

CHAPTER

1 What is phonology?

KEY TERMS

sound
symbol
transcription
grammar
continuous
nature of
speech

PREVIEW

This chapter introduces phonology, the study of the sound systems of language. Its key objective is to:

- ◆ explain the difference between physical sound and “a sound” as a discrete element of language
- ◆ highlight the tradeoff between accuracy and usefulness in representing sound
- ◆ introduce the notion of “sound as cognitive symbol”
- ◆ present the phonetic underpinnings of phonology
- ◆ introduce the notion of phonological rule

Phonology is one of the core fields that compose the discipline of linguistics, which is the scientific study of language structure. One way to understand the subject matter of phonology is to contrast it with other fields within linguistics. A very brief explanation is that phonology is the study of sound structure in language, which is different from the study of sentence structure (syntax), word structure (morphology), or how languages change over time (historical linguistics). But this is insufficient. An important feature of the structure of a sentence is how it is pronounced – its sound structure. The pronunciation of a given word is also a fundamental part of the structure of the word. And certainly the principles of pronunciation in a language are subject to change over time. So phonology has a relationship to numerous domains of linguistics.

An important question is how phonology differs from the closely related discipline of phonetics. Making a principled separation between phonetics and phonology is difficult – just as it is difficult to make a principled separation between physics and chemistry, or sociology and anthropology. While phonetics and phonology both deal with language sound, they address different aspects of sound. Phonetics deals with “actual” physical sounds as they are manifested in human speech, and concentrates on acoustic waveforms, formant values, measurements of duration measured in milliseconds, of amplitude and frequency. Phonetics also deals with the physical principles underlying the production of sounds, namely vocal tract resonances, and the muscles and other articulatory structures used to produce those resonances. Phonology, on the other hand, is an abstract cognitive system dealing with rules in a mental grammar: principles of subconscious “thought” as they relate to language sound.

Yet once we look into the central questions of phonology in greater depth, we will find that the boundaries between the disciplines of phonetics and phonology are not entirely clear-cut. As research in both of these fields has progressed, it has become apparent that a better understanding of many issues in phonology requires that you bring phonetics into consideration, just as a phonological analysis is a prerequisite for phonetic study of language.

1.1 Phonetics – the manifestation of language sound

Ashby and Maidment (2005) provide a detailed introduction to the subject area of phonetics, which you should read for greater detail on the acoustic and articulatory properties of language sounds, and transcription using the International Phonetic Alphabet (IPA). This section provides a basic overview of phonetics, to clarify what phonology is about.

From the phonetic perspective, “sound” refers to mechanical pressure waves and the sensations arising when such a pressure wave strikes your ear. In a physical sound, the wave changes continuously, and can be

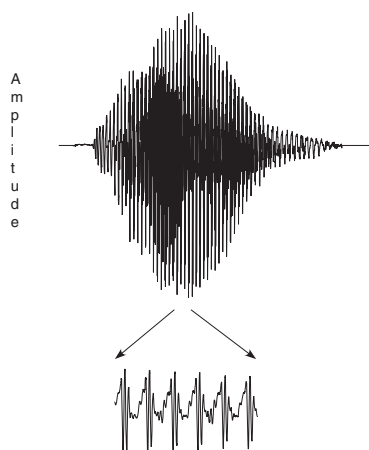


FIGURE 1

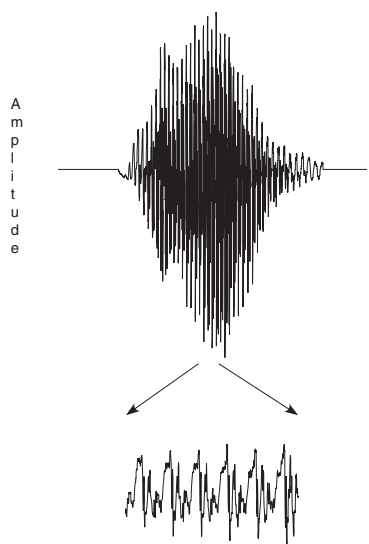


FIGURE 2

graphed as a waveform showing the amplitude on the vertical axis and time on the horizontal axis. Figure 1 displays the waveform of a pronunciation of the word *wall*, with an expanded view of the details of the waveform at the center of the vowel between *w* and *ll*.

Figure 2 provides an analogous waveform of a pronunciation of the word '*will*', which differs from *wall* just in the choice of the vowel.

