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## Appendix 1: Phonetic Symbols

### 1.1 Vowel symbols (see section 2.7)

	<i>Front</i>	<i>Central</i>	<i>Back</i>
(a) UNROUNDED			
High or close	i    ɪ	ɨ	u
High-mid or half-close	e	ə    ɜ	ʏ
Low-mid or half-open	ɛ		ʌ
	æ		
Low or open	a		ɑ
(b) ROUNDED			
High or close	y    ʏ	ɥ	u
High-mid or half-close	ø		o
Low-mid or half-open	œ		ɔ
Low or open	œ		ɒ

#### *Diacritics commonly used with vowels*

- + or < fronted, e.g. [y̟], [y̠] or [u̟] for a fronted version of [u]
- or > retracted, e.g. [e̠], [e̡] or [e̟] for a retracted version of [e]
- + or ^ raised, e.g. [e̝] or [e̞] for a raised version of [e]
- + or v lowered, e.g. [e̜] or [e̝] for a lowered version of [e]
- ˘ or – may indicate a centralized vowel (as in [ɨ̜], [ɨ̝] or [a̜])
- :
- slightly lengthened, or 'half-long', e.g. [uː] or [eː]
- ◌ voiceless or whispered, e.g. [x̥] or [y̥]
- ◌ with breathy voice, e.g. [a̤] or [y̤]
- ◌ with creaky voice, e.g. [a̰] or [y̰]
- ◌ nasalized, e.g. [ã] or [ũ]



- : length, as in [t:] or [n:] (see section 2.15)
- h aspiration, or delayed voice onset or voice onset time, as in [p<sup>h</sup>] or [k<sup>h</sup>] (see section 2.16)

### Alternative symbols

The grooved fricatives [ʃ] and [ʒ] are often represented alternatively as [š] and [ž].

The lamino-palatal approximant [j] may be represented as [y] (in line with the English spelling convention). Since [y] is used in the cardinal vowel system to indicate a high front rounded vowel, those who use [y] for the approximant normally adopt some other convention to represent front rounded vowels, often using [ü] and [ö] instead of [y] and [ø].

Postalveolar or apico-palatal consonants are sometimes written as alveolars with a subscript dot, e.g. [ɹ̥] or [ŋ̥].

The representation of r-sounds is particularly problematic. Various conventions have been used, including the use of [r̥] for an alveolar flap, [r̄] for an alveolar trill, and a subscript dot for articulations further back than alveolar (e.g. [r̥] for a post-alveolar approximant, or [r̄] for a uvular trill). The reader is warned that in many phonetic descriptions of particular languages, the terminology is vague and the symbolization *ad hoc*.

### 1.3 Diacritics and conventions for complex articulations

- ˜ above a vowel or consonant: nasalized, e.g. [ã], [w̃] (see section 3.3)
- ˘ through a consonant: velarization or pharyngealization, e.g. [t̘] or [s̘] (see section 3.6)
- w beneath a consonant: simultaneous labialization, e.g. [k̠]; superscript following a consonant: transitional labialization, e.g. [k<sup>w</sup>] (see section 3.4)
- j beneath a consonant: simultaneous palatalization, e.g. [n̠]; superscript following a consonant: transitional palatalization, e.g. [n<sup>j</sup>] (see section 3.5)
- ˠ superscript following a vowel: vowel retroflexion, e.g. [ɔˠ] (see section 3.9)
- ɿ beneath a consonant: syllabic, e.g. [m̩], [l̩] (see section 3.11)

Vowel onglide and offglide and diphthongs can be represented by combinations of vowel symbols, e.g. onglide [i̯], offglide [ɔ̯], diphthong [ai̯] or [aɪ] (see sections 2.8 and 3.10).

Prenasalized consonants can be represented with an appropriate preceding nasal symbol, e.g. [m̩b] or [ᵐb]; and postnasalized with a corresponding following nasal, e.g. [p̩m̩] or [pᵐ] (see section 3.3).

