

Contents

Preface to the Third Edition	vii
Acknowledgments	ix
Preface to the Second Edition	xi
Preface to the First Edition	xiii
1 Introduction to Phonetics	1
2 Introduction to the International Phonetic Alphabet	21
3 Articulatory Aspects of Phonetics: Consonants	45
4 Articulatory Aspects of Phonetics: Vowels and Diphthongs	93
5 Acoustic Aspects of Phonetics	121
6 Perceptual Phonetics	147
7 Distinctive Features for Consonants and Vowels	165
8 Stress and Intonation	189
9 Dynamics of Connected Speech	207
Appendix A: International Phonetic Alphabet	227
Appendix B: Answers to Exercises	231
Index	247

Preface to the Third Edition

Phonetics, the science and art of spoken sounds in a language, is an older and more established discipline than its adopted fields of speech-language pathology and audiology. Change comes to Phonetics less rapidly, but it comes from many associated areas with a vast accumulation of new resources.

When asked by the publisher to author a third edition of *Phonetics: Principles and Practices*, I was uncertain about capturing the nuances of the many important changes worthy of inclusion, so I solicited and received contributions from two distinguished phoneticians, one an authority on the traditions and history of the field (Dr. Donald Mowrer) and the other a leading expert in the structural and linguistic aspects of the field (Dr. David Ingram). I am grateful to both not only for their help in revising the book, but also for their addition of student-friendly sections with significant practical applications.

This third edition retains the unique presentation of material, developed 31 years ago, which enables students to independently study and master the field. Of course, the help of a teacher and the culture of a classroom enhance students' learning.

Since the publication of the second edition in 1982, the second author of this book, my late wife Kala, was killed by terrorists in a plane hijacking in 1986. Dr. Thomas Hixon, in dedicating his book *Respiratory Function in Speech and Song* to her, wrote:

“For Kala Singh
In Memory of Her Gentle Countenance with Hope for Peace.”

Sadly, the tumult that took Kala's life so many years ago has engulfed the entire world, and Dr. Hixon's "hope for peace" is more elusive today than when her life was lost.

Kala appears posthumously as the second author of this book and many of her contributions have been retained. What could not be

retained, due to the loss of original artwork, was the 85 pages of film strip presentations with associated schematic illustrations and sound spectrograms, showing the power of context in speech production by the tongue, teeth, and jaw movements during production of all vowels and consonants. If you have a copy, retain it.

Sadanand Singh

Table 7-3. Comparison of /w/, /r/, /l/, /d/ phonemes according to their articulatory components involving lips and tongue

Articulators	Phoneme			
	/w/	/r/	/l/	/d/
Lips	Round	Round	Flat	Flat
Tongue	Vowel-like position	Approximate contact with alveolar ridge with smooth central opening	Contact with alveolar ridge with lateral opening	Contact with alveolar ridge without any opening

on the lip dimension; however, they do share similarities on the tongue produced by the contact of the tongue tip with the alveolar ridge, accompanied by an opening. The phoneme /d/ does not share the lip roundedness aspect with /r/. It does share the place of articulation aspect with /r/ and /l/; however, /d/ is distinct from /r/ and /l/ because its production is not accompanied by an opening between the tongue tip and alveolar ridge.

In some English dialects, the phoneme /w/ is allophonic with the phoneme /ʍ/ (wh) at the initial position of the word. For example, the words “what,” “which,” “where,” are produced in most dialects as /wʌt/, /wtʃ/, and /wɛə/, and in some dialects as /ʍʌt/, /ʍɪtʃ/, and /ʍɛə/. In several languages, the phoneme /w/ is in allophonic variation with /b/ and /v/. The phonemes /r, l/ and /w, j/, despite their overall vowel-like acoustic characteristics, possess consonantlike acoustic energy concentration. For example, /w/, because of its labiality, has low-frequency energy; /r/ and /l/, because of their alveolar place, have energy concentration in mid-frequencies; and /j/, because of its palatal nature, has two prominent energy concentration areas.