Inspection of the expanded view of the vowel part of these waveforms shows differences in the overall shape of the time-varying waveforms, which is what makes these words sound different.

It is difficult to characterize those physical differences from the waveform, but an analytical tool of phonetics, the **spectrogram**, provides a

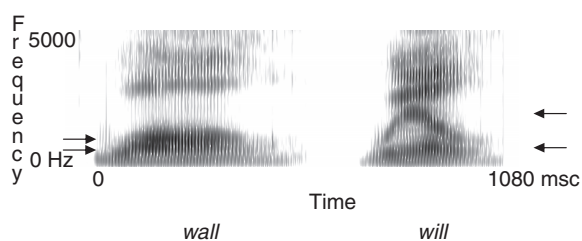


FIGURE 3

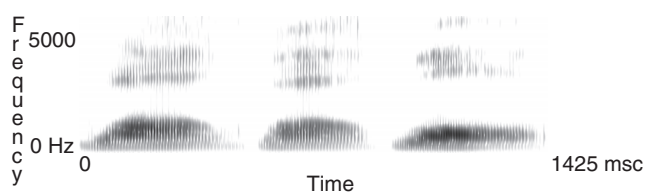


FIGURE 4

useful way to describe the differences, by reducing the absolute amplitude properties of a wave at an exact time to a set of (less precise) amplitude characteristics in different frequency and time areas. In a spectrogram, the vertical axis represents frequency in Hertz (Hz) and darkness represents amplitude. Comparing the spectrograms of *wall* and *will* in figure 3, you can see that there are especially dark bands in the lower part of the spectrogram, and the frequency at which these bands occur – known as **formants** – is essential to physically distinguishing the vowels of these two words. Formants are numbered from the bottom up, so the first formant is at the very bottom.

In *wall* the first two formants are very close together and occur at 634 Hz and 895 Hz, whereas in *will* they are far apart, occurring at 464 Hz and 1766 Hz. The underlying reason for the difference in these sound qualities is that the tongue is in a different position during the articulation of these two vowels. In the case of the vowel of *wall*, the tongue is relatively low and retracted, and in the case of *will*, the tongue is relatively fronted and raised. These differences in the shape of the vocal tract result in different physical sounds coming out of the mouth.

The physical sound of a word's pronunciation is highly variable, as we see when we compare the spectrograms of three pronunciations of *wall* in figure 4: the three spectrograms are obviously different.

The first two pronunciations are produced at different times by the same speaker, differing slightly in where the first two formants occur (634 Hz and 895 Hz for the first token versus 647 Hz and 873 Hz for the second), and in numerous other ways such as the greater amplitude of the lower formants in the first token. In the third token, produced by a second (male) speaker of the same dialect, the first two formants are noticeably lower and closer together, occurring at 541 Hz and 617 Hz.

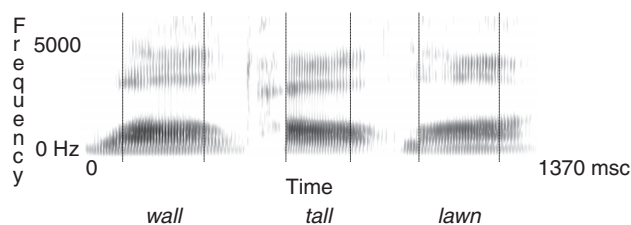


FIGURE 5

Physical variation in sound also arises because of differences in surrounding context. Figure 5 gives spectrograms of the words *wall*, *tall*, and *lawn*, with grid lines to identify the portion of each spectrogram in the middle which corresponds to the vowel.

In *wall*, the frequency of the first two formants rapidly rises at the beginning and falls at the end; in *tall*, the formant frequencies start higher and fall slowly; in *lawn*, the formants rise slowly and do not fall at the end. A further important fact about physical sound is that it is continuous, so while *wall*, *tall*, and *lawn* are composed of three sounds where the middle sound in each word is the same one, there are no actual physical boundaries between the vowel and the surrounding consonants.

The tools of phonetic analysis can provide very detailed and precise information about the amplitude, frequency and time characteristics of an utterance – a typical spectrogram of a single-syllable word in English could contain around 100,000 bits of information. The problem is that this is too much information – a lot of information needs to be discarded to get at something more general and useful.

