

Stony Brook School Linguistics Minicourse

Vowels and Formants

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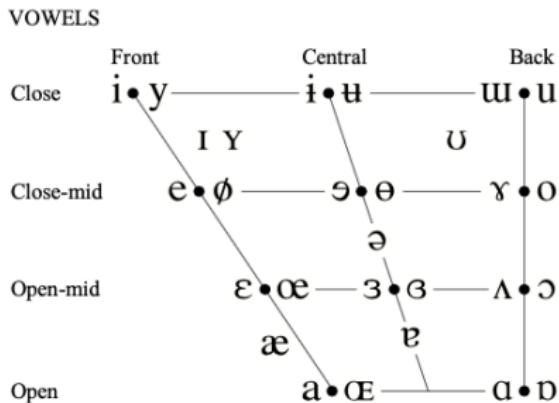
Stony Brook University

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Vowels

- This morning you learned about vowel phonemes in English.
- Some languages use different vowels not found in English.
- The International Phonetic Association's official vowel chart lists all possible contrastive vowels found in the world's languages.



Where symbols appear in pairs, the one to the right represents a rounded vowel.

Vowel Features

We can use certain descriptive features to differentiate the vowels

- Height - roughly how high in the mouth the tongue is
- Front-Backness - roughly how front or back in the mouth the tongue is
- Rounding - whether or not your lips are rounded
- Tense/Lax - ambiguous label but may refer to your tongue root advancing or retracting

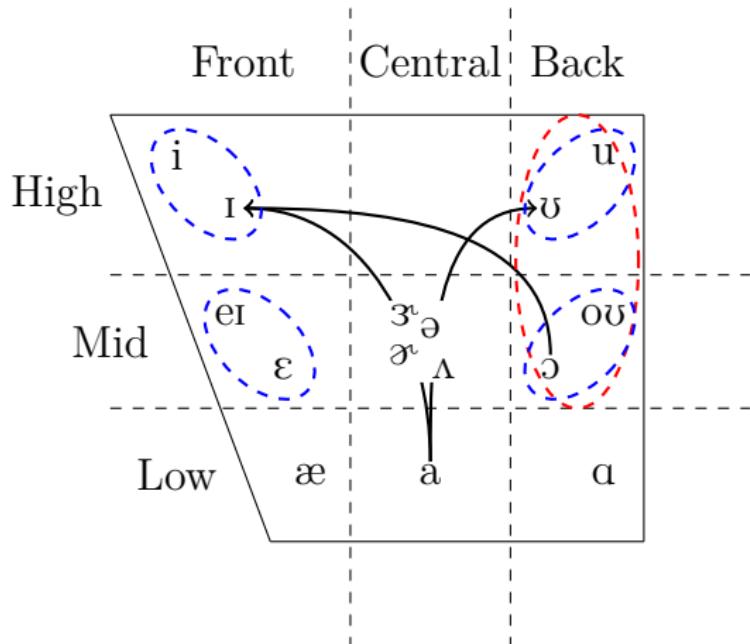
Other Characteristics

Vowels can also be nasalized, r-colored, stressed, and very rarely voiceless.

English Vowels

Vowel	High	Low	Front	Back	Round	Tense	Nasal	R-colored
[i]	+	-	+	-	-	+	-	NA
[ɪ]	+	-	+	-	-	-	-	NA
[eɪ]	-	-	+	-	-	+	-	NA
[ɛ]	-	-	+	-	-	-	-	NA
[æ]	-	+	+	-	-	NA	-	NA
[u]	+	-	-	+	+	+	-	NA
[ʊ]	+	-	-	+	+	-	-	NA
[oʊ]	-	-	-	+	+	+	-	NA
[ɔ]	-	-	-	+	+	-	-	NA
[ɑ]	-	+	-	+	-	NA	-	NA
[ʌ]	-	-	-	-	-	NA	-	NA
[ə]	-	-	-	-	-	NA	-	+

