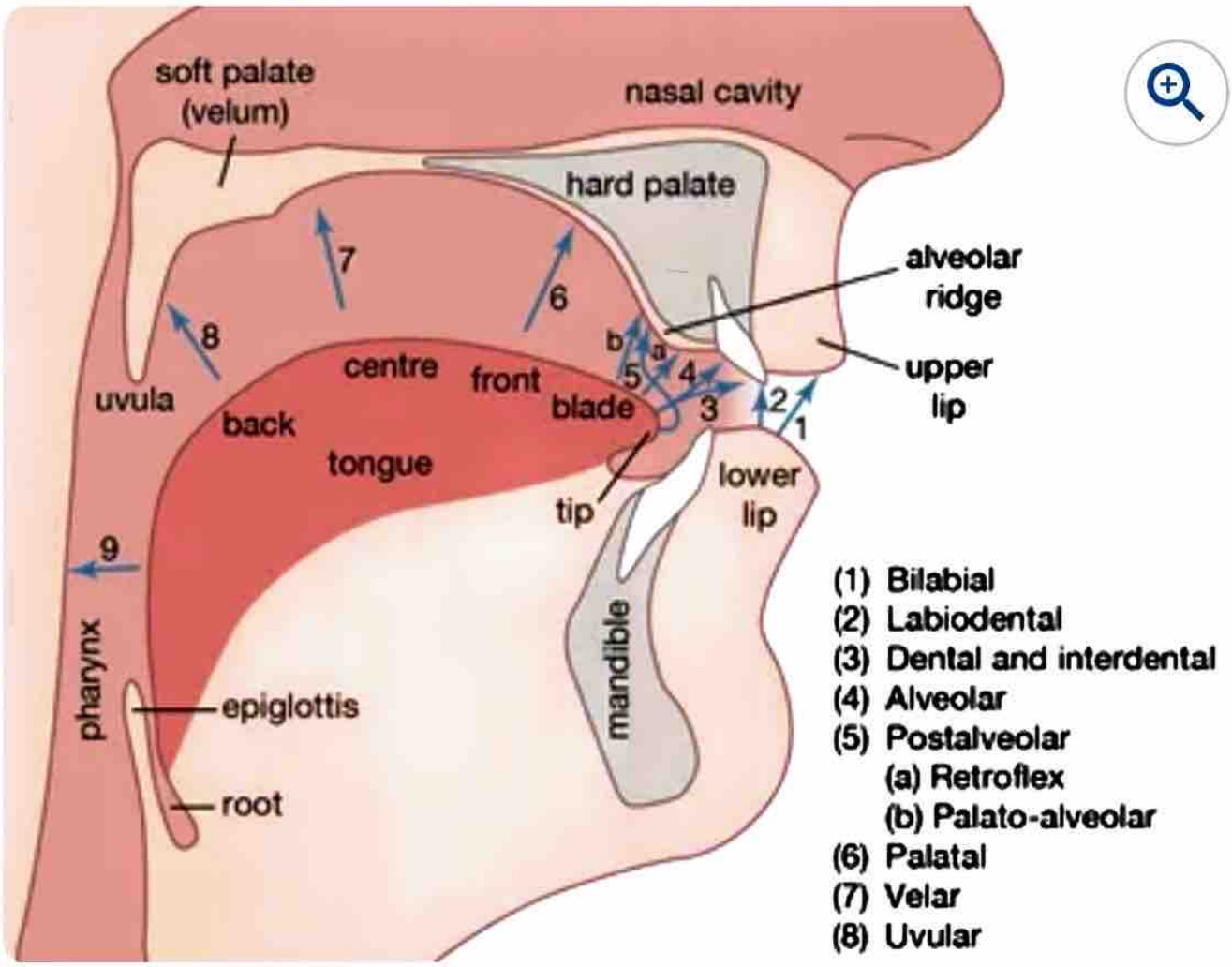

human vocal organs and points of articulation Diagram depicting the location of human vocal organs and possible places of articulation used for speech.

phonetics, the study of speech sounds and their physiological production and acoustic qualities. It deals with the configurations of the vocal tract used to produce speech sounds (articulatory phonetics), the acoustic properties of speech sounds (acoustic phonetics), and the manner of combining sounds so as to make syllables, words, and sentences (linguistic phonetics).

