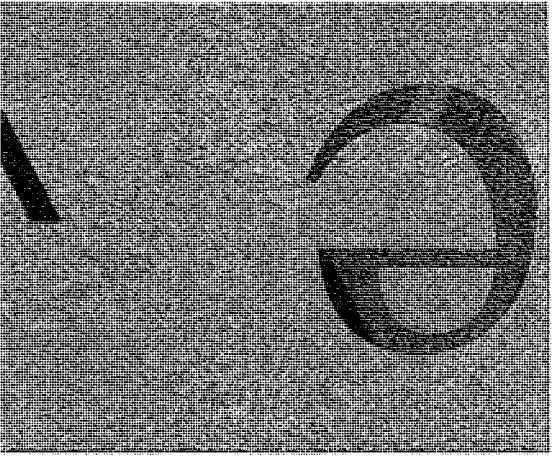


7

Phonology: The Sound Patterns of Language

Speech is human, silence is divine, yet also brutish and dead; therefore we must learn both arts.

THOMAS CARLYLE (1795–1881)

Phonology is the study of telephone etiquette.

A HIGH SCHOOL STUDENT

What do you think is greater: the number of languages in the world, or the number of speech sounds in all those languages? Well, there are thousands of languages, but only hundreds of speech sounds, some of which we examined in the previous chapter. Even more remarkable, only a few dozen features, such as *voicing* or *bilabial* or *stop*, are needed to describe every speech sound that occurs in every human language.

That being the case, why, you may ask, do languages sound so different? One reason is that the sounds form different patterns in different languages. English has nasalized vowels, but only in syllables with nasal consonants. French puts nasal vowels anywhere it pleases, with or without nasal consonants. The speech sound that ends the word *song*—the velar nasal [ŋ]—cannot begin a word in English, but it can in Vietnamese. The common Vietnamese name spelled *Nguyen* begins with this sound, and the reason few of us can pronounce this name correctly is that it doesn't follow the English pattern.

The fact that a sound such as [ŋ] is difficult for an English speaker to pronounce at the beginning of a word, but easy for a Vietnamese speaker, means that there is no general notion of "difficulty of articulation" that can explain all

of the sound patterns of particular languages. Rather, the ability to pronounce particular sounds depends on the speaker's unconscious knowledge of the sound patterns of her own language or languages.

The study of how speech sounds form patterns is **phonology**. These patterns may be as simple as the fact that the velar nasal cannot begin a syllable in English, or as complex as why *g* is silent in *sign* but is pronounced in the related word *signature*. To see that this is a pattern and not a one-time exception, just consider the slippery *n* in *autumn* and *autumnal*, or the *b* in *bomb* and *bombard*.

The word *phonology* refers both to the linguistic knowledge that speakers have about the sound patterns of their language and to the description of that knowledge that linguists try to produce. Thus it is like the way we defined *grammar*: your mental knowledge of your language, or a linguist's description of that knowledge.

Phonology tells you what sounds are in your language and which ones are foreign; it tells you what combinations of sounds could be an actual word, whether it is (*black*) or isn't (*blick*), and what combination of sounds could not be an actual word (*lbick). It also explains why certain phonetic features are important to identifying a word, for example voicing in English as in *pat* versus *bat*, while other features, such as aspiration in English, are not crucial to identifying a word, as we noted in the previous chapter. And it also allows us to adjust our pronunciation of a morpheme, for example the past or plural morpheme, to suit the different phonological contexts that it occurs in, as we will discuss shortly.

In this chapter we'll look at some of the phonological processes that you know, that you acquired as a child, and that yet may initially appear to you to be unreasonably complex. Keep in mind that we are only making explicit what you already know, and its complexity is in a way a wondrous feature of your own mind.

The Pronunciation of Morphemes

> The *t* is silent, as in Harlow.
>
> **MARGOT ASQUITH,** referring to her name being mispronounced by the actress Jean Harlow

Knowledge of phonology determines how we pronounce words and the parts of words we call morphemes. Often, certain morphemes are pronounced differently depending on their context, and we will introduce a way of describing this variation with phonological rules. We begin with some examples from English, and then move on to examples from other languages.

The Pronunciation of Plurals

Nearly all English nouns have a plural form: *cat/cats*, *dog/dogs*, *fox/foxes*. But have you ever paid attention to how plural forms are *pronounced*? Listen to a native speaker of English (or yourself if you are one) pronounce the plurals of the following nouns.

A	B	C	D
cab	cap	bus	child
cad	cat	bush	ox
bag	back	buzz	mouse
love	cuff	garage	criterion
lathe	faith	match	sheep
cam		badge	
can			
call			
bar			
spa			
boy			

The final sound of the plural nouns from Column A is a [z]—a *voiced* alveolar fricative. For column B the plural ending is an [s]—a *voiceless* alveolar fricative. And for Column C it's [əz]. Here is our first example of a morpheme with different pronunciations. Note also that there is a regularity in columns A, B, and C that does not exist in D. The plural forms in D—*children*, *oxen*, *mice*, *criteria*, and *sheep*—are a hodge-podge of special cases that are memorized individually when you acquire English, whether natively or as a second language. This is because there is no way to predict the plural forms of these words.

How do we know how to pronounce this plural morpheme? The spelling, which adds *s* or *es*, is misleading—not a *z* in sight—yet if you know English, you pronounce it as we indicated. When faced with this type of question, it's useful to make a chart that records the phonological environments in which each variant of the morpheme is known to occur. (The more technical term for a variant is **allomorph.**) Writing the words from the first three columns in broad phonetic transcription, we have our first chart for the plural morpheme.

Allomorph	Environment
[z]	After [kæb], [kæd], [bæg], [lʌv], [leð], [kæm], [kæn], [bæŋ], [kɔl], [bar], [spa], [bɔɪ], e.g., [kæbz], [kædz] . . . [bɔɪz]
[s]	After [kæp], [kæt], [bæk], [kʌf], [feθ], e.g., [kæps], [kæts] . . . [feθs]
[əz]	After [bʌs], [bʊʃ], [bʌz], [gəraʒ], [mætʃ], [bædʒ], e.g., [bʌsəz], [bʊʃəz] . . . [bædʒəz]

To discover the pattern behind the way plurals are pronounced, we look for some property of the environment associated with each group of allomorphs. For example, what is it about [kæb] or [lʌv] that determines that the plural morpheme will take the form [z] rather than [s] or [əz]?

To guide our search, we look for **minimal pairs** in our list of words. A minimal pair is two words with different meanings that are identical except for one sound segment that occurs in the same place in each word. For example, *cab* [kæb] and *cad* [kæd] are a minimal pair that differ only in their final segments, whereas *cat* [kæt] and *mat* [mæt] are a minimal pair that differ only in their

initial segments. Other minimal pairs in our list include *cap/cab*, *bag/back*, and *bag/badge*.

Minimal pairs whose members take different allomorphs are particularly useful for our search. For example, consider *cab* [kæb] and *cap* [kæp], which respectively take the allomorphs [z] and [s] to form the plural. Clearly, the final segment is responsible, because that is where the two words differ. Similarly for *bag* [bæg] and *badge* [bædʒ]. Their final segments determine the different plural allomorphs [z] and [əz].

Apparently, the distribution of plural allomorphs in English is conditioned by the final segment of the singular form. We can make our chart more concise by considering just the final segment. (We treat diphthongs such as [ɔɪ] as single segments.)

Allomorph	**Environment**
[z]	After [b], [d], [g], [v], [ð], [m], [n], [ŋ], [l], [r], [a], [ɔɪ]
[s]	After [p], [t], [k], [f], [θ]
[əz]	After [s], [ʃ], [z], [ʒ], [tʃ], [dʒ]

We now want to understand *why* the English plural follows this pattern. We *always* answer questions of this type by inspecting the *phonetic properties* of the conditioning segments. Such an inspection reveals that the segments that trigger the [əz] plural have in common the property of being *sibilants*. Of the nonsibilants, the *voiceless* segments take the [s] plural, and the *voiced* segments take the [z] plural. Now the rules can be stated in more general terms:

Allomorph	**Environment**
[z]	After voiced nonsibilant segments
[s]	After voiceless nonsibilant segments
[əz]	After sibilant segments

An even more concise way to express these rules is to assume that the basic or underlying form of the plural morpheme is /z/, with the meaning "plural." This is the "default" pronunciation. The rules tell us when the default does *not* apply:

1. Insert a [ə] before the plural morpheme /z/ when a regular noun ends in a sibilant, giving [əz].
2. Change the plural morpheme /z/ to a voiceless [s] when preceded by a voiceless sound.

