Introduction to Linguistic Phonetics

Acoustics of Vocoids

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Reflections

Reflection

- Spend ∼3 minutes reviewing your notes from last lecture, homeworks, exit tickets, etc.
- Look for questions you have or clarifications you would like.

Recap from last time

- The glottis produces sound (the source and correlated with *f0*) which resonates in the vocal tract (the filter)
- Changing the position of the articulators changes the resonances by making constrictions at nodes and anti-nodes (perturbation)
- We can see resonances on a spectrum as peaks of high energy in harmonics, and on a spectrogram as dark horizontal bands
- These areas of resonance are called formants

Size matters

Vowels

- Vowels have relatively wide open vocal tract
- This means they are relatively loud and have clear, easy to identify resonances
- The vocal folds provide the source of sound / energy
- The position of the tongue determines the resonances, along with the lips

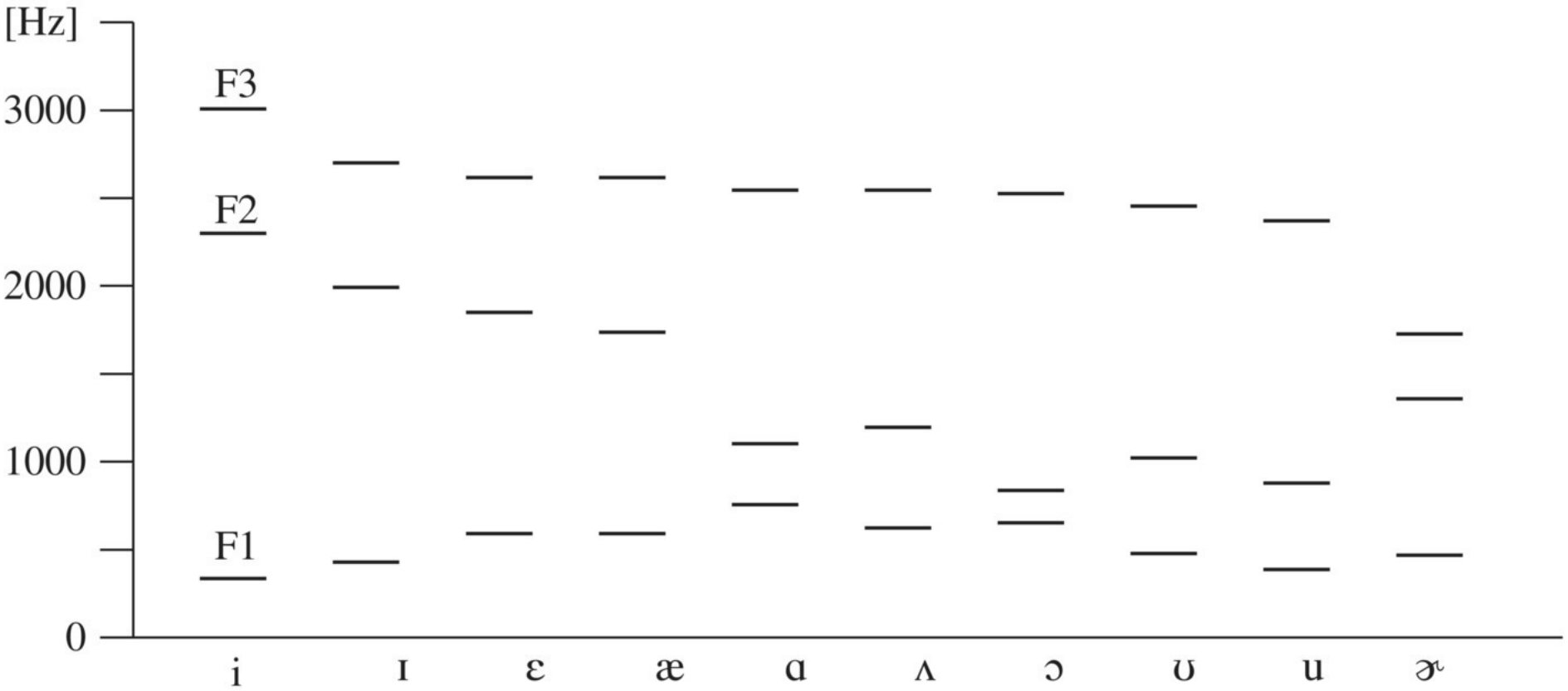
Some things to remember

- The longer the tube, the lower the resonances
- A constriction at a pressure node (particle movement antinode) lowers resonances
- A constriction at a pressure anti-node (particle movement node) raises resonances
- There are multiple resonances for any given configuration of the vocal tract
  - (i.e., there are theoretically an infinite number of formants)
- The vocal folds provide energy at a range of frequencies to resonate in the vocal tract

