

Acoustic Phonetics

Lesson 8b

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Fricative Consonants

Identified primarily by:

- the quality of their frication noise
 - determined the aerodynamics of turbulent airflow at the point of constriction
- the presence of any 'down stream' obstruction
- the resonating characteristics of the vocal tract that 'shape' the spectrum of the noise source.

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On the spectrogram

- The turbulent airflow creates a non-periodic waveform with irregular frequencies
 - white noise pattern visible especially in the higher frequencies over 3500Hz
- the exact pattern varies with the **place of articulation**.

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Detecting the place of articulation

- The noise is located in different areas of the spectrogram, corresponding to the different frequency values of the fricative sounds
 - **[s]** has higher frequencies than **[S]**; both have higher frequencies than **[f]** or **[θ]**.
 - more back = lower frequencies
 - » **[S] > [s] > [θ] > [f]**

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Voiced vs. voiceless Fricatives

- Voiced fricatives have
 - similar noise energy distribution than voiceless fricatives
 - lower intensity than voiceless fricatives
 - a low frequency (less than 1kHz) component due to glottal energy source (voicing)
 - Voicing bar at the low frequencies in the spectrogram

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[s] and [S]

- [s] is alveolar and [S] is post-alveolar
- [S] has more space in vocal tract in front of
 - This “filter” resonates at lower frequencies
 - this acoustic distinction is enhanced through lip rounding → extends the vocal tract → further lowers the resonant frequencies of [S]

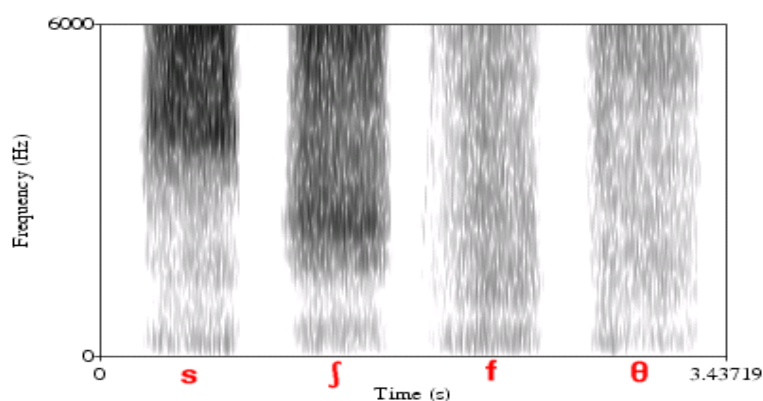
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[f, θ] and [v, δ]

- [f, θ] and [v, δ] are typically hard to distinguish on a spectrogram, as they can be extremely weak acoustically
- If detectable, they are characterized by areas of white noise that are lower than those of alveolar or palatal fricatives

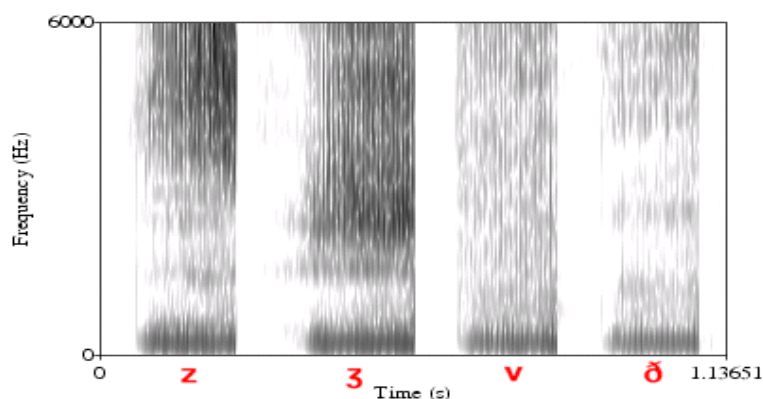
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Voiceless Fricatives



Fonte: <http://www.umanitoba.ca/faculties/arts/linguistics/russell/phonetics/acoustic/spectrogram-sounds.html>
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Voiced Fricative



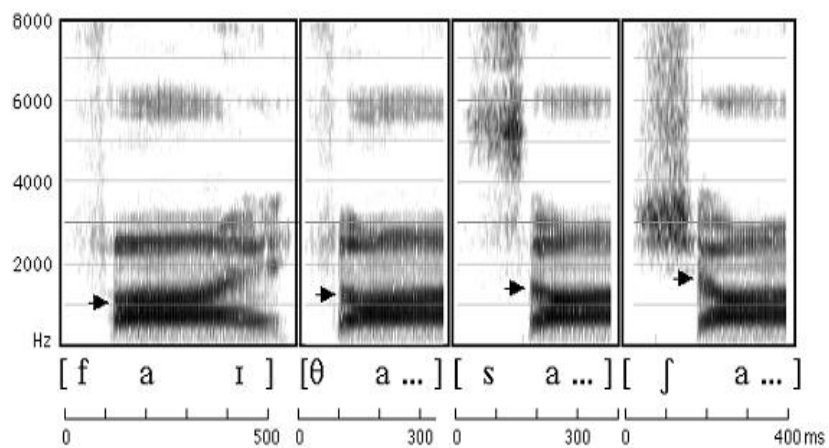
Fonte: <http://www.umanitoba.ca/faculties/arts/linguistics/russell/phonetics/acoustic/spectrogram-sounds.html>
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Place distinctions

- **Labiodental** [f, v]: rising locus into the following vowel
- **Dental** [T, D]: major energy above 6000Hz
- **Alveolar** [s, z]: major energy above 4000Hz
- **Alveopalatal** [S, Z]: major energy above 2000Hz
- **Glottal** [h]: the trace of formant frequencies of neighbouring vowels

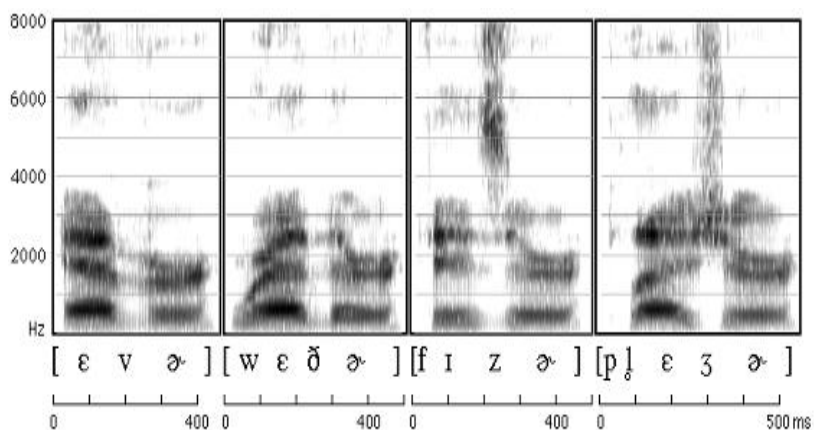
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Example – fie, thigh, sigh, shy

