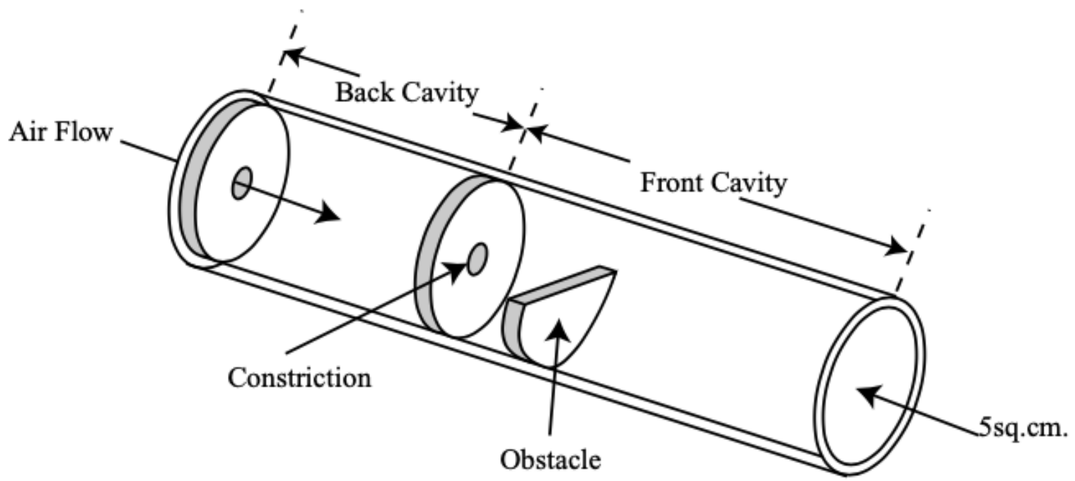
HS 133: Introduction to Phonetics

Instructor: Priyankoo Sarmah

Fricative Acoustics

- Turbulence is the source of the fricatives
- Characterized by the continuant noisy aperiodic component
- The characteristics of the noise are the result of:
  - position of the constriction,
  - the shape of the orifice
  - the aerodynamic forces of the airstream
  - Obstacles
- Dental, alveolar and post alveolar fricatives:
  - front teeth contribute to the quality
  - deflect the airflow, additional turbulence.

Fricative Acoustics

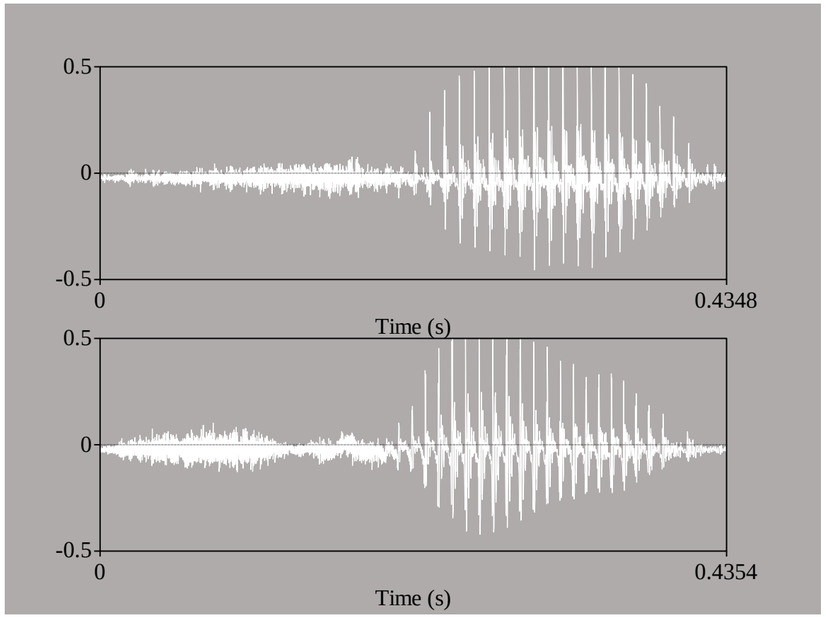


Fricatives

- **Fricatives can be divided into high and low energy sounds:**

- Sibilants [s] [z] [ʃ] [tʃ] [dʒ] [ʒ]: High energy
- Non-Sibilants [f], [v], [h] : Low energy

- Sibilants the orifice is circular (more efficient)
- Non-sibilants elliptical shaped orifice.



Fricatives

- **Sibilants:**
  Concentration of energy in one band in the 1.5 -8kHz range

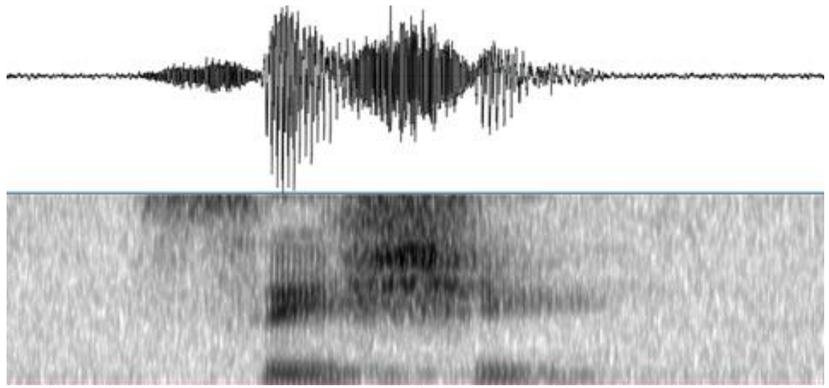
- **Non sibilants:**
- labiodental: even concentration of energy throughout the 1 -8kHz

- Dental: intensification in the 8-16kHz range

- /h/ formant bands in lower frequency

Place and Sibilants

- /s/ has its lower boundary of noise at about 4kHz peaking at about 5.5kHz
- For the palatoalveolars (e.g. /ʃ/):
  - main resonance occurs at a lower frequency
  - due to the longer cavity in front of the constriction
  - The main resonance occurs at about 2.5kHz