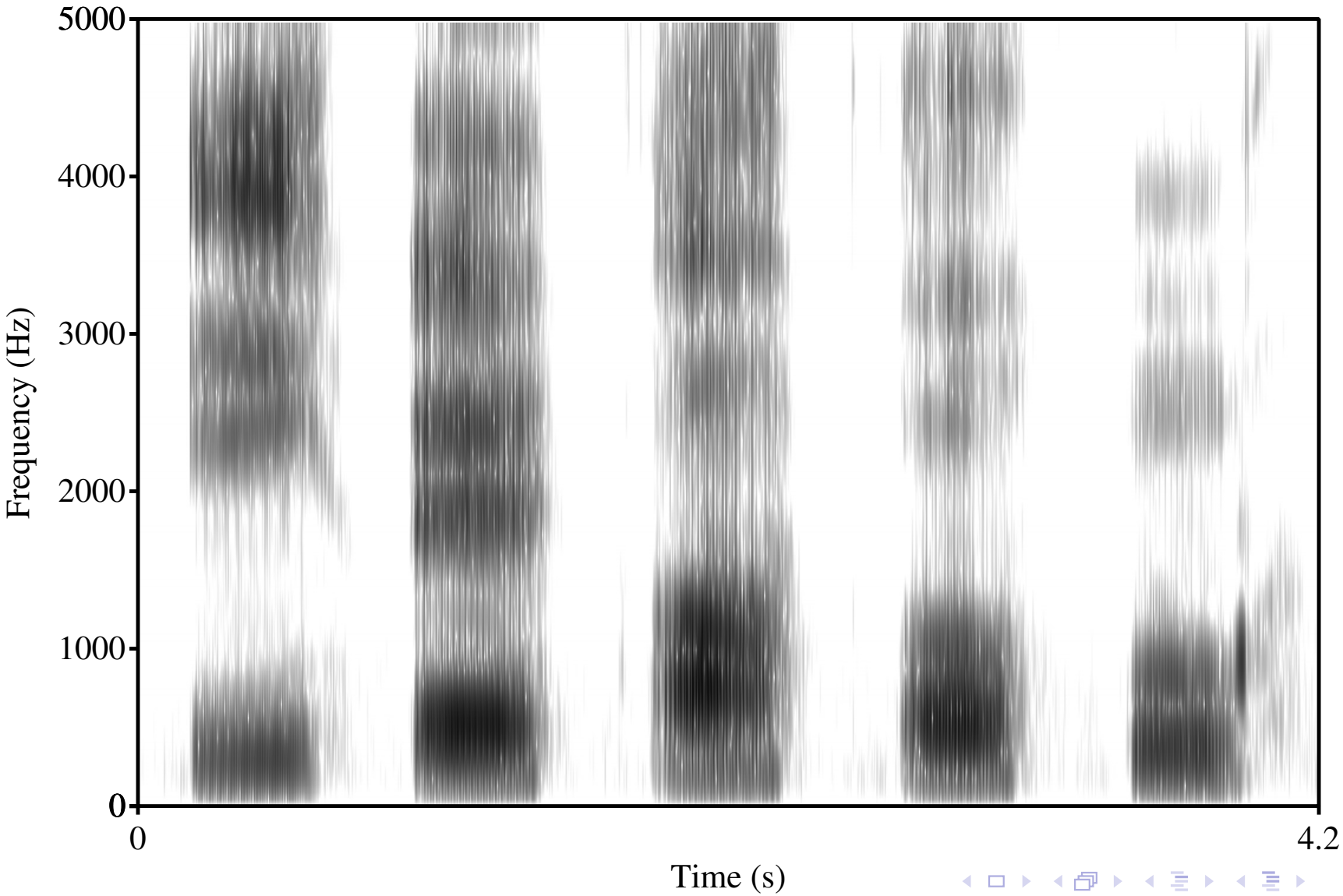
Formants

- Formants are what we call the vocal tract resonances
- We see them as peaks in a spectrum and dark horizontal bands in a spectrogram
- We primarily rely on the first three vocal tract resonances to define different vowels (with the first two being the most crucial)

Formants



Formants



First Formant (F1)

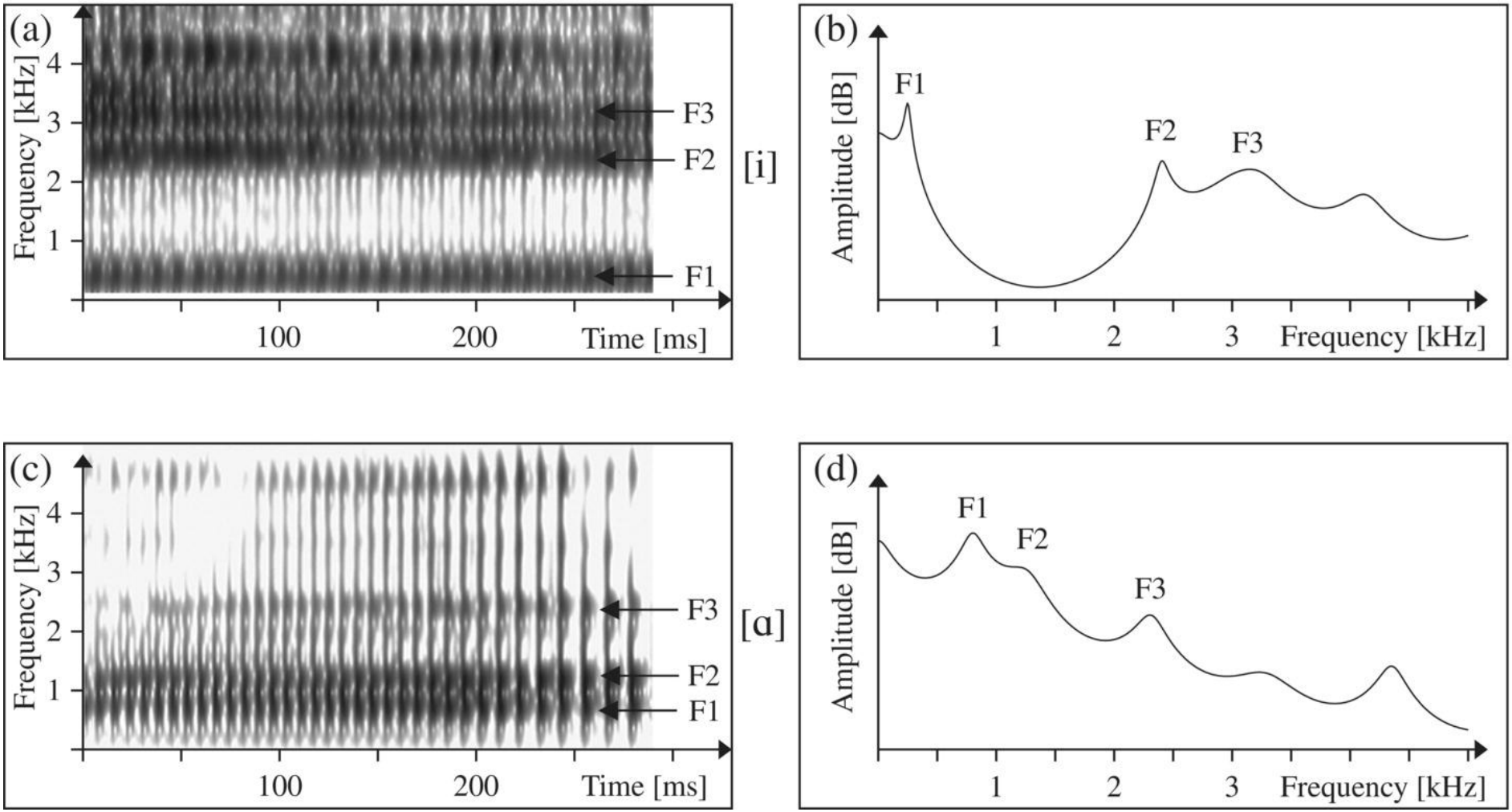
- In adults, it varies from about 200Hz to 800Hz
- Opening the lips and lowering the jaw / tongue will raise it
- Essentially, vowel "height" is inversely related to the first formant (F1)
- Example: /i/ has a lower F1 than /a/