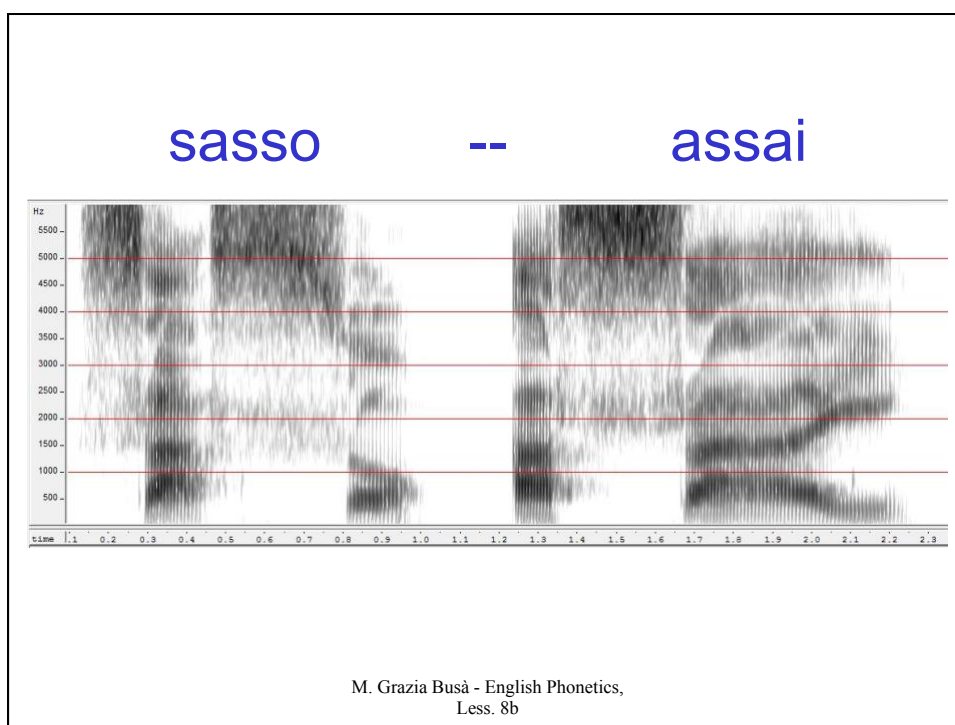
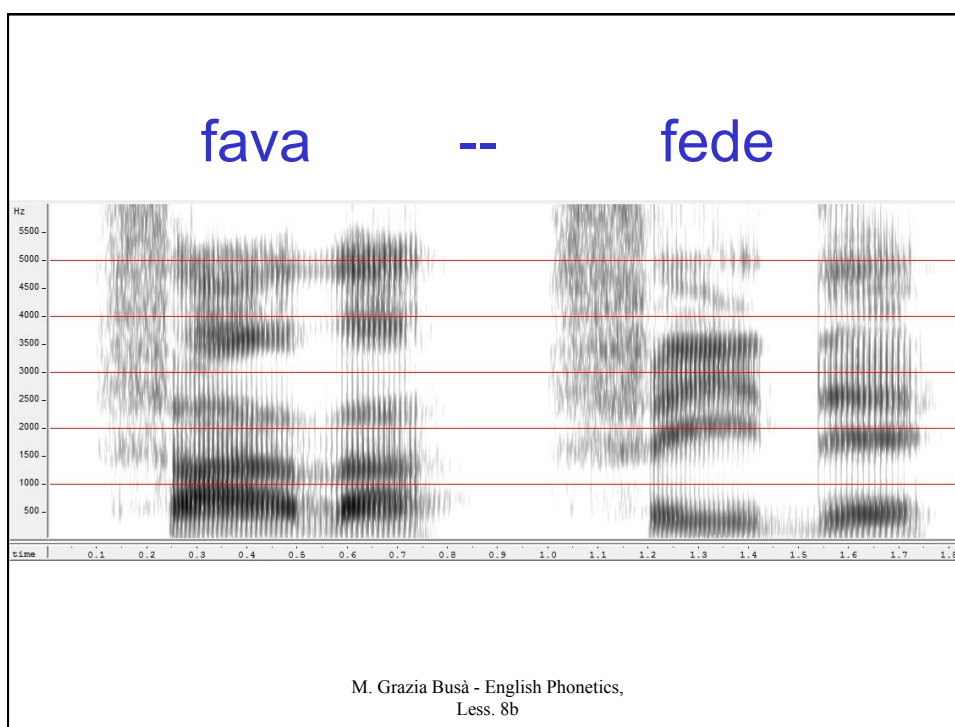


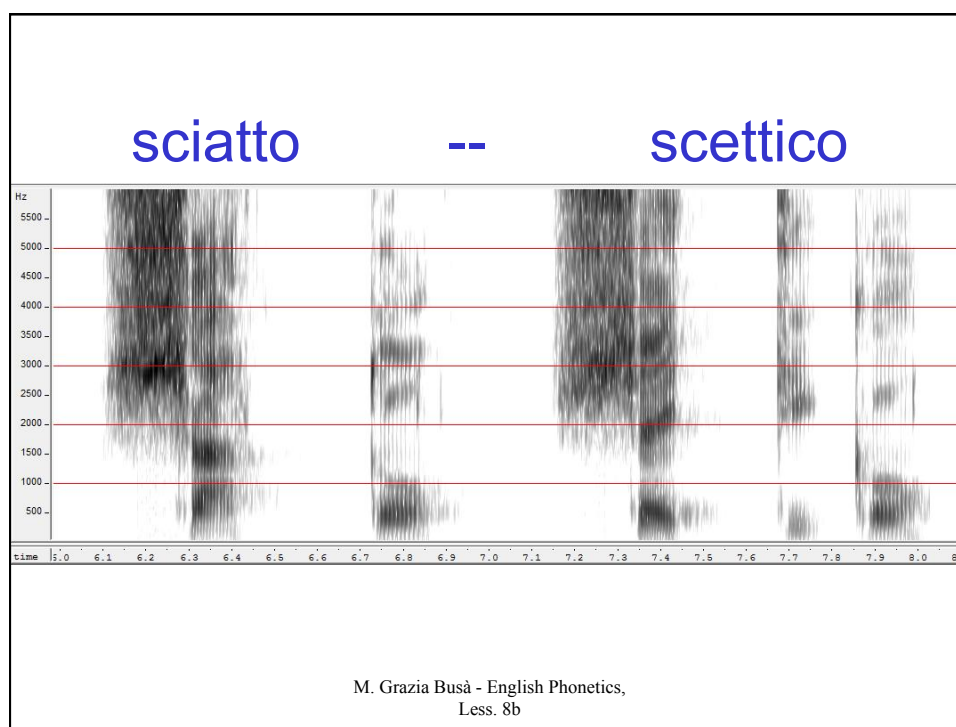
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Example: “ever, weather, fizzer, pleasure”



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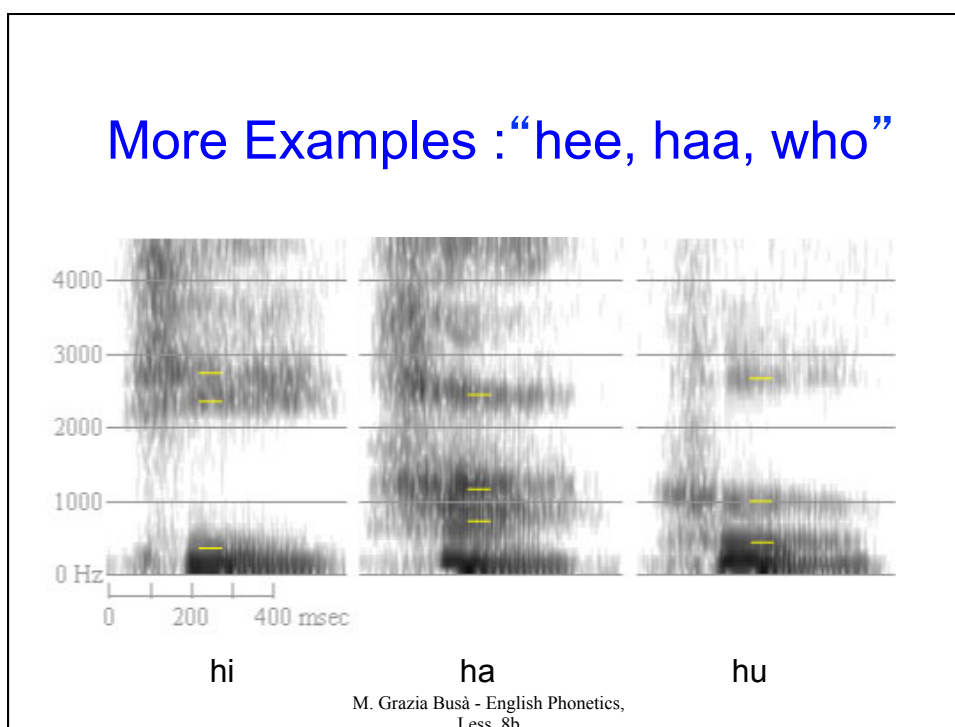
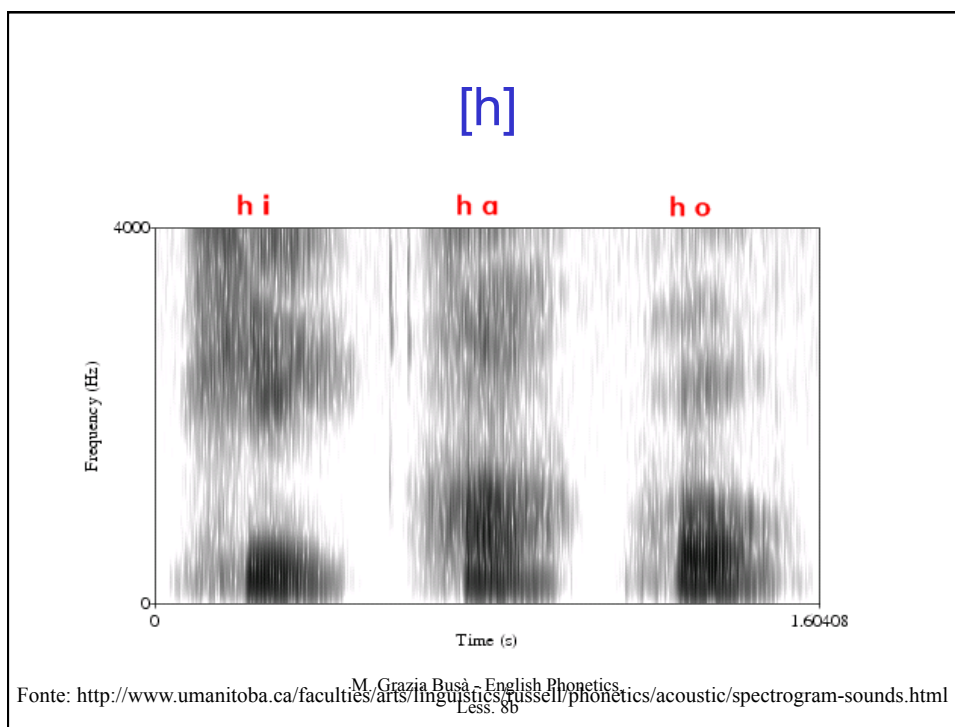




[h]

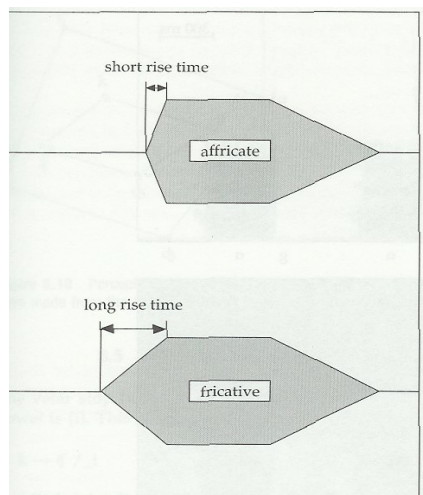
- has characteristics that are in between those of a fricative and a vowel
- appears as a voiceless version of the preceding or following vowel
- Fricative-like noise is visible but typically some weak formants are visible.