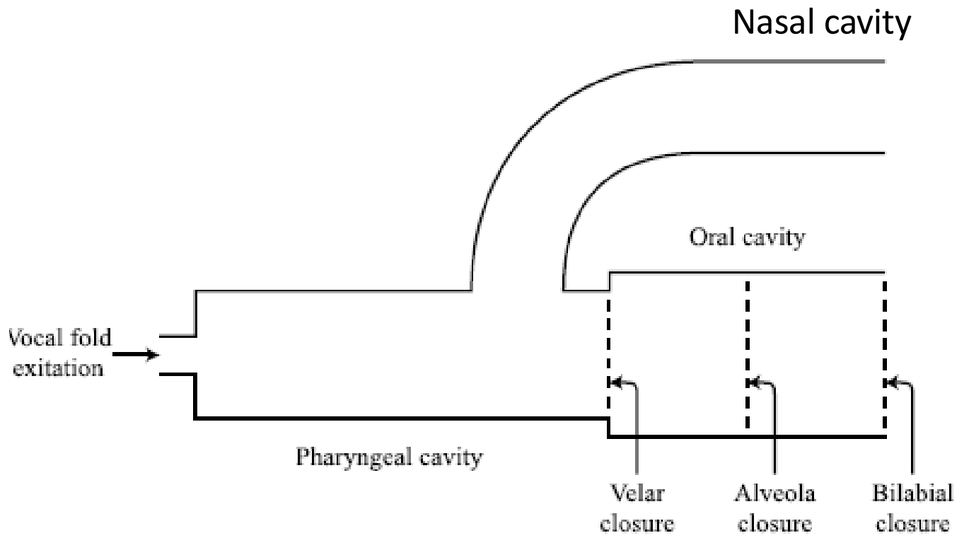
Place and non-sibilants

- The **distribution of energy** in the 7-16kHz range is used in distinguishing /f/ from /ɵ/.
- /f/ main resonance around 10-12kHz (shorter front cavity)
- /ɵ/ main resonance around 8kHz

- **Formant transitions** major cue non-sibilants
- /f/ rising F2 and F3
- /ɵ/ falling F2 and F3

Acoustics of consonants | Nasals

- Nasal cavity has more surface area allowing dampening of soundwaves
- In nasal production, the oral cavity acts as a side cavity
- But the cavity is closed hence, the resonating frequency components are not transmitted
- These frequencies are anti-resonances or anti-formants
- The cavity for /m/ is about 8 cm

