Phonetics Overview

This is a brief overview of basic phonetic properties and symbols, encountered in languages of the world. It is intended for students who have not had a prior course in phonetics, and is based on Chapter 2 of the first edition of *Introducing Phonology*.

1 Vowels: their symbols and properties

Conventionally, the first division in speech sounds is made between vowels and consonants. Symbols for vowels will be considered first, because there are fewer vowels than consonants. American English has a fairly rich vowel inventory, so we can illustrate most of the vowel symbols with English words.

(1)

Symbol	*English equivalent*
i	beat [bijt]
ɪ	bit [bɪt]
e	bait [bejt]
ɛ	bet [bɛt]
æ	bat [bæt]
a	cot [kat]
ɔ	caught [kɔt]
o	coat [kowt]
ʊ	could [kʊd]
u	cooed [kuwd]
ʌ	cud [kʌd]
ə	(unstressed vowel in) 'array' [ə̇rej]

The glides *j* and *w* in the transcription of tense vowels in English reflect the phonetic diphthongal quality of these vowels, which is especially evident when one compares the pronunciation of English *say* and Spanish *se*. There are different ways of transcribing that vowel, e.g. [se], [se:], [sei], [seɪ], [se^{I}] and [sej]. Transcriptions like [se] or [se:] are much broader, that is, reveal less of the phonetic details of English because they suppress the information that this is phonetically a **diphthong**[1] – which can be predicted by a rule - whereas [sei], [seɪ], [se^{I}] and [sej] report this phonetic property. There is little scientific basis for picking a specific one of these latter four transcriptions as a representation of how the word is pronounced, and you are likely to encounter all of them in one source or another. Some dialects of English make no distinction in the pronunciation of the words *cot* and *caught*; even among speakers who distinguish the pronunciation of cot and *caught*, the precise pronunciation of the two vowels differs considerably. An important point developed in this book is that transcriptional symbols are approximations representing a range of similar values, and that symbols do not always have absolute universal phonetic values.

Tongue and lip position in vowels. Values of phonetic symbols are defined in terms of a variety of primarily articulatorily defined phonetic dimensions as in (2).

[1] A diphthong is a sequence of vowel-like elements – vowels and glides – in one syllable.

(2)

tense **lax**	i ɪ				u ʊ	**high**
tense **lax**	e ɛ		ə ʌ		o ɔ	**mid**
	æ		a			**low**
	Front unrounded		**Central unrounded**		**Back rounded**	

The three most important properties for defining vowels are **height, backness,** and **roundness.** The height of a vowel refers to the fact that the tongue is higher when producing the vowel [i] than when producing [e] (which is higher than that used for [æ]), and the same holds for the relation between [u], [o] and [a].

Three primary heights are generally recognized, namely **high, mid** and **low,** with secondary distinctions introduced either under the name **tense ~ lax** or **close ~ open** to distinguish vowel pairs such as [i] (*seed*) vs. [ɪ] (*Sid*), [e] (*late*) vs. [ɛ] (*let*) or [u] (*food*), vs. [ʊ] (*foot*), where [ieu] are tense (close) and [ɪɛʊ] are lax (open). Tense vowels are higher and often less centralized compared to their lax counterparts.

Independent of height, vowels can differ in relative frontness of the tongue. The vowel [i] is produced with a front tongue position, whereas [u] is produced with a back tongue position. In addition, [u] is produced with rounding of the lips: it is common but by no means universal for back vowels to also be produced with lip rounding. Three phonetic degrees of horizontal tongue positioning are generally recognized: **front, central** and **back.** Finally, any vowel can be pronounced with protrusion (rounding) of the lips, and thus [o], [u] are rounded vowels whereas [i], [æ] are unrounded vowels.

With these independently controllable phonetic parameters – five degrees of height, three degrees of fronting, and rounding versus non-rounding – one predicts the possibility of up to thirty vowels, which is many more vowels than are found in English. Many of these vowels are lacking in English, but can be found in other languages. Here are a few examples:

(3)
- y high front round vowel (found in German, French, Turkish)
- ʏ lax mid front round vowel (found in Swiss German)
- ø mid front round vowel (found in German, French, Turkish)
- œ low front round vowel (found in French)
- ɨ, ɯ central (or back) unrounded vowel (found in Turkish, Russian)

All of these vowels can be characterized in terms of the three basic vowel properties of height, backness and rounding. A more complete listing of vowel symbols is given below. It should be borne in mind that the exact phonetic definitions of certain symbols, especially those for low vowels, central vowels, and back unrounded vowels, can vary in usage. Therefore, the symbol <a> might be used to denote a back vowel rather than a central vowel in many published sources; it may also be used for a low front vowel, one which is phonetically lower than [æ].

