

# **A practical introduction to acoustic phonetics day 4: Consonants**

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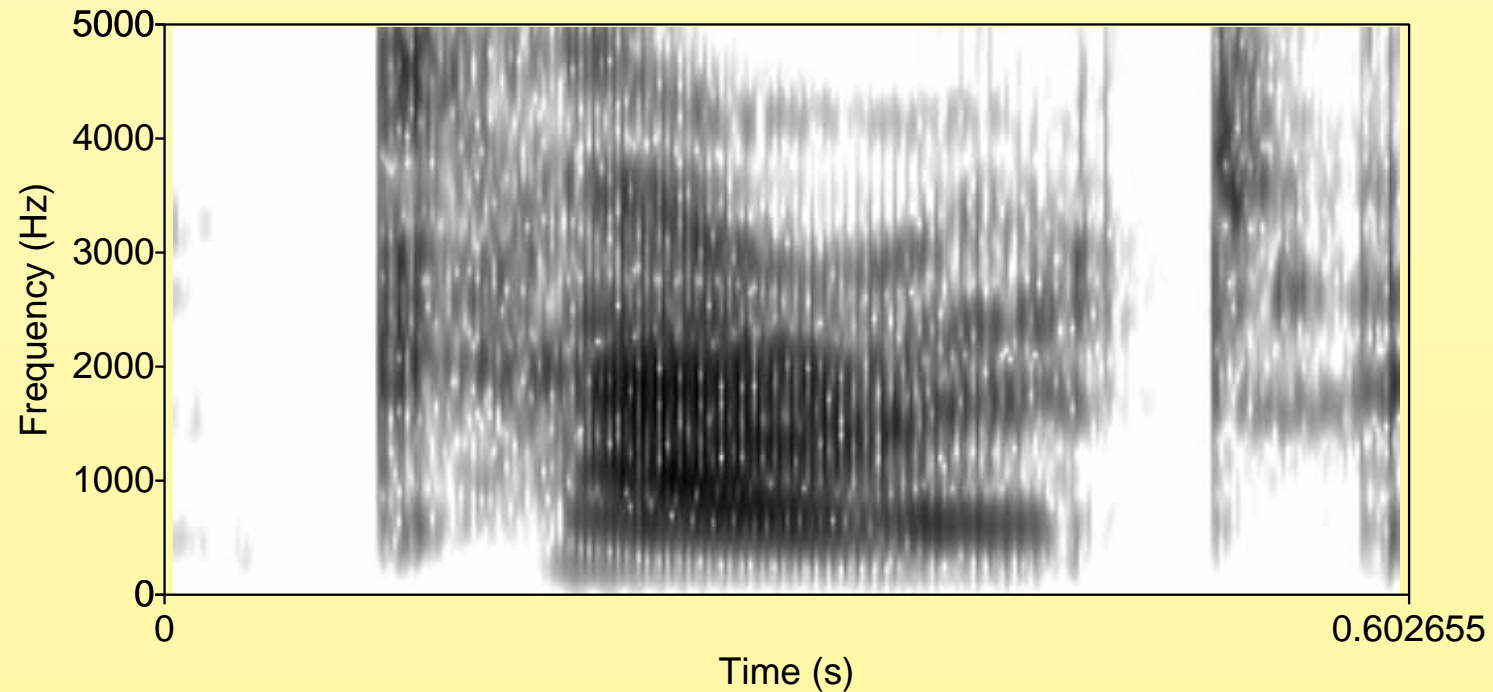
<http://wouter.jansen.kuvik.net/teaching>

January 20, 2005

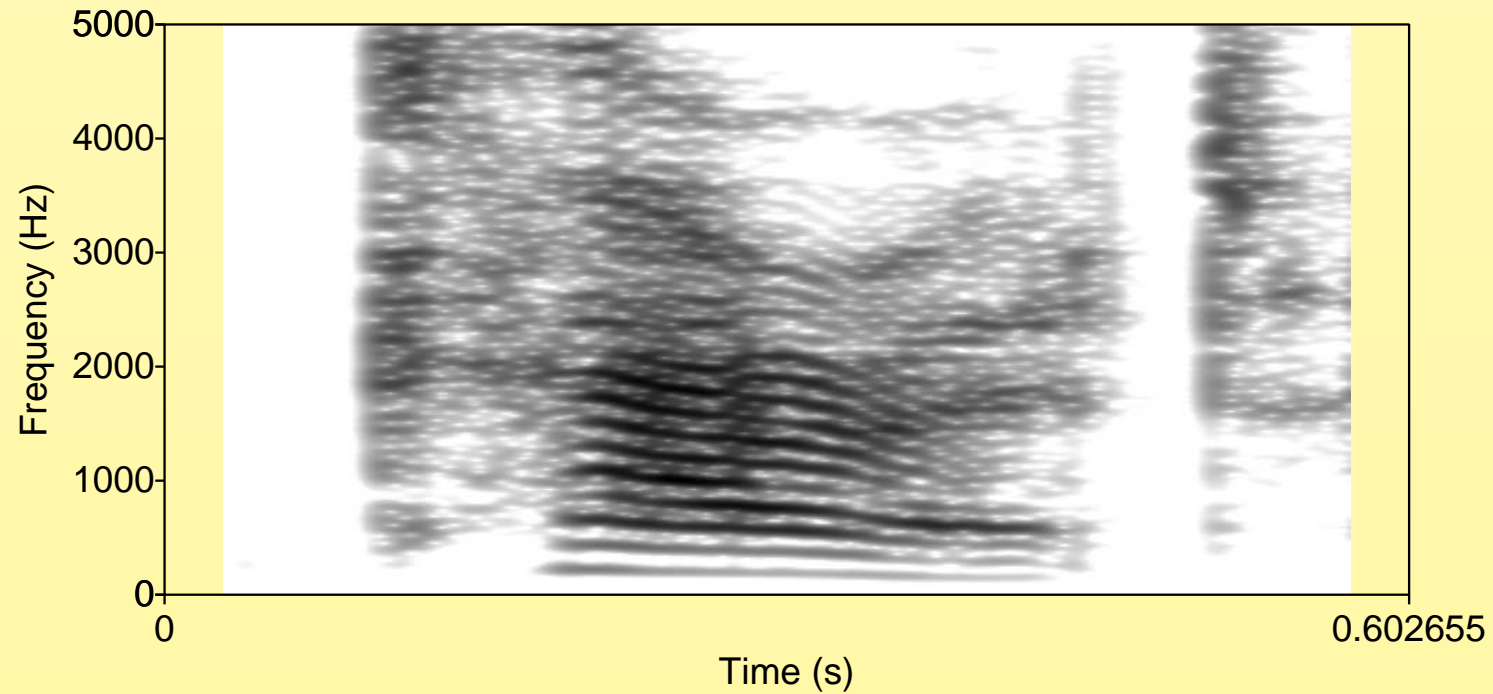
# Broad band and narrow band spectrograms

- Broad band spectrograms are computed over short analysis windows, offer good temporal resolution, and as a result are useful for segmentation
- Narrow band spectrograms are computed over relatively long analysis windows, offer good frequency resolution, and as a result are less useful for segmentation

