

Reading spectrograms: Vowels and consonants

Instrumental phonetics

February 13

Inna Sieber

Reading spectrograms: What for?

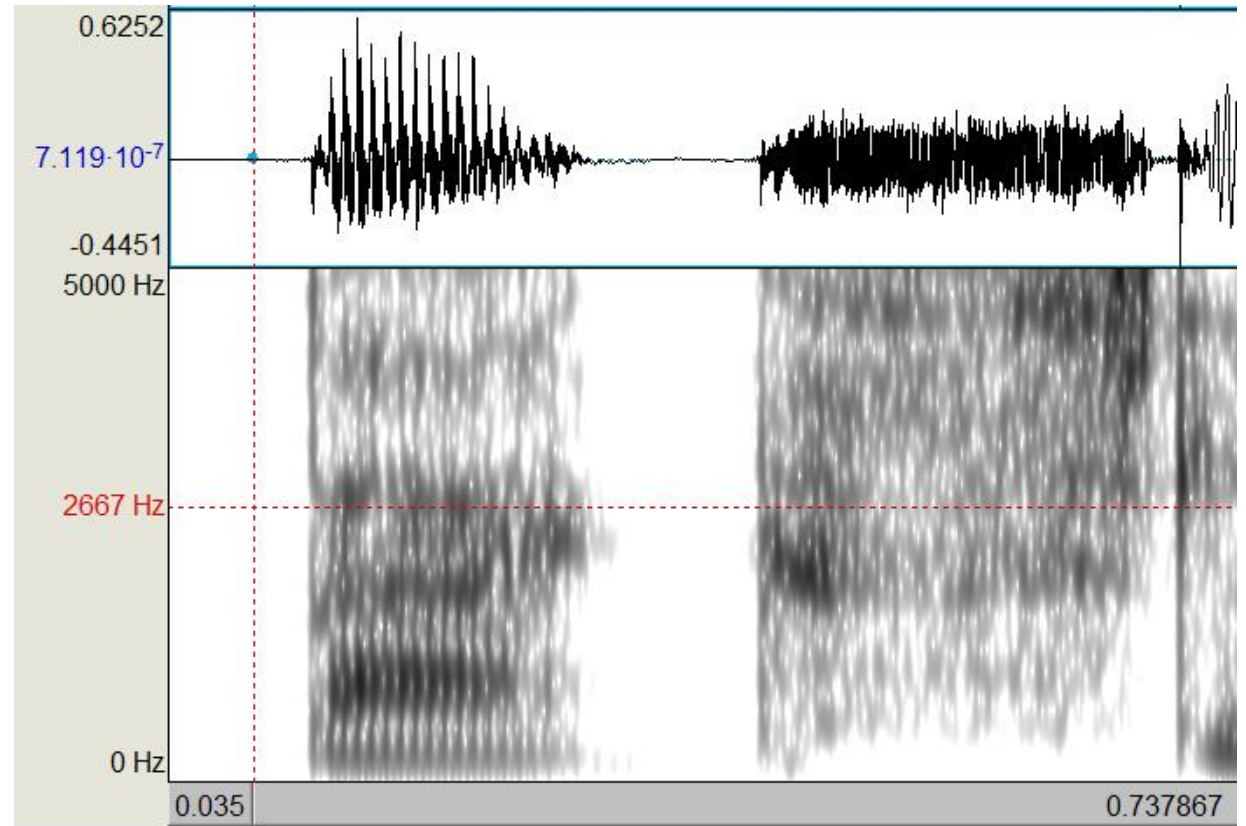
- Reading language descriptions
- Writing language descriptions
- Working with texts on a language
 - Transcribing texts
 - Annotating texts
- Phonetic studies
- Every time you don't believe your ears

Reading spectrograms: now and in real life

- After the course you are expected to look at the spectrogram and read a simple word in English
- In real life you *usually* know what to expect and what to look for
- Today there are only English irregular verbs
- In real life God knows what can happen

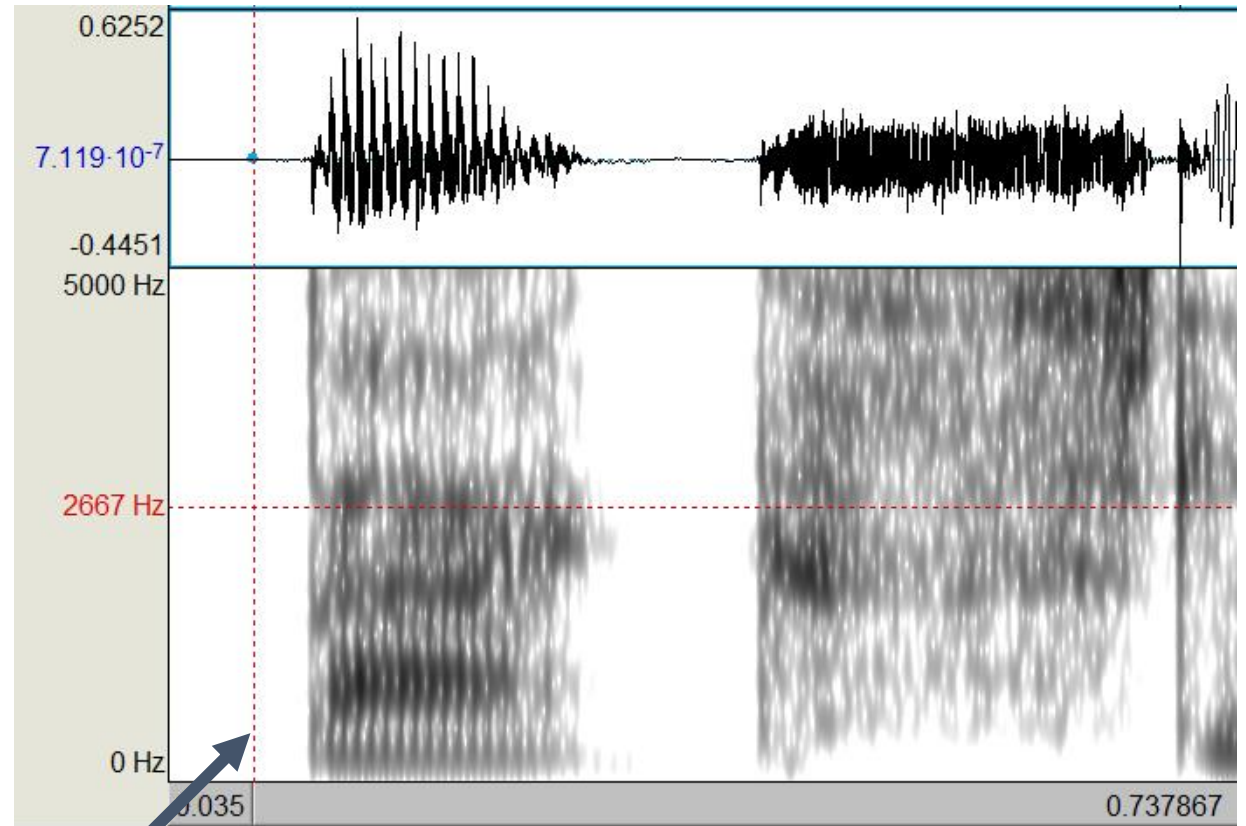
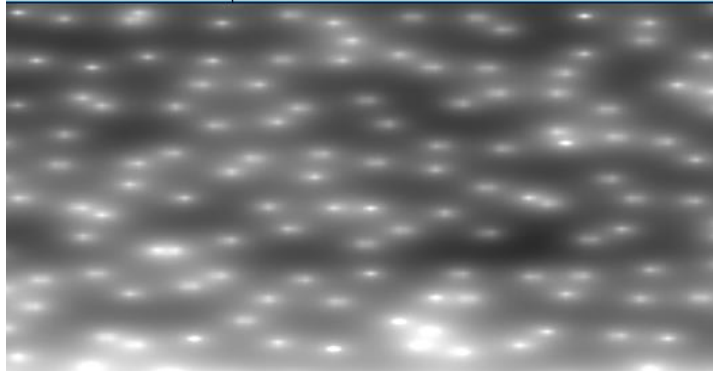
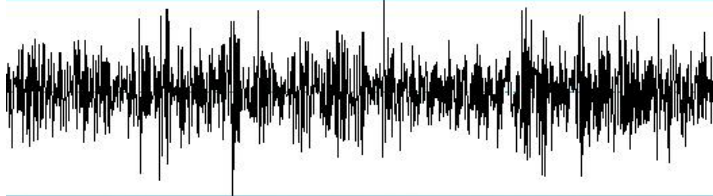
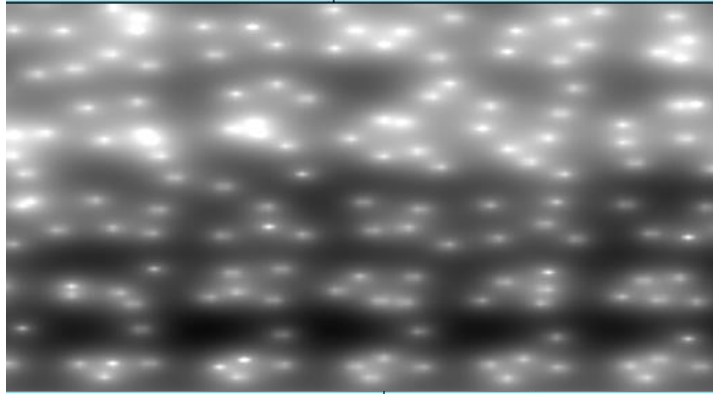
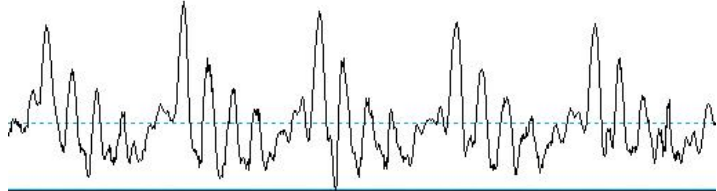
You already know

- Intensity (dB)
- Frequency (Hz)
- Duration (ms)



- Spectrum – relative amplitude of frequencies
- The range of audible sound: 16 Hz – 20.000 Hz
- The range we are interested in: up to 5 kHz