Division into Two Groups

On the basis of the above descriptions, the seven sonorant consonants /m, n, ŋ, j, r, l, w/ can be divided into two functional groups. One group includes /m, n, ŋ, l/, which can serve as “pure” consonants in words such as “man” /mæn/, “king” /kɪŋ/, and “lad” /læd/. These consonants also can serve as vowels (the nucleus of a syllable) in words such as “rope ’em” [rɒp̩m], “button” /bʌtn/, “we c’n go” /wik̩n gou/, and “kettle” /kɛtl/. The syllabic consonants /m, n, ŋ, l/ can be represented by a stroke (,) directly under them.

The second group consists of the syllabic consonants /w, j, r/, which can become entirely independent vowels. After syllabification, the phoneme /j/ becomes /i/ or /ɪ/, /w/ becomes /u/ or /ʊ/, and /r/ becomes /ə/ or /ɜː/. Some examples to substantiate the above rule are: “boy” /bɔɪ/, “bowl” /boʊl/, “bird” /bɜːd/, and “father” /fɑðə/.

Glottal Voiceless Fricative /h/

The phoneme /h/ in English is a voiceless consonant with vocalic characteristics. It is called vocalic because it is articulated without any closure in the vocal tract. The /h/ phoneme is produced by glottal constriction and is a continuant sound. Acoustically, /h/ has high-frequency energy with a very low amplitude. It is a highly intelligible consonant and is rarely confused with any other consonants.

VOWELS

Vowel features are presented separately from consonant features because a vowel-consonant confusion is rare in any language. Actually, we believe that vowels and consonants utilize different sets of distinctive feature systems. For a better understanding of the nature of American English vowels, readers are referred to chapter 4.

Front Vowels

/i/

/i/ is a front-high, tense English vowel. It appears in words such as “bead” [bid], “treat” [trit], “receive” [riˈsiːv], and “believe” [biˈliːv]. It is used to formulate both open and closed syllables such as “tea” [ti] and “need” [niːd], respectively. In most instances it is a stressed vowel.

In acoustic terms, /i/ is a vowel of longer duration than its lax counterpart /ɪ/. Its formant characteristics show an extreme low-frequency F_1 and an extreme high-frequency F_2 . The F_2 and F_3 frequencies of /i/ are in close approximation. A low F_1 is indicative of a high vowel and a high F_2 is indicative of a front vowel.

/ɪ/

/ɪ/ is a front-high, lax English vowel. It appears in words such as “kit” /kɪt/, “it” /ɪt/, and “pity” /pɪti/. In most instances it is unstressed, associating itself with all the necessary functions of unstressing—namely, short duration, low amplitude, and low pitch. It is one of the two most frequently used vowels in conversational American English.

/e/

/e/ is a front-mid, tense English vowel. It occurs very rarely, only in some dialects of English. In most instances, it is assumed that this vowel takes on the diphthongized role of /eɪ/ as in words like “cake” /keɪk/ and “take” [teɪk]. The nondiphthongized [e] is a short vowel with frequency characteristics in a lower range than the two front-high vowels [i] and [ɪ]. /e/ has a slightly higher F₁ and a slightly lower F₂ than the vowels /i/ and /ɪ/.

/ɛ/

/ɛ/ is a front-mid, lax English vowel with frequent occurrence in all English dialects in words such as “head” /hɛd/, “bed” /bɛd/, “let” /lɛt/, and “crest” /krɛst/. It is a stressed vowel with high amplitude and long duration characteristics. Similar to the lax vowel /ɪ/, /ɛ/ also appears only in closed syllables. The stressing of the vowel /ɛ/ may be seen in polysyllabic words like “event” [əˈvɛnt] and “eventually” [əˈvɛntʃəli].

/æ/

/æ/ is a front-low English vowel with frequent occurrence in American English, especially in the midwestern and the western regions of the United States. /æ/ is a widely used variation of the standard British English /ɑ/. For example, the vowel /ɑ/ in the word “dance” /dɑns/ in British English is pronounced as /æ/ in /dæns/ in most speech regions of America. However, in parts of the northeastern region of the United States, such as in Boston, it is more likely to use /ɑ/ in situations where /æ/ would be used in the western United States.

However, speakers of British English use /æ/ in the same way as speakers of American English, in words like “fat” /fæt/, “bad” /bæd/, “bat” /bæt/, and “cat” /kæt/. When the vowel /ɑ/ is followed by a nasal /n/ as in “chance,” the general American pronunciation becomes /æ/, while the New England, British English, and the colonial English pronunciation remains /ɑ/. Examples are “can’t” /kɑnt/, which becomes /kænt/, “dance” /dɑns/ becomes /dæns/, “France” /frɑns/ becomes /fræns/, and “aunt” /ɑnt/ becomes /ænt/.