These rules will derive the phonetic forms—that is, the pronunciations—of plurals for all regular nouns. Because the basic form of the plural is /z/, if no rule applies, then the plural morpheme will be realized as [z]. The following chart shows how the plurals of *bus*, *butt*, and *bug* are formed. At the top are the basic forms. The two rules apply or not as appropriate as one moves downward. The output of rule 1 becomes the input of rule 2. At the bottom are the phonetic realizations—the way the words are pronounced.

	bus + pl.	*butt* + pl.	*bug* + pl.
Basic representation	/bʌs + z/	/bʌt + z/	/bʌg + z/
Apply rule (1)	ə	NA*	NA
Apply rule (2)	NA	s	NA
Phonetic representation	[bʌsəz]	[bʌts]	[bʌgz]

*NA means "not applicable."

As we have formulated these rules, (1) must apply before (2). If we applied the rules in reverse order, we would derive an incorrect phonetic form for the plural of *bus*, as a diagram similar to the previous one illustrates:

Basic representation	/bʌs + z/
Apply rule (2)	s
Apply rule (1)	ə
Phonetic representation	*[bʌsəs]

The particular phonological rules that determine the phonetic form of the plural morpheme and other morphemes of the language are **morphophonemic rules**. Such rules concern the pronunciation of specific morphemes. Thus the plural morphophonemic rules apply to the plural morpheme specifically, not to all morphemes in English.

Additional Examples of Allomorphs

The formation of the regular past tense of English verbs parallels the formation of regular plurals. Like plurals, some irregular past tenses conform to no particular rule and must be learned individually, such as *go/went*, *sing/sang*, and *hit/hit*. And also like plurals, there are three *phonetic* past-tense morphemes for regular verbs: [d], [t], and [əd]. Here are several examples in broad phonetic transcription. Study sets A, B, and C and try to see the regularity before reading further.

Set A: *gloat* [glot], *gloated* [glotəd]; *raid* [red], *raided* [redəd]

Set B: *grab* [græb], *grabbed* [græbd]; *hug* [hʌg], *hugged* [hʌgd]; *faze* [fez], *fazed* [fezd]; *roam* [rom], *roamed* [romd].

Set C: *reap* [rip], *reaped* [ript]; *poke* [pok], *poked* [pokt]; *kiss* [kɪs], *kissed* [kɪst]; patch [pætʃ], *patched* [pætʃt]

Set A suggests that if the verb ends in a [t] or a [d] (i.e., non-nasal alveolar stops), [əd] is added to form the past tense, similar to the insertion of [əz] to form the

plural of nouns that end in sibilants. Set B suggests that if the verb ends in a voiced segment other than [d], you add a voiced [d]. Set C shows us that if the verb ends in voiceless segment other than [t], you add a voiceless [t].

Just as /z/ was the basic form of the plural morpheme, /d/ is the basic form of the past-tense morpheme, and the rules for past-tense formation of regular verbs are much like the rules for the plural formation of regular nouns. These are also *morphophonemic* rules as they apply specifically to the past-tense morpheme /d/. As with the plural rules, the output of Rule 1, if any, provides the input to Rule 2, and the rules must be applied in order.

1. Insert a [ə] before the past-tense morpheme when a regular verb ends in a non-nasal alveolar stop, giving [əd].
2. Change the past-tense morpheme to a voiceless [t] when a voiceless sound precedes it.

Two further allomorphs in English are the possessive morpheme and the third-person singular morpheme, spelled *s* or *es*. These morphemes take on the same phonetic form as the plural morpheme *according to the same rules*! Add [s] to *ship* to get *ship's*; add [z] to *woman* to get *woman's*; and add [əz] to *judge* to get *judge's*. Similarly for the verbs *eat*, *need*, and *rush*, whose third-person singular forms are *eats* with a final [s], *needs* with a final [z], and *rushes* with a final [əz].

That the rules of phonology are based on properties of segments rather than on individual words is one of the factors that makes it possible for young children to learn their native language in a relatively short period. The young child doesn't need to learn each plural, each past tense, each possessive form, and each verb ending, on a noun-by-noun or verb-by-verb basis. Once the rule is learned, thousands of word forms are automatically known. And as we will see when we discuss language development in chapter 8, children give clear evidence of learning morphophonemic rules such as the plural rules by applying the rule too broadly and producing forms such as *mouses*, *mans*, and so on, which are ungrammatical in the adult language.

English is not the only language that has morphemes that are pronounced differently in different phonological environments. Most languages have morpheme variation that can be described by rules similar to the ones we have written for English. For example, the negative morpheme in the West African language Akan has three nasal allomorphs: [m] before *p*, [n] before *t*, and [ŋ] before *k*, as the following examples show ([mɪ] means "I"):

mɪ pɛ	"I like"	mɪ mpɛ	"I don't like"
mɪ tɪ	"I speak"	mɪ ntɪ	"I don't speak"
mɪ kɔ	"I go"	mɪ ŋkɔ	"I don't go"

The rule that describes the distribution of allomorphs is:

> Change the place of articulation of the nasal negative morpheme to agree with the place of articulation of a following consonant.

The rule that changes the pronunciation of nasal consonants as just illustrated is called the **homorganic nasal rule**—*homorganic* means "same place"—because

the place of articulation of the nasal is the same as for the following consonant. The homorganic nasal rule is a common rule in the world's languages.

Phonemes: The Phonological Units of Language

> In the physical world the naive speaker and hearer actualize and are sensitive to sounds, but what they feel themselves to be pronouncing and hearing are "phonemes."
>
> **EDWARD SAPIR,** "The Psychological Reality of Phonemes," 1933

The phonological rules discussed in the preceding section apply only to particular morphemes. However, other phonological rules apply to sounds as they occur in any morpheme in the language. These rules express our knowledge about the sound patterns of the entire language.

This section introduces the notions of **phoneme** and **allophone**. Phonemes are what we have been calling the basic form of a sound and are sensed in your mind rather than spoken or heard. Each phoneme has associated with it one or more sounds, called allophones, which represent the actual sound corresponding to the phoneme in various environments. For example, the phoneme /p/ is pronounced with the aspiration allophone [p^h] in *pit* but without aspiration [p] in *spit*. Phonological rules operate on phonemes to make explicit which allophones are pronounced in which environments.

Vowel Nasalization in English as an Illustration of Allophones

English contains a general phonological rule that determines the contexts in which vowels are nasalized. In chapter 6 we noted that both oral and nasal vowels occur *phonetically* in English. The following examples show this:

bean	[bĩn]	bead	[bid]
roam	[rõm]	robe	[rob]

Taking oral vowels as basic—that is, as the phonemes—we have a phonological rule that states:

> Vowels are nasalized before a nasal consonant within the same syllable.

This rule expresses your knowledge of English pronunciation: nasalized vowels occur only before nasal consonants and never elsewhere. The effect of this rule is exemplified in Table 7.1.

As the examples in Table 7.1 illustrate, oral vowels in English occur in final position and before non-nasal consonants; nasalized vowels occur only before nasal consonants. The nonwords (starred) show us that nasalized vowels do not occur finally or before non-nasal consonants, nor do oral vowels occur before nasal consonants.