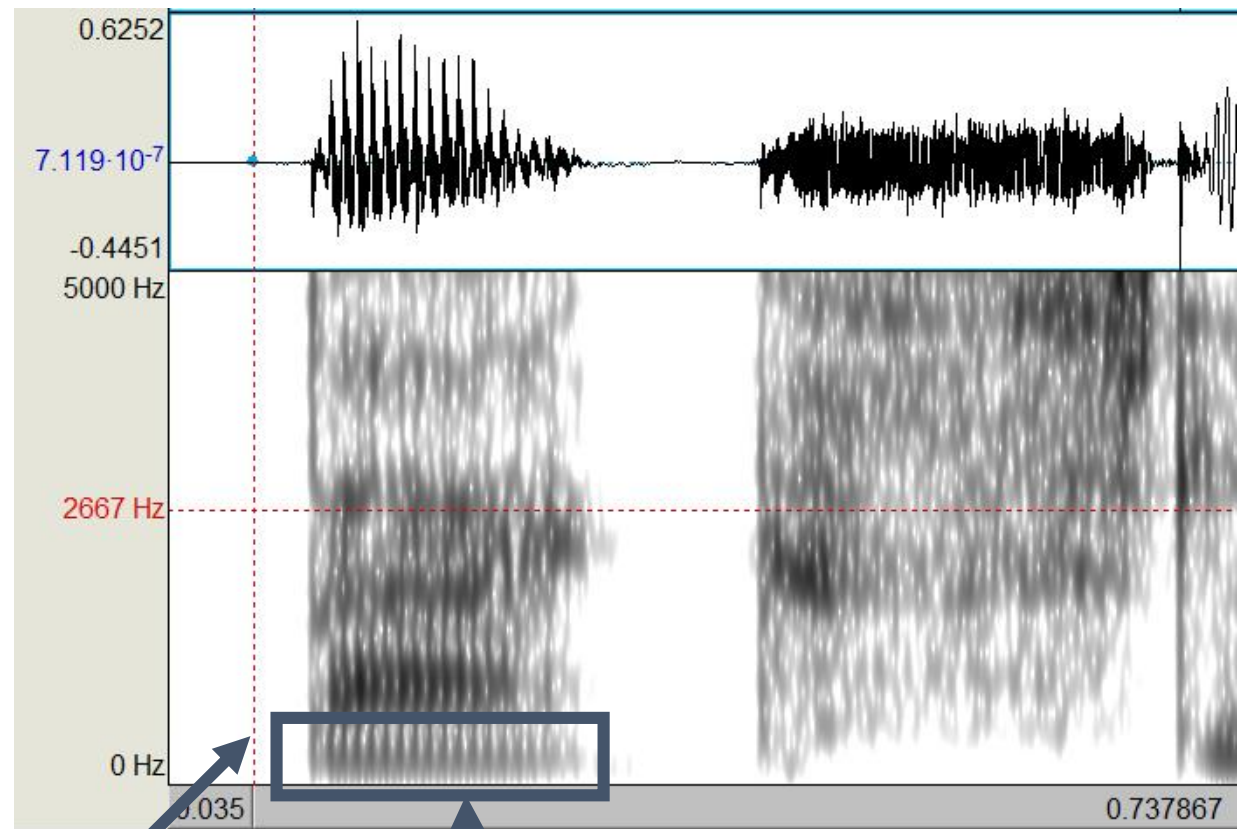
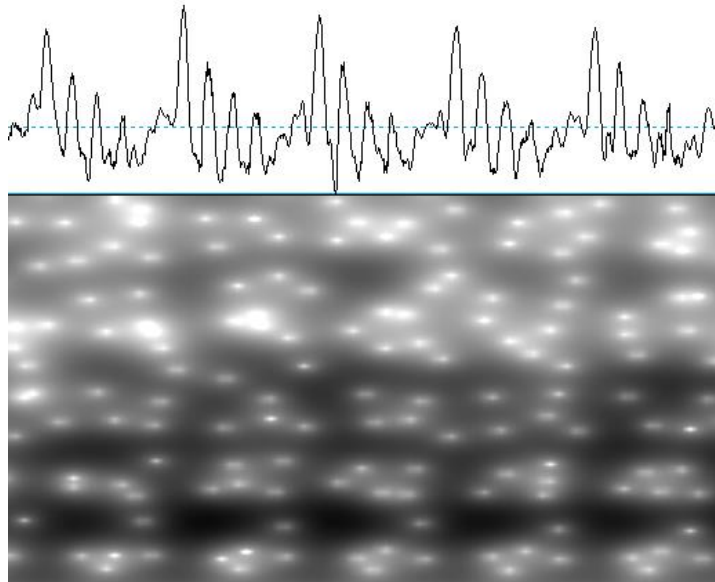
Type of oscillation



Order, “periodic” oscillations

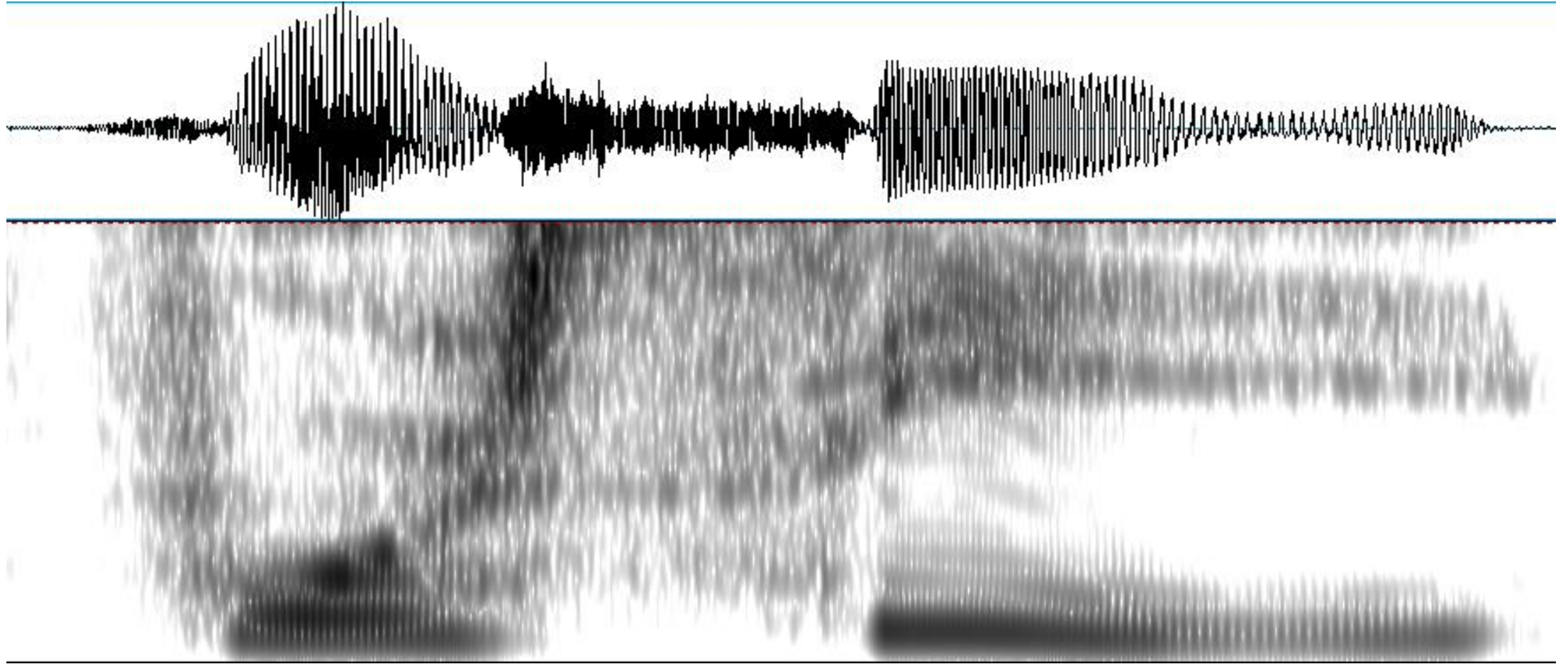
Chaos, non-periodic oscillations

Where is F_0 ?



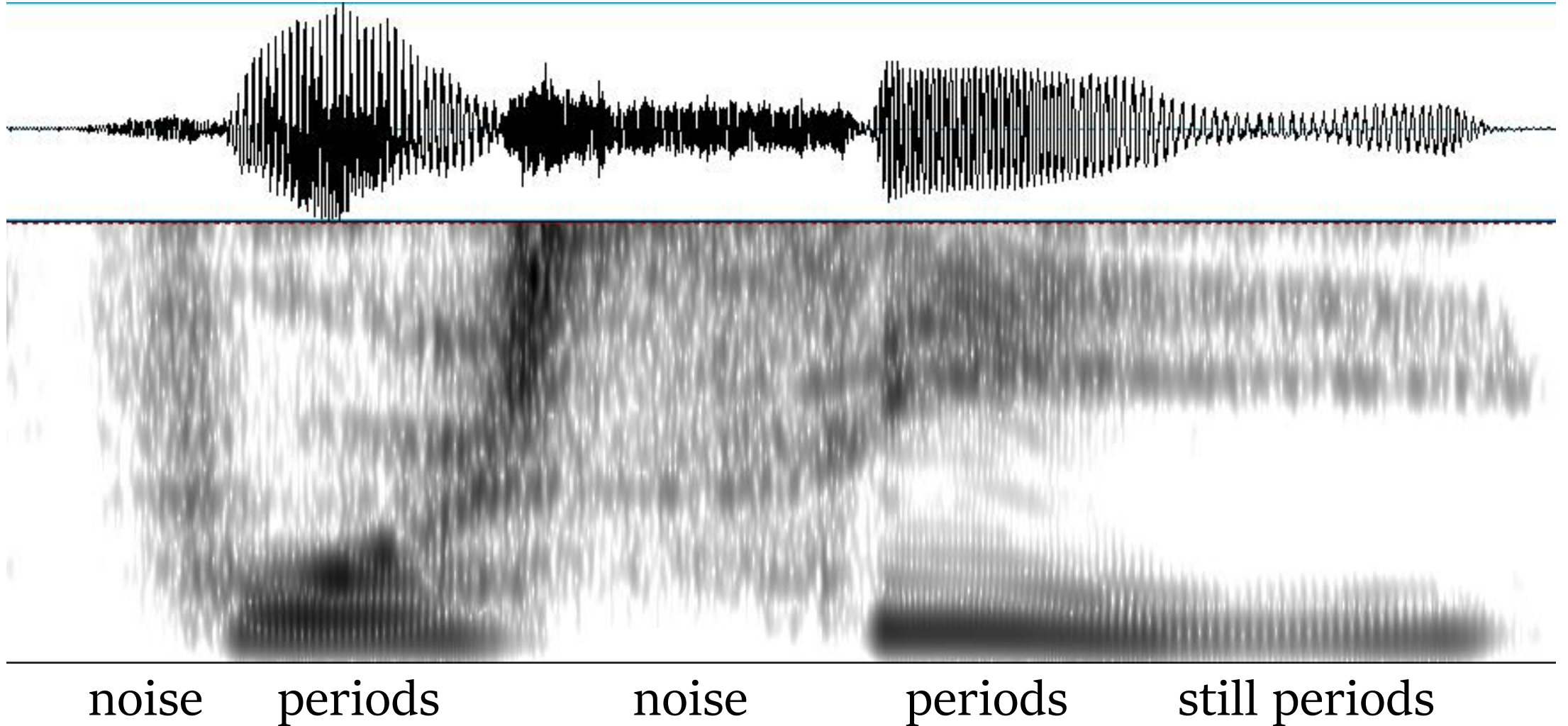
Order, “periodic” oscillations and fundamental frequency (F_0)
 F_0 : vowels and voiced consonants

