Unit 5

$\varphi\omega\nu$

The syllable nucleus in the material world

shaping the airflow to form vocoids.

Print version of the
Practical English Phonetics /
Phonetics with Listening Practice (British & General)
presentation given on
10 November 2026

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5.1

Dedication



Image source: Obituary for John Rupert Firth

https://doi.org/10.1017/S0041977X00092156

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John Rupert Firth 17.06.1890–-14.12.1960

5.2

1 Goals

The goals of today's session are:

1. To briefly discuss the acoustics of sound, concentrating on vowel sounds as made in the human vocal tract
2. To become acquainted with the vowel quadrilateral and the cardinal vowels
3. To become acquainted with the diacritics that are used to specify positions 'in between' the cardinal vowels
4. To check which vowel phonemes in English fall close to cardinal vowels, and which do not

5.3

2 Acoustic phonetics and vowels

Brief overview of acoustic phonetics in relation to vowels

1. Physics of sound waves
2. Overtones and formants
3. Distinguishing vowels by means of formants
4. How to read a spectrogram

5.4

Physics of sound waves

- Motion of particles in direction of propagation of wave ...
- ... but can be represented perpendicular to it.
- Musical sounds as an easy "way in"
- `http://www.spence.saar.de/akustik.jpg`

5.5

Overtones and formants

- voiced continuants and nasals have a fundamental frequency (F_0, "F zero")
- partial overtones (or 'upper harmonics'):
- `http://upload.wikimedia.org/wikipedia/commons/c/c5/Harmonic_partials_on_strings.svg`
- formants: *amplified* upper harmonics
- identifying vowels by their formants (F_1 and F_2)

5.6

Distinguishing vowels by means of formants

- The distinctive 'quality' of a vowel depends on how the vocal tract was shaped when it was being formed, and thus on the acoustic 'formants' (especially F_1 and F_2)
- `http://upload.wikimedia.org/wikipedia/commons/7/77/Spectrogram_-iua-.png`

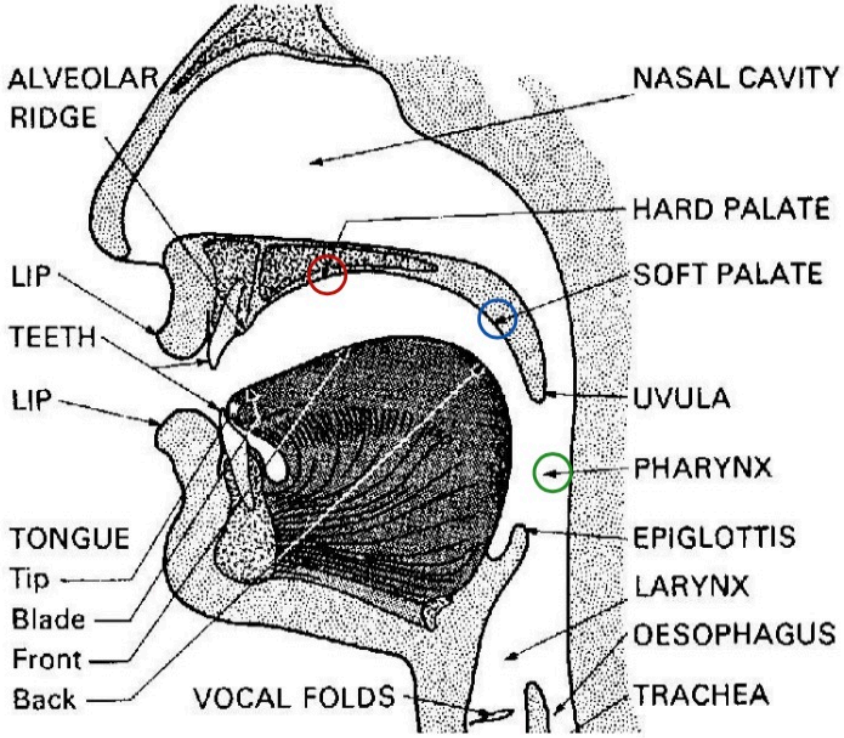
5.7

How to read a spectrogram

- a spectrogram records: frequency (y), time (x), intensity (shading)
- `http://en.wikipedia.org/wiki/File:Praat-spectrogram-tatata.png`
- `http://en.wikipedia.org/wiki/Spectrogram`
- `http://upload.wikimedia.org/wikipedia/commons/c/c5/Spectrogram-19thC.png`