# Broad band and narrow band spectrograms



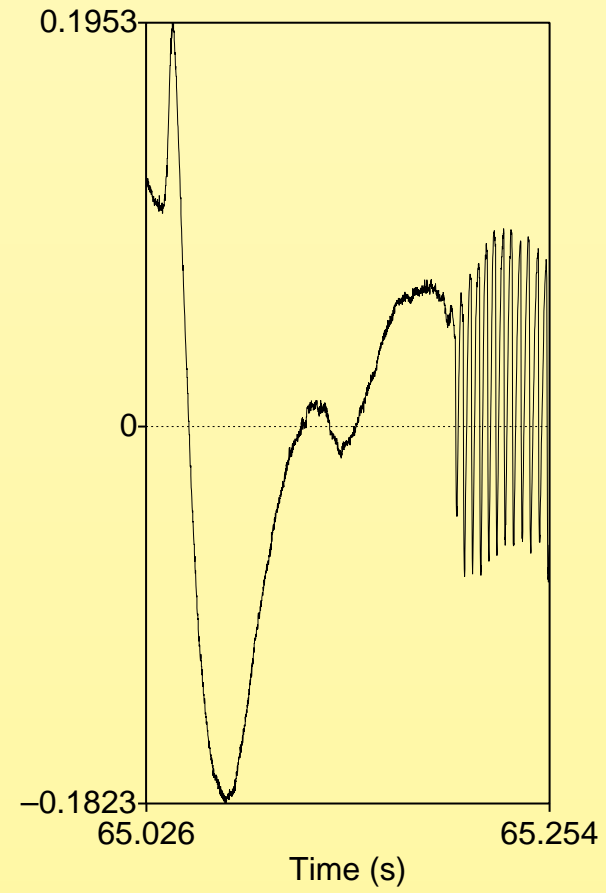
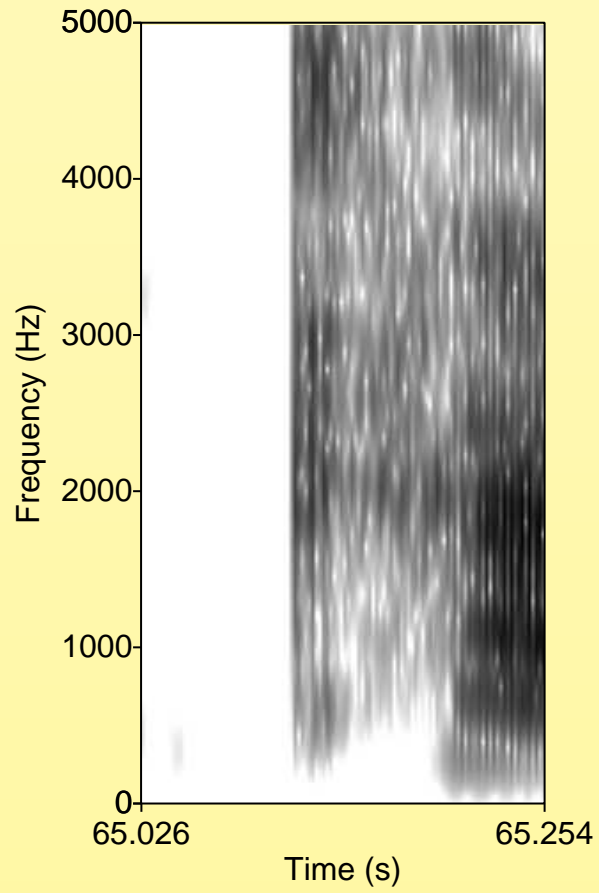
# Broad band and narrow band spectrograms



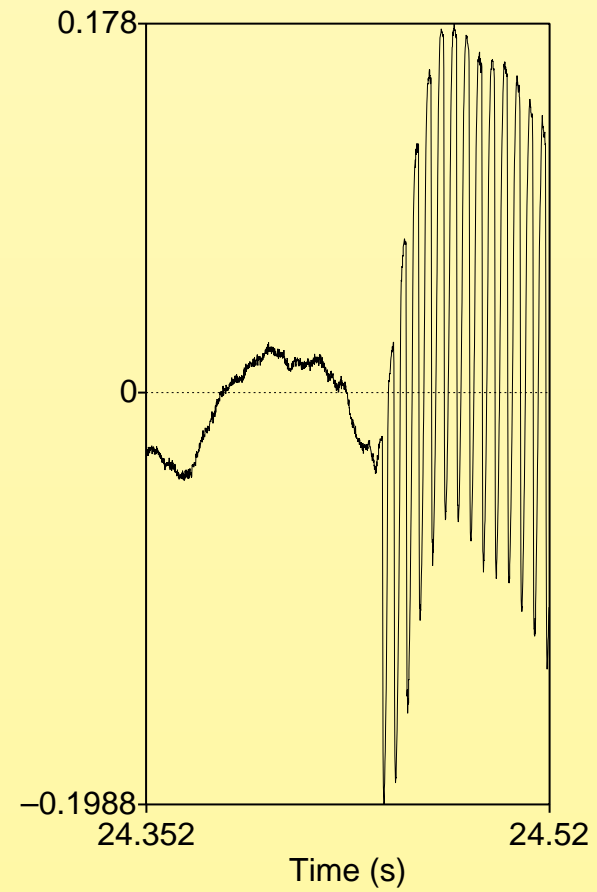
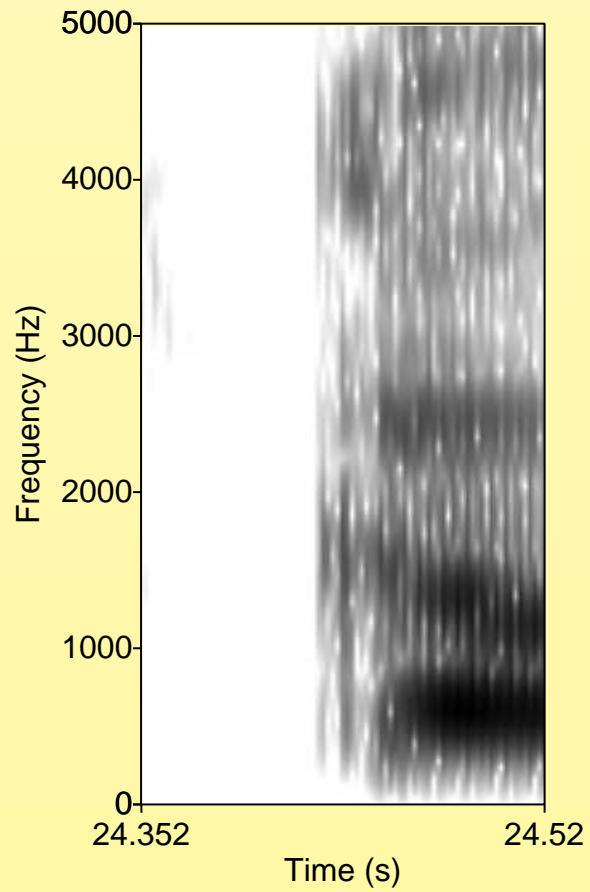
# Spectral characteristics of plosives

- Voiceless stops are composed of:
  1. a period of zero spectral energy corresponding to the fully constricted interval
  2. (often) followed by a **release burst** (transient + friction)
  3. optionally followed by a period of **aspiration** (glottal noise)
- In truly(!) **voiced** plosives, the closure interval is characterised by a low-frequency periodic component or **voice bar** in the spectrogram

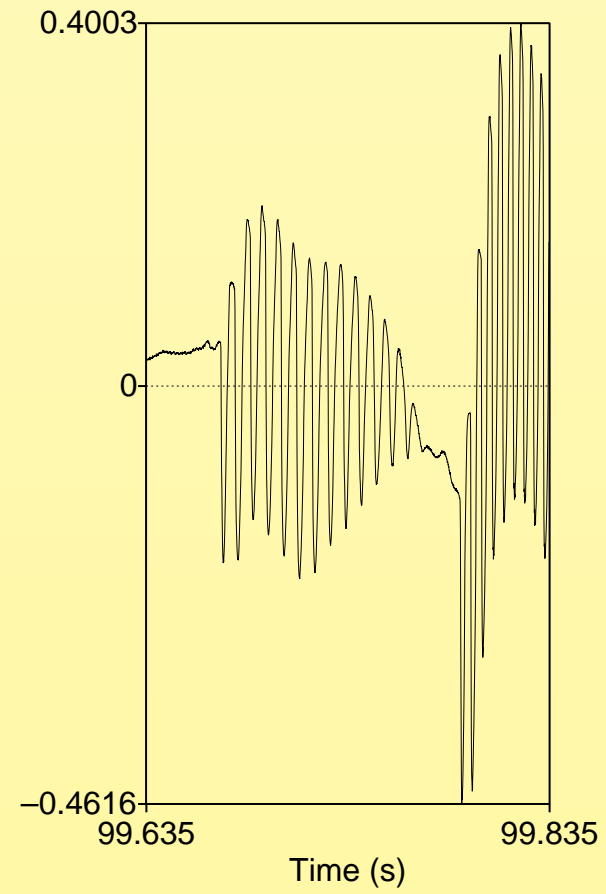
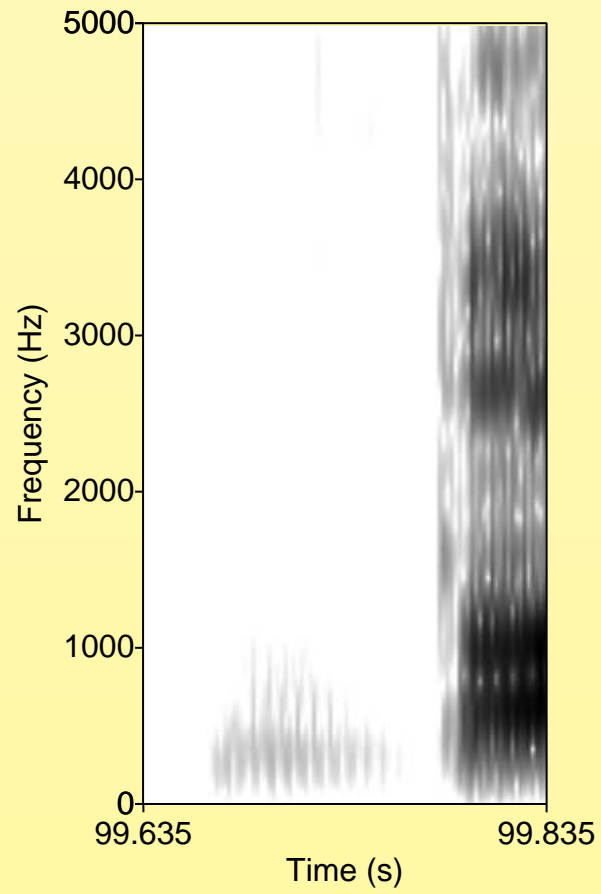
[k<sup>h</sup>]



