W2-1: English vowels and Praat

JAPN398D: The Sounds and Dialects of Japanese

9/6/2023

Today's class

- Diacritics
- Vowels
  - Tongue height
  - Tongue advancement
  - Lip rounding
  - (Tenseness)
- Sonority hierarchy
- Syllabic consonants
- Acoustic displays
  - Waveforms
  - Spectrograms
  - Pitch tracks
- Praat

Diacritics

- There are two kinds of transcription.
  - Broad transcription provides as few details as possible.
  - Narrow transcription provides as many details as possible.

- Example
  - The broad transcription of *peak* is /pik/.
  - The narrow transcription of *peak* is [p^{h}ik].

- In general, slashes // are used for broad transcription, while square brackets [] are used for narrow transcription.

Diacritics

- Diacritics are used for narrow transcription.

- Aspiration is a strong puff of air after the release of a closure.
  - The diacritic for aspiration is ^{h}.
  - A piece of paper in front of your mouth moves!

- In English, syllable-initial voiceless stops are aspirated.
  - e.g. *peak* [p^{h}ik] vs. *speak* [spik]

Diacritics

- The diacritic for voicelessness is ◌̥.
  - e.g. English (some speakers): *witch* [wɪtʃ] vs. *which* [ʍɪtʃ]

- Devoicing is a phonological process where a voiced sound becomes voiceless (e.g. /b, d, g/ > [p, t, k]).
  - Stops, fricatives, and affricates have symbols for voiced and voiceless sounds.
  - The other sounds, including vowels, do not have symbols for voiceless sounds.
  - We will discuss vowel devoicing in Japanese in this class.

Vowels

- 3 parameters for consonants
  - Voicing
  - Place of articulation
  - Manner of articulation

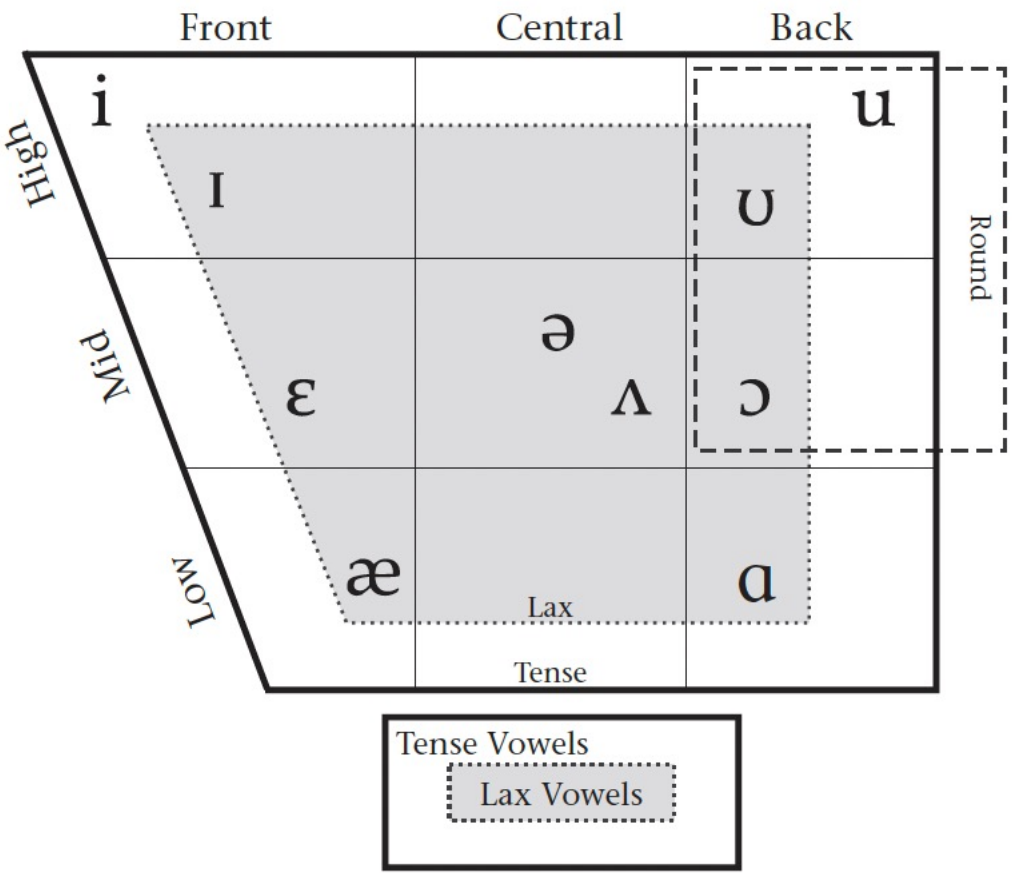
- Vowels are voiced by default.
  - The Voicing feature is not required!

- Vowels involve no constriction of the airstream.
  - Place of articulation and manner of articulation do not work!

Vowels

- Vowels have the following 3(+1) parameters.
  - Tongue height
  - Tongue advancement
  - Lip rounding
  - (Tenseness)

- American Newscaster English has 10 vowels (monophthongs).