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Affricate Consonants

- Are transcribed as stop-fricative sequences
- Acoustically, amplitude rises faster in affricates than in plain fricatives
 - “rise time”
- In the world languages affricates with sibilants are more frequent than other affricates



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Affricates

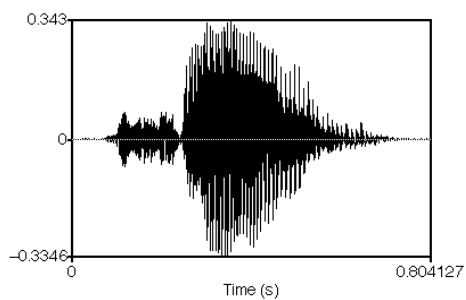
- General
 - Silence as in stops or low energy interval
 - Noise as in fricatives
- [tS]
 - Silence
 - Noise as in [S]
- [dZ]
 - Low frequency energy (or voice bar)
 - Noise as in [Z]

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Fricative vs. Affricate

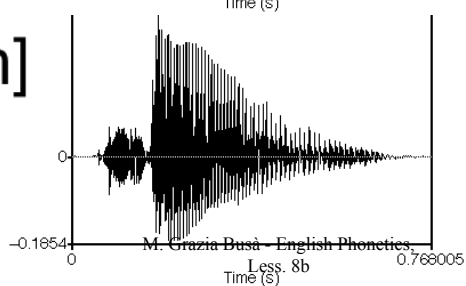
[ʃaɪ]

“shy”



[tʃaɪm]

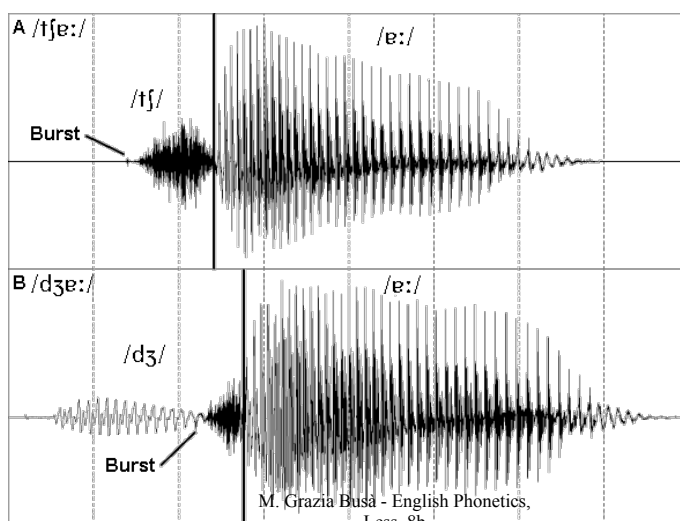
“chime”



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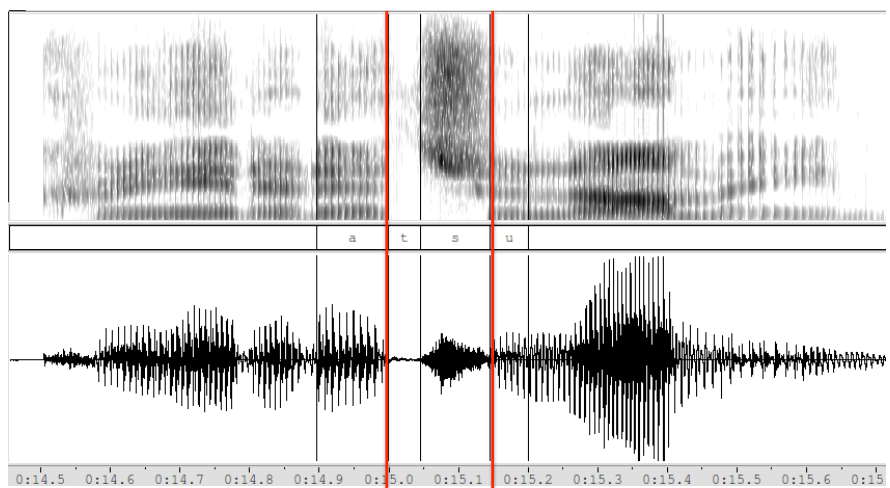
Voiceless and voiced affricates



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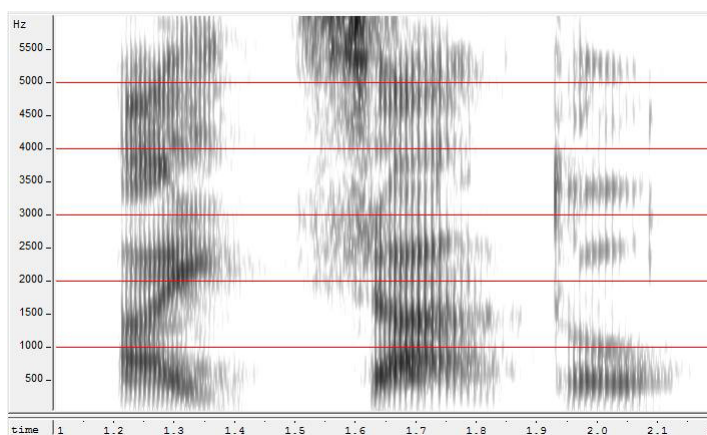
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Example 'atsu'

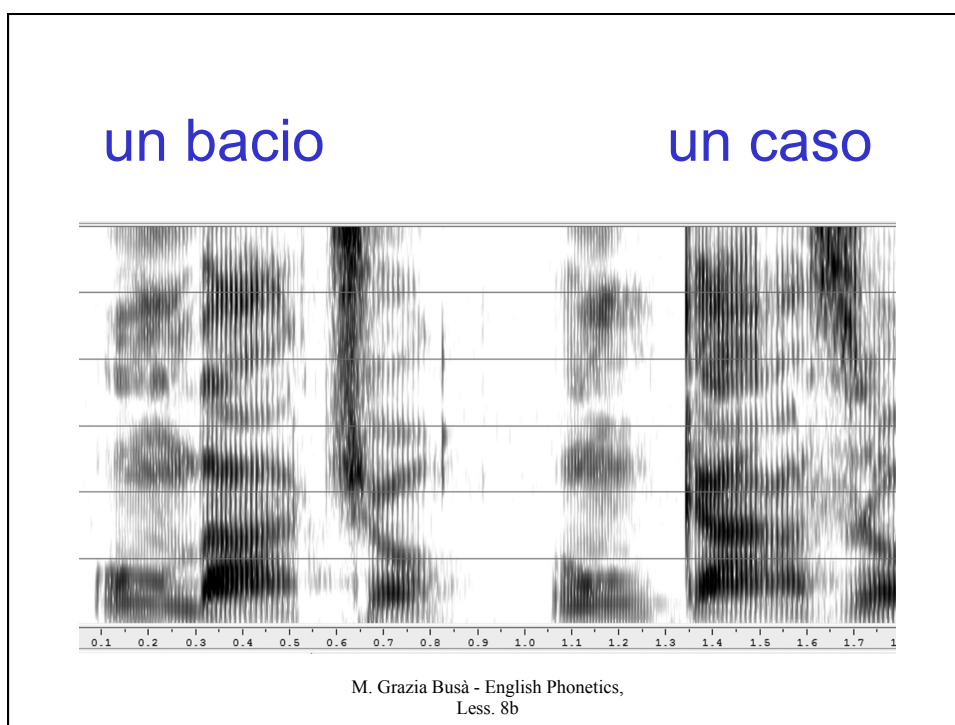
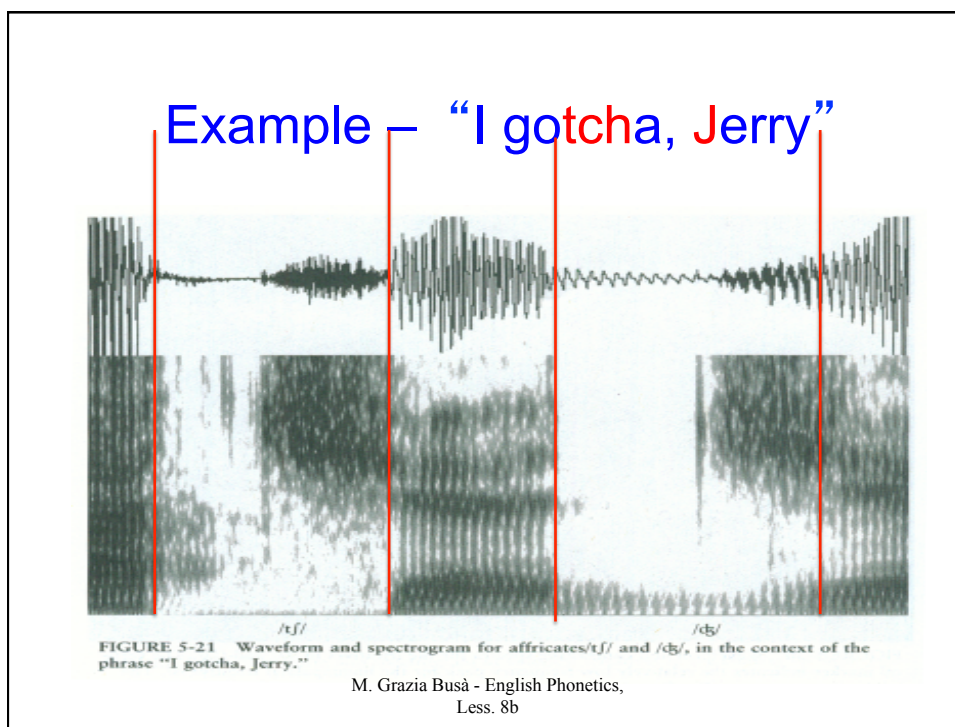