5.8

3 Where vowels are formed in the mouth



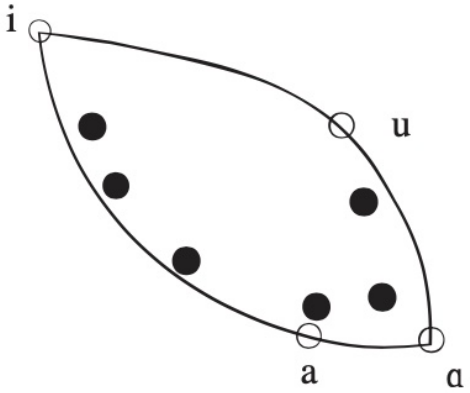
THE INTERNATIONAL PHONETIC ALPHABET (revised to 2005)

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	N		
Trill	B			r					R		
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.

Position of highest part of tongue in relation to the four basic cardinal vowels



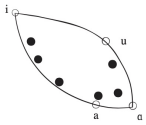
Source: Alex Jones *australian english grammar*, Wild and Woolley, 2001, page 170.

The empty circles show the location of the four basic cardinal vowels [i], [a], [ɑ], [u].

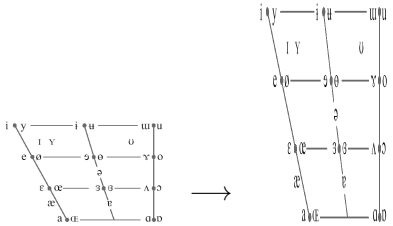
The black circles show the location of the six short vowels of Australian English that are heard in
KIT, DRESS, STRAP, STRUT, LOT, FOOT
(counter-clockwise from upper left). 5.9

From the 'AFL football' to the 'vowel quadrilateral' … and beyond

The roughly oval ARTICULATORY shape as measured in the mouth:



can be stylised to form the 'vowel quadrilateral', based partly on anatomical and partly on psychological (PERCEPTUAL) criteria; this, in turn, can be modified on the basis of ACOUSTIC measurements:



Finally, the quadrilateral shape can be idealised further to form a square or rectangle, if necessary:

/ɪ/		/ʊ/
/e/		
/æ/	/ʌ/	/ɒ/

5.10

4 Vowels: phonetics vs phonemics

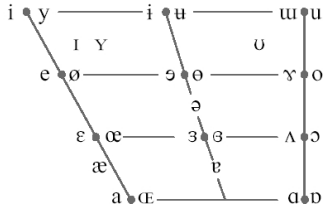
Vowels: phonetics vs phonemics

- How many ***phonetically*** distinct vowels are there along the continuum [i] – [a] – [ɑ] – [u] ?
- How many ***phonemically*** distinct vowels are there along that continuum?
- The answer to the ***first*** question depends on ***how good your hearing is***.
- The answer to the ***second*** question depends on ***what language you're talking about***.
- **Arabic** has / i a u / (each of these three can be short or long)
- **Spanish** has / i e a o u /
- **Italian** has / i e ɛ a ɔ o u /
- **French** has / i e ɛ a ɑ ɔ o u /
- **English** has / iː ɪ e æ ɑː ɒ ʌ ɔː ʊ uː /

5.11

5 Vowel quadrilateral and cardinal vowels

Vowel quadrilateral and cardinal vowels



left-to-right: highest point of tongue is front (left) or back (right); top-to-bottom: jaw is close (top) or open (bottom); lips are unrounded (symbol to the left of the dot) or rounded

