Articulatory Phonetics

We will spend the next few days studying articulatory phonetic: what is involved in the actual movement of various parts of the vocal tract during speech. *(Use transparency to discuss organs of speech; oral, pharyngeal and nasal cavities; articulators, lungs and diaphragm).*

All speech sounds are made in this area. None are made outside of it (such as by stomping, hand clapping, snapping of fingers, farting, etc.)

Theoretically, any sound could be used as a speech sound provided the human vocal tract is capable of producing it and the human ear capable of hearing it. Actually only a few hundred different sounds or types of sounds occur in languages known to exist today, considerably fewer than the vocal tract is capable of producing.

Thus, all speech sounds result from air being somehow obstructed or modified within the vocal tract. This involves 3 processes working together:

a) **the airstream process**--the source of air used in making the sound.

b) **the phonation process**--the behavior of the vocal cords in the glottis during the production of the sound.

c) **the oro-nasal process**--the modification of that flow of air in the vocal tract (from the glottis to the lips and nose).

Let's discuss the airstream process first.

**The airstream process**

The first major way to categorize sounds according to phonetic features is by the source of air. Where does the air come from that is modified by the vocal organs? Languages can use any of three **airstream mechanisms** to produce sounds.
One airstream mechanism is by far the most important for producing sounds in the world's languages. Most sounds in the world's languages are produced by manipulating air coming into the vocal tract as it is being exhaled by the lungs, a method referred to as the pulmonic egressive airstream mechanism. Sounds made by manipulating air as it is exhaled from the lungs are called pulmonic egressive sounds. Virtually all sounds in English and other European languages are produced by manipulating exhaled air. And most sounds in other languages are also pulmonic egressive.

There is another variety of this pulmonic airstream mechanism. Inhaled air can also be modified to produce speech sounds. This actually occurs in a few rare and special cases, such as in Tsou, an aboriginal language of Taiwan, which has inhaled [f] and [h] (['h5/˝ps˝'] ashes; ['f5/tsuju'], egg). Such sounds are called pulmonic ingressive sounds, and the airstream mechanism for making such sounds is called the ingressive rather than the egressive version of the pulmonic airstream mechanism. Perhaps because it is physiologically harder to slow down an inhalation than an exhalation, pulmonic ingressive sounds are extremely rare.

The majority of the sounds in all languages of the world are pulmonic egressive sounds. However, in addition to using air being actively exhaled (or inhaled), two other airstream mechanisms are used to produce some of the sounds in some of the world's languages.

1) To understand the second airstream mechanism, the glottalic airstream mechanism, let's first look at a special pulmonic egressive sound, the glottal stop. Air being exhaled from the lungs may be stopped in the throat by a closure of the glottis. This trapping of air by the glottis is called a glottal stop. English actually has a glottal stop in certain exclamations: [u?o’’], u?u], [a?a], and in certain dialectical pronunciations: [bottle]. The IPA renders the glottal stop as a question mark without the period.

The glottal stop itself is an example of a pulmonic egressive sound, since air from the lungs is being stopped. However, the
glottis can be closed immediately before the production of certain other sounds, trapping a pocket of air in the vocal tract. If this reservoir of stationary air is then manipulated in the production of a sound it yields another type of airstream mechanism, the **glottalic airstream mechanism**. Here’s how it works. First, the vocal cords completely close so that for a brief moment no air escapes from the lungs and air is compressed in the throat (pharynx).

If the closed glottis is raised to push the air up and outward, an **ejective** consonant is produced. The air is forced into the vocal tract and there manipulated by the organs of speech. *Compare glottalized vs. non-glottalized* [k] *in Georgian*. Ejectives are found in the languages of the Caucasus mountains, among many Native American languages, and among the Afroasiatic languages of north Africa (Hausa, Amharic).

If the closed glottis is lowered to create a small vacuum in the mouth, an **implosive** consonant is produced. The lowering glottis acts like the downward movement of a piston to create a brief rarification of the air in the vocal tract. When the stricture in the mouth is released air moves into the mouth. Swahili has three implosives: [b], [d], [g]. Implosives occur mostly in languages of east Africa, in several Amerindian languages and in some IE languages of northern India. (Compare the difference between implosives, using the glottalic airstream mechanism, and ingressives, which use inhaled air.)