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aizzato



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Nasal Acoustics

- General
 - Periodic voicing
 - Overall amplitude lower than in vowels.
 - Formants similar to vowels but fainter
 - Formants have broad “bandwidths”.
 - Relatively rapid formant transitions

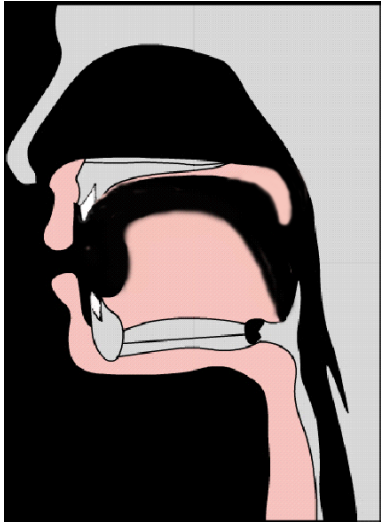
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Nasals Acoustics (2)

- Formants
 - Very low F1 (about 250Hz), F2 (about 2500Hz), and F3 (about 3250Hz)
- Place distinction
 - bilabial [m]: downward F2, F3 locus
 - alveolar [n]: less amount of F2 transition
 - velar [ŋ]: velar pinch

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	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Nasal	m	n̥		n		ɳ	ɲ	ŋ	ɴ		



[m]

Bilabial nasal

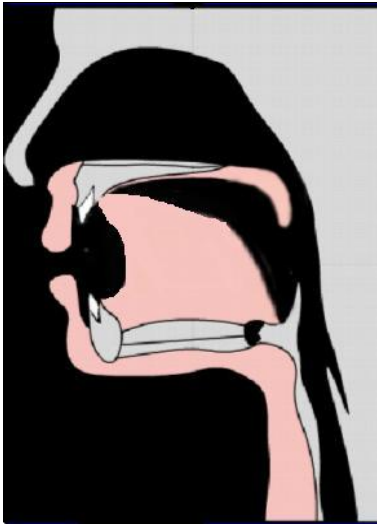
	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Nasal	m̥	n̥		n		ɳ	ɲ	ŋ	ɴ		



[ɱ]

Labiodental nasal

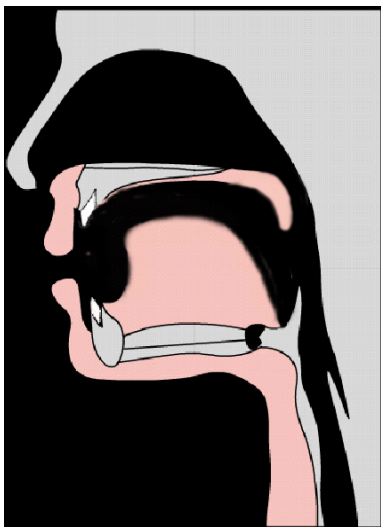
	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		



[n]

Alveolar nasal M. Grazia Busà - English Phonetics, Less. 8b

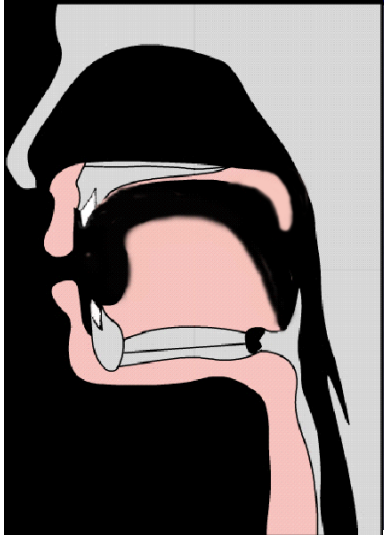
	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		




[ɲ]

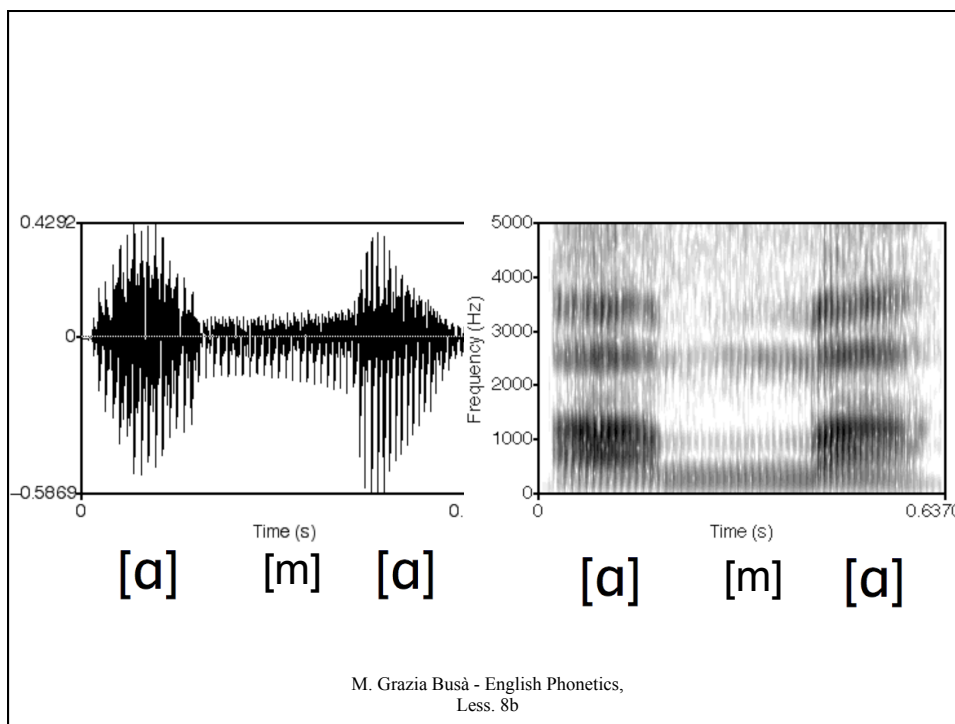
Palatal nasal

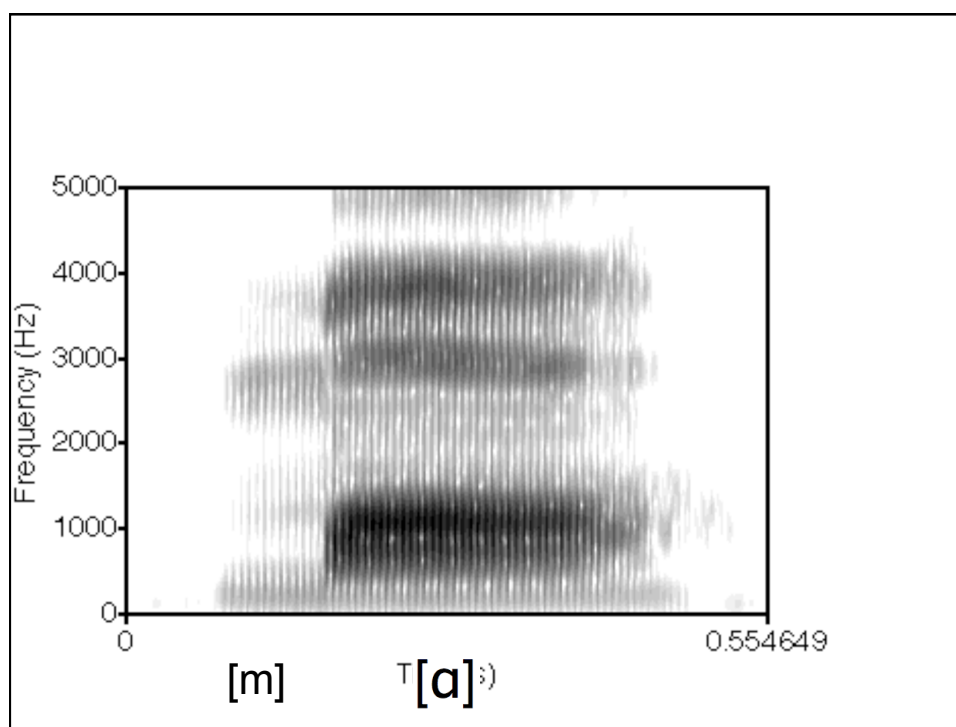
	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		





