten languages will characteristically use syllable, not sound, divisions. They may even resist the notion that any further breakdown is possible (Ladefoged, 2006). Also, preschool children use syllabification if they try to analyze a word. It is only after children are exposed to letters and writing that they begin to understand the possibility of dividing words into sounds. Thus, syllables appear to be easily recognizable units.

Counting the number of syllables in a word is a relatively simple task. Probably all will agree on the number of syllables in the word *away* or *articulation,* for example. What we might disagree on are the beginning and end points of the syllables in question. To arrive at a consensus, it is first necessary to differentiate between written and spoken syllables.

If one consults a dictionary, written syllabification rules are found. We learn that the word *cutting* is to be divided cut-ting. However, differences may, and often do, exist between written and spoken syllables. The written syllabification rules for *cutting* do not reflect the way we would syllabify the word when speaking. The divisions [kʌ tɪŋ] would be more probable during normal speech. An awareness of existing differences between spoken and written syllable boundaries is important for speech-language specialists.

This is especially critical because a dictionary of rules for the boundaries of *spoken* syllables does not exist. Thus, two competent speakers of a given language may syllabify the same word in different ways. Words such as *hammer* and *window* would probably not cause problems. However, how should one syllabify *telephone,* as [tɛ lə foᵘn] or as [tɛl ə foᵘn]? That is, does [l] belong to the second or to the first syllable? Variations in the syllabification of spoken words do indeed exist between speakers. To understand this, a look at the syllable structure might be a good way to begin.

Structurally, the syllable can be divided into three parts: *peak, onset,* and *coda* (Sloat, Taylor, and Hoard, 1978). The **peak** is the most prominent, acoustically most intense part of the syllable. Although vowels are clearly more prevalent as syllable peaks, consonants are not strictly excluded. Consonants that serve as the syllable peak are referred to as *syllabics*. A peak may stand alone, as in the first syllable of the word *a-way,* or it can be surrounded by other sounds, as in *tan* or *bring*.

The **onset** of a syllable consists of all the segments prior to the peak, whereas the **coda** is made up of all the sound segments of a syllable following its peak. The segments that compose the onset are also termed *syllable releasing* sounds, and those of the coda are termed *syllable arresting* sounds. Thus, the onset of *meet*

[mit] is [m]; that is, [m] is the syllable releasing sound. The coda, or syllable arresting sound, of *meet* is [t]. This applies also to consonant blends within one syllable. The onset of *scratched* is [skr], its peak is [æ], and the coda [tʃt]. Not all syllables have onsets or codas. Both syllables of *today* [tu deᴵ] lack a coda, whereas *off* [ɑf] does not have an onset. The number of segments that an onset or a coda may contain is regulated by rules of the language in question. General American English syllables can have one to three segments in an onset (ray, stay, stray) and one to four segments in a coda (sit, sits, sixth [sɪksθ], sixths [sɪksθs])

The peak and coda together are referred to as the **rhyme** (Carr, 1999). Therefore, in the word *sun*, the onset is "s" and the rhyme is "un." Syllables that do not contain codas are called **open** or **unchecked syllables.** Examples of open, unchecked syllables are *do* [du], *glee* [gli], or the first syllable of *rebound* [ri baᵁnd]. Syllables that do have codas are called **closed** or **checked syllables,** such as in *stop* [stɑp] or the first syllable in *window* [wɪn].

The use of specific syllable structures is often neglected when analyzing the speech characteristics of children. However, they do seem to play an important developmental role. A child's first words consist typically of open or unchecked syllables, such as [bɑ] for *ball* or [mɪ] for *milk*. If children start to produce closed syllables, they usually contain only single-segment codas. Similarly, two-syllable words at this stage of development consist usually of open syllables (e.g., Ingram, 1976; Menn, 1971; Velten, 1943; Vihman, Ferguson, and Elbert, 1986). Productions such as [beᴵ bi] for *baby* or [ti pɑ] for *teapot* are examples.

Syllable Structure: Clinical Implications

The syllable is also an important unit when assessing and treating children with articulatory or phonological disorders. Sometimes, the syllable unit can give us a more accurate picture of the child's articulatory capabilities than can individual sound productions. The ease of syllable production can be affected by at least three circumstances: (1) the *number of syllables* an utterance contains, (2) the *type of syllable* (open versus closed), and (3) the *degree of syllable stress* (stressed or unstressed) (Fleming, 1971; Kent, 1982). Generally, fewer syllables, open syllables, and stressed syllables usually facilitate accurate productions of specific target sounds.

The designs of most articulation tests document a striking lack of attention to these variables. Most assessment instruments focus on the beginning-initial, the middle-medial, and the end-final sound positions within words. At first glance, it may seem as if initial could be related to the syllable onset, medial to syllable peak, and final to syllable coda. However, this is not the case. For example, the word *window* may be used in an articulation test to assess the production of the word-medial [d] sound, while the word *bathtub* is used to test the word-medial [θ] and [t] sounds. The elicitation of the word *pajamas* tests [dʒ] medially. From these examples, it appears that *medial* indicates anything between the beginning and the end of an utterance.