[ǰ]



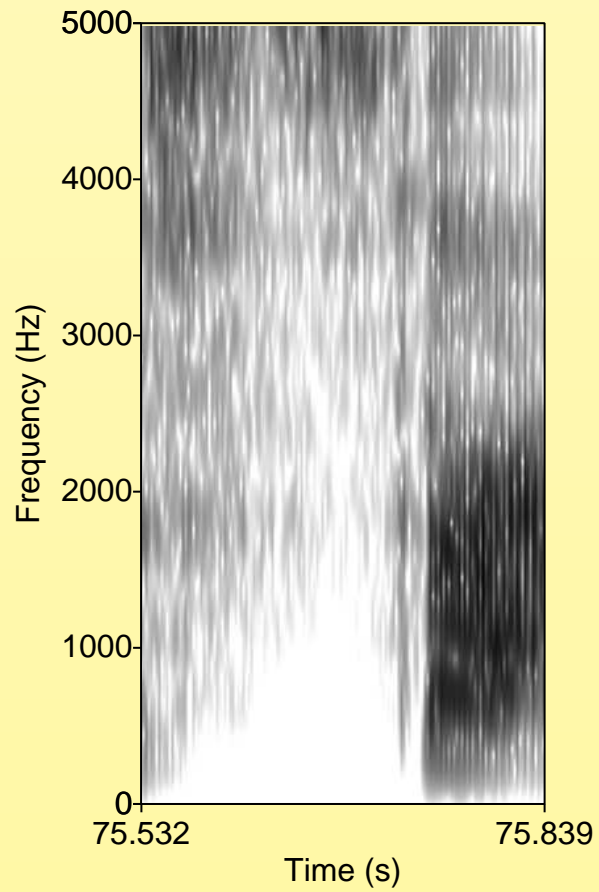
[b]



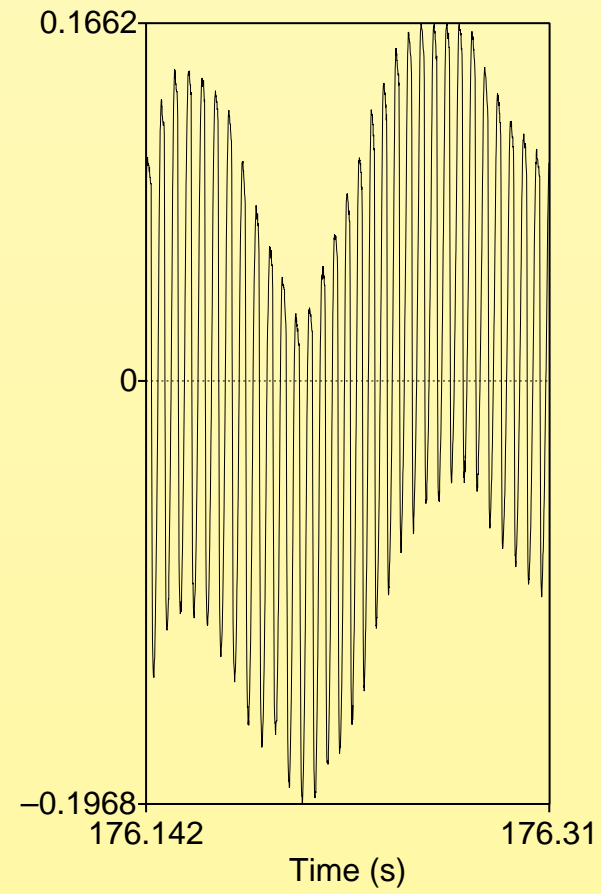
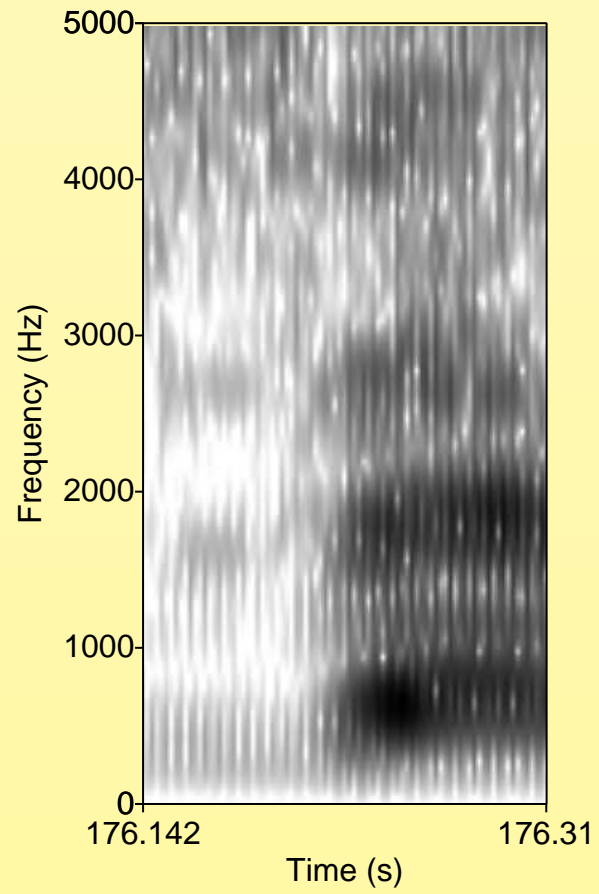
# Spectral characteristics of fricatives

- **Voiceless fricatives** are composed of a period of friction noise generated at the oral constriction
- The spectral characteristics of this friction noise are determined by the precise way in which the noise source is generated, and by the filter function of the part of the vocal tract that is **anterior** to the constriction
- **Voiced** fricatives contain an additional low-frequency periodic component