(4) *Nonround vowels*

tense	i		i		ɯ	**high**
lax	ɪ					
tense	e		ə		ɤ	
lax	ɛ		ʌ			**mid**
	æ		a,ɐ		ɑ	**low**
	Front unrounded		**Central unrounded**		**Back unrounded**	

Round vowels

tense	y		ʉ		u	**high**
lax	ʏ				ʊ	
tense	ø		ɵ		o	
lax	œ				ɔ	**mid**
	ɶ				ɒ	**low**
	Front unrounded		**Central unrounded**		**Back unrounded**	

While this yields a fairly symmetrical system of symbols and articulatory classifications, there are gaps such as the lack of tense/lax distinctions among low vowels or central vowels except for the [ʌ] ~ [ə] distinction.

These properties of tongue and lip position are the ones most commonly exploited for making vowels, but there are a number of other phonetic properties that play a role in defining vowels, and we turn to those properties next.

Nasalization. Typical vowels are produced with air flowing from the lungs through the mouth, but any vowel can be produced with **nasalization**, where air flows through the nose as well as through the mouth, by lowering the velum. Nasalized vowels occur in French, Portuguese, Hindi and other languages. Rather than representing each nasalized vowel with its own symbol, the property of nasalization is symbolized with a tilde diacritic [˜] placed over the vowel, so the phonetic transcription of French *bon* would be [bɔ̃].

Length. Vowels (as well as consonants) may also be either long or short, that is, produced with relatively greater versus lesser duration, and length can be represented with a colon [ː], a macron [ˉ], a raised dot [ˑ], or a pair of points which resemble a colon [ˏ] placed after the appropriate symbol. Thus a long version of the vowel [a] may be symbolized as [aː], [ā], [aˑ] or [aˏ]. Equally common is the practice of doubling the vowel or consonant symbol, so long [a] could be represented as [aa]. Examples of languages which systematically exploit the difference between long and short vowels include Japanese ([go] ‘5’, [goo] ‘issue’) and the Tanzanian Bantu language Kikerewe ([ihuna] ‘owl’ versus [ihuuna] ‘hut’). Languages with long and short consonants include Japanese ([ita] ‘was’ versus [itta] ‘went’) and Saami (Arctic Europe) as in the pairs [miella] ‘intention (nominative)’ versus [miela] ‘intention (accusative)’.

Stress. The marking of **stress** generally encompasses the distinction between stresses, notated with raised and lowered ticks [ˈ, ˌ] placed before the initial consonants of a stressed syllable, the raised tick for primary stress and the lowered tick for secondary stress. Alternatively an acute accent [ˊ] can mark main stress, and secondary stress can be marked with a grave accent. The first syllable of the English word *telegraphic* has a secondary stress and the third syllable has the primary stress: thus the word could be transcribed either as [tèləgræfık] or as [ˌtɛlə'græfık]. It is notoriously difficult to give any simple definition of the acoustics or articulation of stress, and indeed the phonetic realization of stress seems to vary considerably across languages, being expressed in terms of amplitude, pitch, duration, vowel quality, as well as a host of other properties. Typically, though, stressed syllables have higher pitch and greater duration and amplitude.

Tone. Tone differences, as found in many Asian, American and African languages, and in addition a few European languages such as Norwegian and Swedish, are also typically transcribed with accent marks. The articulatory basis for producing tone is the rate of vocal fold vibration, which we perceive in terms *of pitch*, so that the vocal folds might vibrate at the rate of 120 cycles per second (120 Hertz, abbreviated Hz) for the production of a low-pitched vowel and at the rate of 170 Hz for the production of a high-pitched vowel. The actual frequency of vibration of a given tone varies from language to language, and also varies from speaker to speaker (depending on age, size and gender inter alia), and even varies within a speaker depending on mood, emphasis and so on. Thus tones do not represent specific frequency values, but are defined relative to a given pitch range used at the moment. A high tone is relatively high within the range that a speaker is using, and if the physical range is raised or lowered, the actual pitch of a high tone is raised or lowered. The traditions for marking tone are rather varied. Accents are generally used to mark tones, and the following examples illustrate the most common usages. As many as five distinct levels are distinguished, arranged in (5) from highest to lowest in pitch.