TABLE 7.1 | Nasal and Oral Vowels: Words and Nonwords

Words						Nonwords		
be	[bi]	bead	[bid]	bean	[bĩn]	*[bĩ]	*[bĩd]	*[bin]
lay	[le]	lace	[les]	lame	[lẽm]	*[lẽ]	*[lẽs]	*[lem]
baa	[bæ]	bad	[bæd]	bang	[bæ̃ŋ]	*[bæ̃]	*[bæ̃d]	*[bæŋ]

You may be unaware of this variation in your vowel production, but this is natural. Whether you speak or hear the vowel in *bean* with or without nasalization does not matter. Without nasalization, it might sound a bit strange, as if you had a foreign accent, but *bean* pronounced [bĩn] and *bean* pronounced [bin] would convey the same word. Likewise, if you pronounced *bead* as [bĩd], with a nasalized vowel, someone might suspect you had a cold, or that you spoke nasally, but the word would remain *bead*. Because nasalization is an inessential difference insofar as what the word actually is, we tend to be unaware of it.

Contrast this situation with a change in vowel height. If you intend to say *bead* but say *bad* instead, that makes a difference. The [i] in *bead* and the [æ] in *bad* are sounds from *different* phonemes. Substitute one for another and you get a different word (or no word). The [i] in *bead* and the [ĩ] in the nasalized *bead* do not make a difference in meaning. These two sounds, then, belong to the same phoneme, an abstract high front vowel that we denote between slashes as /i/.

Phonemes are not physical sounds. They are abstract mental representations of the phonological units of a language, the units used to represent words in our mental lexicon. The phonological rules of the language apply to phonemes to determine the pronunciation of words.

The process of substituting one sound for another in a word to see if it makes a difference is a good way to identify the phonemes of a language. Here are twelve words differing only in their vowel:

beat	[bit]	[i]	boot	[but]	[u]
bit	[bɪt]	[ɪ]	but	[bʌt]	[ʌ]
bait	[bet]	[e]	boat	[bot]	[o]
bet	[bɛt]	[ɛ]	bought	[bɔt]	[ɔ]
bat	[bæt]	[æ]	bout	[baʊt]	[aʊ]
bite	[baɪt]	[aɪ]	bot	[bat]	[a]

Any two of these words form a *minimal pair*: two *different* words that differ in one sound. The two sounds that cause the word difference belong to different phonemes. The pair [bid] and [bĩd] are not different words; they are variants of the same word. Therefore, [i] and [ĩ] do *not* belong to different phonemes. They are two actualizations of the same phoneme.

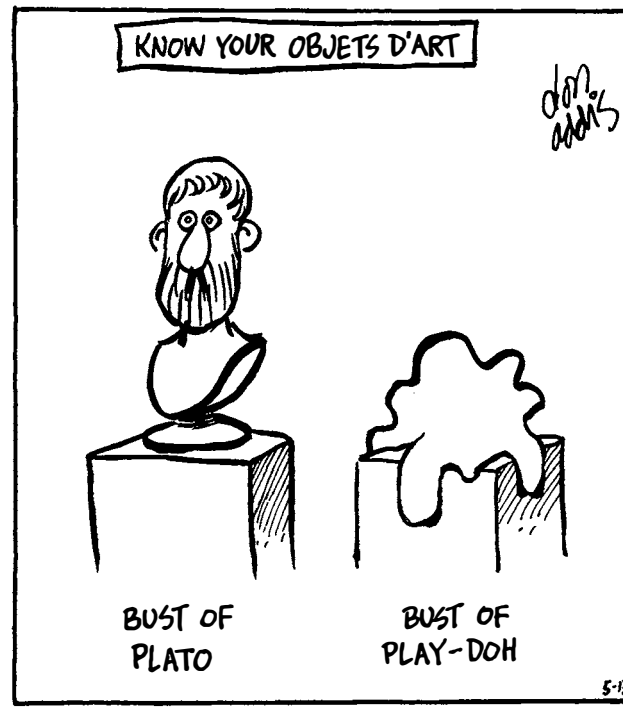
From the minimal set of [b–t] words we can infer that English has at least twelve vowel phonemes. (We consider diphthongs to function as single vowel sounds.) To that total we can add a phoneme corresponding to [ʊ] resulting from minimal pairs such as *book* [bʊk] and *beak* [bik]; and we can add one for [ɔɪ] resulting from minimal pairs such as *boy* [bɔɪ] and *buy* [baɪ].

Our minimal pair analysis has revealed eleven monophthongal and three diphthongal vowel phonemes, namely, /i ɪ e ɛ æ u ʊ o ɔ a ʌ/ and /aɪ/, /aʊ/, /ɔɪ/. (This set may differ slightly in other variants of English.) Importantly, each of these vowel phonemes has (at least) two allophones (i.e., two ways of being pronounced: orally as [i], [ɪ], [e], etc., and nasally as [ĩ], [ɪ̃], [ẽ], etc.), as determined by the phonological rule of nasalization.

A particular realization (pronunciation) of a phoneme is called a **phone**. The collection of phones that are the realizations of the same phoneme are called the *allophones* of that phoneme. In English, each vowel phoneme has both an oral and a nasalized allophone. The choice of the allophone is not random or haphazard; it is *rule-governed*.

To distinguish between a phoneme and its allophones, we use slashes / / to enclose phonemes and continue to use square brackets [ ] for allophones or phones. For example, [i] and [ĩ] are allophones of the phoneme /i/; [ɪ] and [ɪ̃] are allophones of the phoneme /ɪ/, and so on. Thus we will represent *bead* and *bean* phonemically as /bid/ and /bin/. We refer to these as *phonemic* transcriptions of the two words. The rule for the distribution of oral and nasal vowels in English shows that phonetically these words will be pronounced as [bid] and [bĩn]. The pronunciations are indicated by phonetic transcriptions, and written between square brackets.

Allophones of /t/



Consonants, too, have allophones whose distribution is rule-governed. For /t/ the following examples illustrate the point.

tick [tʰɪk] stick [stɪk] hits [hɪts] bitter [bɪɾər]

In *tick* we normally find an aspirated [tʰ], whereas in *stick* and *hits* we find an unaspirated [t], and in *bitter* we find the flap [ɾ]. As with vowel nasalization, swapping these sounds around will not change word meaning. If we pronounce *bitter* with a [tʰ], it will not change the word; it will simply sound unnatural (to most Americans).

We account for this knowledge of how *t* is pronounced by positing a phoneme /t/ with three allophones [tʰ], [t], and [ɾ]. We also posit phonological rules, which roughly state that the aspirated [tʰ] occurs before a stressed vowel, the unaspirated [t] occurs directly before or after /s/, and the flap [ɾ] occurs between a stressed vowel and an unstressed vowel.

Whether we pronounce *tick* as [tʰɪk], [tɪk], or [ɾɪk], we are speaking the same word, however strangely pronounced. The allophones of a phoneme do not *contrast*. If we change the voicing and say *Dick*, or the manner of articulation and say *sick*, or the nasalization and say *nick*, we get different words. Those sounds *do* contrast. *Tick*, *Dick*, *sick*, and *nick* thus form a minimal set that shows us that there are phonemes /t/, /d/, /s/, and /n/ in English. We may proceed in this manner to discover other phonemes by considering *pick*, *kick*, *Mick* (as in Jagger), *Vic*, *thick*, *chick*, *lick*, and *Rick* to infer the phonemes /p/, /k/, /m/, /v/, /θ/, /tʃ/, /l/, and /r/. By finding other minimal pairs and sets, we would discover yet more consonant phonemes such as /ð/, which, together with /θ/, contrasts the words *thy* and *thigh*, or *either* and *ether*.

Each of these phonemes has its own set of allophones, even if that set consists of a single phone, which would mean there is only one pronunciation in all environments. Most phonemes have more than one allophone, and the phonological rules dictate when the different allophones occur. It should be clear at this point that pronunciation is not a random process. It is systematic and rule-governed, and while the systems and the rules may appear complex, they are no more than a compendium of the knowledge that every speaker has.

Complementary Distribution

Minimal pairs illustrate that some speech sounds in a language are contrastive and can be used to make different words such as *big* and *dig*. These contrastive sounds group themselves into the phonemes of that language. Some sounds are non-contrastive and cannot be used to make different words. The sounds [t] and [ɾ] were cited as examples that do not contrast in English, so [raɪtər] and [raɪɾər] are not a minimal pair, but rather alternate ways in which *writer* may be pronounced.

