| | | | |
|---|---|---|---|
| c) | I see him | [aj si hɪm] | [aj siəm] |
| d) | within | [wɪθɪn] | [wɪðɪn] |
| e) | balloons | [bəlunz] | [blunz] |
| f) | careful | [kʰɛɹfʊl] | [kʰɛɹf̩] |
| g) | sit down | [sɪt dawn] | [sɪɾawn] |
| h) | my advice | [maj ədvajs] | [maj əvajs] |
| i) | Scotch tape | [skɑtʃ tʰejp] | [kʰɑtʃstejp] |
| j) | protection | [pr̥owtʰɛkʃn̩] | [pɹ̩tʰɛkʃn̩] |
| k) | hand me that | [hænd mi ðæt] | [hæ̃miðæt] |
| l) | Pam will miss you | [pæm wɪl mɪs ju] | [pæmɫ̩mɪʃjə] |

To try more advanced exercises, go to **bedfordstmartins.com/linguistics/phonetics** and click on **Exercises.**

## For the Student Linguist

For more food for thought on phonetics, go to **bedfordstmartins.com/linguistics/phonetics** and click on **For the Student Linguist.**

*three*

# Phonology: The Function and Patterning of Sounds

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*A person's tongue is a twisty thing, there are plenty of words there of every kind, and the range of words is wide, and their variation.*
– HOMER, *The Iliad*, 20

### OBJECTIVES

*In this chapter, you will learn:*

- how we know which language sounds are distinctive in a particular language
- how distinctive sounds in a particular language can vary systematically according to the context in which they occur
- how we use transcription to represent distinctive sounds and systematic variations of these sounds
- how syllables are constructed and the influence of language-specific syllable structure
- how individual sounds can be broken down further, according to specific features
- how we can construct rules to explain systematic variations in the production of sounds

We saw in Chapter 2 that human beings can produce and perceive a large number of speech sounds. No human language exploits *all* of these phonetic possibilities. Instead, every language makes its own particular selection from the range of all possible speech sounds and organizes them into a system. The component of grammar that determines the selection of speech sounds and that governs both the sound patterns and the systematic phonetic variation found in language is known as **phonology**. While phonetics is primarily concerned with the concrete physical properties of language sounds, phonology investigates how sound and meaning are connected.

Speakers have some subconscious knowledge of the phonetic patterns that make up phonological systems. For example, as we saw in Chapter 1, speakers of English

recognize without being taught that certain combinations of consonants are acceptable in English, even if those combinations occur in forms that are not real words, while other combinations are not acceptable; thus, *slish* [slɪʃ] and *screnk* [skɹɛŋk] are acceptable to English speakers, while *srish* [sɹɪʃ] and *screpk* [skɹɛpk] are not. In fact, speakers can do more than recognize that certain forms are unnatural in their system; they can even correct unnatural forms to make them conform to the patterns that are acceptable in their own language. Without knowing exactly why, most English speakers would pronounce a form like *srish* as [səɹɪʃ] breaking up the unacceptable consonant combination with a vowel, rather than, say, deleting one of the consonants to form [sɪʃ] or [ɹɪʃ] (something that children learning English as a first language or adults learning English as a second language might do). The task of phonologists, then, is (1) to discover and describe the systematic phonetic patterns found in individual languages and (2) to discover the general principles that underlie the patterning of sounds across all human languages. In doing this, phonologists hope to uncover the largely subconscious knowledge that speakers have of sound patterns. We want to answer the question *what do you know when you know the phonology of your language?*

It turns out that phonological knowledge can be characterized as knowledge of structures at different levels. In this chapter, we will examine three major phonological units: the **feature**, the **segment**, and the **syllable**.

We are already acquainted with the idea that the flow of speech can be divided into segments (as reflected in the phonetic transcription of a word like [sɛgmɛnt̚]) and that segments are characterized by specific phonetic properties (voicing, nasality, etc.). In this chapter we will investigate the types of patterned, predictable phonetic variation that segments exhibit in individual languages and cross-linguistically. We will also demonstrate that segments are composed of smaller structural units known as *features*.

Features correspond to articulatory or acoustic categories such as [voice] or [strident]. They are the smallest building blocks of phonological structure, and, as we will see, the types of phonological patterns found in language are directly related to the properties of the features that make up segments.

We will also learn about the ways in which segments combine to form into larger structural units known as *syllables*. Syllables consist of a syllabic element—usually a vowel—and any preceding or following segments that are associated with it. As the representation of the word *segment* in Figure 3.1 illustrates, features, segments, and

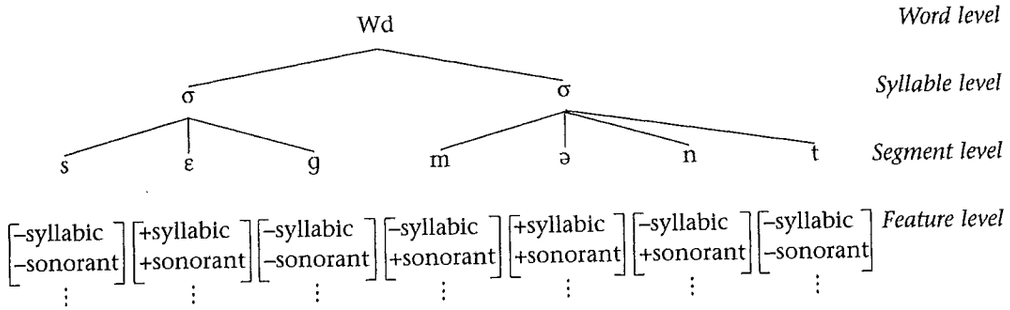


***Figure 3.1*** Partial phonological representation of *segment*



syllables are organized into hierarchical levels, where each level is composed of units from the level beneath it. In Figure 3.1, *segment* is a word-level unit represented by the abbreviation *Wd*. This word in turn consists of two syllables, each of which is represented by the Greek letter σ (sigma). Each syllable itself consists of several segments. Finally, each segment is composed of features. (For purposes of illustration, only a few features are provided for each segment. The internal hierarchical structure of syllables and segments is not represented; these are treated in Sections 4 and 5.2, respectively.)

As units of phonological structure, syllables, segments, and features play major roles in the processes we investigated in the previous chapter, and, in combination with certain general principles of phonology, produce the sound patterns of language that characterize our phonological knowledge. In the next sections we examine these sound patterns and the phonological knowledge that enables speakers to distinguish among forms and to deal with the systematic phonetic variation found in the pronunciation of speech sounds. We begin by looking at how sound changes can lead to meaning changes.

# 1 Segments in Contrast

All speakers know which segments of their language **contrast** and which do not. Segments are said to contrast (or to be *distinctive* or be in *opposition*) in a particular language when their presence alone may result in a change of meaning. For instance, the phonetically distinct segments [s] and [z] contrast in the English words *sip* and *zip*, as do the vowels in the words *hit*, *hate*, and *hot*. In these examples, when we change the sound, we also change the meaning.

In this section we will consider how to determine which segments contrast in a language. In Section 2 we will consider the systematic patterns associated with phonetically similar segments when they do not contrast.

## 1.1 Minimal Pairs

Since knowledge of segmental contrasts is fundamental to knowing any language, the first step in an analysis of the phonology of a language is to establish which sounds in that language are in contrast with each other. In order to establish contrasts, it is necessary to examine the distribution of sounds in words and to compare word meanings. The most straightforward way to accomplish this examination is by way of the **minimal pair** test.

A minimal pair consists of two forms with distinct meanings that differ by only one segment found in the same position in each form (for example, at the beginning or the end of a word). Thus, the examples [sɪp] *sip* and [zɪp] *zip* form a minimal pair (changing the sound at the beginning of the word) which shows that the sounds [s] and [z] contrast in English. The words [lus] *loose* and [luz] *lose* are also minimal pairs (changing the sound at the end of the word).

A number of minimal pairs that demonstrate consonant contrasts for English are given in Table 3.1. It is important to remember that it is on the basis of *sound* and

***Table 3.1*** Contrasts among consonants in English

| | *Labial* | *Interdental* | *Alveolar* | *Alveopalatal* | *Palatal* | *Velar* | *Glottal* |
|---|---|---|---|---|---|---|---|
| Stops and Affricates | tap [p]<br>tab [b] | | pat [t]<br>pad [d] | batch [tʃ]<br>badge [dʒ] | | pick [k]<br>pig [g] | |
| Fricatives | leaf [f]<br>leave [v] | thigh [θ]<br>thy [ð] | sip [s]<br>zip [z] | mesher [ʃ]<br>measure [ʒ] | | | hip [h] |
| Nasals | sum [m] | | sun [n] | | | sung [ŋ] | |
| Liquids and Glides | | | leer [l]<br>rear [ɹ] | | yet [j] | wet [w] | |

not spelling that minimal pairs are established. For purposes of analysis, contrasting words are often placed along the horizontal axis with respect to their place of articulation, reading from left to right (labial, alveolar, and so on), and vertically with respect to manner of articulation, in order to show which places and manners of articulation are relevant to the language in question.

The phonetic context in which a sound occurs is called its **environment.** Examples of environments include *at the beginning of a word* or *after a nasal.* Pairs of words that have segments in *nearly* identical environments (sometimes languages don't give the linguist a perfect data set for analysis), such as *assure* [əʃʊ̈ɹ]/*azure* [ǽʒɨ], which contrast [ʃ] and [ʒ], or *author* [ɔθɨ]/*either* [íðɨ], which contrast [θ] and [ð], are called **near-minimal pairs.** They can be used to establish contrasts if no minimal pairs for a particular set of segments can be found.

Once you have established the existence of a minimal or a near-minimal pair for a set of two segments, you may assume that those two segments contrast—or are *distinctive*—in that language. Segments that contrast with each other in a particular language are said to belong to separate **phonemes** of that language. Phonemes then are contrastive phonological units in a particular language, and native speakers of the language perceive them as different and distinctive sounds. When you know the phonology of a language, you know which sounds are capable of producing a change in meaning. Whereas *phones* come out of your mouth, *phonemes* are in your head. Notationally, this is captured by using square brackets for phones like [i] and slash brackets for phonemes like /i/. Thus all the consonants in Table 3.1 belong to separate phonemes in English, since all of them are contrastive in the language.

When looking for the contrastive sounds of a language, it is rare to find minimal pairs for all possible pairs of sounds, since some sounds are used more frequently than others, and some do not occur in particular environments. For example, you will find no minimal pairs involving [h] and [ŋ] in word-initial or word-final position in English, because there are no words that begin with [ŋ] or end in [h]. It is also difficult to find minimal pairs in English that have the phone [ʒ], which occurs for the most part in words borrowed from French, such as *azure* and *mirage*. *Leash* and *liege* are one pair. See if you can come up with any more.



## Vowel Contrasts in English

Vowel contrasts in English can be established with a few sets of examples. We assume in Table 3.2 that English vowel-glide sequences like [ej] and [ow] are single vowels. You can think of these sounds as being phonetically complex but acting

***Table 3.2*** Vowel contrasts in American English

| | | |
|---|---|---|
| beet | [bit] | [i] |
| bit | [bɪt] | [ɪ] |
| bait | [bejt] | [ej] |
| bet | [bɛt] | [ɛ] |
| bat | [bæt] | [æ] |
| cooed | [kʰud] | [u] |
| could | [kʰʊd] | [ʊ] |
| code | [kʰowd] | [ow] |
| cawed | [kʰɔd] | [ɔ] (for some dialects) |
| cod | [kʰɑd] | [ɑ] |
| cud | [kʰʌd] | [ʌ] |
| lewd | [lud] | [u] |
| loud | [lawd] | [aw] |
| lied | [lajd] | [aj] |
| Lloyd | [lɔjd] | [ɔj] |

**LANGUAGE MATTERS Tongue Twisters**

Although some tongue twisters are difficult because of repeated sound combinations (e.g., The Leath police dismisseth us), others are tricky because of the phonemic contrasts they require you to make (e.g., She sees cheese). For more tongue twisters, go to **www.uebersetzung.at/twister/.**

Try these tongue twisters from other languages:

**Yiddish**
Fir Funr Forn Firn Korn, Barg Arup un Barg Arip.
('Four wagons are driving carrying wheat, up hill and down hill'.)

**Swedish**
I åa ä e ö å i öa ä e å.
(å represents the sound [oː]; ä represents the sound [ɛː]; ö represents the sound [øː].)
('In the stream there is an island and in the island there is a stream.')

**Gujarati**
Kala Kaka a Kali Kaki ne Kanma Kahyu Ke Kando Kapi Kachumber Kar.
('Uncle Kala whispered to Auntie Kali to prepare a salad by cutting the onion.')

**Italian**
Il papá pesa il pepe a Pisa. A Pisa pesa il pepe al papá.
('The father weighs the pepper in Pisa. In Pisa, the pepper is weighed by the father.')

phonologically as simple sounds. (Note that English does not have a phonological contrast between a word like /bej/ and a word like /be/.) From this perspective, we can say that the vowels [ej] and [ɛ] or [aw] and [aj] contrast.

For dialectal differences in vowel contrasts in North American English, go to **bedfordstmartins.com/linguistics/phonology** and click on **American dialects**. Also see the interactive map of North America at **American dialects interactive feature**.

## 1.2 Language-Specific Contrasts

Whether segments contrast with each other is determined on a language-particular basis. In other words, two sounds can be phonetically distinct without necessarily being phonologically distinct or contrastive. Moreover, sounds that are contrastive in one language may not necessarily be contrastive in another. For example, the difference between the vowels [ɛ] and [æ] is crucial to English, as we can see from minimal pairs like *Ben* [bɛn] and *ban* [bæn] (see Table 3.3). But in Turkish, this difference in pronunciation is not distinctive. A Turkish speaker may pronounce the word for 'I' as [bɛn] or [bæn], and it will make no difference to the meaning.

***Table 3.3*** Language-specific vowel contrasts: English versus Turkish

| *English* | | *Turkish* | |
|---|---|---|---|
| [bɛn] | 'Ben' | [bɛn] | 'I' |
| [bæn] | 'ban' | [bæn] | 'I' |

Conversely, sounds that do not contrast in English, such as long and short vowels, may be distinctive in another language. There are no minimal pairs of the type [hæt]:[hæːt] or [lus]:[luːs] in English. But in Japanese and Finnish, short and long vowels contrast, as the examples in Table 3.4 show.

Establishing the contrasting segments in a language is a first step in phonological analysis. However, in any language, there are also many sounds that never contrast. The following section deals with this aspect of phonology.

***Table 3.4*** Short/long vowel contrasts in Japanese and Finnish

| *Japanese* | | | |
|---|---|---|---|
| [toɽi] | 'bird' | [toɽiː] | 'shrine gate' |
| [kibo] | 'scale' | [kiboː] | 'hope' |
| *Finnish* | | | |
| [tuli] | 'fire' | [tuːli] | 'wind' |
| [hætæ] | 'distress' | [hæːtæː] | 'to evict' |



# 2 Phonetically Conditioned Variation: Phonemes and Allophones

Everyday speech contains a great deal of phonetic variation that speakers pay little or no attention to. Some of this variation arises from nonlinguistic factors such as fatigue, excitement, orthodontic work, gum chewing, and the like. This kind of variation is not part of the domain of phonology as it is unpredictable or random. You may stumble over some words or sounds when you're excited but this is more a property of your motoric system than something represented in your phonological grammar. Yet there is much phonetic variation that is systematic. It occurs most often among phonetically similar segments and is conditioned by the phonetic context or environment in which the segments are found. This variation occurs because segments are affected and altered by the phonetic characteristics of neighboring elements or by the larger phonological context in which they occur. We saw this in Chapter 2 when we discussed assimilation. Speakers and listeners of any language tend to factor out this type of variation in order to focus on the contrasts that affect meaning, which is why you may never have noticed it. In this section we will consider the patterns of variation exhibited by noncontrastive sounds, how to analyze these patterns, and the conclusions that can be drawn from them.

## 2.1 Complementary Distribution

Most speakers of Canadian dialects and speakers of some American dialects have what is known as **Canadian raising**, which produces variation in the pronunciation of /aw/ as seen in Table 3.5.