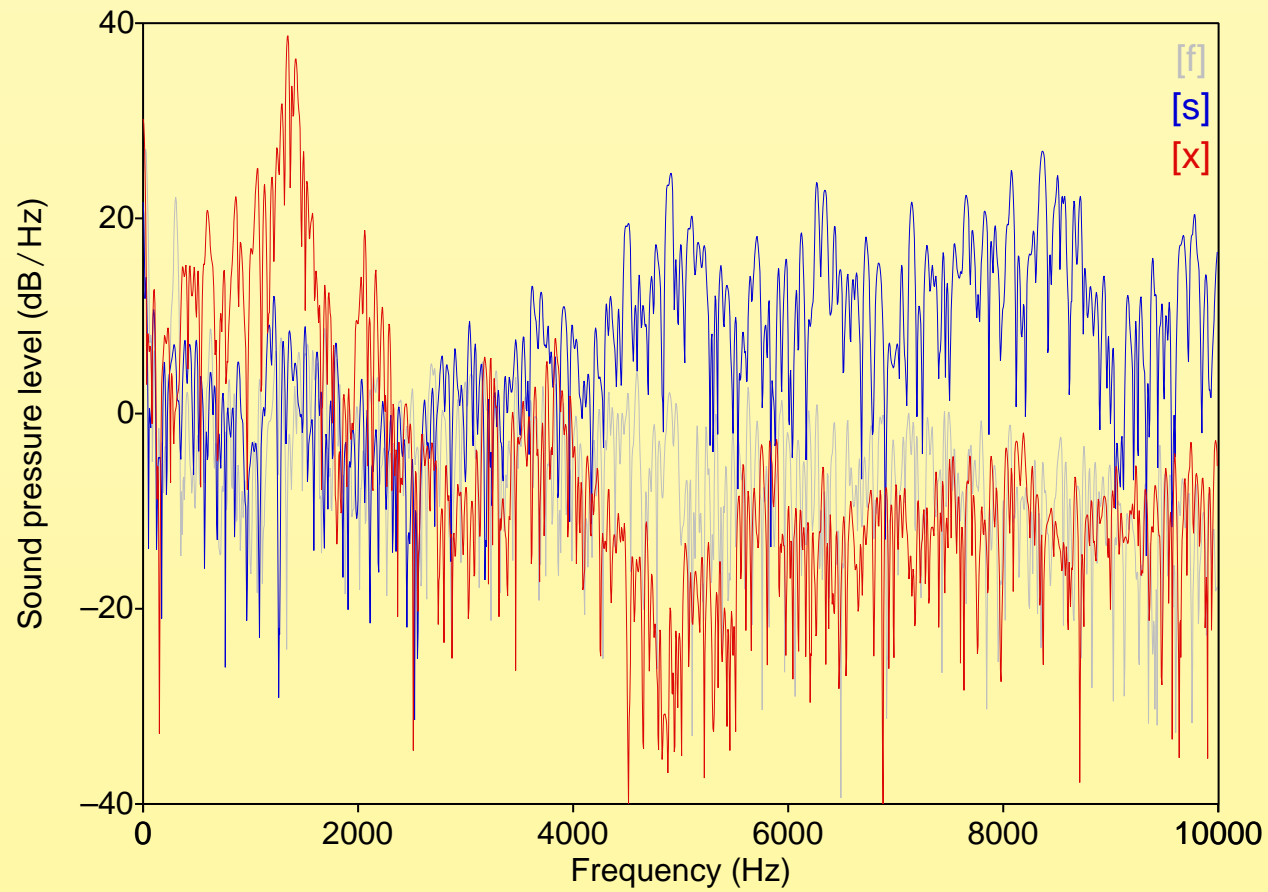
[s]



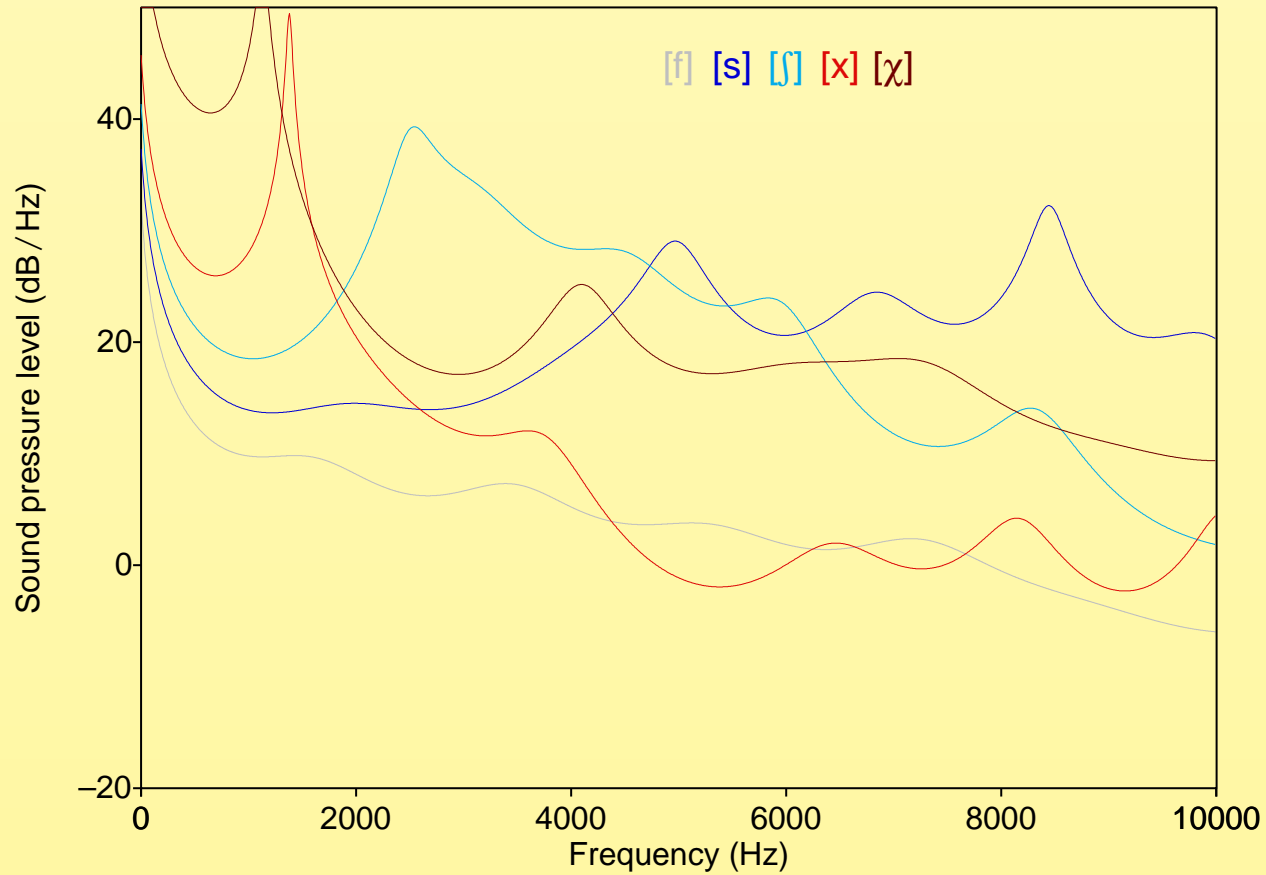
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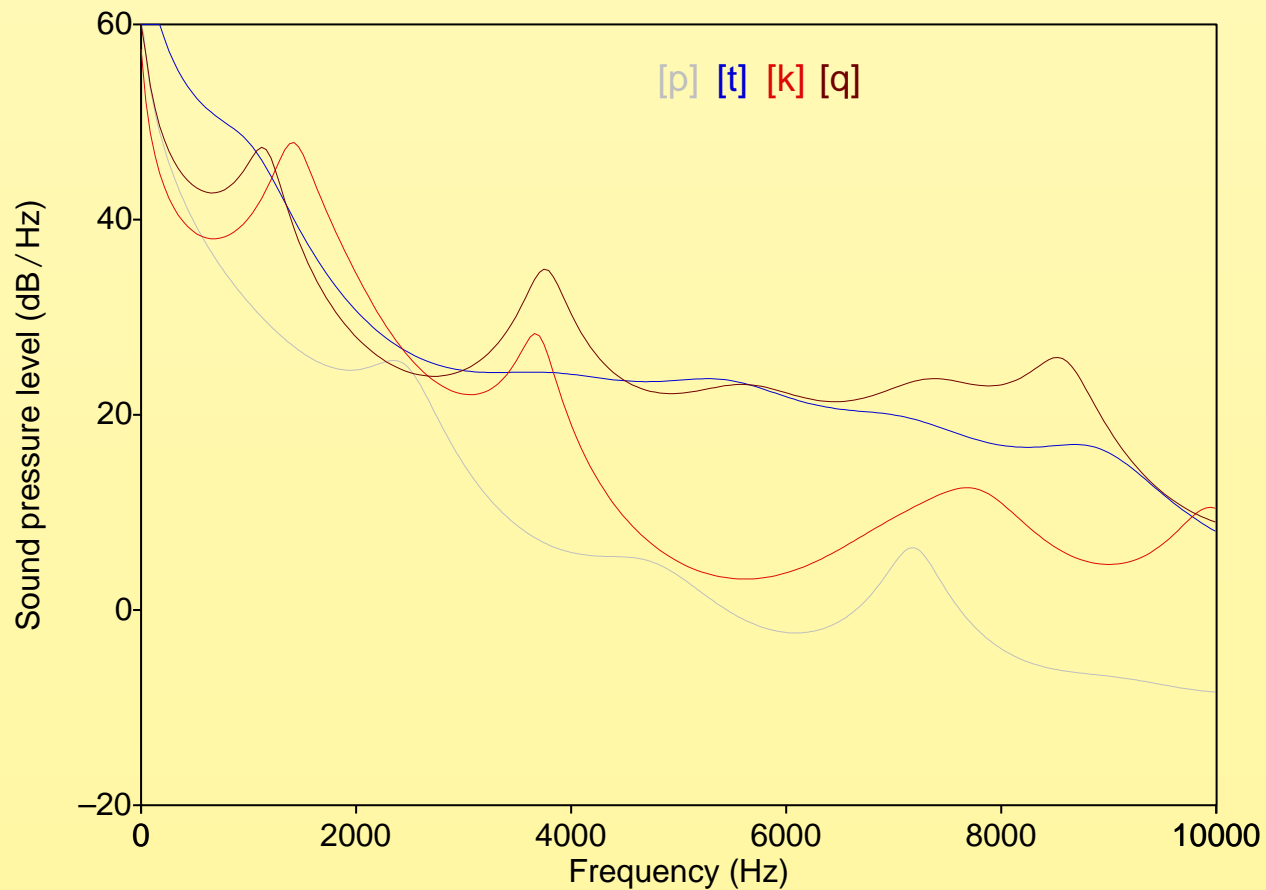
# [f] – [s] – [x]