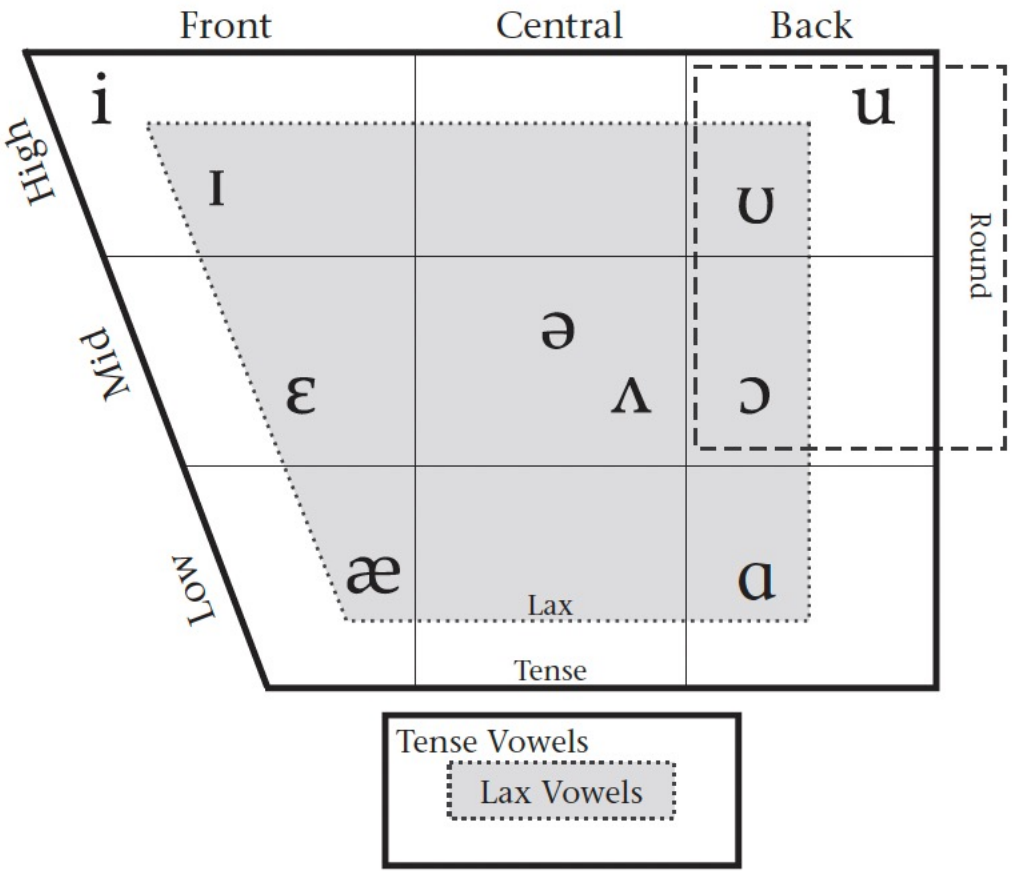


American Newscaster English vowels
Language Files, p. 59

Vowels

IPA	Articulatory description	Example
i	High front unrounded	beat
ɪ	(Semi-)high front unrounded	bit
ɛ	(Lower-)mid front unrounded	bet
æ	(Semi-)low front unrounded	bat
ɑ	Low back unrounded	box
ʌ	(Lower-)mid back unrounded	but
ɔ	(Lower-)mid back rounded	boss
ʊ	(Semi-)high back rounded	book
u	High back rounded	boot
ə	Mid central unrounded (Schwa: reduced vowel)	baton

Vance (2008): Table 1-1

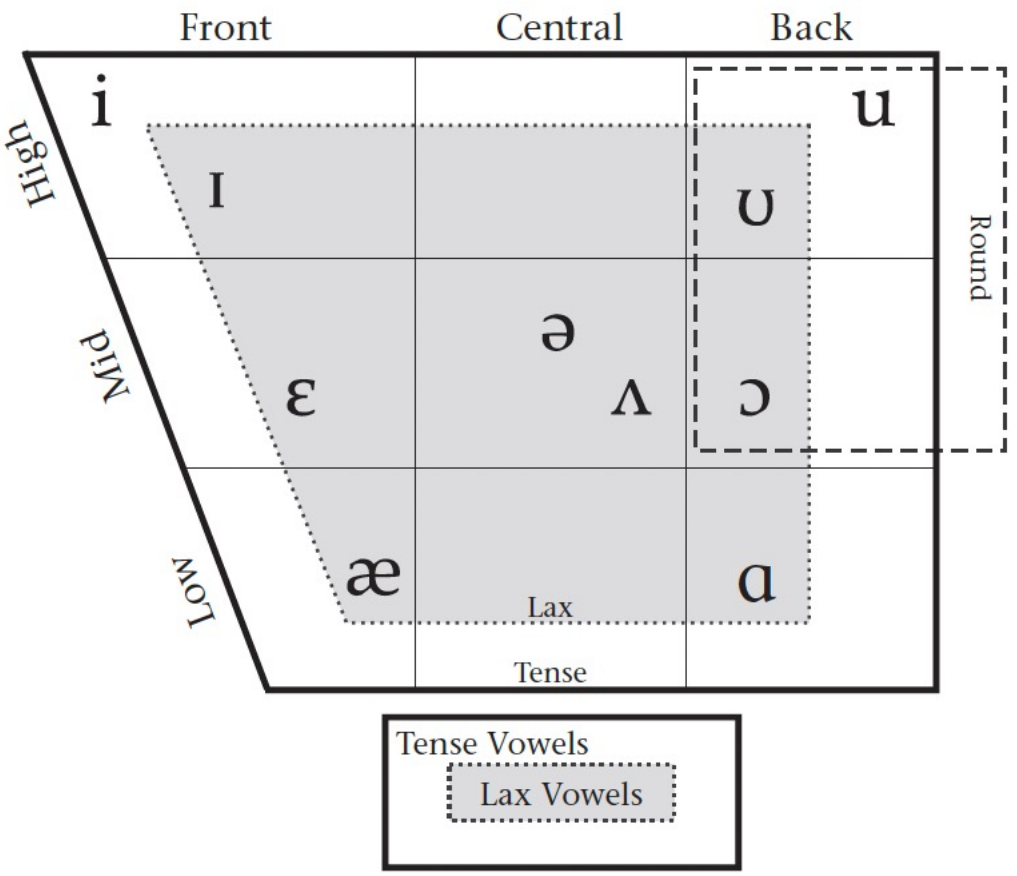


American Newscaster English vowels
Language Files, p. 59

Vowels

- Tongue height
  - The highest point of the tongue is close to the roof of the mouth in high vowels ←→ low vowels.