Velar nasal





Example – Nasals “many angles”

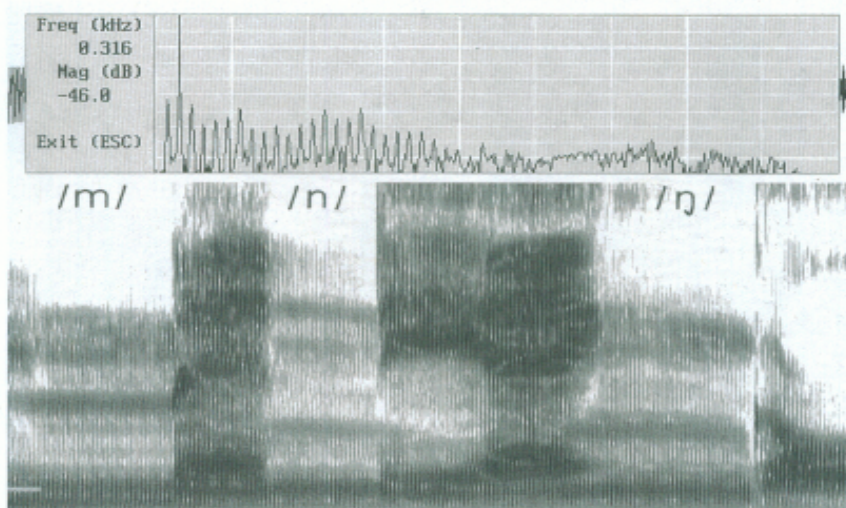
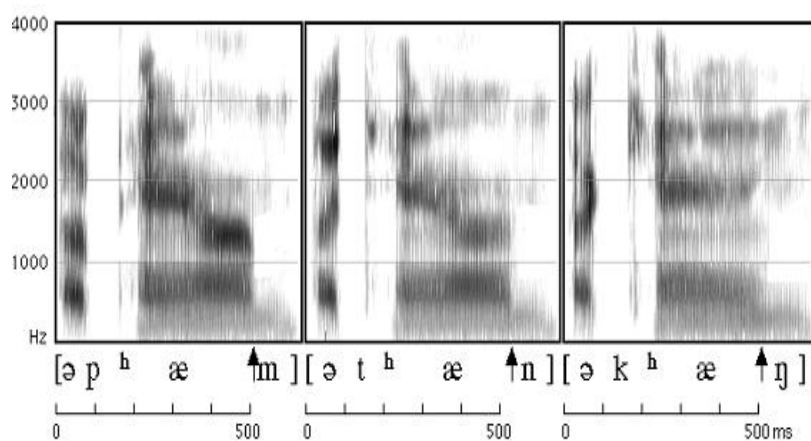


FIGURE 5-18 Nasal consonants. The spectrogram in the lower part of the figure shows /m n ŋ/ in the context of the phrase “many angles.” The top of the figure shows a fast Fourier transform spectrum for the /n/. M. Grazia Busà - English Phonetics, Less. 8b

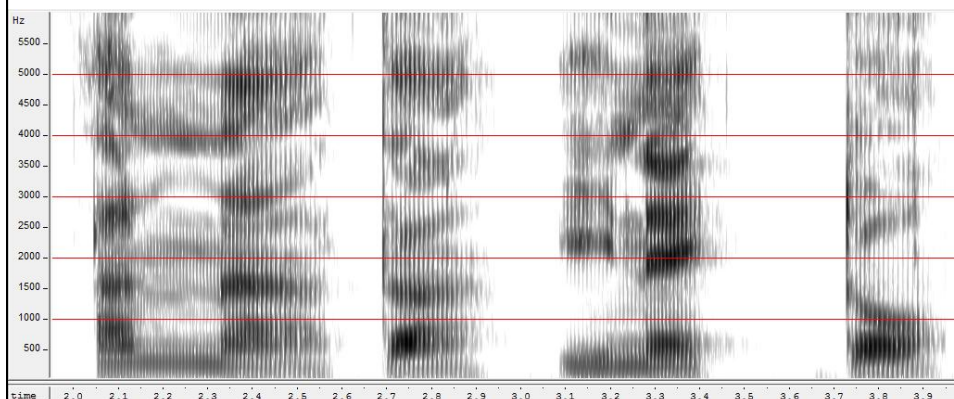
Examples: “a Pam, a tan, a kang”



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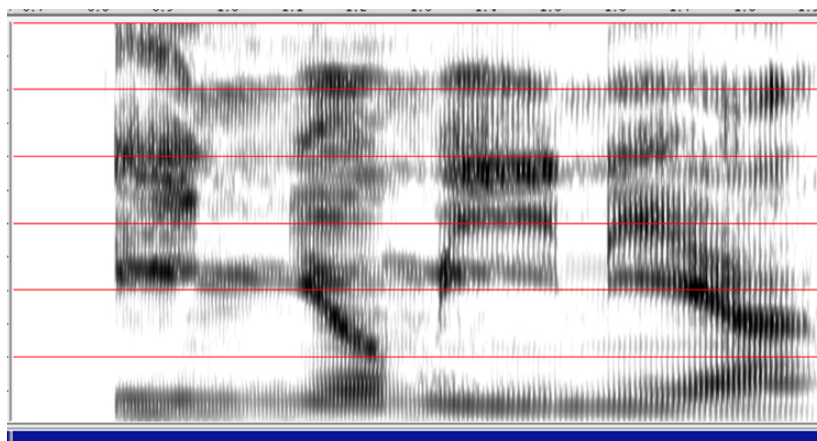
annata

inetta



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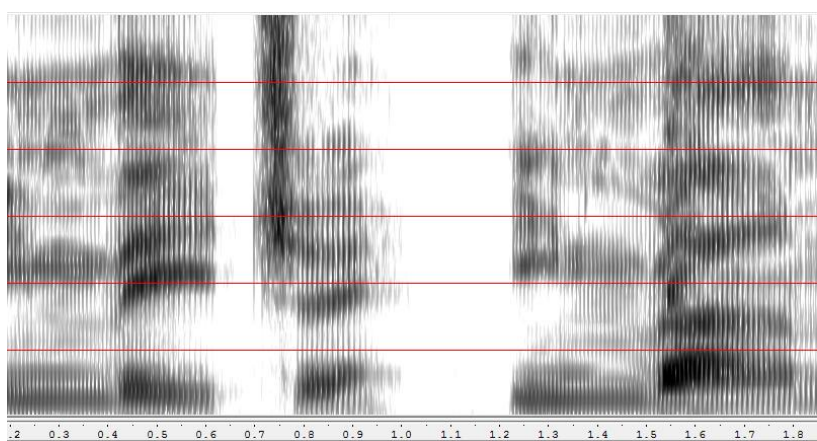
ignominia



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invece

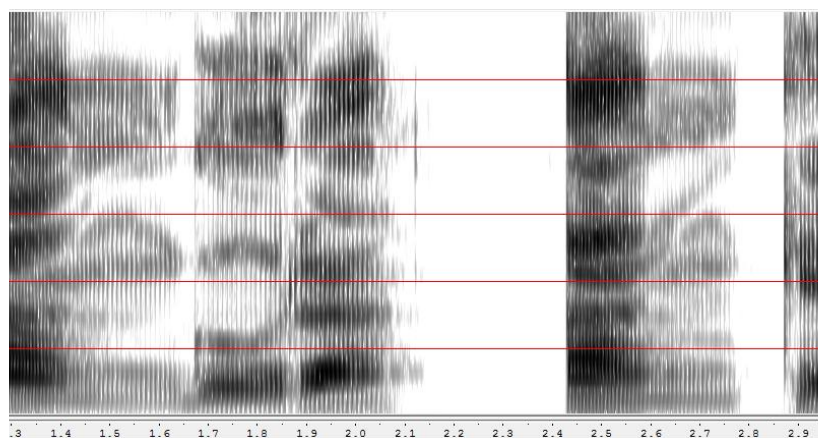
invano



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angora

ambo



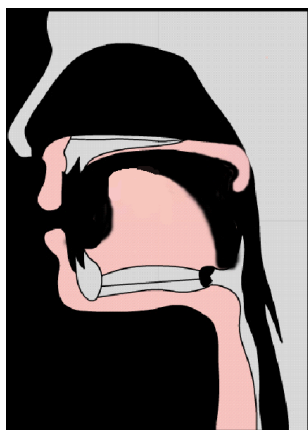
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Liquids & Approximants

- General
 - Formants similar to vowels but weaker intensity (especially at high frequency regions)
 - Approximately F1(250Hz), F2(1200Hz), F3(2400Hz)
 - Slow formant movements