The third and final airstream mechanism used by human language is confined to certain languages of southwest Africa. It is called the **velaric airstream mechanism**. There is regular oral articulation, while the back of tongue seals off air from the lungs and creates a relative vacuum. Air in the mouth is rarified by backward and downward movement of the tongue. When the stricture is released the air rushes in, creating a click. Although we think of such sounds as exotic, English uses a few of them for quasi-linguistic sound gestures: 'grandmother's kiss' (bilabial click), encouraging a horse (lateral click), tisk-tisk (actually a dental or alveolar click). Some Khoisan languages have over a dozen clicks. (release of click can be supplemented by additional features:
aspirated, nasal/ non-nasal). One Khoisan language !Xung has 48 different click sounds. A few of the Bantu languages of South Africa, such as Zulu, have clicks; presumably, these sounds were borrowed from the San (Bushmen) and Khoikhoi (Hottentot) peoples who originally lived throughout all southern Africa. Zulu and the other Bantu languages that use clicks spell them with the letters c, x, q. (cf. the name of the tribe Xhosa). Notice that clicks stop up the air only in the oral cavity; pulmonic air continues through the nose (one can produce a nasal hum while producing clicks).

For the sake of completeness, it should be said that at least one other airstream mechanism could possibly be used for producing sounds in human language. A puff of air could be trapped in either cheek, then released to be manipulated by the speech organs. This is the airstream mechanism employed by the Walt Disney character Donand Duck and could be called the **buccal airstream mechanism**. So far as we know, Donald Duck is unique in using it. And no language uses a **gastric airstream mechanism**, which would be modifying air burped up from the stomach.

**The phonation process**

The vocal cords can be in one of several positions during the production of a sound. The muscles of the vocal cords in the glottis can behave in various ways that affect the sound. The effect of this series of vocal cord states is called the **phonation process**.

**Voicing.** Vocal cords can be narrowed along their entire length so that they vibrate as the air passes through them. All English vowels are voiced. Voiceless vowels also occur but are far rarer than voiceless consonants are much more common than voiceless vowels. Voiceless vowels usually occur between voiceless consonants, as in Japanese. No language has only voiceless vowels; a language has either only voiced vowels or voiced and a few voiceless vowels.

There are also several other vocal cord states that are used to modify sound in the world's languages. None is used as a regular feature of English.
Laryngealization. The posterior (artenoid) portion of the vocal cords can be closed to produce a laryngealized or creaky sound. This doesn't play a meaningful role in English phonology, although we might use a creaky voice to imitate an old witch when reading fairy tales. Some languages of Southeast Asia and Africa have creaky vowels and consonants, as in Margi, a Nigerian language: ja to give birth/ laryngealized ja thigh; or in Lango a Nilotic language: man this/ laryngealized man testicles.

Murmur. The anterior (ligamental) portion of the vocal cords can be closed, with the vocal cords vibrating. This produces murmured or breathy sounds. Murmured or breathy vowels occur in some languages of Southeast Asia. We make murmured sounds to imitate the Darth Vader voice. In many Indo-European languages of India the stop consonants have a murmured release; in other words the anterior portion of the vocal cords remain closed after the stop has been produced during part of the time the vowel is pronounced: bh, dh, gh, Buddha.

Whisper. A similar vocal cord state is used to produce the whisper. The vocal chords are narrowed but not vibrated, narrowing is more complete at the anterior end, less so at the posterior end. Whispered sounds do not contrast with non-whispered sounds to produce differences of meaning in any known language, but the whispered voice is common as a speech variant across languages. There is no IPA symbol for a whispered sound.

The oro-nasal process

Regardless of which airstream mechanism is used, speech sounds are produced when the moving air is somehow obstructed within the vocal tract. The vocal tract consists of three joined cavities: the oral cavity, the nasal cavity, and the pharyngeal cavity. The surfaces and boundaries of these cavities are known as the organs of speech. What happens to the air within these cavities is known as the oro-nasal process.

Let's talk first about the oro-nasal process in the articulation, or production, of consonants.
There are two major ways to classify the activity of the speech organs in the production of consonants: place of articulation and manner of articulation.

**Consonantal place of articulation**

The place of articulation is defined in terms of two *articulators* These may be: lips, teeth, alveolar ridge, tongue tip (apex), tongue blade (laminus), or back of the tongue (dorsum), hard palate, soft palate (velum), uvula, glottis, pharynx, glottis (the "voice box," or cartilaginous structure where the vocal cords are housed).

**bilabial** [b, p, m, w]

**labiodental**, [f, v]

**interdental**, [T, D]

**(apico)-dental** the tip (or apex) of the tongue and the back teeth: Spanish [t, d, s, z].

**alveolar** (apico-or lamino-) tongue and alveolar ridge (compare 'ten' vs. 'tenth'). Examples: English [t, d, s, z]

**postalveolar or palatoalveolar (apico- or lamino-)** (English [S]/[Z]),

**retroflex** (apico-palatal) bottom of the tongue tip and palate, or alveolar ridge: Midwest English word-initial [«] and [t, d, n] in many Dravidian languages and many languages of Australia.