- High: i, u > ɪ, ʊ
- Mid: ə > ɛ, ʌ, ɔ
- Low: æ > ɑ

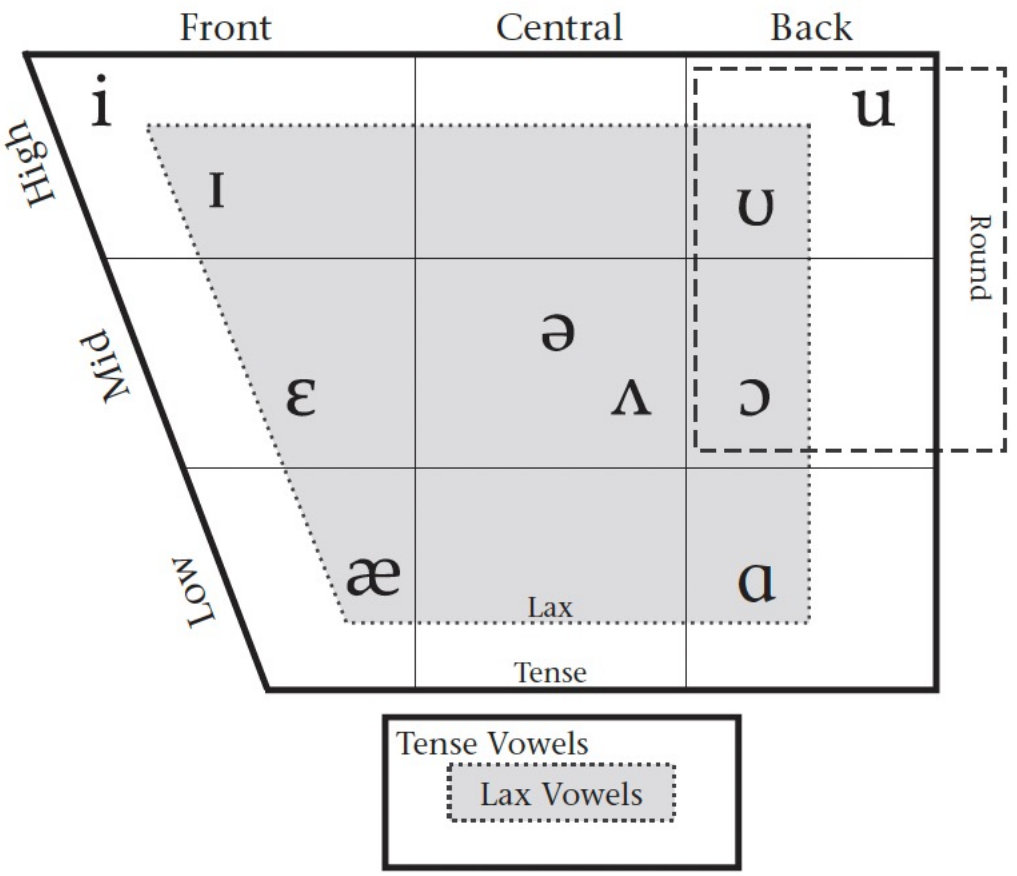


American Newscaster English vowels
Language Files, p. 59

Vowels

- Tongue advancement
  - The body of the tongue is advanced in front vowels ←→ back vowels.

- Front: i, ɪ, ɛ, æ
- Central: ə
- Back: u, ʊ, ɔ, ʌ, ɑ



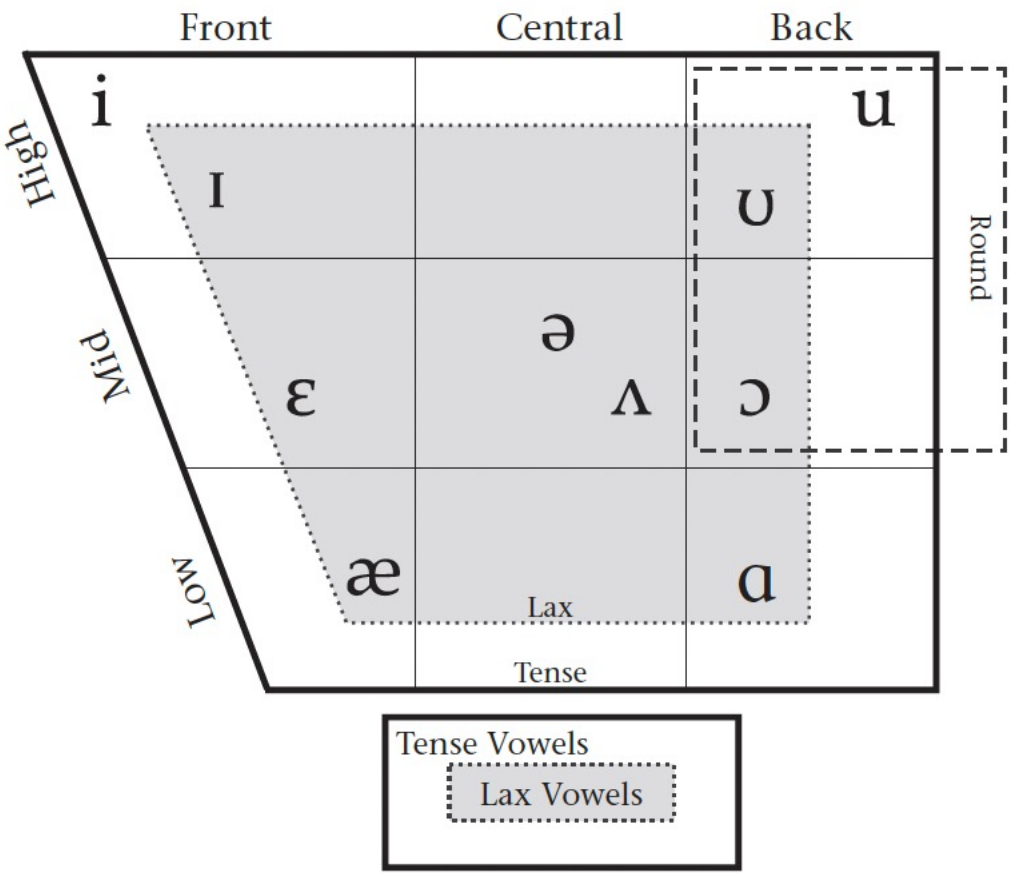
American Newscaster English vowels
Language Files, p. 59

Vowels

- Lip rounding

- Rounded: u, ʊ, ɔ
- Unrounded: i, ɪ, ɛ, æ, ɑ, ʌ, ə

- Non-low back vowels are rounded by default.