English Vowels

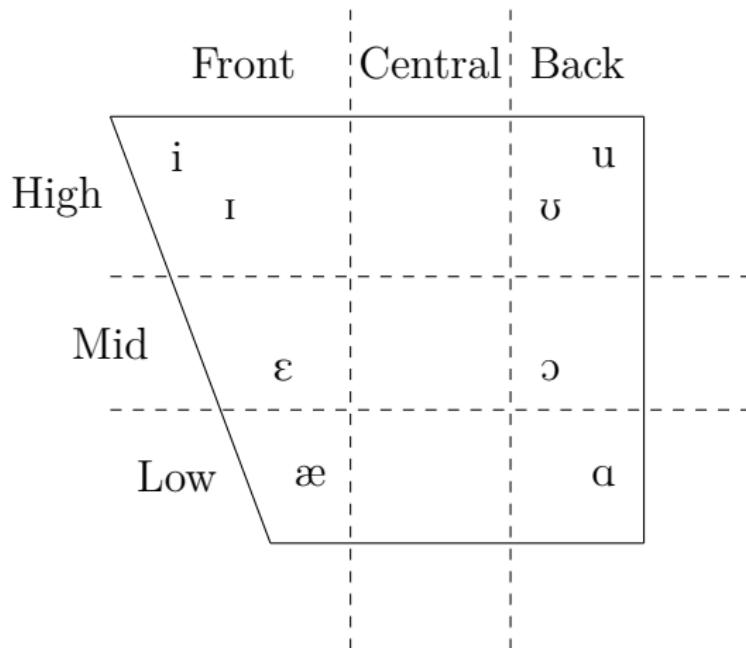


Key:

Arrows = major diphthongs;
Blue circles = tense/lax pairs;
Red circle = rounded vowels

English Vowels

We will focus on these 8 vowels and how to measure their height and front-back differences in the acoustic signal.



Acoustic Phonetics

- The IPA vowel chart is organized based on **acoustics**.
- Vowel height is based on the value of the **first formant**.
- Vowel front-backness is based on the value of the **second formant**.

Formants

Formants are natural resonances within the vocal tract.

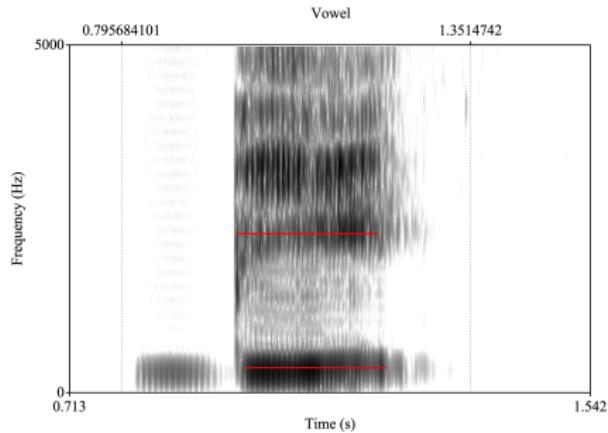
- These are concentrations of energy around certain frequencies.
- They show up as dark bands on a spectrogram.
- We can predict where they should occur using the **source-filter theory** and **tube models** of the vocal tract.
 - ▶ Certain frequencies resonate (what we are calling formants) depending on the length of the tubes and whether not they are open or closed at either end.
 - ▶ Low vowels can be modeled as two tubes that are closed on one end and open on the other.
 - ▶ Non-low vowels can be modeled as two tubes: a back tube closed at both ends and a front tube open at one end.
- Watch linked video.

Vowel Acoustics

- Vowel height decreases as F1 increases.
- Vowel frontness increases as F2 increases.
- Formants are measured in Hertz (Hz).

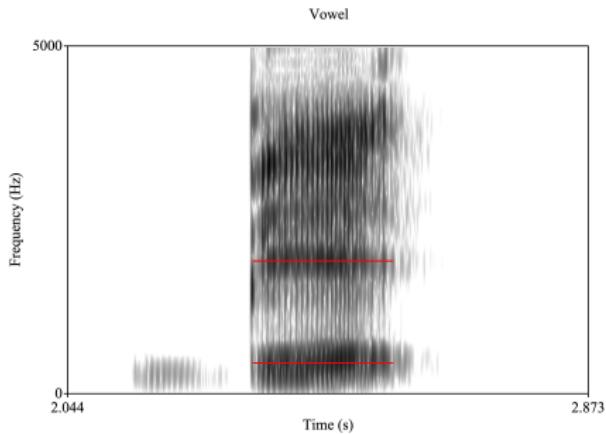
Formants: [i]