***Table 3.5*** Variation in /aw/ in Canadian English

| | | | |
|---|---|---|---|
| [hawz] | (to) house (verb) | [hʌws] | house (noun) |
| [mawð] | (to) mouth (verb) | [mʌwθ] | mouth (noun) |
| [lawd] | loud | [lʌwt] | lout |
| [kaw] | cow | [skʌwt] | scout |
| [gawdʒ] | gouge | [ʌwtʃ] | ouch |
| [tawn] | town | | |

The [aw] and [ʌw] are not separate phonemes; speakers of raising dialects do not perceive them as contrastive, and there are no minimal pairs in which the difference between [aw] and [ʌw] would make a difference in meaning. Speakers of dialects with Canadian raising generally do not realize that they have two different ways of pronouncing the phoneme /aw/ until it is pointed out to them. On the other hand, people who do not speak raising dialects of English are very aware of their presence in Canadian English.

The two variants [aw] and [ʌw] are phonetically similar: the initial vowel in both diphthongs is a nonhigh central vowel, and both diphthongs end with a [w]

**LANGUAGE MATTERS Canadian Raising**

I don't agree he was an American. . . . Where all other English-speaking people pronounce OU as a diphthong, the Canadian . . . makes a separate sound for each letter. The word *about*, for instance, he pronounces as *ab-oh-oot*.

– Philip MacDonald, *The List of Adrian Messenger*

*Townsman:* Say—you must be a Canadian.
*Davis: Delighted.* I am. How'd you know?
*Townsman:* Say 'house' [haws].
*Davis:* House [hʌws].
*Townsman:* Say 'about' [əbawt].
*Davis:* About [əbʌwt].
*Townsman:* I knew it.

Source: Rick Salutin and Theatre Passe Muraille, *1837: The Farmers' Revolt.*

off-glide. The [ʌ] is higher than the [a], which is why this phenomenon is known as *raising*.

The variants [aw] and [ʌw] are not simply produced randomly; when we look at the data in Table 3.5, we see that there is a predictable pattern for [ʌw]. Every instance of [ʌw] is found before a voiceless consonant, whereas [aw] is never found before a voiceless consonant. Instead, [aw] is found before voiced sounds and word-finally, but [ʌw] is never found in these environments. When two sounds always occur in different environments and never occur in the same environment, we say that they are in **complementary distribution**. (See Table 3.6.)

***Table 3.6*** Complementary distribution of [aw] and [ʌw]

| *Environment* | *[aw]* | *[ʌw]* |
|---|---|---|
| before voiceless consonants | no | yes |
| elsewhere | yes | no |

When two variants are in complementary distribution, we can predict where each will occur because we can simply look at the environment and say which sound occurs in that environment. With Canadian raising dialects, we know that [ʌw] will occur only before a voiceless consonant, and [aw] will occur elsewhere. (We use the term *elsewhere* here because [aw] occurs in more environments that are less predictable than those in which [ʌw] occurs.) Conversely, [aw] will never occur before a voiceless consonant, and [ʌw] will never occur anywhere else. Thus we can predict that the word *shout*, for example, would be pronounced [ʃʌwt] because the diphthong is followed by the voiceless consonant [t]. In contrast, we can predict that the words *bough* and *proud* will be pronounced as [baw] and [pɹawd] because there is not a voiceless consonant following the diphthong. In raising dialects,



then, [aw] and [ʌw] are in complementary distribution because they are phonetically similar, they occur in separate environments, and they can be predicted based on the environments.

As another example of complementary distribution, consider the voiced and voiceless *l*s in English shown in Table 3.7.

***Table 3.7*** Voiced and voiceless /l/ in English

| *A* | | *B* | |
|---|---|---|---|
| blue | [blu] | plow | [pl̥aw] |
| gleam | [glim] | clap | [kl̥æp] |
| slip | [slɪp] | clear | [kl̥ɪɹ] |
| flog | [flɔg] | play | [pl̥ej] |
| leaf | [lif] | | |

If you are a native speaker of English, you probably do not hear any difference in the two *l*s, yet an acoustic measurement of your pronunciation of the *l*s would show that those in column B are indeed voiceless. Although measurably distinct, both the voiced and voiceless *l* are phonetically similar—both are *l*s. For speakers of English, they are not different phonemes because they are not contrastive. However, they do occur in separate and predictable environments. Voiceless *l* occurs only after voiceless stops, whereas voiced *l* occurs everywhere else (elsewhere). Thus, in English, voiced and voiceless *l* are in complementary distribution.

To sum up, then, variants of the same phoneme that are in complementary distribution are perceived by their speakers to be phonologically the same; in other words, they are not contrastive in the language. The variant pronunciations are phonetically similar, and the environment in which each occurs is systematic and predictable; where one occurs, the other never occurs and vice versa.

## 2.2 Phonemes and Allophones

When two (or more) segments are phonetically distinct, but phonologically the same, they are referred to as **allophones** (predictable variants) of one phoneme (contrastive phonological unit). The ability to group phonetically distinct sounds into phonemes is shared by all speakers of all languages. Phonologists represent this phonological knowledge formally by distinguishing two levels of representation: the **phonetic representation** that consists of predictable variants or allophones, and the **phonemic** (or phonological) **representation** that consists of the phonemes to which the allophones belong. A representation of the relationship between phonemes and their allophones is given in Figure 3.2.

In Figure 3.2 the symbols for allophones are enclosed in square brackets, while the symbol for the phoneme is placed between slashes. Notice that the phoneme /l/ in Figure 3.2 is the same as its voiced allophone [l]. In most cases, the elsewhere variant or allophone of a phoneme can be chosen to represent the phoneme itself.

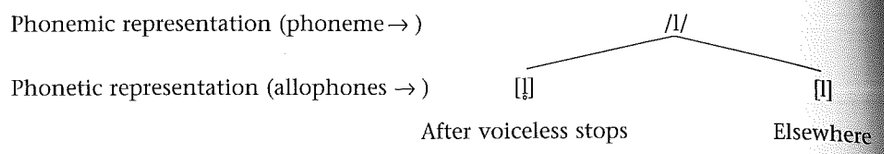


***Figure 3.2*** The phoneme /l/ and its allophones [l̥] and [l] in English

In thinking of the difference between phonemic and phonetic representations, remember the following: Phonemes are mental representations, the way in which sounds are stored in the mind. When you learn a word, you need to remember the phonemes because they make a difference when it comes to the meaning of a word. Allophones, on the other hand, are not part of what you remember when you store a word in your mind. We have a phonological system that automatically produces the appropriate variant of a particular phoneme when you pronounce a word. As we have said before, phonemes (like /l/) are in your head, but allophones (like [l] and [l̥]) come out of your mouth.

As we have seen, segments that can be considered allophones of one phoneme are phonetically similar and occur in phonetically predictable environments. In fact, it is frequently the case that allophones of one phoneme are in complementary distribution with each other. (That is, they never occur in the same environment.) Consequently, we can use the fact that allophones occur in complementary distribution as a way of testing whether or not two (or more) segments should be considered to be allophones of one phoneme.

Allophonic variation is found throughout language. In fact, every speech sound we utter is an allophone of some phoneme. An important part of phonological analysis thus deals with discovering inventories of the phonemes of languages and accounting for allophonic variation.

**LANGUAGE MATTERS Can You Predict the Variation?**

Here is an example that may help you to understand the notion of predictable versus unpredictable variation. Consider the sounds [p] and [b] in English. In the following phonetic environment can you predict whether you will get a [p] or a [b]?

[___ aj]

You can't predict, as both *pie* [paj] and *buy* [baj] are possible words. This is unpredictable variation which means that [p] and [b] are contrastive and hence that /p/ and /b/ are phonemes. Now consider the sounds [l] and [l̥] in English. In the following phonetic environment can you predict whether you will get an [l] or an [l̥]?

[___ aj]

In this case you can predict that you will get an [l] because the voiceless allophone never occurs at the beginning of a word. This is predictable variation which means that [l] and [l̥] are not contrastive in English and hence that they are not phonemes but rather allophones.



## Some Problematic Distributions

At this point, some other considerations in determining phonemes and allophones must be taken into account. So far, we have seen that a minimal pair test is a quick and direct way of establishing that two sounds belong to separate phonemes in a language. If the sounds contrast, they are members of different phonemes. We have also seen that if certain sounds are noncontrastive and in complementary distribution, they may be considered allophones of a single phoneme. In some cases, however, we must go beyond these procedures to discover the phonemic inventory of a language.

As noted in Section 1.1, certain patterns of distribution prevent some sounds in a language from ever contrasting with each other. In cases like these, we can establish the phonemic status of a sound by default. If the sound cannot be grouped together with any other phonetically similar sounds as an allophone of a phoneme, we may assume that it has phonemic status itself. The following data from English help to illustrate this point.

| | | | | |
|---|---|---|---|---|
| 1) | *[ŋowp] | (does not exist) | [howp] | 'hope' |
| | *[ŋejt] | (does not exist) | [hejt] | 'hate' |

We can see here that [h] and [ŋ] do not contrast in initial position in English. The following examples show that they do not contrast in final position either.

| | | | | |
|---|---|---|---|---|
| 2) | [lɑŋ] | 'long' | *[lɑh] | (does not exist) |
| | [sɪŋ] | 'sing' | *[sɪh] | (does not exist) |
| | [kl̥æŋ] | 'clang' | *[kl̥æh] | (does not exist) |

These lists could be extended for pages, but a minimal pair involving [h] and [ŋ] could never be found in English. Additionally, as *1* and *2* have shown, [h] and [ŋ] are in complementary distribution. Do these facts taken together not lead us to conclude that [h] and [ŋ] are allophones of one phoneme? No. Since [h] and [ŋ] are so distinct phonetically, we assume that each one is a member of a separate phoneme and that the pattern of distribution is of secondary importance in this instance.

Minimal pairs or near-minimal pairs help us establish which sounds contrast in a language; phonetic similarity and complementary distribution help us decide which sounds are allophones of a particular phoneme. But not all examples of variation among sounds can be dealt with through these approaches.

In some cases, phonetically similar sounds are neither in complementary distribution nor are they found to contrast. It is still possible, nevertheless, to determine which phonemes these sounds belong to. A case in point is the variation in English voiceless stops when they are found in word-final position, as in the word *stop*. Sometimes an English speaker releases the articulation of these sounds rather forcefully. Let us represent this with a diacritic sign [ˈ]. At other times, the same speaker may keep the articulators closed for a moment before releasing the final stop consonant; the diacritic [˺] represents this extended closure. Some speakers may even coarticulate a glottal closure (represented here with the raised symbol for a glottal stop following the consonant in question) and produce the word as [stɑpˀ]. Thus, we can find at least three pronunciations of *stop*: [stɑpˈ], [stɑp˺], and [stɑpˀ]. Since there is no difference in the meaning of these forms and since the final consonants are phonetically similar, we say that these sounds are in **free variation**, and that they are all allophones of the phoneme /p/. The same pattern holds for the other voiceless stops of English.

## 2.3 Classes and Generalization in Phonology

Phonological analysis permits us to account for the great amount of phonetic variation in everyday speech. This variation, which is usually systematic, is found throughout language. Evidence of its systematic nature comes from the fact that allophones in languages pattern according to their membership in phonetic classes. This point is illustrated in Table 3.8 by comparing the patterns of distribution of *r*s and glides in English to the patterning of *l*s that was illustrated earlier in Table 3.5.

***Table 3.8*** Voiced and voiceless allophones of English /ɹ/

| *A* | | *B* | |
|---|---|---|---|
| brew | [bɹu] | prow | [pr̥aw] |
| green | [gɹin] | trip | [tr̥ɪp] |
| drip | [dɹɪp] | creep | [kr̥ip] |
| frog | [frɔg] | pray | [pr̥ej] |
| shrimp | [ʃɹɪmp] | | |

The data in Table 3.8 show that in English, voiceless [r̥] occurs after voiceless stops, while voiced [ɹ] occurs elsewhere. Based on this information we can conclude that there is an /ɹ/ phoneme in English with (at least) two allophones—one voiced, the other voiceless—and that the allophones of English /ɹ/ thus pattern like those of /l/. But if we were to stop there, we would overlook an important point. The phonemes /ɹ/ and /l/ belong to the same class of sounds: both are *liquids*. By taking this information into account, we can state a general fact about English.

3) In English, liquids have voiceless allophones after voiceless stops and voiced allophones elsewhere.

Now examine the data in Table 3.9.

***Table 3.9*** Voiced and voiceless allophones of English glides

| *A* | | *B* | |
|---|---|---|---|
| beauty | [bjuɾi] | putrid | [pj̥utɹɪd] |
| Duane | [dwejn] | twin | [tw̥ɪn] |
| Gwen | [gwɛn] | quick | [kw̥ɪk] |
| view | [vju] | cute | [kj̥ut] |
| swim | [swɪm] | | |
| thwack | [θwæk] | | |

These forms demonstrate that the contrasting glides /j/ and /w/ pattern like the liquids. We can now extend our general statement even further.

4) In English, liquids and glides have voiceless allophones after voiceless stops, and voiced allophones elsewhere.



When we consider the fact that liquids and glides all belong to the same phonetic class, namely, the class of nonnasal sonorant consonants, we can understand why the allophones of liquids and glides pattern similarly.

Similarly, with Canadian raising, we can extend the generalization made in Section 2.1 by making use of phonetic classes. You will recall that /aw/ becomes the allophone [ʌw] when it is followed by a voiceless consonant. Now examine the data in Table 3.10.

***Table 3.10*** [aj] and [ʌj] in Canadian English

| | | | |
|---|---|---|---|
| [tɹajb] | tribe | [tɹʌjp] | tripe |
| [bɹajd] | bride | [bɹʌjt] | bright |
| [ajz] | eyes | [ʌjs] | ice |
| [lajz] | lies | [lʌjs] | lice |
| [flaj] | fly | [flʌjt] | flight |

As with [aw] and [ʌw], the allophones [aj] and [ʌj] are also in complementary distribution. Like [ʌw], the [ʌj] allophone occurs before voiceless consonants; like [aw], the [aj] occurs elsewhere. Both [aw] and [ʌw] are two allophones of the single phoneme /aw/. The same relationship holds between the vowels [aj] and [ʌj], which are allophones of /aj/ (see Figure 3.3).

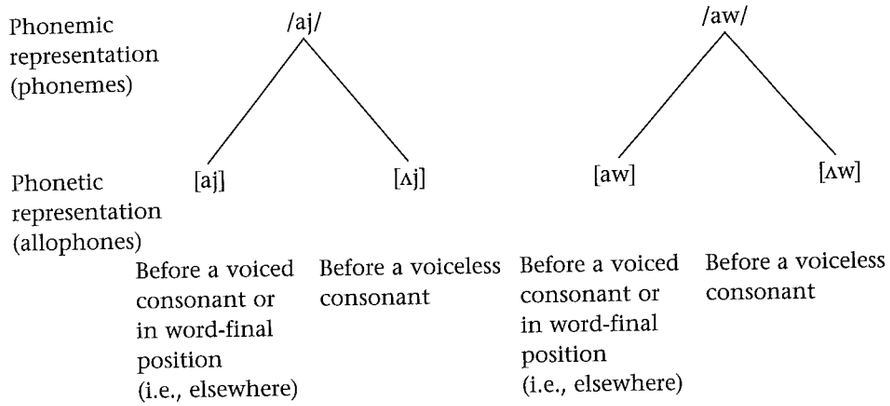


***Figure 3.3*** Allophones of /aj/ and /aw/ in Canadian English

There is a systematic pattern here that we can generalize by making use of the phonetic classes to which the allophones belong. The vowels that exhibit the Canadian raising alternation are the central unreduced vowels of English. The low diphthongs /aw/ and /aj/ are raised to the nonlow allophones [ʌw] and [ʌj], respectively, when they are followed by a voiceless consonant.

For audio examples of Canadian raising, go to **bedfordstmartins.com/linguistics/phonology** and click on **Canadian Raising**.

Just as in the case of liquid and glide devoicing patterns, the allophones that participate in the Canadian raising pattern are distributed according to their membership

in phonetic classes. One of the major goals of phonological description is the discovery of such broad patterns of variation and the formulation of the most general statements possible to describe them.

## 2.4 English Mid Vowels and Glides

A final example of predictable variation that refers to classes of segments but that differs crucially from examples seen so far also comes from English.

Table 3.2 showed contrasts among English vowels. In most dialects of English, the mid tense vowels [ej] and [ow] are always diphthongized and thus end in the glide [j] or [w]. Significantly, the nonback (i.e., front) vowel [e] is always followed by the palatal glide [j], which is a nonback unrounded segment, while the back rounded vowel [o] is always followed by the labiovelar glide [w], which is a back rounded segment. These facts are summed up in Table 3.11.