Find periods vs. noise

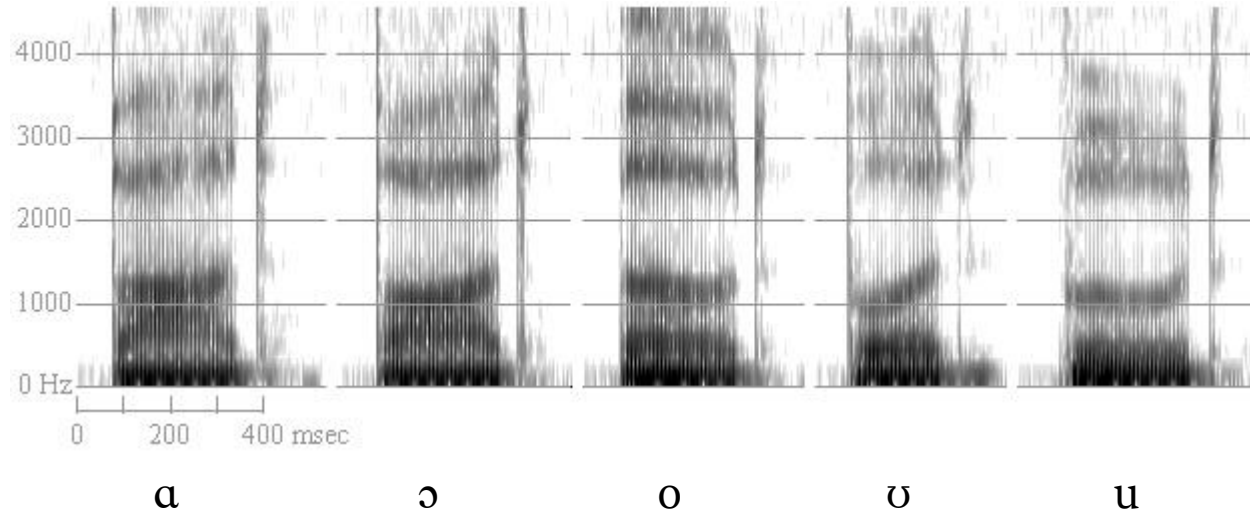


Find periods vs. noise

forsee

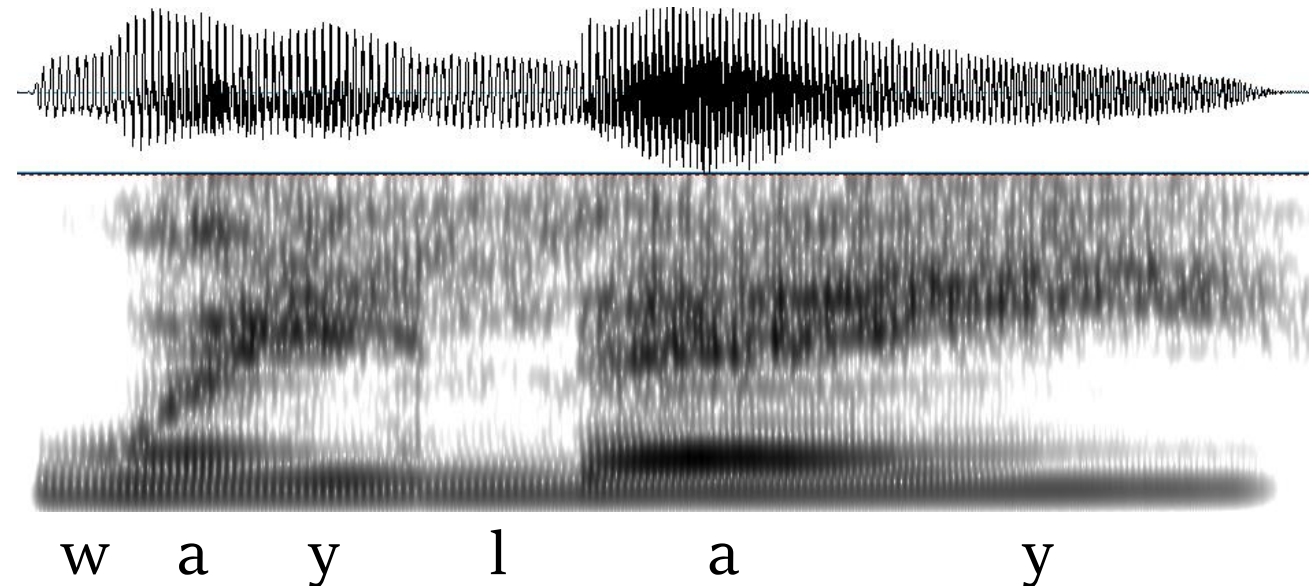


Find vowels

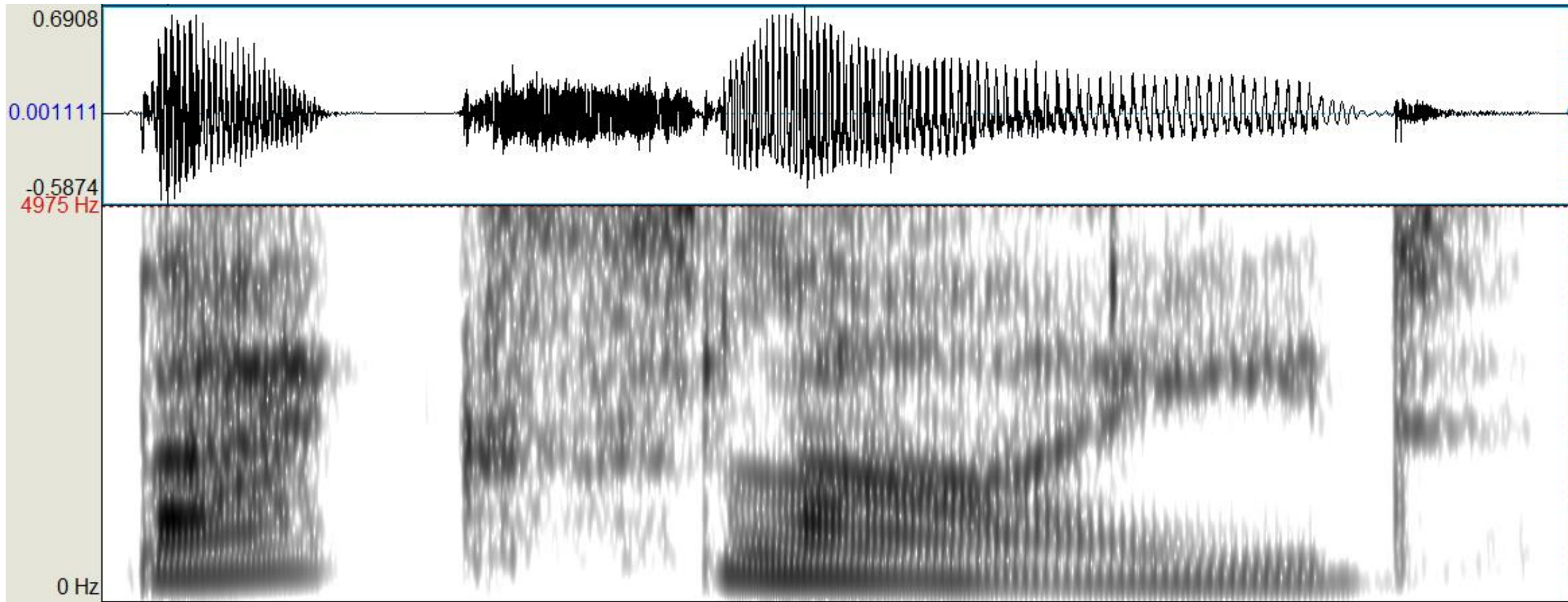


- Formants are the most intensive parts of the spectrum (“worms”)
- We see bright formants in vowels and faint ones in sonorants