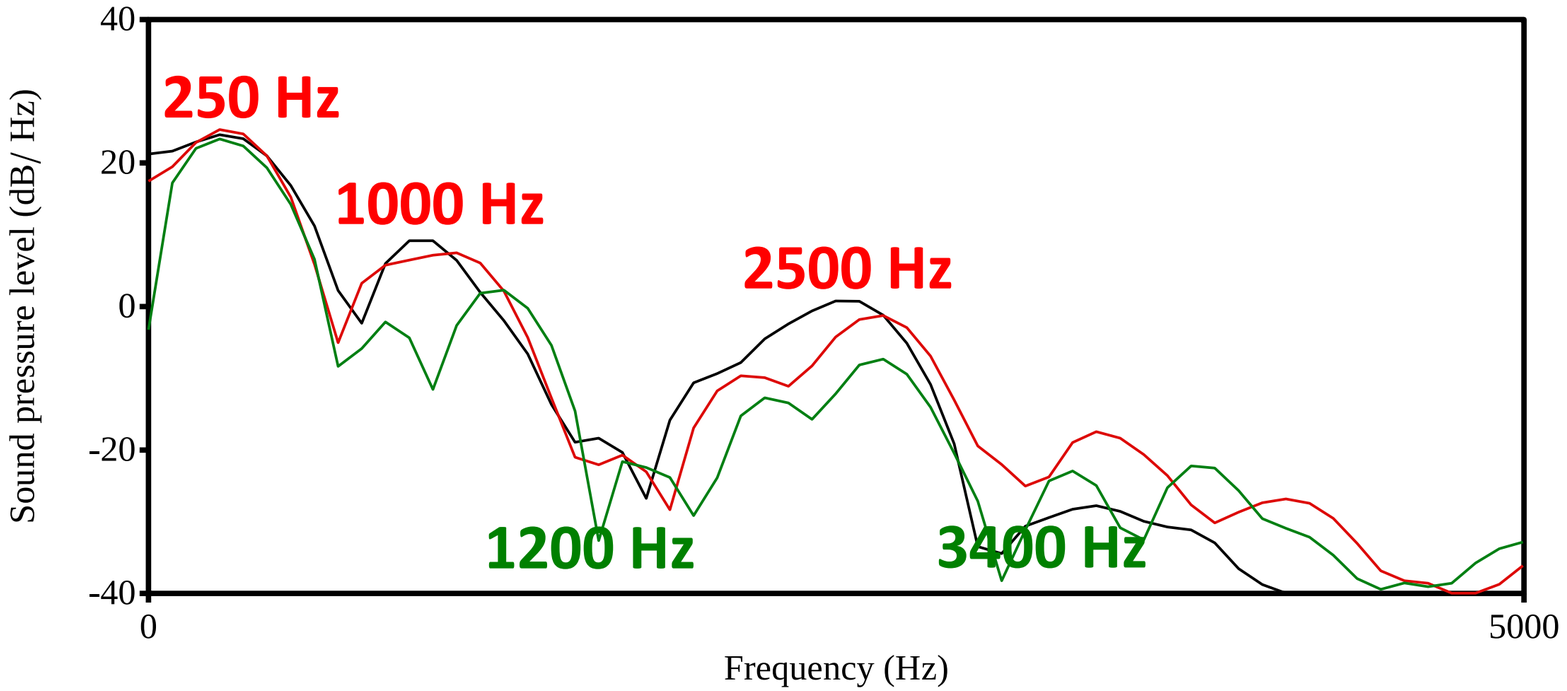


Acoustics of consonants | Nasal formants

m

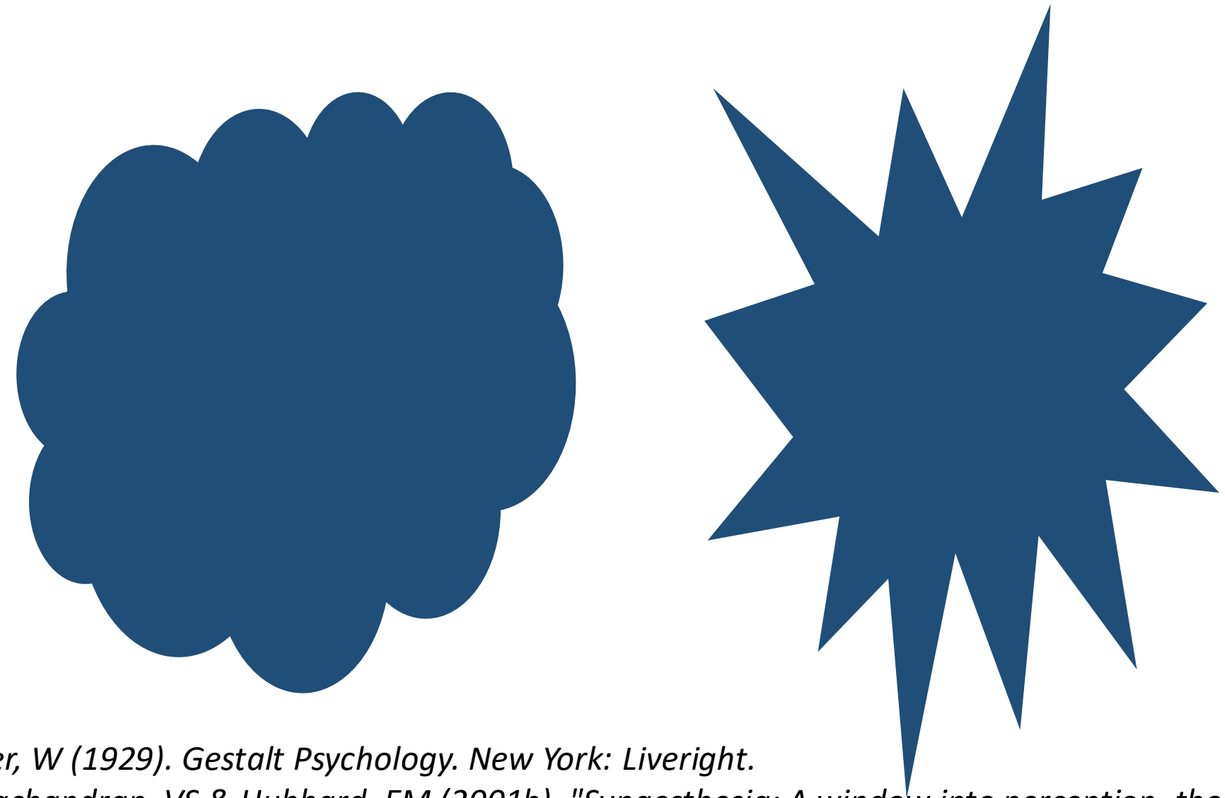
n

ŋ



Vowels and Consonants| Sounds and Shapes

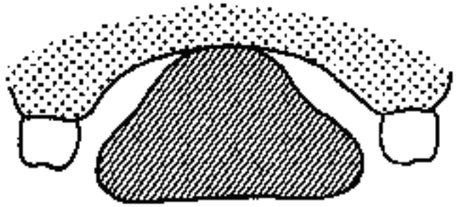
Which one below is Kiki and which one is Bouba?



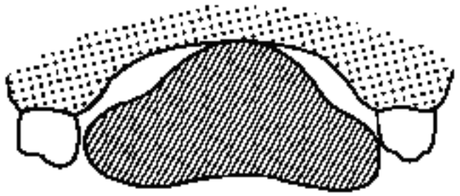
1. *Köhler, W (1929). Gestalt Psychology. New York: Liveright.*
2. *Ramachandran, VS & Hubbard, EM (2001b). "Synaesthesia: A window into perception, thought and language"*

Laterals

- Airstream is passed along the sides of the tongue
- Blocked in the middle
- Tongue touches the alveolar ridge or teeth



Non-fricatives or spirants



Fricatives

CONSONANTS (PULMONIC) ©⓪◎ 2020 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	ɴ		
Trill	ʙ			r					ʀ		
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			

Symbols to the right in a cell are voiced, to the left are voiceless. Shaded areas denote articulations judged impossible.

Lateral acoustics

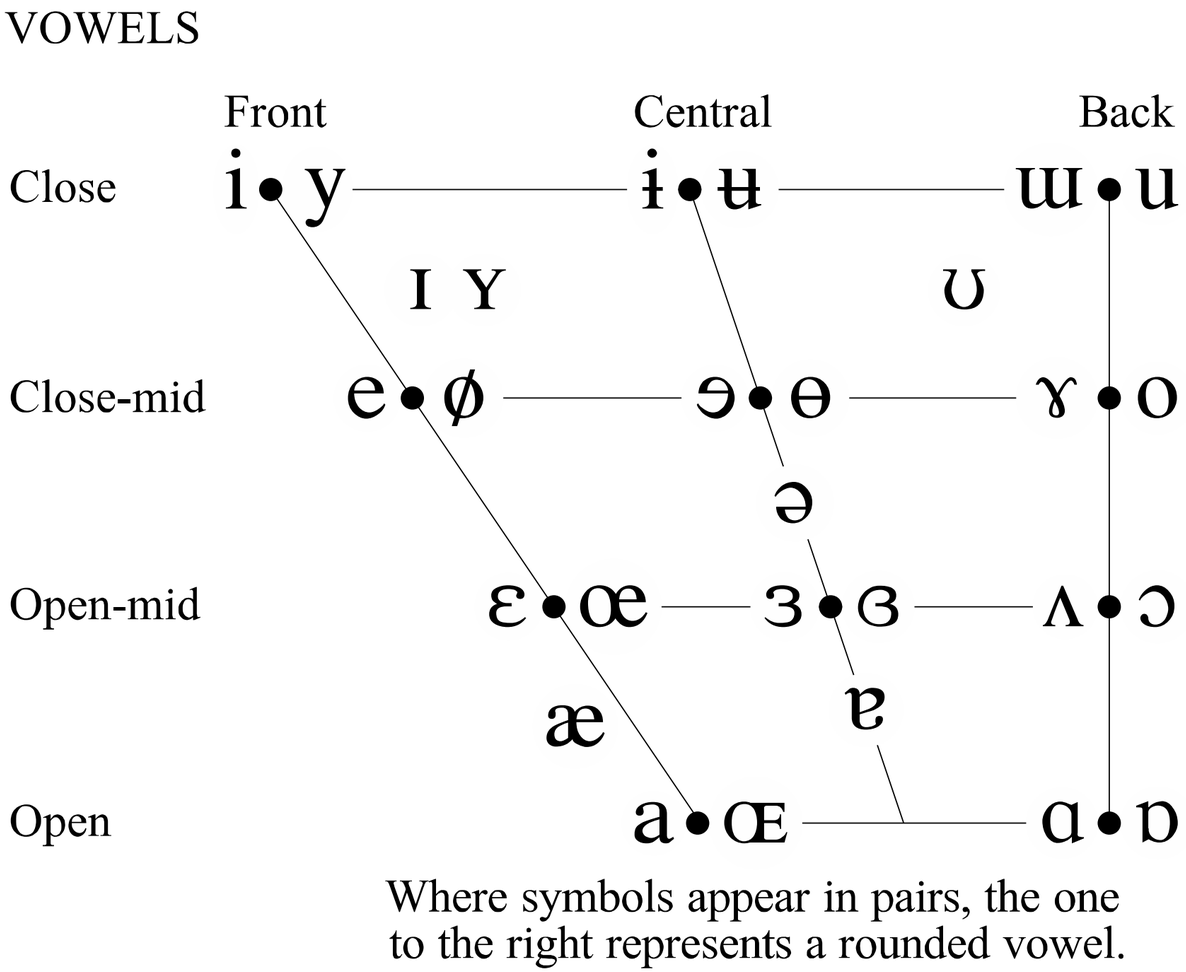
- Laterals also have a side branch - the pocket behind the tongue tip is a side branch to the main tube(s) passing around the side(s) of the tongue.

- Laterals are thus also characterized by zeroes - the lowest appears between F2 and F3, often significantly reducing the amplitude of F2.