Oral and nasal vowels in English are also non-contrastive sounds. What's more, the oral and nasal allophones of each vowel phoneme never occur in the same phonological context, as Table 7.2 illustrates.

Where oral vowels occur, nasal vowels do not occur, and vice versa. In this sense the phones are said to complement each other or to be in **complementary distribution**. By and large, the allophones of a phoneme are in complementary

TABLE 7.2 | Distribution of Oral and Nasal Vowels in English Syllables

	In Final Position	Before Nasal Consonants	Before Oral Consonants
Oral vowels	Yes	No	Yes
Nasal vowels	No	Yes	No

distribution—never occurring in identical environments. Complementary distribution is a fundamental concept of phonology, and interestingly enough, it shows up in everyday life. Here are a couple of examples that draw on the common experience of reading and writing English.

The first example focuses on *printed* letters such as those that appear on the pages of this book. Each printed letter of English has two main variants: lowercase and uppercase (or capital). If we restrict our attention to words that are not proper names or acronyms (such as Ron or UNICEF), we can formulate a simple rule that does a fair job of determining how letters will be printed:

> A letter is printed in uppercase if it is the first letter of a sentence; otherwise, it is printed in lowercase.

Even ignoring names and acronyms, this rule is only approximately right, but let's go with it anyway. It helps to explain why written sentences such as the following appear so strange:

> phonology is the study of the sound patterns of human languageS.
> pHONOLOGY iS tHE sTUDY oF tHE sOUND pATTERNS oF hUMAN lANGUAGES.

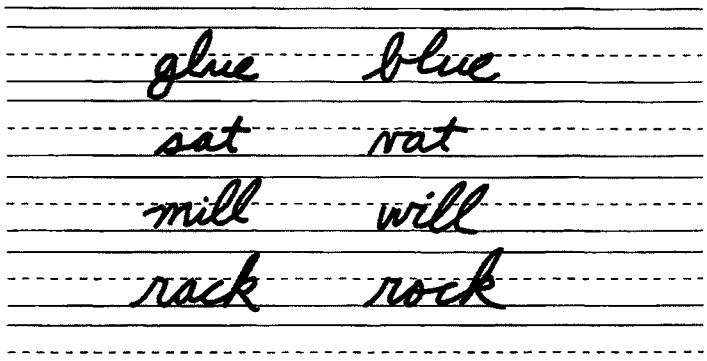
These "sentences" violate the rule in funny ways, despite that they are comprehensible, just as the pronunciation of *bead* with a nasal [ĩ] as [bĩd] would sound funny but be understood.

To the extent that the rule is correct, the lowercase and uppercase variants of an English letter *are in complementary distribution.* The uppercase variant occurs in one particular context (namely, at the beginning of the sentence), and the lowercase variant occurs in every other context (or elsewhere). Therefore, just as every English vowel phoneme has an oral and a nasalized allophone that occurs in different spoken contexts, every letter of the English alphabet has two variants, or allographs, that occur in different written contexts. In both cases, the two variants of a single mental representation (phoneme or letter) are in *complementary distribution* because they never appear in the same environment. And, substituting one for the other—a nasal vowel in place of an oral one, or an uppercase letter in place of a lowercase one—may sound or look unusual, but it will not change the meaning of what is spoken or written.

Superman and Clark Kent, or Dr. Jekyll and Mr. Hyde—for those of you familiar with these fictional characters—are in complementary distribution *with respect to time.* At a given moment in time, the individual is either one or another of his alter egos.

Our next example turns to *cursive* handwriting, which you are likely to have learned in elementary school. Writing in cursive is in one sense more similar to the act of speaking than printing is, because in cursive writing each letter of a

word (usually) connects to the following letter—just as adjacent sounds connect during speech. The following figure illustrates that the connections between the letters of a word in cursive writing create different variants of a letter in different environments:



Compare how the letter *l* appears after a *g* (as in *glue*) and after a *b* (as in *blue*). In the first case, the *l* begins near the bottom of the line, but in the second case, the *l* begins near the middle of the line (which is indicated by the dashes). In other words, the same letter *l* has two variants. It doesn't matter where the *l* begins, it's still an *l*. Likewise, it doesn't matter whether a vowel in English is nasalized or not, it's still that vowel. Which variant occurs in a particular word is determined by the immediately preceding letter. The variant that begins near the bottom of the line appears after letters like *g* that end near the bottom of the line. The variant that begins near the middle of the line appears after letters like *b* that end near the middle of the line. The two variants of *l* are therefore in complementary distribution.

This pattern of complementary distribution is not specific to *l* but occurs for other cursive letters in English. By examining the pairs *sat* and *vat*, *mill* and *will*, and *rack* and *rock*, you can see the complementary distribution of the variants of *a*, *i*, and *c*, respectively. In each case, the immediately preceding letter determines which variant occurs, with the consequence that the variants of a given letter are in complementary distribution.

We turn now to a general discussion of phonemes and allophones. When sounds are in complementary distribution, they do not contrast with each other. The replacement of one sound for the other will not change the meaning of the word, although it might not sound like typical English pronunciation. Given these facts about the patterning of sounds in a language, a phoneme can be defined as a set of phonetically similar sounds that are in complementary distribution. A set may consist of only one member. Some phonemes are represented by only one sound; they have one allophone. When there is more than one allophone in the set, the phones must be *phonetically similar*; that is, share most phonetic features. In English, the velar nasal [ŋ] and the glottal fricative [h] are in complementary distribution; [ŋ] does not occur word initially and [h] does not occur word finally. But they share very few phonetic features; [ŋ] is a voiced velar nasal stop; [h] is a voiceless glottal fricative. Therefore, they are not allophones of the same phoneme; [ŋ] and [h] are allophones of different phonemes.

Speakers of a language generally perceive the different allophones of a single phoneme as the same sound or phone. For example, most speakers of English are unaware that the vowels in *bead* and *bean* are different phones because mentally, speakers produce and hear phonemes, not phones.

Distinctive Features of Phonemes

We are generally not aware of the phonetic properties or features that distinguish the phonemes of our language. *Phonetics* provides the means to describe the phones (sounds) of language, showing how they are produced and how they vary. *Phonology* tells us how various sounds form patterns to create phonemes and their allophones.

For two phones to contrast meaning, there must be some phonetic difference between them. The minimal pairs *seal* [sil] and *zeal* [zil] show that [s] and [z] represent two contrasting phonemes in English. They cannot be allophones of one phoneme because one cannot replace the [s] with the [z] without changing the meaning of the word. Furthermore, they are not in complementary distribution; both occur word initially before the vowel [i]. They are therefore allophones of the two different phonemes /s/ and /z/. From the discussion of phonetics in chapter 6, we know that [s] and [z] differ in voicing: [s] is voiceless and [z] is voiced. The phonetic feature of voicing therefore distinguishes the two words. Voicing also distinguishes *feel* and *veal* [f]/[v] and *cap* and *cab* [p]/[b]. When a feature distinguishes one phoneme from another, hence one word from another, it is a **distinctive feature** or, equivalently, a **phonemic feature.**

Feature Values

One can think of voicing and voicelessness as the presence or absence of a single feature, *voiced*. This single feature may have two values: plus (+), which signifies its presence, and minus (–), which signifies its absence. For example, [b] is [+voiced] and [p] is [–voiced].

The presence or absence of nasality can similarly be designated as [+nasal] or [–nasal], with [m] being [+nasal] and [b] and [p] being [–nasal]. A [–nasal] sound is an oral sound.

We consider the phonetic and phonemic symbols to be *cover symbols* for sets of distinctive features. They are a shorthand method of specifying the phonetic properties of the segment. Phones and phonemes are not indissoluble units; they are composed of phonetic features, similar to the way that molecules are composed of atoms. A more explicit description of the phonemes /p/, /b/, and /m/ may thus be given in a feature matrix of the following sort.

	p	b	m
Stop	+	+	+
Labial	+	+	+
Voiced	–	+	+
Nasal	–	–	+

Aspiration is not listed as a phonemic feature in the specification of these units, because it is not necessary to include both [p] and [p^h] as phonemes. In a pho-

netic transcription, however, the aspiration feature would be specified where it occurs.