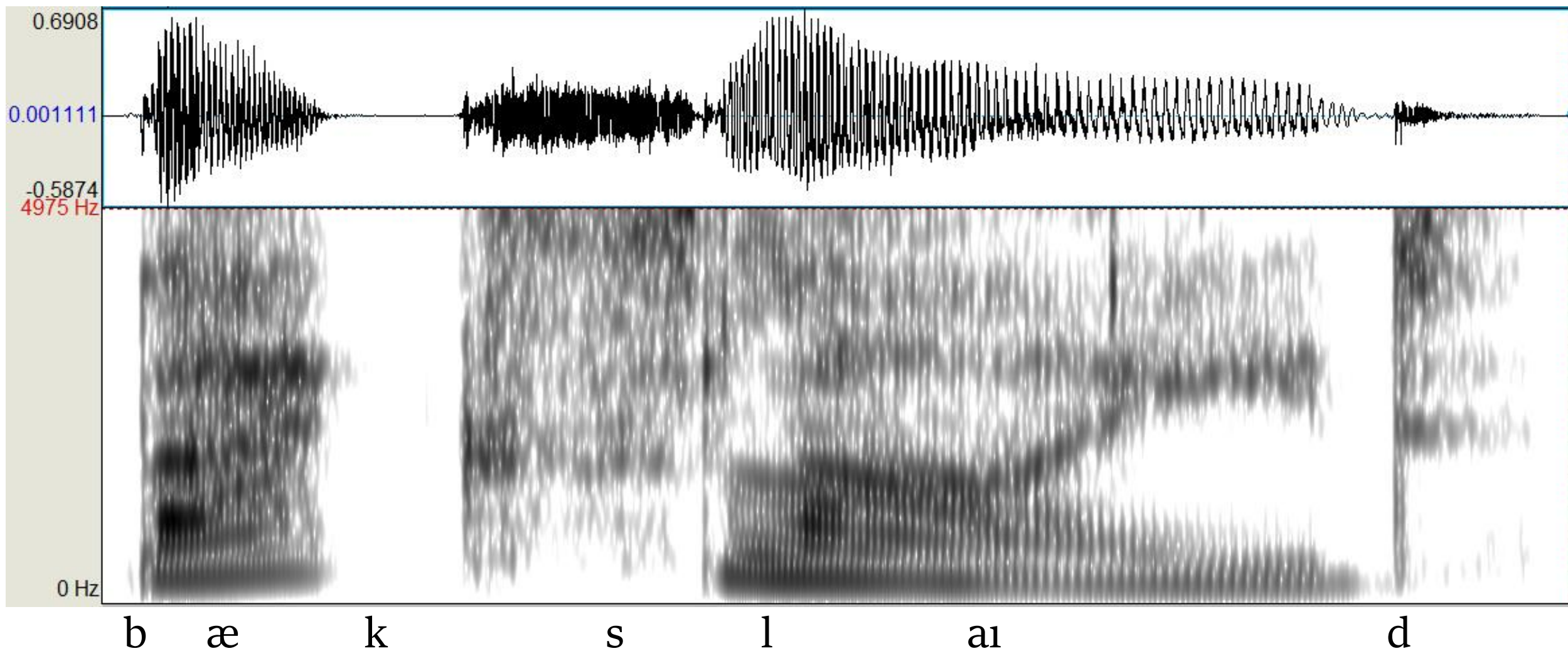
waylay



Find vowels, silence and noise



backslide ‘to return to old, often bad, habits, or to a worse condition’



Please watch [a short video](#) on reading vowel spectrum!

Vowels: Articulation and acoustics

- The larger is the opening, the higher is F1 (height)
- The more front is the tongue, the higher is F2 (backness)
- Roundness lowers F2



i



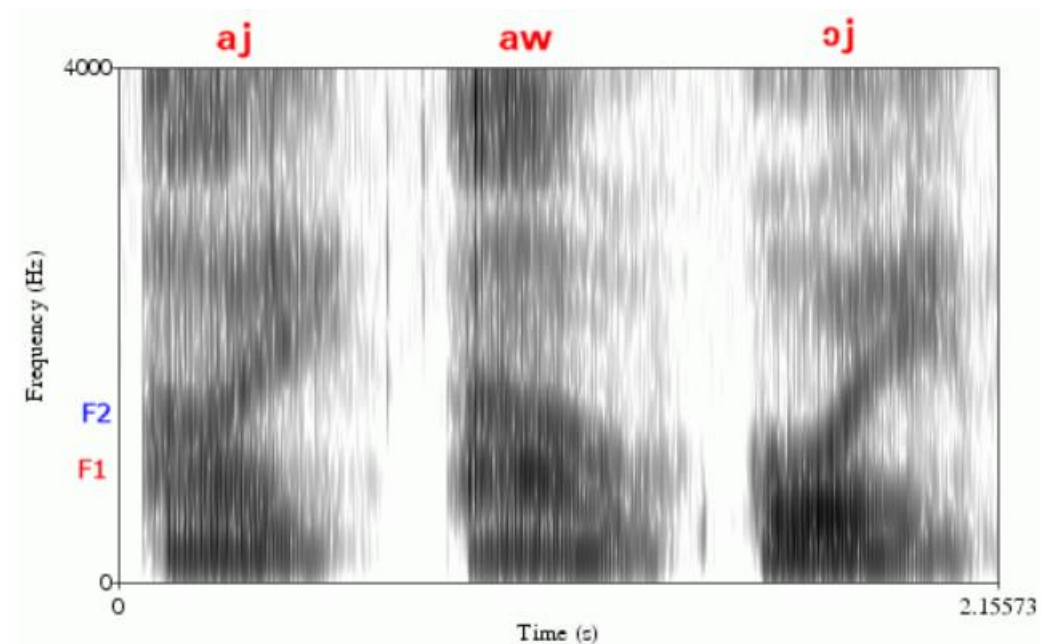
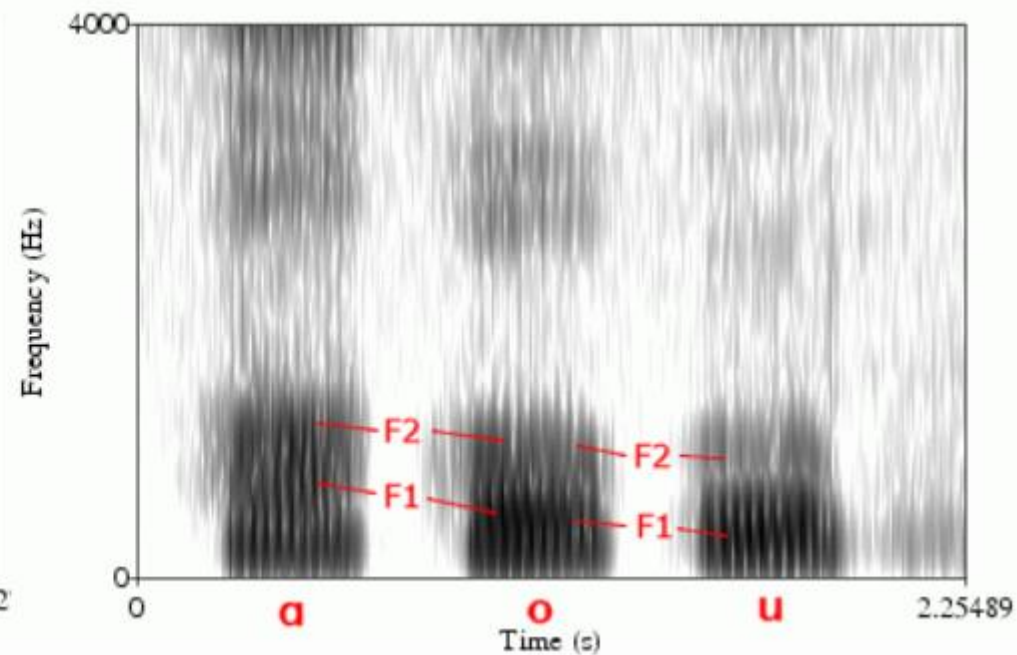
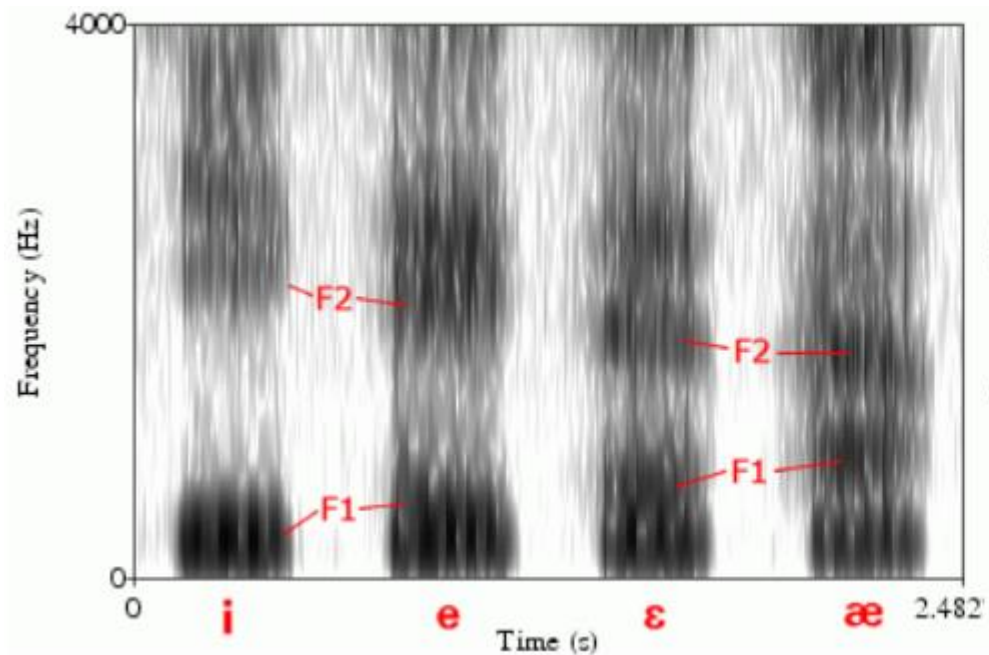
a



u

[i]:	F1	F2+F3
[a]:	F1+F2	F3
[u]:	F1+F2	F3

More
pictures



[U.ofManitoba](http://www.umanitoba.ca)

Please watch [a short video](#) on consonants!

Distinguish between consonants

Manner of articulation:

Obstruents:

Stops

Fricatives

Affricates

Sonorants:

Approximants

Nasals

Laterals

Rhotics

Place of articulation:

Labials

Alveorals

Palatals

Velars

The diagram consists of two vertical columns of text. The left column is under the heading 'Manner of articulation:' and lists 'Obstruents:' followed by 'Stops', 'Fricatives', and 'Affricates', and then 'Sonorants:' followed by 'Approximants', 'Nasals', 'Laterals', and 'Rhotics'. The right column is under the heading 'Place of articulation:' and lists 'Labials', 'Alveorals', 'Palatals', and 'Velars'. Two blue arrows originate from the left column: one from the 'Obstruents' section pointing down to 'The noise/formant structure', and another from the 'Place of articulation' section pointing down to 'Formant transitions in vowels'.