Is there any comparability between these "medial" positions? Let's examine the syllable structures of these three words:

"window" [wɪn-doᵁ] target [d]

1st syllable	stressed	onset-peak-coda
2nd syllable	unstressed	onset-peak

"bathtub" [bæθ-tʌb] target [θ] and [t]

1st syllable	stressed	onset-peak-coda
2nd syllable	unstressed	onset-peak-coda

"pajamas" [pədʒæməz] target [dʒ]

1st syllable	unstressed	onset-peak
2nd syllable	stressed	onset-peak
3rd syllable	unstressed	onset-peak-coda

As one can see, the medial sound [d] in *window* is actually the onset of an unstressed, open

syllable. The preceding syllable ends with a coda, thus, two consonants (i.e., [n] + [d]) must be produced in immediate succession. The medial [θ] tested in *bathtub* poses a different problem. It represents the coda of a stressed syllable. Again, there is the complication of two consonants in sequence, [θ] and [t]. The word-medial [t] now appears as a syllable onset in a closed syllable. The third example of medial [dʒ] in *pajamas* exemplifies a quite different articulatory situation again. Here, a three-syllable word is elicited in which the medial [dʒ] is actually an onset of a stressed open syllable.

An analysis of an articulation test according to the syllable structure rather than the word unit would eliminate these problems. If onset, peak, and coda for each syllable are examined, the results also become more accurate and, therefore, clinically more valid. Accuracy of any assessment process is the key to successful treatment. The information attained from examining sound articulation with the syllable as a basic structural unit complements the word-based results and gives additional insight into the child's true articulatory abilities.

SUMMARY

This chapter presented an overview of the form and function of vowels and consonants of General American English. Both vowels and consonants were classified according to their articulatory production features and their linguistic functions. Phonetic descriptors were given to provide the clinician with a detailed account of articulatory action during norm production of vowels and consonants. These features can later be contrasted to those noted in the impaired sound realizations of children and adults with articulatory-phonological impairments.

In the second portion of this chapter, coarticulation, assimilation processes, and syllable structure were defined and examined. Coarticulation and resulting assimilatory processes were described as normal articulatory consequences that regularly occur in the speech of individuals. Assimilatory processes were defined according to the type and degree of sound modification. Examples were given of assimilatory processes in children as well as of the possible impact these processes could have on articulation test results. The last section, on syllable structure, defined the parts of the syllable. Variations in syllable structure do not seem to be accounted for when testing individual sounds within most articulation tests. However, this may be a factor that could affect the articulatory proficiency of children and adults with impaired speech. An analysis of syllable structures would provide the clinician with additional knowledge when evaluating individuals with articulatory-phonological disorders.

CASE STUDY

The following sample is from Tina, age 3;8.

dig	[dɛg]	cat	[tæt]	fan	[vɛn]	ring	[wɪŋ]
house	[haʊθ]	bath	[bæt]	yes	[wɛt]	thumb	[dʌm]
knife	[naf]	red	[led]	boat	[bot]	that	[zæt]
duck	[dʊt]	ship	[sɪp]	cup	[tʊp]	zip	[wɪp]
				lamp	[wæmp]	key	[di]
				goat	[dot]	win	[jɪn]

Compare the typical vowel productions to those noted in the sample according to (1) the portion of the tongue that is involved in the articulation (front, central, back) and (2) the tongue's position relative to the palate (high, mid, low). For example:

dig	[dɛg]	a high-front vowel changed to a mid-front vowel

Compare the typical consonant productions to those noted in the sample according to voicing, organ, place, and manner characteristics. For example:

house	[haʊθ]	a voiceless apico-alveolar (predorsal-alveolar) fricative is changed to a voiceless interdental (apico-alveolar) fricative

THINK CRITICALLY

1. Some younger children have trouble producing [s] and [z]; they substitute [θ] and [ð] for these sounds. Thus, the word *Sue* would be pronounced [θu] and *zoo* as [ðu]. Both of the target sounds and the substitutions are fricatives. Compare the two articulations and see if you might be able to describe to a child what he or she would have to do to change the articulation from [θ] and [ð] to [s] to [z].
2. Children often have trouble with the lip rounding associated with the sh-sounds ([ʃ] and [ʒ]). Which type of vowel contexts would promote lip rounding? Can you find five words that you could use to assist the lip rounding of [ʃ] or [ʒ]?
3. Identify the following assimilation processes according to the following parameters: contact versus remote, progressive versus regressive, phonemic assimilation, phonetic similitude, or coalescence.