**palatal** (apico- or lamino-) (English [j]), [S]/[Z] in many languages

**velar or dorso-velar** Eng. [k, g, N] German [x] Greek [V]

**uvular** French [R], also found in many German dialects.

**pharyngeal** (constriction of the sides of the throat),
glottal (glottal stop, the vocal chords are the two articulators. cf. A-ha, bottle, Cockney English 'ave). [h] is a glottalic fricative sound.

**Manner of articulation**

Now let's look at the ways that moving air can be blocked and modified by various speech organs. There are several methods of modifying air when producing a consonant, and these methods are called **manners of articulation**. We have already examined where the air is blocked. Now let's look at how the air can be blocked.

1) Sounds that completely stop the stream of exhaled air are called **plosives**: [d], [t], [b], [p], and [g], [k], glottal stop. Another word for plosive is stop (nasals are also stops, however, since the air is stopped in the oral cavity during their production).

2) Sound produced by a near complete stoppage of air are called **fricatives**: [s], [z], [f], [v], [T], [D], [x], [V], [h], pharyngeals.

3) Sometimes a plosive and a fricative will occur together as a single, composite sound called an **affricate**: [tS], [ts], [dz], [dZ], [pf].

4) All other types of continuant are produced by relatively slight constriction of the oral cavity and are called **approximants**. Approximants are those sounds that do not show the same high degree of constriction as fricatives but are more constricted than are vowels. During the production of an approximant, the air flow is smooth rather than turbulent. There are four types of approximants.

   a) The glottis is slightly constricted to produce [h], a glottalic approximant.

   b) If slight stricture occurs between the roof of the mouth and the tongue a palatal **glide** is produced [j]. If the constriction is between the two lips, a labiovelar glide is produced. The glides [j] and [w] are also called **semivowels**, since they are close to vowels in degree of blockage.
c) If the stricture is in the middle of the mouth, and the air flows out around the sides of the tongue, a lateral is produced. Laterals, or lateral approximants, are the various l-sounds that occur in language. In terms of phonetic features, l-sounds are + lateral, while all other sounds are + central.

d) The third type of approximant includes any of the various R-sounds that are not characterized by a flapping or trilling: alveolar and retroflex approximants. This includes the American English r (symbolized in the IPA by an upside down [®], but we will use the symbol [r]).

   It the air flow is obstructed only for a brief moment by the touch of the tongue tip against the teeth or alveolar ridge, a tap, or tapped [] is produced: cf. Am Engl ladder; British Engl. very.

   If the tongue tip is actually set in motion by the flow of air so that is vibrates once, a flap or flapped r is produced: this is the sound of the Spanish single r. Flaps can even be labio-dental, as in one African language, Margi, spoken in Northern Nigeria.

   If the air flow is set into turbulence several times in quick succession, a trill is produced. Trills may be alveolar, produced by the apex of the tongue: the Spanish double rr perro; the French uvular [R]: de rien; Bilabial trills [B] have been found to occur in two languages of New Guinea: mBulei = rat in Titan.

**Degree of blockage**

   In discussing manner of articulation, it is also relevant to classify consonants according to the total degree of blockage. Remember that all sounds that involve significant stoppage of air in the vocal tract are known as consonants (this distinguishes them from vowel, which are produced by very little blockage of the airstream). Consonants differ in the manner as well as the degree to which the airstream is blocked. While we are discussing the manner in which air is blocked, we can also classify sounds as to the degree of blockage.
Plosives, fricatives, and affricates are all sounds made by nearly complete or complete blockage of the airstream. For this reason they are known collectively as **obstruents**.

Consonants produced by less blockage of the airstream are called **sonorants**. With little blockage the airstream flows out smoothly, with relatively little turbulence. There are several types of sonorants, depending upon where the airstream is blocked in the vocal tract and how air flows around the impediment.

Sonorants are produced using the following manners of articulation:

1) Sounds produced by stoppage at the vocal tract and release through the nose are called **nasals**. The nasals [m], [n], and [ng] have the same point of articulation as the plosives [d], [b], and [g], except that the velum rises and air passes freely through the nose during their production; the oral stoppage is not released. Plosives are also known as **oral stops**, to distinguish them from the **nasal stops**. All known languages have at least one nasal except for several Salishan languages spoken around the Puget Sound (including Snohomish).

The division of consonants into obstruents and sonorants is not absolute. In some languages, such as Russian, the glide [j] is produced by much more blockage and could almost as easily be called a fricative.

Also, some l- and r- sounds are definitely fricatives rather than approximants. Some types of l- and r-sounds are characterized by a highly turbulent flow of air over the tongue, even more than for the trilled [r].

In Czech, besides the regular flapped r, there is a strident trilled and tensed [r] which is much more like an obstruent than a sonorant. Navaho has a fricative [tl] which is definitely more fricative than approximant.