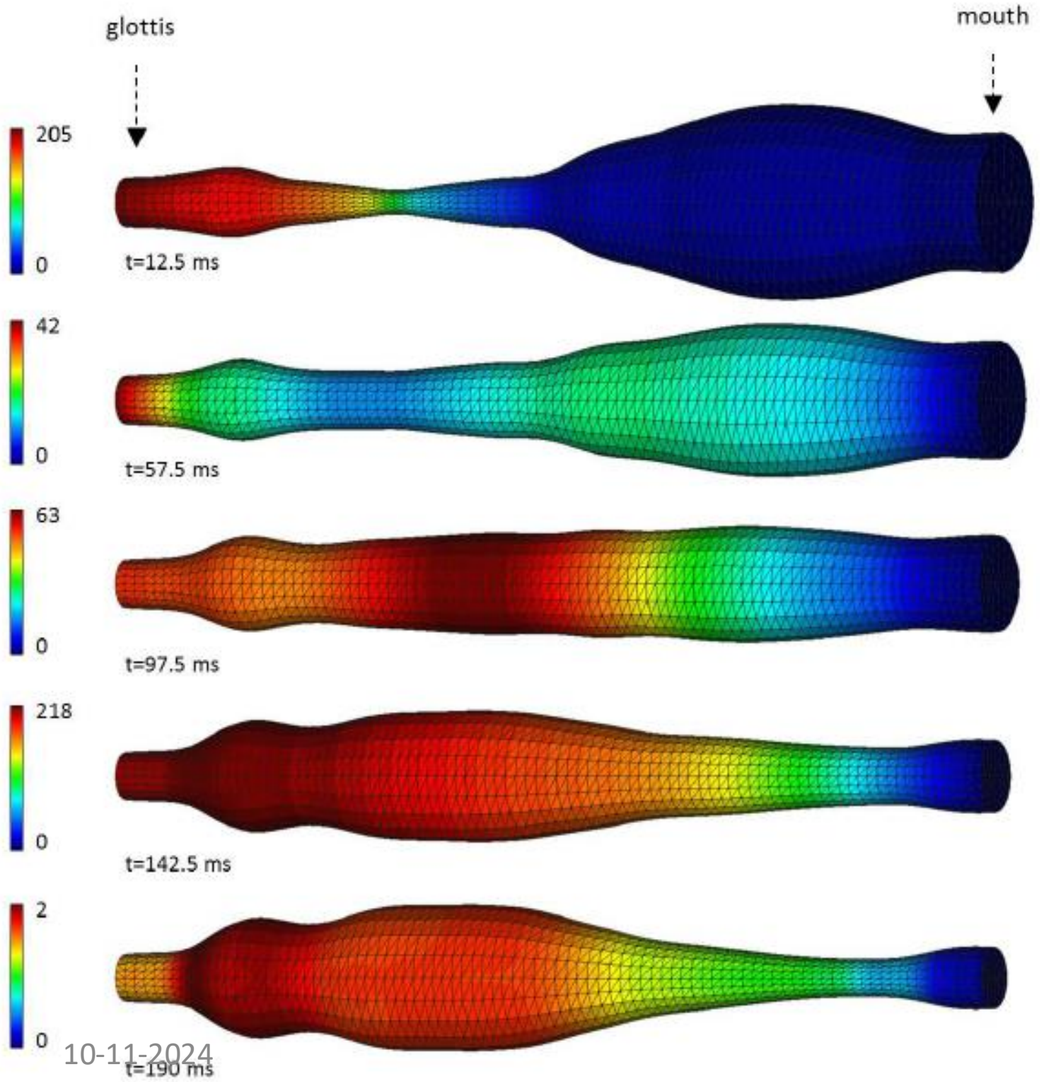
- The presence of zeroes and the coronal constriction reduce the intensity of laterals compared to most vowels.

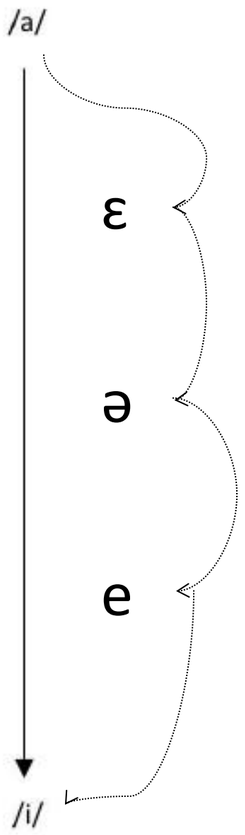
- On spectrograms, laterals look similar to nasals, but differ in the location of formants and zeros, and in their effects on neighboring vowels.

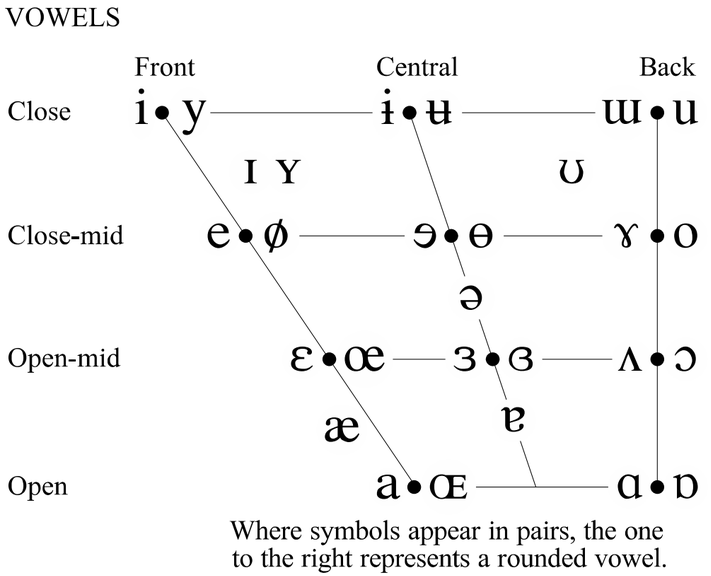
Articulation of vowels | Height, backness and roundness