- Spectrogram of “beat”
- Transcription: [bit]
- F1: 279 Hz
- F2: 2319 Hz



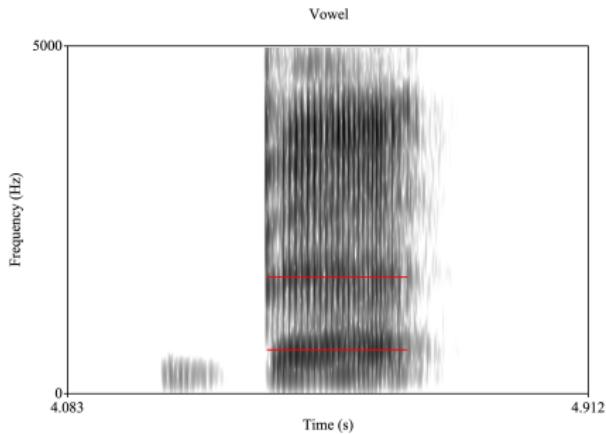
Formants: [ɪ]

- Spectrogram of “bit”
- Transcription: [bit]
- F1: 410 Hz
- F2: 1874 Hz



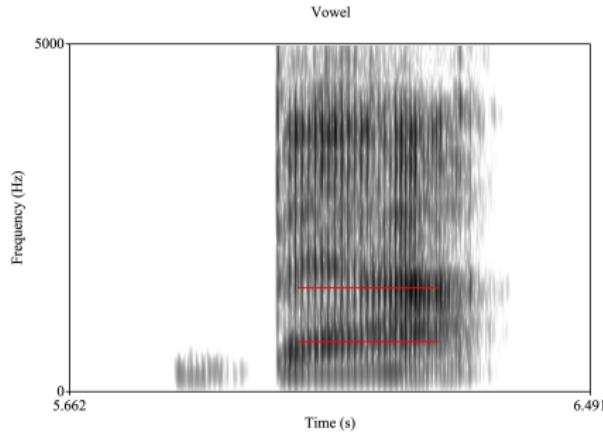
Formants: [ɛ]

- Spectrogram of “bet”
- Transcription: [bɛt]
- F1: 592 Hz
- F2: 1587 Hz



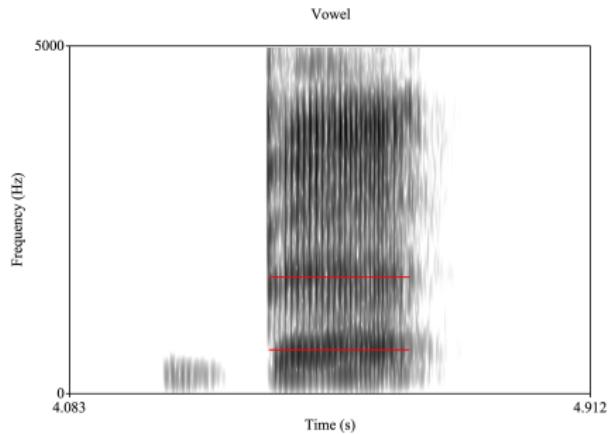
Formants: [æ]

- Spectrogram of “bat”
- Transcription: [bæt]
- F1: 698 Hz
- F2: 1456 Hz



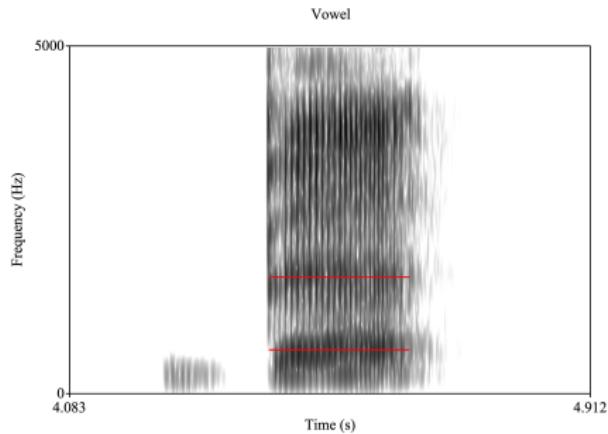
Formants: [u]