(symbol to the right of the dot); beware [ə] [ɐ] (unrounded), [ʊ] (rounded); NOTE: [a] is 'front' (just like [i])

5.12

Only for freaks

- the meaning of the vowel quadrilateral in terms of **formants**:
  - **CLOSE** [i] [u] (**LOW** F_1) vs **OPEN** [ɑ] (**HIGH** F_1);
  - ***back*** [u] [ɑ] (***low*** F_2, ***small*** F_2-F_1 ***difference***) vs ***front*** [i] (***high*** F_2, ***large*** F_2-F_1 ***difference***)
  - check it: `https://de.wikipedia.org/wiki/Datei:Spectrogram_-iua-.png`
- synthesise some vowels: `http://www.asel.udel.edu/speech/tutorials/synthesis/vowels.html` LINK BROKEN!
  - try $F_1 = 240$ & $F_2 = 2400$ (leave F_3 blank); what did you hear?
  - try $F_1 = 750$ & $F_2 = 940$ (leave F_3 blank); what did you hear?
  - try $F_1 = 250$ & $F_2 = 595$ (leave F_3 blank); what did you hear?
- experiment with synthesising more vowels for yourself: `http://www.asel.udel.edu/speech/tutorials/synthesis/vowels.html` LINK BROKEN!

5.13

6 English vowel phonemes vs. cardinal vowel positions

English vowel phonemes vs. cardinal vowel positions

- The **cardinal vowel positions** on the IPA chart are **reference** points, designed to ***'sound equidistant'***.
- The pronunciation of the English phoneme /ə/ is [ə], i.e. it falls ***exactly*** on one of the cardinal vowel positions.
- The pronunciation of the English phoneme /e/ falls ***halfway between*** the cardinal vowel positions [e] and [ɛ].
- We write /e/ rather than /ɛ/ because ⟨e⟩ is ***easier to typeset*** than ⟨ɛ⟩ and because we want to discourage German speakers from pronouncing that English phoneme as [ɛ], which might sound too German; pronouncing it as [e] would merely sound too Australian.
- See if you can identify ***other*** cardinal vowels that are used in pronouncing English phonemes.
- ***Beware*** the English phoneme /ʌ/. This has evolved away from the [ʌ] position, and is now nearly [ɐ]. (Should it be written as /ɐ/?)
- Look at the **diacritics** on your IPA chart for ways of ***'fine-tuning'*** phonetic transcriptions of vowels.

5.14

7 Using diacritics for vowels

Using diacritics for vowels

e̝ Raised — Lowered e̞

u̟ Advanced — Retracted i̠

ä Centralized — Mid-Centralized ɪ̽

ɔ̹ More rounded — Less rounded ɔ̜

ɛ̃ Nasalized Rhoticity ɜ˞

5.15

8 English sounds classified (A. I. Jones)

English sounds classified (A. I. Jones)

SOUNDS		
OBSTRUENTS	RESONANTS	
	NASAL AND LATERAL RESONANTS	CENTRAL ORAL RESONANTS
[p t tʃ k] [b d dʒ g] [f θ s ʃ] [v ð z ʒ]	[m n ŋ] [l / ɬ]	[w ɹ j] [ə] [ɪ e æ ʌ ɒ ʊ] [iː eɪ aɪ ɔɪ uː əʊ aʊ] [ɪə eə ɜː ɑː ɔː ʊə]
[h]		
CONTOIDS		VOCOIDS
SOUNDS		

5.16

9 Listening Exercise

Listening Exercise

If you have time, do this listening exercise:
`http://www.spence.saar.de/phonetics/exercise_sheet_02-01/exercise_sheet_02-01.pdf`
And if you have even more time, do this one as well.
CONTENT NOTICE: contains innuendo(!):
`http://www.spence.saar.de/phonetics/exercise_sheet_01-01/exercise_sheet_01-01.pdf`

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