Acoustics of vowels | Vocal tract







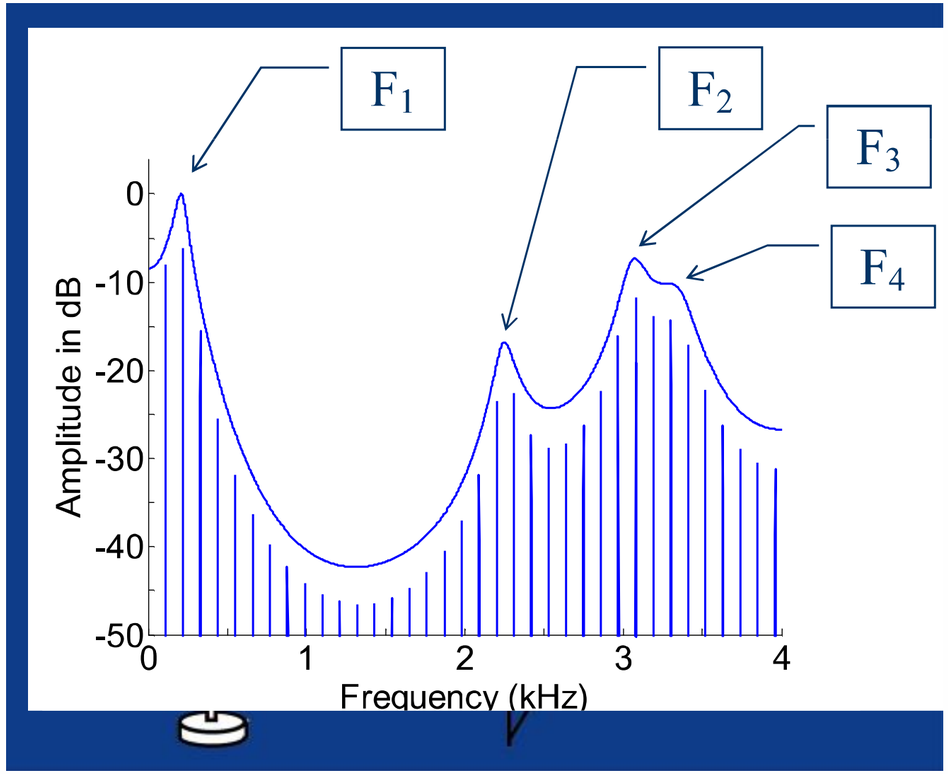
Guasch, O. et al. 2016. A Stabilized Finite Element Method for the Mixed Wave Equation in an ALE Framework With Application to Diphthong Production

Acoustics of vowels | Vowel formants

- Filtered source signals filter out certain harmonics and allows certain harmonics

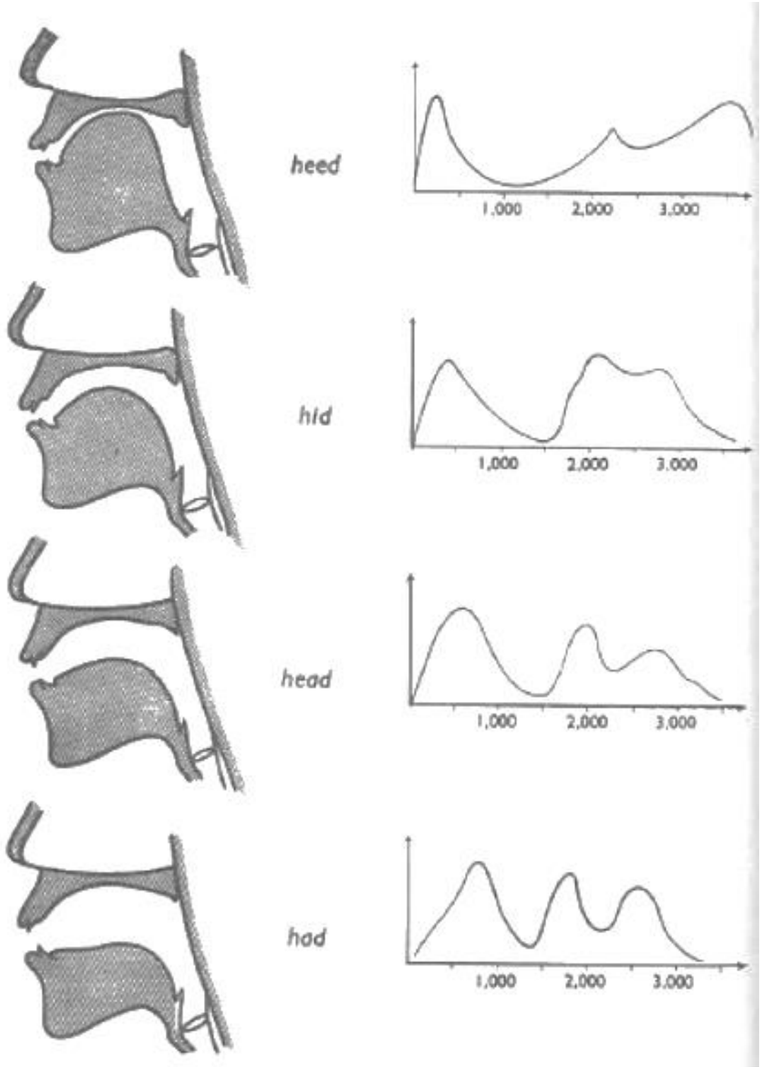
- The peaks formed by ‘allowed’ harmonics are called F1, F2 and F3 etc.

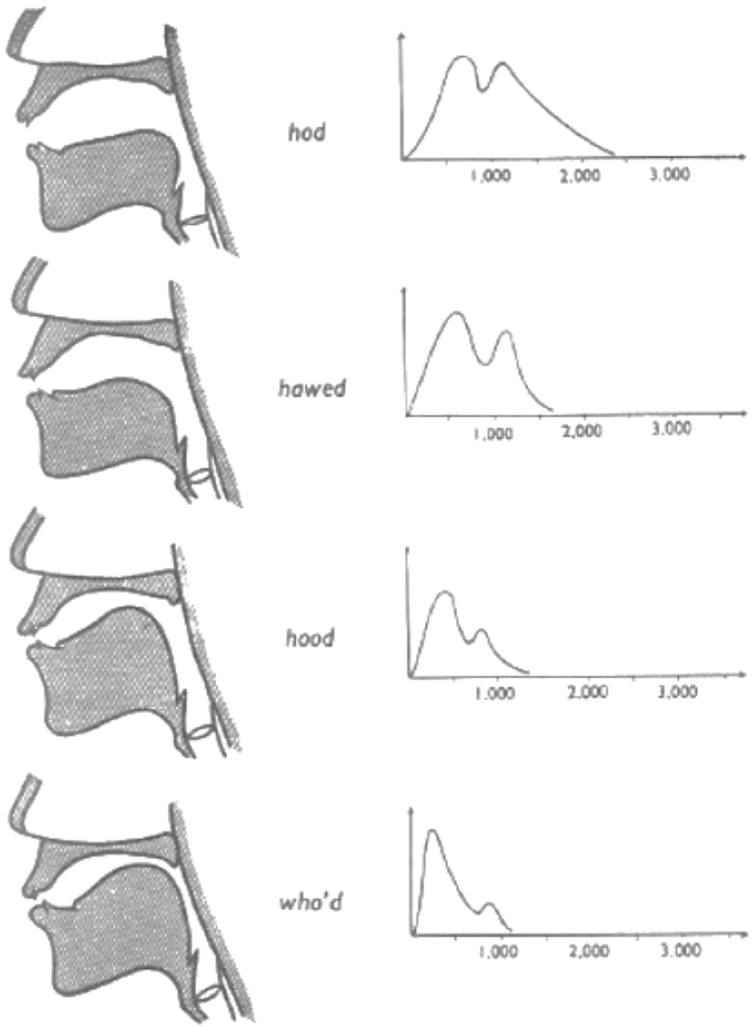
  - F1 is inversely proportionate to tongue height
  - F2 is related to vowel backness
  - F3 is related to vowel rounding