The noise/formant structure

Formant transitions in vowels

Obstruents. Stops

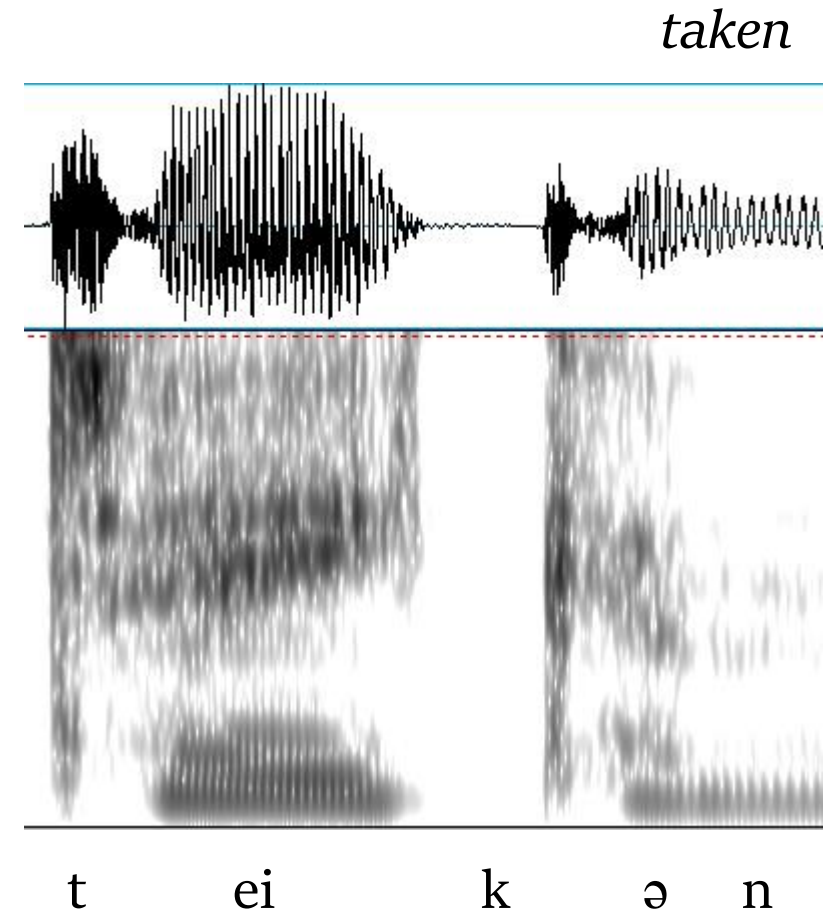
Stops: closure (silence) + burst

Aspirated stops: closure (silence) + burst + h
(voiceless vowel)

Labial stops [p b]: long closure, short faint burst

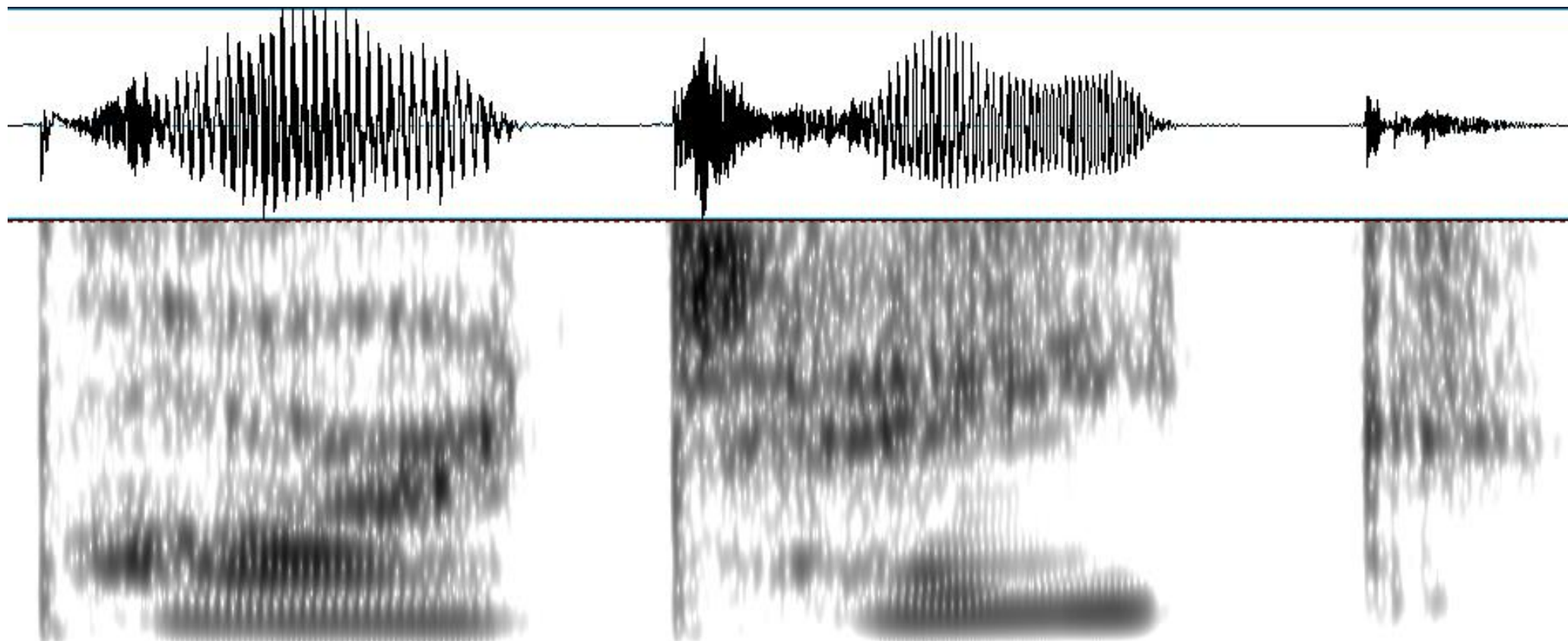
Velar stops [k g]: short closure, long noisy burst
(or 2-3 bursts)

Alveolar stops [t d]: somewhere in between



Obstruents. Stops

partake



p

ar

t

ei

k

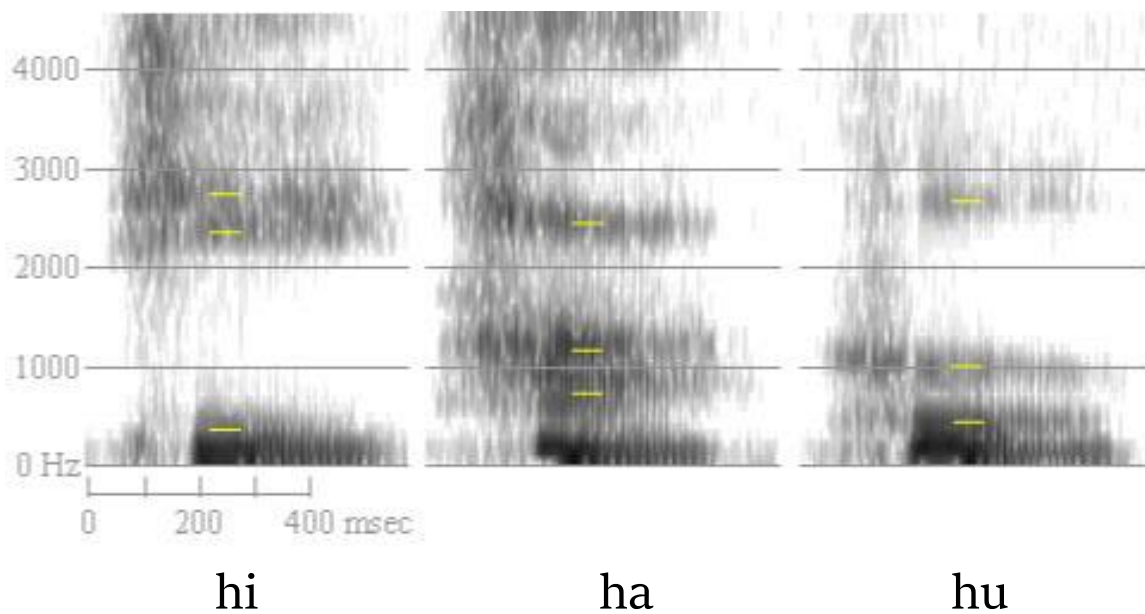
Obstruents. Fricatives

Fricatives: fricative noise

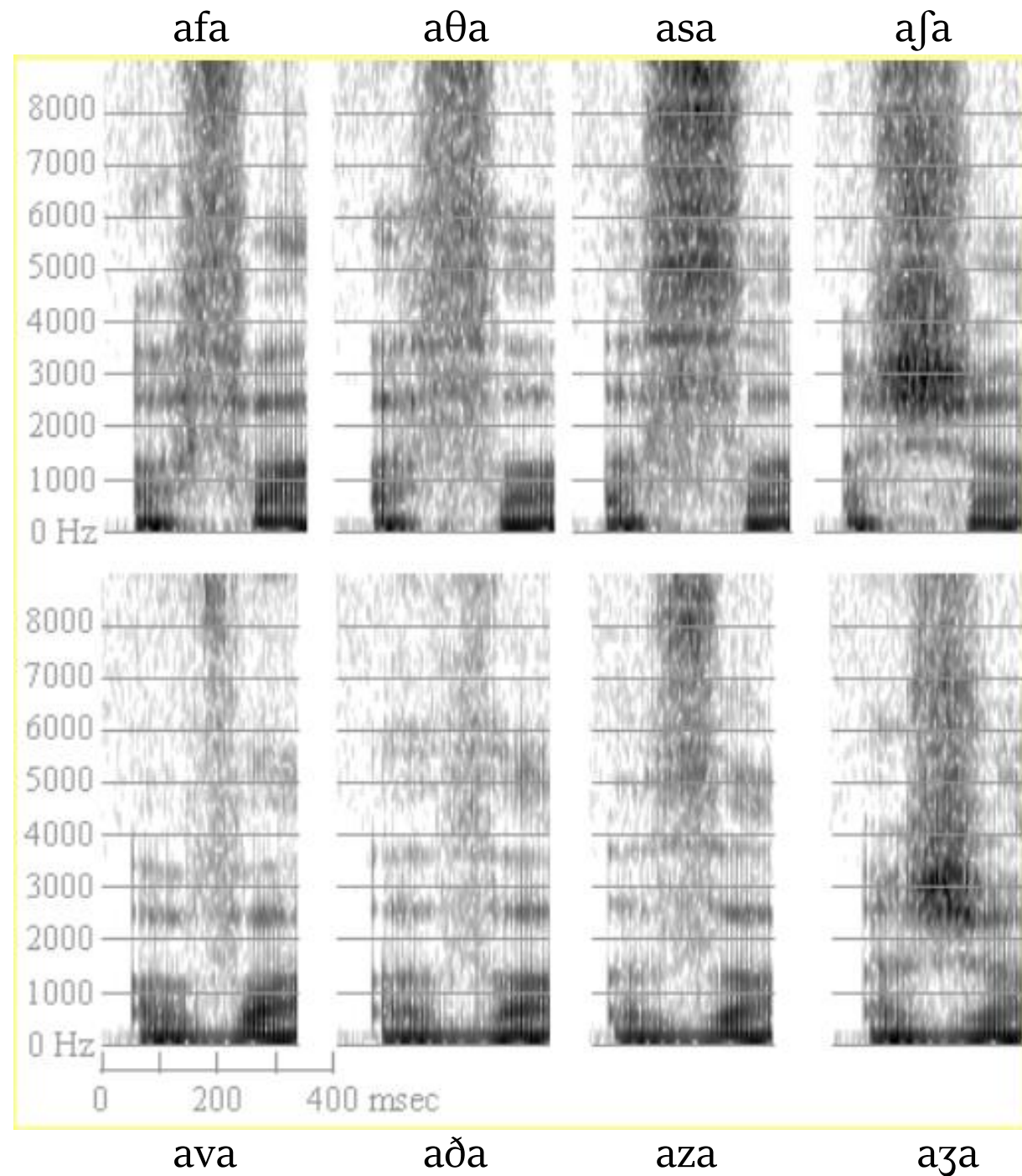
Sibilants [s z ʃ ʒ]: high speed airflow faces the teeth
high intensity, high frequency