***Table 3.11*** Tense vowel-glide combinations in English

| *Vowel* | *Glide* | | | *Vowel* | *Glide* | | |
|---|---|---|---|---|---|---|---|
| *(both nonback and unrounded)* | | | | *(both back and rounded)* | | | |
| e | j | [fejt] | fate | o | w | [bowt] | boat |
| | | [kejn] | cane | | | [kown] | cone |

In other words, the occurrence of the glides following the mid tense vowels is predictable. The following generalization states the distribution of the two glides.

5) The mid tense vowels of English are predictably followed by a glide that has the same backness and roundness as the vowel.

The data in Table 3.11 show parallels with the **allophonic distribution** we have considered so far in the sense that certain elements in it are predictable under certain phonetic conditions. However, there is a difference between allophonic distribution and the kind of distribution exhibited by the glides. Specifically, in Table 3.11, instead of a number of variants of one phoneme, we have two segments, [ej] and [ow], which share a predictable phonetic characteristic: these mid tense vowels of English are always followed by glides of the same backness and roundness. We have seen that when certain sounds are found predictably in a given environment, they are not included in phonemic representations. Thus, although the phonetic representations of English mid vowels include the glides, the corresponding phonemic representations do not (see Figure 3.4).

| | | |
|---|---|---|
| Phonemic representation | /e/ | /o/ |
| | \| | \| |
| Phonetic representation | [ej] | [ow] |

***Figure 3.4*** Two representations of mid vowels in English

This is consistent with something we have said before: the phonemic representation includes information that is not predictable. Phonetic detail—whether it is about voiceless sonorants or which glide follows a mid vowel—of this type is predictable.



## 2.5 Language-Specific Patterns

The phenomenon of allophonic variation is universal. However, just as the phonemic contrasts found in each language are specific to that language, the actual patterning of phonemes and allophones is also language-specific. Thus, whatever distribution we discover for one language may not hold true for another.

### Language-Specific Variation in Allophonic Nasalization

Some languages have nasal as well as oral vowels and glides. It is usual in such languages for nasal vowel (and nasal glide) allophones to occur near nasal consonants, but, as Tables 3.12 and 3.13 illustrate, the details of the patterning may vary from language to language.

In Scots Gaelic, for instance, whenever a nasal consonant occurs in a word, the vowel adjacent to it is nasalized. Glides do not get nasalized, however.

***Table 3.12*** Nasal and oral vowels in Scots Gaelic

| | |
|---|---|
| [mõ:r] | 'big' |
| [nĩ] | 'cattle' |
| [nẽ:l] | 'cloud' |
| [mũ] | 'about' |
| [rũ:n] | 'secret' |
| [ʃalak] | 'hunting' |

The generalization governing the distribution of nasal vowels in Scots Gaelic is stated as follows.

6) Vowels are nasal in Scots Gaelic when preceded or followed by a nasal consonant.

***Table 3.13*** Nasalization in Malay

| | |
|---|---|
| [mẽw̃ãh] | 'luxurious' |
| [mãj̃ãn] | 'stalk' |
| [mãrah] | 'scold' |
| [nãɛ̃ʔ] | 'ascend' |
| [mə̃laraŋ] | 'forbid' |
| [mãkan] | 'eat' |
| [rumãh] | 'house' |
| [kəreta] | 'car' |

Malay, a language spoken in Malaysia and Singapore, has both nasalized vowels and glides. In Malay, all vowels and glides following a nasal are predictably nasalized until an obstruent, liquid, or glottal ([h], [ʔ]) is reached.

For Malay, then, the generalization governing nasalization is different from the Scots Gaelic case both in the direction and the targets of nasalization.

7) In Malay, all vowels and glides following a nasal consonant and not separated from it by a nonnasal consonant are nasalized.

## Language-Specific Variation in Allophonic Distribution

In Section 1.2 we saw that a phonemic contrast in one language may not prove to be a phonemic contrast in another. This means that the relationship of phonemes to allophones may vary. A comparison of the contrasts among stops in English and Khmer (Cambodian) in Table 3.14 illustrates this point. In both languages, aspirated and unaspirated phones can be heard.

***Table 3.14*** Stop phones in English and Khmer

| *English* | | *Khmer* | |
|---|---|---|---|
| [p] | [pʰ] | [p] | [pʰ] |
| [t] | [tʰ] | [t] | [tʰ] |
| [k] | [kʰ] | [k] | [kʰ] |

In English, aspirated and unaspirated stops are allophones of their respective phonemes (the distribution is explained in Section 4.5 of this chapter); there are no contrasting forms like [pɪk] and [pʰɪk]. In Khmer, though, unaspirated and aspirated voiceless stops contrast (see Table 3.15).

***Table 3.15*** Khmer contrastive voiceless stops

| | | | |
|---|---|---|---|
| [pɔːŋ] | 'to wish' | [pʰɔːŋ] | 'also' |
| [tɔp] | 'to support' | [tʰɔp] | 'be suffocated' |
| [kat] | 'to cut' | [kʰat] | 'to polish' |

The phonological contrasts of the two languages are different, even though the phones are not (see Figure 3.5). These distributions are the same for the other voiceless stops in both languages.

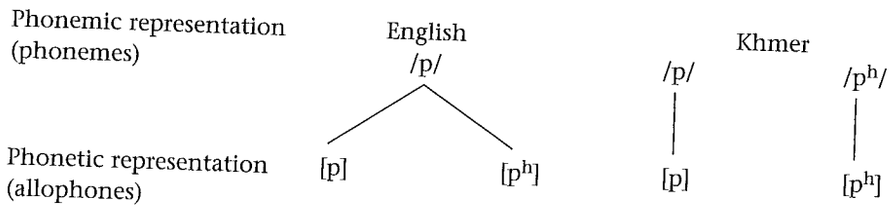


***Figure 3.5*** English and Khmer voiceless bilabial stop phonemes and allophones

# 3 Phonetic and Phonemic Transcription

We have seen so far that each language has a set of contrastive phonemes (which can be established largely by means of the minimal pair test) and that phonemes themselves can have predictable variants or allophones (which are usually in



complementary distribution with each other). We have also seen that there are two distinct levels of representation: the phonemic (or phonological) and the phonetic. We can now illustrate more clearly the types of transcription used at each level of representation.

The phonetic level of representation includes both predictable and unpredictable phonetic information. In contrast, the phonemic level includes all and only those aspects of a representation that are unpredictable; all predictable information is excluded. The examples in Table 3.16 show this difference for the classes of sounds in English that we have examined so far.

***Table 3.16*** Phonetic and phonemic transcription of English

| *Phonetic transcription* | *Phonemic transcription* | *Word* | *Predictable property(s) not represented in phonemic transcription* |
|---|---|---|---|
| [pl̥aw] | /plaw/ | plow | voicelessness of liquid |
| [kɹ̥ip] | /kɹip/ | creep | voicelessness of liquid |
| [kw̥ɪk] | /kwɪk/ | quick | voicelessness of glide |
| [lejt] | /let/ | late | glide after mid tense vowel |
| [lɛt] | /lɛt/ | let | — |
| [tʰajd] | /tajd/ | tied | aspiration |
| [tʰʌjt] | /tajt/ | tight | aspiration; Canadian Raising |

In the **phonemic transcriptions** in Table 3.16 the words are transcribed using only phonemes; in the **phonetic transcriptions**, however, the allophones of each phoneme are transcribed (in the environments in which they predictably occur). There is thus more phonetic information in the phonetic transcriptions than in the phonemic ones. If one compares the two transcriptions of *tight*, for instance, one sees that the phonetic transcription indicates the aspiration of the initial *t*, and the raised pronunciation of the vowel. In the corresponding phonemic transcription, the aspiration is left out, because its occurrence is predictable, and the [ʌj] allophone of /aj/ is replaced by its phoneme.

The contrast between phonetic and phonemic representation is even more striking for the Malay forms given earlier, as shown in Table 3.17.

***Table 3.17*** Phonetic and phonemic transcription of Malay nasal vowels

| *Phonetic transcription* | *Phonemic transcription* | *Word* | *Predictable property(s) not represented in phonemic transcription* |
|---|---|---|---|
| [mẽw̃ãh] | /mewah/ | 'luxurious' | nasalization |
| [mãj̃ãn] | /majan/ | 'stalk' | nasalization |
| [nãɛ̃ʔ] | /naɛʔ/ | 'ascend' | nasalization |

Here, nasalization on all vowel and glide segments is predictable and is therefore omitted from the phonemic representation.

## 3.1 Phonetic and Phonemic Inventories

All languages have both a phonetic level of representation and a phonemic one. The phonetic level represents the allophones of a language. The phonemic level represents the language's phonemes. What this means is that each language has two inventories of sounds: one inventory, which includes the allophones of the language, is used in phonetic transcription; the other inventory, which includes only the phonemes of the language, is used in phonemic transcription. Since every language has more allophones of phonemes than it has phonemes, phonetic inventories of sounds are always larger than phonemic ones. Table 3.18 illustrates a partial phonetic inventory and the phonemic inventory for the vowels of English. Only those allophones that we have discussed so far in this chapter are listed (the phonetic inventory is thus obviously incomplete). Phonetically, vowels are described as *front*, *central* or *back*, but phonologically (as we will see in Section 5) only the features *front* and *back* are necessary.

***Table 3.18*** Phonetic and phonemic inventories of the vowels of English

| *Partial phonetic inventory* | | | | *Phonemic inventory* | | | |
|---|---|---|---|---|---|---|---|
| *Front* | *Central* | | *Back* | *Front* | *Back* | | |
| i | | | u | i | | | u |
| ɪ | | | ʊ | ɪ | | | ʊ |
| ej | ə | | ow | e | ə | | o |
| ɛ | ʌ | ʌj | ɔj | ɛ | ʌ | | ɔj |
| | | ʌw | ɔ | | | | ɔ |
| æ | aj | aw | ɑ | æ | aj | aw | ɑ |

Table 3.19 illustrates a partial phonetic inventory (again based on allophones discussed so far) and the phonemic inventory of English consonants.

***Table 3.19*** Phonetic and phonemic inventories of the consonants of English

| *Partial phonetic inventory* | | | | | | *Phonemic inventory* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| p | | t | | k | | p | | t | | k | |
| pʰ | | tʰ | | kʰ | | | | | | | |
| b | | d | | g | | b | | d | | g | |
| | | | tʃ | | | | | | tʃ | | |
| | | | dʒ | | | | | | dʒ | | |
| | f θ | s | ʃ | | h | | f θ | s | ʃ | | h |
| | v ð | z | ʒ | | | | v ð | z | ʒ | | |
| m | | n | | ŋ | | m | | n | | ŋ | |
| | | l | j | w | | | | l | j | w | |
| | | l̥ | j̥ | w̥ | | | | | | | |
| | | ɹ | | | | | | ɹ | | | |
| | | ɹ̥ | | | | | | | | | |

Since there are two levels of representation—the phonetic and the phonemic—one obvious question to ask is how they are related to each other. In Section 6 we consider in detail the nature of the relationship between phonetic and phonemic



levels and inventories and discuss how this relationship can be represented formally. Before we get to that, though, let us consider another level of representation.

# 4 Above the Segment: Syllables

So far we have been discussing the distributional properties of segments, and have established the existence of the segmental units of phonological analysis known as phonemes and their allophones. We have also seen that allophonic variation may be conditioned by neighboring segments. We turn now to a different unit of phonological representation, namely, the syllable. We will see that syllables are composed of segments, and thus impose an organization on segments; in this sense, syllables are what are known as **suprasegmental** units (that is to say, units above the segment). We will also see that the shapes of syllables are governed by both universal and language-specific constraints. Finally, we will examine examples of allophonic variation that is conditioned by syllable structure, rather than by neighboring segments.

## 4.1 Defining the Syllable

As we saw in Chapter 2, vowels, glides, liquids, and nasals are **sonorant** (singable) sounds, while **obstruents** (stops, fricatives, and affricates) are not; of the sonorant sounds, vowels are most sonorous, and glides, liquids, and nasals are correspondingly less sonorous. A syllable consists of a sonorous element and its associated nonsyllabic (less sonorous) segments. Since vowels are the most sonorous sounds, syllables usually have a vowel nucleus at their core. Less sonorous sounds may appear on either side of a nucleus. Thus the word *telegraph* has three syllables because it has three vowels that serve as syllable nuclei. Note how in the word *plant*, the vowel is in the middle, with a liquid and a nasal on either side, and stops at the edges.

Native speakers of a language demonstrate their awareness of the sonority values of segments and of the syllable as a unit of phonological structure whenever they count syllables in a word. No English speaker would hesitate to say that the words *telegraph* and *accident* have three syllables, and most speakers would feel confident that the words could be broken up into the syllables [tɛ.lə.gɹæf] and [æk.sə.dn̩t] (the "." marks syllable divisions informally).

Speakers also know that syllables have internal subsyllabic structure as well. This internal organization of the syllable unit is shown in Figure 3.6 for the monosyllabic English word *sprint*. As you can see, syllables consist of an **onset** and a **rhyme**; the rhyme, in turn, consists of the **nucleus** or syllable core, and a **coda**.

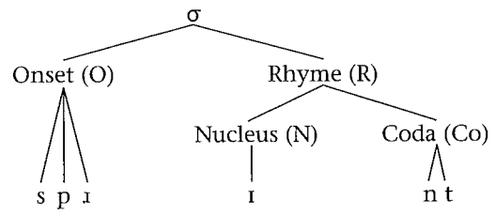


***Figure 3.6*** Internal structure of a syllable

**LANGUAGE MATTERS Ever Wonder Where Rhymes in Poetry Come From?**

Draw the internal structure of the final syllables in each line of the following poems and see what patterns you observe.

All that is gold does not glitter,
Not all those who wander are lost,
The old that is strong does not wither,
Deep roots are not reached by frost.
–J.R.R. Tolkien, *The Lord of the Rings*

My candle burns at both ends;
It will not last the night;
But, ah, my foes, and, oh, my friends—
It gives a lovely light.
–Edna St. Vincent Millay, "First Fig" from *A Few Figs from Thistles*

What constituents are most important in the creation of rhyming?

We will see later on in this chapter that some allophonic variation makes reference to internal subsyllabic structure such as the coda.

In addition, one version of the English language game known as Pig Latin is played by displacing the onset of the first syllable of a word to the end of the word and then tacking on the rhyme *ay* [ej]: thus *strong* becomes *ong-str-ay*, and *swivel* become *ivel-sw-ay*. Speakers can do this because they have knowledge of the internal structure of syllables.

Furthermore, when speakers are asked to syllabify words, they are able to do so in ways that are neither random nor variable. The word *extreme* /ɛkstɹim/ would never be syllabified as /ɛ.kstɹim/, for example. Instead, syllables comply with certain constraints that prohibit them from beginning with a sequence like *kstr* and thus result in the actual syllabification /ɛk.stɹim/. The examples in Table 3.20 are all from English, but similar kinds of evidence for the existence of subsyllabic constituents can be found in many other languages as well.

***Table 3.20*** Some examples of English syllables

| | |
|---|---|
| /ə.plɔd/ | applaud |
| /di.klajn/ | decline |
| /ɛk.splen/ | explain |
| /ɪm.pɹə.vajz/ | improvise |

All languages have syllables. The shapes of these syllables are governed by various kinds of constraints, but certain universal tendencies are observable: (1) syllable nuclei usually consist of one vowel (V); (2) syllables usually begin with onsets; (3) syllables often end with codas; (4) onsets and codas usually consist of one consonant (C). Putting these tendencies together, we find that the most common



types of syllables found in languages throughout the world take the shapes CV and CVC. These are general tendencies, not absolute laws, and languages may, and often do, violate them. But even when a language violates the universal tendencies, the types of syllables that do occur are governed by other constraints on the shapes of the subsyllabic units O, N, and Co. To illustrate this, we turn to the constraints that govern the phonological shape of consonant sequences in onsets in English.

## 4.2 Onset Constraints and Phonotactics

Native speakers of any language intuitively know that certain words from other languages sound unusual, and they often adjust the segment sequences of these words to conform with the pronunciation requirements of their own language. These intuitions are based on a tacit knowledge of the permissible syllable structures of the speaker's own language. For example, English-speaking students learning Russian often have difficulty pronouncing a word like *vprog* /fprɔk/ 'for future use', since the sequence /fpr/ is never found in English onsets. Since speakers typically adjust an impermissible sequence by altering it to a permissible one, many English speakers would pronounce the Russian word [fprɔk] as [fəprɔk], or even delete the initial /f/ and say [prɔk] in order to adjust the impermissible sequence /fpr/ to a permissible English onset. **Phonotactics**—the set of constraints on how sequences of segments pattern—forms part of a speaker's knowledge of the phonology of his or her language.