Second Formant (F2)

- The second formant ranges from 700 Hz to 2400Hz in adults
- It can be raised by moving the tongue forward
- Thus, it generally correlates with backness
  - The "fronter" the vowel, the higher the F2
  - So /i/ has a higher F2 than /u/
- For the high vowels, F2 generally derives from the front cavity resonances
  - Note that rounding will lower the front cavity resonance by both lengthening the vocal tract ahead of the constriction and forming a helmholtz resonator[1]

[1] A closed off chamber that can resonant

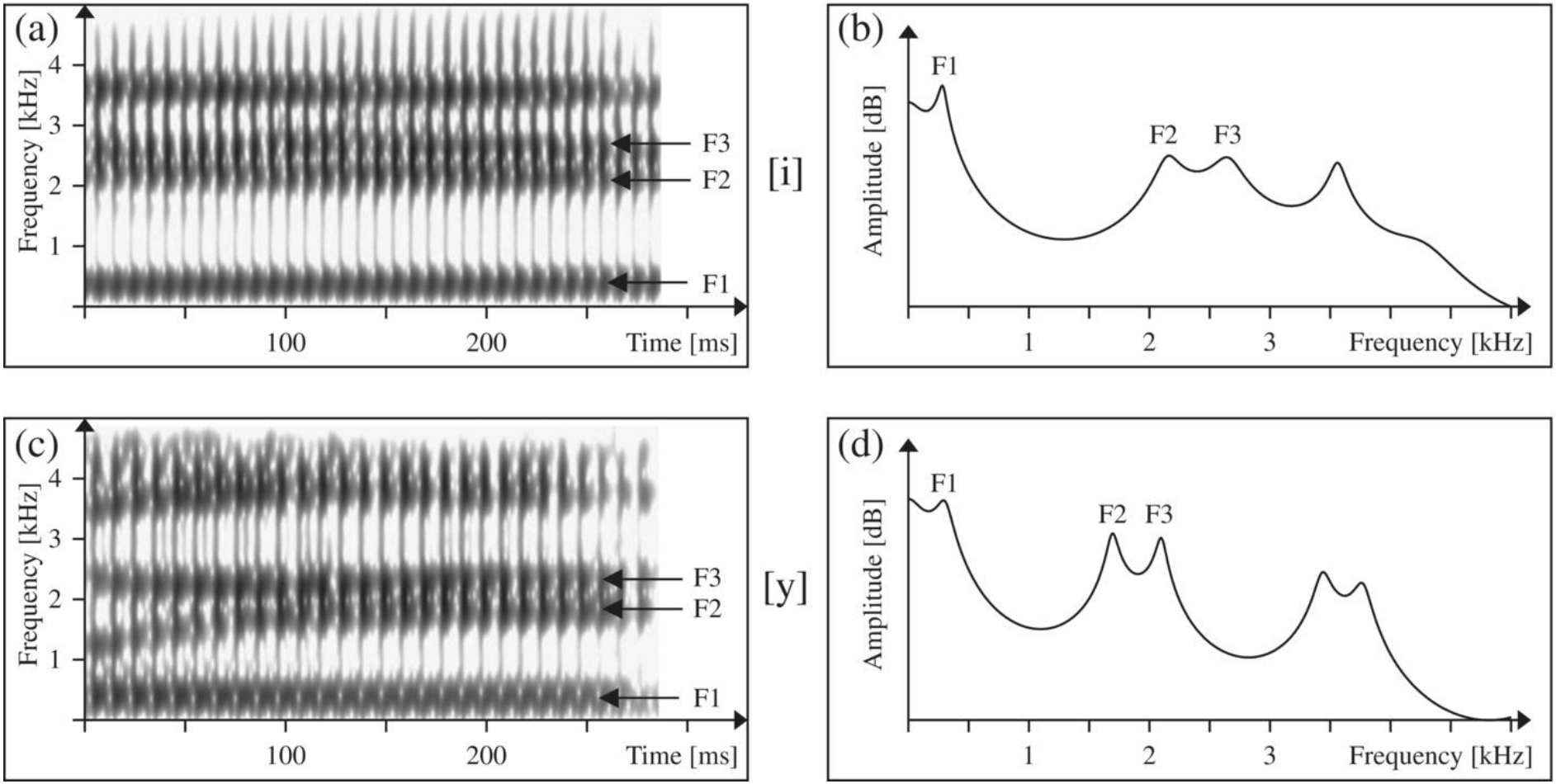
F1xF2


(a)
Frequency [kHz]
4
3
2
1
F3
F2
F1
100
200
Time [ms]
[i]
(b)
Amplitude [dB]
F1
F2
F3
1
2
3
Frequency [kHz]
(c)
Frequency [kHz]
4
3
2
1
F3
F2
F1
100
200
Time [ms]
[ɑ]
(d)
Amplitude [dB]
F1
F2
F3
1
2
3
Frequency [kHz]

Third Formant (F3)

- The third vocal tract resonance varies from 2000Hz 3000Hz
- **It is not nearly as neatly aligned with the articulatory features of vowels!**
  - That is, it's not as important for defining front / back distinctions
- English /ɚ,ɹ/ generally have a low F3
- Front round / unround pairs *sometimes* show F3 differences
  - In these cases, front round vowels usually have an F3 lowered to near F2
- But rounding also affects F1 and F2!