(5)	a̋	superhigh toned [a]
	á	high toned [a]
	ā or a̍	mid toned [a]
	à	low toned [a]
	ȁ	superlow toned [a]

The characteristic property of a contour-toned vowel is that pitch changes during the vowel, and we can characterize the contour in terms of the tonal values at the beginning and ending points. The diacritic for rising tone is a "hacek," as in [ă], which combines the low tone mark grave accent (as in [à]) followed by the high tone mark acute accent (as in [á]), reflecting the fact that a rising tone begins low and ends high. Falling tone is analogously symbolized with a circumflex, as in [â], since it starts high (acute accent) and ends low (grave accent). Many other combinations are possible, for example a mid-to-high rising tone which combines the accents for mid and high, as in [ā´]: you can see that rather than defining a large number of special symbols to indicate the twenty possible contour tones, it is simpler to define symbols for specific levels and describe contours as movement between levels. Another convention for marking tones is to write a superscripted number referring to the pitch level, e.g. *ta*^{3}, and combinations of numbers to mark contours e.g. *ta*^{31}. Traditions for languages in different

parts of the world, such as Africa versus Asia or Mexico, differ as to whether 1 refers to the highest or lowest pitch level.
Another pitch property of importance to phonological analysis is **downstep** and **upstep,** which are the systematic lowering and raising of the overall pitch space for lexical and grammatical purposes. When a downstep occurs (symbolized by a raised exclamation mark as in (6)), it indicates that all subsequent tones are produced with the upper and lower values of the pitch range decreased. An example comes from Akan, a language of Ghana. Phonologically, each vowel after the first syllable [mè] has a high tone. However, as indicated by the downstep marker, the actual pitch level of a high tone is lower on the third vowel than it is on the second vowel; the pitch of the sixth high-toned vowel is lower than that of the fifth, and so on – in principle, this process can continue infinitely, the only limit being the speaker's ability to actually produce lower pitches.

(6) mè kó!fí ɛ́!dɔ́ á!bóá dá!déɛ́ ḿ!pá

[_ ¯ – – – – – – ¯ – – – _] "My Kofi's love's pet iron bed"

Analogous to downstep, upstep involves raising the pitch range. Upstep, symbolized with a raised inverted exclamation mark, is rare in comparison to downstep, but is found in Krachi, another language of Ghana: the upstep appears between the third and fourth vowels.

(7) àlí kɔ́¡tɔ́!ná 'our mat'

[_ – – ¯ –]

Downstep and upstep may also be symbolized with downward and upward arrows, viz. [á!pá] = [á↓pá], [á¡pá] = [á↑pá]

Phonation type. A number of languages such as Ju /'hoansi (Namibia), Dinka (Sudan), Hmong (SE Asia) and Mazateco (Mexico) employ distinctive patterns of vocal fold vibration or **phonation** in the production of vowels. One such phonation, known as creaky voicing or laryngealization, is produced by closing the vocal folds abruptly, and gives vowels a particularly "sharp" sound which is notated by placing a tilde beneath the vowel. The other type of phonation, known as breathy voice, is produced by more gradual and even incomplete closure of the vocal folds giving vowels a "soft" quality, and is marked with two dots below the vowel.

(8) a̰ creaky [a] a̤ breathy [a]

These modes of phonation are probably familiar to most people (but the labels assigned to these phonations are unfamiliar), since some individuals systematically speak with a creaky quality to their voice (for example, the actor Edward G. Robinson), or with a breathy quality (Marilyn Monroe). What is special about these phonations in languages such as Ju/'hoansi is that they can be used as a meaningful property of specific words realized on single segments, not just as general voice quality properties of all sounds coming from a particular speaker.

Glides. Standing between consonants and vowels in terms of their phonological function and phonetic properties are the glides, also known as semi-vowels. The typical glides are [j] and [w] as in English *yes*, *wet*, termed "palatal" and "labial" or "labiovelar." These glides are very similar to the high vowels [i], [u], but are shorter and have a greater degree of constriction than the corresponding vowels. It is often very difficult to distinguish glides and vowels based solely on what they sound like, and one often has to consider the rules of the language in order to decide whether to transcribe e.g. [kau] or [kaw], [tua] or [twa]. In addition, some languages such as French, Chinese and Kotoko (Central Africa) have a "labiopalatal" glide, with the tongue position of [j] and the lip position of [w], transcribed as [ɥ]: an example from French is *huit* 'eight,' transcribed [ɥit]. Like vowels, glides may also be nasalized, breathy, or creaky.