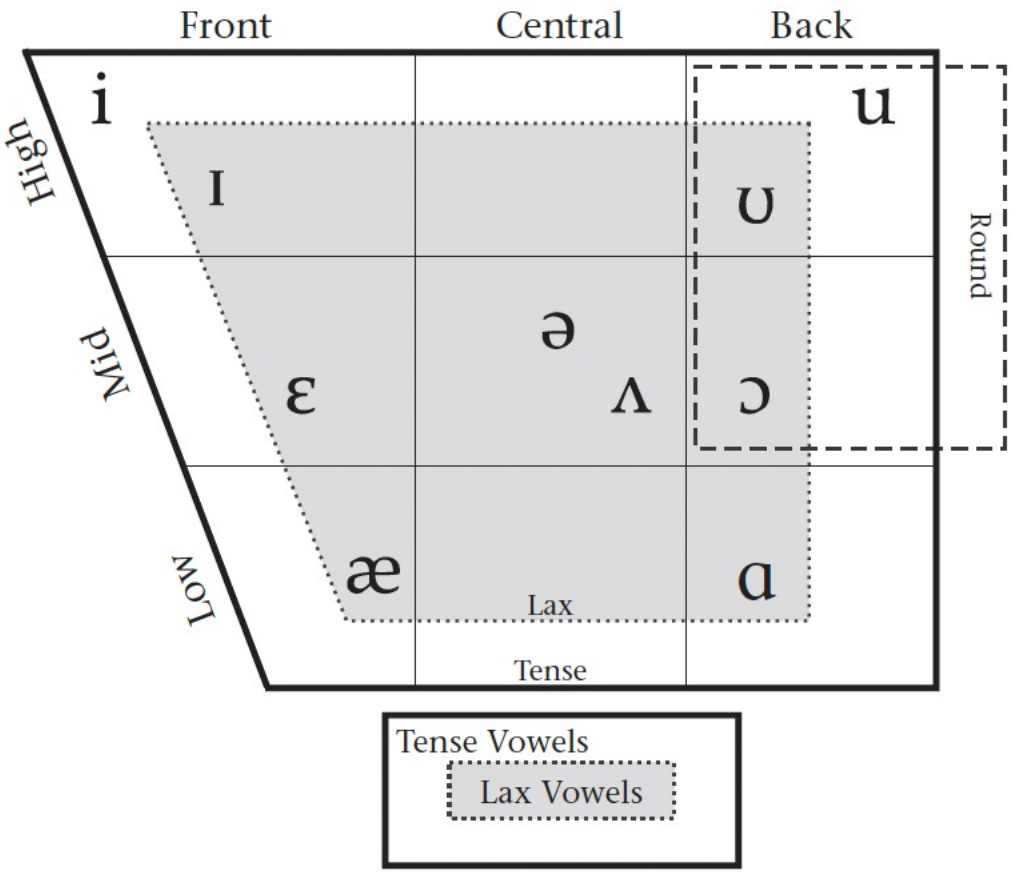
American Newscaster English vowels
Language Files, p. 59

Vowels

- Tenseness
  - Tense vowels can end a syllable, but lax vowels cannot.

- Tense vowels
  - /i/: *beat* /bit/, *he* /hi/
  - /u/: *boot* /but/, *who* /hu/

- Lax vowels
  - /ɪ/: bit /bɪt/
  - /ʊ/: book /bʊk/



American Newscaster English vowels
Language Files, p. 59

Vowels

- Two facts are relevant to Japanese phonology.

1. /i/ and /u/ are high vowels.
2. Non-low back vowels (e.g. /u/) are rounded by default.

Vowels

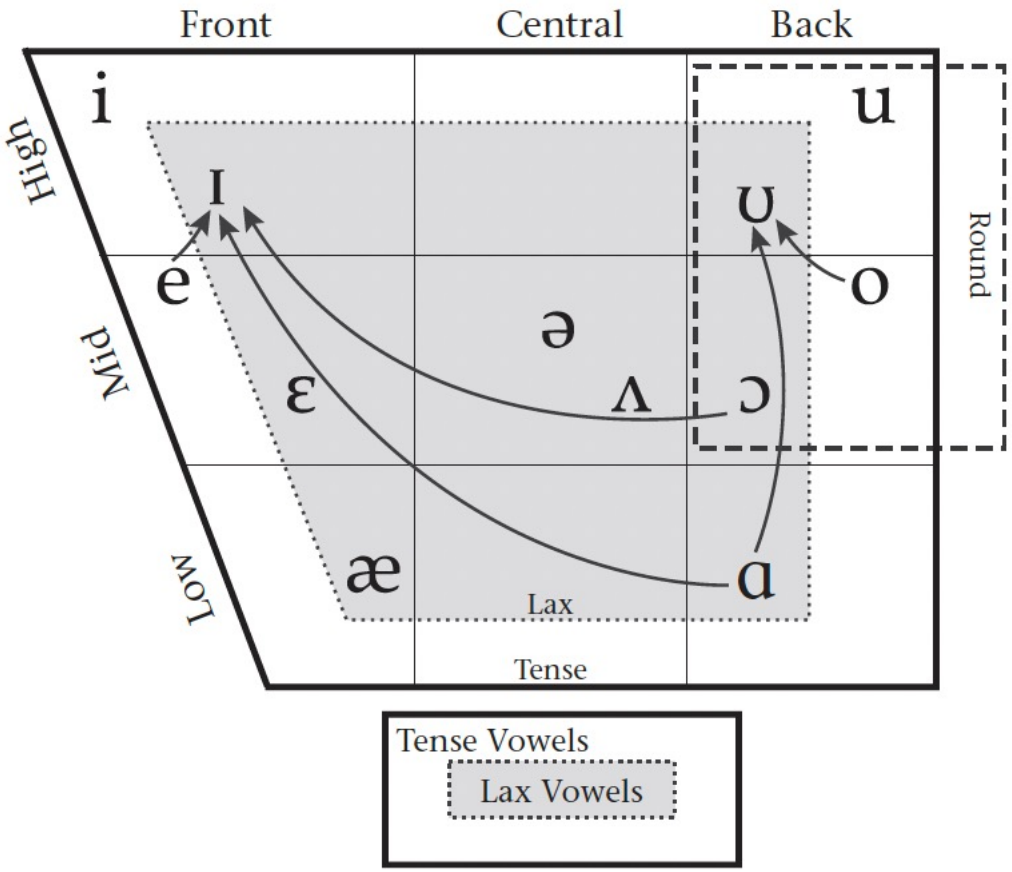
- So far, we have seen 10 monophthongs (simple vowels) in American English.