1.2 Phonology: the symbolic perspective on sound

Physical sound is too variable and contains too much information to allow us to make meaningful and general statements about the grammar of language sound. We require a way to represent just the essentials of language sounds, as mental objects which grammars can manipulate. A phonological representation of an utterance reduces this great mass of phonetic information to a cognitive minimum, namely a sequence of discrete segments.

1.2.1 Symbolic representation of segments

The basic tool for converting the continuous stream of speech sound into discrete units is the phonetic transcription. The idea behind a transcription is that the variability and continuity of speech can be reduced to sequences of abstract symbols whose interpretation is predefined, a symbol standing for all of the concrete variants of the sound. Phonology then is the study of higher-level patterns of language sound, conceived in

terms of discrete mental symbols, whereas phonetics is the study of how those mental symbols are manifested as continuous muscular contractions and acoustic waveforms, or how such waveforms are perceived as the discrete symbols that the grammar acts on.

The idea of reducing an information-rich structure such as an acoustic waveform to a small repertoire of discrete symbols is based on a very important assumption, one which has proven to have immeasurable utility in phonological research, namely that there are systematic limits on possible speech sounds in human language. At a practical level, this assumption is embodied in systems of symbols and associated phonetic properties such as the International Phonetic Alphabet of figure 6. Ashby and Maidment (2005) give an extensive introduction to phonetic properties and corresponding IPA symbols, which you should consult for more information on phonetic characteristics of language sound.

The IPA chart is arranged to suit the needs of phonetic analysis. Standard phonological terminology and classification differ somewhat from this usage. Phonetic terminology describes [p] as a “plosive,” where that sound is phonologically termed a “stop”; the vowel [i] is called a “close” vowel in phonetics, but a “high” vowel in phonology. Figure 7 gives the important IPA vowel letters with their phonological descriptions, which are used to stand for the mental symbols of phonological analysis.

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

Three primary heights are generally recognized, namely **high**, **mid**, and **low**, augmented with the secondary distinction **tense/lax** for nonlow vowels which distinguishes vowel pairs such as [i] (*seed*) vs. [ɪ] (*Sid*), [e] (*late*) vs. [ɛ] (*let*), or [u] (*food*) vs. [ʊ] (*foot*), where [i, e, u] are tense and [ɪ, ɛ, ʊ] are lax. Tense vowels are higher and articulated further from the center of the vocal tract compared to their lax counterparts. It is not clear whether the tense/lax distinction extends to low vowels.

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

With these independently controllable phonetic parameters – five degrees of height, three degrees of fronting, and rounding versus non-rounding – we have the potential for up to thirty vowels, which is

THE INTERNATIONAL PHONETIC ALPHABET (revised to 2005)

CONSONANTS (PULMONIC) © 2005 IPA

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			ʀ					ʀ		
Tap or Flap		ⱱ		ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

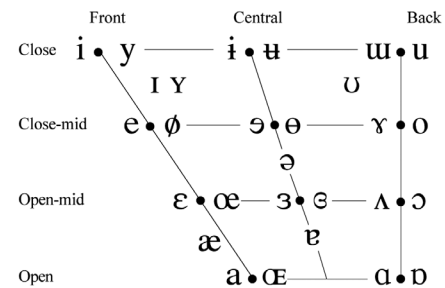
CONSONANTS (NON-PULMONIC)

Clicks	Voiced implosives	Ejectives
◌ ʘ Bilabial	ɓ Bilabial	ʼ Examples:
◌ ǀ Dental	ɗ Dental/alveolar	ɓʼ Bilabial
◌ ǃ (Post)alveolar	ɟ Palatal	ɗʼ Dental/alveolar
◌ ǁ Palatoalveolar	ɡ Velar	ɡʼ Velar
◌ ǂ Alveolar lateral	ɠ Uvular	sʼ Alveolar fricative

OTHER SYMBOLS

ʌ Voiceless labial-velar fricative	ɕ ʑ Alveolo-palatal fricatives
ʋ Voiced labial-velar approximant	ɺ Voiced alveolar lateral flap
ɥ Voiced labial-palatal approximant	ɺ Simultaneous ʃ and x
ħ Voiceless epiglottal fricative	
ʕ Voiced epiglottal fricative	Affricates and double articulations can be represented by two symbols joined by a tie bar if necessary.
ʔ Epiglottal plosive	

VOWELS



Where symbols appear in pairs, the one to the right represents a rounded vowel.