# [f] – [s] – [ʃ] – [x] – [χ] (LPC smoothed)



# Plosive release spectra (LPC smoothed)



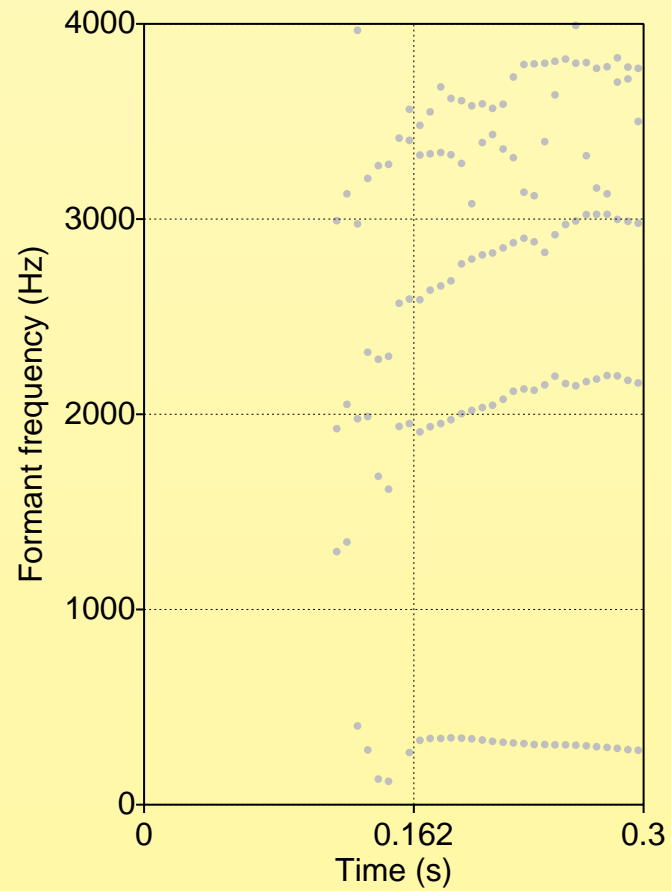
# Spectral characteristics of nasals and laterals

- Both nasals and lateral approximants are characterised by a lower overall intensity than vowels
- Nasals have a low, broad first formant commonly referred to as **nasal murmur**
- Both nasals (except for [ŋ]) and laterals have spectral ‘valleys’ known as **antiformants** that arise from the presence of closed tubes in the vocal tract during their articulation

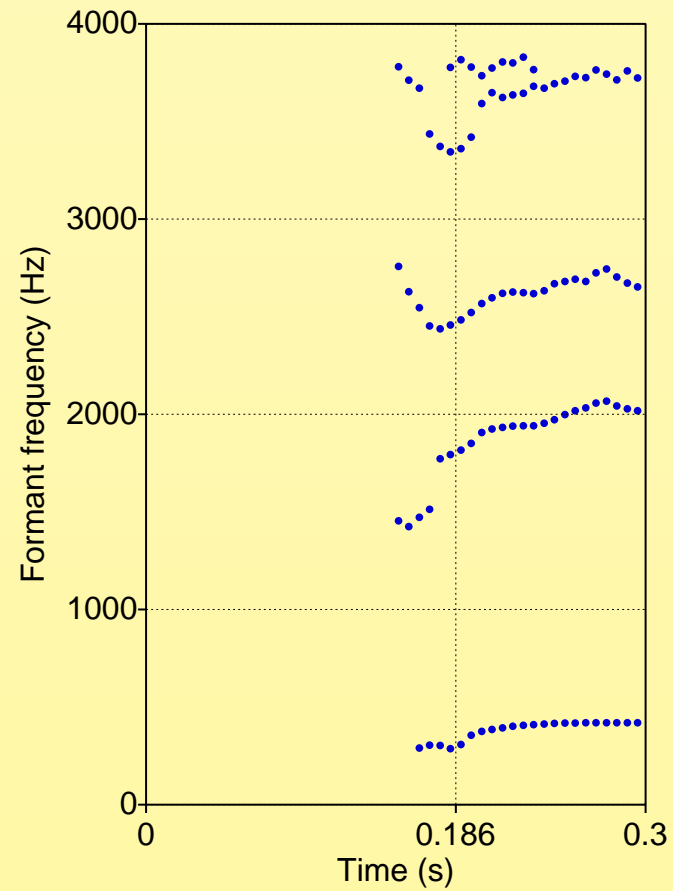
# Spectral characteristics of approximants

- Approximants have vowel-like spectra in target positions, but have no relatively long stable phase

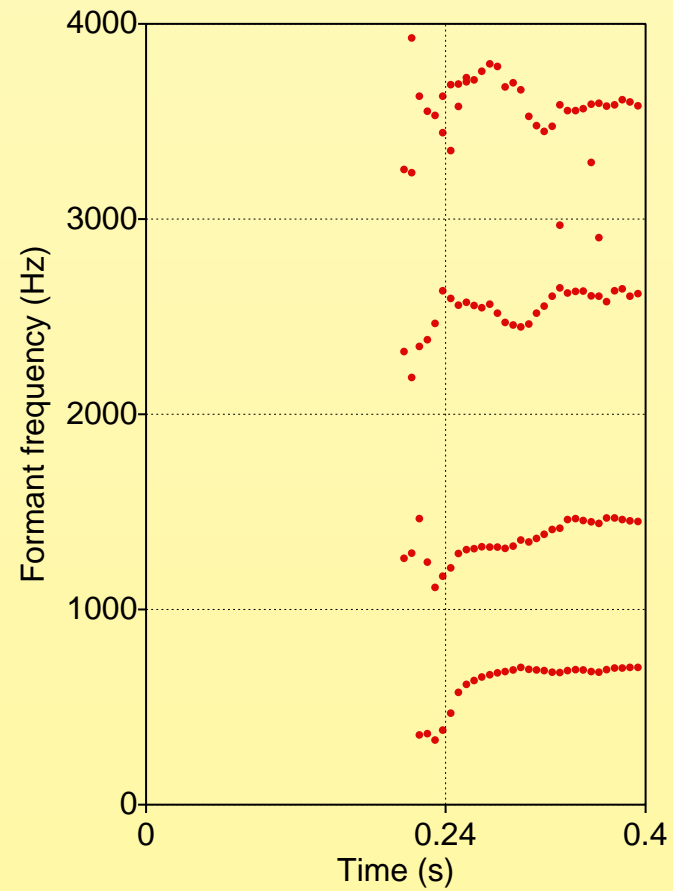
# Formant transitions – [bi]