### Some English Onsets

English is a language that allows onsets to contain more than one consonant; in this sense, English permits syllables that are more complex than those found in many languages. Nevertheless, there are very strict phonotactic constraints on the shapes of English onsets. Table 3.21 contains examples of the possible syllable-initial consonant sequences of English that contain a voiceless stop consonant. These sequences are all illustrated in word-initial position to make them easier to pick out. (Stress marking and phonetic details such as liquid-glide devoicing that are not relevant to the present discussion are omitted here.)

***Table 3.21*** Initial consonant clusters in English containing a voiceless stop

| *Labial + sonorant* | | *Coronal + sonorant* | | *Velar + sonorant* | |
|---|---|---|---|---|---|
| [pl] | please | [tl] | — | [kl] | clean |
| [pɹ] | proud | [tɹ] | trade | [kɹ] | cream |
| [pw] | — | [tw] | twin | [kw] | queen |
| [pj] | pure | [tj] | tune (British) | [kj] | cute |
| [spl] | splat | [stl] | — | [skl] | sclerosis |
| [spɹ] | spring | [stɹ] | strip | [skɹ] | scrap |
| [spw] | — | [stw] | — | [skw] | squeak |
| [spj] | spew | [stj] | stew (British) | [skj] | skewer |

The examples in Table 3.21 show that the first segment of a word-initial three-consonant cluster in English is always *s*; the second consonant in the series is always

a voiceless stop, and the third is either a liquid or a glide. These sound patterns can be formally represented as follows:

$$\sigma\ [s \begin{Bmatrix} p \\ t \\ k \end{Bmatrix} \begin{Bmatrix} (l) \\ ɹ \\ (w) \\ j \end{Bmatrix}$$

In this formalization, σ indicates the boundary of a syllable and the curly braces designate 'either/or'. The sounds in parentheses are not found in all combinations. An important observation about the types of onsets that are allowed in English is that the consonant combinations are not random: in fact, (1) the consonant combinations are dependent primarily on the manners of articulation of the consonants and (2) sonorant consonants (here liquids and glides) are closer to the nucleus than are stops and fricatives. Both these phonotactic constraints reflect universal restrictions on consonant combinations, and are found in other languages that allow complex onsets.

## 4.3 Accidental and Systematic Gaps

Although there are twenty-four possible two- and three-consonant syllable-initial sequences in English containing a voiceless stop, not all of these combinations are exploited in the vocabulary of the language.

Some gaps in the inventory of possible English words include *snool*, *splick*, *sklop*, *flis*, *trok*, and *krif*, although none of these forms violates any constraints on onset combinations found in English. Gaps in a language's vocabulary that correspond to nonoccurring but possible forms are called **accidental gaps**. Occasionally, an accidental gap will be filled by the invention of a new word. The word *Kodak* is one such invented word; its shape conforms to the phonotactic constraints of English, but it only became part of English vocabulary in this century. Borrowed words such as *perestroika* (from Russian), *taco* (from Spanish), and *Zen* (from Japanese) are readily accepted into English because their syllable structures conform to the phonotactic patterns of the language.

Table 3.21 has shown which syllable-initial consonant clusters involving voiceless stops are permissible in English. Gaps in the syllable structures of a language that result not by accident, but from the exclusion of certain sequences are called **systematic gaps**. Certain onset sequences like /bz/, /pt/, and /fp/ are systematic gaps in the pattern of English. They are outright unacceptable to English speakers, and never occur in spoken English. Instead, such sequences will be adjusted phonologically when they are pronounced in spontaneous speech. This can be seen in the case of borrowings from other languages into English. Many Greek words beginning with *ps-* and *pt-* have been absorbed into English, as the spellings of *psychology*, *psoriasis*, and *pterodactyl* attest. In all of them the impermissible syllable-initial clusters **ps-* and **pt-* have been reduced to *s-* or *t-* in onsets of spoken English. However, when these same forms occur word-internally, where their syllabification is different, the lost segments may resurface. For example, the *pter* of *pterodactyl* means 'wing'; both consonants are heard in the word *helicopter,* where English syllabification has resulted in a structure *he.li.cop.ter* in which the members of the cluster *pt* belong to different syllables.



Other words that violate phonotactic constraints commonly appear in spoken English, including *pueblo* [pwɛblow] and *Tlingit* [tlɪŋɪt]. The fact that such words and pronunciations occur in spoken English even though they violate phonotactic constraints is due to the fact that phonotactic constraints vary in their strength. Thus, the sequences **ps-*, **pt-*, and **bz-* are excluded from the initial position of English syllables because English has a very strong and absolute constraint against allowing stop-stop or stop-fricative clusters in onsets. In contrast, the restriction against sequences like **pw-* and **tl* in English onsets is due to a weaker and violable constraint on stop-sonorant onset sequences with the same place of articulation. Thus, a labiovelar glide is not usually permitted to occur after a labial consonant, and an alveolar stop such as /t/ is not usually permitted to precede an alveolar /l/ in English words, but as our examples show, this constraint is violable.

### Language-Specific Phonotactics

It is important to emphasize again that certain aspects of the particular constraints discussed in the previous section are universal whereas others are language-specific. An onset like *pl* is found in many languages besides English (for example, in Russian, Thai, and French), while an onset sequence like *lp* is never found. We may therefore say that no restrictions against an onset like *pl* appear to exist as part of universal linguistic knowledge, whereas the nonexistence of onsets like **lp* suggest that something in their phonetic makeup disqualifies them from occurring in language. Language-specific constraints, on the other hand, hold true for individual languages such as English, but they may or may not be found in other languages. Each language has its own set of restrictions on the phonological shapes of its syllable constituents. Speakers of Russian, for example, are quite accustomed to pronouncing onset sequences such as *fsl-* and *mgl-*, which are not found in English (see Table 3.22).

***Table 3.22*** Some onset sequences in Russian

| | |
|---|---|
| [fslux] | 'aloud' |
| [mgla] | 'fog' |

Phonotactic constraints of the kind that we have seen for English represent one kind of phonological knowledge. You might, however, wonder what prevents English words like *extreme*, *applaud*, *decline*, *explain*, and *improvise* from being syllabified as the incorrect */ɛks.tɹim/, */əp.lɔd/, */dik.lajn/, */ɛks.plen/, and */ɪmp.ɹəv.ajz/, instead of the correct /ɛk.stɹim/, /ə.plɔd/, /di.klajn/, /ɛk.splen/, and /ɪm.pɹə.vajz/. In the incorrect syllabifications, the syllable divisions do not violate any phonotactic constraints, raising the question of why the syllabifications are nevertheless incorrect. The answer is that such syllabifications are prevented by a universal constraint on general syllable shapes, rather than by a phonotactic constraint on segment sequences. As mentioned in Section 4.1, there is a universal syllable-shape constraint that encourages languages to make syllables with onsets; as a result, onsets in languages tend to be as large as possible. The next section illustrates how this universal constraint works by providing a procedure for establishing the association of consonants and vowels within syllables.

## 4.4 Setting Up Syllables

Each language defines its own syllable structure through the interaction of universal and language-specific constraints. The process for setting up syllables in a given language has three steps: (1) nucleus-formation, (2) onset-formation, and (3) coda-formation. Then the resulting syllables are incorporated into word-level units. The first step reflects the universal tendency for syllables to have a sonorant core; the second step reflects the tendency for syllables to have onsets, and the third step reflects the tendency for syllables to have codas. Ordering onset-formation before coda-formation reflects a cross-linguistic tendency of *Onsets before codas:* (in a sequence of VCV, the consonant C will always be syllabified as an onset rather than a coda), and ensures that onsets gather up as many consonants as possible before any codas are formed.

- **Step a** *Nucleus-formation:* Since the syllable nucleus is the only obligatory constituent of a syllable, it is constructed first. Each vowel segment in a word makes up a syllabic nucleus. To represent this, link a vowel to an N symbol above it by drawing an **association line**. Above each nucleus symbol, place an R symbol (for rhyme—in Section 4.1 we saw that the rhyme consists of the nucleus plus the coda), which is filled out in step c below. Above each R, place a σ symbol; link all with association lines (see Figure 3.7).

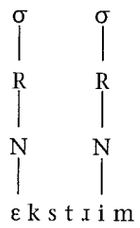


***Figure 3.7***

- **Step b** *Onset-formation:* The longest sequence of consonants to the left of each nucleus that does not violate the phonotactic constraints of the language in question is the onset of the syllable. Link these consonants to an O symbol and join it to the same syllable as the vowel to the right (see Figure 3.8). Note that there is no onset in the first syllable of *extreme*.


***Figure 3.8***

- **Step c** *Coda-formation:* Any remaining unassociated consonants to the right of each nucleus form the coda, and are linked to a Co symbol above them. This Co



is associated with the syllable nucleus to its left in the rhyme (see Figure 3.9). A syllable with a coda is called a **closed syllable**; a syllable without a coda is called an **open syllable**.

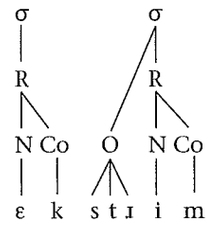


***Figure 3.9***

- **Step d** *Word-level construction:* Syllables that make up a single form (usually a word) branch out from the representation *Wd* as in Figure 3.10 (this step is frequently omitted from phonological representations to save space; the complete representation is understood even when *Wd* is not written out).

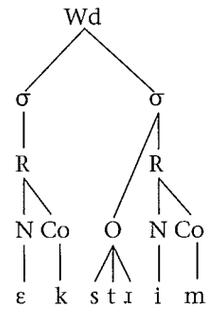


***Figure 3.10***

The steps in the procedure just outlined reflect universal constraints on syllable shapes. These interact with universal and language-specific phonotactic constraints. Given the procedure and the phonotactic constraints, we can now explain why words such as *applaud* and *explain* are syllabified as /ə.plɔd/ and /ɛk.splen/ (see Figure 3.11). In accordance with step b, onset-formation, all the consonants in the clusters between the two vowel nuclei in each word (*pl* and *kspl*, respectively) are considered for syllabification as onsets of the second syllable. Thus *pl* is a possible candidate for an onset. According to the phonotactic constraints that are active in English, it is also a permissible onset, so both consonants are syllabified as part of the second syllable onset. In contrast, *kspl* is not a permissible onset in English; *spl* is a permissible onset, however, so the last three consonants of *kspl* are syllabified as part of the second syllable onset, and the first consonant *k* is left to be syllabified as a coda to the preceding syllable.

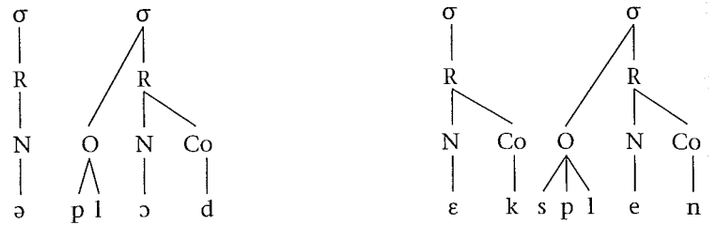


***Figure 3.11*** Syllabification: onsets before codas and phonotactic constraints

For a more advanced discussion of these issues, go to **bedfordstmartins.com/linguistics/phonology** and click on **Syllabification**.

## 4.5 Syllabic Phonology

One reason that syllables are treated as units of phonological structure is that they are relevant to stating generalizations about the distribution of allophonic features. The next sections provide examples of the role of syllables and subsyllabic constituents in phonological patterns. The fact that syllables and their internal constituents have such a role is thus evidence that they are part of the knowledge that speakers have of the phonology of their language.

### Aspiration in English

As Table 3.23 shows, the voiceless stops of English each have an aspirated and an unaspirated allophone.

***Table 3.23*** English aspiration

| *A* | | *B* | | *C* | |
|---|---|---|---|---|---|
| [pʰǽn] | pan | [spǽn] | span | [slǽp] | slap |
| [pʰéjn] | pain | [spéjn] | Spain | [slát] | slot |
| [pʰówk] | poke | [spówk] | spoke | [blák] | block |
| [tʰówn] | tone | [stówn] | stone | | |
| [kʰín] | kin | [skín] | skin | | |
| [pʰɨspájɹ] | perspire | [splǽt] | splat | | |
| [tʰəméjɾow] | tomato | [ʌpsét] | upset | | |
| [kʰənú] | canoe | | | | |
| [əpʰɔn] | upon | | | | |
| [ətʰǽk] | attack | | | | |
| [tʰəkʰílə] | tequila | | | | |

The distribution of aspiration can be stated generally by referring to syllable structure, and, in the case of the distribution of unaspirated stops, by referring to the subsyllabic onset and coda units (see Table 3.24).



***Table 3.24*** Distribution of aspirated stops in English

| *Aspirated stops* | *Unaspirated stops* |
|---|---|
| • syllable-initially | Elsewhere<br>• in a syllable onset preceded by *s* (whether another C follows or not)<br>• in a coda |

**LANGUAGE MATTERS A Syllabic Game**

Many cultures have language games that attempt to create secret languages. One such game in English is known (with some dialect variation) as *Ubbi Dubbi*. The game works like this. Start with a one-syllable word like *John* ([dʒɑn]) and insert the nonsense syllable [ʌb] after the onset. Try it. This will now be pronounced as [dʒʌbɑn]. This may seem pretty easy. Now try a two-syllable word like *Peter* [pitɻ]. Insert the nonsense syllable after both onsets. This is a bit harder, right? [pʌbitʌbɻ]. And it's probably getting a bit harder to understand. Try words of more syllables and build up to a sentence. [jʌbu wʌbɪl fʌbajnd ðʌbæt pɹʌbæktʌbɪs ʌbɪz hʌbɛlpfʌbl].

The phonemic representations of the three English stops are unaspirated, since aspiration is predictable. The environments where aspiration occurs can be stated very generally by referring to syllable structure.

8) English voiceless stops are aspirated syllable-initially.

This statement accounts for all the data in column A of Table 3.23, where voiceless stops appear syllable-initially. No aspiration is found in the forms in columns B and C since the voiceless stops appear either as the second member of the syllable onset (in *span*, *Spain*, *spoke*, *stone*, and *skin*), or in a coda, as in *upset*.

### Phonetic Length in English Vowels

English offers a second example of the phonological relevance of syllables. Phonetic length is predictable in English vowels, as the examples in Table 3.25 show.

***Table 3.25*** Phonetic length in English: long vowels before voiced coda consonants

| *A* | | *B* | |
|---|---|---|---|
| bad | [bæːd] | bat | [bæt] |
| Abe | [eːjb] | ape | [ejp] |
| phase | [feːjz] | face | [fejs] |
| leave | [liːv] | leaf | [lif] |
| tag | [tʰæːg] | tack | [tʰæk] |
| brogue | [bɹoːwg] | broke | [bɹowk] |
| | | tame | [tʰẽjm] |
| | | meal | [mil] |
| | | soar | [sɔɹ] |
| | | show | [ʃow] |

English vowels, whether or not they are diphthongs, are shorter before voiceless consonants, before sonorant consonants, and in word-final position; they are longer before voiced nonsonorant consonants provided these nonsonorant consonants are in coda position in the same syllable. As the next examples show, if vowels are followed by nonsonorant consonants that are onsets of the following syllable, the vowels are short. Thus, in Table 3.26 the vowels in the first syllable all precede a voiced, nonsonorant consonant, but they are short since the voiced consonant is in the following syllable.

***Table 3.26*** Short vowels before voiced onset consonants in English

| | | |
|---|---|---|
| obey | [ow.bej] | /obe/ |
| redo | [ɹi.du] | /ɹidu/ |
| regard | [ɹi.gɑɹd] | /ɹigɑɹd/ |

Compare your vowel length in the following pairs where one item has a closed syllable (lengthened vowel) and the other has an open syllable (shortened vowel).

robe/obey
brogue/ogre
rode/Odin

In order for an English vowel to be long, it must be followed by a voiced obstruent in the same syllable. The following generalization can now be made.

9) English vowels are long when followed by a voiced obstruent in the coda position of the same syllable.

As the analyses of the distribution of aspiration and vowel length in English have shown, the use of syllabic representations in phonology permits us to make more general statements about certain allophonic patterns in language than if we use only statements that do not make reference to syllable structure.

For more discussion of syllables and stress in English, go to **bedfordstmartins.com/linguistics/phonology** and click on **Syllables and stress**.

## 5 Features

In the previous section, we saw the role that syllable structure plays in verse, language games, and especially in allophonic variation. We also saw that universal and language-specific constraints govern the ways in which segment units combine to form the suprasegmental units of structure known as syllables. In this section we will discover that segments themselves are composed of even smaller, subsegmental, phonological units known as features. In fact, features are like atoms: they are the smallest units of phonology and as such are the basic building blocks of human speech sounds.