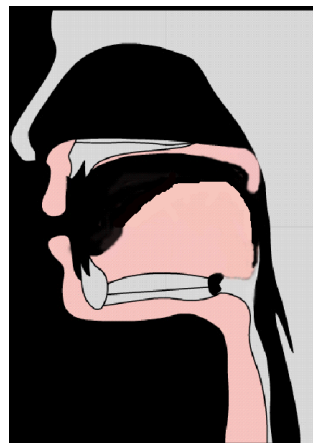
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approximants



[j]

Palatal approximant

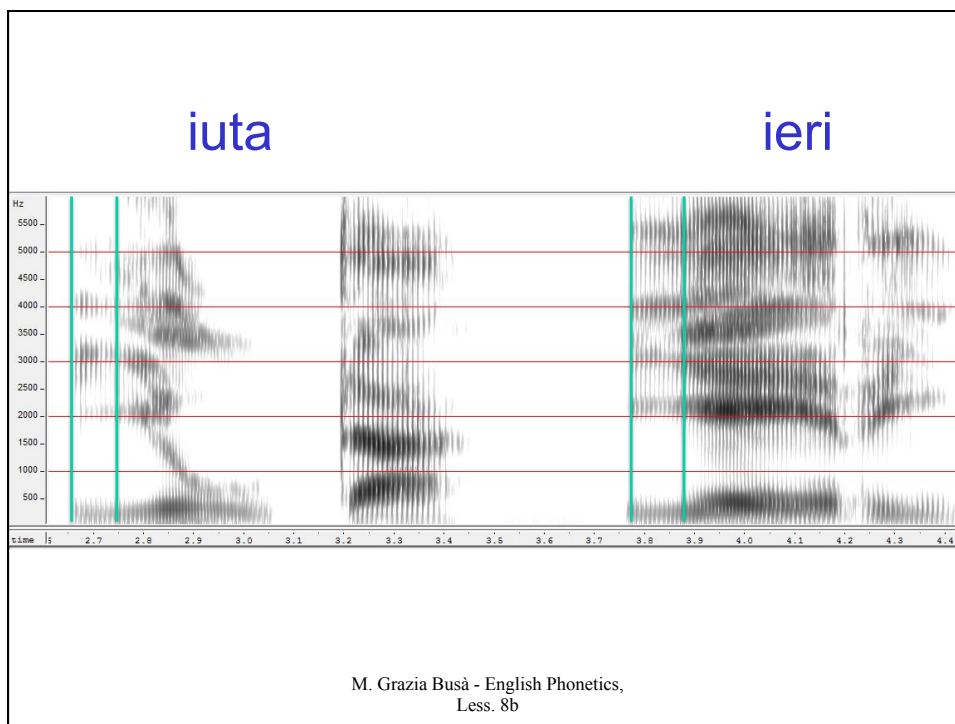
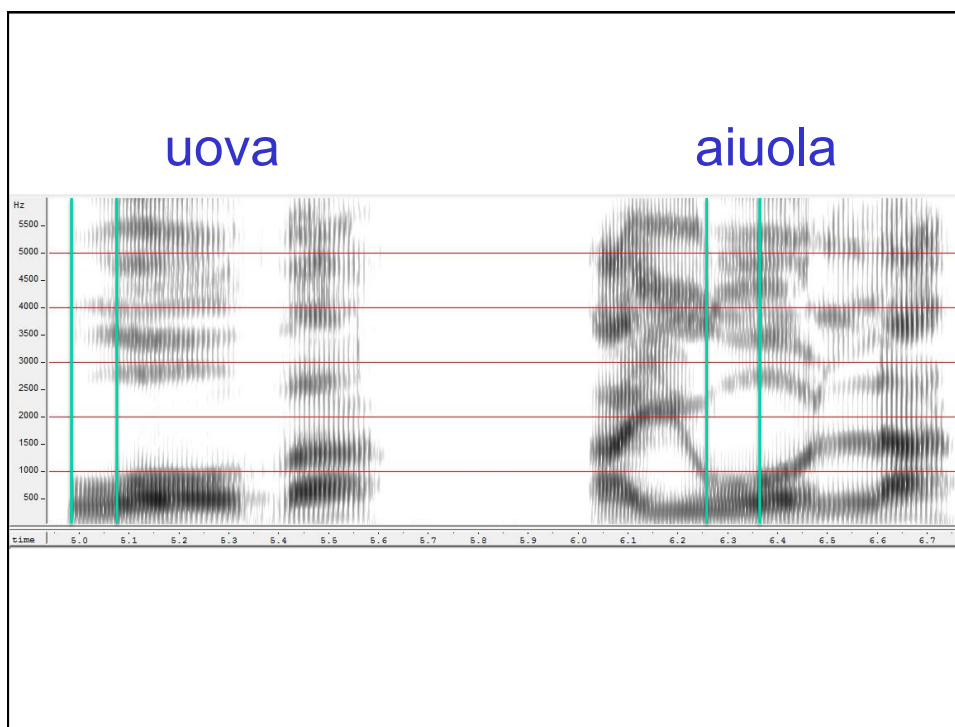


[w]

labio-velar approximant

Glides

- Labial glide [w]:
 - very low F1, F2 (600-1000Hz), relatively low F3
 - rapid falloff of spectral amplitude (formant movements)
- Palatal glide [y]:
 - extremely low F1
 - extremely high F2, F3

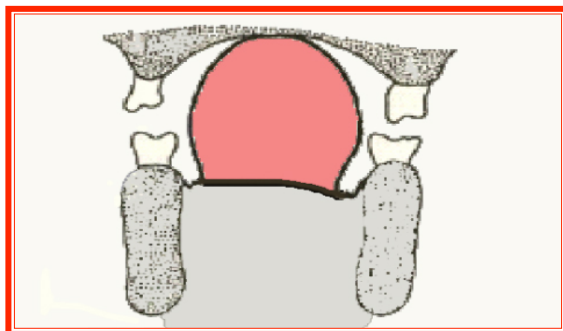


Lateral [l]

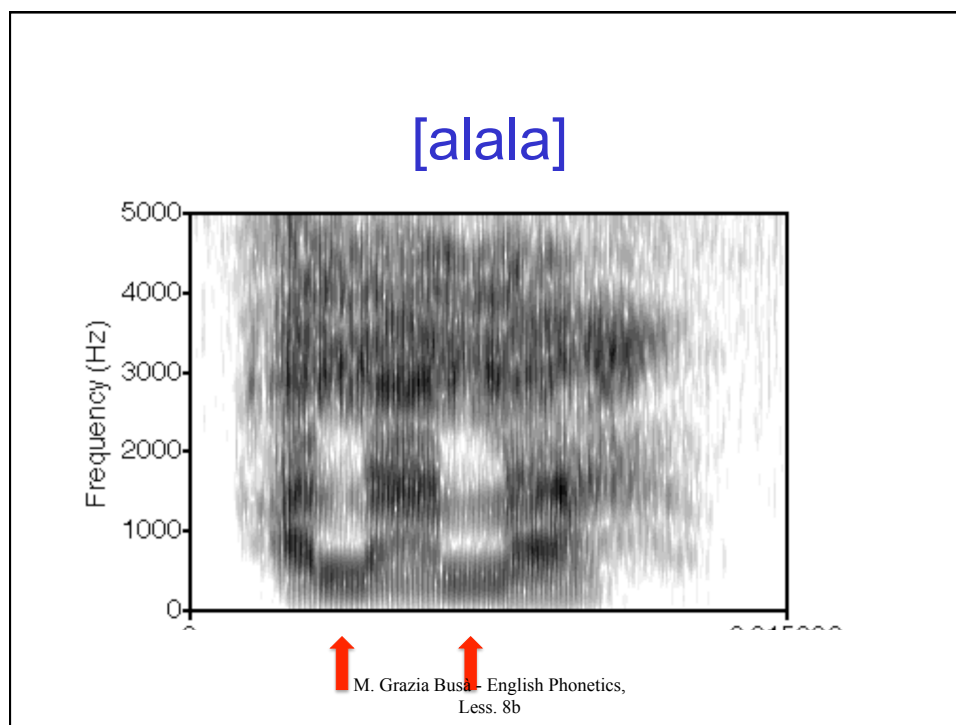
- Lateral [l]:
 - Low F1, F2 (approx. F1 250Hz, F2 1200Hz)
 - usually substantial energy in the high F region
 - Relatively slow formant transition (cf. [n])

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Lateral sounds [l, λ]



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Clear 'l' and dark 'l'

<ul style="list-style-type: none"> • 'clear l' • Palatalized [l] [lʲ] • /l/V ... ou C/l/V ... • "lot", "clear", etc. 	<ul style="list-style-type: none"> • 'dark l' • Velarized [ɫ] • ...V/l/, ...V/l/C, ou ...VC/l/ • "feel", "salt", "apple", etc.
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palatalization