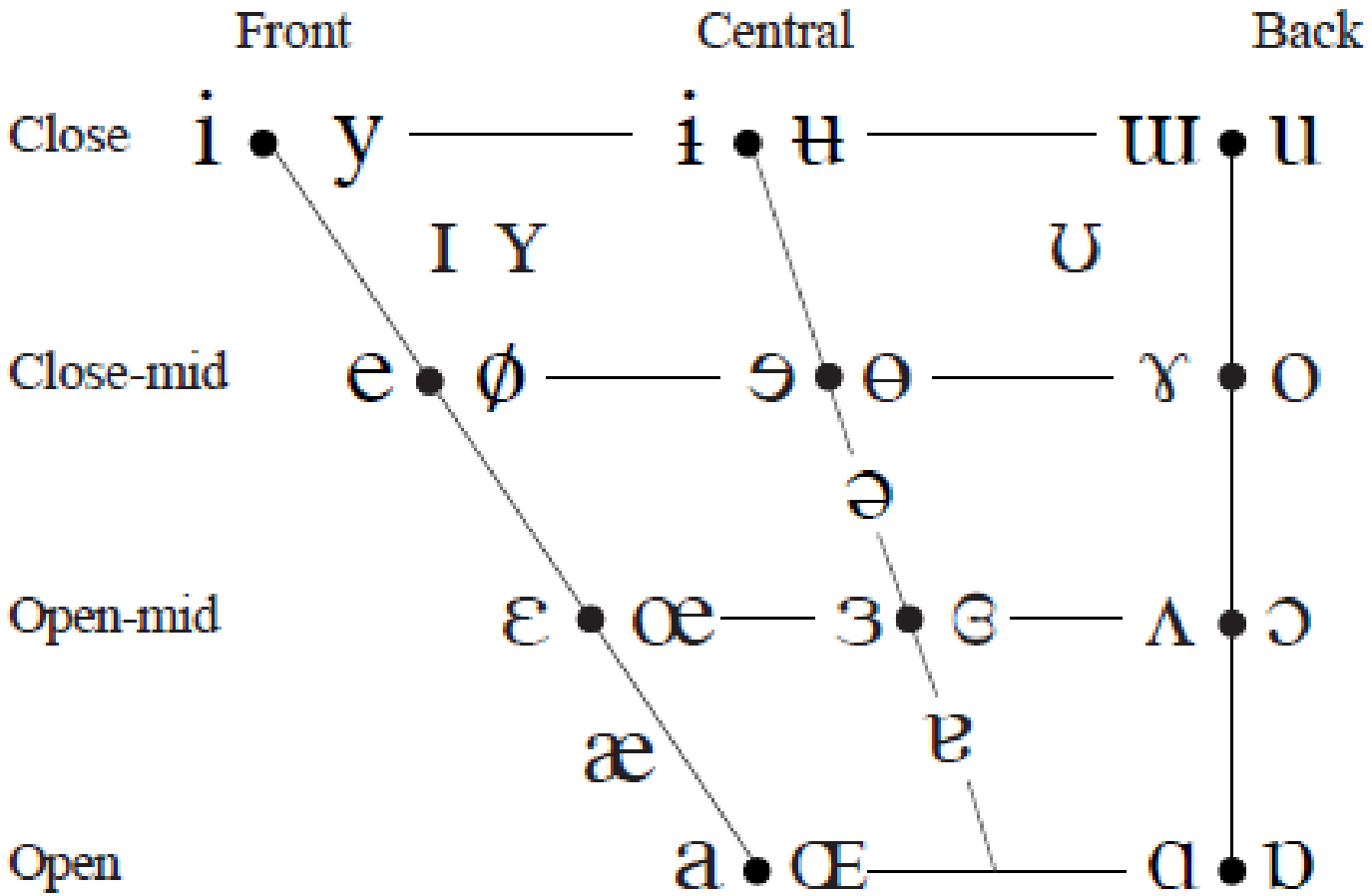
Formant lowering



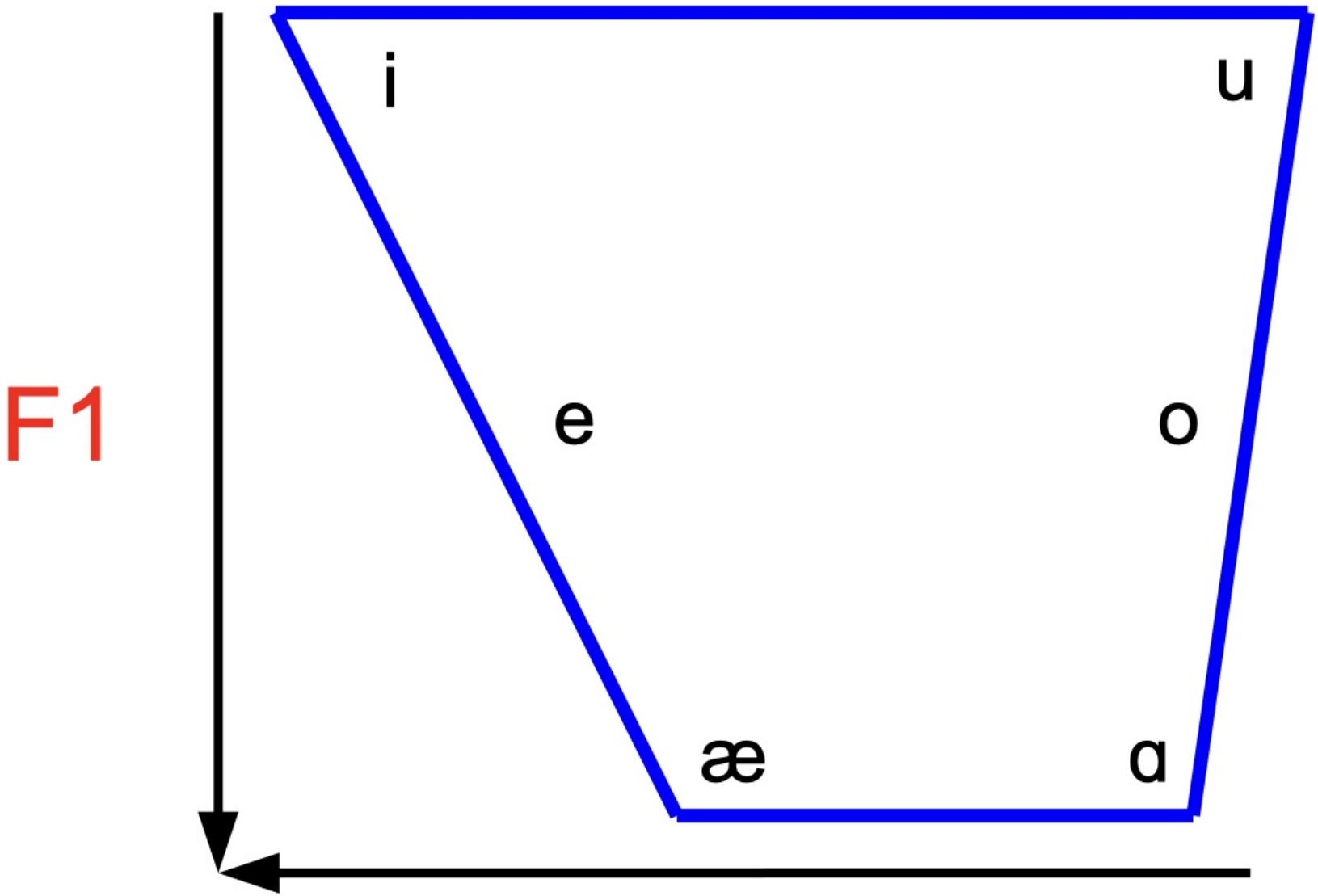
The vowel trapezoid

Question:

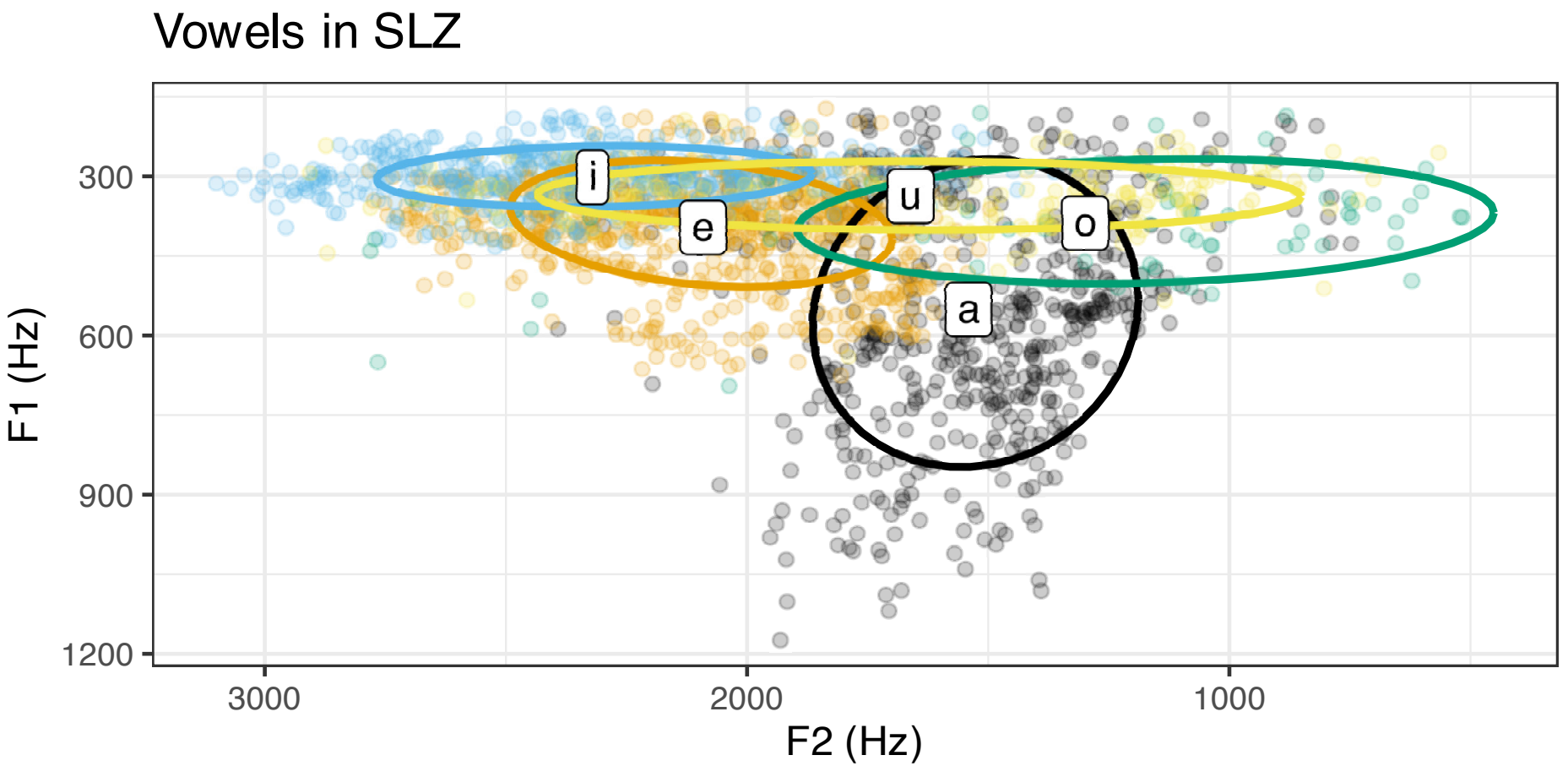
What does this have to do with our vowel trapezoid?



The F1xF2 plane



SLZ vowels ploted on F1xF2 plane



Break Time!