## 5.1 Why We Use Features

There are a number of reasons why linguists consider features to be the most basic units of the phonology.

### Features as Independent and Coordinated Phonetic Elements

We have already seen in Chapter 2 that speech is produced by a number of independent but coordinated articulatory activities such as voicing, tongue position, lip rounding, and so on. For example, when we produce the voiceless bilabial stop [p], the vocal cords in the larynx are open and not vibrating (hence the sound is voiceless), and the lips are pressed together to form a complete constriction (hence the sound is a labial stop). Each sound is thus the result of the coordinated articulatory activity of the larynx, and the various articulators, such as the tongue body, the tongue blade, the lips, and the velum, found in the oral and nasal cavities of the vocal tract. By assuming that segments are composed of features, we are able to model this phonetic reality.

The features are divided into groups that describe, among other things:

- Major class features: whether the segment is consonantal, syllabic, or sonorant
- Laryngeal states: whether the segment is voiced or not
- Place of articulation: what articulators are active in the oral cavity (lips, tongue tip, or tongue body) and specific features associated with that articulator

All features, except those for the articulators, are written as either "+" or "–." The articulator feature is written with an "o" to show which articulator is active. As an example, Figure 3.12 shows the features of the sound [ɑ]. In this representation the features of the segment are listed in an array called a **matrix**. This is a common way of presenting sets of features.

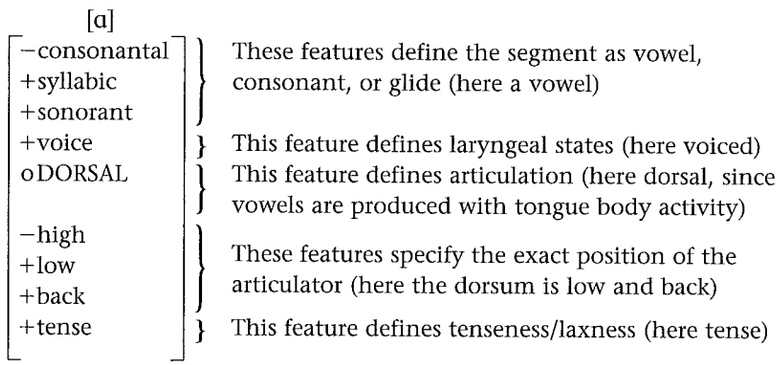


***Figure 3.12*** Feature representation for the English vowel /ɑ/

By "reading" the matrix, we see that [ɑ] is a vowel and is sonorant and voiced. It is produced by the tongue body, so its place of articulation is DORSAL. In addition, the tongue body is low, back, and tense. By using features in this way, we can capture the independent and coordinated phonetic properties of an individual sound.

## Features and Natural Classes

A second reason for viewing segments as composed of features is that doing so gives us an economical way of characterizing natural classes. **Natural classes** are classes of sounds that share a feature or features and that pattern together in sound systems.

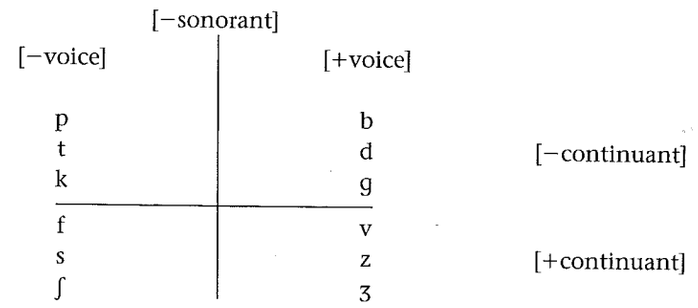


***Figure 3.13*** Natural classes: obstruents in English

To see what is meant by this, consider the set of English sounds /p/, /t/, /k/, /f/, /s/, /ʃ/, and /b/, /d/, /g/, /v/, /z/, /ʒ/, given in Figure 3.13. In fact, by using just three features, we can group these sounds into nine different natural classes:

- To capture the fact that all these sounds are obstruents, we can say that they are all [−sonorant], meaning they are not sonorants.
- We can distinguish the subset of sounds that are voiced from those that are voiceless with the feature [±voice].
- The feature [±continuant] refers to whether or not a sound is produced with a continuous flow of air through the oral cavity. Stops, which are [−continuant], can thus be distinguished from fricatives, which are [+continuant].

Table 3.27 shows the nine natural classes captured by the three features [sonorant], [voice], and [continuant].

***Table 3.27*** Nine natural classes: obstruents in English

| *Obstruents* | *Stops* | *Fricatives* | *Voiceless obstruents* | *Voiced obstruents* | *Voiceless stops* | *Voiced stops* | *Voiceless fricatives* | *Voiced fricatives* |
|---|---|---|---|---|---|---|---|---|
| [−sonorant] | [−sonorant, −continuant] | [−sonorant, +continuant] | [−sonorant, −voice] | [−sonorant, +voice] | [−sonorant, −continuant, −voice] | [−sonorant, −continuant, +voice] | [−sonorant, +continuant, −voice] | [−sonorant, +continuant, +voice] |
| p t k<br>b d g<br>f s ʃ<br>v z ʒ | p t k<br>b d g | f s ʃ<br>v z ʒ | p t k<br>f s ʃ | b d g<br>v z ʒ | p t k | b d g | f s ʃ | v z ʒ |



Any natural class requires fewer features to define it than to define any one of its members. In Table 3.27 the largest class, that of the obstruents, is defined by only one feature, while the four classes containing three segments each are defined by three features each.

Every set of sounds that constitutes a natural class has the potential to pattern together in some way in the phonology of a language. For instance, we saw above that aspiration in English affects /p/, /t/, and /k/, the [−sonorant, −continuant, −voice] sounds of the language. All and only these sounds are affected by the aspiration process. An interesting point about features is that their use allows us to exclude sounds from natural classes (as well as including them). Thus, because /b/ is [+voice], it does not belong to the same class in English as /p/, /t/, and /k/. As a result /b/ is not affected by aspiration.

Table 3.28 provides an additional illustration of the use of features to distinguish natural classes—in this case, the class of front and back vowels in English. Again we see that fewer features are needed to define the larger class of English front vowels than to capture the vowel /æ/ alone.

***Table 3.28*** Two natural classes: front and back vowels in English

| *Front vowels* | *Back vowels* | |
|---|---|---|
| [−consonantal, +syllabic, +sonorant, oDORSAL, −back] | [−consonantal, +syllabic, +sonorant, oDORSAL, +back] | [−consonantal, +syllabic, +sonorant, oDORSAL, −back, −high, +low, −tense, −reduced] |
| /i/<br>/ɪ/<br>/e/<br>/ɛ/<br>/æ/ | /u/<br>/ʊ/<br>/o/<br>/ʌ/<br>/ɑ/ | /æ/ |

In preceding sections, we listed those segments of English that contrast and therefore make up the phonemes of English. We can describe the contrasts between individual phonemes by referring to features; for example, the phoneme /p/ is distinguished from the phoneme /b/ by the single feature [voice]. But because features define natural classes, it is not just individual pairs of phonemes such as /p/ versus /b/ and /k/ versus /g/ that contrast in English; in fact, the entire class of voiced stops contrasts with the entire class of voiceless stops. In this economic way, then, features can be used to define all the contrasts found in the English sound system and in the sound system of any language. When a feature is the source of phonemic contrasts in

a language, we say that it is a **distinctive feature** in the language. Thus, [voice] is a distinctive feature in English.

Other features provide for other contrasts. For example, we can capture the contrast between /t/ and /s/ in English with the feature [continuant]. Both /t/ and /s/ are voiceless and have an alveolar point of articulation. By viewing the relevant distinctive feature as [continuant], we can use the same feature to distinguish between /p/ and /f/, /b/ and /v/, and /d/ and /z/ (see Table 3.29).

***Table 3.29*** Stop-fricative contrasts as a feature

| [−continuant] | [+continuant] |
|---|---|
| p | f |
| b | v |
| t | s |
| d | z |

By systematically examining the phonemic contrasts of a language, we can extract the distinctive features and use these irreducible linguistic elements to describe the phonemic inventory.

### Features, Processes, and Allophonic Variation

A third reason for using features is that reference to features enables us to understand the nature of allophonic variation more exactly. Viewed from the perspective of features, allophonic variation is seen to be not simply the substitution of one allophone for another, but rather the environmentally conditioned change or specification of a feature or features. The liquid-glide devoicing that occurs in English words like *tree* and *twinkle*, for example, is a change in the value of the feature [voice] from [+voice] to [−voice] after voiceless stops. Similarly, the vowel and glide nasalization that occurs in Malay forms like /mewah/ [mɛ̃w̃ãh] 'luxurious' is a change in the value of the feature [nasal] from [−nasal] to [+nasal] following a nasal consonant.

We saw above that features reflect the fact that speech is produced by a number of independent but coordinated articulatory activities. Certain features, however, reflect classes of sounds that are not always recognized in the traditional descriptive terminology of phonetics that was introduced in Chapter 2, but that are nevertheless relevant to phonological patterning. For example, the feature [CORONAL] refers to the class of sounds made with the tongue tip or blade raised; this class includes sounds made with interdental, alveolar, and alveopalatal places of articulation. It turns out that just this feature is required to state a constraint on the selection of consonant sequences in coda position in English: according to this constraint, when a vowel is tense and followed by two consonants (*pint*), or when a vowel is lax and followed by three consonants (*next* [nɛkst]), the final consonant in the coda must always be [CORONAL] (t, d, s, z, θ, ð, ʃ, ʒ, tʃ, or dʒ). Although the feature [CORONAL] does not reflect a traditional phonetic term, it plays a very important role in the phonologies of many languages. This fact shows us that features reflect articulatory reality in a way that involves more than just presenting traditional phonetic descriptions in a different guise.



## 5.2 Feature Representations

We have seen that segments are composed of subsegmental units or features and that features reflect phonetic reality. Since features are considered to be the basic building blocks of speech sounds, and thus of phonology, linguists have attempted to state all possible phonological facts about language with the fewest number of features possible. Only a limited number of features—currently around twenty-four—have been proposed. Features thus constitute an important part of a theory of what is possible (and what is not possible) in the phonological behavior of human beings. In this section we present and define features that are needed to characterize the sounds of English, as well as of many other languages.

### Defining the Features of English

Most features have labels that reflect traditional articulatory terms such as [voice], [consonantal], and [nasal]. These features require little further description. A few features have less familiar labels, such as [CORONAL] and [anterior]. From this point on, features will be used to describe classes of sounds. At the same time, we will continue throughout the book to use terms such as *consonant, glide,* and *obstruent* in phonetic description. This traditional terminology will be maintained because it is still widely used in phonetic description.

Features are organized into groups that reflect natural classes. The following headings indicate what these classes are and how the features represent them. Most of the features given below are written in lowercase and are **binary features**; in other words, they can have one of two values, "+" or "−," each of which defines a particular class of sounds. For example, [+voice] sounds involve vibration or voicing in the larynx, while [−voice] sounds involve an open glottis and therefore no vibration or voicing. Three of the features ([LABIAL], [CORONAL], and [DORSAL]) are written in uppercase and have only one value.

- **Major class features:** *features that represent the classes consonant, obstruent, and sonorant (nasal, liquid, glide, vowel)*

  **[±consonantal]** Sounds that are [+consonantal] are produced with a major obstruction in the vocal tract. All nonsonorant consonants (except the glottals [h] and [ʔ]), as well as liquids and nasals, are [+consonantal]. Glides and vowels are [−consonantal].

  **[±syllabic]** Sounds that can act as syllable nuclei are [+syllabic]; this includes vowels, and syllabic liquids or syllabic nasals. All other sounds are [−syllabic].

  **[±sonorant]** All and only those sounds that are singable are [+sonorant]; this includes vowels, glides, liquids, and nasals (even if the [+sonorant] sounds are voiceless). All nonsingable sounds (obstruents) are [−sonorant].

Table 3.30 illustrates how the major class features are used to divide sounds into classes. Note that nasals and liquids have the same values for the three major class features; to distinguish these two classes from each, other additional (manner) features are therefore needed.

***Table 3.30*** Use of major class features

| | *Obstruents* | *Nasals* | *Liquids* | *Glides* | *Vowels* |
|---|---|---|---|---|---|
| [±consonantal] | + | + | + | − | − |
| [±syllabic] | − | −/+ | −/+ | − | + |
| [±sonorant] | − | + | + | + | + |
| Examples: | p d v tʃ | m n | l ɹ | j w | i a |

The manner features given next represent manners of articulation. Their use is particularly important in distinguishing the following classes: stops/affricates as opposed to fricatives ([±continuant]); affricates as opposed to stops ([±delayed release]); nasals from nonnasals ([±nasal]); and laterals from nonlaterals ([±lateral]).

- **Manner features:** *features that represent manner of articulation*

  **[±continuant]** Sounds produced with free or nearly free airflow through the center of the oral cavity are [+continuant]; these include vowels, glides, liquids, and fricatives. All other sounds are [−continuant]; these include nasal and oral stops.

  **[±delayed release] ([±DR])** An affricate such as [tʃ] is composed of a stop [t] plus a fricative [ʃ]. In an affricate, the tongue is slower in releasing the stop portion of the affricate than when the stop is produced on its own. Hence affricates are said to be produced with delayed release. All and only affricates such as [tʃ] and [dʒ] are [+delayed release]. All other sounds are [−delayed release].

  **[±nasal]** Sounds produced with a lowered velum are [+nasal]; this includes nasal stops and all nasalized sounds. Sounds that are oral, and thus produced with a raised velum, are [−nasal].

  **[±lateral]** All and only varieties of *l* are [+lateral]. All other sounds are [−lateral].

Voicing, aspiration, and glottal constriction are all the result of laryngeal activity. To represent different laryngeal states, we use the features [±voice], [±spread glottis], and [±constricted glottis].

- **Laryngeal features:** *features that represent laryngeal activity*

  **[±voice]** All voiced sounds are [+voice]; all voiceless sounds are [−voice].

  **[±spread glottis] ([±SG])** All aspirated consonants are [+SG]; all others are [−SG].

  **[±constricted glottis] ([±CG])** All sounds made with a closed glottis are [+CG]; all others are [−CG]. In English only the glottal stop [ʔ] is [+CG].

The last set of features represents place of articulation, which is supralaryngeal (i.e., it occurs above the larynx). Unlike all the other features we have discussed so far, the place features include three articulator features that are not binary and are written in capital letters. These nonbinary articulator features are [LABIAL], [CORONAL], and [DORSAL]. These are used to distinguish the articulators that determine place of articulation: [LABIAL] sounds are made with the lips; [CORONAL] sounds are made with the tongue tip or blade; and [DORSAL] sounds are made with the tongue body. If an articulator is not used for a particular sound, it does not appear in the matrix of features. For example, the articulator feature for /k/ is [DORSAL] since the tongue back is used; the lips and tongue tip are not involved, so the features [LABIAL] and [CORONAL] do not appear in the feature matrix.



The three articulator features [LABIAL], [CORONAL], and [DORSAL] can be further refined by the use of binary features specific to each place of articulation. For example, both [k] and [j] belong to the natural class of [DORSAL] sounds. However, [k] is pronounced with the tongue [+high] and [+back], whereas [j] is pronounced with the tongue body [+high] and [−back].

- **Place of articulation features:** *features that represent supralaryngeal activity*

  **[LABIAL]** Any sound that is produced with involvement of one or both of the lips is [LABIAL]. This includes bilabial and labiodental sounds.

  **[±round]** A sound produced with the labial articulator may be produced by protruding the lips; such sounds are [+round]; labial sounds made with no lip protrusion are [−round]. Rounded vowels and the rounded labiovelar glide [w] are [+round], while [p, b, f, v] are [−round].

  **[CORONAL]** Any sound that is produced with involvement of the tongue tip or blade raised is [CORONAL]. Interdental, alveolar, and alveopalatal sounds are all [CORONAL].

  **[±anterior]** All coronal sounds articulated in front of the alveopalatal region (interdentals and alveolars) are [+anterior]; coronal sounds articulated at or behind the alveopalatal region (alveopalatals) are [−anterior].

  **[±strident]** All "noisy" coronal fricatives and affricates ([s z ʃ ʒ tʃ dʒ]) are [+strident]; all other coronal fricatives and affricates ([θ, ð]) are [−strident].

  **[DORSAL]** Any sound that is produced with involvement of the body of the tongue is [DORSAL]. This includes vowels and palatal and velar consonants.