Because all l- and r- sounds (whether approximant and non-approximant) are produced in the same way--with the the air
flowing around or over the tongue like water moving around a solid object--there is a collective term for these sounds: **liquids**. Liquids and nasals are sometimes able to carry a syllable. Syllabic r and l occur in Czech and Slovak: *StrC prst skrz krk*. The IPA uses a dot beneath them to signify syllabicity.

**Review of some articulatory terminology**

**Stops** (air completely blocked in the oral cavity)-nasal and oral (plosives).

**Obstruents** (high degree of blockage) include: plosives, fricatives, and affricates.

**Sonorants** (low degree of blockage) include: nasals and approximants.

**Approximants** (the lowest degree of blockage) include: the glottal approximant [h], the glides [j] and [w], and most l- and r-sounds.

**Liquid**: all l- and r-sounds, whether fricative or approximant.

*Go over the handout on the English sound system (up to the vowel questions)*

**Secondary articulation features in consonants**

**Lack of release.** Plosives may not be released fully when pronounced at the end of words. This occurs with English [p} b}, t}, d}, k}, g}]

**Length.** Consonants may be relatively long or short. Long consonants and vowels are common throughout the world, cf. Finnish, Russian: zhech/szhech *to burn*; Italian: *pizza, spaghetti*. Long or double consonants are also known as geminate consonants and are indicated in the IPA by the symbol [...]. Geminate plosives and affricates are also known as delayed release consonants.

**Nasal release.** In certain African languages: [dn].
**Palatalization.** Concomitant raising of the blade of the tongue toward the palate: *cannon/canyon, do/dew*; common among the sounds of Russian and other East-European languages: *mat/mat*’ luk/lyuk. There are thousands of such doublets in Russian.

**Labialization.** Concomitant lip rounding cf. sh in *shoe* vs. *she* (IPA uses a superscript w to transcribe labialization) In some languages of Africa the contrast between labialized and non-labialized sounds signal differences in meaning, as in Twi: *ofa’ he finds/ ofwa’ snail.*

**Velarization.** The dorsum of the tongue is raised slightly. Compare the l in *wall, all* (velarized or dark l) vs. *like, land* (continental or light l). The glide [w] is also slightly velarized. In Russian all non-palatalized consonants are velarized.

**Pharyngealization.** Concomitant constriction of throat. Afroasiatic languages of north Africa, such as Berber: *zurn they are fat/ zghurn they made a pilgrimage.*

**Tensing.** The muscles of the articulators can be or lax when pronouncing a sound. Cf. Korean stops: Lax unvoiced p, lax voiced b, tense unvoiced pp. Tensing also occurs in the vocal cords during the production of tensed stops, so tenseness could also have been listed under phonation processes.

**The oro-nasal process in vowels**

*Go over part D on the handout now; go over part E during the lecture on vowels.*

Sounds produced by no blockage other than a slight raising of the tongue or a narrowing of the lips are called vowels. Vowels differ in several phonetic features. Three are most important.

1) which part of the tongue is **raised:** front/central/back (mention the difference between the [a] of father in English dialects.)

2) how high the tongue is raised: high, middle, low
3) whether or not the lips are rounded.

Several other features distinguish vowels on a more limited basis across the world's languages.

4) whether or not the tongue is tense (bunched up; in English, diphthongalized) or lax (relaxed and slightly shorter, closer to the center of the oral cavity). In English, stressed lax vowels only occur in closed syllables, tense vowels occur in either open or closed syllables:

Tense= by, too, way, so, ma

Lax= bit, but, full, get, oil/or, and, (also, hard, in New England pronunciation), as well as schwa: sofa

5) nasal vs. non-nasal (describe the velum and oro-nasal process)

6) long vs. short. Many languages have a distinction between short and long vowels: Hawaiian, Navajo, etc. Estonian has three vowel lengths; in English vowels are slightly longer before voiced consonants and slightly shorter before voiceless.

7) Different phonation processes involving the vocal cords produce several featural contrasts in vowels as in consonants:
   voiced/voiceless (whispered) laryngealized (creaky), murmured (breathy).

There are three diphthongs in General American English

\[ [a^U] \] house \quad [a^I] \] like, \quad [O^I] \] oil, boy, toy

Diphthongs in other American dialects.

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The study of phonetics is not simply the sounds that are made when a word is articulated, but also the way in which those sounds are created. Articulatory phonetics is a specific branch of phonetic study that looks at how the vocal tract produces speech sounds. Simply put, it is the study of the physiological characteristics of speech sounds: The production of any sound involves the movement of air through the vocal tract. This writeup is not intended to be a comprehensive resource for all the topics included, but more as an overview. The study of articulatory phonetics is a broad field. Consult
nodes of specific value to get more in-depth on any of the topics covered herein. (Note: Please see International Phonetic Alphabet for a description of any IPA symbols used in this writeup. All sounds described in this writeup will be placed between / symbols.)