A phonetic feature is distinctive when the + value of that feature in certain words contrasts with the – value of that feature in other words. At least one feature value difference must distinguish each phoneme from all the other phonemes in a language.

Because the phonemes /b/, /d/, and /g/ contrast by virtue of their place of articulation features—*labial*, *alveolar*, and *velar*—these place features are also distinctive in English. Because uvular sounds do not occur in English, the place feature *uvular* is not distinctive. The distinctive features of the voiced stops in English are shown in the following:

	b	m	d	n	g	ŋ
Stop	+	+	+	+	+	+
Voiced	+	+	+	+	+	+
Labial	+	+	–	–	–	–
Alveolar	–	–	+	+	–	–
Velar	–	–	–	–	+	+
Nasal	–	+	–	+	–	+

Each phoneme in this chart differs from all the other phonemes by at least one distinctive feature.

Vowels, too, have distinctive features. For example, the feature [±back] distinguishes the vowel in *rock* [rak] ([+back]) from the vowel in *rack* [ræk] ([–back]), among others, and is therefore distinctive. Similarly, [±tense] distinguishes [i] from [ɪ] (*beat* versus *bit*), among others, and is also a distinctive feature of the vowel system.

Nondistinctive Features

We have seen that nasality is a distinctive feature of English consonants, but it is a **nondistinctive feature** for English vowels. Given the arbitrary relationship between form and meaning, there is no way to predict that the word *meat* begins with a nasal bilabial stop [m] and that the word *beat* begins with an oral bilabial stop [b]. You learn this when you learn the words. On the other hand, the nasality feature value of the vowels in *bean*, *mean*, *comb*, and *sing* is predictable because they occur before nasal consonants. When a feature value is predictable by rule for a certain class of sounds, the feature is a **nondistinctive** or **redundant** or **predictable feature** *for that class.* (The three terms are equivalent.) Thus nasality is a redundant feature in English vowels, but a **nonredundant** (distinctive or phonemic) feature for English consonants.

This is not the case in all languages. In French, nasality is a distinctive feature for both vowels and consonants: *gars* (pronounced [ga]) "lad" contrasts with *gant* [gã], which means "glove"; and *bal* [bal] "dance" contrasts with *mal* [mal] "bad." Thus, French has both oral and nasal consonant phonemes and vowel phonemes; English has oral and nasal consonant phonemes, but only oral vowel phonemes.

Like French, the African language Akan (spoken in Ghana) has nasal vowel phonemes. Nasalization is a distinctive feature for vowels in Akan, as the following examples illustrate:

[ka]	"bite"	[kã]	"speak"
[fi]	"come from"	[fĩ]	"dirty"
[tu]	"pull"	[tũ]	"den"
[nsa]	"hand"	[nsã]	"liquor"
[tʃi]	"hate"	[tʃĩ]	"squeeze"
[pam]	"sew"	[pãm]	"confederate"

Nasalization is not predictable in Akan as it is in English. There is no nasalization rule in Akan, as shown by the minimal pair [pam] and [pãm]. If you substitute an oral vowel for a nasal vowel, or vice versa, you will change the word.

Two languages may have the same phonetic segments (phones) but have two different phonemic systems. Phonetically, both oral and nasalized vowels exist in English and Akan. However, English does not have nasalized vowel phonemes, but Akan does. The same phonetic segments function differently in the two languages. Nasalization of vowels in English is redundant and nondistinctive; nasalization of vowels in Akan is nonredundant and distinctive.

Another nondistinctive feature in English is aspiration. In chapter 6 we pointed out that in English both aspirated and unaspirated voiceless stops occur. The voiceless aspirated stops [p^h], [t^h], and [k^h] and the voiceless unaspirated stops [p], [t], and [k] are in complementary distribution in English, as shown in the following:

Syllable Initial before a Stressed Vowel			**After a Syllable Initial /s/**			**Nonword***		
[p^h]	[t^h]	[k^h]	[p]	[t]	[k]			
pill	*till*	*kill*	*spill*	*still*	*skill*	[pɪl]*	[tɪl]*	[kɪl]*
[p^hɪl]	[t^hɪl]	[k^hɪl]	[spɪl]	[stɪl]	[skɪl]	[sp^hɪl]*	[st^hɪl]*	[sk^hɪl]*
par	*tar*	*car*	*spar*	*star*	*scar*	[par]*	[tar]*	[kar]*
[p^har]	[t^har]	[k^har]	[spar]	[star]	[skar]	[sp^har]*	[st^har]*	[sk^har]*

Where the unaspirated stops occur, the aspirated ones do not, and vice versa. If you wanted to, you could say *spit* with an aspirated [p^h], as [sp^hɪt], and it would be understood as *spit*, but listeners would probably think you were spitting out your words. Given this distribution, we see that aspiration is a redundant, nondistinctive feature in English; aspiration is predictable, occurring as a feature of voiceless stops when they occur initially in a stressed syllable.

This is the reason speakers of English usually perceive the [p^h] in *pill* and the [p] in *spill* to be the same sound, just as they consider the [i] and [ĩ] that represent the phoneme /i/ in *bead* and *bean* to be the same. They do so because the difference between them is *predictable*, *redundant*, *nondistinctive*, and *nonphonemic* (all equivalent terms). This example illustrates why we refer to the phoneme as an abstract unit or as a mental unit. We do not utter phonemes; we produce phones, the allophones of the phonemes of the language. In English /p/ is a phoneme that is realized phonetically (pronounced) as both [p] and [p^h], depending on context. The phones or sounds [p] and [p^h] are allophones of the phoneme /p/.

Phonemic Patterns May Vary across Languages

> The tongue of man is a twisty thing, there are plenty of words there of every kind, the range of words is wide, and their variance.
>
> **HOMER,** *The Iliad,* c. 900 B.C.E.

We have seen that the same phones may occur in two languages but pattern differently because the phonologies are different. English, French, and Akan have oral and nasal vowel phones; in English, oral and nasal vowels are allophones of one phoneme, whereas in French and Akan they represent distinct phonemes.

Aspiration of voiceless stops further illustrates the asymmetry of the phonological systems of different languages. Both aspirated and unaspirated voiceless stops occur in English and Thai, but they function differently in the two languages. Aspiration in English is not a distinctive feature because its presence or absence is predictable. In Thai it is not predictable, as the following examples show:

Voiceless Unaspirated		**Voiceless Aspirated**	
[paa]	*forest*	[p^haa]	*to split*
[tam]	*to pound*	[t^ham]	*to do*
[kat]	*to bite*	[k^hat]	*to interrupt*

The voiceless unaspirated and the voiceless aspirated stops in Thai occur in minimal pairs; they contrast and are therefore phonemes. In both English and Thai, the phones [p], [t], [k], [p^h], [t^h], and [k^h] occur. In English they represent the phonemes /p/, /t/, and /k/; in Thai they represent the phonemes /p/, /t/, /k/, /p^h/, /t^h/, and /k^h/. Aspiration is a distinctive feature in Thai; it is a nondistinctive redundant feature in English.

The phonetic facts alone do not reveal what is distinctive or phonemic:

> The *phonetic representation* of utterances shows what speakers know about the pronunciation of sounds.
> The *phonemic representation* of utterances shows what speakers know about the patterning of sounds.

That *pot/pat* and *spot/spat* are phonemically transcribed with an identical /p/ reveals the fact that English speakers consider the [p^h] in *pot* [p^hat] and the [p] in *spot* [spat] to be phonetic manifestations of the same phoneme /p/. This is also reflected in spelling, which is more attuned to phonemes than to individual phones.