2 Consonants: their symbols and properties

There are many more consonants than vowels. English only has a fraction of the full range of possible consonants, so illustration of many of these symbols involves more extensive consideration of languages other than English. Most English dialects systematically use the following consonants:

(9)

p	**p**ig	b	**b**ig
m	**m**ug	f	**f**og
v	**v**armint	θ	**th**ing
ð	**th**is	t	**t**op
s	**s**op	d	**d**og
n	**n**og	$t^{ʃ}$	**ch**uck
ʃ	**sh**uck	$d^{ʒ}$	**j**ug
ʒ	mea**s**ure	k	**c**ot
g	**g**ot	ŋ	ha**ng**
h	**h**orse		

Other segments used in English include *r, l, z, h:* this is only a partial list. There are a few additional phonetic segments found in English which, because they only arise due to general rules of the type to be discussed in the next chapter, are not immediately obvious:

(10)

- ɸ voiceless bilabial fricative; variant of p found in words like *ras**p**s* in casual speech.
- x variant of *k* found in words like *mas**k**s* in casual speech; also found in German, Russian, Greek, Scots (English).
- ɱ labiodental nasal; variant of *m* found before [f] and [v] as in *co**m**fort.*
- t̪ dental *t*. Found in English before [θ]: the word *width* is actually pronounced [wɪt̪θ]. Also how t is pronounced in French.
- n̪ dental *n*; found in English before [θ] as in *pa**n**ther*.
- ʔ glottal stop; found in most dialects of American English (except in certain parts of the American south, such as Texas) as the pronunciation of t before syllabic n, i.e. *bu**t**ton.* Also stereotypical of British "Cockney" pronunciation *bo**t**tle*, *coul**d**a*.
- ɾ flapped t in American English *wa**t**er.*

Some other consonants found in European languages, for instance, are the following.

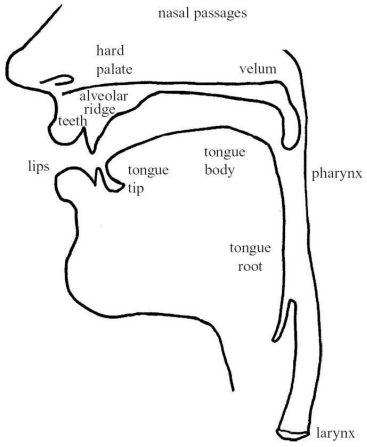
(11) p^f, t^s voiceless labiodental and alveolar affricates found in German (<Pfanne> [p^fanə] ‘pan’, <Zeit> [t^sait] ‘time’)

β voiced bilabial fricative, found phonetically in Spanish (<huevo> [weβo] ‘egg’)

γ voiced velar fricative, found in Modern Greek ([aγapo] love’) and Spanish (<fuego> [fweγo] ‘fire’)

Many consonants are only encountered in typically unfamiliar languages, such as retroflex consonants (*ɻ*, etc.) found in Hindi, Tamil and Ekoti, or uvulars and pharyngeals such as *q*, *χ*, *ħ* found in Arabic.

Consonant symbols are traditionally given in tabular form, treating the place of articulation where the major constriction occurs as one axis, and treating properties such as voicing, being a continuant, or nasality as the other axis. Eleven places of articulation for consonants are usually recognized: bilabial, labiodental, dental, alveolar, alveopalatal, retroflex, palatal, velar, uvular, pharyngeal and laryngeal, an arrangement which proceeds from the furthest forward to furthest back points of the vocal tract. Here are the relevant anatomical landmarks.



Manner of articulation refers to the way in which a consonant at a certain place of articulation is produced, indicating how airflow is controlled: the standard manners include stops, fricatives, nasals and affricates. A further property typically represented in these charts is whether the sound is voiced or voiceless. The following table of consonants illustrates some of the consonants found in various languages, organized along those lines.