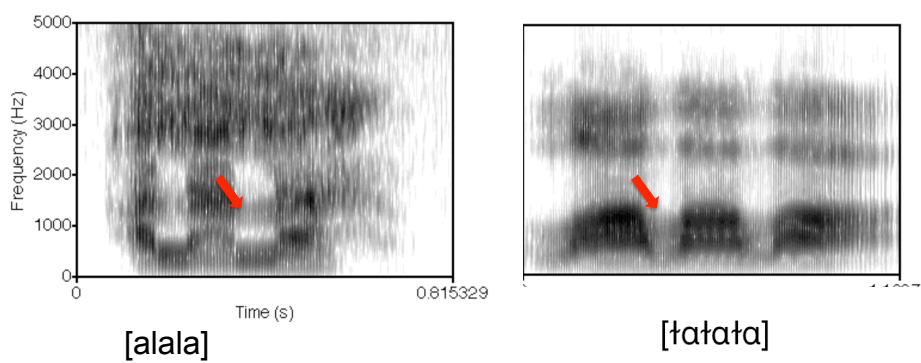
velarization

pharyngealization

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Clear // vs. Dark //

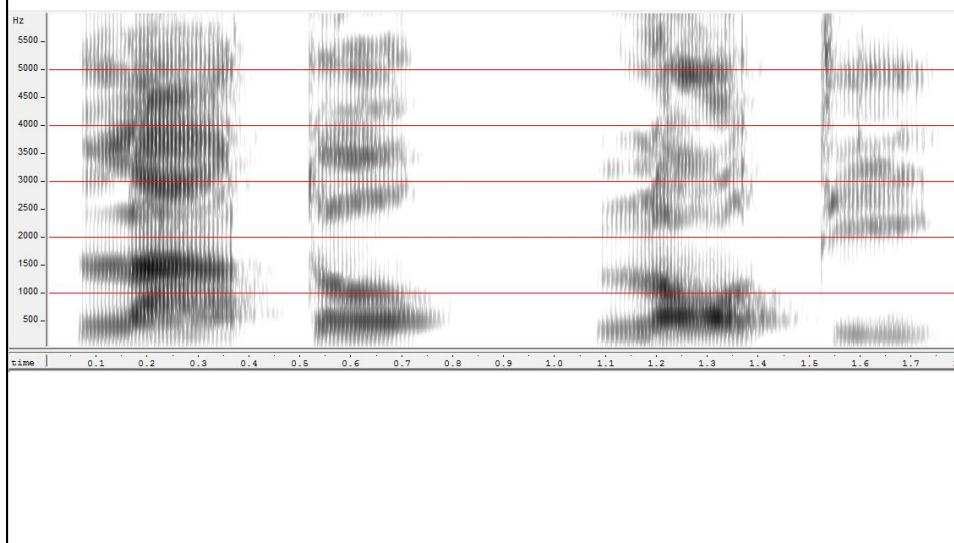
- // often has low F2 in English because it is velarized.

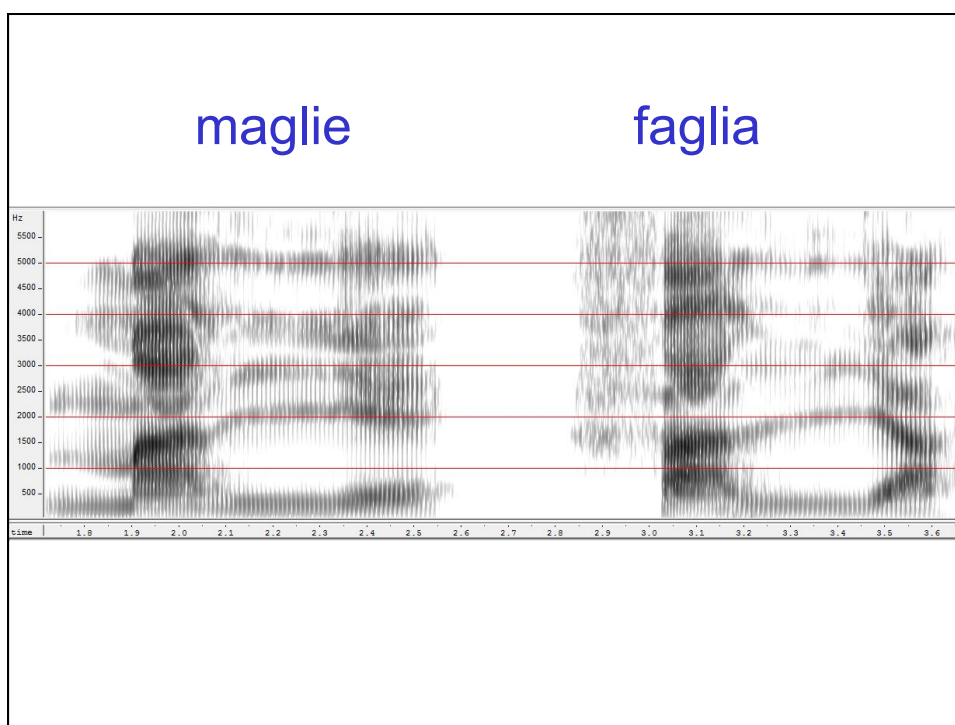
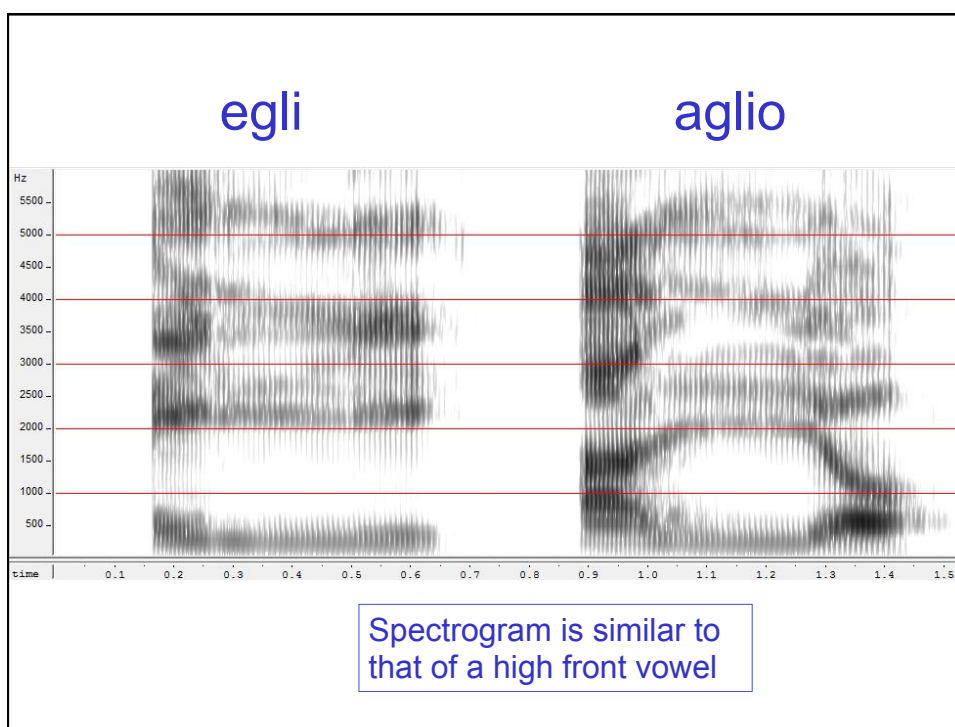


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Lato

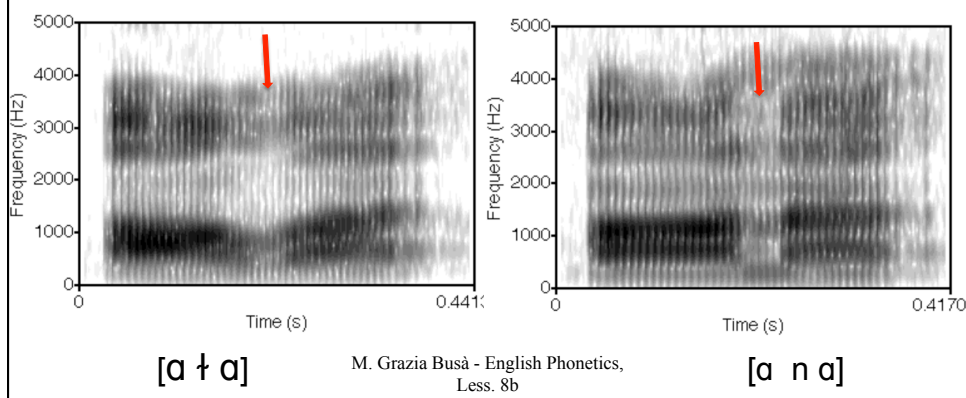
Loti





[l] vs. [n]

Laterals are usually more intense than nasals
 ⇒ break between vowels and laterals is less clear



Flaps and retroflex

- Flap [ɾ]: soft burst, short duration
- Retroflex [ɻ]:
 - F3 dipping down close to F2
 - General lowering of F3, F4

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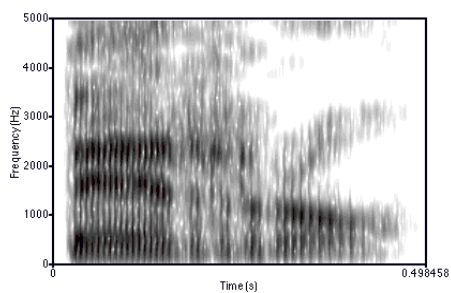