news	[nuz̲]	however	newspaper	[nus̲pe^{l}pɚ]
panty	[pænti]	→	[pæni]	
did you	[dɪd ju]	→	[dɪdʒu]	
incubate	[ɪnkjube^{l}t]	→	[ɪŋkjube^{l}t]	
misuse	[mɪsjuz]	→	[mɪʃuz]	

4. Identify the following syllable structures according to (a) onset, peak, and coda and (b) closed or open syllables. For example:

   win.dow → [wɪn.doʊ]

   1st syllable: onset-peak-coda, closed syllable
   2nd syllable: onset-peak, open syllable

   telephone
   wagon
   shovel
   banana
   pajamas

5. You are testing [k] sounds in the initial, medial, and final positions with a child who is 4 years old with a [t] for [k] substitution. You would like to keep the syllable structure and the stress consistent for all the words used. Therefore, all words should be two syllables in length, stress should be on the same syllable, and syllable structures should be comparable. Find six words that could be used for a 4-year-old child that would test [k] under these conditions.

TEST YOURSELF

1. Vowels are defined as
   a. under normal circumstances having no simultaneous vocal fold vibration
   b. having articulatory constriction along the sagittal midline of the vocal tract
   c. having a relatively unimpeded airstream from the vocal folds to the lips
   d. having relatively less acoustic intensity
2. Which consonants are considered to be sonorant consonants?

a. fricatives and affricates
b. stop-plosives
c. all voiced consonants
d. nasals, liquids, and glides

3. The vowel [i] is described phonetically as a
   a. high-front vowel that is unrounded and lax
   b. mid-front vowel that is unrounded and tense
   c. high-front vowel that is unrounded and tense
   d. high-back vowel that is unrounded and tense
4. The consonant [l] is described phonetically as
   a. voiced apico-alveolar lateral approximant
   b. voiced coronal-alveolar glide
   c. voiced predorsal-alveolar lateral approximant
   d. none of the above
5. Sibilants are characterized by the presence of high-frequency components. Which one of the following is not a sibilant?
   a. [θ]
   b. [s]
   c. [z]
   d. [ʃ]
6. A very young child says [gɑg] for *dog*. This is which type of assimilation process?
   a. regressive phonemic assimilation
   b. progressive phonemic assimilation
   c. regressive phonetic similitude
   d. coalescence
7. A young child says [nɔɪni] for *noisy*. This is which type of assimilation process?
   a. progressive contact phonemic assimilation
   b. regressive contact phonemic assimilation
   c. progressive remote phonemic assimilation
   d. progressive remote phonetic similitude
8. Which one of the following words has an unchecked syllable structure?
   a. cupcake
   b. tomato
   c. jumping
   d. bathtub
9. What is the rhyme of "reached"?
   a. [i]
   b. [itʃt]
   c. [itʃ]
   d. none of the above
10. If you were testing [s] in the medial position, which one of the following words would have the same syllable and stress structure as "cassette"?
    a. message
    b. receipt
    c. basic
    d. Lassie

WEBSITES

www.uiowa.edu/~acadtech/phonetics/about.html

This website provides an animated articulatory diagram of each consonant and vowel as well as a description of how the sound is produced. It seems to be very user-friendly. Some of the terminology is a bit different from that used in this text. For example, the term *lingua-*, as organ of articulation, is used for all tongue placements and the terms *tongue blade* and *tongue back* are descriptors for what has been referenced here as *pre-, medio-,* and *postdorsal*.

www.everything2.com/index.pl?node_id=441666

This website gives some basic definitions of the various articulators for consonant production, although the tongue as organ of articulation is not mentioned. It does give some basic definitions and examples of manners of articulation and defines vowels according to tongue height, front–back dimensions, and lip rounding. Nasal vowels and the concept of tense versus lax are also a portion of this webpage. Several links are provided, for example, to the International Phonetic Alphabet. Other links are humorous and the webpage is worded in a light style.

en.wikipedia.org/wiki/Vowel and
en.wikipedia.org/wiki/Consonant

These two websites give basic definitions of the vowel and consonant concepts as well as many links to other webpages that are both informative

and detailed. These are good reference sources for information.

cla.calpoly.edu/~jrubba/phon/syllables.html

This website, developed by Dr. Johanna Rubba (English Department, Linguistics, Cal Poly State University), deals with syllable structure. Basic definitions are given and several examples are provided. Although the website gives information beyond what this chapter covers, the examples on syllable structure will be helpful.

FURTHER READINGS

Ashby, P. (2005). *Speech sounds*. London: Routledge.

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Garn-Nunn, P., & Lynn, J. (2004). *Calvert's descriptive phonetics* (3rd ed.). New York: Thieme.

Ladefoged, P. (2005). *Vowels and consonants* (2nd ed.). Malden, MA: Blackwell.

Yavaş, M. (2005). *Applied English phonology*. Malden, MA: Blackwell.