The vowel /æ/ is stressed in English. It appears in stressed positions in words like “transfer” /ˈtrænsfɜː/ and “intransitive” /ɪnˈtrænzətɪv/. The acoustic characteristics of the vowel /æ/ include a high F₁, high F₂, and a relatively high F₃. The formant bandwidth is wide, with indications of the presence of high amplitude. Because /æ/ is produced with a considerable amount of mouth opening coupled with lip flattening, the oral cavity works as the most effective resonator (amplifier). The large resonator size results in greater amplification in the low-frequency regions.

Because of its rich acoustic properties, /æ/ is a highly intelligible vowel. However, for teachers of English as a foreign language, it is very troublesome because most non-American speakers of English use /ɑ/ for /æ/.

Back Vowels

/ɑ/

/ɑ/ is one of the most widely used vowels in the world. It is perhaps the most universal of all speech sounds. It is one of the earliest learned vowels by children of all languages. The convenience and facilitation of its articulatory delivery is, perhaps, the basis for its universal usage and early acquisition. It is a back-low vowel produced with considerable opening of the oral cavity. Because of this large cavity size, the F_1 and F_2 are adjacent to each other. A comparison of the formant frequencies shows that /ɑ/ has a higher F_1 and a lower F_2 than /æ/. Similar to the vowel /æ/, /ɑ/ is a vowel of long duration, high amplitude, and low pitch. As far as the articulatory effort is concerned, /ɑ/ is produced with the least amount of effort. The lips are not required to be widened or rounded because a total opening of the oral cavity provides the best quality to this vowel. /ɑ/ is a stressed vowel in English and used in words such as “father” /fɑðə/ and “hot” /hɑt/. It is not differentiated from /ɔ/ in most American English dialects, except when /ɔ/ is followed by /r/.

/ɔ/

/ɔ/ is a back-mid, lax English vowel used in the stressed position in words such as “bought” /bɔt/, “fought” /fɔt/, “thoughtful” /'θɔtful/, and “costly” /'kɔstli/. The frequency with which this vowel appears in English is relatively low. The articulatory dimension includes slight lip rounding together with wide mouth opening. The back portion of the tongue is in the low-mid position. Thus, not unlike the vowel /ɑ/, there is a considerable amount of resonance in the oral cavity during its production. The lower two formant frequencies are extremely close to each other, indicating a great deal of speech power.

In perception, /ɔ/ is confused most frequently with the vowel /ɑ/. In some dialects of English, it is in allophonic variation with /ɑ/, for example, “hot” /hɑt/ becomes /hɔt/, “shot” /ʃɑt/ becomes /ʃɔt/. This results from the articulatory overlap between these two vowels. Actually, we have found that, in some speakers of American English, the formant frequencies of these two vowels totally overlap.

/o/

/o/ is a back-mid, tense English vowel used mainly in the secondary stress position in English words. Usually, the vowel /o/ is pronounced as the diphthong /ou/, as in “program” /prəʊgræm/ and “window” /wɪndəʊ/. The articulatory uniqueness of the vowel /o/ lies in the maximal rounding of the lips. This phenomenon is reflected in the acoustic representation of the formant frequencies of this vowel. Because of the primary role of lip rounding, F₁ and F₂ frequencies are both low.

/ʊ/

/ʊ/ is a back-high, lax English vowel used mostly in the position of secondary stress, as in words like “input” /ɪnput/ and “thoughtful” /'θɔtful/. It is a frequently used vowel in the English language. For example, the suffix /-fʊl/ is utilized in a number of words, such as “youthful” /'juθfʊl/, “joyful” /'dʒɔɪfʊl/, and “mouthful” /'maʊθfʊl/. One-syllable words such as “should” /ʃʊd/, “could” /kʊd/, and “put” /pʊt/ further increase its frequency of utilization. Its first two formants are low. A low F₁ is indicative of a high vowel and a low F₂ is indicative of a back vowel.