Alveolar trills

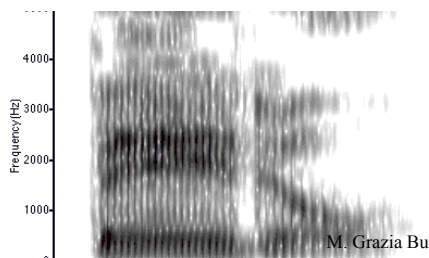
[r]

[r]

Tap and Trill Acoustics

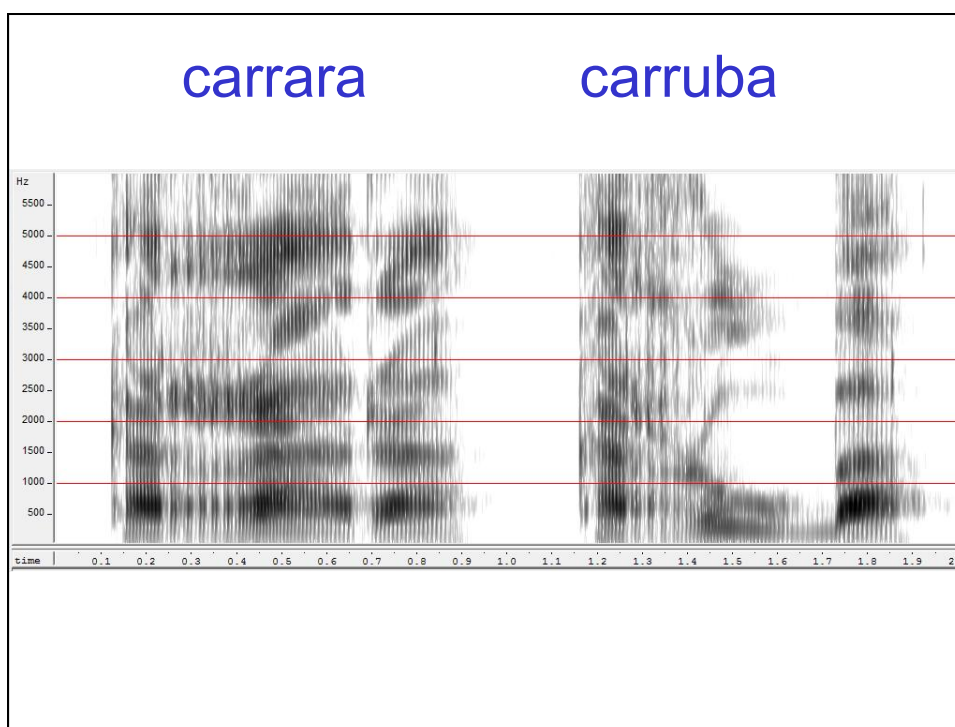
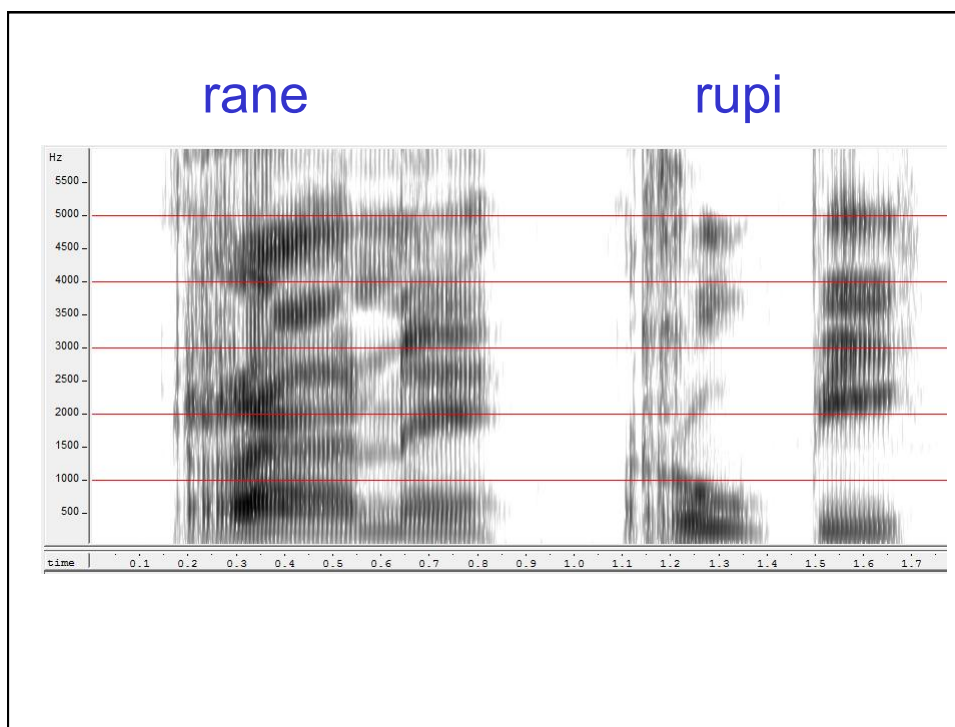


[r] pero 'dog'

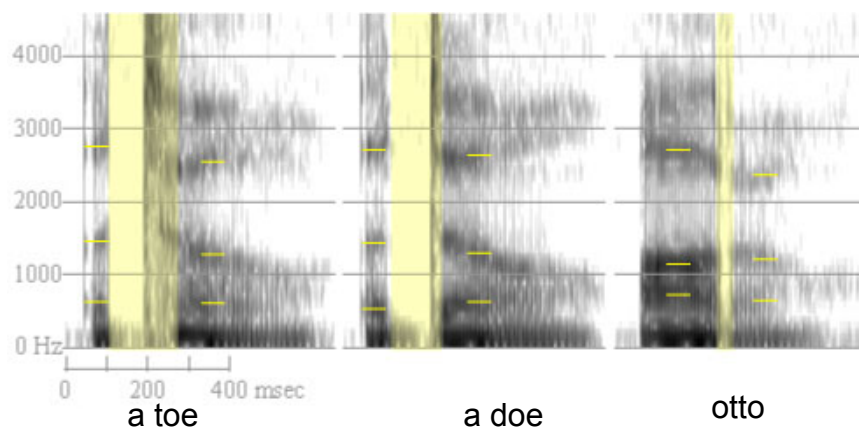


[r] pero 'but'

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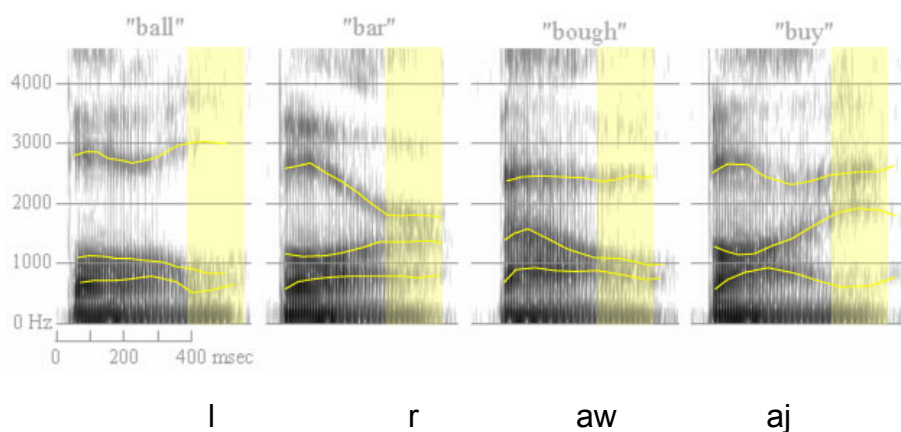


Example: stops vs flap



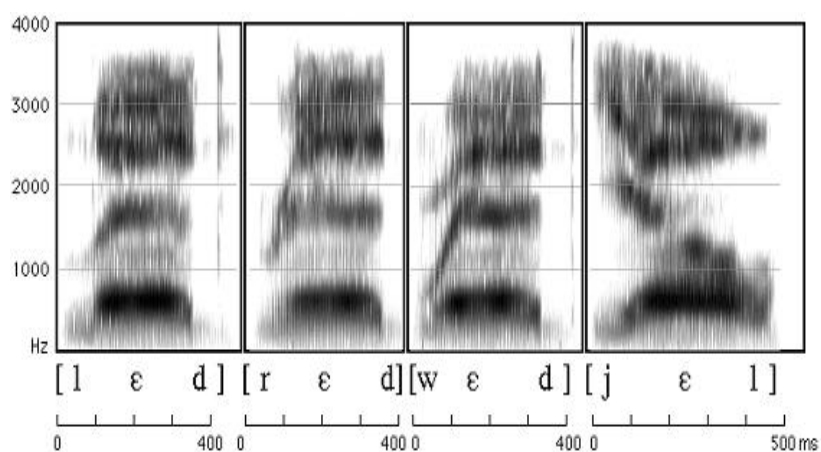
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Example – approximants “ball”, “bar”, “bough”, “buy”



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Example – “led, red, wed, yell”



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bagno