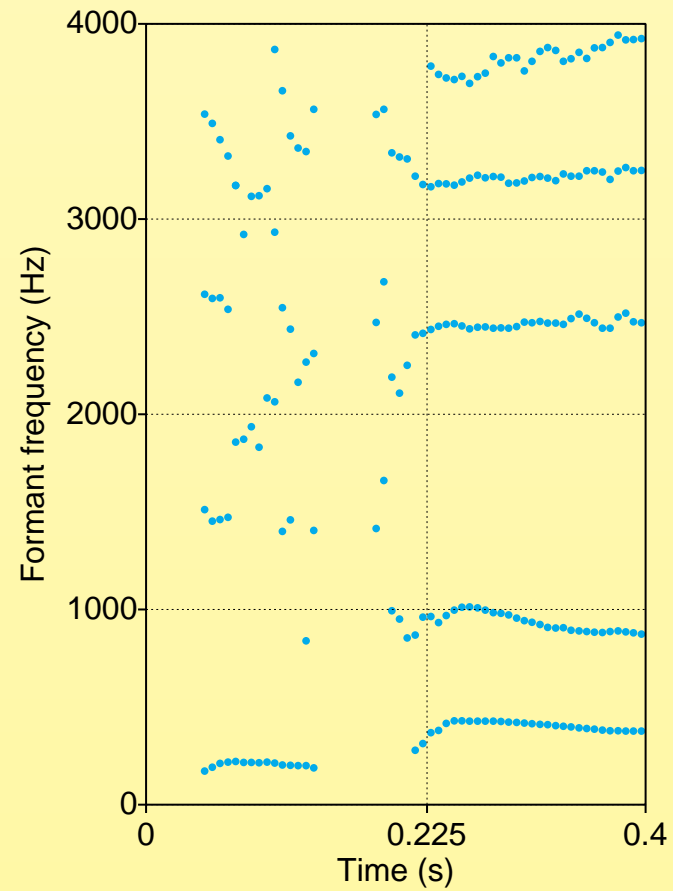
# Formant transitions – [be]



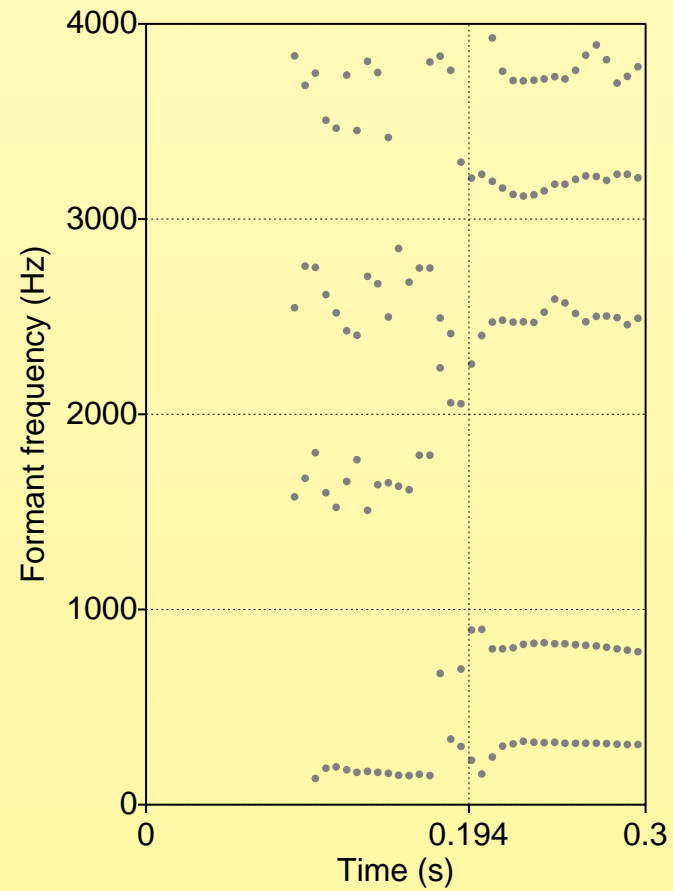
# Formant transitions – [ba]



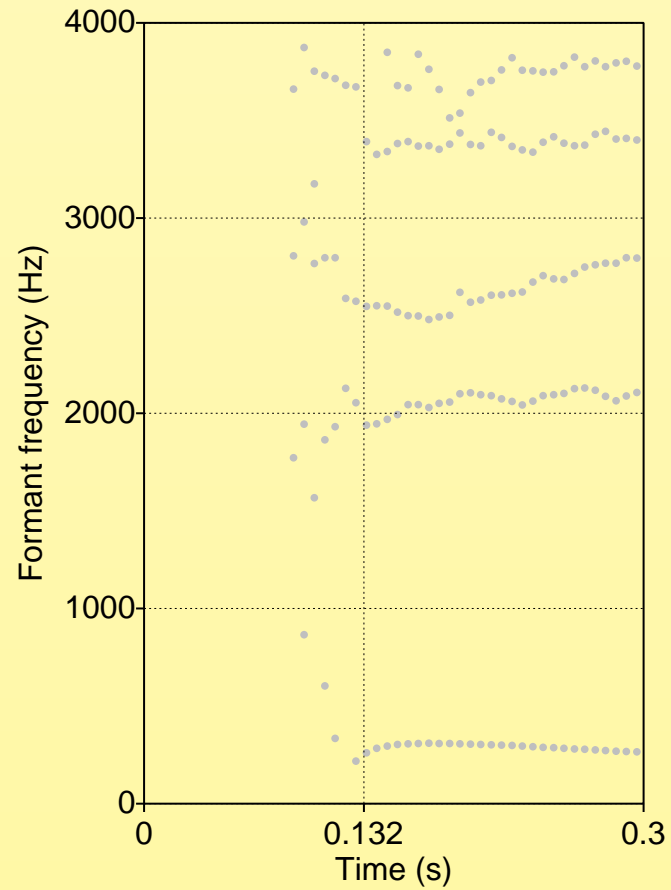
# Formant transitions – [bo]



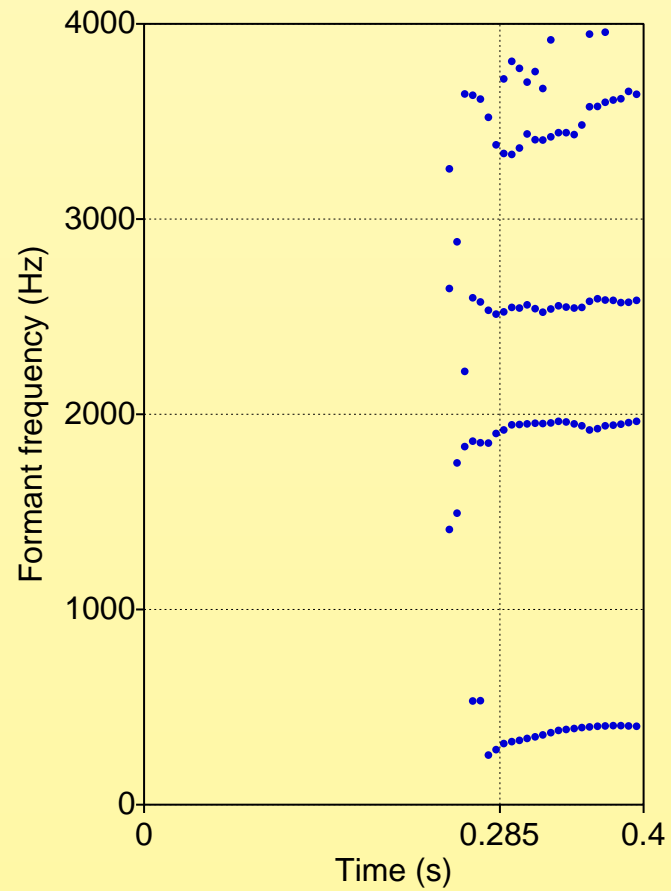
# Formant transitions – [bu]