- American English also has 5 diphthongs (complex vowels).
  - There is a transition from one vowel to another vowel.
  - Each diphthong is a one sound.

Vowels

IPA	Articulatory description	Example
eɪ	(Higher-)mid front unrounded	say
	(Semi-)high front unrounded	
ɑɪ	Low back unrounded	hi
	(Semi-)high front unrounded	
ɔɪ	(Higher-)mid back rounded	soy
	(Semi-)high front unrounded	
oʊ	(Higher-)mid back rounded	so
	(Semi-)high back rounded	
ɑʊ	Low back unrounded	how
	(Semi-)high back rounded	

Vance (2008): Table 1-2
Note: There are some minor changes from Vance's descriptions.



American Newscaster English vowels
Language Files, p. 62

Sonority hierarchy

- Sonority hierarchy is a ranking according to sonority.

- The more sonorous a sound is, the more audible and louder it is.

- Sonorants
- Obstruents (including affricates)

1. Vowels (Most sonorous)
2. Glides
3. Liquids
4. Nasals
5. Voiced fricatives
6. Voiceless fricatives
7. Voiced stops
8. Voiceless stops (Lease sonorous)

(cf. Clements 1990)

Syllabic consonants

- Sonorant consonants (liquids and nasals) can act like vowels in syllables in English.
  - ˌ is the diacritic for syllabicity.

- /l/ in English → e.g. *castle* /kæ.səl/ or [kæ.sl̩]
- /ɹ/ in English → e.g. *herd* /həɹd/ or [hɹ̩d]

- /m/ in English → e.g. *rhythm* /ɹɪ.ðəm/ or [ɹɪ.ðm̩]
- /n/ in English → e.g. *fasten* /fæ.sən/ or [fæ.sn̩]

Acoustic displays

- Waveforms
- Spectrograms
- Pitch tracks

- Praat (Software)

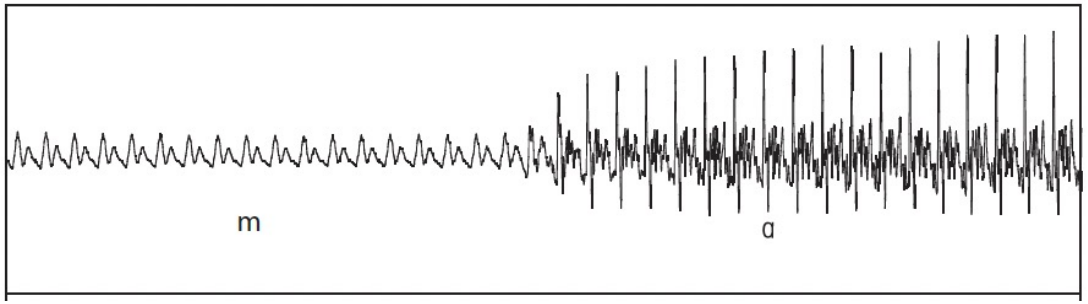
Waveforms

- Waveforms show amplitude (= loudness, sonority) over time.

- Waveforms include information about manner of articulation (and voicing).
  - Information about place of articulation is not included.

Waveforms

- Vowels have the highest relative amplitude and periodic waves.
- Sonorant consonants are similar to vowels, but the amplitude is lower.

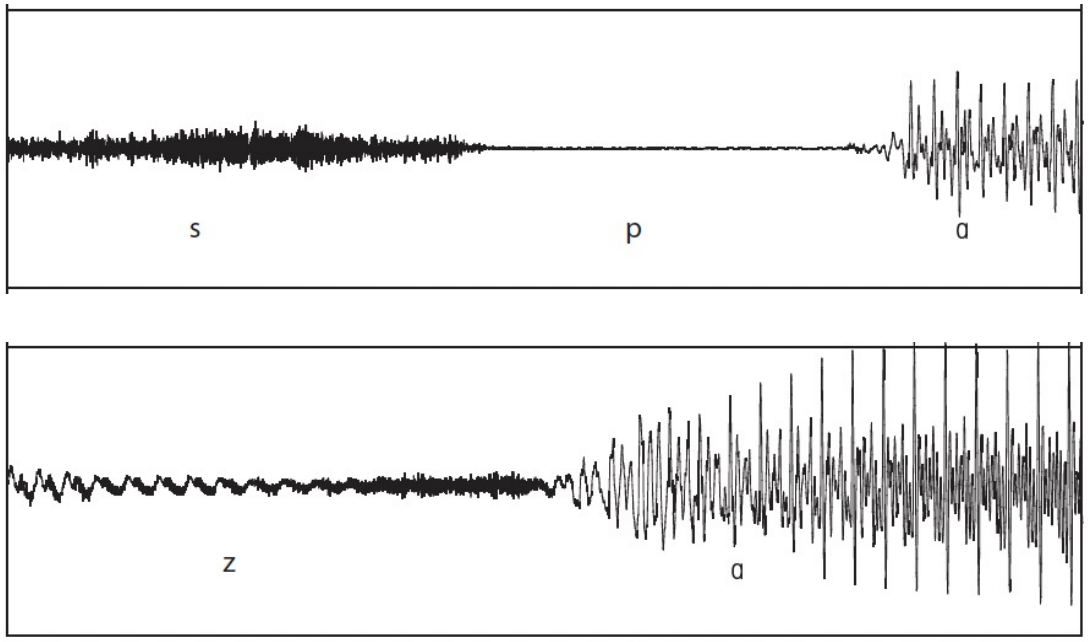


Zsiga (2013): Figure 7.8

Waveforms

- Voiceless fricatives have an aperiodic pattern (= random noise).