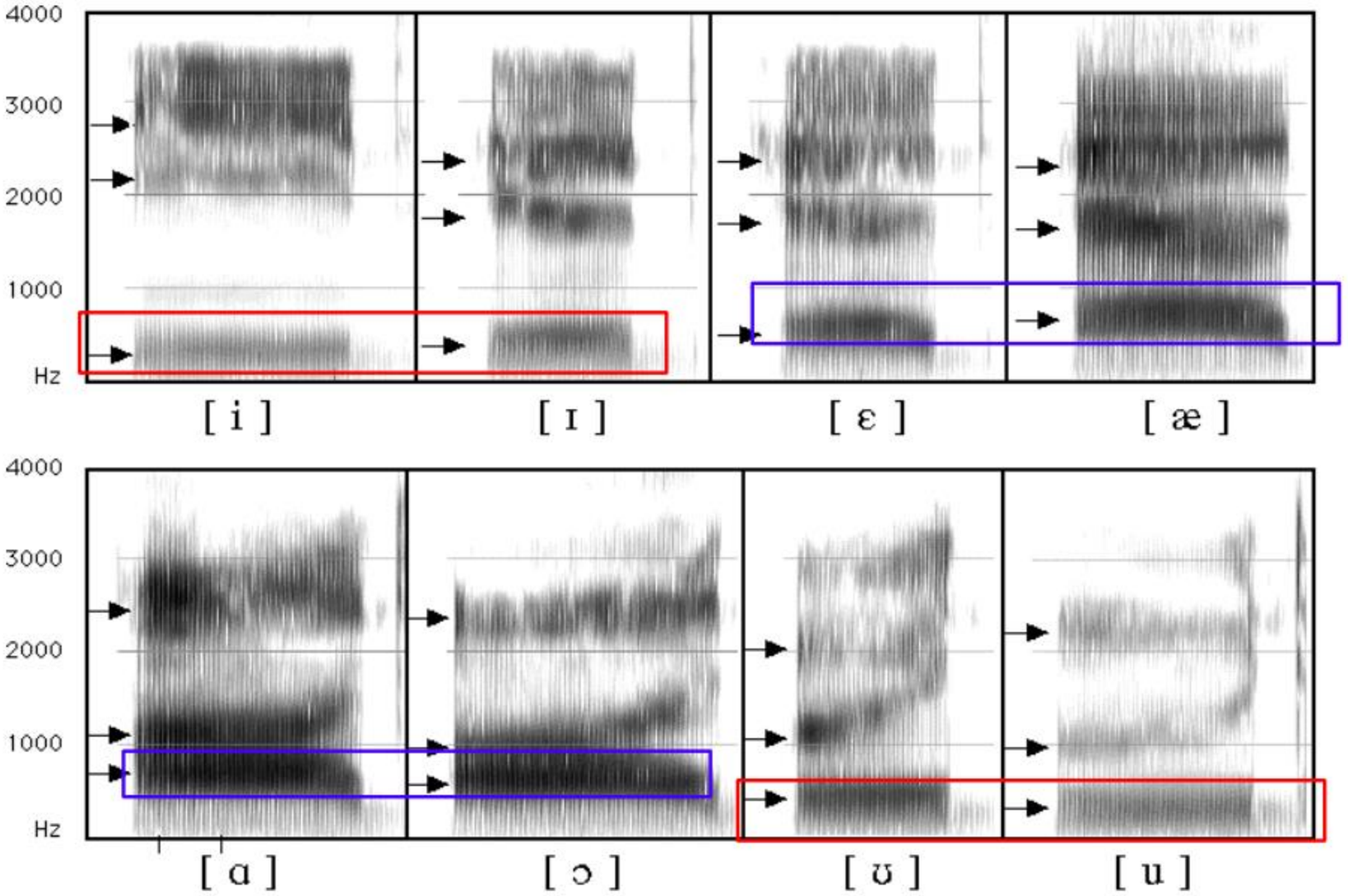
Source: Fitch, W. T. Evolution of Speech: A Comparative Review. Elsevier Science,