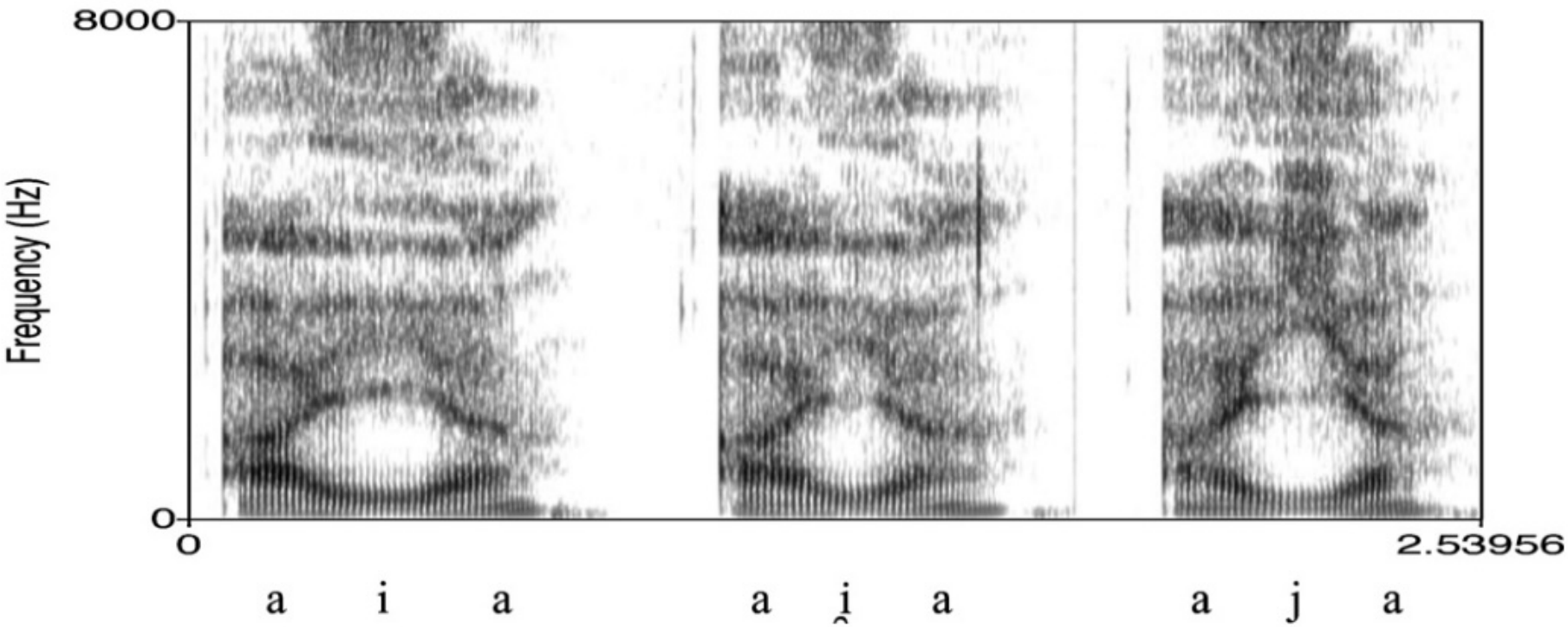
10 minute break
(stretch, grab a drink, etc.)

Approximants

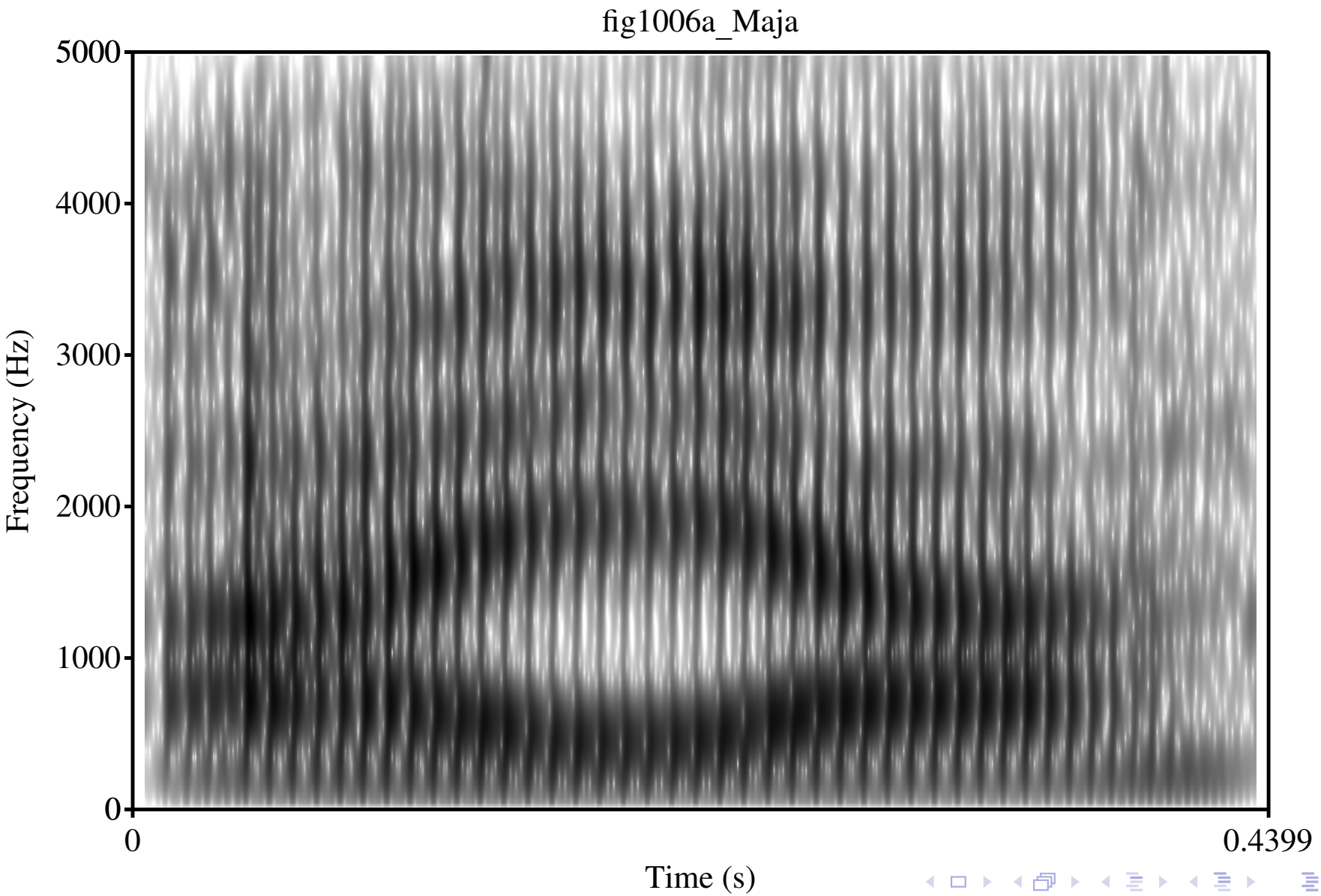
- Approximants are acoustically very similar to vowels.
- However, there is not a really good definition for what an approximant is.
- Essentially, they are a sound that is somewhere between a vowel and consonant
  - This is why they are sometimes called *semivowels*
- This term is what we technically call a "trashcan"-term[2]

[2] Credit to Ryan Bennett (UCSC).