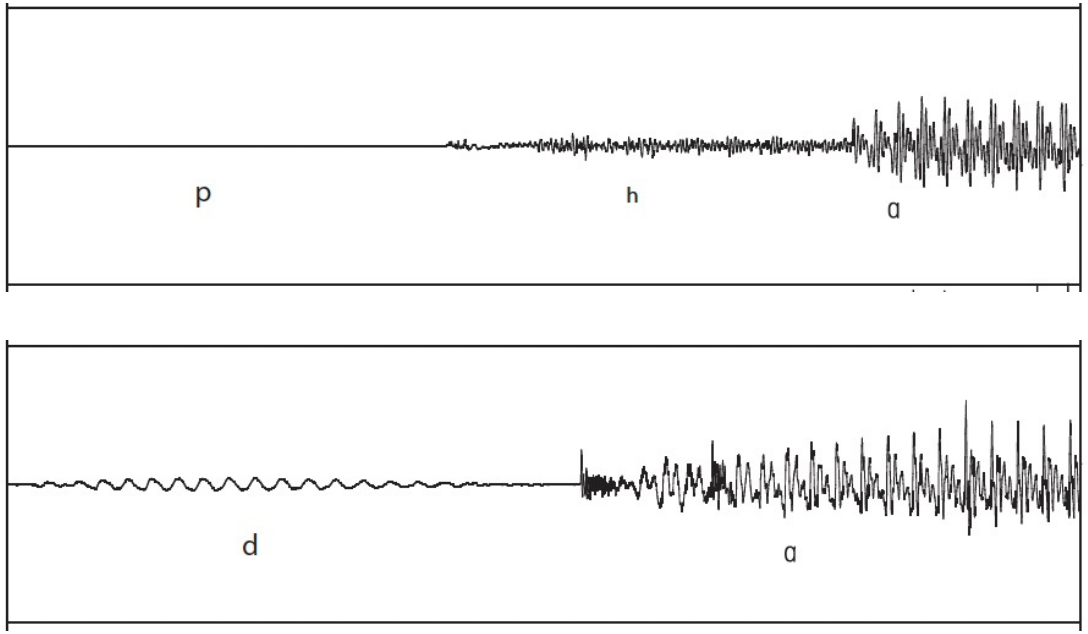
- Voiced fricatives have both periodic and aperiodic patterns.



Zsiga (2013): Figure 7.8

Waveforms

- Voiceless stops have zero amplitude, usually followed by aspiration.
- Voiced stops have periodic waves, but the amplitude is very low.



Zsiga (2013): Figure 7.8

Spectrograms

- Spectrograms are three-dimensional displays of speech sounds.
  - Vertical axis: Frequency (Hz)
  - Horizontal axis: Time
  - Degree of darkness: Amplitude

- Identifying sounds in spectrograms
  - https://home.cc.umanitoba.ca/~krussll/phonetics/acoustic/spectrogram-sounds.html

Spectrograms

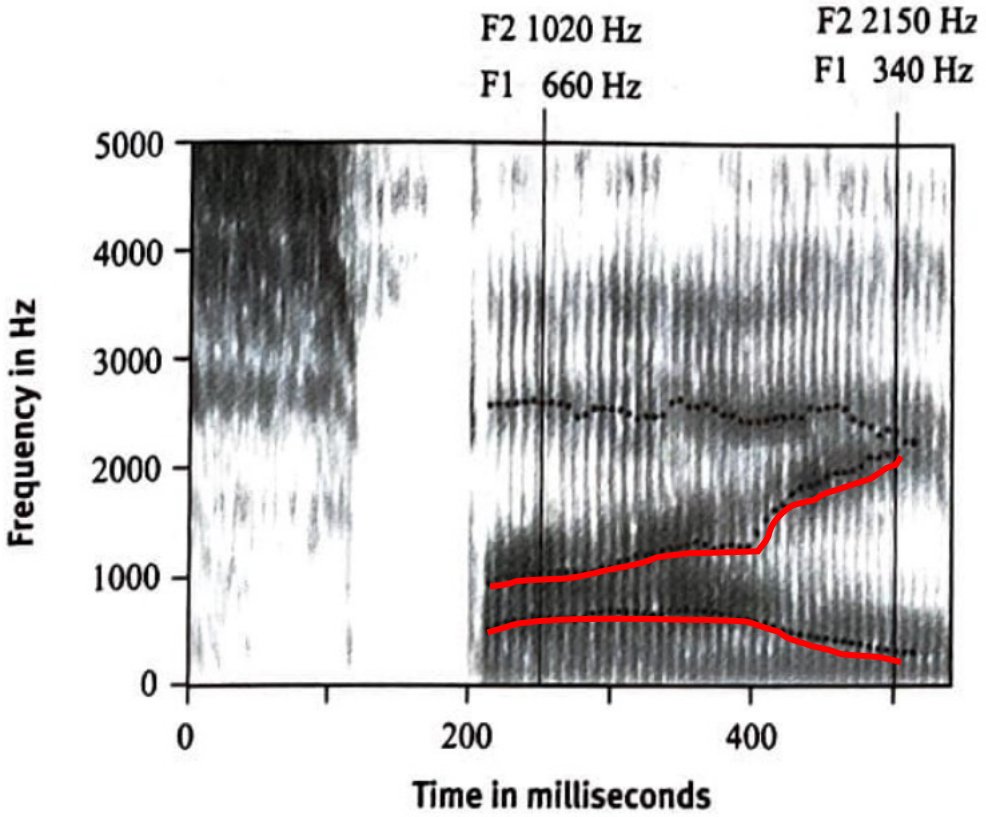
- Fundamental frequency (called F0; *Language Files*, p. 698)
  - The rate at which the vocal folds vibrate during voicing.
  - The frequency of repetition of a periodic wave.
  - Closely related to pitch.