Acoustics of vowels | Vowel formants



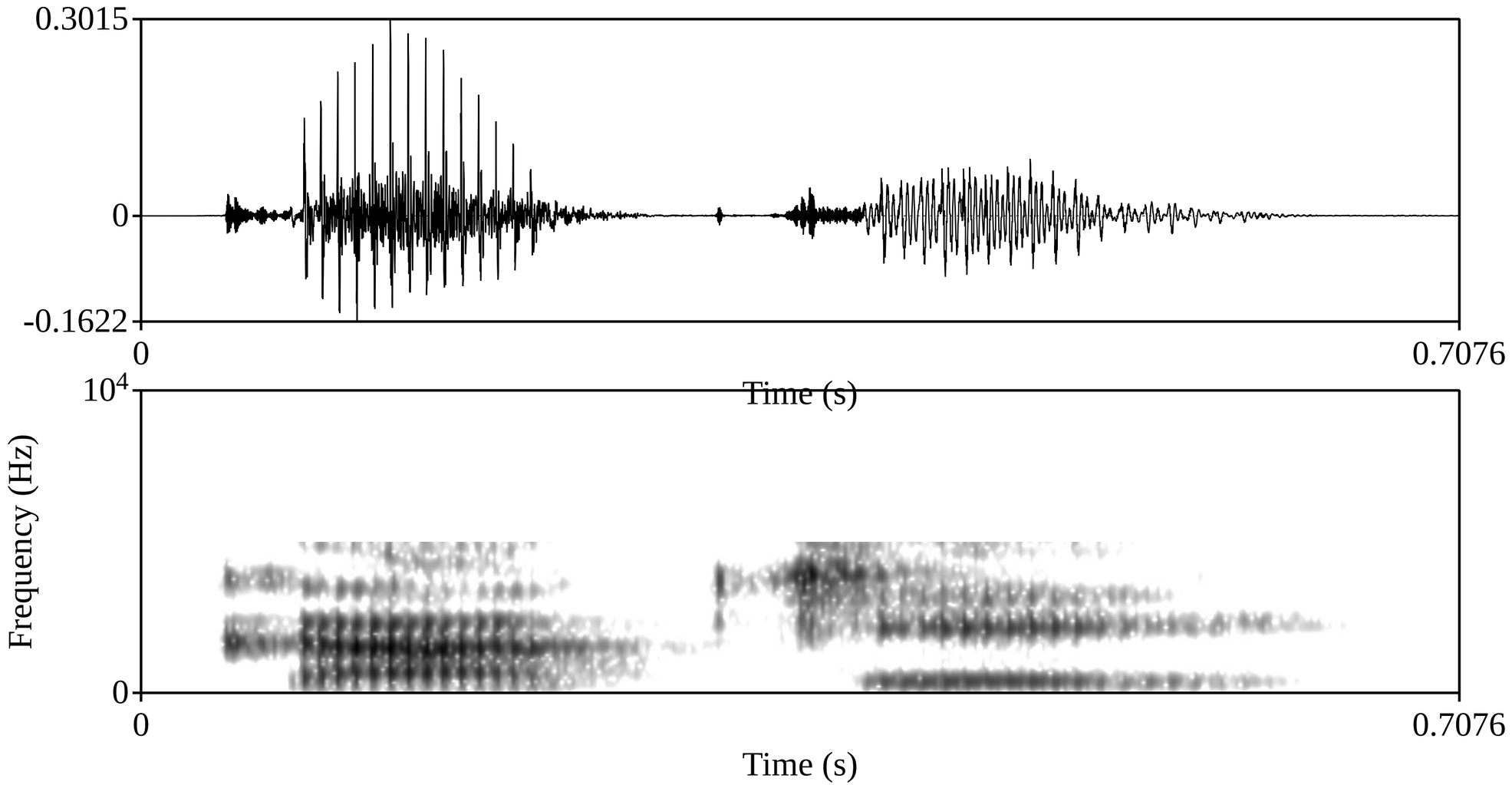


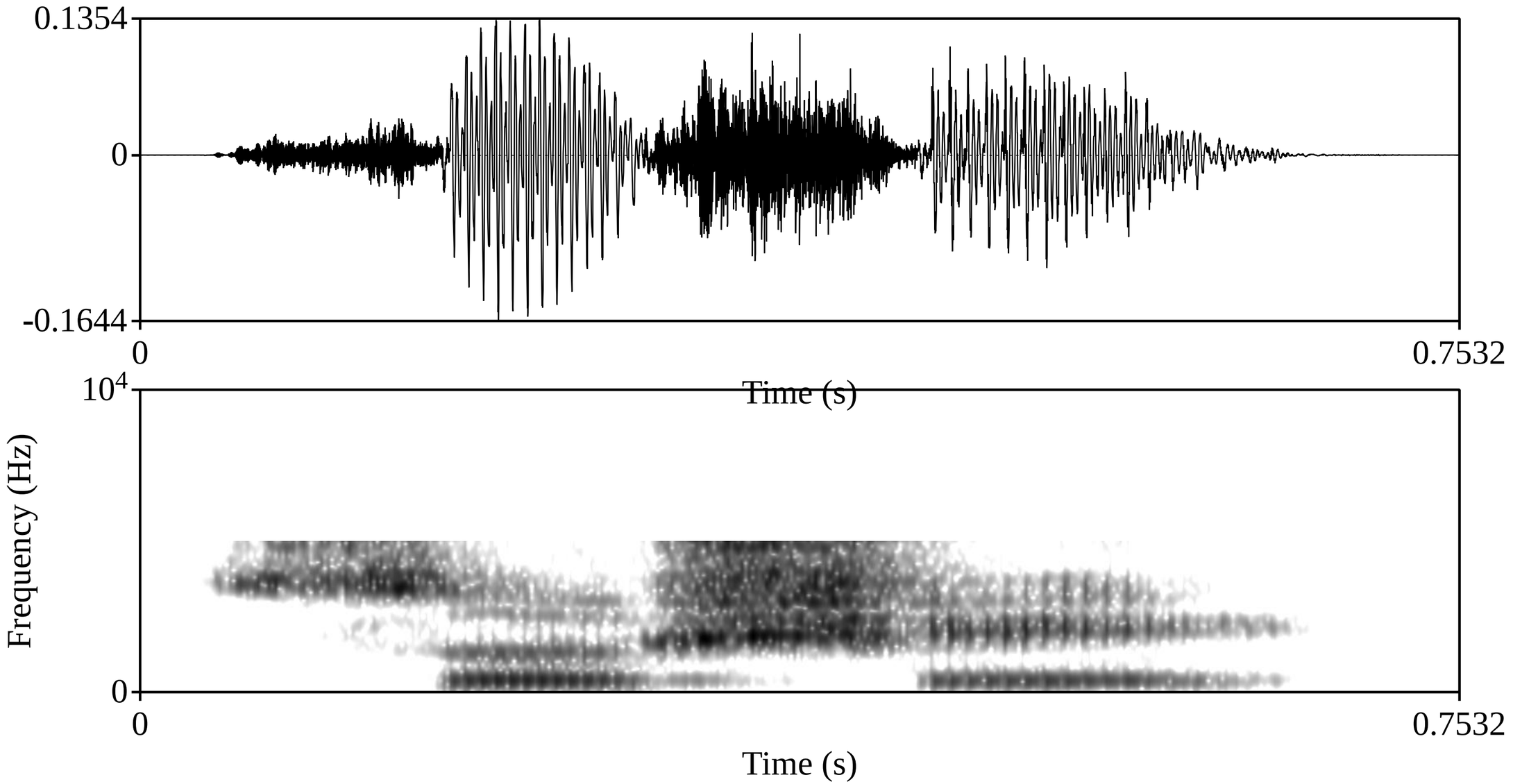
Acoustics of vowels | Vowel formants

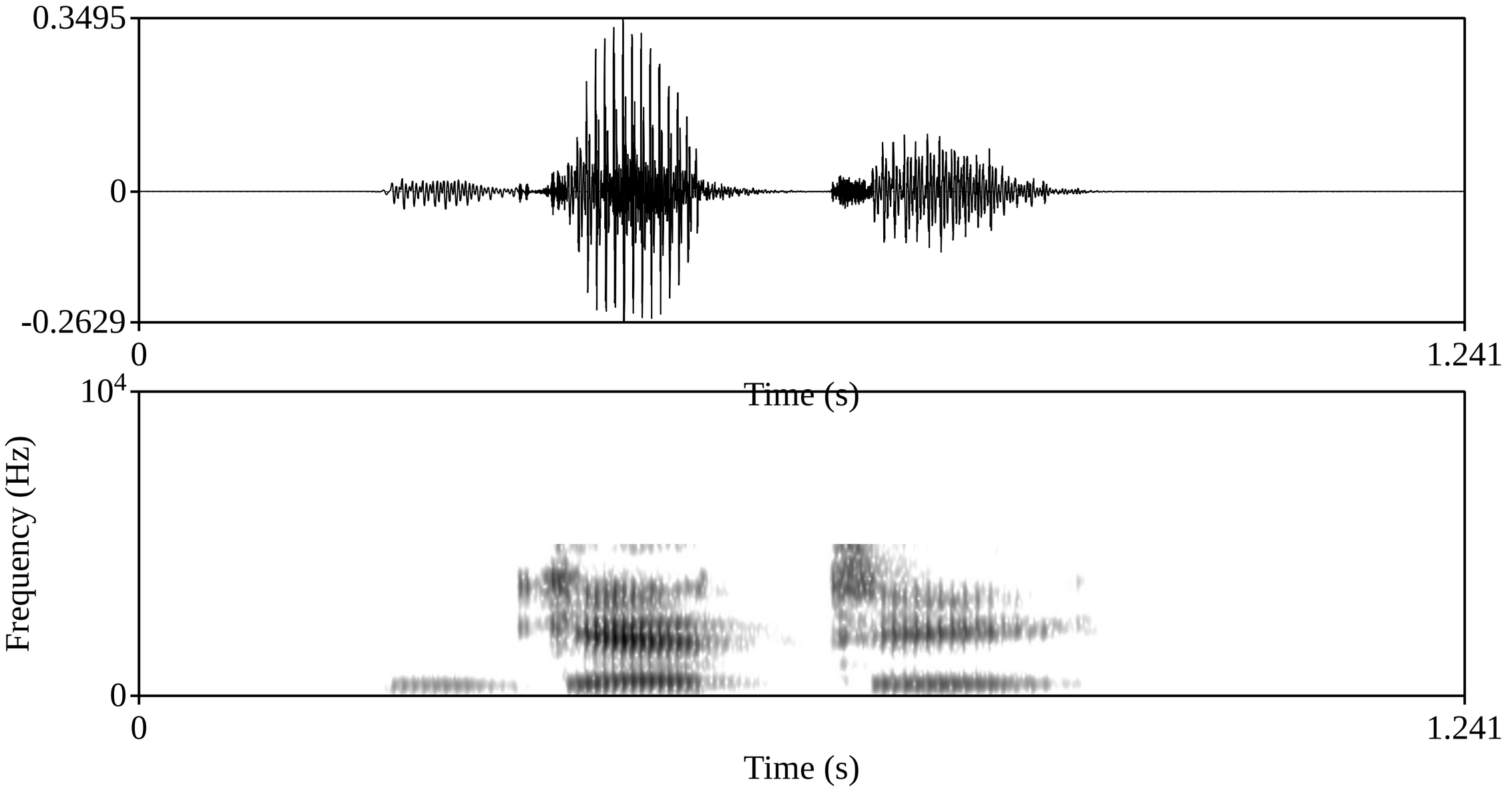


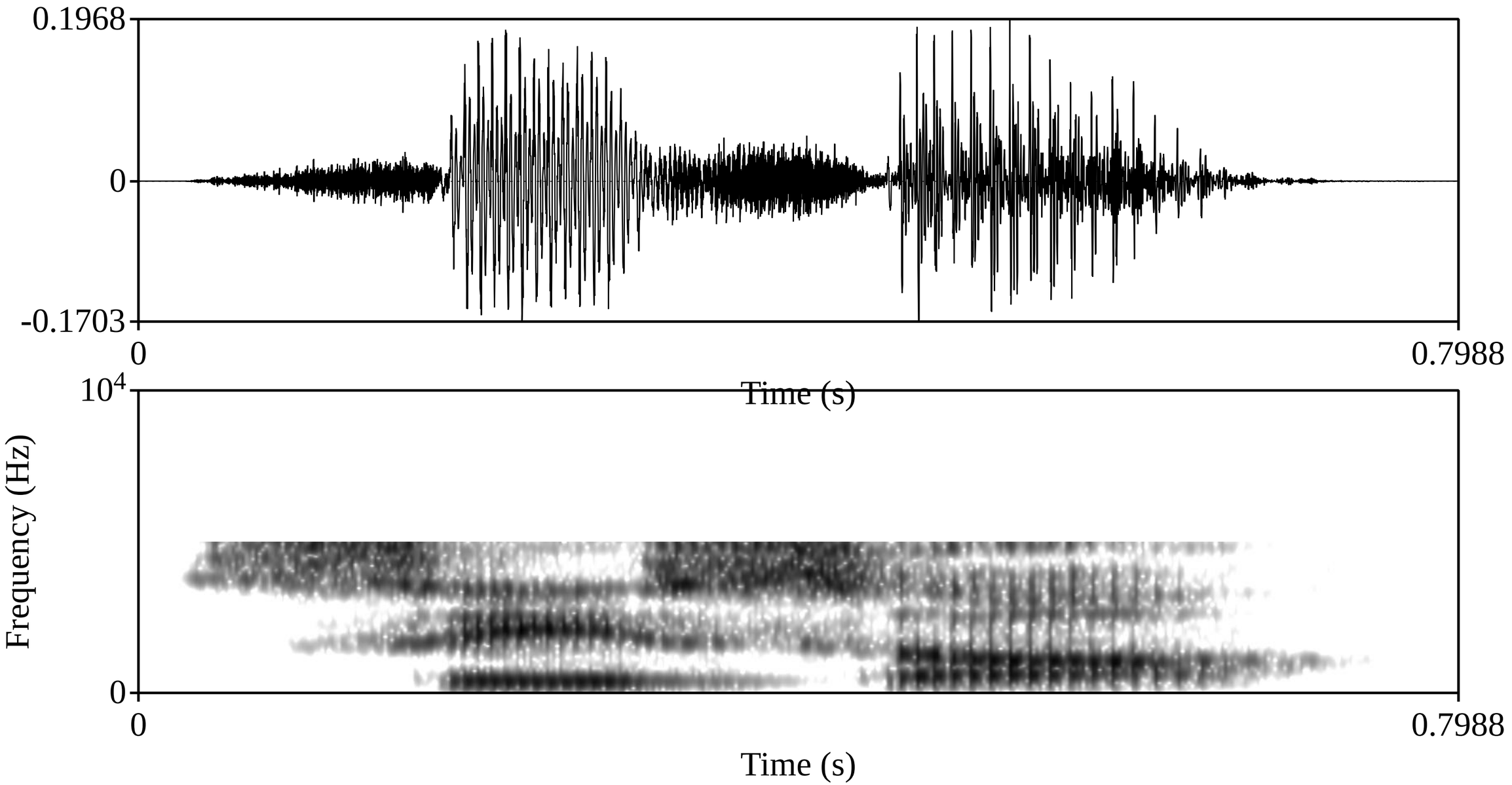
Acoustics of vowels | Vowel formants

	F1	F2		F1	F2
[i]	280	2250	[u]	310	870
[ɪ]	400	1920	[ʊ]	450	1030
[ɛ]	550	1770	[ɔ]	590	880
[æ]	690	1660	[ɑ]	710	1100


0.3015
0
-0.1622
0
0.7076
Time (s)
10^4
Frequency (Hz)
0
0
0.7076
Time (s)


0.1354
0
-0.1644
0
0.7532
Time (s)
10^4
Frequency (Hz)
0
0
0.7532
Time (s)


0.3495
0
-0.2629
0
1.241
Time (s)
10^4
Frequency (Hz)
0
0
1.241
Time (s)


0.1968
0
-0.1703
0
0.7988
Time (s)
10^4
Frequency (Hz)
0
0
0.7988
Time (s)