In English, vowel length and consonant length are nonphonemic. Prolonging a sound in English will not produce a different word. In other languages, long and short vowels that are identical except for length are phonemic. In such languages, length is a nonpredictable distinctive feature. For example, vowel length is phonemic in Korean, as shown by the following minimal pairs (recall that the colon-like symbol : indicates length):

il	"day"	i:l	"work"
seda	"to count"	se:da	"strong"
kul	"oyster"	ku:l	"tunnel"

In Italian the word for "grandfather" is *nonno* /non:o/, which contrasts with the word for "ninth," which is *nono* /nono/, so consonant length is phonemic in Italian. In Luganda, an African language, consonant length is also phonemic: /kula/ with a short /k/ means "grow up," whereas /k:ula/ with a long /k:/ means "treasure." Thus consonant length is unpredictable in Luganda, just as whether a word begins with a /b/ or a /p/ is unpredictable in English.

ASL Phonology

As discussed in chapter 6, signs can be broken down into smaller units that are in many ways analogous to the phonemes and distinctive features in spoken languages. They can be decomposed into location, movement, and handshape and there are minimal pairs that are distinguished by a change in one or another of these features. Figure 6.6 in chapter 6 provides some examples. The signs meaning "candy," "apple," and "jealous" are articulated at the same location on the face and involve the same movement, but contrast minimally in hand configuration. "Summer," "ugly," and "dry" are a minimal set contrasting only in place of articulation, and "tape," "chair," and "train" contrast only in movement. Thus signs can be decomposed into smaller minimal units that contrast meaning. Some features are non-distinctive. Whether a sign is articulated on the right or left hand does not affect its meaning.

Natural Classes of Speech Sounds

> It's as large as life, and twice as natural!
>
> **LEWIS CARROLL,** *Through the Looking-Glass,* 1871

We show what speakers know about the predictable aspects of speech through phonological rules. In English, these rules determine the environments in which vowels are nasalized or voiceless stops aspirated. These rules apply to *all* the words in the language, and even apply to made-up words such as *sint*, *peeg*, or *sparg*, which would be /sɪnt/, /pig/, and /sparg/ phonemically and [sĩnt], [p^{h}ig], and [sparg] phonetically.

The more linguists examine the phonologies of the world's languages, the more they find that similar phonological rules involve the same classes of sounds such as nasals or voiceless stops. For example, many languages besides English have a rule that nasalizes vowels before nasal consonants:

Nasalize a vowel when it precedes a nasal consonant in the same syllable.

The rule will apply to all vowel phonemes when they occur in a context preceding any segment marked [+nasal] in the same syllable, and will add the feature [+nasal] to the feature matrix of the vowel. Our description of vowel nasalization in English needs only this rule. It need not include a list of the individual vowels to which the rule applies or a list of the sounds that result from its application.

Many languages have rules that refer to [+voiced] and [–voiced] sounds. For example, the aspiration rule in English applies to the class of [–voiced] noncontinuant sounds in word-initial position. As in the vowel nasality rule, we do not

need to consider individual segments. The rule automatically applies to initial /p/, /t/, /k/, and /tʃ/.

Phonological rules often apply to **natural classes** of sounds. A natural class is a group of sounds described by a small number of distinctive features such as [–voiced], [–continuant], which describe /p/, /t/, /k/, and /tʃ/. Any individual member of a natural class would require more features in its description than the class itself, so /p/ is not only [–voiced], [–continuant], but also [+labial].

The relationships among phonological rules and natural classes illustrate why segments are to be regarded as bundles of features. If segments were not specified as feature matrices, the similarities among /p/, /t/, /k/ or /m/, /n/, /ŋ/ would be lost. It would be just as likely for a language to have a rule such as

1. Nasalize vowels before *p*, *i*, or *z*.

as to have a rule such as

2. Nasalize vowels before *m*, *n*, or *ŋ*.

Rule 1 has no phonetic explanation, whereas Rule 2 does: the lowering of the velum in anticipation of a following nasal consonant causes the vowel to be nasalized. In Rule 1, the environment is a motley collection of unrelated sounds that cannot be described with a few features. Rule 2 applies to the natural class of nasal consonants, namely sounds that are [+nasal], [+consonantal].

The various classes of sounds discussed in chapter 6 also define natural classes to which the phonological rules of all languages may refer. They also can be specified by + and – feature values. Table 7.3 illustrates how these feature values combine to define some major classes of phonemes. The presence of +/– indicates that the sound may or may not possess a feature depending on its context. For example, word-initial nasals are [–syllabic] but some word-final nasals can be [+syllabic], as in *button* [bʌtn̩].

TABLE 7.3 | Feature Specification of Major Natural Classes of Sounds

Features	Obstruents	Nasals	Liquids	Glides	Vowels
Consonantal	+	+	+	–	–
Sonorant	–	+	+	+	+
Syllabic	–	+/–	+/–	–	+
Nasal	–	+	–	–	+/–

Feature Specifications for American English Consonants and Vowels

Here are feature matrices for vowels and consonants in English. By selecting all segments marked the same for one or more features, you can identify natural classes. For example, the natural class of high vowels /i, ɪ, u, ʊ/ is marked [+high] in the vowel feature chart of Table 7.4; the natural class of voiced stops /b, m, d, n, g, ŋ, dʒ/ are the ones marked [+voice] [–continuant] in the consonant chart of Table 7.5.

TABLE 7.4 | Features of Some American English Vowels

Features	i	ɪ	e	ɛ	æ	u	ʊ	o	ɔ	a	ʌ
High	+	+	−	−	−	+	+	−	−	−	−
Mid	−	−	+	+	−	−	−	+	+	−	+
Low	−	−	−	−	+	−	−	−	−	+	−
Back	−	−	−	−	−	+	+	+	+	+	−
Central	−	−	−	−	−	−	−	−	−	−	+
Round	−	−	−	−	−	+	+	+	+	−	−
Tense	+	−	+	−	−	+	−	+	−	+	−

The Rules of Phonology

> But that to come
> Shall all be done by the rule.
>
> **WILLIAM SHAKESPEARE,** *Antony and Cleopatra*, 1623

Throughout this chapter we have emphasized that the relationship between the *phonemic* representation of a word and its *phonetic* representation, or how it is pronounced, is *rule-governed*. Phonological rules are part of a speaker's knowledge of the language.

The phonemic representations are *minimally specified* because some features or feature values are predictable. For example, in English all nasal consonants are voiced, so we don't need to specify voicing in the phonemic feature matrix for nasals. Similarly, we don't need to specify the feature *round* for non–low back vowels. If Table 7.5 was strictly phonemic, then instead of a + in the *voice*-row for *m*, *n*, and *ŋ*, the cells would be left blank, as would the cells in the *round*-row of Table 7.4 for *u*, *ʊ*, *o*, *ɔ*. Such underspecification reflects the redundancy in the phonology, which is also part of a speaker's knowledge of the sound system. The phonemic representation should include only the nonpredictable, distinctive features of the phonemes in a word. The phonetic representation, derived by applying the phonological rules, includes all of the linguistically relevant phonetic aspects of the sounds. It does not include all of the physical properties of the sounds of an utterance, however, because the physical signal may vary in many ways that have little to do with the phonological system. The absolute pitch of the sound, the rate of speech, or its loudness is not linguistically significant. The phonetic transcription is therefore also an abstraction from the physical signal; it includes the nonvariant phonetic aspects of the utterances, those features that remain relatively constant from speaker to speaker and from one time to another.

Although the specific rules of phonology differ from language to language, the kinds of rules, what they do, and the natural classes they refer to are universal.