Articulatory phonetics

The traditional method of describing speech sounds is in terms of the movements of the vocal organs that produce them. The main structures that are important in the production of speech are the lungs and the respiratory system, together with the vocal organs shown in Figure 1. The airstream from the lungs passes between the vocal cords, which are two small muscular folds located in the larynx at the top of the windpipe. The space between the vocal cords is known as the glottis. If the vocal cords are apart, as they are normally when breathing out, the air from the lungs will have a relatively free passage into the pharynx (see Figure 1) and the mouth. But if the vocal cords are adjusted so that there is a narrow passage between them, the airstream will cause them to be sucked together. As soon as they are together there will be no flow of air, and the pressure below them will be built up until they are blown apart again. The flow of air between them will then cause them to be sucked together again, and the vibratory cycle will continue. Sounds produced when the vocal cords are vibrating are said to be voiced, as opposed to those in which the vocal cords are apart, which are said to be voiceless.

The air passages above the vocal cords are known collectively as the vocal tract. For phonetic purposes they may be divided into the oral tract within the mouth and the pharynx, and the nasal tract within the nose. Many speech sounds are characterized by movements of the lower articulators—*i.e.*, the tongue or the lower lip—toward the upper articulators within the oral tract. The upper surface includes several important structures from the point of view of speech production, such as the upper lip and the upper teeth; Figure 1 illustrates most of the terms that are commonly used. The alveolar ridge is a small protuberance just behind the upper front teeth that can easily be felt with the tongue. The major part of the roof of the mouth is formed by the hard palate in the front, and the soft palate or velum at the back. The soft palate is a muscular flap that can be raised so as to shut off the nasal tract and prevent air from going out through the nose. When it is raised so that the soft palate is pressed against the back wall of the pharynx there is said to be a velic closure. At the lower end of the soft palate is a small hanging appendage known as the uvula.

As may be seen from Figure 1, there are also specific names for different parts of the tongue. The tip and blade are the most mobile parts. Behind the blade is the so-called front of the tongue; it is actually the forward part of the body of the tongue and lies underneath the hard palate when the tongue is at rest. The remainder of the body of the tongue may be divided into the centre, which is partly beneath the hard palate and partly beneath the soft palate; the back, which is beneath the soft palate; and the root, which is opposite the back wall of the pharynx.

The major division in speech sounds is that between vowels and consonants. Phoneticians have found it difficult to give a precise definition of the articulatory distinction between these two classes of sounds. Most authorities would agree that a vowel is a sound that is produced without any major constrictions in the vocal tract, so that there is a relatively free passage for the air. It is also syllabic. This description is unsatisfactory in that no adequate definition of the notion syllabic has yet been formulated.

Stops

Stops involve closure of the articulators to obstruct the airstream. This manner of articulation can be considered in terms of nasal and oral stops. If the soft palate is down so that air can still go out through the nose, there is said to be a nasal stop. Sounds of this kind occur at the beginning of the words *my* and *nigh*. If, in addition to the articulatory closure in the mouth, the soft palate is raised so that the nasal tract is blocked off, then the airstream will be completely obstructed, the pressure in the mouth will be built up, and an oral stop will be formed. When the articulators open the airstream will be released with a plosive quality. This kind of sound occurs in the consonants in the words *pie, tie, kye, buy, die*, and *guy*. Many authorities refer to these two articulations as nasals, meaning nasal stops (closure of the articulators in the oral tract), and stops, meaning oral stops (raising of the soft palate to form a velic closure).

Fricatives

A fricative sound involves the close approximation of two articulators, so that the airstream is partially obstructed and a turbulent airflow is produced. The mechanisms used in the production of these sounds may be compared to the physical forces involved when the wind "whistles" round a corner. Examples are the initial sounds in the words *fie*, *thigh*, *sigh*, and *shy*. Some authorities divide fricatives into slit and grooved fricatives, or rill and flat fricatives, depending on the shape of the constriction in the mouth required to produce them. Other authorities divide fricatives into sibilants, as in *sigh* and *shy*, and nonsibilants, as in *fie* and *thigh*. This division is based on acoustic criteria (see below).

Approximants

Approximants are produced when one articulator approaches another but does not make the vocal tract so narrow that a turbulent airstream results. The terms frictionless continuant, semivowel, and glide are sometimes used for some of the sounds made with this manner of articulation. The consonants in the words *we* and *you* are examples of approximants.

Trills

A trill results when an articulator is held loosely fairly close to another articulator, so that it is set into vibration by the airstream. The tongue tip and blade, the uvula, and the lips are the only articulators than can be used in this way. Tongue tip trills occur in some forms of Scottish English in words such as *rye* and *ire*. Uvular trills are comparatively rare but are used in some dialects of French, but not Parisian French. Trills of the lips are even rarer but do occur in a few African languages.

