

What distinguishes one sound from the other? If you bang a large round drum you will get one sound; if you bang a small round drum you will get a different sound; if you bang a small oblong drum you will get still another sound. The size and shape of the air being pushed around makes a difference. This is also true in the production of speech sounds. The vocal tract through which the air passes during the production of speech is shown in Figure 6-1. When the shape of this vocal tract is changed, different sounds are produced.

Airstream Mechanisms

Sounds produced by using air from the lungs are called **pulmonic** sounds; since the air is pushed out, they are called **egressive**. The majority of sounds used in languages of the world are produced by a **pulmonic egressive** airstream mechanism. All the sounds in English are produced in this manner.

Other airstream mechanisms are used in other languages to produce sounds called **ejectives**, **implosives**, and **clicks**. Instead of lung air, the body of air in the mouth may be moved. When this air is sucked in instead of flowing out, **ingressive** sounds, like implosives and clicks, are produced. When the air in the mouth is pushed out, ejectives are produced; they are therefore also **egressive** sounds. Implosives and ejectives are produced by a **glottalic airstream mechanism**, while clicks are produced by a **velaric airstream mechanism**.

Ejectives are found in many American Indian and African languages as well as languages spoken in the Caucasus, a region between the Black and Caspian Seas. Implosives also occur in the languages of the American Indians and throughout Africa, India, and Pakistan. Clicks occur in the Southern Bantu languages such as Xhosa and Zulu, and in the languages spoken by the Bushmen and Khoikhoi. A detailed description of these different airstream mechanisms goes beyond the requirements of an introductory text. They are mentioned to show that sounds can be classified according to the airstream mechanism used to produce them. In the rest of this chapter we will be discussing only sounds produced by a pulmonic egressive airstream mechanism.

Consonants

The sounds of all languages fall into two major natural classes—consonants and vowels, often referred to by the cover symbols **C** and **V**. Consonantal sounds are produced with some restriction or closure in the vocal tract as the air from the lungs is pushed through the glottis out the mouth.

Places of Articulation

As stated above, different consonantal sounds result when we change the shape of the oral cavity by moving the lips and tongue, the **articulators**, and change the **place of articulation** in the oral cavity. The major consonantal place features are given below. As you read the description of each class of sounds, pronounce them and try to feel which articulators are moving and to where.

Bilabials: [p] [b] [m] When we produce a [p], [b], or [m] we articulate by bringing both lips together. These sounds are therefore called **bilabials**.

Labiodentals: [f] [v] We also use our lips to form [f] and [v] as in *fine* [fajn] and *vine* [vajn]. We articulate these sounds by touching the bottom lip to the upper teeth, which is why these sounds are called **labiodental**, *labio-* referring to lips and *dental* to teeth.

Interdentals: [θ] [ð] [θ] and [ð] are both represented orthographically by the *th* in the words *thin* [θɪn], *ether* [iθər], *then* [ðen], and *either* [iðər]. To articulate these **interdental** (“between the teeth”) sounds, one inserts the tip of the tongue between the upper and lower teeth.

Alveolars: [t] [d] [n] [s] [z] [l] [r] **Alveolar** sounds are articulated by raising the front part of the tongue to the **alveolar ridge** (see Figure 6-1). Pronounce the words *do* [du], *new* [nu], *two* [tu], *sue* [su], *zoo* [zu]. You should feel your tongue touch or almost touch the bony tooth ridge as you produce the first sounds in these words.

To produce the **lateral [l]**, the tongue is raised to the alveolar ridge with the sides of the tongue down, permitting the air to escape laterally over the sides of the tongue.

The sound [r] is produced in a variety of ways. Many English speakers produce [r] by curling the tip of the tongue back behind the alveolar ridge. Such sounds are also called **retroflex** sounds. In some languages, the [r] may be an alveolar **trill**, produced by the tip of the tongue vibrating against the roof of the mouth. There are other symbols which can be used for these different *r* sounds, and in a very detailed phonetic description we would include some of them. For the purposes of this book, however, we will use the symbol [r] for all the varieties produced by speakers of English.