Approximants



Approximants



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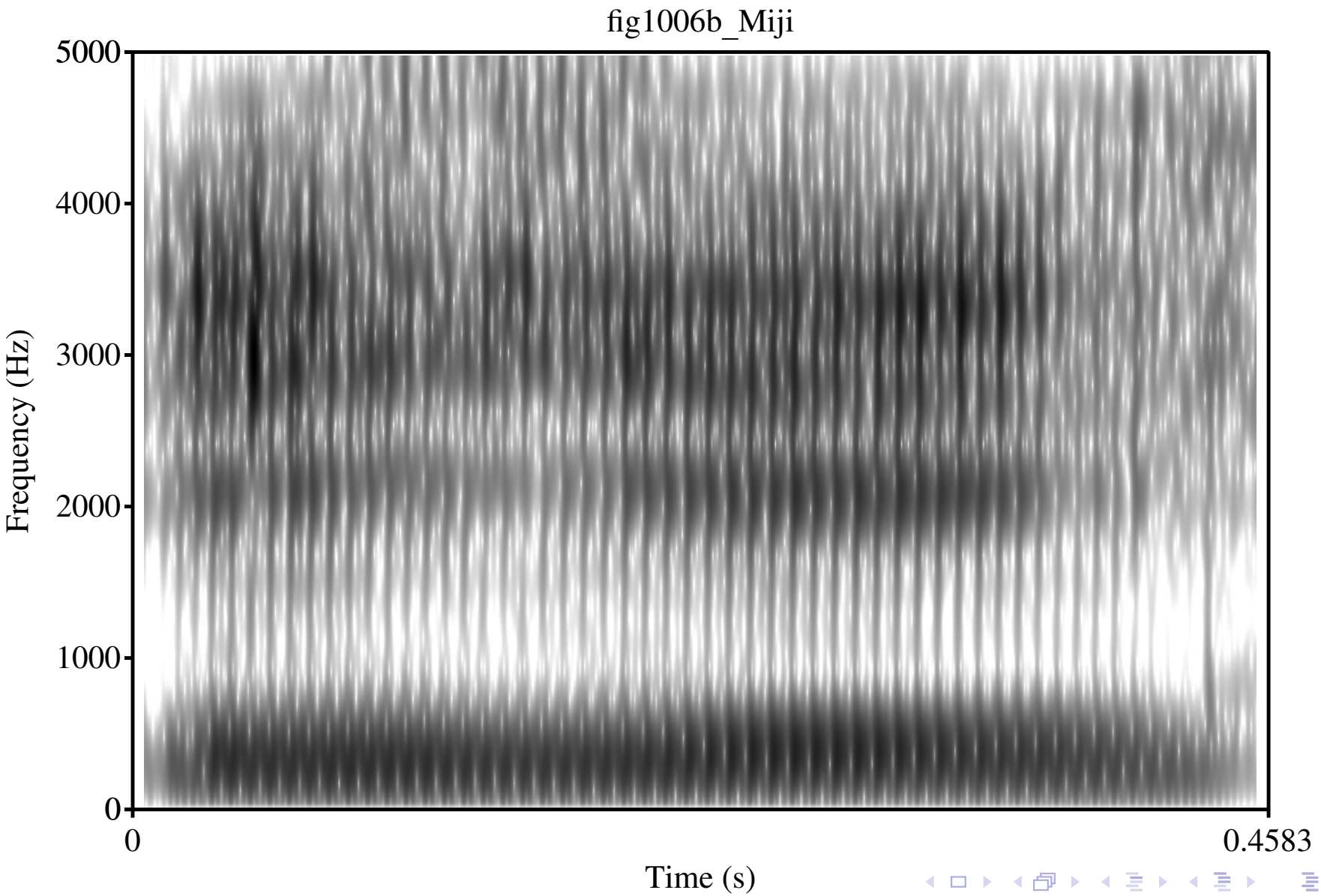