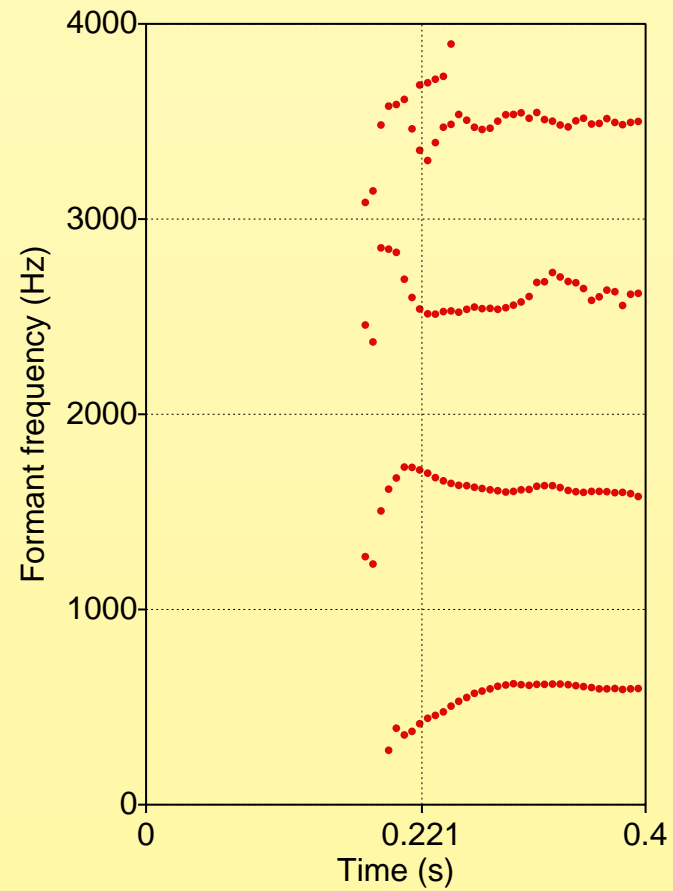
# Formant transitions – [di]



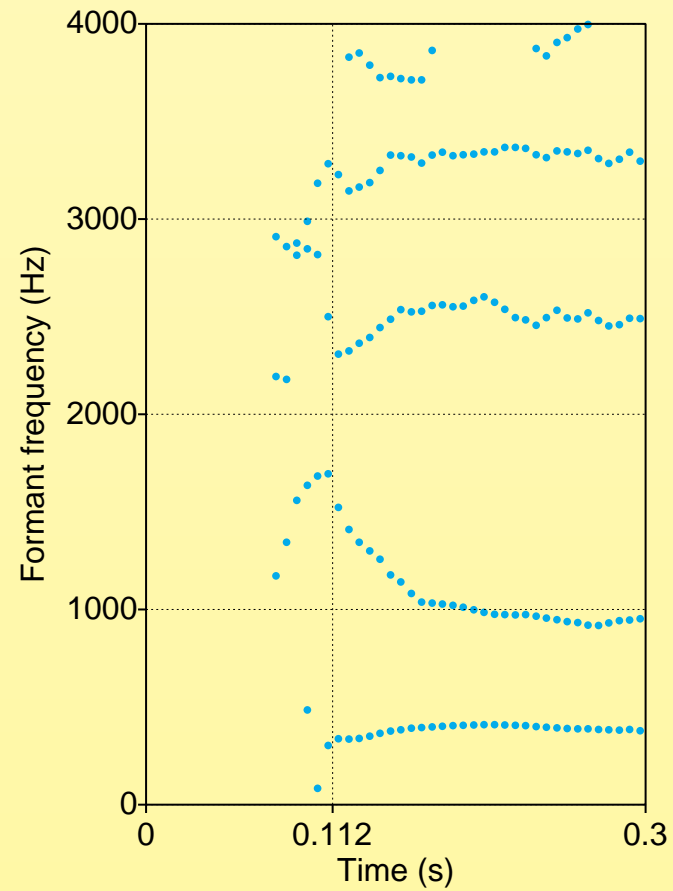
# Formant transitions – [de]



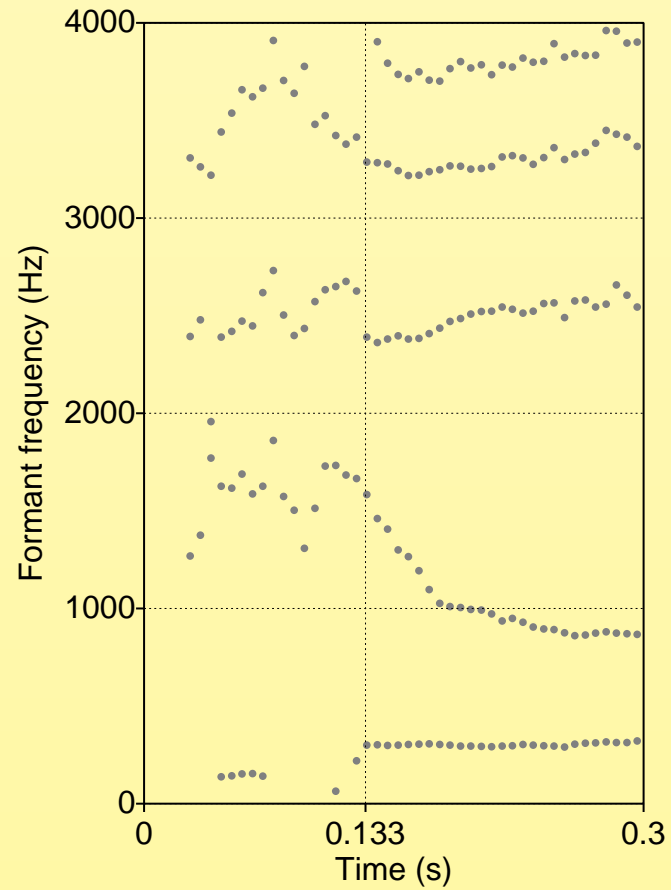
# Formant transitions – [da]



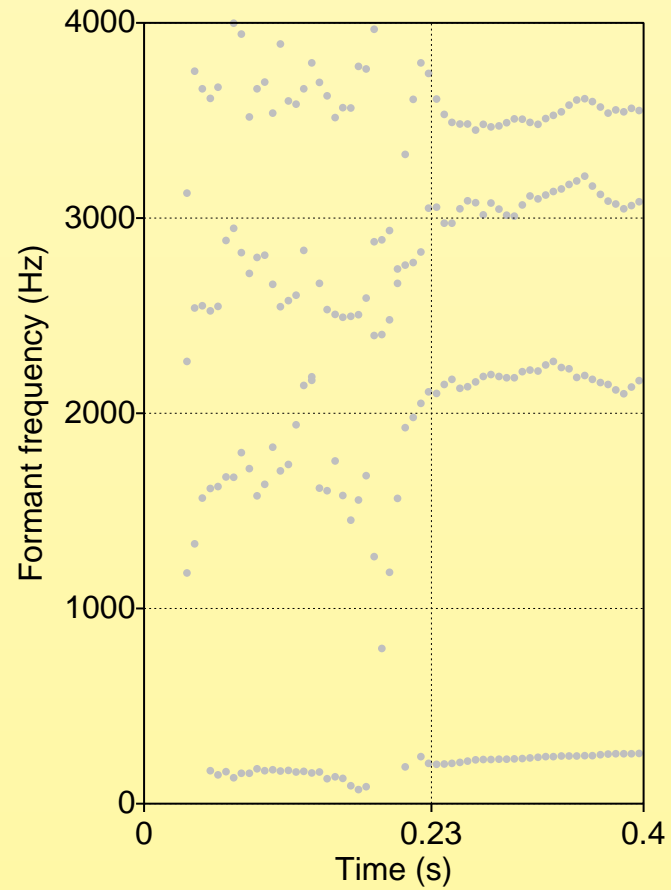
# Formant transitions – [do]