The majority of the items covered in this writeup will focus on English, save for a few things not easily explained through English or need further explanation. Tone languages, for example, will not be discussed at all (even though the vast majority of languages in the world are tone languages) because tone has no linguistic application in English.

The Players

In order to get a firm grasp of just how articulatory phonetics is described by linguists, a cursory glance at the bit players involved in the production of sound is required, starting with the front of the oral cavity (the lips) all the way down the throat to the glottis. Bear with me, there are more things between sucking in a breath and uttering Shakespeare than you might have guessed.

The Lips: These are those fleshy bits right in front of your face. You smile and with them, and you use them to shape the letters that are going to pop out. These bits of muscle won't help differentiate a /b/ sound from a /p/ sound (one is voiced, the other is voiceless—see the glottis, below), but they do help in distinguishing /b/ from a /v/ (one is a bilabial (two-lipped) consonant, the other is a labiodental consonant).

The Teeth: Your dentist loves these things, and so do linguists. The teeth act in two ways to create sound. The first is to act with the lips to create labiodental (bottom lip + teeth) consonants, the /v/ or /f/ sounds in English, and the second is to create interdental (between the teeth) consonants (such as the 'th' sound /θ/ in 'thin' or /ð/ in 'though').

The Alveolar Ridge: Right behind the teeth is a ridge of tightly skin-covered bone we call the alveolar ridge. This point of articulation is important for all alveolar consonants, when the tongue goes up to tap, glide along, or curl behind that ridge. See the alveolar consonants for more on this (isn't it convenient that alveolar consonants are made on the alveolar ridge? Linguists are economical with their words).

The Palate and Velum: At the back of the oral cavity lies the palate and the velum, sometimes distinguished as the hard and soft palate, but more often just as the palate and the velum. This is the rest of what is commonly known as the mouth that continues back to the uvula (the hanging down bit that we prod vigorously to make vomiting easier). The second half of the palate as a whole (the fleshy bit—prod with your tongue, you'll be able to feel where the bone ends and fleshiness begins) is the velum or soft palate. In this whole cavity, palatals, velars and uvular consonants are created.

The Glottis: If you know German, you know the glottis. This is the opening between the vocal cords, and is located in the larynx (the "voice box"), at the bottom of the throat-tube just past the tongue called the pharynx. The glottis is used in creating glottal consonants, and for glottal stops (such as the 't' in 'button' if your dialect doesn't pronounce the word /bʌt/ but instead /bʌʔən/).

Airstream Mechanisms

The vast majority of sounds that'll ever come out of your mouth (in terms of language—belches are only considered language when communicating during a football game, so far as I can tell) are pushed out from your lungs through your vocal tract and out your mouth. These are pulmonic sounds (they came from your lungs) and egressive (since they were pushed out). That covers all the sounds you'll ever make in English—pulmonic egressive airstream mechanics.

Naturally, there are still a few languages in the world that use other airstream mechanisms to make their sounds. Ejective egressive sounds are made when air in the mouth is pressurized by an upward movement of the closed glottis and released suddenly, creating a sharp sound. Try it with 'p' to make an explosive popping sound. These ejectives are found in many American Indian and African languages.

There are several languages that use ingressive sounds, when the air is sucked into the mouth to make clicks (the tsk sound you heard when your great aunt chided you for eating too many sweets).
Additionally, implosive sounds still exist in a tiny fraction of the world's languages, but so far as I can manage, they are impossible to portray in text format to the layman. But if you know Southern Bantu languages such as Xhosa and Zulu, or the languages of the Bushmen and Khoikhoi, you can know what I'm talking about.

**Manners of Articulation - Consonants**

There are two basic concepts linguists use to describe sounds being pushed out of your vocal tract. The first concept asks whether the sound is voiced or not, the second asks if it is nasal or not. "But I thought all sounds came out of the vocal tract, mister!" Hold on, I'll get to the nasal/oral distinction in a minute. The manners of articulation that follow exist to differentiate between the large variety of consonants and vowels that exist in all languages. The distinctions exist to help reproduce the sounds, the descriptors internationally excepted. Refer to the writeups on International Phonetic Alphabet for examples of these voiced/voiceless and nasal/oral sounds. I will attempt to keep my discussion to English.

**Voiced and Voiceless Sounds**

Quick, put your fingers in your ears. Seriously. Now say "ssssss" as a continuous sound. Okay, now say "zzzzzz." Could you feel the difference? The difference lies in your vocal cords. When they're apart, letting air stream right through the glottis and supraglottal cavities (see above), the sound produced is voiceless. The /s/ sound is voiceless. When the vocal cords are together, vibrating when the air is pushed through them, you get a voiced sound. Therefore, the /z/ sound is voiced.