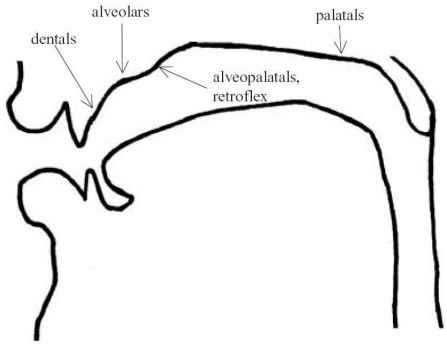
(12) *Consonant symbols*

Consonant manner and voicing							
Place of articulation	vcls stop	vcls affricate	vcls fricative	vcd stop	vcd affricate	vcd fricative	nasal
bilabial	p	(p^{Φ})	ɸ	b	(b^{β})	β	m
labiodental		p^{f}	f		b^{v}	v	ɱ
dental	t̪	t^{θ}	θ	d̪	$d^{ð}$	ð	n̪
alveolar	t	t^{s}	s	d	d^{z}	z	n
alveopalatal		$t^{ʃ}$,$t^{ʃ}$	ʃ		$d^{ʒ}$	ʒ	ɲ
retroflex	ʈ	$ʈ^{ʂ}$	ʂ	ɖ	$ɖ^{ʐ}$	ʐ	ɳ
palatal	c	($c^{ç}$)	ç	ɟ	$ɟ^{ʝ}$	ʝ	ɲ
velar	k	k^{x}	x	g	$g^{ɣ}$	ɣ	ŋ
uvular	q	$q^{χ}$	χ	ɢ	$ɢ^{ʁ}$	ʁ	ɴ
pharyngeal			ħ		ʕ		
laryngeal ~ glottal	ʔ		h			ɦ	

2.1 Place of articulation

The place of articulation of consonants is divided into primary place of articulation - something that every consonant has - and secondary place of articulation - something that some consonants may add to a primary place of articulation. We begin with primary place. Proceeding from the furthest-forward articulation (the top row of (12)) to the furthest-back articulation (the bottom row of (12)), the bilabial consonants such as *m* have a constriction of both lips. This closure of the lips is not just a property of *m*, it is a defining characteristic of the whole bilabial row *p*, p^{Φ}, *φ*, *b*, b^{β}, *β* and *m*. A labiodental constriction as found in *f* is formed with a constriction between the lower lip and the upper teeth.

Lingual consonants. The tip or blade of the tongue is the active (move-able) articulator in the production of many consonants, including dental, alveolar, alveopalatal, retroflex and palatal consonants. These consonants form a constriction involving the tongue and an appropriate place on the teeth, or hard or soft palate. The contact is with the teeth in the case of dentals, on the hard palate behind the teeth in the case of alveolars, behind the alveolar ridge in the case of alveopalatals and retroflex consonants, and with the blade of the tongue at the boundary between the hard and soft palate in the case of palatals. In many traditional organizations of segments, retroflex consonants are classified as a separate place of articulation from alveolars and alveopalatals. This traditional concept of “place of articulation” combines properties of both active (moveable) articulators and a passive articulator - the target towards which an active articulator moves. What unifies the various kinds of retroflex consonants across languages is not the specific location of the constriction on the hard palate, but rather the manner in which just the tongue tip approaches the palate.



The terminology used for "palatal" sounds may be particularly confusing. Alveopalatals (sometimes termed "palatoalveolars") are exemplified by the English consonants [ʃ ʒ tʃ dʒ] (*sheep*, *measure*, *watch*, *judge*), and ("true") palatals are found in Norwegian *kjøpe* [çø:pe] 'buy' and German *ich* [iç] 'I.' The term "palatalized" refers to a secondary articulation (discussed below), but in some linguistic traditions such consonants may also be called "palatals." In addition, alveopalatals may be palatalized or not: the Russian fricatives <ж ш> [ʒ ʃ] are nonpalatalized whereas the affricate <ч> [tʃʲ] is a palatalized alveopalatal.

"Back" consonants. The body of the tongue can also be positioned in a number of places in the back of the vocal tract to form a constriction, so if the tongue is retracted and raised a velar consonant such as *k* (*cool*) is formed; if the tongue is retracted but not raised and thus approaches the uvula, a uvular such as q is formed, and if the back of the tongue is retracted and lowered toward the pharynx, a pharyngeal such as ʕ is formed. Finally, a consonant can be formed with no constriction above the glottis, when the constriction is made with the vocal folds as in the case of the laryngeal consonants *h*, ʔ.

Secondary articulations. Consonants may have more than one point of constriction: generally, one of these constrictions is the major (most radical) constriction and the other constrictions are less radical – more vowel-like in nature. The most common of these secondary constrictions are given in (13). Secondary articulations are notated by combining the appropriate symbol for the primary place with the symbol representing a kind of glide at the secondary place of articulation.