- Formant (*Language Files*, p. 697)
  - Resonant frequency that amplifies some groups of harmonics above others; appears as a dark band on a spectrogram.

Spectrograms

- First formant (F1)
  - Inversely correlated with the tongue height of a vowel.
  - High F1 → Low vowels
  - Low F1 → High vowels
- Second formant (F2)
  - Correlated with the tongue advancement of a vowel.
  - High F2 → Front vowels
  - Low F2 → Back vowels

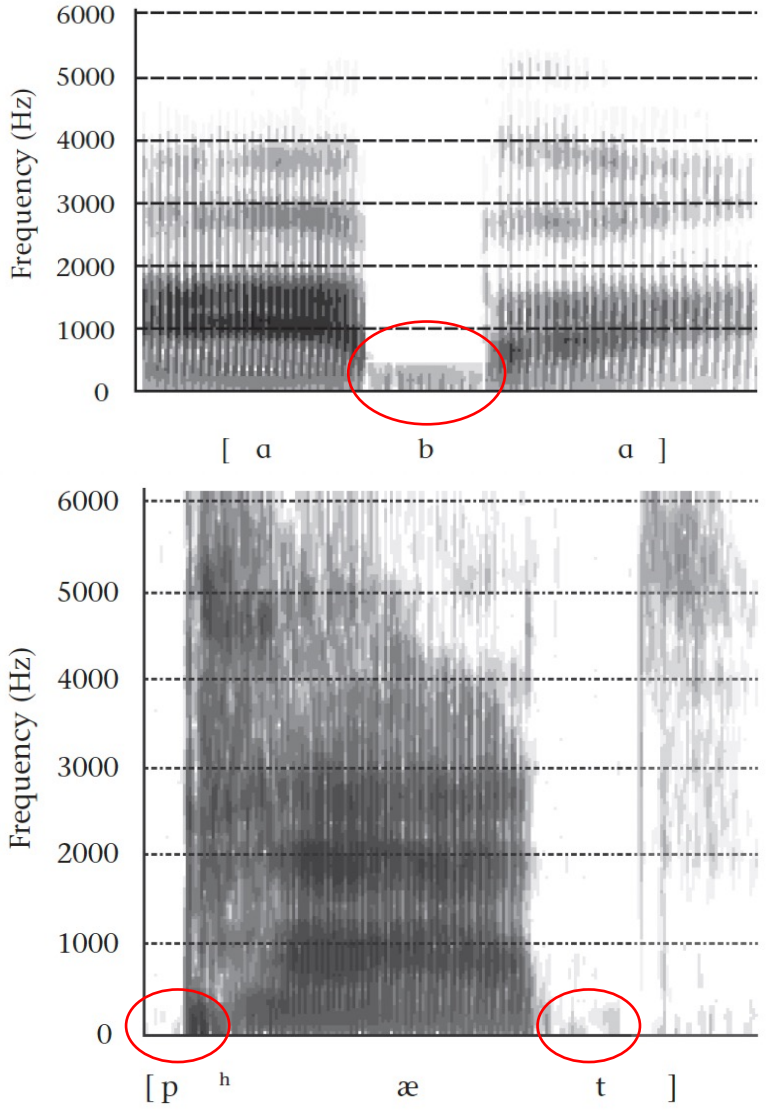
ɑ: Low back rounded
ɪ: (Semi-)high front unrounded



Vance (2008): Figure 1-15

Spectrograms

- A dark bar at the bottom of a spectrogram tells us that the sound is voiced.
- This dark bar is called a voice bar.