- Spectrogram of “boot”
- Transcription: [but]
- F1: 279 Hz
- F2: 959 Hz



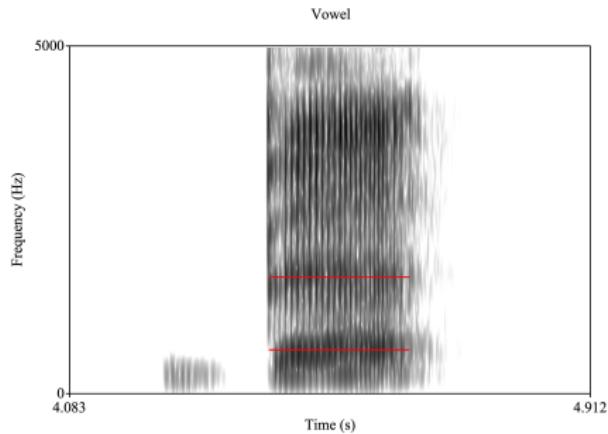
Formants: [ʊ]

- Spectrogram of “put”
- Transcription: [put]
- F1: 462 Hz
- F2: 1168 Hz



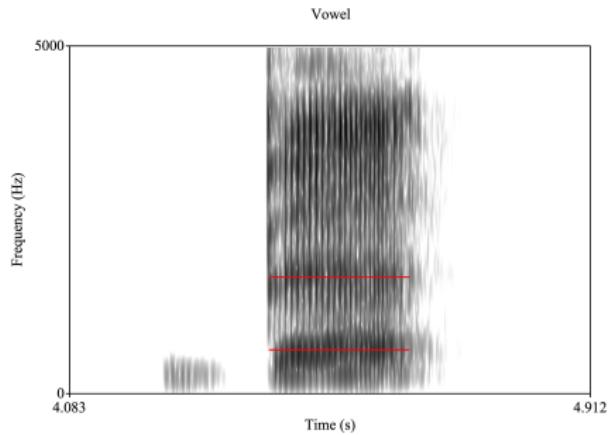
Formants: [ɔ]

- Spectrogram of “bought”
- Transcription: [bɔt]
- F1: 697 Hz
- F2: 1011 Hz



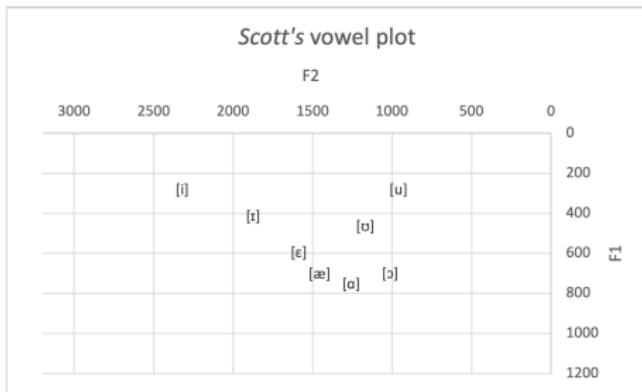
Formants: [a]

- Spectrogram of “bot”
- Transcription: [bat]
- F1: 750 Hz
- F2: 1257 Hz



Plotting Formants

- If we make a scatter plot from the formant values we get a personalized vowel chart!



- Notice there are subtle differences in the location of vowels within the space.
 - ▶ This is due to personal dialect/pronunciation.

Conclusion

- We can differentiate vowels based on their acoustic properties (formants)
- Measuring vowels this way also allows linguists to study language variation:
 - ▶ Between-language variation: difference between one language and another.
 - ▶ Within-language variation: difference between one speaker and another speaker of the same language.
- There are other acoustic measurements that are useful.
 - ▶ E.g. - pitch, which you will learn about in the next lesson.
- To end today, you will use Praat to measure your vowel space.