  **[±high]** Dorsal consonants or vowels produced with the tongue body raised from a central position in the oral cavity are [+high]. Sounds produced with a neutral or lowered tongue body are [−high].

  **[±low]** Vowels produced with the tongue body lowered from a central position in the oral cavity are [+low]. All other vowels are [−low]. Consonants in English do not need the feature [low], although it may be used in languages that have uvular or pharyngeal consonants.

  **[±back]** Dorsal consonants or vowels produced with the tongue body behind the palatal region (hard palate) in the oral cavity are [+back]. Velars and uvulars are [+back]. Sounds produced with the tongue body at the palatal region are [−back].

  **[±tense]** Vowels that are tense are [+tense]; vowels that are lax are [−tense].

  **[±reduced]** The schwa ([ə]) is a lax and exceptionally brief vowel and is therefore [+reduced]; all other vowels are [−reduced].

It is important to remember that the binary articulatory features like [±anterior] or [±high] are specific to individual place features. For example, only the [LABIAL] articulator (the lips) can be rounded, so [±round] only appears in the feature matrix for [LABIAL] sounds. Since neither the tongue tip nor tongue body can be rounded, the [±round] feature is irrelevant and does not appear in the feature matrix for

[CORONAL] or [DORSAL] sounds. Conversely, the features [±anterior] and [±strident] are only used for [CORONAL] sounds, and [±high], [±low], and [±back] are only used for [DORSAL] sounds.

To see exactly how the articulator features are used to represent the various places of articulation of the consonants found in English, let us look at Table 3.31. In the feature representations, "o" indicates that the relevant articulator is active in the production of a sound. Where no "o" is present, the articulator is inactive.

***Table 3.31*** Use of place of articulation features in representing some English consonants

| | *Labials* | | *Dentals* | *Alveolars* | *Alveopalatals* | *Palatals* | *Velars* |
|---|---|---|---|---|---|---|---|
| | p | w | θ | s | ʃ | j | k |
| LABIAL | o | o | | | | | |
| [±round] | − | + | | | | | |
| CORONAL | | | o | o | o | | |
| [±anterior] | | | + | + | − | | |
| [±strident] | | | − | + | + | | |
| DORSAL | | o | | | | o | o |
| [±high] | | + | | | | + | + |
| [±back] | | + | | | | − | + |

The feature representations in Table 3.31 can be understood as follows:

- [p] is produced with the lips in an unrounded state. It is therefore a [LABIAL], [−round] sound. The tongue blade and the tongue body are not used in the production of [p] and therefore it has no feature specifications for the coronal and dorsal articulators or for [CORONAL] or [DORSAL] features.
- [θ s ʃ] are all [CORONAL] sounds because they are produced with the tongue blade. [θ s] are produced with the tongue blade in front of or at the alveolar ridge and are therefore [+anterior], while [ʃ] is produced with the tongue blade behind the alveolar ridge and is therefore [−anterior]. [θ] is produced with a quiet airflow and so is [−strident], while [s ʃ] are produced with noisy airflow and so are [+strident]. Since neither the lips nor the tongue body are used to produce these sounds, they have no specifications for [LABIAL] or [DORSAL] features.
- [j k] are both produced with the tongue body and are therefore [DORSAL] sounds. Both have a raised tongue body so are [+high], but [j] is pronounced with the tongue body at the hard palate, so is [−back]. In contrast, [k] is pronounced with the tongue body behind the hard palate, so it is [+back]. Finally, since neither the lips nor the tongue blade are used to produce these sounds, they have no specifications for [LABIAL] or [CORONAL] features.
- [w] is a labiovelar sound and is thus coarticulated; it is produced with both a tongue body that is raised and behind the hard palate, *and* with lip rounding. This means that both the dorsum and the lips are used to produce [w], so it is therefore both [LABIAL] and [DORSAL]; as a [LABIAL] sound it is [+round], and as a [DORSAL] sound it is [+high, +back]. Since the tongue blade is not used to produce this sound, it has no specifications for [CORONAL] features.



Table 3.32 exemplifies how the place of articulation features are used to represent vowels in English. All the vowels in the table are produced with an active tongue body and therefore are [DORSAL]; this is true of all vowels, in English and in all other languages. Vowels that involve lip rounding are also produced with the [LABIAL] articulator. [CORONAL] is never used in the feature representations of vowels. All vowels except schwa are unreduced and therefore specified as [−reduced].

***Table 3.32*** Use of place of articulation features in representing some English vowels

| | ɛ | ə | u | ɑ |
|---|---|---|---|---|
| LABIAL | | | o | |
| [±round] | | | + | |
| DORSAL | o | o | o | o |
| [±high] | − | − | + | − |
| [±low] | − | − | − | + |
| [±back] | − | + | + | + |
| [±tense] | − | − | + | + |
| [±reduced] | − | + | − | − |

- [ɛ] is a mid, front, lax, unrounded vowel. Since it is unrounded, it does not use the labial articulator. As a mid vowel, it has neither a raised nor a lowered tongue body, so it is [DORSAL] and specified as both [−high] and [−low]. As a front vowel, it is [−back] and as a lax vowel, it is [−tense].
- [ə] is a mid, central, unrounded, lax, and reduced vowel. As a mid vowel, it is [DORSAL, −high] and [−low]. As a central and therefore nonfront vowel, it is [+back]. (All central vowels are always [+back] in feature representations.) Being unrounded, it does not involve the labial articulator. Because it is a lax reduced vowel, it is [−tense] and [+reduced].
- [u] is a high, back, tense vowel, and is therefore specified as [+high], [+back], and [+tense]. Since it is round, it is [LABIAL, +round] in addition to being [DORSAL]. Since it is [+high], it is also [−low]. (Since the tongue body cannot be both raised and lowered at the same time, all [+high] vowels are also [−low].)
- [ɑ] is a low, back, unrounded, tense vowel. Since it is produced with a lowered tongue body it is [DORSAL, +low]; because a lowered tongue body cannot be simultaneously raised, it is also [−high]. Since it is back, it is [+back]. Being tense, it is [+tense], and being unrounded, it has no labial specifications.

Feature notation does not provide a convenient way to distinguish diphthongs such as [aj], [aw], and [ɔj] from the other vowels. These diphthongs may be treated as vowel-glide sequences when using features.

For more advanced information on determining feature representations, please go to **bedfordstmartins.com/linguistics/phonology** and click on **Feature representations**.

Tables 3.33 and 3.34 provide the feature representations for all the consonants and vowels of English. As you go through these tables, notice that features are listed

**Table 3.33** Feature matrix for English consonants

| | | Stops | | | | | | Fricatives | | | | | | | | Affricates | | Nasals | | | Liquids | | Glides | | | Glottals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | p | b | t | d | k | g | f | v | θ | ð | s | z | ʃ | ʒ | tʃ | dʒ | m | n | ŋ | l | ɹ | j | w | ʍ | h | ʔ |
| *Major class features* | [consonantal] | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | – | – | – | – | – | – | – | – | – | – |
| | [sonorant] | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | + | + | + | + | + | + | + | + | – | – |
| | [syllabic] | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | + | + | + | + | + | + | + | + | – | – |
| *Manner features* | [nasal] | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | + | + | + | + | + | – | – | – | – | – |
| | [continuant] | – | – | – | – | – | – | + | + | + | + | + | + | + | + | – | – | – | – | – | + | + | + | + | + | + | + |
| | [lateral] | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | + | – | – | – | – | – | – |
| | [delayed release] | – | – | – | – | – | – | – | – | – | – | – | – | – | – | + | + | – | – | – | – | – | – | – | – | – | – |
| *Laryngeal features* | [voice] | – | + | – | + | – | + | – | + | – | + | – | + | – | + | – | + | + | + | + | + | + | + | + | + | – | – |
| | [CG] | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | + |
| | [SG] | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | + | – |
| *Place of articulation features* | LABIAL | o | o | | | | | o | o | | | | | | | | | | | | | | | | | | |
| | [round] | – | – | | | | | – | – | | | | | | | | | | | | | | | | | | |
| | CORONAL | | | o | o | | | | | o | o | o | o | o | o | o | o | | | | | | | | | | |
| | [anterior] | | | + | + | | | | | + | + | + | + | + | + | + | + | | | | | | | | | | |
| | [strident] | | | – | – | | | | | – | – | + | + | – | – | + | + | | | | | | | | | | |
| | DORSAL | | | | | o | o | | | | | | | | | | | | | o | | | o | o | | | |
| | [high] | | | | | + | + | | | | | | | | | | | | | + | | | + | + | | | |
| | [back] | | | | | + | + | | | | | | | | | | | | | + | | | + | + | | | |

*Note:* [low], [tense], and [reduced] are not used for English consonants.
Aspirated stops [$p^h$, $t^h$, $k^h$] will have the feature [+SG].
Syllabic liquids and nasals will have the feature [+syllabic].



in the following order for every sound: major class features, manner features, laryngeal features, and place of articulation features. To remind yourselves of what a feature matrix for a segment looks like, go back to Figure 3.12, which illustrates the matrix for the segment [ɑ].

For further discussion of how to determine feature representations, go to **bedfordstmartins.com/linguistics/phonology** and click on **Representations**.

***Table 3.34*** Feature matrix for English vowels

| | | i | ɪ | e | ɛ | æ | ə | ʌ | u | ʊ | o | ɔ | ɑ/a* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Major class features* | [consonantal] | – | – | – | – | – | – | – | – | – | – | – | – |
| | [sonorant] | + | + | + | + | + | + | + | + | + | + | + | + |
| | [syllabic] | + | + | + | + | + | + | + | + | + | + | + | + |
| *Manner feature* | [continuant] | + | + | + | + | + | + | + | + | + | + | + | + |
| *Laryngeal feature* | [voice] | + | + | + | + | + | + | + | + | + | + | + | + |
| *Place of articulation features* | LABIAL | | | | | | | | o | o | o | o | |
| | [round] | | | | | | | | + | + | + | + | |
| | DORSAL | o | o | o | o | o | o | o | o | o | o | o | o |
| | [high] | + | + | – | – | – | – | – | + | + | – | – | – |
| | [low] | – | – | – | – | + | – | – | – | – | – | – | + |
| | [back] | – | – | – | – | – | + | + | + | + | + | + | + |
| | [tense] | + | – | + | – | – | – | – | + | – | + | – | + |
| | [reduced] | – | – | – | – | – | + | – | – | – | – | – | – |

**Note*: While [a] and [ɑ] are phonetically different, in English they have the same phonological features because they are not contrastive—and remember, central vowels (like [a]) are [+back]. For languages in which they contrast phonemically, the two sounds would have distinct feature specifications.

For more advanced discussion of features go to **bedfordstmartins.com/linguistics/phonology** and click on **Feature hierarchy**.

## 6 Derivations and Rules

To this point we have established the existence of related levels of phonological structure. In this model, phonological units from a lower level of structure are organized and grouped into higher-level structural units. Thus, features are grouped into segments, which in turn are organized into syllables. We have established that segments can be contrastive and hence belong to separate phonemes, or noncontrastive and hence function as predictable allophonic variants of phonemes. We have also seen that general statements referring to natural classes and to syllable structure can account for the patterning of noncontrastive elements. Finally, we have seen that there are two levels of representation associated with the difference between contrastive and noncontrastive segments: the phonemic level represents unpredictable,

phonemic properties and units of a language, while the phonetic level represents predictable, allophonic properties and units. In this section we will explore the relationship between the phonemic and phonetic levels of representation and illustrate how this relationship is formalized.

Phonologists assume that phonemic representations are equivalent to the mental representations that speakers have of the words in their language, while phonetic representations are equivalent to the actual phonetic outputs that are produced in the course of speech. In this sense, phonemic representations are understood to be the basic representations of units such as the word. The unpredictable phonological information represented in a phonemic representation thus underlies all actual phonetic forms; for this reason, phonemic representations are also called **underlying representations** (or forms) while phonetic representations are also called **surface representations** (or forms).

Phonemic representations become phonetic representations as a result of being acted upon by **phonological processes** such as the devoicing of liquids and glides that follow voiceless stops in English, the aspiration of voiceless stops at the beginning of syllables in English, the lengthening of English vowels preceding voiced coda obstruents, and so on. Thus we say that phonetic or surface forms are derived from phonemic or underlying forms by means of phonological processes. These phonological processes are formalized as **phonological rules** (formalized statements of phonological processes). In this section, we focus on understanding how rules act in **derivations** and how they should be formalized.

## 6.1 Derivations

Underlying representations are composed of phonemes (which are composed of distinctive features). Phonological processes—formalized as rules—operate on underlying representations to produce phonetic forms.

The derivation of three phonetic representations (PRs) from underlying representations (URs) is illustrated in Figure 3.14. Here, the underlying representation is on the top line (the cross hatch # symbolizes a word boundary); reading downward, each rule applies in sequence, and the underlying representation is adjusted as required. Where a rule fails to apply, the form remains unchanged; this information is conveyed by dashes. The resulting output then serves as the input to the following rule. Finally, when all rules relevant to the derivation in question have applied, a phonetic representation is formed. The two rules presented in the following example are aspiration and vowel lengthening (see Section 4.5).

| UR | #slæp# | 'slap' | #tæp# | 'tap' | #pæd# | 'pad' |
|---|---|---|---|---|---|---|
| Aspiration | – | | #tʰæp# | | #pʰæd# | |
| V-length | – | | – | | #pʰæːd# | |
| PR | [slæp] | | [tʰæp] | | [pʰæːd] | |

***Figure 3.14*** The phonological derivation of three English words

In this example, two rules have applied (since the words being derived are all monosyllabic, the syllable boundaries are equivalent to word boundaries and so are not



indicated here). The first accounts for aspiration. Since the initial consonants of the URs #tæp# and #pæd# are voiceless stops found in onset position, they fulfill the conditions under which English stops become aspirated. We therefore indicate that aspiration occurs by providing an intermediate form on a new line.

We have also seen that in English, vowels are predictably long when they occur before a voiced stop in the same syllable. In Figure 3.14, the /æ/s of *slap* and *tap* occur before voiceless stops and so are not lengthened. The vowel of *pad*, however, occurs in just the environment associated with long vowels and so is predictably lengthened.

The use of such derivations underscores the fact that allophonic variation is the result of processes that apply in the course of language use. Underlying representations capture the knowledge that speakers have about the nature of their phonological system, rules reflect the application of allophonic processes, and the phonetic representation reflects the speech output. The relationship between phonemic or underlying representations and phonetic or surface representations is the result of the action of phonological processes.

## 6.2 Rule Application

We have seen that more than one rule may be employed in a derivation. Consequently, we must now ask how several rules are applied to a given underlying form when these rules interact.

### Rule Ordering

In Figure 3.14 we examined the application of the rules of English aspiration and vowel lengthening, which apply to voiceless stops and vowels, respectively. Note that the environments in which each of these rules applies (onset and precoda position, respectively) are entirely different. Therefore, these rules do not interact or affect each other in any way; the order in which they are applied makes no difference to the outcome of the derivation. As Figure 3.15 shows, there is no difference in the outcome when the same rules are applied in reverse order.

| UR | #slæp# | 'slap' | #tæp# | 'tap' | #pæd# | 'pad' |
|---|---|---|---|---|---|---|
| V-length | – | | – | | #pæːd# | |
| Aspiration | – | | #tʰæp# | | #pʰæːd# | |
| PR | [slæp] | | [tʰæp] | | [pʰæːd] | |

***Figure 3.15*** Unordered rule application

We therefore say that the rules of aspiration and vowel lengthening are **unordered** with respect to each other. There are cases, however, in which two rules have to be **ordered** with respect to each other. For example, in some instances, the application of one rule creates an environment that makes possible the application of another rule. A case of ordered rules is illustrated in Figure 3.16. In casual speech, the word *parade* in English is pronounced [pɻéːjd]: there is initially a schwa between *p* and *r* which gets deleted by means of a rule of schwa-deletion because it is unstressed. After the schwa is deleted, the liquid *r* that follows the schwa in the

| UR | #pəɹed# 'parade' |
|---|---|
| Stress | #pəɹéd# |
| Schwa deletion | #pɹéd# |
| Liquid-glide devoicing | #p̥ɹéd# |
| Diphthongization | #p̥ɹéjd# |
| Vowel lengthening | #p̥ɹéːjd# |
| PR | [p̥ɹéːjd] |

***Figure 3.16*** Rule order in a derivation

underlying representation gets positioned directly after a voiceless stop. As a result, the *r* becomes subject to the rule of liquid-glide devoicing (given in example *4* in Section 2.3), and is therefore devoiced.