Both the /s/ and /z/ sounds are alveolars, articulated in the same place in the vocal cavity. Try it out. Say 'sssssszzzzzz.' You'll notice that your tongue does not move from its position when shifting between the two sounds. The only difference is in how the vocal cords are acting.

*Note: All vowels are voiced.*

A subcategory of the voice/voiceless distinction is in aspiration. In IPA, this distinction is portrayed by putting a superscript 'h' next to the letter that is aspirated. In English, we make no distinction between the /p/ sound in 'pin' and the /p/ sound in 'spin.' To a speaker of English, they are allophonic. There is, however, a difference. In 'pin,' the /p/ is aspirated, which means there is a brief period of voicelessness immediately after the /p/ sound is released--the vocal cords remain open for a very short time after the lips come apart. In 'spin,' however, the vocal cords start vibrating as soon as the lips open. (see chart below). In some languages (Hindi, for example), there is a phonemic distinction between aspirated and unaspirated consonants. Which means (made-up words follow) /pin/ and /pʰin/ are two completely different words, meaning totally different things, distinct only by their level of aspiration. If you think that's confusing, some languages in the Far East make no distinction between /r/ and /l/, just as we make no distinction between /p/ and /pʰ/.

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Note on word constructions:
/bɪn/ is completely voiced.
/spɪn/ is a voiceless /s/ and then an unaspirated, voiceless /p/. /ɪn/ is voiced.
/prɪn/ has a voiceless, aspirated /pʰ/.

**Nasal and Oral Sounds**

So, how we know whether or not a sound is voiced or voiceless, we need to know if it is a nasal or oral sound. We know that bilabial /p/ is distinguished from bilabial /b/ in that /p/ is voiceless and /b/ is voiced. However, /m/ is also a voiced bilabial. How is /m/ distinguished? /m/ is a nasal voiced bilabial consonant, made nasal because the velum (soft palate) is not in its raised position, allowing air to escape through the nasal cavity. In English, all nasal consonants are voiced, however nasal voiceless consonants exist in other languages.

In English, there are only three consonants that are nasal: /m n ŋ/.

**Manners of Articulation - Vowels**

So far, all of this has been about consonant sounds. Now the vowel must take center stage, as the glue that makes words singable. Or something. They're a bit trickier than consonants. When you're standing in front of the mirror and you make the /b/ sound, you can see your lips come together. When you articulate /t/, you can feel your tongue touching the alveolar ridge. We produce vowels, however, without any articulators touching, so it may be difficult to feel what is happening. The vowel sounds are created by the tongue (how high and what part of the tongue is involved) and by the lips' position.

**Tongue Position**

When sounding a vowel, the tongue moves to a high, mid, or low position with its front, central or back part. Confused? Great, that's a good place to start. And while we're busy making funny noises in our bedrooms from the zzz-sss bit, try this one on: Say "hack, hah, hack, hah, hack, hah." You should be able to feel your tongue moving forward and backward in the lower part of your mouth. You've just demonstrated for yourself the vowels /æ/ (as in "hack," /hæk/) and /a/ (as in "hah," /ha/). The /æ/ is pronounced with the front part of the tongue low in the mouth, and /a/ is pronounced with the back part of the tongue low in the mouth. They are both considered low vowels, as they both are made with the tongue low in the mouth. A similar distinction exists between the /e/ in "bait," /bet/ and the /o/ in "boat," /bot/. Try the same experiment with those two words. Both those vowel sounds are made with the tongue at its middle height, the /e/ articulated with the front of the tongue, the /o/ articulated with the back, with rounded lips.

**Lip Rounding**

The second half of vowel creation is done with the lips, and is easy to see in the mirror. Take the vowel sounds from "beet," and "boot," which are /i/ and /u/ respectfully. Elongate the sound and look in the mirror. "eeeee-e-oooooo." The lips are only rounded for the /u/ sound, the lips are tense and spread apart (unrounded) for the /i/ sound. For English, all back vowels (/u ʊ o ɔ/) are rounded, the rest are unrounded. The chart below shows the position of each vowel in English, as well as where the tongue is when the sound is articulated.

<table>
<thead>
<tr>
<th>Part of the Tongue Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH</td>
</tr>
<tr>
<td>MID</td>
</tr>
</tbody>
</table>
Diphthongs

No doubt you've heard of diphthongs. They're an interesting breed of vowel, and can be defined simply as a vowel + a glide, making a two-vowel-sound vowel. All the vowel sounds up to this point are called monophthongs. That's awfully fun to say. A monophthong is a vowel with only (you guessed it!) one vowel sound. The /a/ in 'father' /faðə/. In words like 'bite,' however, you've got two vowel sounds. Take that /a/ and glide it into the /j/ sound (as in 'yes' /jɛs/), and you're left with a long 'i' sound, described conveniently enough as /aj/. Take the /a/ and merge it with a /w/, and you're left with /aw/ as in 'cow' /caw/. Take the /i/ from 'caught' /kɔt/ and merge it with the glide /j/ and you have the vowel sound in 'boy' /bɔj/.