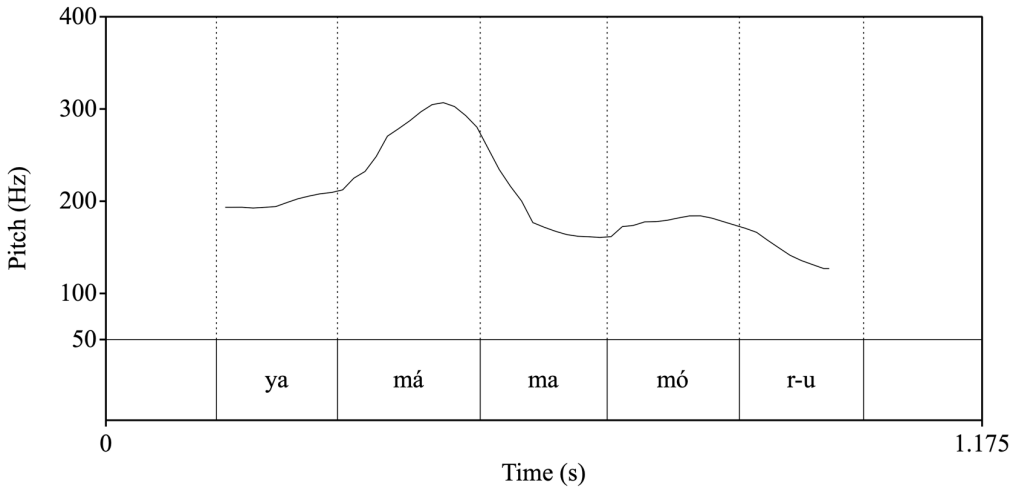


Language Files, p. 82

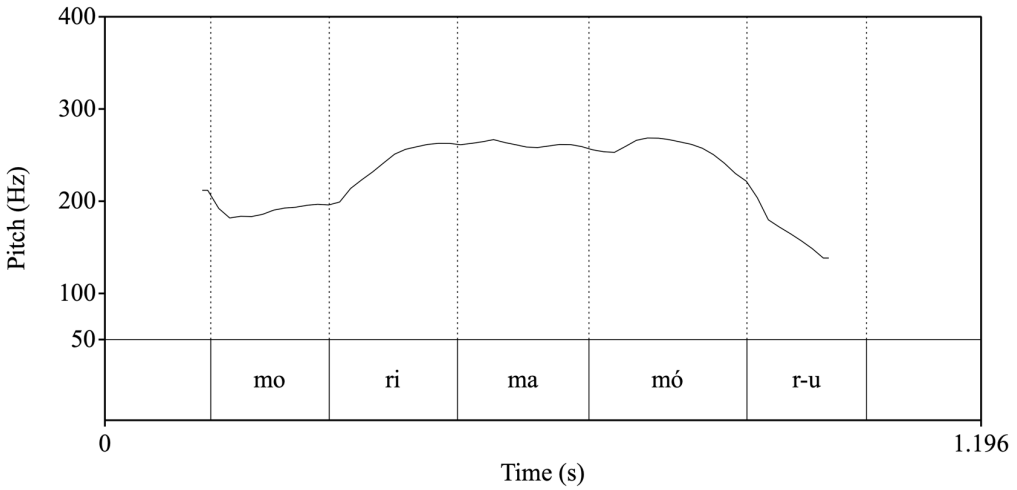
Pitch tracks

- Pitch tracks show fundamental frequency (F0; ≈ pitch) over time.
- Pitch tracks are useful for research on pitch accent.
- You must use voiced sounds for pitch tracks because voiceless sounds do not have F0.
  - The more sonorant, the better.
  - Sonorant consonants are better than voiced obstruents.

Pitch tracks



山守る by a female Tokyo speaker



森守る by a female Tokyo speaker

Praat

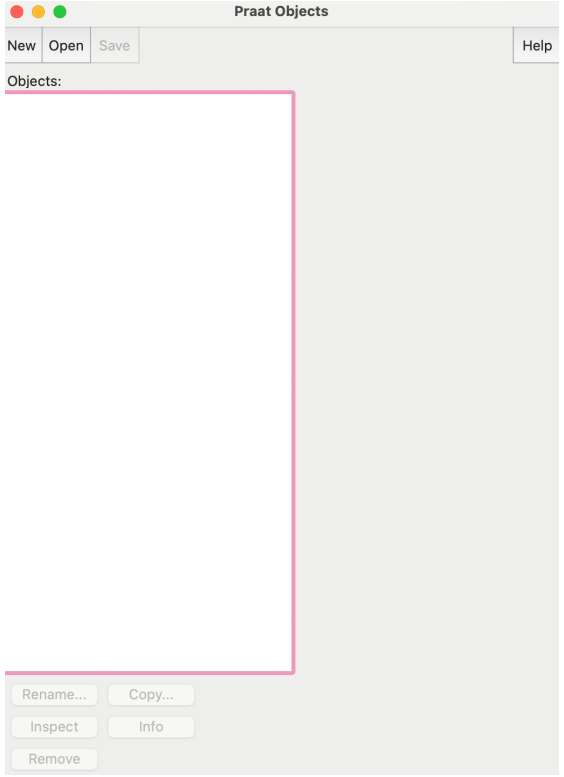
- Praat (https://www.fon.hum.uva.nl/praat/) is a free software for acoustic speech analysis.

- Praat was developed by Paul Boersma and David Weenink of the University of Amsterdam.
  - *Praat* means *talk* in Dutch.

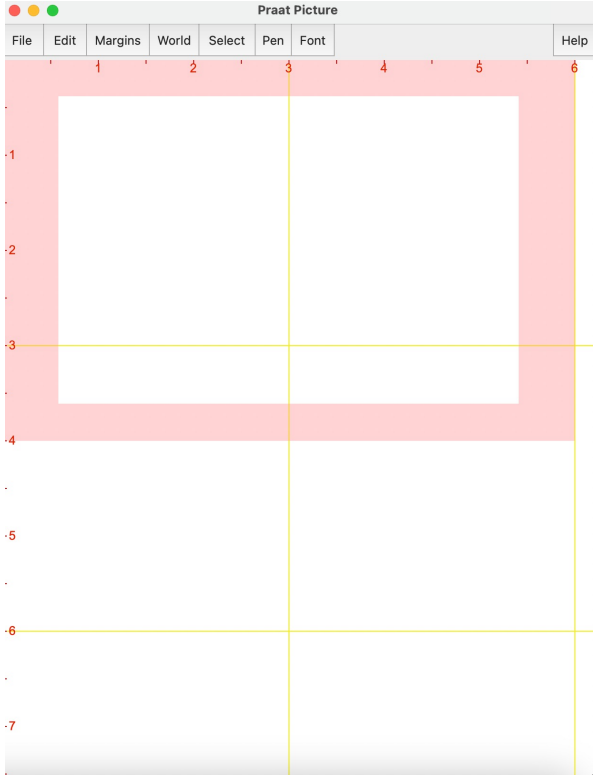
- We can make waveforms, spectrograms, and pitch tracks with Praat.

Praat

Praat Objects



Praat Picture



Praat

- Make waveforms, spectrograms, pitch tracks.

- Practice Tokyo pitch accent.
  - あめ → HL ‘rain (雨)’ vs. LH ‘candy (飴)’
  - はしは → HLL ‘chopsticks=TOP (箸は)’ vs. LHL ‘bridge=TOP (橋は) vs. LHH edge=TOP (端は)’

References

- Boersma, Paul. 2001. Praat, a system for doing phonetics by computer. *Glot International* 5:9/10, 341-345.
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