(13)

		Secondary articulation	*Example language*
p	t	(none)	English
pʲ	tʲ	palatalized	Russian
pʷ	tʷ	rounded	Nupe (Nigeria)
pˠ	tˠ	velarized	ɪrshallese (Marshall Island)
pˤ	tˤ	pharyngealized	Arabic
pᵚ	tᵚ	ɪnded and fronted	Baulé (Ivory Coast)

Plain consonants are those produced with only a single, narrow constriction. Palatalized consonants are formed by combining the basic constriction of the consonant with a less radical vowel-like constriction of the kind that is found in the glide *j* or the vowel *i*; secondarily articulated consonants sound essentially like combinations of consonant plus a glide *j*, w. Rounded consonants analogously involve a protrusion of the lips (as do round vowels and the glide *w*). Velarized consonants are produced by combining the narrower primary articulation of a consonant with a raised, retracted tongue position which is similar to the back unrounded vowel [ɯ] or the velar fricative [ɣ], and pharyngealized consonants combine a consonantal constriction with a retracted and lowered tongue position, appropriate for a pharyngeal consonant such as [ʕ]. Rounding of the lips and fronting of the tongue can be combined simultaneously in a secondary articulation, e.g. [tᶣ].

Consonants formed with two major constrictions. In a number of languages of Africa (Yoruba, Nupe, Konni, Kuku and others), as well as some languages of New Guinea (Amele), there are consonants typically transcribed as *kp*, *gb*, *ŋm*, which are phonologically single consonants produced with two (virtually) simultaneous complete constrictions, one at the lips and the other formed by raising the body of the tongue to the soft palate, as in the production of a velar. Occasionally, to make clear that this is a single consonant, a "tie" character is written over the two components, viz. *k͡p*, *g͡b*. This would be especially necessary in a language like Eggon, which phonetically distinguishes the consonant cluster *k+p*, *g+b* from single consonants with simultaneous labial and velar constrictions, for example [k͡pu] 'die' with a single consonant at the beginning versus [kpu] 'kneel' with a cluster; [g͡bu] 'arrive' with a labiovelar, and [gba] 'divide' with a cluster of a velar followed by a labial.

If consonants can be formed by simultaneously combining both complete labial and velar constrictions, one would reasonably expect there to exist other such consonants with lingual and velar constrictions, or lingual and labial constrictions. In fact, **clicks** such as lateral [ǁ], alveolar [!], palatoalveolar [ǂ] or dental [ǀ] which are found in Khoisan language such as !Xõo and Khoekhoe (Namibia) or southern Bantu languages such as Zulu and Xhosa (South Africa) are exactly such lingual-velar consonants. These consonants are formed by raising the back of the tongue to form a constriction at the velar place of articulation, and raising the tip or blade of the tongue to make an appropriate constriction on the palate. The middle of the tongue is lowered, creating a vacuum. When the lingual constriction is released, a very loud noise results, which is the typical sound of a click. Finally, lingual-labial consonants, i.e. *t͡p*, which involve simultaneous complete constrictions with the tongue and lips, are found in the New Guinean language Yeletnye.

2.2 Manner of articulation

Stops, fricatives and affricates. Largely independent of the place where a consonant's constriction is formed, the manner in which the constriction is formed can be manipulated in various ways. If a constriction is formed which completely blocks the flow of air, the resulting sound, such as *t*, is called a **stop.** A consonant can also be produced by forming a narrow constriction which still allows air to pass through the vocal tract, resulting in noise at the constriction, and such consonants, for example s and *v*, are called **fricatives.** A combination of complete constriction followed by a period of partial constriction is termed an **affricate,** as in *t͡ʃ*. From a phonetic perspective, such consonants can generally be thought

of as a sequence of a stop plus a fricative at the same place of articulation (a *homorganic* sequence) *t͡ʃ*. From a phonological perspective, they function as single-stop consonants, and are considered to be a particular kind of stop consonant, one with an affricated release. Even from a phonetic perspective, the characterization of affricates as sequence of stop plus fricative is not completely adequate, since there are cases where there is a phonetic difference between stop plus fricative, versus affricate. The most well-known case of this type is Polish, which contrasts the affricate [t͡ʃ] versus the stop-plus-fricative sequence [tʃ] in the words [t͡ʃɨ] 'whether' versus [tʃɨ] 'three'.

Liquids, glides and approximants. Additionally, languages typically have some kind of **liquid** consonants, a class of consonants involving the blade or tip of the tongue in their production. The typical examples of liquids are [r] and [l]. The symbol [r] is generally used to refer to "trilled r" as found in Italian. The variety of *r* used in American English is, phonetically speaking, a **glide** or **approximant**, which is a segment involving very little constriction in the vocal tract, and would be transcribed as [ɹ]. Some languages also have a type of *r* which is produced by quickly tapping the tongue against the alveolar ridge: this flapped *r* would be transcribed as [ɾ]. English actually has this segment, which is a phonetic variant of /t/ and /d/ in words such as *motto* which is phonetically [mɔɾow]. The uvular *r* found in French, German and the Bergen dialect of Norwegian is transcribed as [ʀ]. Vowels, liquids, glides and nasals are usually grouped together as **sonorants**.