Palatals: [ʃ]/[ʃ̥] [ʒ]/[ʒ̥] [ç] [j] To produce the sounds in the middle of the words *mesher* [meʃər] and *measure* [meʒər], the front part of the tongue is raised to a point on the hard palate just behind the alveolar ridge. [ʃ̥], the voiceless sound in *mesher* (spelled *sh*) and [ʒ̥], the voiced sound in *measure* (spelled *s*) are **palatal** sounds. (These palatal sounds are also referred to as **alveopalatals**.)

The alveopalatal region of the roof of the mouth is also the place of articulation in the production of [ç] and [j], the sounds that begin and end the words *church* and *judge*.

Velars: [k] [g] [ŋ] Another class of sounds is produced by raising the back of the tongue to the soft palate or velum. The initial and final sounds of the words *kick* [kɪk], *gig* [gɪg], and the final sounds of the words *back* [bæk], *bag* [bæg], and *bang* [bæŋ]—[k], [g], and [ŋ]—are produced in this way and are called **velar** sounds.

Uvulars: [ʀ] [q] [ɢ] Uvular sounds are produced by raising the back of the tongue to the uvula. The *r* in French is uvular and is symbolized by [ʀ]. Uvular sounds are also found in other languages. Arabic for example has two uvular sounds symbolized as [q] and [ɢ].

Glottal: [ʔ] [h] The [h] sound that starts words such as *house* [haws], *who* [hu], and *hair* [her] is a **glottal** sound. The glottis is open; no other modification of the airstream mechanisms occurs in the mouth. The tongue and lips are usually in the position for the production of the following vowel as the airstream passes through the open glottis.

If the air is stopped completely at the glottis by tightly closed vocal cords, the sound produced is a **glottal stop**. This is the sound sometimes used instead of [t] in *button* and

Latin. It also may occur in colloquial speech at the end of words like *don't*, *won't*, or *can't*. In some American dialects it regularly replaces the *tt* sound in words like *bottle* or *glottal*. The glottal stop does not occur in the speech of all speakers of English. But if you say "ah-ah-ah-ah-" with one "ah" right after another and do not sustain the vowel sound, you will be producing glottal stops between the vowels. In some languages, the glottal stop functions like the stops [p] or [t] or [k] do in English. The IPA symbol for a glottal stop looks something like a question mark without the dot on the bottom [ʔ].

Table 6.2 summarizes the classification of the consonants of English by their place of articulation. The glottal stop is not included in this table since it is used only by some speakers in some words. The uvular sounds do not occur in English.

TABLE 6.2 Place of Articulation of English Consonants

Bilabial:	p	b	m				
Labiodental:	f	v					
Interdental:	θ	ð					
Alveolar:	t	d	n	s	z	l	r
Palatal:	ʃ	ʒ	ç	ʝ			
Velar:	k	g	ŋ				
Glottal:	h						

Manners of Articulation

We have described a number of classes of consonants according to their place of articulation, yet we are still unable to distinguish the sounds in each class from each other. What distinguishes [p] from [b], or [b] from [m]? All are bilabial sounds. What is the difference between [t], [d], and [n], which are all alveolar sounds?

Speech sounds are also differentiated by the way the airstream is affected as it travels from the lungs up and out of the mouth and nose. Such features or phonetic properties have traditionally been referred to as **manners of articulation** or simply manner features.

Voiced and Voiceless Sounds If the vocal cords are apart when the airstream is pushed from the lungs, the air is not obstructed at the glottis and it passes freely into the supraglottal cavities (the parts of the vocal tract above the glottis; see Figure 6-1). The sounds produced in this way are **voiceless** sounds; [p], [t], [k], and [s] in the English words *seep* [sip], *seat* [sit], and *seek* [sik] are voiceless sounds.

If the vocal cords are together, the airstream forces its way through and causes them to **vibrate**. Such sounds are **voiced** sounds and are illustrated by the sounds [b], [d], [g], and [z] in the words *bate* [bet], *date* [det], *gate* [get], *cob* [kab], *cod* [kad], *cog* [kag], and *daze* [dez]. If you put a finger in each ear and say the voiced "z-z-z-z-z" you can feel the vibrations of the vocal cords. If you now say the voiceless "s-s-s-s-s" you will not feel these vibrations (although you might hear a hissing sound in your mouth). When you whisper, you are making all the speech sounds voiceless.