Taps

A tap is produced if one articulator is thrown against another, as when the loosely held tongue tip makes a single tap against the upper teeth or the alveolar ridge. The consonant in the middle of a word such as *letter* or *Betty* is often made in this way in American English. The term flap is also used to describe these sounds, but some authorities make a distinction between taps as defined here and flaps, in which the tip of the tongue is raised up and back and then strikes the alveolar ridge as it returns to a position behind the lower front teeth. Some languages—*e.g.*, Hausa, the principal language of Northern Nigeria—distinguish between words containing a flap and words containing a tap. The distinction between a trill and a tap is used in Spanish to distinguish between words such as *perro*, meaning "dog," and *pero*, meaning "but."

Laterals

When the airstream is obstructed in the mid-line of the oral tract, and there is incomplete closure between one or both sides of the tongue and the roof of the mouth, the resulting sound is classified as a lateral. The sounds at the beginning and end of the word *lull* are laterals in most forms of American English.

The production of many sounds involves more than one of these six basic manners of articulation. The sounds at the beginning and end of the word *church* are stops combined with fricatives. The articulators—tongue tip or blade, and alveolar ridge—come together for the stop, and then, instead of coming fully apart, they separate only slightly so that a fricative is made at the same place of articulation. This kind of combination is called an affricate. Lateral articulations may also occur in combination with other manners of articulation. The laterals in a word such as *lull* might more properly be called lateral approximants, in that the airstream passes out freely between the sides of the tongue and the roof of the mouth without a turbulent airstream being produced. But in some sounds in other languages the sides of the tongue are closer to the roof of the mouth and a lateral fricative occurs; an example is the sound

spelled *ll* in Welsh words such as *llan* “church” and the name *Lluellyn*.

Secondary articulations

When an approximant articulation occurs at the same time as another articulation is being made at a different place in the vocal tract, the approximant is said to form a secondary articulation. There are special terms for some of these possibilities. Added lip rounding is called labialization; it occurs in the formation of several English sounds—*e.g.*, during the pronunciation of the palato-alveolar fricative at the beginning of the word *shoe*. Raising of the front of the tongue while simultaneously making another articulation elsewhere in the vocal tract is called palatalization. It is the distinguishing characteristic of the soft consonants in Russian and also occurs, to a lesser extent, in English; *e.g.*, in the first consonant in the word *leaf*. Raising of the back of the tongue to form a secondary articulation is called velarization; it occurs in the last consonant in the word *feel*, which therefore does not contain the same sounds as those in the reverse order in the word *leaf*. Retracting of the root of the tongue while making another articulation is called pharyngealization; it

The states of the glottis, places of articulation, and manners of articulation discussed above are sufficient to distinguish between the major contrasts among the consonants of English and many other languages. But additional possibilities have to be taken into account in a more detailed description of English, or in descriptions of several other languages. Among these possibilities are variations in the timing of the states of the glottis. In addition to the contrast between the voiced and voiceless states of the glottis that occur during an articulation, there may be variations in the state of the glottis during the release of the articulation. Thus both the *p* in *pin* and that in *spin* are voiceless bilabial stops, but they differ in that the glottis remains in a voiceless position for a short time after the release of the bilabial stop in *pin*, whereas in *spin* the voicing starts as soon as the lips come apart. When there is a period of voicelessness during the release of an articulation, the sound is said to be aspirated. The main difference between the consonants in *pea* and *bee*, when these words are said in isolation, is not that the one is voiceless and the other voiced, but that the first is aspirated and the second is unaspirated. Some languages distinguish between both voiced–voiceless and

aspirated–unaspirated sounds. Thus Thai has contrasts between voiceless aspirated stops, voiceless unaspirated stops, and voiced unaspirated stops.

Several languages use more than just the voiced and voiceless states of the glottis. In Hindi and many of the other languages of India, some sounds are produced while the vocal cords are vibrating for part of their length but are apart, so that a considerable amount of air escapes between them at one end. This phenomenon is known as breathy voice, or murmur. Other languages have sounds in which the vocal cords are held tightly together so that only part of their length can vibrate. This kind of sound, which is usually very low pitched, is sometimes called creaky voice, or vocal fry. It is used to make contrasts between consonants in several American Indian languages. An additional glottal state that is widely used—*e.g.*, in the Austronesian (Malayo–Polynesian) languages of the Philippines—is a glottal stop, a tight closure of the two vocal cords. This articulation also occurs in many forms of English as the usual pronunciation of *t* in words such as *bitten* and *fatten*.