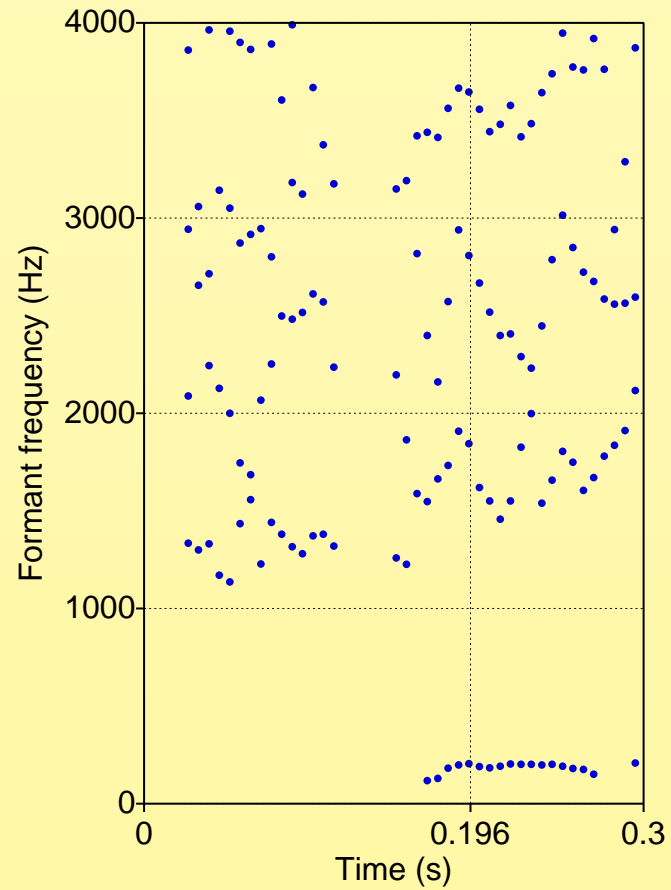
# Formant transitions – [du]



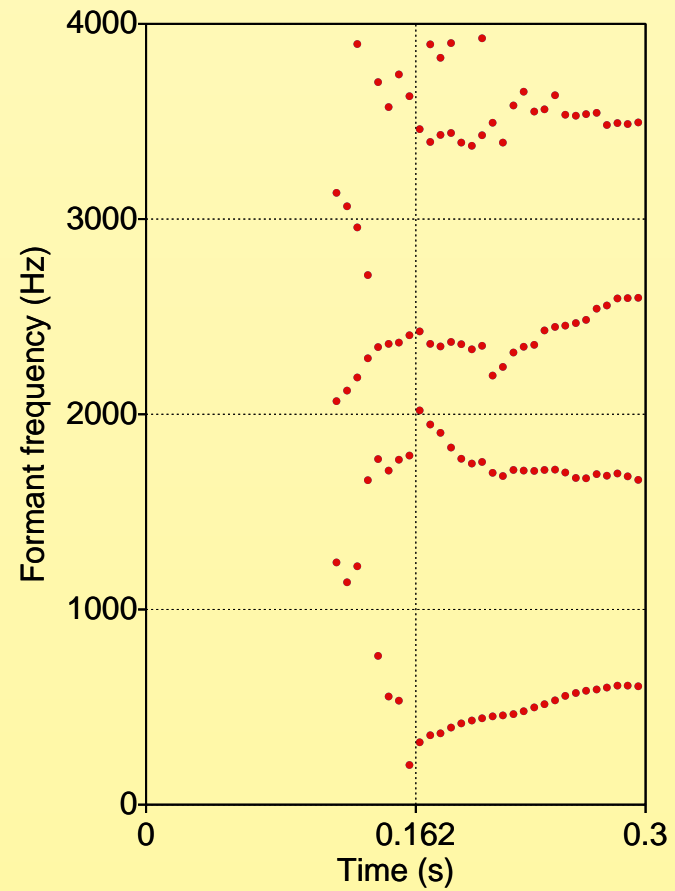
# Formant transitions – [gi]



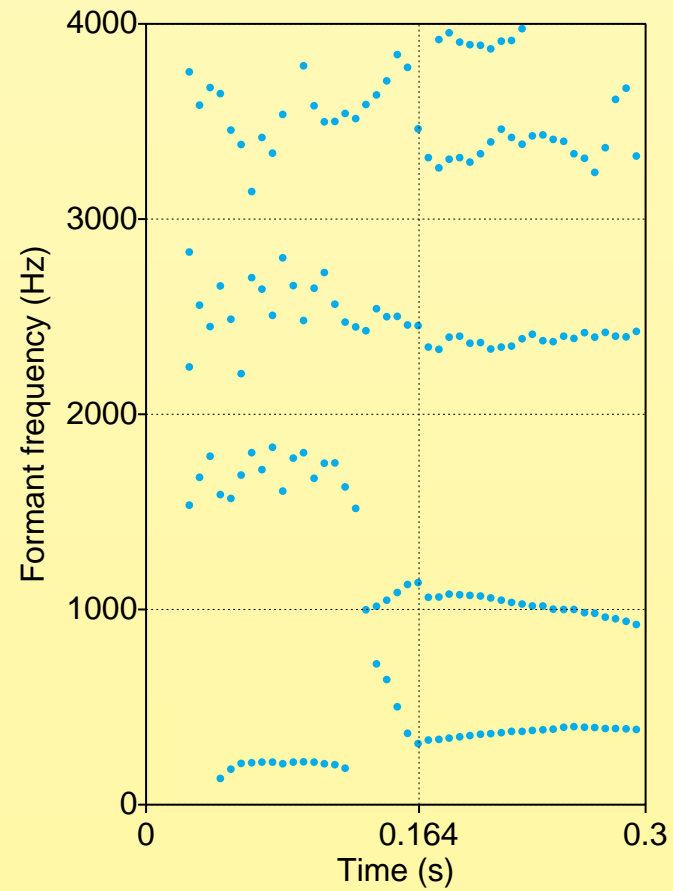
# Formant transitions – [ge]



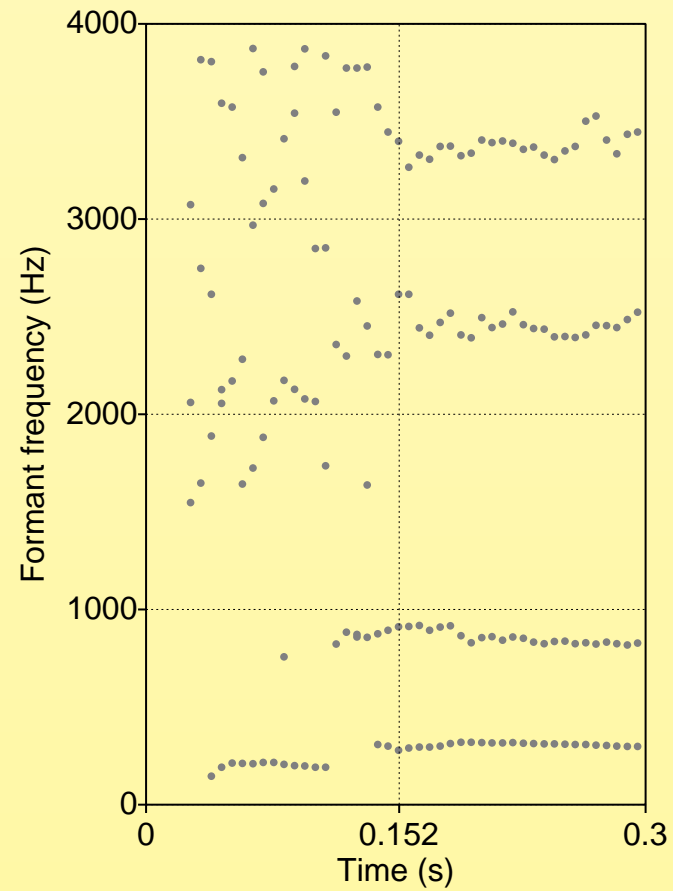
# Formant transitions – [ga]



# Formant transitions – [go]



# Formant transitions – [gu]



# When you want to know about the acoustic characteristics of specific sounds

- First ports of call: [Ladefoged & Maddieson \(1996\)](#); [Johnson \(1997\)](#) (these contain plenty of references)
- For detailed acoustic modelling (of some sounds): [Stevens \(1998\)](#) (not for the faint of heart)

# References

Clark, J. & C. Yallop (1995) *An Introduction to Phonetics and Phonology*. 2nd ed. London: Blackwell.

Johnson, K. (1997) *Acoustic and auditory phonetics*. London: Blackwell.

Ladefoged, P. (2003) *Phonetic Data Analysis. An Introduction to Fieldwork and Instrumental Techniques*. Oxford: Blackwell.

Ladefoged, P. & I. Maddieson (1996) *Sounds of the World's Languages*. Oxford: Blackwell.

Stevens, K. (1998) *Acoustic Phonetics* Cambridge, MA: MIT Press.