The voiced/voiceless distinction is a very important one in English. It is this phonetic feature or property that distinguishes between word pairs like the following:

<i>rope/robe</i>	<i>fate/fade</i>	<i>rack/rag</i>	<i>wreath/wreathe</i>
[rɒp]/[rɒb]	[fɛt]/[fɛd]	[ræk]/[ræg]	[riθ]/[rið]

The first word of each pair ends with a voiceless sound and the second word with a voiced sound. All other aspects of the sounds of these words are identical; the position of the lips and tongue is the same in each of the paired words.

The voiced/voiceless distinction is also shown in the following pairs; the first word begins with a voiceless sound and the second with a voiced sound:

<i>fine/vine</i>	<i>seal/zeal</i>	<i>choke/joke</i>
[fajn]/[vajn]	[sil/zil]	[çɒk]/[jɒk]

The initial sounds of the first words of the following pairs are also voiceless, and for many speakers of English, the second words begin with voiced sounds. (We will discuss other differences between the initial [p] and [b] sounds below; the phonetic transcriptions of many of these words have been simplified to help the reader grasp basic concepts and may include other details that will be discussed in subsequent sections.)

<i>peat/beat</i>	<i>tote/dote</i>	<i>kale/gale</i>
[pit]/[bit]	[tot]/[dot]	[kel]/[gel]

Aspirated and Unaspirated Sounds

In our discussion of the voiceless bilabial stop [p], we did not distinguish the initial sound in the word *pit* from the second sound in the word *spit*. There is, however, a phonetic difference in these two voiceless stops. During the production of voiceless sounds the glottis is open and the air passes freely through the opening between the vocal cords. When a voiceless sound is followed by a voiced sound such as a vowel, the vocal cords must close in order to permit them to vibrate.

Voiceless sounds fall into two classes depending on the “timing” of the vocal cord closure. In English when we pronounce the word *pit*, there is a brief period of voicelessness immediately after the *p* sound is released. That is, after the lips come apart the vocal cords remain open for a very short time. Such sounds are called **aspirated** because an extra puff of air is produced.

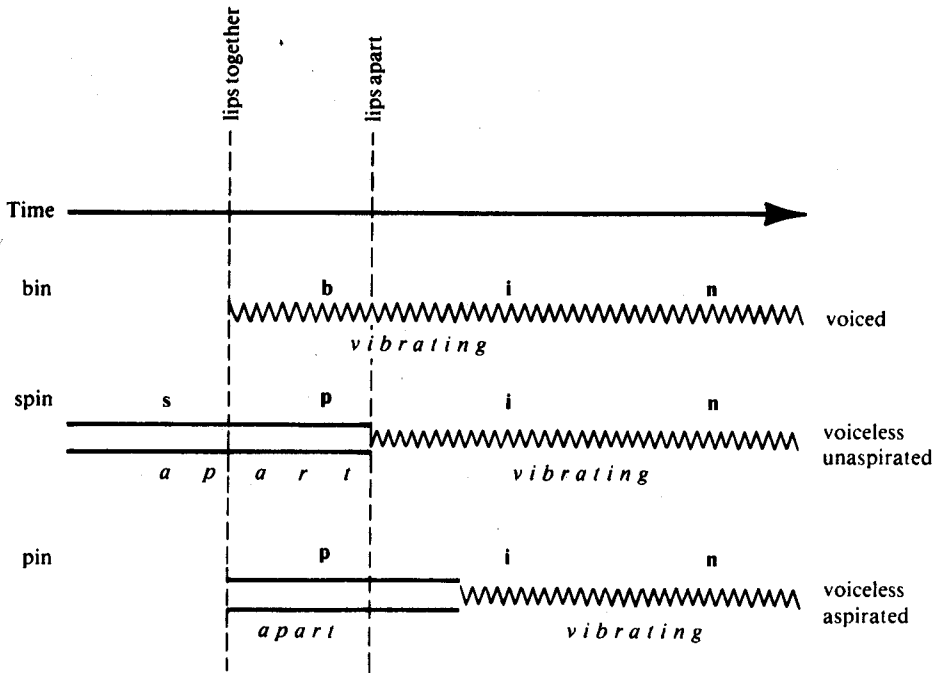
When we pronounce the *p* in *spit*, however, the vocal cords start vibrating as soon as the lips are opened. Such sounds are called **unaspirated**. The *t* in *tick* and the *k* in *kin* are also aspirated voiceless stops, while the *t* in *stick* and the *k* in *skin* are unaspirated. Hold a strip of paper in front of your lips and say *pit*; a puff of air (the aspiration) will push the paper. The paper will not move when you say *spit*.