Nasal Vowels

You didn't think you'd get away with only nasal consonants, did you? Of course not! Vowels, too, can be produced with the velum raised so that air is allowed to shoot out through the nasal passage. This occurs primarily when the vowel precedes one of the three nasal consonants /m n ŋ/. In phonemic transcription, a nasal vowel has a tilde diacritic mark, as in the case of 'cane' /kẽn/ or 'team' /tĩm/. (Note: If the tilde is not displaying properly in your browser, just imagine that a ~ is sitting on top of the 'e' and 'i' respectfully.)

In English, of course, this is all true. However, in other languages, a nasal consonant is not required to create a nasal vowel. French, Polish and Portuguese are notorious for this. The French word 'bon' has an 'n' when written, but in IPA it becomes a simple /b ɔ̃/. In this case, the 'n' in the spelling indicates that the vowel is nasalized, but the sound /n/ is not pronounced.

Tense and Lax Vowels

There are four pairs of tense and lax vowels in the English language. In the second chart, describing the location of the tongue when pronouncing vowels, notice that the /i/ is higher than the /ɪ/. This not only points to the location of the tongue, but also the tense/lax variation. When you say the word 'beet' /bɪt/, notice that you tongue becomes tense on that /i/ sound, and the sound is quite long. Similarly, when you say 'bit' /bɪt/, notice your tongue is quite relaxed and a little bit shorter in sound. This characteristic is described as saying the /ɪ/ is a lax or shorter vowel, and the /i/ is a tense or longer vowel. The other three pairings are /e /, /u /, and /o /, paired tense and lax respectfully.

Conclusion

Just in case you have forgotten from the first couple of paragraphs, this is, by no means, a complete writeup on articulatory phonetics. This is just an introduction to the basic principles of the field. The writeup would simply be too long. I very much welcome any questions or corrections, feel free to send me a message, and I will be more than happy to fill you in on anything else if I can, or point you in the direction that might help you out.
Syllable Structure in English

Contents of this page:
- Syllables and their parts
- Liquids and nasals as syllable nuclei
- Summary of the elements of a phonological system

Syllables and their parts

Words can be cut up into units called syllables. Humans seem to need syllables as a way of segmenting the stream of speech and giving it a rhythm of strong and weak beats, as we hear in music. Syllables don't serve any meaning-signalling function in language; they exist only to make speech easier for the brain to process. A word contains at least one syllable.

Most speakers of English have no trouble dividing a word up into its component syllables. Sometimes how a particular word is divided might vary from one individual to another, but a division is always easy and always possible. Here are some words divided into their component syllables (a period is used to mark the end of a syllable):

- tomato = to.ma.to
- window = win.dow
- supercalifragilisticexpialidocious: su.per.ca.li.fr.a.gi.lis.ti.cex.pi.a.li.do.cious (some people might put some of the periods in different places in this word).

Syllables have internal structure: they can be divided into parts. The parts are **onset** and **rhyme**; within the rhyme we find the **nucleus** and **coda**. Not all syllables have all parts; the smallest possible syllable contains a nucleus only. A syllable may or may not have an onset and a coda.

- **Onset**: the beginning sounds of the syllable; the ones preceding the nucleus. These are always consonants in English. The nucleus is a vowel in most cases, although the consonants [ r ], [ l ], [ m ], [ n ], and the velar nasal (the 'ng' sound) can also be the nucleus of a syllable. In the following words, the onset is in bold; the rest underlined.

  - read
  - flop
  - strap

If a word contains more than one syllable, each syllable will have the usual syllable parts:
Rhyme (or rime): the rest of the syllable, after the onset (the underlined portions of the words above). The rhyme can also be divided up:

Rhyme = nucleus + coda

The nucleus, as the term suggests, is the core or essential part of a syllable. A nucleus must be present in order for a syllable to be present. Syllable nuclei are most often highly 'sonorant' or resonant sounds, that can be relatively loud and carry a clear pitch level. In English and most other languages, most syllable nuclei are vowels. In English, in certain cases, the liquids [ l r ] and nasals [ m n ] and the velar nasal usually spelled 'ng' can also be syllable nuclei.