Lip rounding is an added feature of /ʊ/. In perceptual confusions, /ʊ/ is most frequently confused with the low-central, neutral vowel /ʌ/. It is seldom confused with the vowel /u/, although /ʊ/ and /u/ are adjacent to each other on the vowel diagram.

/u/

/u/ is a back-high, tense English vowel. Comparing it with /i/, it is different only because of the advancement component. /u/ and /ʊ/ are different in terms of the amount of articulatory tension involved. /u/ appears at the stressed positions of a word. Because of its tenseness it appears in both open and closed syllables. Thus, we have words like “boot” /but/ and “shoes” /ʃuz/, as well as words like “shoe” /ʃu/ and “true” /tru/. The stressing of this vowel can be exemplified by words such as “prudent” /'prʊdənt/ and “moonlit” /'munlɪt/. The acoustic representation of /u/ shows low F₁ and F₂ frequencies and a high F₃. The tongue is at its highest position and is farthest back in the mouth, and the lips are maximally rounded.

Central Vowels**/ʌ/**

The vowel /ʌ/ is a central-low, stressed English vowel used in words such as “trust” /trʌst/, “but” /bʌt/, and “cut” /kʌt/. Besides the fact that /ʌ/ is a

lower vowel than /ə/, /ʌ/ has longer duration and higher amplitude characteristics than /ə/.

/ə/

The vowel /ə/ is an unstressed neutral English vowel. Its neutrality indicates that the tongue is at its rest position on both the advancement and the height continua. It is used most frequently in English in words such as “again” /əˈɡeɪn/ and “about” /əˈbaʊt/. Because the tongue advancement and tongue elevation are neutrally located in the production of the vowel /ə/, the F₁, F₂, and F₃ are ideally at uniform distances from each other.

/ɜ̣, ɝ̣/

/ɜ̣/ and /ɝ̣/ are unstressed and stressed retroflex vowels, respectively. Their locations are neutral on the vowel diagram. Actually, for all practical purposes, /ɜ̣/ can be expressed as the vowel /ə/ plus the consonant /ɾ/, and similarly /ɝ̣/ can be expressed as the vowel /ɜ/ plus the consonant /ɾ/. Although these expressions do not violate any principle involved in vowel production, they simplify the phonologic description of the vowels in the sense that one need not mark the retroflexion feature for the vowels. At the present time, however; in phonetic transcription /ɜ̣/ is most often used in unstressed words at the word-final position, for example, “father” /ˈfɑðɜ̣/, “mother” /ˈmʌðɜ̣/, and “either” /ˈiðɜ̣/. The long-duration, high-amplitude, stressed vowel /ɝ̣/ most usually occurs in the word-medial position, as in the words “bird” /bɜ̣d/ and “hurdle” /ˈhɜ̣dl/.

It is believed by some phoneticians that the unstressed neutral vowels /ə/ and /ɜ̣/ are not independent phonemes but are allophones of all other English vowels in certain unstressed positions.

EXERCISES

Fill in the Blanks

Consonants

1. Of the seven distinctive features, the phonemes /p/ and /z/ are separated by _____ feature(s), namely, _____, _____, _____, and _____.
2. In the production of /m/ the lip closure and vocal fold vibrations have to be synchronized with _____.

3. Because of the lip-rounding component, /w/ is considered as having the feature _____.
 4. The phoneme pair /f/, /v/ differs from the phoneme pair /p/, /b/ by the feature _____.
 5. The pair /p, b/ and the pair /f, v/ are called _____.
 6. Of the phonemes /p/, /b/, /f/, /v/, the phoneme _____ is the most complex in terms of articulatory and acoustic details.
 7. In the so-called nonstandard form of English, the phonemes /θ/, and /ð/ are substituted by _____ at the word-initial position and by _____ at the word-final position.
 8. Besides being an English consonant, the phoneme /t/ also serves the function of a _____.
 9. The phonemes /s/ and /θ/ are separated by the feature _____.
 10. The /k/, /g/ pair has an equal probability of being substituted by _____ and _____ pairs.
 11. The consonant /r/ becomes _____ in the word-final position.
 12. The _____ phoneme pair is separated from the /m/, /n/ pair by the feature nasality.
-

13. In most English dialects, the phoneme /w/ is allophonic with

_____.

14. The continuant sound produced by glottal constriction is

_____.

Vowels

1. In analyzing formant frequencies of vowels, a lower F_1 is indicative of a _____ and a lower F_2 is indicative of a

_____.

2. In many instances the vowels /e/ and /o/ take on the role of a

_____.

3. The lax counterpart of the vowel /o/ is the vowel

_____.

4. Vowel unstressing is usually related to _____

duration, _____ amplitude, and _____
pitch.