When a fully voiced [b], or any voiced stop, is produced, the vocal cords vibrate throughout the articulation. In English, voiced stops may not be fully voiced.

Figure 6-2 shows in diagrammatic form the timing of the articulators (in this case the lips) in relation to the state of the vocal cords. In the production of the voiced [b], the

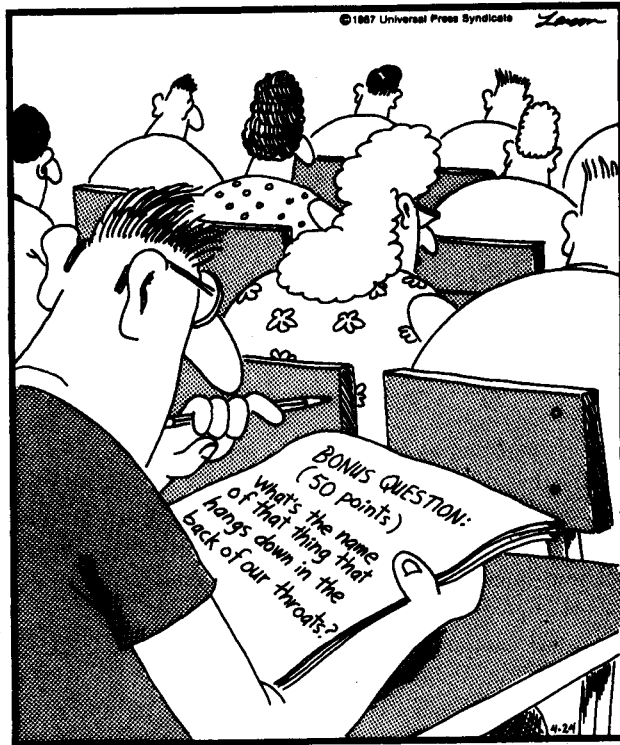
vocal cords are vibrating throughout the closure of the lips and continue to vibrate for the vowel production after the lips are opened. Most English speakers do not voice initial [b] to the full extent. Because we heavily aspirate an initial [p], there is no difficulty in distinguishing these two sounds. In the unaspirated *p* in *spin*, the vocal cords are open during the lip closure and come together and start vibrating as soon as the lips open. In the production of the aspirated *p* in *pin* the vocal cords remain apart for a brief period after the lip closure is released. These remarks apply to all English stops.

FIGURE 6-2 Timing of articulators and vocal-cord vibration for voiced, voiceless unaspirated, and voiceless aspirated stops.



Aspirated sounds may be indicated by following the phonetic symbol with a raised **h**, as in the following examples:

<i>pate</i>	[p ^h et]	<i>spate</i>	[spet]
<i>tale</i>	[t ^h el]	<i>stale</i>	[stel]
<i>kale</i>	[k ^h el]	<i>scale</i>	[skel]