Affricates can be represented by symbols for the appropriate stop and fricative components, e.g. [t͡s] or [t͡ʃ]. For the affricates [t͡ʃ] and [d͡ʒ], the special symbols [t͡ʃ̥] and [t͡ʃ̥] are also available (see section 3.7).

Double articulation – sounds involving two simultaneous places of articulation – can be represented by two component symbols, e.g. [k͡t̪] for an alveolar-velar plosive, or [ŋ͡m̩] for a labio-velar nasal (see section 3.8).

## 1.4 Symbols used in transcription of English

### Vowels

Unless otherwise indicated, English examples in this book assume the kind of pronunciation heard in south-eastern England and Australia. In this variety of English – unlike English spoken in Scotland, Ireland and most of North America – words such as *hard*, *board* and *heard* contain long vowels with no r-sound following them. Words such as *fear* and *fare* likewise have no r-sound and are pronounced with centring diphthongs. This is also a version of English in which words such as *put* and *look* are pronounced with a short vowel distinct from the long vowel in *boot* and *Luke*, and in which words such as *rod* and *pot* have a short rounded vowel distinct both from the vowel of *broad* and *bought*, and from that of *hard* and *part*.

For full exemplification of this vowel system, each vowel is listed below with some sample words. The first symbol on the left is the one generally preferred in this text. These symbols omit vowel length, on the grounds that length can be predicted from the vowel quality; but we show the long symbols (with:) as alternatives and use these symbols in the text when it seems necessary to draw attention to the vowel length. Other symbols in common use are also included below: those incorporating /y/ and /w/ are widely used in North American publications.

It should be noted that these symbols provide for a broad or phonemic transcription (in the sense outlined in chapter 4) and each symbol may therefore cover a number of variants. In Australian English, for example, a vowel can be quite noticeably influenced by a following /l/, so that the vowel in *bowl* and *dole* may sound different from the vowel in *boat* and *dough*. It is nevertheless assumed that such differences can be included as context-sensitive variants implied by a single symbol. But the symbols do *not* cover all varieties of English, given that some varieties have quite different vowel systems.

The sequence /ju/ is included as a diphthong although there are reasons for taking it to be simply the vowel /u/ preceded by the consonant /j/. It is worth noting that some varieties of English have /u/ instead of /ju/ in many words.

Vowels	Sample words
<i>Short</i>	
/ɪ/	hid, bit, lick
/ɛ/ /e/	head, bet, wreck
/æ/	had, bat, lack
/ʌ/ /ɐ/	thud, but, luck
/ɒ/	rod, pot, lock
/ʊ/	hood, put, look
<i>Long</i>	
/i:/ /i:/ /iy/	heed, beat, bee
/ɜ:/ /ɜ:/	heard, pert, burr
/ɑ:/ /ɑ:/	hard, part, bar
/ɔ:/ /ɔ:/	hoard, bought, pore, poor, paw
/u:/ /u:/ /uw/ /u:/	food, boot, boo
<i>Diphthongs</i>	
/eɪ/ /ey/	fade, bait, bay
/aɪ/ /ay/	hide, bite, buy
/ɔɪ/ /oy/	void, quoit, boy
/oʊ/ /əʊ/ /ow/	hoed, boat, dough
/aʊ/ /aw/	loud, bout, bough
/ɪə/	feared, beard, beer
/ɛə/	fared, bared, bare, bear
/ʊə/	toured, lure
/ju:/ /ju:/ /jɜ:/	hewed, cute, due, dew, few
<i>Indeterminate (only in unstressed syllables)</i>	
/ə/	(first syllable of:) above, parade, correct (second syllable of:) China, better, carrot

### Consonants

Compared with the vowel system, English consonants show much less variation, either regionally or socially, and there is relatively little controversy about a broad or phonemic transcription. Within the English of south-eastern England and Australia, a few consonants do vary substantially according to context, notably /l/ and /r/, but the use of a single symbol does not deny the existence of such context-sensitive variation.