Non-sibilants [f v θ]: less intensive, low intensity throughout the spectrum

Obstruents. Fricatives



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Obstruents. Affricates

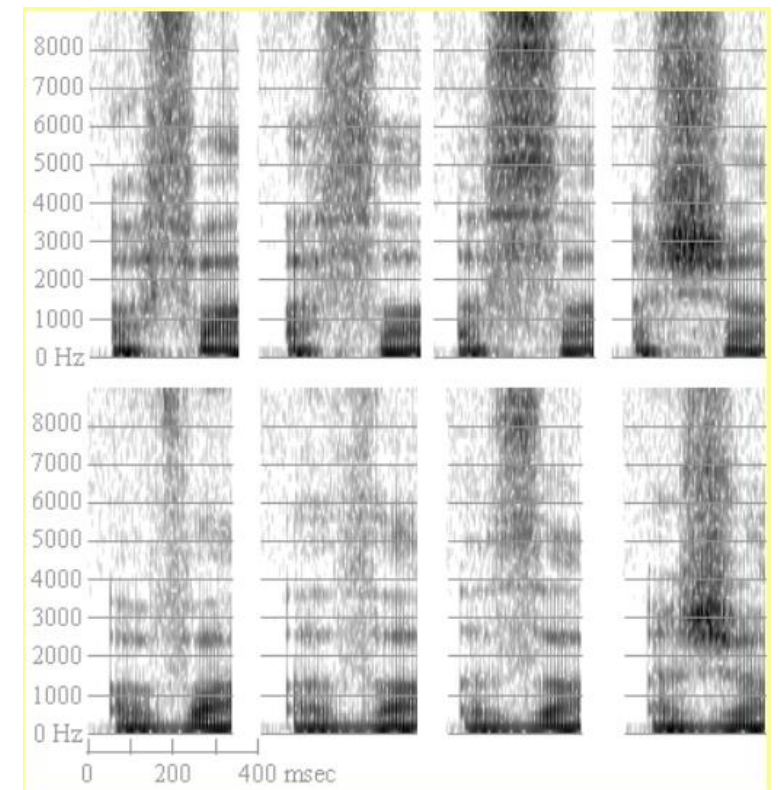
Affricates: closure (silence) + burst + fricative noise

Sibilants [ts dʒ ʈ]: high speed airflow faces the teeth
high intensity, high frequency

Affricates' closure is shorter than that of stops

Affricates' noise is shorter than that of fricatives

Important for all obstruents: voiced are less noisy!

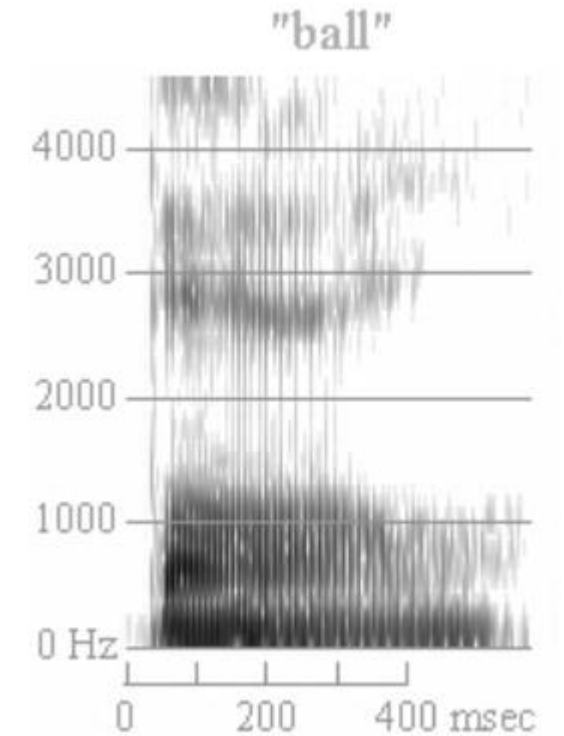
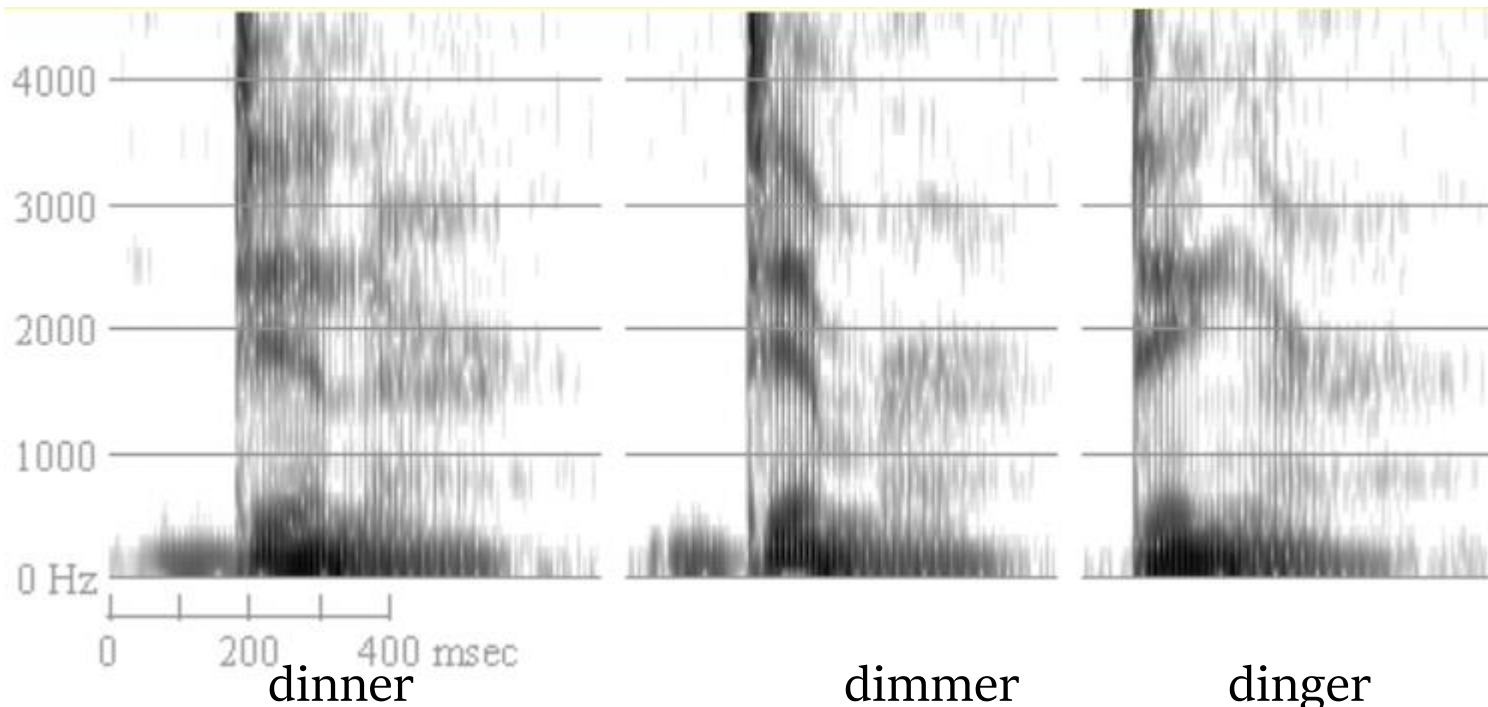


Sonorants: very complicated

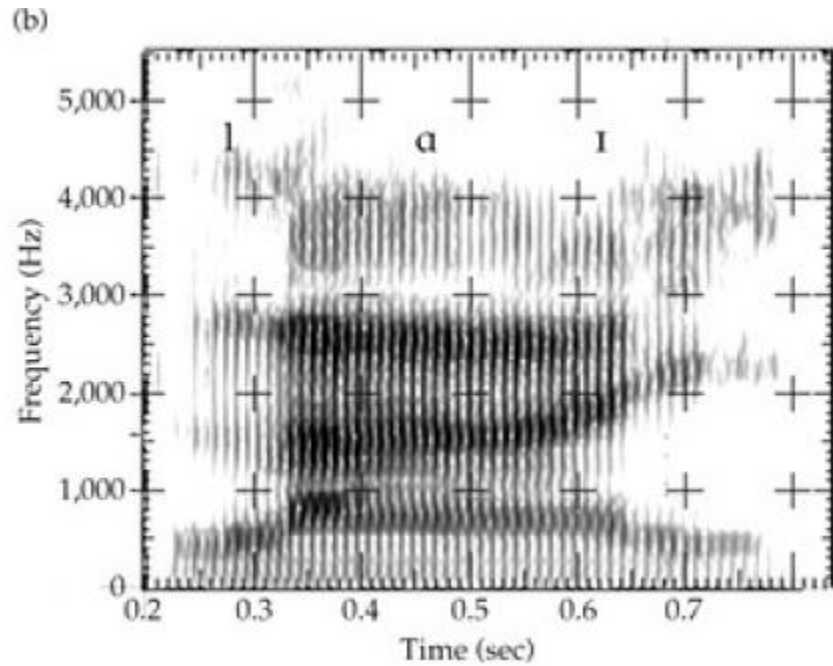
Approximants: like vowels, faint formants (F2 and higher)