Final page of the Medical Boards

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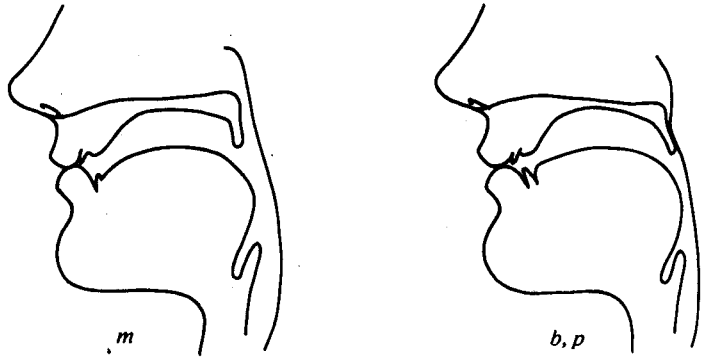
Nasal and Oral Sounds The voiced/voiceless distinction differentiates the bilabials [b] from [p]. [m] is also a bilabial and, in addition, it is voiced. What, then, distinguishes the [m] from the [b]?

[m] is a **nasal** sound. When you produce [m], air escapes not only through the mouth (when you open your lips), but also through the nose.

In Figure 6-1, the roof of the mouth is divided into the **palate** and the soft palate (or **velum**). The palate is a hard bony structure at the front of the mouth. You can feel it with your thumb. As you slide your thumb back toward the throat you will feel the velum, which is where the flesh becomes soft and is movable. Hanging down from the end of the velum is the **uvula**, which you can see in a mirror if you open your mouth wide and say “aaah.” When the velum is raised all the way to touch the back of the throat, the passage through the nose is cut off and air can escape only through the mouth.

Sounds produced with the velum up, blocking the air from escaping through the nose, are called **oral sounds**, since the air can only escape through the oral cavity. [b] is an oral sound. When the velum is lowered, air escapes through the nose as well as the mouth; sounds produced this way are called **nasal sounds**. [m], [n], and [ŋ] are the nasal consonants of English. All other consonant sounds are oral. The diagrams in Figure 6-3 show the position of the lips and the velum when [m], [b], and [p] are

FIGURE 6-3 Position of lips and velum for *m* (lips together, velum down) and *b*



articulated. [p], like [b] and [m], is produced by stopping the airflow at the lips. It differs from both [b] and [m] by being voiceless; it differs from [m] in being oral.

The same nasal/oral difference occurs in *beet* [bit] and *meat* [mit], *dear* [dir] and *near* [nir]. The velum is raised in the production of [b] and [d], preventing the air from flowing through the nose, whereas in [m] and [n] the velum is down, letting the air go through both the nose and the mouth when the closure is released. [m], [n], and [ŋ] are therefore nasal sounds and [b], [d], and [g] are oral sounds.

These **phonetic features** or properties permit the classification of all speech sounds into four classes: voiced, voiceless, nasal, oral, in addition to the place of articulation classes discussed above. One sound may belong to more than one class, as shown in Table 6.3.

Stops: [p] [b] [m] [t] [d] [n] [k] [g] [ŋ] [ç] [j] [ʔ] We are seeing finer and finer distinctions of speech sounds. [t] is a voiceless, alveolar, oral sound. But [s] is also voiceless and alveolar and oral. What distinguishes [t] from [s]?

In producing sounds, the airstream, after entering the oral cavity, may be completely stopped (as in the production of [t]), or partially obstructed (as in the articulation of [s]), or it may flow freely out of the mouth. Sounds that are **stopped completely** in the oral cavity for a brief period are, not surprisingly, called **stops**.

The final sounds in the words *top* [tap], *bomb* [bam], *dude* [dud], *dune* [dun], *root* [rut], *rack* [ræk], *rag* [ræg], *rang* [ræŋ] are stops that occur in English.

TABLE 6.3 Four Classes of Speech Sounds

	Oral	Nasal
Voiced	b d g	m n ŋ
Voiceless	p t k	*

*Nasal consonants in English are usually voiced. Both voiced and voiceless nasal sounds occur in other languages.

In the production of the nasal stops [n], [m], [ŋ], although the air flows freely through the nose, the airflow is blocked completely in the mouth; therefore, nasal consonants are stops.

Sounds in which there is no stoppage in the oral tract are **continuants**. All the sounds of a language are either stops or continuants (nonstops).