In Figure 3.16 the arrow, which is not normally written in derivations, indicates that the schwa deletion rule must apply before liquid-glide devoicing. Notice also that a rule that assigns stress to the final vowel applies before schwa-deletion. In addition, notice that if liquid-glide devoicing applied before schwa-deletion, the devoicing of *r* would not be able to take place because *r* would not be positioned right after the voiceless *p* and therefore would not get devoiced. What is clear, then, is that to get the correct surface form [p̥ɹéːjd], schwa-deletion must be ordered before liquid-glide devoicing.

## 6.3 The Form and Notation of Rules

General statements about allophonic distribution are formalized as rules, which are written so as to reflect the dynamic nature of processes (see Chapter 2, Section 9.3).

### Rules

Rules take the following form.

10) $A \rightarrow B \,/\, X \_\_ Y$

In this notation, *A* stands for an element in representation, *B* for the change it undergoes or for the output of the rule, and *X* and *Y* for the conditioning environment. Either *X* or *Y* may be absent (null) if the conditioning environment is found only on one side of the allophone. The __ (focus bar) indicates the position of the segment undergoing the rule. The slash separates the statement of the change from the statement of the conditioning environment, and can be thought of as meaning 'in the environment of'. This rule is therefore read as *A becomes B in the environment between X and Y.*

As an example of rule writing, we return to the distribution of liquid-glide devoicing in English (Section 2.3): liquids and glides have voiceless allophones after syllable-initial voiceless stops (and voiced allophones elsewhere). The rule statement treats the voiced allophones of liquids and glides as basic (underlying) and changes the feature [+voice] to [−voice] in the appropriate environment (see Figure 3.17).

The rule in Figure 3.17 is a shorthand for the prose statement given in *11*.

11) Liquids and glides become voiceless after syllable-initial voiceless stops.



$$\begin{bmatrix}\text{–syllabic}\\ \text{+sonorant}\\ \text{+voice}\\ \text{–nasal}\end{bmatrix} \rightarrow [\text{–voice}] \,/\, \sigma \begin{bmatrix}\text{–syllabic}\\ \text{+consonantal}\\ \text{–sonorant}\\ \text{–continuant}\\ \text{–voice}\\ \text{–delayed release}\end{bmatrix} \_\_\_\_$$

***Figure 3.17*** Liquid-glide devoicing in English expressed as a rule

The use of features in Figure 3.17 expresses the fact that liquids and glides form a natural class of sounds: specifically, they are the nonnasal sonorant consonants of English. It also formally represents the fact that the process is phonetically based. For example, the devoicing of liquids and glides in English is a typical process of assimilation. The rule notation in Figure 3.17 explicitly shows this by indicating that the [+voice] feature of sonorant consonants changes to [−voice] following the class of voiceless stops, sounds that are themselves [−voice].

### Deletion and Epenthesis as Rules

We have already seen that English speakers (optionally) drop a schwa [ə] in an open syllable when it is followed by a stressed syllable, as in *police* [p̥lís] and *parade* [p̥ɹéjd]. The rule can be formalized as in Figure 3.18. Here, $C_0$ is an abbreviation for any number of successive consonants from zero on up and the σ represents a syllable boundary.

$$[\text{ə}] \rightarrow \emptyset \,/\, C_0 \_\_ \sigma\ C_0 \qquad \begin{matrix}\text{V}\\ [\text{+stress}]\end{matrix}$$

***Figure 3.18*** Schwa deletion in English

The null sign Ø in Figure 3.18 is used in writing both deletion and epenthesis rules. **Deletion** gets rid of something that was present in the underlying form; conversely, **epenthesis** adds something that was not present in the underlying form, as shown schematically in *12*.

12)

| | Underlying form → Surface form | / (Environment) |
|---|---|---|
| Rule form: | A → B | / . . . |
| Deletion: | A → Ø | / . . . |
| Epenthesis: | Ø → B | / . . . |

An example of epenthesis in English involves vowel insertion that is frequently triggered when an impermissible phonotactic structure is encountered in a borrowed word, as in the English pronunciation of the name *Dmitri*. It is also the case that in some dialects of English, a coda consisting of *l* and another consonant is not permitted. In these dialects, *milk* is pronounced [mɪlək] and *film* [fɪləm]. This latter change can be represented in rule format as in Figure 3.19. It should be noted, however, that this rule applies for only a small number of words.

$$\emptyset \rightarrow [\text{ə}] \,/\, [\text{+lateral}] \_\_\_\_ \begin{bmatrix}\text{–syllabic}\\ \text{+consonantal}\end{bmatrix} \sigma$$

***Figure 3.19*** Schwa epenthesis in English as a rule

For more on the rules of epenthesis, go to **bedfordstmartins.com/linguistics/phonology** and click on **Epenthesis: alpha notation**.

### Rules That Refer to Syllable Structure

The epenthesis rule in Figure 3.19 refers to syllable structure. Notice that there is a syllable boundary marker [σ] at the end of the rule statement; this marker is used to indicate that the schwa is inserted between a lateral and another consonant at the end of a syllable. Although the rule formulated in Figure 3.19 does not explicitly state this, the insertion of the schwa actually changes the syllable structure of the input word. In other words, a word such as *film*, which constitutes one syllable initially, becomes two syllables after epenthesis. This change in syllable structure is illustrated in Figure 3.20.

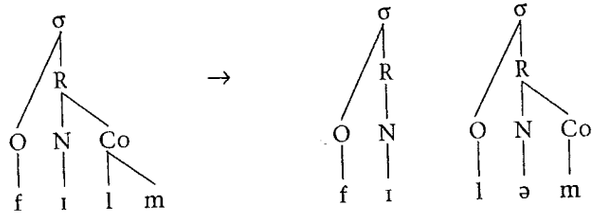


***Figure 3.20*** Syllabic representations of schwa epenthesis in English

Many other rules in English and in other languages make reference to syllable structure. One of these is the rule of vowel lengthening in English. Remember the data from Table 3.25 that showed the differences in vowel length in words such as *phase* versus *face*?

13) English vowels are long when followed by a voiced obstruent consonant in the same syllable.

The corresponding rule (in Figure 3.21) states that an underlying short vowel is lengthened in the appropriate context. As in the case of the epenthesis rule, the boundary of the syllable is represented by a syllable marker σ. Notice that the onset of the syllable is irrelevant to the statement of the rule and so is not included in the formalization.

$$\begin{bmatrix} +\text{syllabic} \\ -\text{consonantal} \\ +\text{sonorant} \\ -\text{long} \end{bmatrix} \rightarrow [+\text{long}] \; / \; \underline{\quad} \; \begin{bmatrix} -\text{syllabic} \\ +\text{consonantal} \\ -\text{sonorant} \\ +\text{voice} \end{bmatrix} \; \sigma$$

***Figure 3.21*** Vowel lengthening in English

For an advanced discussion of the nature and structure of phonological representations, go to **bedfordstmartins.com/linguistics/phonology** and click on **Representations**.



## 6.4 Processes and Rules: A Last Word

The combined use of features and processes in phonological description reflects the dynamic nature of linguistic behavior. First, the use of features reflects a basic level of phonological activity—contrasts take place on the feature level, not on the level where segments are represented. Secondly, the use of process notation and formalization with rules reflects the realities of linguistic production, in which sounds are affected by the context in which they are pronounced as we speak. Overall, the patterning of phonological units follows from the interaction of a universal set of features, universal and language-specific phonotactic constraints and syllabification procedures, and the use of rules. This current theory of phonology is based on principles that are applicable to the study of any human language.

## Summing Up

Phonology deals with the sequential and phonetically conditioned patterning of sounds in language. To account for this patterning, three units of phonological representation have been established: the **feature**, the **phoneme**, and the **syllable**. Phonemes are contrastive segmental units composed of distinctive features. Phonetically conditioned variants of phonemes are called **allophones**.

Phonology makes use of **underlying forms**, **derivations**, and **phonological rules** in its formal notation. Some rules are ordered with respect to each other.

## Key Terms

*General terms*

environment
feature
phonology
segment
syllable

*Distinctive sounds and their variations*

allophones
allophonic distribution
Canadian raising
complementary distribution
contrast
free variation
minimal pair
near-minimal pairs
phonemes
phonemic representation
phonemic transcriptions
phonetic representation
phonetic transcriptions

*Terms concerning syllable structure*

accidental gaps
association line
closed syllable
coda
nucleus
onset
open syllable
phonotactics
rhyme
suprasegmental
systematic gaps

*General terms concerning classes of sounds and features*

binary features
consonantal
distinctive feature
matrix
natural classes
obstruents
sonorant
syllabic

*Manner features*

continuant
delayed release (DR)
lateral
nasal

*Laryngeal features*

constricted glottis (CG)
spread glottis (SG)
voice

*Place features*

anterior
back
CORONAL
DORSAL
high
LABIAL
low
reduced
round
strident
tense

*Terms concerning rules, representations, and processes*

deletion
derivations
epenthesis
ordered (rule application)
phonological processes
phonological rules
surface representations (forms)
underlying representations (forms)
unordered (rule application)

For more information on the sources used in this chapter, see the Sources section at the back of the book, or go to **bedfordstmartins.com/linguistics/phonology** and click on **Sources**.

## Recommended Reading


Anderson, Stephen R. 1985. *Phonology in the Twentieth Century.* Chicago: University of Chicago Press.

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## Appendix: Hints for Solving Phonology Problems

The task of solving a phonology problem is made easier if certain facts presented in this chapter and summarized here are kept in mind. The data that we consider below are taken from Tagalog (Filipino), a language spoken in the Philippines.

1. In the following data, consider the phones [h] and [ʔ] and determine whether they contrast, or whether they are allophones of one phoneme.

| | | | |
|---|---|---|---|
| a) kahon | 'box' | d) ʔaɾi | 'property' |
| b) haɾiʔ | 'king' | e) humagos | 'to paint' |
| c) ʔumagos | 'to flow' | | |

   In order to determine whether the phones contrast, we begin by looking for minimal pairs. These establish which segments are contrastive. For example, in the data in a) through e), a minimal pair occurs in items c–e; b–d is a near-minimal pair. The existence of minimal and near-minimal pairs of words indicates that [h] and [ʔ] contrast. Therefore we can conclude that /h/ and /ʔ/ are separate phonemes.

2. Now consider the following data, and determine whether the two sounds [d] and [ɾ] contrast or whether they are allophones of one phoneme.

| | | | |
|---|---|---|---|
| a) datiŋ | 'to arrive' | f) daɾaʔiŋ | 'will complain' |
| b) dami | 'amount' | g) maɾumi | 'dirty' |
| c) dumi | 'dirt' | h) maɾami | 'many' |
| d) daɾatiŋ | 'will arrive' | i) daʔiŋ | 'to complain' |
| e) mandurukot | 'pickpocket' | j) mandukot | 'to go pickpocketing' |

   Since there are no minimal pairs in the data which contrast [d] and [ɾ], we proceed to check whether the two sounds are in complementary distribution. Normally, when two sounds are in complementary distribution and therefore allophones of one phoneme, they must be phonetically similar. In Tagalog, [d] and [ɾ] are both voiced alveolar segments; thus, they are sufficiently similar phonetically to be viewed as potential allophones of one phoneme.

   To check whether two (or more) sounds are in complementary distribution, the best thing to do is to list the environments in which the sounds occur:

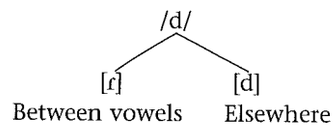
| [d] occurs: | [ɾ] occurs: |
|---|---|
| –word-initially (e.g., *dami*) | –between two vowels (e.g., *maɾami*) |
| –following a nasal (e.g., *mandukot*) | |

   [d] never occurs between two vowels, and [ɾ] never occurs word-initially or following a nasal. Since the two sounds never occur in identical environments, they are in complementary distribution and their distributions are predictable.

3. If two potential allophones of one phoneme are in complementary distribution, we can be reasonably sure that they are allophones of one phoneme. We can therefore

make a general statement about their distribution, in terms of some natural phonological class. For example: Tagalog [d] and [ɾ] are in complementary distribution and are allophones of one phoneme. The allophone [ɾ] occurs between vowels; [d] occurs elsewhere—here, word-initially, as in items a), b), c), f), and so on, and after nasal consonants, as in items e) and j).

4. Once we have determined that two sounds are allophones of one phoneme, we need to determine what the phoneme that they are both derived from is. Usually this can be done by selecting one of the allophones as basic. In most cases, the allophone chosen to represent the phoneme is the one with the widest distribution (the elsewhere variant). In the Tagalog case, the elsewhere variant is [d], so we posit the phoneme /d/, which has two allophones, [d] and [ɾ]. It may be helpful to set up a traditional phoneme-allophone diagram to illustrate this (see Figure 3.2).




5. Now that we know that [d] and [ɾ] are allophones of the phoneme /d/, we need to determine the phonological rule that accounts for the predictable features of the other allophones. Our rule is probably correct if it describes a common linguistic process (such as assimilation) in terms of natural classes of sounds interacting with neighboring segments and/or syllable structure.

   For example, for the above: d → ɾ / V___V

   The process at work here is a form of assimilation, in that an underlying voiced stop consonant becomes a continuant when found between two continuants (vowels).

6. We can assume that segments are phonemic if there are no minimal pairs for them but they cannot be shown to be allophones of one phoneme. In such a case, we can conclude that the data simply did not provide minimal pairs.

## Exercises

Assume phonetic transcription of the data in all exercises.

1. *Inuktitut* (Eastern) (Native Canadian)
   The data here are in a relatively broad transcription.

| | | | | | |
|---|---|---|---|---|---|
| a) | iglumut | 'to a house' | h) | pinna | 'that one up there' |
| b) | ukiaq | 'late fall' | i) | ani | 'female's brother' |
| c) | aiviq | 'walrus' | j) | iglu | '(snow)house' |
| d) | aniguvit | 'if you leave' | k) | panna | 'that place up there' |
| e) | aglu | 'seal's breathing hole' | l) | aivuq | 'she goes home' |
| f) | iglumit | 'from a house' | m) | ini | 'place, spot' |
| g) | anigavit | 'because you leave' | n) | ukiuq | 'winter' |

   *i)* List all the minimal pairs in this data. Based on the minimal pairs you have found, list all the contrastive pairs of vowels. (Refer to Section 1.1.)



   *ii)* Using the vowel charts in Figures 2.8 and 2.9 in Chapter 2 as your models, make a chart of Inuktitut vowel phonemes.

   *iii)* Now consider the data again; here it is transcribed in narrower transcription. In it, there are phonetically similar segments that are in complementary distribution. Look for them and then answer the question that follows the data.

| | | | | | |
|---|---|---|---|---|---|
| aa) | iglumut | 'to a house' | hh) | pinna | 'that one up there' |
| bb) | ukiaq | 'late fall' | ii) | anɪ | 'female's brother' |
| cc) | aivɪq | 'walrus' | jj) | iglʊ | '(snow)house' |
| dd) | aniguvit | 'if you leave' | kk) | panna | 'that place up there' |
| ee) | aglʊ | 'seal's breathing hole' | ll) | aivʊq | 'she goes home' |
| ff) | iglumit | 'from a house' | mm) | inɪ | 'place, spot' |
| gg) | anigavit | 'because you leave' | nn) | ukiʊq | 'winter' |

   *iv)* List the phonetically similar segments that are in complementary distribution. State their distribution in words. (Refer to Sections 2 and 3.)

2. *Hindi* (Hindi is a language of the Indo-European family spoken in India.)
   Consider the segments [b] and [b̤] in the data below and answer the questions that follow. The segment transcribed [b̤] is a murmured voiced stop.

| | | | | | |
|---|---|---|---|---|---|
| a) | [bara] | 'large' | f) | [b̤ed] | 'disagreement' |
| b) | [b̤ari] | 'heavy' | g) | [bais] | 'twenty-two' |
| c) | [bina] | 'without' | h) | [b̤əs] | 'buffalo' |
| d) | [b̤ir] | 'crowd' | i) | [bap] | 'father' |
| e) | [bori] | 'sackcloth' | j) | [b̤ag] | 'part' |

   *i)* Are the segments [b] and [b̤] allophones of the same phoneme or do they belong to separate phonemes? If you believe they belong to separate phonemes, give evidence from the data to support your analysis. If you believe they are allophones of the same phoneme, list the conditioning environments. (Refer to Sections 2 and 3.)