The syllable structure analysis of the words 'read', 'flop', 'strap' and 'window' are as follows (IPA symbols are used to show the sounds in the word/syllable):

read = one syllable
Onset = [ r ]
Rhyme = [ id ] (within the rhyme:)
   Nucleus = [ i ]
   Coda = [ d ]

flop = one syllable
Onset = [ f l ]
Rhyme = [ a p ]
   Nucleus = [ a ]
   Coda = [ p ]

window = 2 syllables
First syllable: [wIn]
Onset = [ w ]
Rhyme = [ I n ]
   Nucleus = [ I ]
   Coda = [ n ]
Second syllable: [ d o ]
Onset = [ d ]
Rhyme = [ o ]
  Nucleus = [ o ]
(This syllable has no coda)

Linguists often use tree diagrams to illustrate syllable structure. 'Flop', for example, would look like this (the word appears in IPA symbols, not English spelling). 's' = 'syllable'; 'O' = 'onset'; 'R' = 'rhyme'; 'N' = 'nucleus'; 'C' = 'coda'. (The tree may not come out well-aligned on your screen, because your computer may show this page in a different font). The syllable node at the top of the tree branches into Onset and Rhyme; the Onset node branches because it contains two consonants, [ f ] and [ l ]. The Rhyme node branches because this syllable has both a nucleus and a coda.

\[
\begin{array}{c}
s \\
/ \ \\
O \ R \\
/\ / \ \\
| | N C \\
| | | | \\
[ f l a p ]
\end{array}
\]

**Liquids and nasals as syllable nuclei**

The English liquids [ r l ] and the nasals [ m n ] can be the nuclei of syllables under certain conditions. [ r ] can be a nucleus as easily as a vowel, in any position: the words 'bird', 'word', 'her', 'fur', the first syllable of 'perceive' and 'surname' and the final syllables of 'mother', 'actor' (in casual pronunciation) all have [ r ] as the nucleus; in other words, there is no vowel in the pronunciation of these syllables, even though they have one in the spelling.

[ l ] and the nasals [ m n ] become syllable nuclei when they follow an alveolar consonant in the last syllable of a word. This happens in the relaxed or casual rather than very formal articulation of the word. Compare casual vs. formal pronunciations of 'button', 'bottle', 'bottom'.

When one of these sounds is a syllable nucleus, this is shown in transcription by putting a very short vertical line under the IPA symbol [ r l m n ].
A word with a syllabic [ r ] as nucleus is 'bird':

[b r d]

Summary of the elements of a phonological system

The phonological system of a language includes various units plus patterns which are used to combine the units into larger units. The units of a phonological system are:

- **features**: aspects or characteristics of a speech sound that arise from the way the sound is articulated or the way it sounds to the ear. 'Voicing' is a feature that varies according to whether or not the vocal cords vibrate during the articulation of a sound; the sound [ s ] is voiceless, but the sound [ z ] is voiced, for example. Other features include 'manner', or what sort of gesture or position is used to make a consonant sound (a 'stop' involves blocking the airstream completely for a fraction of a second, as for [ p ], while a 'fricative' involves creating a narrow opening through which air escapes, as for [ f ]. There are also suprasegmental features, which are 'overlaid' on syllables or words. One such feature is stress, known outside linguistics as 'where the accent is in a word'. In 'potato', the stress falls on the second syllable; in 'promise' on the first.

- **segments**: a segment is a speech sound such as [ m ] or [ i ]. Speech sounds are made by putting several features together. [ m ], for example, is created by vibrating the vocal cords (feature: voiced), closing the mouth at the lips (feature: bilabial), and lowering the soft palate so that air can escape through the nose (feature: nasal). These three gestures occur simultaneously. The result is a voiced bilabial nasal, [ m ]. Thus, segments are units that are built up from features; features are the building blocks for segments.

- **syllables**: a syllable is a rhythmic unit of speech. Syllables exist to make the speech stream easier for the human mind to process. A syllable comprises one or more segments; segments are the building blocks for syllables. Details on the syllable are found below.

- **words**: words are made of syllables.

The patterns or rule systems of a phonological system include:
• **phonotactics**, also known as **sequence constraints**. These are restrictions on the number and type of segments that can combine to form syllables and words; they vary greatly from one language to another. In English, for example, a word may begin with up to three consonants, but no more than three. If a word does begin with three consonants, the first will always be [s], the second must be chosen from among the voiceless stops [p t k] and the third from among the liquids [l r] or glides [w y]. Thus we get words such as 'squeeze' [s k w i z] in English, but not words such as [p s t a p].

• **phonological processes**, including **coarticulation processes**, are modifications of the feature structure of a sound that occur for one of two reasons: to make sounds that are near each other more alike, thus make articulation easier (assimilation), or to make sounds more different from each other (for instance, aspiration makes voiceless stops such as [p] and [k] more different from voiced ones such as [b] and [g].