SUPRASEGMENTALS

- ˈ Primary stress
- ˌ Secondary stress
- ː Long
- ˑ Half-long
- ˑ Extra-short
- ˑ Minor (foot) group
- ˑ Major (intonation) group
- Syllable break
- ˑ Linking (absence of a break)

DIACRITICS Diacritics may be placed above a symbol with a descender, e.g. ɲ̥

◌ ɹ	Voiceless	◌ ɹ̥	◌ ɹ̥	◌ ɹ̥	Breathily voiced	◌ ɹ̥	◌ ɹ̥	◌ ɹ̥	Dental	◌ ɹ̥	◌ ɹ̥
◌ ɹ̥	Voiced	◌ ɹ̥	◌ ɹ̥	◌ ɹ̥	Creaky voiced	◌ ɹ̥	◌ ɹ̥	◌ ɹ̥	Apical	◌ ɹ̥	◌ ɹ̥
◌ ɹ̥	Aspirated	◌ ɹ̥ʰ	◌ ɹ̥ʰ	◌ ɹ̥	Linguolabial	◌ ɹ̥	◌ ɹ̥	◌ ɹ̥	Laminal	◌ ɹ̥	◌ ɹ̥
◌ ɹ̥	More rounded	◌ ɹ̥̞	◌ ɹ̥̞	◌ ɹ̥	Labialized	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	Nasalized	◌ ɹ̥̃	◌ ɹ̥̃
◌ ɹ̥	Less rounded	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	Palatalized	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	Nasal release	◌ ɹ̥̟	◌ ɹ̥̟
◌ ɹ̥	Advanced	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	Velarized	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	Lateral release	◌ ɹ̥̟	◌ ɹ̥̟
◌ ɹ̥	Retracted	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	Pharyngealized	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	No audible release	◌ ɹ̥̟	◌ ɹ̥̟
◌ ɹ̥	Centralized	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	Velarized or pharyngealized	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥		◌ ɹ̥̟	◌ ɹ̥̟
◌ ɹ̥	Mid-centralized	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	Raised	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥		◌ ɹ̥̟	◌ ɹ̥̟
◌ ɹ̥	Syllabic	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	Lowered	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥		◌ ɹ̥̟	◌ ɹ̥̟
◌ ɹ̥	Non-syllabic	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	Advanced Tongue Root	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥		◌ ɹ̥̟	◌ ɹ̥̟
◌ ɹ̥	Rhoticity	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥	Retracted Tongue Root	◌ ɹ̥̟	◌ ɹ̥̟	◌ ɹ̥		◌ ɹ̥̟	◌ ɹ̥̟

- TONES AND WORD ACCENTS
- LEVEL
- ◌ or ◌ Extra high
 - ◌ or ◌ High
 - ◌ or ◌ Mid
 - ◌ or ◌ Low
 - ◌ or ◌ Extra low
 - ◌ Downstep
 - ◌ Upstep
- CONTOUR
- ◌ or ◌ Rising
 - ◌ or ◌ Falling
 - ◌ or ◌ High rising
 - ◌ or ◌ Low rising
 - ◌ or ◌ Rising-falling
 - ◌ or ◌ Global rise
 - ◌ or ◌ Global fall

FIGURE 6

<i>Nonround</i>				
tense	i	ɨ	ɯ	high
lax	ɪ			
tense	e	ɘ	ɤ	mid
lax	ɛ	ɜ	ʌ	
	æ	a	ɑ	low
	Front	Central	Back	

<i>Round</i>				
tense	y	ɥ	u	high
lax	ɣ		ʊ	
tense	ø	ɵ	o	mid
lax	œ	ɶ	ɔ	
	œ		ɒ	low
	Front	Central	Back	

FIGURE 7

many more vowels than are found in English. Many of these vowels are lacking in English, but can be found in other languages. This yields a fairly symmetrical system of symbols and articulatory classifications, but there are gaps such as the lack of tense/lax distinctions among central high vowels.

The major consonants and their classificatory analysis are given in figure 8.

Where the IPA term for consonants like [p b] is “plosive,” these are referred to phonologically as “stops.” Lateral and rhotic consonants are termed “liquids,” and non-lateral “approximants” are referred to as “glides.” Terminology referring to the symbols for implosives, ejectives, diacritics, and suprasegmentals is generally the same in phonological and phonetic usage.