3. *Mokilese* (Mokilese is an Austronesian language of the South Pacific.)
   Examine the following data from Mokilese carefully, taking note of where voiceless vowels occur.

| | | | | | |
|---|---|---|---|---|---|
| a) | pi̥san | 'full of leaves' | g) | uduk | 'flesh' |
| b) | tu̥pu̥kta | 'bought' | h) | kaskas | 'to throw' |
| c) | pu̥ko | 'basket' | i) | poki | 'to strike something' |
| d) | ki̥sa | 'we two' | j) | pil | 'water' |
| e) | su̥pwo | 'firewood' | k) | apid | 'outrigger support' |
| f) | kamwɔki̥ti | 'to move' | l) | ludʒuk | 'to tackle' |

   *i)* The vowel phonemes of Mokilese are /i e ɛ u o ɔ a/. In Mokilese, [i̥] is an allophone of /i/, and [u̥] is an allophone of /u/. No other vowels have voiceless allophones. State in words the conditioning factors that account for this distribution. Be as general as possible in referring to classes of sounds. (Refer to Sections 2 and 3.)

   *ii)* If you have completed the section on rule formalization, write a rule (using features) that accounts for the derived allophones. (Refer to Sections 5 and 6.3.)

4. *Gascon* (Gascon is spoken in southwest France.)
The phones [b], [β], [d], [ð], [g], and [ɣ] are all found in Gascon, as the following examples show. The phone [β] is a voiced bilabial fricative; [ɣ] is a voiced velar fricative. The phone [y] is a high tense front rounded vowel. (Refer to Sections 2 and 3.)

| | | | | |
|---|---|---|---|---|
| a) | brẽn | 'endanger' | n) gat | 'cat' |
| b) | bako | 'cow' | o) lũŋg | 'long' |
| c) | ũmbro | 'shadow' | p) saliβo | 'saliva' |
| d) | krãmbo | 'room' | q) noβi | 'husband' |
| e) | dilys | 'Monday' | r) aβe | 'to have' |
| f) | dũŋko | 'until' | s) ʃiβaw | 'horse' |
| g) | duso | 'sweet' | t) byðɛt | 'gut' |
| h) | taldepãn | 'leftover bread' | u) eʃaðo | 'hoe' |
| i) | pũnde | 'to lay eggs' | v) biɣar | 'mosquito' |
| j) | dudze | 'twelve' | w) riɣut | 'he laughed' |
| k) | guteʒa | 'flow' | x) agro | 'sour' |
| l) | ẽŋgwãn | 'this year' | y) ʒuɣɛt | 'he played' |
| m) | puðe | 'to be able' | | |

*i)* Group the six phones [b], [β], [d], [ð], [g], and [ɣ] into three pairs of sounds. Within each pair, the two phones should be phonetically similar. Describe the members of each pair phonetically in terms of place and manner of articulation and voicing.

*ii)* List the environments in which the phones [b], [β], [d], [ð], [g], and [ɣ] are found. You may ignore word-final position in your consideration.

*iii)* What is the evidence, if any, for grouping the pairs of sounds into phonemes? State the evidence for each pair.

*iv)* Make a general statement about the patterning of the phonemes you have established.

*v)* Following your analysis, write the following forms in phonemic transcription.

a) [puɣo] b) [deðat] c) [ʃiβaw] d) [krãmbo]

5. *Swampy Cree* (Swampy Cree is a Native Canadian language of the Algonquian family.)
The following data from Swampy Cree shows a number of different voiced and voiceless consonantal segments.

| | | | | |
|---|---|---|---|---|
| a) | niska | 'goose' | l) nisto | 'three' |
| b) | kodak | 'another' | m) tʃi:gahigan | 'axe' |
| c) | asaba:p | 'thread' | n) adim | 'dog' |
| d) | wasko:w | 'cloud' | o) mi:bit | 'tooth' |
| e) | paskwa:w | 'prairie' | p) pimi: | 'lard' |
| f) | ni:gi | 'my house' | q) mide | 'heart' |
| g) | ko:go:s | 'pig' | r) o:gik | 'these' |
| h) | tahki | 'often' | s) tʃi:ma:n | 'canoe' |
| i) | namwa:tʃ | 'not at all' | t) wa:bos | 'rabbit' |
| j) | ospwa:gan | 'pipe' | u) na:be:w | 'man' |
| k) | midʒihtʃij | 'hand' | v) mi:dʒiwin | 'food' |

*i)* Do [p] and [b] belong to separate phonemes, or are they allophones of one phoneme? If you think they belong to separate phonemes, list data



to support your case. If you think they are allophones, first state the conditioning factors in words, and then, using features, write a rule that accounts for their distribution. (Refer to Sections 2, 3, 5, and 6.3.)

*ii)* Do the same for [t] and [d], [k] and [g], and [tʃ] and [dʒ].

*iii)* Make a general statement about the relationship among all the consonantal pairs whose distribution you have examined.

*iv)* Using Figure 3.14 in Section 6.1 as your model, provide complete derivations of the forms for k) *hand*, m) *axe*, and o) *tooth*.

6. There are a number of natural classes in the vowel and consonant data below. (Refer to Section 5, especially 5.1.) Circle three natural classes in each set of data. Indicate which feature or features define the class, as in the example. The phone [x] is a voiceless velar fricative.

*Example:* [+voice]— (b d) tʃ (k) h —[–continuant]

a)

| | | |
|---|---|---|
| i | | u |
| e | | o |
| | a | |

b)

| | | | | |
|---|---|---|---|---|
| p | | | tʃ | k |
| | | | dʒ | |
| f | θ | ʃ | | x |
| m | | | | ŋ |

7. Name a single feature that distinguishes the following pairs of sounds. (Refer to Section 5.)

a) [θ] : [ð]
b) [p] : [f]
c) [u] : [ʊ]
d) [i] : [e]
e) [b] : [m]
f) [s] : [ʃ]
g) [i] : [ɪ]
h) [k] : [g]
i) [ʌ] : [ə]
j) [s] : [θ]
k) [e] : [ɛ]
l) [u] : [o]

8. Complete the feature matrix for each of the sounds indicated. The V abbreviates the features [+syllabic, −consonantal], and the C abbreviates the features [−syllabic, +consonantal]. (Refer to Section 5.)

a) [e] V
[+sonorant
oDORSAL
–high
–low]

b) [ʃ] C
[–sonorant
–voice
–nasal]

c) [m] C
[+sonorant
oLABIAL]

d) [s] C
[–sonorant
oCORONAL
+strident]

e) [g] C
[–sonorant
oDORSAL
+high]

f) [j]
[–syllabic
–consonantal]

9. *English/Korean*
As we have seen, phonological adaptation of loan words may reflect facts about syllable structure. The Korean automobile name *Hyundai* has been adapted into English in various ways, one of which follows. Given the Korean form and the English adaptation provided, state two reasons based on syllable structure

conditions that explain why the English form is pronounced the way it is. (Refer to Section 4.)

| *Korean form* | | *English form* |
|---|---|---|
| /hjʌndæ/ | → | /hʌnde/ [hʌndej] |

10. *English*
Many speakers of English have two variants of [l]. One, called *clear l*, is transcribed as [l] in the following data. The other, called *dark l*, is transcribed with [ɬ]. Use of [l] and [ɬ] varies according to dialect. Examine the data from one dialect, and answer the questions that follow.

| | | | |
|---|---|---|---|
| a) [lajf] | 'life' | g) [pʰɪɬ] | 'pill' |
| b) [lip] | 'leap' | h) [fiɬ] | 'feel' |
| c) [luːz] | 'lose' | i) [hɛɬp] | 'help' |
| d) [ilowp] | 'elope' | j) [bʌɬk] | 'bulk' |
| e) [dilajt] | 'delight' | k) [sowɬd] | 'sold' |
| f) [slip] | 'sleep' | l) [fʊɬ] | 'full' |

Do [l] and [ɬ] belong to separate phonemes or are they allophones of the same phoneme? If you think they belong to separate phonemes, answer question *i*. If you think they are allophones of the same phoneme, answer questions *ii–iv*. (Refer to Section 2.)

*i)* List the evidence that makes your case for considering [l] and [ɬ] as separate phonemes.
*ii)* State the distribution of [l] and [ɬ] in words.
*iii)* Which variant makes the best underlying form? Why?
*iv)* What role does syllable structure play in your distribution statement? If you have covered Section 6.1, write the distribution statement in rule form.

11. *Canadian French*
For the purposes of this problem, you may assume that syllables in Canadian French have the following structure:

- Maximum number of consonants in an onset: 2. Where there are two onset consonants, the first must be an obstruent, the second a sonorant or a fricative.
- Each vowel forms a syllable nucleus.
- Maximum number of consonants in a coda: 2.

With these stipulations in mind, syllabify the following forms (see Section 4):

a) bukan 'smoke'
b) erite 'to inherit'
c) pudrəri 'snowstorm'
d) plie 'to fold'

In the following data from Canadian French, each pair of phones is in complementary distribution.

| | |
|---|---|
| [i] and [ɪ] | are allophones of one phoneme |
| [y] and [ʏ] | are allophones of a second phoneme |
| [u] and [ʊ] | are allophones of a third phoneme |

It is possible to make a general statement about the distribution of the vowel allophones that accounts for all three phonemes. [y] is a high, front, rounded, tense vowel while [ʏ] is a high, front, rounded, lax vowel.



Examine the data and answer the questions that follow.

| | | | | | |
|---|---|---|---|---|---|
| a) | pilʏl | 'pill' | o) | fini | 'finished' |
| b) | griʃe | 'to crunch' | p) | fɪj | 'girl' |
| c) | grɪʃ | 'it crunches' | q) | dzʏr | 'hard' |
| d) | pətsi | 'little (masc.)' | r) | tryke | 'to fake' |
| e) | pətsɪt | 'little (fem.)' | s) | fʊl | '(a) crowd' |
| f) | vitamɪn | 'vitamin' | t) | plʏs | 'more' |
| g) | saly | 'hi' | u) | ru | 'wheel' |
| h) | ʒʏp | 'skirt' | v) | rʊt | 'road' |
| i) | fyme | 'smoke' | w) | suvã | 'often' |
| j) | lynɛt | 'glasses' | x) | trupo | 'herd' |
| k) | tɔrdzy | 'twisted" | y) | sʊp | 'flexible' |
| l) | lʏn | 'moon' | z) | tʊʃ | 'touch' |
| m) | pɪp | 'pipe' | aa) | fu | 'crazy (masc.)' |
| n) | grimas | 'grimace' | bb) | trʏk | '(a) trick' |

*i)* Provide a statement of the distribution of [i] and [ɪ], [y] and [ʏ], [u] and [ʊ] in words. Make your statement as general as possible, but be precise! (You may find Section 4.5 helpful.)
*ii)* If you have completed the section on rule formalization in Section 6.3, write a single rule that derives the allophones of each phoneme from the underlying form. Use features! Be sure to give your rule a name; use this name in the answer to question *iii*.
*iii)* Provide derivations for the following underlying forms. (See Section 6.2.)

| UR | # | # | 'vitamin' | # | # | 'glasses' |
|---|---|---|---|---|---|---|
| PR | [vitamɪn] | | | [lynɛt] | | |

12. *English*
The following data contains both careful speech and fast speech forms. Note the differences and answer the questions that follow. Some phonetic detail irrelevant to the question has been omitted from the transcription. Remember that an asterisk before a form indicates that it is not acceptable to (most) native speakers.

| | *Careful speech* | | *Fast speech* | *Spelled form* |
|---|---|---|---|---|
| a) | [æspəɹən] | k) | [æspɹən] | aspirin |
| b) | [pɔ́ɹsələn] | l) | [pɔ́ɹslən] | porcelain |
| c) | [næʃənəlàjz] | m) | [næʃnəlàjz] | nationalize |
| d) | [ɹízənəbl̩] | n) | [ɹíznəbl̩] | reasonable |
| e) | [ɪmædʒənətɪv] | o) | [ɪmædʒnətɪv] | imaginative |
| f) | [sèpəɹəbílɪɾi] | p) | [sèpɹəbílɪɾi] | separability |
| g) | [méθəd] | q) | [méθəd] *[méθd] | method |
| h) | [féjməs] | r) | [féjməs] *[féjms] | famous |
| i) | [mɛ́məɹàjz] | s) | [mɛ́məɹàjz] *[mɛ́mɹàjz] | memorize |
| j) | [kʰənsìdəɹéjʃn̩] | t) | [kʰənsìdəɹéjʃn̩] *[kʰənsìdɹéjʃn̩] | consideration |

*i)* The schwa deletion between the careful speech forms and the rapid speech forms in items a–f is systematic. State in words the phonetic conditions that account for the deletion.

*ii)* The same pattern that occurs between the careful speech forms and the rapid speech forms in items a–f does not occur in items g–j. State in words the phonetic difference between these sets of forms that accounts for the lack of schwa deletion.

*iii)* Now that you have taken items g–j into account, will you have to change your original statement of the phonetic conditions governing schwa deletion in the fast speech forms? If so, do this in words.

*iv)* If you have completed the section on rule formalization in Section 6.3, convert your statement in *iii* into formal notation.

13. Change the following statements into rule notation. Be sure to name the process in question for each case. (Refer to Section 6.3.)
    a) Voiceless stops become corresponding fricatives between vowels.
    b) A schwa is inserted between a voiced stop and a word-final voiced fricative.
    c) Low unrounded vowels become rounded before *m*.

14. State each of the following rules in English, making reference to natural classes and common linguistic processes. (See Sections 5 and 6.)

*Example:* $\begin{bmatrix}\text{–syllabic}\\ \text{+consonantal}\\ \text{–sonorant}\end{bmatrix} \rightarrow \emptyset \,/\, \underline{\quad} \,\#$ (*an obstruent is deleted word-finally*)

a) $\emptyset \rightarrow \begin{bmatrix}\text{+syllabic}\\ \text{–consonantal}\\ \text{+sonorant}\\ \text{oDORSAL}\\ \text{–high}\\ \text{–low}\\ \text{–back}\\ \text{+tense}\end{bmatrix} \,/\, \#\, \underline{\quad} \begin{bmatrix}\text{–syllabic}\\ \text{+consonantal}\\ \text{–sonorant}\end{bmatrix} \begin{bmatrix}\text{–syllabic}\\ \text{+consonantal}\\ \text{–sonorant}\end{bmatrix}$

b) $\begin{bmatrix}\text{–syllabic}\\ \text{+consonantal}\\ \text{–sonorant}\\ \text{–nasal}\\ \text{–continuant}\\ \text{–delayed release}\\ \text{+voice}\\ \text{oCORONAL}\\ \text{+anterior}\end{bmatrix} \rightarrow [\text{+nasal}] \,/\, \underline{\quad} \begin{bmatrix}\text{–syllabic}\\ \text{+consonantal}\\ \text{+sonorant}\\ \text{+nasal}\end{bmatrix}$

c) $\begin{bmatrix}\text{+syllabic}\\ \text{–consonantal}\\ \text{+sonorant}\end{bmatrix} \rightarrow [\text{+round}] \,/\, \begin{bmatrix}\text{–syllabic}\\ \text{+consonantal}\\ \text{oLABIAL}\end{bmatrix} \underline{\quad} \begin{bmatrix}\text{–syllabic}\\ \text{+consonantal}\\ \text{oLABIAL}\end{bmatrix}$



15. *Tamil* (Tamil is a Dravidian language spoken in South India and Sri Lanka.) In the following Tamil data, some words begin with glides while others do not. The symbol [ɖ] represents a voiced retroflex stop and the diacritic [ˌ] indicates dentals.

| *Initial j-glide* | | *Initial w-glide* | | *No initial glide* | |
|---|---|---|---|---|---|
| a) jeli | 'rat' | f) woɖi | 'break' | k) arivu | 'knowledge' |
| b) ji: | 'fly' | g) wo:laj | 'palm leaf' | l) aiṉṯu | 'five' |
| c) jilaj | 'leaf' | h) wu:si | 'needle' | m) a:saj | 'desire' |
| d) jeŋge: | 'where' | i) wujir | 'life' | n) a:ru | 'river' |
| e) jiɖuppu | 'waist' | j) wo:ram | 'edge' | o) a:di | 'origin' |

*i)* The occurrence of these glides is predictable. Using your knowledge of natural classes, make a general statement about the distribution of the glides. (Refer to Section 2.)

*ii)* Assuming the glides are not present in the underlying representations, name the process that accounts for their presence in the phonetic forms. (Refer to Section 6.3.)

## For the Student Linguist

For more food for thought on phonology, go to **bedfordstmartins.com/linguistics/phonology** and click on **For the Student Linguist**.