Assimilation Rules

We have seen that nasalization of vowels in English is nonphonemic because it is predictable by rule. The vowel nasalization rule is an assimilation rule, or a rule

TABLE 7.5 | Features of Some American English Consonants

Features	p	b	m	t	d	n	k	g	ŋ	f	v	θ	ð	s	z	ʃ	ʒ	tʃ	dʒ	l	r	j	w	h
Consonantal	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−
Sonorant	−	−	+	−	−	+	−	−	+	−	−	−	−	−	−	−	−	−	−	+	+	+	+	+
Syllabic	−	−	−/+	−	−	−/+	−	−	−/+	−	−	−	−	−	−	−	−	−	−	−/+	−/+	−	−	−
Nasal	−	−	+	−	−	+	−	−	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Voiced	−	+	+	−	+	+	−	+	+	−	+	−	+	−	+	−	+	−	+	+	+	+	+	−
Continuant	−	−	−	−	−	−	−	−	−	+	+	+	+	+	+	+	+	−	−	+	+	+	+	+
Labial	+	+	+	−	−	−	−	−	−	+	+	−	−	−	−	−	−	−	−	−	−	−	+	−
Alveolar	−	−	−	+	+	+	−	−	−	−	−	−	−	+	+	−	−	−	−	+	+	−	−	−
Palatal	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	−	+	−	−
Anterior	+	+	+	+	+	+	−	−	−	+	+	+	+	+	+	−	−	−	−	+	+	−	−	−
Velar	−	−	−	−	−	−	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Coronal	−	−	−	+	+	+	−	−	−	−	−	+	+	+	+	+	+	+	+	+	+	+	−	−
Sibilant	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+	+	+	−	−	−	−	−

Note: The phonemes /r/ and /l/ are distinguished by the feature [lateral], not shown here. /l/ is the only phoneme that would be [+lateral].

that makes neighboring segments more similar by duplicating a phonetic property. For the most part, assimilation rules stem from articulatory processes. There is a tendency when we speak to increase the ease of articulation. It is easier to lower the velum while a vowel is being pronounced before a nasal stop than to wait for the completion of the vowel and then require the velum to move suddenly.

We now wish to look more closely at the phonological rules we have been discussing. Previously, we stated the vowel nasalization rule:

Vowels are nasalized before a nasal consonant within the same syllable.

This rule specifies the class of sounds affected by the rule:

Vowels

It states what phonetic change will occur by applying the rule:

Change phonemic oral vowels to phonetic nasal vowels.

And it specifies the context or phonological environment.

Before a nasal consonant within the same syllable.

A shorthand notation to write rules, similar to the way scientists and mathematicians use symbols, makes the rule statements more concise. Every physicist knows that $E = mc^2$ means "Energy equals mass times the square of the velocity of light." We can use similar notations to state the nasalization rule as:

V → [+nasal] / __ [+nasal] $

Let's look at the rule piece by piece.

V	→	[+nasal]	/	__	[+nasal]	$
Vowels	become	nasalized	in the environment	before	nasal segments	within a syllable

To the left of the arrow is the class of sounds that is affected. To the right of the arrow is the phonetic change that occurs. The phonological environment follows the slash. The underscore __ is the relative position of the sound to be changed within the environment, in this case *before* a nasal segment. The dollar sign denotes a syllable boundary and guarantees that the environment does not cross over to the next syllable.

This rule tells us that the vowels in such words as *den* /dɛn/ will become nasalized to [dɛ̃n], but *deck* /dɛk/ will not be affected and is pronounced [dɛk] because /k/ is not a nasal consonant. As well, a word such as *den$tal* /dɛn$təl/ will be pronounced [dɛ̃n$təl], where we have showed the syllable boundary explicitly. However, the first vowel in *de$note*, /di$not/, will not be nasalized, because the nasal segment does not precede the syllable boundary, so the "within a syllable" condition is not met.

Any rule written in formal notation can be stated in words. The use of formal notation is a shorthand way of presenting the information. Notation also reveals the *function* of the rule more explicitly than words. It is easy to see in the for-

mal statement of the rule that this is an assimilation rule because the change to [+nasal] occurs before [+nasal] segments. Assimilation rules in languages reflect **coarticulation**—the spreading of phonetic features either in the anticipation or in the perseveration (the "hanging on") of articulatory processes. The auditory effect is that words sound smoother.

The following example illustrates how the English vowel nasalization rule applies. It also shows the assimilatory nature of the rule, that is, the change from no nasal feature to [+nasal]:

	"bob"			"boom"		
Phonemic representation	/b	a	b/	/b	u	m/
Nasality: phonemic feature value	–	0*	–	–	0	+
Apply nasal rule		NA			↓	
Nasality: phonetic feature value	–	–	–	–	+	+
Phonetic representation	[b	a	b]	[b	ũ	m]

*The 0 means not present on the phonemic level.

There are many assimilation rules in English and other languages. Recall that the voiced /z/ of the English regular plural suffix is changed to [s] after a voiceless sound, and that similarly the voiced /d/ of the English regular past-tense suffix is changed to [t] after a voiceless sound. These are instances of voicing assimilation. In these cases the value of the voicing feature goes from [+voice] to [–voice] because of assimilation to the [–voice] feature of the final consonant of the stem, as in the derivation of *cats*:

/kæt + z/ → [kæts]

We saw a different kind of assimilation rule in Akan, where we observed that the nasal negative morpheme was expressed as [m] before /p/, [n] before /t/, and [ŋ] before /k/. (This is the homorganic nasal rule.) In this case the place of articulation—bilabial, alveolar, velar—of the nasal assimilates to the place of articulation of the following consonant. The same process occurs in English, where the negative morpheme prefix spelled *in-* or *im-* agrees in place of articulation with the word to which it is prefixed, so we have *impossible* [ĩmpʰasəbəl], *intolerant* [ĩntʰalərə̃nt], and *incongruous* [ĩŋkʰə̃ngruəs]. In effect, the rule makes two consonants that appear next to each other more similar.

ASL and other signed languages also have assimilation rules. One example is handshape assimilation, which takes place in compounds such as the sign for "blood." This ASL sign is a compound of the signs for "red" and "flow." The handshape for "red" alone is formed at the chin by a closed hand with the index finger pointed up. In the compound "blood" this handshape is replaced by that of the following word "flow," which is an open handshape (all fingers extended). In other words, the handshape for "red" has undergone assimilation. The location of the sign (at the chin) remains the same. Examples such as this tell us that while the features of signed languages are different from those of spoken languages, their phonologies are organized according to principles like those of spoken languages.

Dissimilation Rules

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It is understandable that so many languages have assimilation rules; they permit greater ease of articulation. It might seem strange, then, to learn that languages also have **dissimilation rules,** in which a segment becomes less similar to another segment. Ironically, such rules have the same explanation: it is sometimes easier to articulate dissimilar sounds. The difficulty of tongue twisters like "the sixth sheik's sixth sheep is sick" is based on the repeated similarity of sounds. If one

were to make some sounds less similar, as in "the second sheik's tenth sheep is sick," it would be easier to say. The cartoon makes the same point, with *toy boat* being more difficult to articulate repeatedly than *sail boat*, because the [ɔɪ] of *toy* is more similar to [o] than is the [e] of *sail*.

An example of easing pronunciation through dissimilation is found in some varieties of English, where there is a fricative dissimilation rule. This rule applies to sequences /fθ/ and /sθ/, changing them to [ft] and [st]. Here the fricative /θ/ becomes dissimilar to the preceding fricative by becoming a stop. For example, the words *fifth* and *sixth* come to be pronounced as if they were spelled *fift* and *sikst*.

A classic example of the same kind of dissimilation occurred in Latin, and the results of this process show up in the derivational morpheme /-ar/ in English. In Latin a derivational suffix *-alis* was added to nouns to form adjectives. When the suffix was added to a noun that contained the liquid /l/, the suffix was changed to *-aris*; that is, the liquid /l/ was changed to the dissimilar liquid /r/. These words came into English as adjectives ending in *-al* or in its dissimilated form *-ar*, as shown in the following examples:

-al	**-ar**
anecdot-al	angul-ar
annu-al	annul-ar
ment-al	column-ar
pen-al	perpendicul-ar
spiritu-al	simil-ar
ven-al	vel-ar

All of the *-ar* adjectives contain an /l/, and as *columnar* illustrates, the /l/ need not be the consonant directly preceding the dissimilated segment.

Though dissimilation rules are rarer than assimilation rules, they are nevertheless found throughout the world's languages.