Nonnasal or oral stops are also called **plosives** because the air that is blocked in the mouth “explodes” when the closure is released. This explosion does not occur during the production of nasal stops because the air escapes through the nose.

[p], [b], and [m] are bilabial stops, with the airstream stopped at the mouth by the complete closure of the lips.

[t], [d], and [n] are alveolar stops; the airstream is stopped by the tongue making a complete closure at the alveolar ridge.

[k], [g], and [ŋ] are velar stops with the complete closure at the velum.

[č] and [j] are alveopalatal or palatal affricates with complete stop closure. These will be discussed below.

Although there is no stoppage of air in the oral cavity, the air is completely stopped at the glottis in the production of the glottal stop.

We have been discussing the sounds that occur in English. There are sounds, including stops, that occur in other languages but are not found in English. In Quechua, for example, a major language spoken in Bolivia and Peru, **uvular** stops occur. These are produced when the back of the tongue is raised and moved backward to form a complete closure with the uvula. The letter *q* in words in this language, as in the language name, usually represents the uvular stop phonetically symbolized as [q]. The voiced uvular stop symbolized as [g] also occurs in Quechua. As noted above, glottal stops also occur in a number of languages, such as Lebanese Arabic.

Fricatives: [s] [z] [f] [v] [θ] [ð] [š] [ž] In the production of some continuants, while the airstream is not completely stopped, it is obstructed from flowing freely. If you put your hand in front of your mouth and produce an [s], [z], [f], [v], [θ], [ð], [š], or [ž] sound, you will feel the air coming out of your mouth. The passage in the mouth through which the air must pass, however, is very narrow, causing **friction** or turbulence. Such sounds are called **fricatives**. (They are also sometimes referred to as **spirants**, from the Latin word *spirare*, “to blow.”)

In the production of the labiodental fricatives [f] and [v], the friction is created at the lips, where a narrow passage permits the air to escape.

[s] and [z] are alveolar fricatives with the friction created at the alveolar ridge.

The palatal or alveopalatal fricatives, [š] and [ž], such as those in *mesher* [mešər] and *measure* [mežər], are produced with friction created as the air passes through the narrow opening behind the alveolar ridge. In English, the voiced palatal fricative never begins words (except in words borrowed from the French like *genre* or *gendarme* which some English speakers produce with a French pronunciation). The voiceless palatal sound begins the words *shoe* [šu] and *sure* [šur] and ends the words *rush* [ɾʌš] and *push* [puš].

In the production of the interdental fricatives [θ] and [ð], represented by *th* in *thin* and *then*, the friction occurs at the opening between the tongue and teeth.

Most dialects of modern English do not include velar fricatives, although they occurred in an earlier stage of English in such words as *right*, *knight*, *enough*, and *through*, where the *gh* occurs in the spelling. If you raise the back of the tongue as if you were about to produce a [g] or [k], but stop just short of touching the velum, you will

produce a velar fricative. The *ch* ending in the German pronunciation of the composer's name *Bach* is a velar fricative. Some speakers of modern English substitute a voiceless velar fricative in words like *bucket* and a voiced velar fricative in such words as *wagon* for the velar stops that occur for other speakers in those words. [x] is the IPA symbol for the voiceless velar fricative and [ɣ] for the voiced velar fricative.

In some languages of the world, such as French, the uvular fricative [ʀ] occurs as the sound represented by *r* in French words such as *rouge* "red" or *rose* "pink." Voiced glottal fricatives, which do not occur in English, do occur in other languages, such as Czech. In Arabic pharyngeal fricatives are produced by pulling the tongue root toward the back wall of the pharynx. It is difficult to pull the tongue far enough to make a complete pharyngeal stop closure, but both voiced and voiceless pharyngeal fricatives can be produced and can be distinguished from velar fricatives.

All fricatives are continuants: Although the airstream is obstructed as it passes through the oral cavity, it is not completely stopped.