Other classificatory terminology is used in phonological analysis to refer to the fact that certain sets of sounds act together for grammatical purposes. Plain stops and affricates are grouped together, by considering affricates to be a kind of stop (one with a special fricative-type release). Fricatives and stops commonly act as a group, and are termed **obstruents**, while glides, liquids, nasals, and vowels likewise act together, being termed **sonorants**.

The release of affricates will be written as a superscript letter, analogous to IPA conventions for nasal and lateral release. This makes it clear that affricates are single segments, not clusters.

1.2.2 The concerns of phonology

As a step towards understanding what phonology is, and especially how it differs from phonetics, we will consider some specific aspects of sound structure that would be part of a phonological analysis. The point which is most important to appreciate at this moment is that

Consonant symbols

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

Glides and liquids

	labiovelar	palatal	labiopalatal	velar	
Glides:	w	j	ɥ	ɯ	
	tap, flap	trill	glide	retroflex	uvular
Rhotics:	r	r	ɻ	ɻ	ʀ
	plain	retroflex	voiceless fricative	voiced fricative	
Laterals:	l	ɭ	ɭ	ɭ	

FIGURE 8

the “sounds” which phonology is concerned with are symbolic sounds – they are cognitive abstractions, which represent but are not the same as physical sounds.

The sounds of a language. One aspect of phonology investigates what the “sounds” of a language are. We would want to take note in a description of the phonology of English that we lack the vowel [ø] that exists in German in words like *schön* ‘beautiful,’ a vowel which is also found in French (spelled *eu*, as in *jeune* ‘young’), or Norwegian (*øl* ‘beer’). Similarly, the consonant [θ] exists in English (spelled *th* in *thing*, *path*), as well as Icelandic, Modern Greek, and North Saami), but not in German or French,

and not in Latin American Spanish (but it does occur in Continental Spanish in words such as *cerveza* 'beer').

Sounds in languages are not just isolated atoms; they are part of a system. The systems of stops in Hindi and English are given in (1).

(1) Hindi stops				English stops		
p	t	ʈ	k	p	t	k
p ^h	t ^h	ʈ ^h	k ^h	p ^h	t ^h	k ^h
b	d	ɖ	g	b	d	g
b ^h	d ^h	ɖ ^h	g ^h			

The stop systems of these languages differ in three ways. English does not have a series of voiced aspirated stops like Hindi [b^h d^h ɖ^h g^h], nor does it have a series of retroflex stops [ʈ ʈ^h ɖ ɖ^h]. Furthermore, the phonological status of the aspirated sounds [p^h t^h k^h] is different in the languages, as discussed in chapter 2, in that they are basic lexical facts of words in Hindi, but are the result of applying a rule in English.

Rules for combining sounds. Another aspect of language sound which a phonological analysis takes account of is that in any language, certain combinations of sounds are allowed, but other combinations are systematically impossible. The fact that English has the words [bɪk] *brick*, [breɪk] *break*, [brɪdʒ] *bridge*, [brɛd] *bread* is a clear indication that there is no restriction against having words that begin with the consonant sequence *br*; besides these words, one can think of many more words beginning with *br* such as *bribe*, *brow* and so on. Similarly, there are many words which begin with *bl*, such as [blu] *blue*, [bleʔnt] *blatant*, [blæst] *blast*, [blend] *blend*, [blɪŋk] *blink*, showing that there is no rule against words beginning with *bl*. It is also a fact that there is no word *[blɪk]¹ in English, even though the similar words *blink*, *brick* do exist. The question is, why is there no word **blick* in English? The best explanation for the nonexistence of this word is simply that it is an accidental gap – not every logically possible combination of sounds which follows the rules of English phonology is found as an actual word of the language.

Native speakers of English have the intuition that while *blick* is not a word of English, it is a theoretically possible word of English, and such a word might easily enter the language, for example via the introduction of a new brand of detergent. Sixty years ago the English language did not have any word pronounced [bɪk], but based on the existence of words like *big* and *pick*, that word would certainly have been included in the set of nonexistent but theoretically allowed words of English. Contemporary English, of course, actually does have that word – spelled *Bic* – which is the brand name of a ballpoint pen.

While the nonexistence of *blick* in English is accidental, the exclusion from English of many other imaginable but nonexistent words is based on

¹ The asterisk is used to indicate that a given word is nonexistent or wrong.