5. _____ is a low-front English vowel

6. /ɔ/ is a _____, _____,

_____ vowel in English.

7. The tongue is in its highest position and is farthest back in the

mouth during the production of the vowel _____.

8. /ə/ differs from /æ/ in that /ə/ is _____.

True or False**Consonants**

- _____ 1. A substitution error is considered more serious when the distinctive feature difference between two phonemes is great.
- _____ 2. The distinctive feature system is unable to provide a numerical value to the difference between two phonemes.
- _____ 3. /m/ has properties of a sonorant and of a stop.
- _____ 4. /w/ does not possess the feature front.
- _____ 5. In articulation and speech perception errors, /w/ is replaced by /r/ and vice versa
- _____ 6. There is a three-feature difference between the phonemes /p/ and /v/.
- _____ 7. In substitution errors, voiced sounds become voiceless.
- _____ 8. The phoneme /b/ has three allophonic variations.
- _____ 9. /f/ has two permitted allophones in English.
- _____ 10. /d/ and /θ/ are minimally distinct phonemes
- _____ 11. /h/ and /ʃ/ are minimally distinct phonemes.
- _____ 12. Most languages make a distinction between oral and nasal consonants.
- _____ 13. Nasal consonants are rarely substituted by continuants.
- _____ 14. The phoneme /h/ is rarely confused with other consonants.

Vowels

- _____ 1. A vowel-consonant confusion is rare in any language
- _____ 2. /i/ is a central-high, tense vowel in English.
- _____ 3. The vowel /æ/ is one of the earliest learned by children all over the world.
- _____ 4. In the word “bought,” the vowel used is /o/.
- _____ 5. Most American English speakers pronounce the vowel /o/ as the diphthong /aʊ/.
-

Multiple Choice

Consonants

- _____ 1. The phonemes in the /b/, /m/ pair differ by:
- one feature
 - two features
 - three features
- _____ 2. The possibility of speech production and speech perception errors is _____ in the /p/, /b/ pair than in the /p/, /s/ pair.
- lesser
 - greater
 - the same
- _____ 3. One of the first phonemes produced by children is:
- /p/
 - /k/
 - /f/
- _____ 4. The musculature that is well strengthened in children is:
- soft palate
 - tongue
 - lip
- _____ 5. /p/, /b/ sounds are the most:
- oral
 - visible
 - complex
- _____ 6. One of the last sounds to be lost if one loses language is:
- /p/
 - /t/
 - /k/
- _____ 7. /p/, /b/ and /f/, /v/ pairs differ by the feature:
- labiality
 - continuancy
 - sonorancy
- _____ 8. There exists a triple distinction between the phonemes:
- /p/, /ð/
 - /p/, /θ/
 - /b/, /ð/
- _____ 9. The phonemes /w/, /j/, /r/ possess one common property. They are all:
- back consonants
 - sonorants

Vowels

- _____ 1. Acoustically, the formant characteristics of /i/ show a _____ F₁.
- high
 - low
- _____ 2. For the vowel /æ/, most non-American speakers of English use:
- /ɔ/
 - /ɑ/
 - /e/
- _____ 3. The back-high, lax vowel of English is:
- /u/
 - /ʊ/
 - /ɔ/

- _____ 4. In the production of vowel /ə/, the distance between the F_1 , F_2 , and F_3 formants is:
- a. uniform
 - b. greater between F_1 and F_2 .
 - c. greater between F_2 and F_3 .

RECOMMENDED READINGS

- Forrest, K. M., & Morrisette, M. (1998). Feature analysis of segmental errors in children with phonological disorders. *Journal of Speech, Language, and Hearing Research*, 42(1), 187-194.
- Keating, P. A. (1994). *Phonological structure and phonetic form*. Cambridge, UK: Cambridge University Press.
- Yavas, M. S. (1998). *Phonology: Development and disorders*. Albany, NY: Delmar Thomson.
-