Nasals: faint F2, additional 200-300 Hz formant

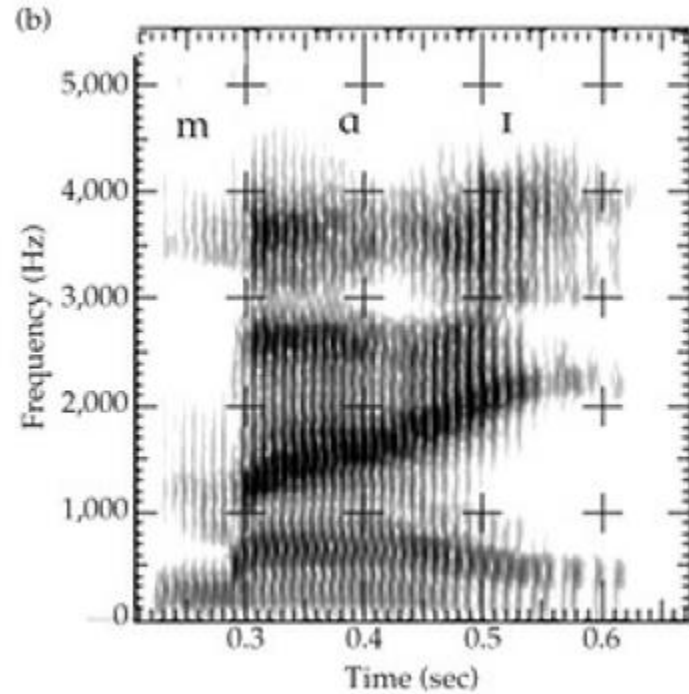
Laterals: “a window” with silence



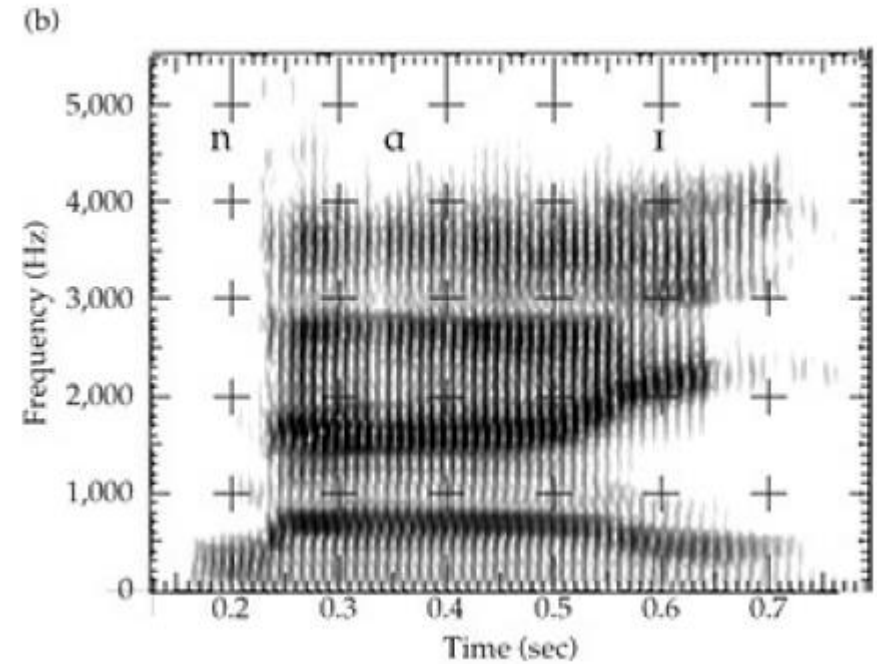
Sonorants: very complicated



lai

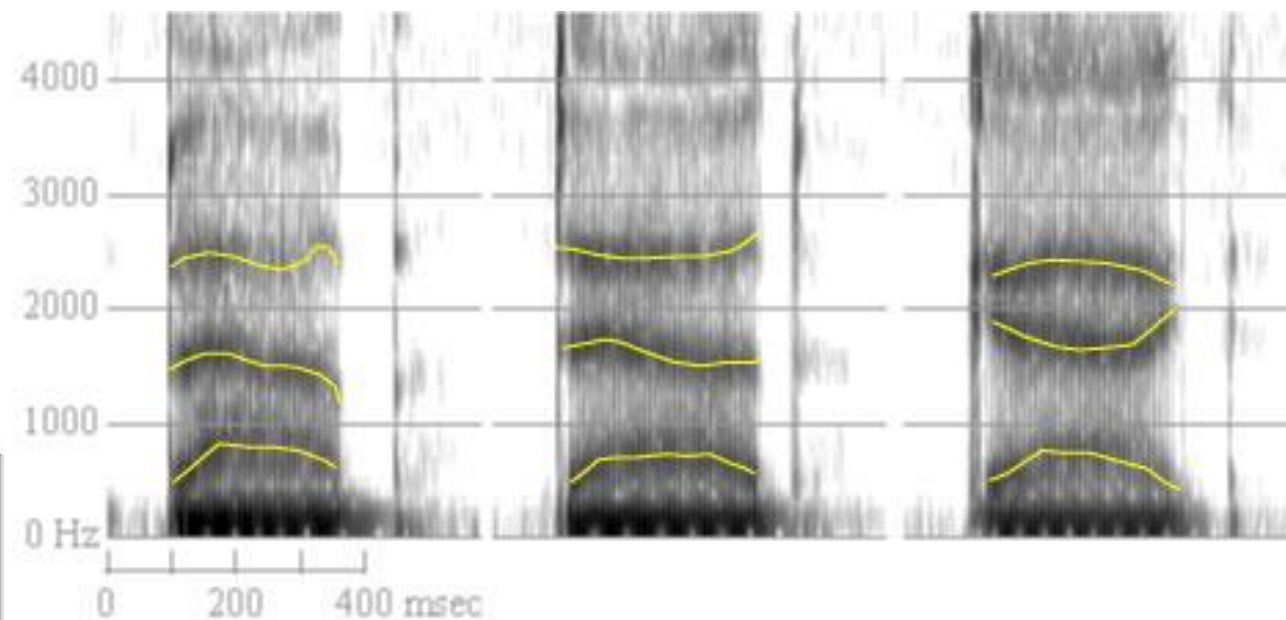
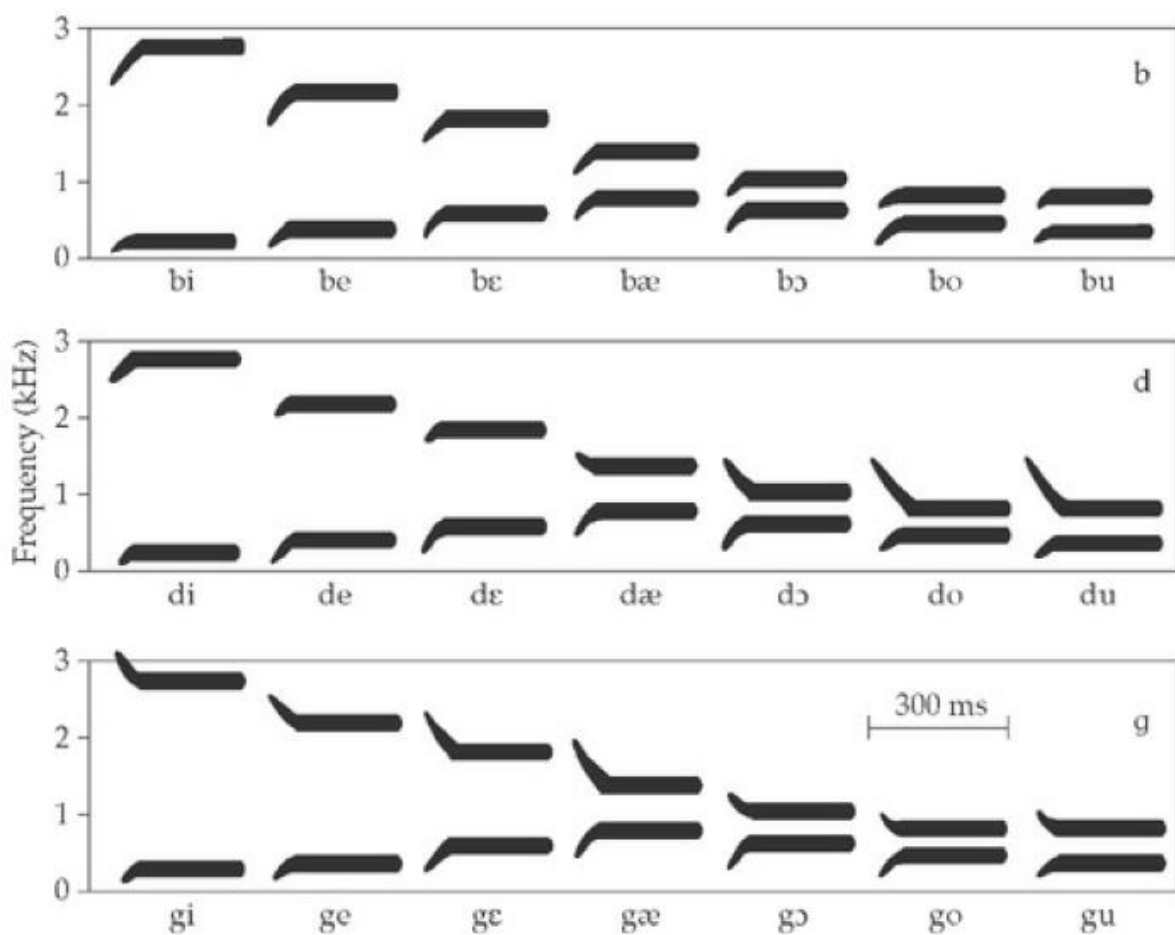