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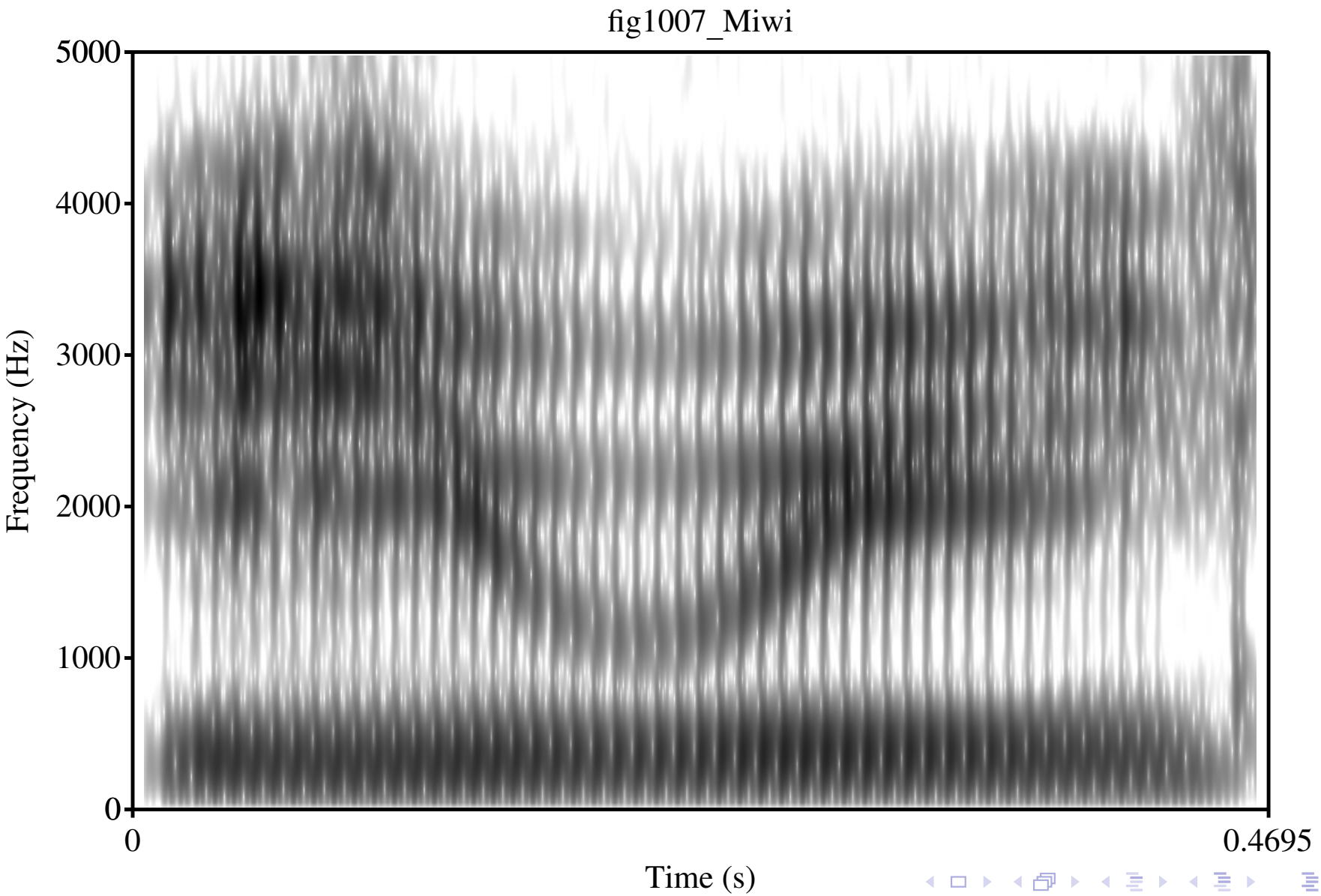

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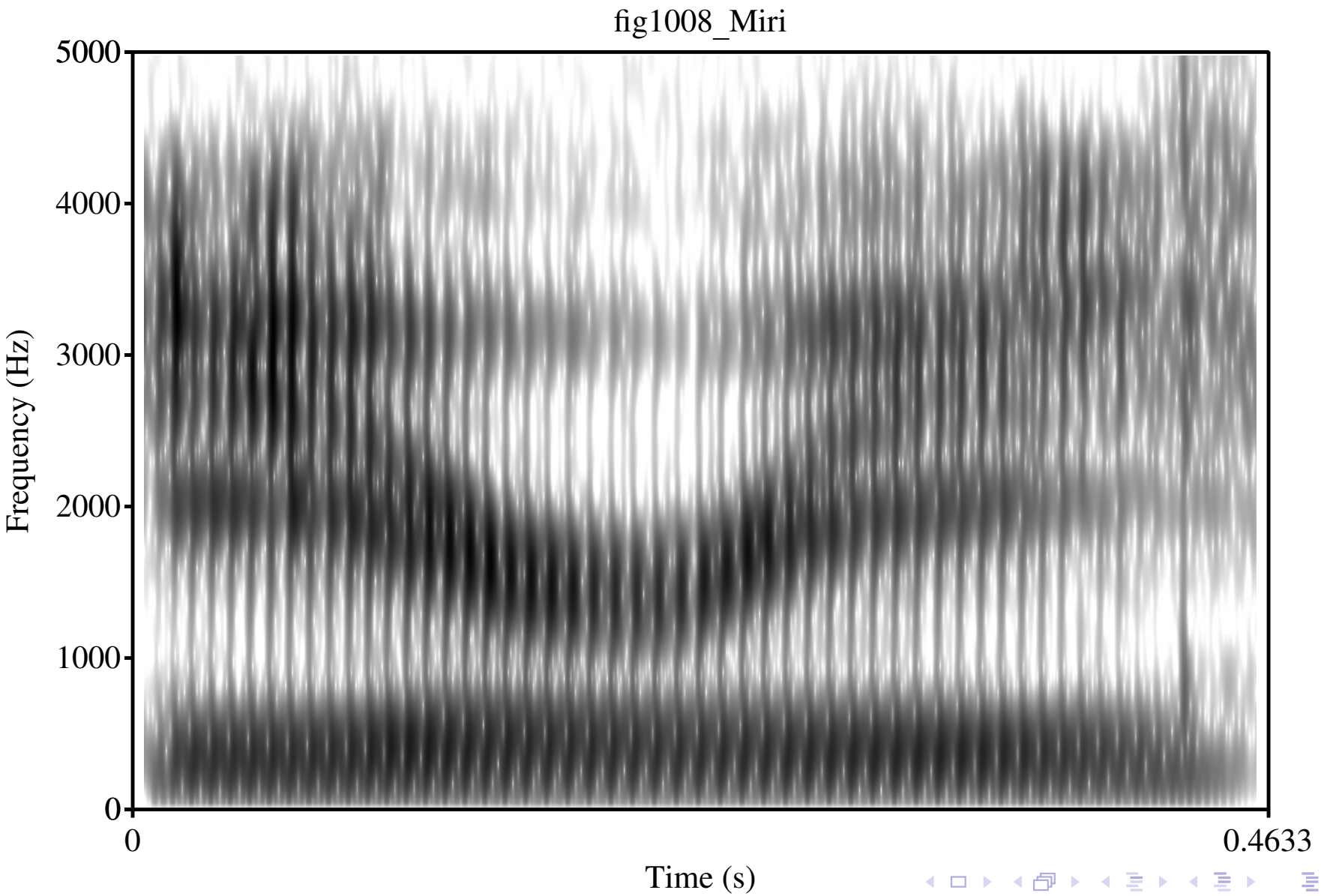

Practice Time!

Let's measure vowels!

To Do:

- Complete the exit ticket for today on Canvas by 12:30pm.
- IPA Practice 1 is due Friday
- Quiz 3 is due Monday
- Lab 1 is due by Tuesday at 23:59
- Homework 4 is due by Tuesday at 08:30