Alternative symbols are again included. Sample words are in three groups, illustrating (where possible) the consonant in (1) initial, (2) medial and (3) final positions.

Consonants	Sample words (1)	(2)	(3)
<i>Voiceless plosives</i>			
/p/	peer, paw	leper, rapid	rip, loop
/t/	tier, tore	letter, baton	writ, loot
/k/	core, keel	wrecker, icon	rick, Luke
<i>Voiced plosives</i>			
/b/	beer, bore	pebble, rabid	rib, cube
/d/	dear, door	redder, idol	rid, rude
/g/	gear, gore	beggar, eagle	rig, dog
<i>Voiceless affricate</i>			
/tʃ/ /tʃ/	cheer, chore	lecher, catcher	rich, pouch
<i>Voiced affricate</i>			
/dʒ/ /dʒ/	jeer, jaw	ledger, badger	ridge, rage
<i>Voiceless fricatives</i>			
/f/	fear, four	heifer, offer	whiff, roof
/θ/	thaw, theme	method, Ethel	myth, tooth
/s/	sear, saw	lesser, acid	miss, loose
/ʃ/ /ʃ/	sheer, shore	pressure, ration	dish, gauche
/h/	hear, hoar	—	—
<i>Voiced fricatives</i>			
/v/	veer, vaunt	ever, liver	live, move
/ð/	there, thy	leather, other	lithe, soothe
/z/	zeal, zone	resin, dozen	fizz, lose
/ʒ/ /ʒ/	—	measure, closure	—
<i>Nasals</i>			
/m/	mere, more	lemon, simmer	rim, room
/n/	near, nor	venom, sinner	win, spoon
/ŋ/	—	hanger, singer	ring, rang
<i>Approximants</i>			
/l/	leer, law	melon, miller	will, rule
/r/ /r/	rear, raw	heron, mirror	—
/w/	weir, war	away, bewildered	—
/j/ /j/	year, your	beyond	—

## Appendix 2: Features

### 2.1 Jakobson and Halle's distinctive features (based on Jakobson and Halle 1956, pp. 29ff.)

The features are defined in both acoustic and articulatory terms. Each feature is an opposition between two relative values; for example, vocalic sounds have a *relatively* clear formant structure in comparison with nonvocalic sounds.

Feature	Opposed to	Acoustic description	Articulatory description
1 Vocalic	Nonvocalic	Sharply defined formant structure	Voiced, with free passage of air through vocal tract
2 Consonantal	Nonconsonantal	Low total energy	Obstruction in vocal tract
3 Compact	Diffuse	Energy concentrated in central area of spectrum	High ratio of front resonance chamber to back
4 Tense	Lax	High energy with greater spread across spectrum and longer duration	Greater deformation of vocal tract from its rest position
5 Voiced	Voiceless	Periodic low frequency excitation	Vocal cord vibration
6 Nasal	Oral	Additional formants and less intensity in existing formants	Coupling of nasal cavity
7 Discontinuous	Continuant	Interruption or abrupt transition	Rapid closure and opening of vocal tract
8 Strident	Mellow	High intensity noise	'Rough-edged' effect at point of articulation
9 Checked	Unchecked	Higher rate of energy discharge	Glottalized
10 Grave	Acute	Energy concentrated in lower frequencies	Peripheral (towards front or back of vocal tract)

		Features	
11 Flat	Plain	Downward shift or weakening of upper frequencies	Narrowed aperture (e.g. by lip rounding)
12 Sharp	Plain	Upward shift of upper frequencies	Reduced oral cavity and widened pharynx

### 2.2 Chomsky and Halle's universal set of phonetic features (based on Chomsky and Halle 1968, pp. 298ff.)

The features are described principally in articulatory terms, although Chomsky and Halle also refer (occasionally) to acoustic and perceptual correlates. Each feature is a 'physical' scale defined by two points, e.g. sonorant–nonsonorant. The features are binary for linguistic description – e.g. all sounds are functionally either [+voiced] or [–voiced] – but may have several values when taken as physical or phonetic scales. Where only one of the two functional values is given below, the other is a simple negative – e.g. nonvocalic, nonconsonantal.

