



# Unit 4

## Vowels (1)

### Approaching vowels via acoustic and articulatory phonetics

Print version of the  
*Phonetics with Listening Practice (British)*  
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<English Phonetics: Unit 4:>

/ˈɪŋ ɡlɪʃ/ /fə ˈnet ɪks/ /ˈjuːn ɪt/ /ˈfɔː/

[ˈɪŋ.ɡlɪʃ fə.ˈnet.ɪks ˈjuː.n.ɪt ˈfɔː] (AusE)

<Vowels (1)>

/ˈvaʊəlz/ /wʌn/

[ˈvəʊəlz ˈwʌn] (AusE)

<Approaching vowels via acoustic and articulatory phonetics>

/ə ˈprəʊtʃɪŋ/ /vaʊəlz/ /ˈvɑː ə/ /ə ˈkuːst ɪk/ /ən(d)/ /ɑː ˈtɪk jəl ət\_ər i/ /fə ˈnet ɪks/

[ə.ˈprəʊtʃɪŋ ˈvəʊ.əlz ˈvɑː.ə.ə. ˈkʰuː.st.ɪk\_ən\_ɑː. ˈtɪk.jəl.ət\_ɪ.i fə.ˈnet.ɪks (modern RP)]

4.1

4.2

## 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 (10 mins)
2. To become acquainted with the vowel quadrilateral and the cardinal vowels (10 mins)
3. To check which vowel phonemes in English fall close to cardinal vowels, and which do not (10 mins)
4. To prepare the ground for a comparison between German and English vowel phonemes and their typical phonetic realizations (allophones) (10 mins)

4.3

## 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

4.4

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>

4.5

## Overtone 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](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  $F_2$ )

4.6

## 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](http://upload.wikimedia.org/wikipedia/commons/7/77/Spectrogram_- iua- .png)

4.7

## 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>

4.8

# 3 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 ε a ɔ o u /
- French has / i e ε a ɑ ɔ o u /
- English has / i : e æ ɑ : ɒ ʌ ɔ : ʊ u : /

4.9

# 4 Vowel quadrilateral and cardinal vowels

## Vowel quadrilateral and cardinal vowels

The diagram shows a vowel quadrilateral with various vowel symbols plotted. The symbols are arranged in four rows from top to bottom: Row 1: i, y, i, u, u, u; Row 2: e, ø, ə, ø, ø, o; Row 3: ε, œ, ɜ, ɞ, ʌ, ɔ; Row 4: æ, œ, ɒ. The diagram is annotated with phonetic characteristics: '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), [ɔ] (rounded); NOTE: [a] is ‘front’ (just like [i])'.

4.10

### Only for freaks

- the meaning of the vowel quadrilateral in terms of formants:
  - close [i] [u] (low  $F_1$ ) vs open [a] (high  $F_1$ );
  - back [u] [ɑ] (low  $F_2$ , low  $F_2-F_1$  difference) vs front [i] (high  $F_2$ , high  $F_2-F_1$  difference)
  - check it: [https://de.wikipedia.org/wiki/Datei:Spectrogram\\_ia.png](https://de.wikipedia.org/wiki/Datei:Spectrogram_ia.png)
- synthesise some vowels: <http://www.asel.udel.edu/speech/tutorials/synthesis/vowels.html>
  - 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>

4.11

## 5 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 we want to discourage German speakers from pronouncing that English phoneme as [ɛ], which would 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.

4.12

## 6 Using diacritics for vowels

### Using diacritics for vowels

ɘ Raised

ɘ Lowered

ɤ Advanced

ɤ Retracted

ä Centralized

ä Mid-Centralized

ɔ̣ More rounded

ɔ̣ Less rounded

ẽ Nasalized

ɚ Rhoticity

4.13

## 7 Vowels: comparing German and English

### Vowels: comparing German and English

- This will be one of the main topics we will be dealing with over the two weeks, but we will also be comparing different dialects of English with each other and getting you to practise the vowels of RP (the Received Pronunciation of British English)
- Look at the diagrams on pages 111 and 149 of Eckert & Barry  
see: pages 3 and 4 of the handout, here:  
[http://www.spence.saar.de/courses/phoneticswithlistening/unit04\\_20231/C\\_\\_Handout/](http://www.spence.saar.de/courses/phoneticswithlistening/unit04_20231/C__Handout/)
- Which English vowels do you think will be most problematic for native German speakers?
- Which English diphthongs do you think will be most problematic for native German speakers?
- Have a look at the discussion on page 109 of Eckert & Barry  
see: page 5 of the handout, here:  
[http://www.spence.saar.de/courses/phoneticswithlistening/unit04\\_20231/C\\_\\_Handout/](http://www.spence.saar.de/courses/phoneticswithlistening/unit04_20231/C__Handout/)