Feature-Changing Rules

The assimilation and dissimilation rules we have seen may all be thought of as *feature-changing rules*. In some cases a feature already present is changed. The /z/ plural morpheme has its voicing value changed from plus to minus when it follows a voiceless sound. Similarly, the /n/ in the phonemic negative prefix morpheme /ɪn/ undergoes a change in its place of articulation feature when preceding bilabials or velars. In the case of the Latin dissimilation rule, the feature [+lateral] is changed to [–lateral], so that /l/ is pronounced [r].

The addition of a feature is the other way in which we have seen features change. The English vowel nasalization rule is a case in point. Phonemically, vowels are not marked for nasality; however, in the environment specified by the rule, the feature [+nasal] is added.

Some feature-changing rules are neither assimilation nor dissimilation rules. The rule in English that aspirates voiceless stops at the beginning of a syllable simply adds a nondistinctive feature. Generally, aspiration occurs only if the following vowel is stressed. The /p/ in *pit* and *repeat* is an aspirated [p^h], but the /p/ in *inspect* or *compass* is an unaspirated [p]. We also note that even with an

intervening consonant, the aspiration takes place so that words such as *crib*, *clip*, and *quip* ([kʰrɪb], [kʰlɪp], and [kʰwɪp]) all begin with an aspirated [kʰ]. And finally, the affricate /tʃ/ is subject to the rule, so *chip* is phonetically [tʃʰɪp]. We can now state the rule:

> A voiceless, noncontinuant has [+aspirated] added to its feature matrix at the beginning of a syllable containing a stressed vowel with an optional intervening consonant.

Aspiration is not specified in any phonemic feature matrices of English. The aspiration rule adds this feature for reasons having to do with the timing of the closure release rather than in an attempt to make segments more alike or not alike, as with assimilation and dissimilation rules.

Remember that /p/ and /b/ (and all such symbols) are simply cover symbols that do not reveal the phonemic distinctions. In phonemic and phonetic feature matrices, these differences are made explicit, as shown in the following phonemic matrices:

	p	**b**	
Consonantal	+	+	
Continuant	−	−	
Labial	+	+	
Voiced	−	+	← distinctive difference

The nondistinctive feature "aspiration" is not included in these phonemic representations because aspiration is predictable.

Segment Insertion and Deletion Rules

Phonological rules may add or delete entire segments. These are different from the feature-changing and feature-adding rules we have seen so far, which affect only parts of segments. The process of inserting a consonant or vowel is called **epenthesis.**

The rules for forming regular plurals, possessive forms, and third-person singular verb agreement in English all require an epenthesis rule. Here is the first part of that rule that we gave earlier for plural formation:

> Insert a [ə] before the plural morpheme /z/ when a regular noun ends in a sibilant, giving [əz].

Letting the symbol ∅ stand for "null," we can write this *morphophonemic* epenthesis rule more formally as "null becomes schwa between two sibilants," or like this:

$$\varnothing \rightarrow \text{ə} \;/\; [+\text{sibilant}] \_\_\_ [+\text{sibilant}]$$

Similarly, we recall the first part of the rule for regular past-tense formation in English:

> Insert a [ə] before the past-tense morpheme when a regular verb ends in a non-nasal alveolar stop, giving [əd].

This epenthesis rule may also be expressed in our more formal notation:

$\varnothing \rightarrow$ ə / [– nasal, + alveolar, – continuant] ___ [– nasal, + alveolar, – continuant]

There is a plausible explanation for insertion of a [ə]. If we merely added a [z] to *squeeze* to form its plural, we would get [skwiz:], which would be hard for English speakers to distinguish from [skwiz]. Similarly, if we added just [d] to *load* to form its past tense, it would be [lod:], which would also be difficult to distinguish from [lod], because in English we do not contrast long and short consonants. These and other examples suggest that the morphological patterns in a language are closely related to other generalizations about the phonology of that language.

Just as vowel length can be used for emphasis without changing the meaning of a word, as in "Stoooooop [sta:p] hitting me," an epenthetic schwa can have a similar effect, as in "P-uh-lease [pʰəliz] let me go."

Segment deletion rules are commonly found in many languages and are far more prevalent than segment insertion rules. One such rule occurs in casual or rapid speech. We often delete the unstressed vowels that are shown in bold type in words like the following:

mystery general memory funeral vigorous Barbara

These words in casual speech sound as if they were written:

mystry genral memry funral vigrous Barbra

The silent *g* that torments spellers in such words as *sign* and *design* is actually an indication of a deeper phonological process, in this case, one of segment deletion. Consider the following examples:

A		**B**	
sign	[sãɪn]	signature	[sɪgnətʃər]
design	[dəzãɪn]	designation	[dɛzɪgneʃən]
paradigm	[pʰærədãɪm]	paradigmatic	[pʰærədɪgmærək]

In none of the words in column A is there a phonetic [g], but in each corresponding word in column B a [g] occurs. Our knowledge of English phonology accounts for these phonetic differences. The "[g]—no [g]" alternation is regular, and we apply it to words that we never have heard. Suppose someone says:

"He was a salignant [səlɪgnə̃nt] man."

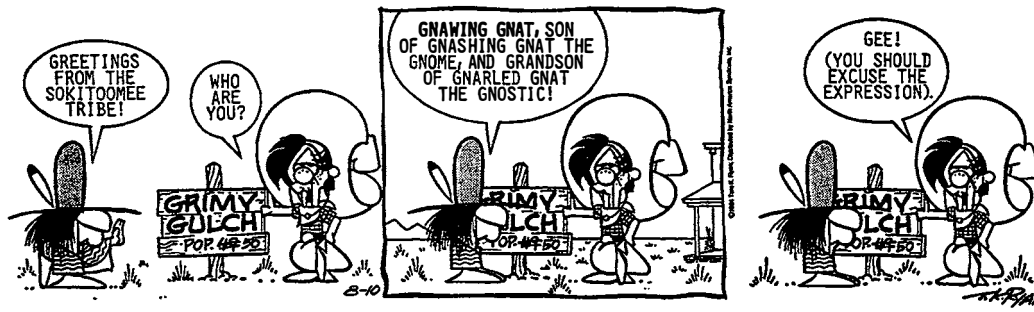
Not knowing what the word means (which you couldn't, since we made it up), you might ask:

"Why, did he salign [səlãɪn] somebody?"

It is highly doubtful that a speaker of English would pronounce the verb form without the *-ant* as [səlɪgn], because the phonological rules of English would delete the /g/ when it occurred in this context. This rule might be stated as:

Delete a /g/ when it occurs before a syllable-final nasal consonant.

The rule is even more general, as evidenced by the pair *gnostic* [nastɪk] and *agnostic* [ægnastɪk], and by the silent *g*'s in the cartoon:



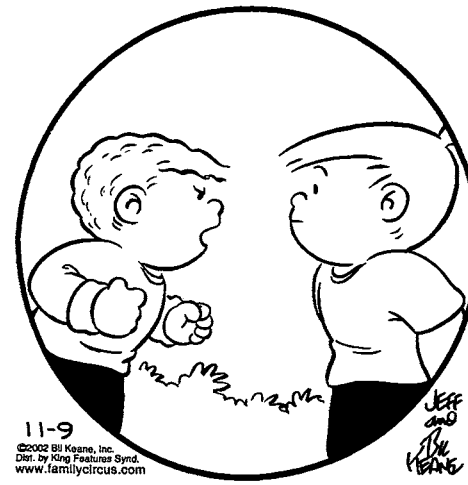
"Tumbleweeds" © Tom K. Ryan. Reprinted with permission of North America Syndicate.

This more general rule may be stated as:

Delete a /g/ word initially before a nasal consonant or before a syllable-final nasal consonant.

Given this rule, the phonemic representation of the stems in *sign/signature*, *design/ designation*, *malign/malignant*, *phlegm/phlegmatic*, *paradigm/paradigmatic*, *gnostic/agnostic*, and so on will include a /g/ that will be deleted by the regular rule if a prefix or suffix is not added. By stating the class of sounds that follow the /g/ (nasal consonants) rather than any specific nasal consonant, the rule deletes the /g/ before both /m/ and /n/.

Movement (Metathesis) Rules



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