Feature	Articulatory description
<i>Major class features</i>	
1 Sonorant	Produced with vocal tract cavity configuration in which spontaneous voicing is possible (Nonsonorant = obstruent)
2 Vocalic	Constriction does not exceed that of high vowels, and position of vocal cords allows spontaneous voicing (Syllabic)
3 Consonantal	Radical obstruction in mid-sagittal region of vocal tract
<i>Cavity features</i>	
4 Coronal	Produced with blade of tongue raised from neutral position
5 Anterior	Produced with obstruction in front of palato-alveolar region
6 High	Tongue body above neutral position
7 Low	Tongue body below neutral position
8 Back	Tongue body retracted from neutral position
9 Round(ed)	Narrowing of lip orifice
10 Distributed	Constriction extends for some distance along direction of airflow

(cont'd)

11 Covered	Pharynx walls narrowed and tensed and larynx raised (in vowel production)
12 Glottal constriction	Constriction of vocal cords
13 Nasal	Lowered velum
14 Lateral	Lowered side(s) of mid-section of tongue
<i>Manner of articulation features</i>	
15 Continuant	Primary constriction in vocal tract does not block air flow
(Noncontinuant = stop)	
16 Instantaneous release	Instantaneous release (of stops)
<i>Chomsky and Halle's discussion, 1968, pp. 318–22, suggests two release features:</i>	
16a Instantaneous versus delayed release of primary closures	
16b Instantaneous versus delayed release of secondary closures	
17 Velar(ic) suction	Velar closure producing suction (clicks)
18 Implosion	Glottal closure producing suction (implosives)
19 Velar(ic) pressure	(Velar closure producing pressure – no evidence of use in language)
20 Ejection	Glottal closure producing pressure (ejectives)
21 Tense	Deliberate, accurate, maximally distinct articulation (of supraglottal musculature)
(Nontense = lax)	
<i>Source features</i>	
22 Heightened subglottal pressure	Tenseness in subglottal musculature producing greater subglottal pressure
23 Voiced	Vocal cord vibration (induced by appropriate glottal opening and airflow)
(Nonvoiced = voiceless)	
24 Strident	Turbulence (in fricatives and affricates) caused by nature of surface, rate of airflow and angle of incidence at point of articulation
<i>Prosodic features</i> (listed but not discussed in Chomsky and Halle 1968)	
25 Stress	
26 Pitch (high, low, elevated, rising, falling, concave)	
27 Length	

### 2.3 Ladefoged's 'Traditional Features' (based on Ladefoged 1982, pp. 254ff.)

Each feature (except 'syllabic') relates to a physical scale, either articulatory or acoustic. The features are not binary in principle and may have two or more values. Where only one value is listed, the feature *is* binary (e.g. 'click' implies +click versus -click).