Laterals. Consonants produced with the blade of the tongue may be produced in such a way that air flows over the sides of the teeth, and such consonants are referred to as *laterals.* English *l* is an archetypical example of a lateral; languages can have lateral fricatives such as voiceless [ɬ] which appears in Welsh, Lushootseed, Zulu and Xhosa, and voiced [ɮ] found in Zulu and Xhosa, affricates such [t͡ɬ] found in many languages of the Pacific Northwest, and lateral clicks such as [ǁ].

Nasalization. There are other phonetic properties which relate to the manner in which consonants are produced, apart from the location of the constriction. One such modification, which we have already considered since it is applicable to vowels, is nasalization. Consonants such as [m,n,ɲ,ŋ] are the archetypical nasals; however, one can produce other nasal consonants (or "nasalized" consonants) by lowering the velum during the production of the consonant. Such nasalized consonants are rare, due to the fact that it is quite difficult to distinguish them from their oral counterparts, but nasalized versions of fricatives and approximants such as [h], [β], [v], [ɣ], [r], [l] do exist in the world's languages. Nasalized fricatives are extremely rare, but the fricative [ṽ] is attested in the Angolan Bantu language Umbundu (Schadeberg 1982), and voiceless nasal fricatives are found in Coatzospan Mixtec of Mexico (Gerfen 1999). It is also claimed that various languages have "prenasalized" consonants, transcribed *ᵐb, ⁿd, ᵑg,* but it is controversial whether these are truly single segments, and not just clusters of nasal plus consonant, i.e. *mb*, *nd*, *ŋg.*

2.3 Laryngeal properties

Different actions of the larynx result in consonantal distinctions. The following examples illustrate the major consonant differences which are due to the action of the larynx.

(14)				
	p	t	k	unaspirated voiceless
	b	d	g	unaspirated voiced
	p^h	t^h	k^h	aspirated voiceless
	b^h~$b^ɦ$~$b̤^ɦ$	d^h~$d^ɦ$~$d̤^ɦ$	g^h~$g^ɦ$~$g̤^ɦ$	aspirated voiced
	p’	t’	k’	ejective
	ɓ	ɗ	ɠ	implosive

Voiced stops are produced with vibration of the vocal folds during their production, whereas voiceless stops are produced with no such vocal fold vibration. Voiceless aspirated stops differ from voiceless unaspirated stops by the presence, in aspirated stops, of a significant delay between the moment when the constriction for the consonant is released and the moment when voicing begins. Such sounds are typically perceived as having a “puff of air” at their release, due to the high volume of air flow during their production. Voiced aspirated consonants, on the other hand, maintain vocal fold vibration, but also are produced with spread vocal folds, resulting in high air flow and a “murmured” quality. Implosives and ejectives are produced by one basic glottal gesture, but they are differentiated in terms of supplementary laryngeal actions. In the case of ejectives, the glottis is first constricted, then the larynx is raised resulting in high pressure in the vocal tract behind the main consonantal constriction; when that constriction is released, a loud high-pitched popping sound results. In the case of implosives, the glottis is also constricted, but is then lowered resulting in a vacuum within the oral cavity. When the constriction is released, a dull, lower-pitched resonance results.

A final property of stop consonants, partially related to laryngeal activity, is the property of release. In some languages, stop consonants in certain positions (before other consonants or at the end of a word) are produced without audibly releasing the consonantal constriction. This property of consonants is notated with the symbol [ˀ]. In American English, voiceless consonants, especially *t*, are often unreleased at the end of the word, and thus *hit* may be realized phonetically as [hɪtˀ]. This generally involves cutting off the flow of air at the glottis during or somewhat before the time when the consonant closure is made. When pronounced with release, as [hɪt], there is a brief burst of noise as the consonant constriction is released and air begins to flow again, which sounds like aspiration.

2.4 Syllabicity

A further phonetic property of consonants that may be transcribed is whether the consonant is *syllabic.* There is a phonetic difference between the *n* of American English *cotton* and that of *con:* the *n* of *cotton* is syllabic, whereas the *n* of *con* is nonsyllabic. A syllabic consonant is indicated by placing a vertical tick under the consonant, so *cotton* is transcribed [kaʔn̩] and *con* is transcribed [kan]. There is no simple definition of “syllabic consonant” versus “nonsyllabic consonant,” save that a syllabic consonant forms the peak of a syllable and a nonsyllabic consonant does not. Given that *cotton* has two syllables, and taking it for the moment to be a principle that every syllable has a peak, then *n* must be the peak of the second syllable in *cotton.* The main phonetic correlate of the distinction between syllabic and nonsyllabic consonant is duration, where syllabic consonants are generally longer than their

nonsyllabic counterparts. Especially in tone languages, syllabic consonants can have distinctive tone, for example Hehe (Tanzania) [ń̩dage] ‘chase me!’.