Affricates Some sounds are produced by a stop closure followed immediately by a slow release of the closure characteristic of a fricative. These sounds are called **affricates**. The alveopalatal sounds that begin and end the words *church* and *judge* are voiceless and voiced affricates, respectively. Phonetically, an affricate may be considered a sequence of a stop plus a fricative. Thus, the *ch* in *church* is the same as the sound combination [t] + [ʃ] as shown by observing that in fast speech *white shoes* and *why choose* may be pronounced identically. The voiceless and voiced affricates may be symbolized as [tʃ] (IPA [tʃ]) and [dʒ] (IPA [dʒ]), respectively. In the American tradition, [č], [ǰ] are the more commonly used symbols for these sounds, and are the ones used in this book.

Because the air is stopped completely during the initial articulation of an affricate, these sounds are also classified as stops.



'WHO'S MAKING ALL THOSE MISTAKES? THEY'RE ALWAYS PASSING THE CORRECTION PLATE.'

DENNIS THE MENACE® used by permission of Hank Ketcham and © by North America Syndicate.

Liquids: [l] [r] In the production of the sounds [l] and [r], there is some obstruction of the airstream in the mouth, but not enough to cause any real constriction or friction. These sounds are called **liquids**. [l] is a **lateral liquid**, as described above.

As mentioned earlier, the *r* sounds that occur in different dialects of English and different languages differ somewhat from each other. We are using the symbol [r] for this whole class of sounds. An alveolar trilled *r* occurs in many languages, such as Spanish. In addition, uvular trills occur, produced by vibrating the uvula. Some French speakers use uvular trills in the pronunciation of *r*; others use uvular fricatives. In other languages the *r* is produced by a single **tap** or a **flap** of the tongue against the alveolar ridge. In Spanish both the trilled and tapped *r* occur.

Some speakers of British English pronounce the *r* in the word *very* with a flap. It sounds like a very fast *d*. Most American speakers produce a flap instead of a [t] or [d] in words like *writer* or *rider*, or *latter* or *ladder*. The IPA symbol for the alveolar tap or flap is [ɾ]. American linguists often use the upper case [D] to represent this sound.

In English, [l] and [r] are regularly voiced. When they follow voiceless sounds, as in *please* and *price*, they may be automatically “devoiced.” Many languages of the world have a voiceless *l*. Welsh is such a language; the name *Lloyd* in Welsh starts with the voiceless *l*.

Some languages may lack liquids entirely, or may have only a single one. The Cantonese dialect of Chinese has the single liquid [l]. Some English words are difficult for Cantonese speakers to pronounce, and they may substitute an [l] for an [r] when speaking English.

The reason why speakers in languages with only one liquid tend to use that sound as a substitute for the sound that does not occur in their language is because of the acoustic similarity of these sounds. This physical similarity is the reason they are grouped together in one class and why they function as a single class of sounds in certain circumstances. For example, in English, the only two consonants that occur after an initial [k], [g], [p], or [b] are the liquids [l] and [r]. Thus we have *crate* [kret], *clock* [klak], *plate*, [plet], *prate* [pret], *bleak* [blik], *break* [brek], but no word starting with [ps], [bt], [pk], and so on. (Notice that in words like *psychology* or *pterodactyl* the *p* is not pronounced. Similarly in *knight* or *knot* the *k* is not pronounced, although at an earlier stage of English it was.)

Glides: [j] [w] The sounds [j] and [w], the initial sounds of *you* and *woo* [wu], are produced with little or no obstruction of the airstream in the mouth. When occurring in a word, they must always be either preceded or followed directly by a vowel. In articulating [j] or [w], the tongue moves rapidly in gliding fashion either toward or away from a neighboring vowel, hence the term **glide**. Glides are transition sounds that are sometimes called *semivowels*.

[j] is a **palatal glide**; the blade of the tongue is raised toward the hard palate in a position almost identical to that in producing the vowel sound [i] in the word *beat* [bit]. In pronouncing *you* [ju], the tongue moves rapidly from the [j] to the [u] vowel.

The glide [w] is produced by both raising the back of the tongue toward the velum and simultaneously rounding the lips. It is thus a **labio-velar glide**, or a rounded velar glide. In the dialect of English where speakers have different pronunciations for the words *which* and *witch*, the velar glide in the first word is voice-