Feature	Values	Description of physical scale
1 Glottalic	Ejective Pulmonic Implosive	Upward or downward movement of the glottis
2 Velaric	Click	Degree of suction of air in mouth
3 Voice	Glottal stop Laryngealized Voiced Murmur Voiceless	Degree of glottal stricture
4 Aspiration	Aspirated Unaspirated Voiced	Delay in onset of voicing
5 Place	Bilabial Labio-dental Dental Alveolar Retroflex Palato-alveolar Palatal Velar Uvular Pharyngeal Glottal	Location of articulation
6 Labial	Labial	Approximation of centres of lips
7 Stop	Stop Fricative	Degree of approximation of articulators
8 Nasal	Nasal	Lowering of soft palate
9 Lateral	Lateral	Amount of airflow over sides of tongue
10 Trill	Trill	Vibration of articulator
11 Flap	Flap	Rate of articulatory movement
(Ladefoged notes uncertainty about the characterization of flaps.)		
12 Sonorant	Sonorant	Amount of acoustic energy
13 Sibilant	Sibilant	Amount of high-frequency energy
14 Grave	Grave	Ratio of low- to high-frequency energy
15 Height	4 height 3 height 2 height 1 height	Inverse of frequency of first formant (distinguishing four degrees of vowel height)
16 Back	Back	Difference between frequencies of formants two and one
17 Round	Round	Inverse of distance between corners of lips
18 Wide	Wide	Advancement of tongue root
19 Rhotacized	Rhotacized	Lowering of frequency of formant three
20 Syllabic	Syllabic	(No agreed physical scale)

## 2.4 Components in dependency phonology (based on Anderson and Ewen 1987, chs 4–6)

Articulation is resolved into gestures, subgestures and components. Some components are scales or continua, others may be simply present or absent. In the characterization of particular sounds, components may 'preponderate' to a greater or lesser extent. The vowel [e], for example, may combine the components [i] and [a], with [i] preponderant; [æ] may combine the same two components, with [a] preponderant.

<i>Gesture</i>	<i>Subgesture</i>	<i>Components</i>
Categorial	Phonatory	Consonantality or periodicity: a scale ranging from [V] 'relatively periodic' to [C] 'periodic energy reduction'
	Initiatory	Degree of glottal opening: a scale encompassing aspiration as well as voicing, represented by the extent to which a component [O] is prominent; [O] is absent in the glottal stop [G] glottalicness (in glottalic sounds, absent in pulmonic) [K] velaricness (present in clicks, absent for other sounds)
Articulatory	Locational	[i] frontness (acuteness, sharpness)
		[a] lowness (sonority)
		[u] roundness (gravity, flatness)
		[ə] centrality
		[l] linguality (present in sounds in which the blade or body of the tongue is active)
		[t] apicality
		[d] dentality
		[r] retracted tongue root (present in pharyngeal consonants and in vowels with narrowed pharynx)
		[ɑ] advanced tongue root (relevant only to languages which distinguish vowels with advanced tongue root from vowels with neutral tongue root posture)
		[λ] laterality
Oro-nasal	[n] nasality	

## References

### Abbreviations

- ACLS American Council of Learned Societies  
 ANPE *Archives Néerlandaises de Phonétique Expérimentale*  
 AUMLA *Journal of the Australasian Universities Modern Language Association*  
 IEEE-TA *Institute of Electrical and Electronics Engineers, Transactions on Signal Processing*  
 IJAL *International Journal of American Linguistics*  
 IPO Instituut voor Perceptie Onderzoek (Institute for Perception Research), Eindhoven, Netherlands  
 IRAL *International Review of Applied Linguistics*  
 JASA *Journal of the Acoustical Society of America*  
 JIPA *Journal of the International Phonetic Association*  
 JP *Journal of Phonetics*  
 JSHLR *Journal of Speech, Hearing, and Language Research*  
 JSHR *Journal of Speech and Hearing Research*  
 LInq *Linguistic Inquiry*  
 MIT Massachusetts Institute of Technology  
 MIT-QPR Research Laboratory of Electronics, MIT, Quarterly Progress Reports  
 MQSLRC Macquarie University Speech and Language Research Centre, Working Papers  
 PMLA *Publications of the Modern Languages Association*  
 SC *Speech Communication*  
 STL-QPSR Speech Transmission Laboratory, Royal Institute of Technology, Stockholm, Quarterly Progress and Status Reports  
 UCLA-WP University of California at Los Angeles Phonetics Laboratory, Working Papers in Phonetics  
 WP-SILAAB Working Papers of the Summer Institute of Linguistics, Australian Aborigines Branch  
 ZP *Zeitschrift für Phonetik*

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