Because the concept “syllabic consonant” depends on the notion “syllable,” we also need to consider the syllable itself, and how to indicate it in a transcription. It is generally agreed that in English, the words *spring*, *sixths* and *Mike* have one syllable, and *osprey*, *happy* and *allow* have two. The syllable is made up of a contiguous sequence of segments, so the main issue regarding syllables is where the syllable begins and ends. The conventional symbol for marking the beginning and end of a syllable is a period, which can be unambiguously assigned in the monosyllabic words [.sprɪŋ.], [.sɪksθs.] and [.majk.]. There is also no problem in deciding where the syllable breaks are in [.ə.láẃ.]. However, in dealing with words having certain clusters of consonants or certain stress patterns, the question becomes more complicated. It would be reasonable to transcribe *osprey* either as [.ás.pri.] or [.á.spri.] (whereas *[.ásp.ri.] would almost certainly be wrong for any speaker of English), and research on the organization of syllables has in fact proposed both [.hǽ.pi.] and [.hǽp.i.] as transcriptions for the word *happy*. Determining syllable boundaries is thus not trivial.

A number of sonorant consonants of English can be syllabic: [baɹ̩] ‘bottle’, [fr̩] ‘fur’, [lɛsn̩] ‘lesson.’ There is even a special phonetic symbol for syllabic [r̩], written either as [ɚ] or [ɝ]. Syllabic sonorants also exist in other languages, such as Sanskrit, Serbo-Croatian, and many African languages. Generally, one finds syllabic sonorants only between consonants, or between a consonant and the beginning or end of a word. Thus in English, final [r] is nonsyllabic when it is preceded by a vowel, as in [kar] ‘car,’ and syllabic when preceded by a consonant, as in [kapr̩] ‘copper.’ One can almost completely predict the difference between syllabic and nonsyllabic sonorant in English from surrounding segments. However, in normal speech American English [tərejn] *terrain* is pronounced as [tr̩ejn] distinct from *train* which is [trejn], and [pəlajt] *polite* is pronounced as [pl̩ajt] which is different from [plajt] *plight.* Still, the syllabic consonants can be predicted by a rule in English. In some languages this is not possible: in Serbo-Croatian the word *groze* ‘fear (genitive)’ has a nonsyllabic [r] before a vowel and *gr̩oce* ‘little throat; larynx’ has syllabic [r] in the same context. In Swahili, the word [mbuni] ‘ostrich’ has a nonsyllabic [m], and [m̩buni] ‘coffee plant’ has a syllabic [m̩] in the same position.

2.5 Symmetry in consonants

There would be gaps in an otherwise symmetrical universal table of consonants, were we to list all of the consonants found in human languages. In some instances, the gap reflects physiological impossibility, such as the fact that one cannot produce a nasal pharyngeal, analogous to velar nasal [ŋ] but at a pharyngeal place of articulation. A nasal involves making a complete obstruction at a given point of articulation and also requires air to flow through the velum. In order to make a pharyngeal nasal, it would be necessary to make a complete constriction at the pharynx. But since the pharynx lies below the velum, no air can flow through the nasal passages if the pharynx is totally constricted. However a nasalized pharyngeal continuant, i.e. the consonant [ʕ̃] produced with simultaneous nasal airflow, would not be a physical impossibility, since that consonant does not require complete constriction of the pharynx. (This does not mean that it is impossible to lower the velum and make a complete pharyngeal constriction at the same time. It means that the air will not flow through the nose, which is a defining property of a nasal consonant, so you could not tell

from the sound itself whether it is nasalized). In other cases, the gap indicates that no such sound has been found, but there is no immutable physical reason for such a sound not to exist. Thus bilabial affricates do not seem to be attested, nor do plain nonaffricated alveopalatal stops, nor do nasalized pharyngeal fricatives. Similarly, while pharyngealized consonants exist, and rounded consonants exist, there are apparently no cases of consonants which are both rounded and pharyngealized, though such segments are not logically impossible. These lacunae may be an indication of a deeper constraint on sound systems; however, it is also possible that these segments do exist in some language which has not been studied yet, since there are many languages in the world which remain uninvestigated.