mai



nai

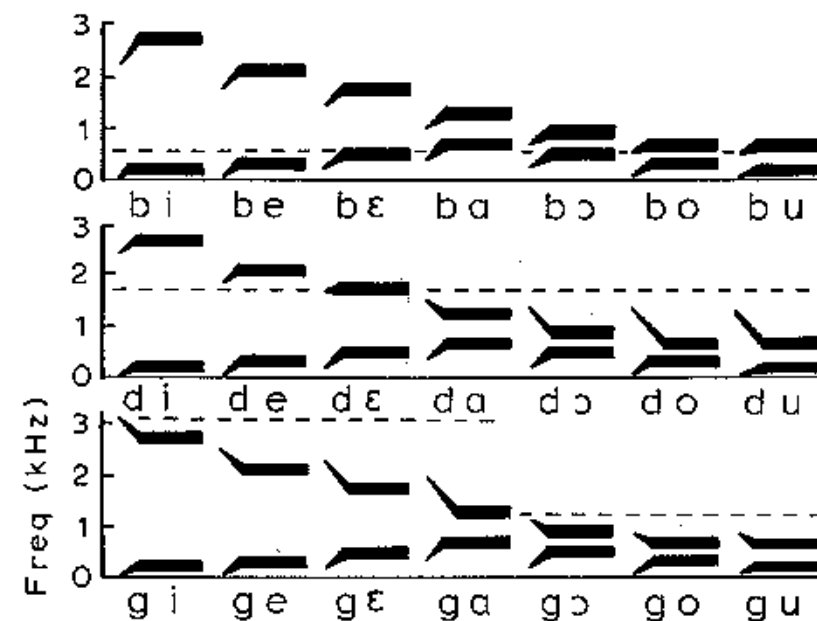
Formant transitions



bab

dad

gag

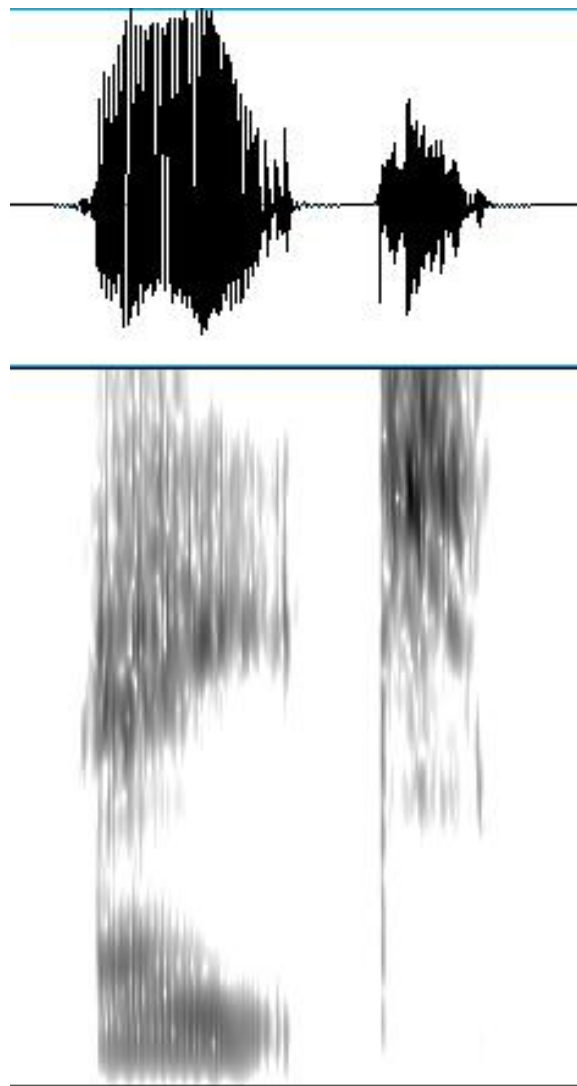
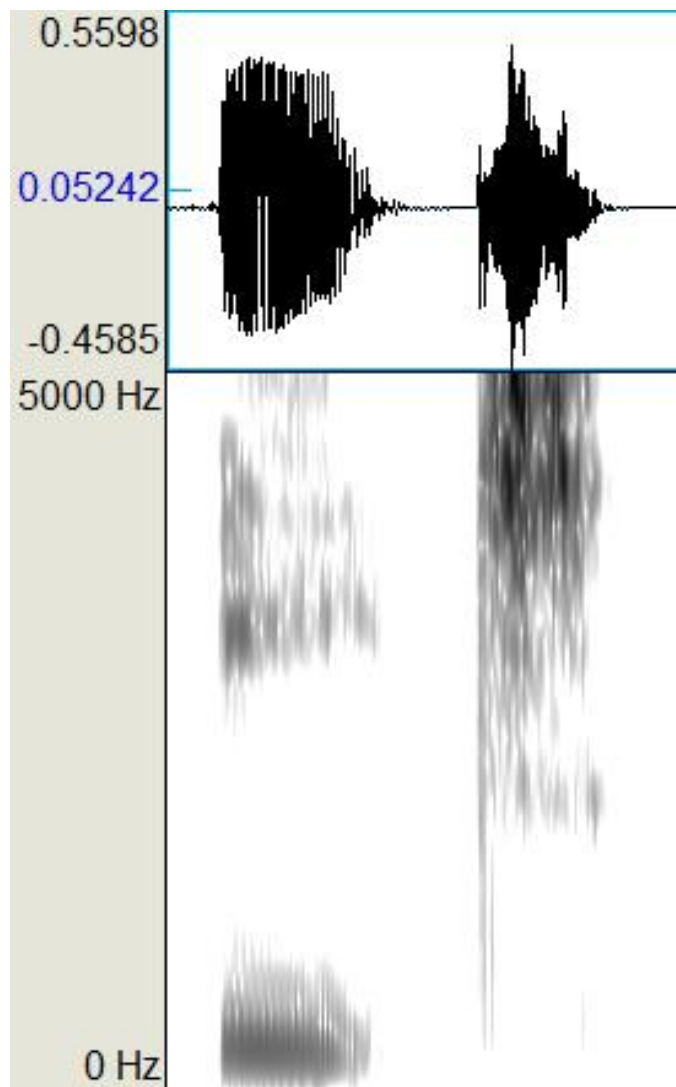


Delattre 1955

How we read spectrograms

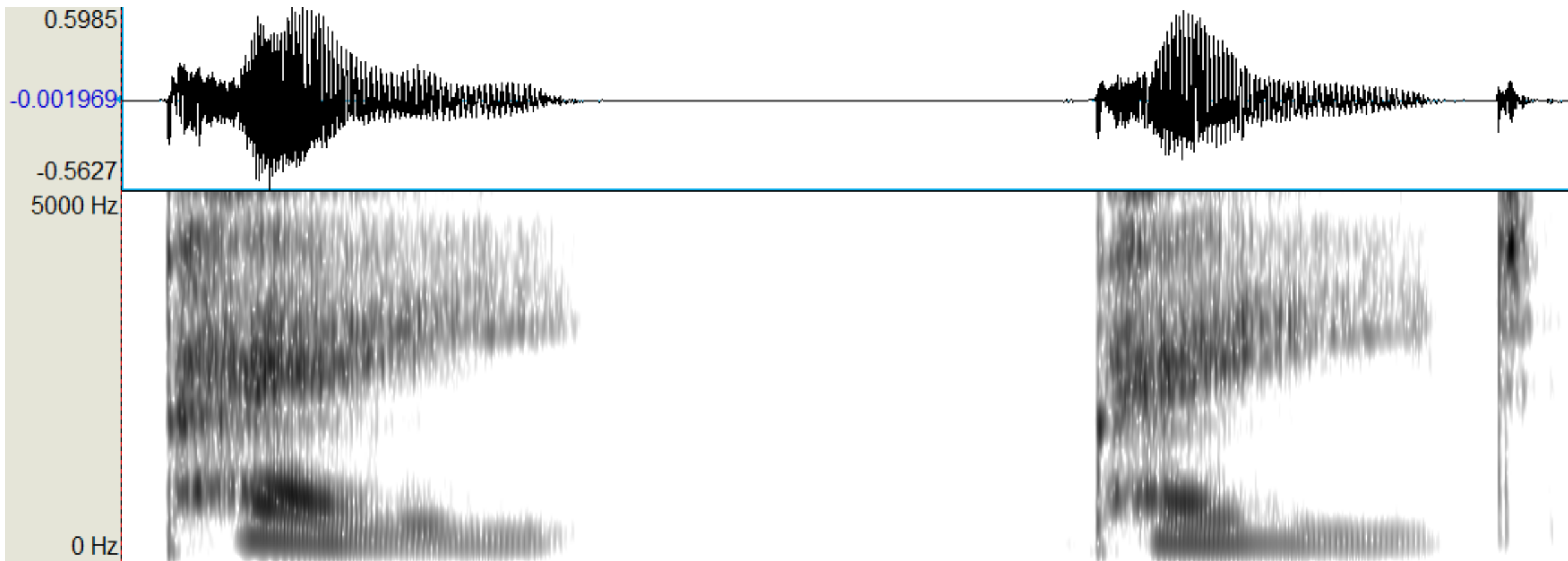
1. Find vowels, guess about syllables
2. Find acoustic events (changes): silence / burst / fricative noise / formants + fricative noise
3. Go from the beginning rightwards or start with the segments you are sure of. Guess what are the segments
4. Find the combination that makes sense
5. Brilliant!

Infinitive and Past Simple forms



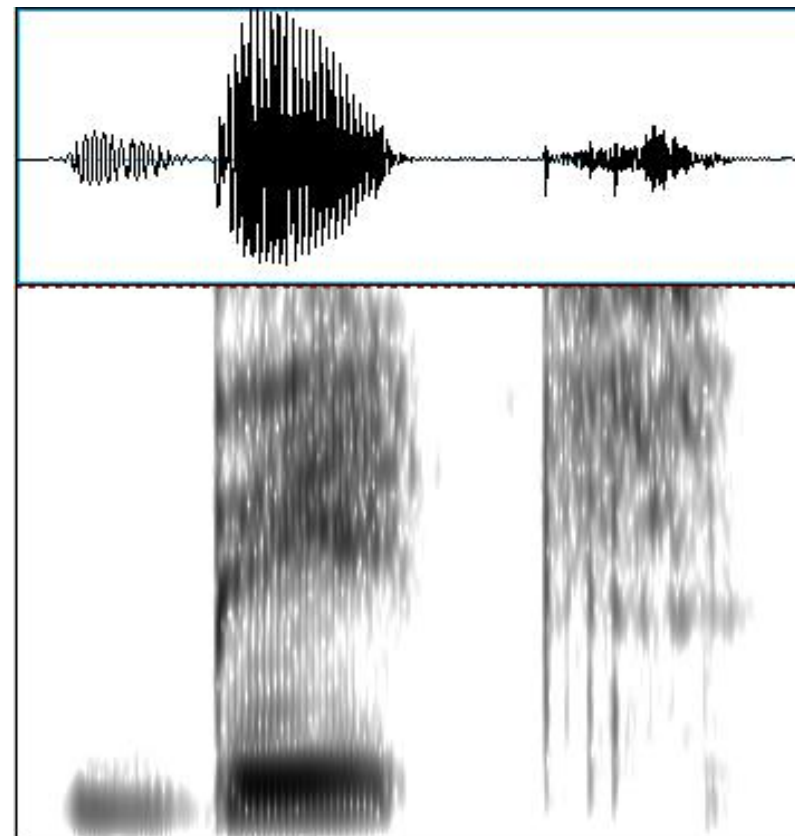
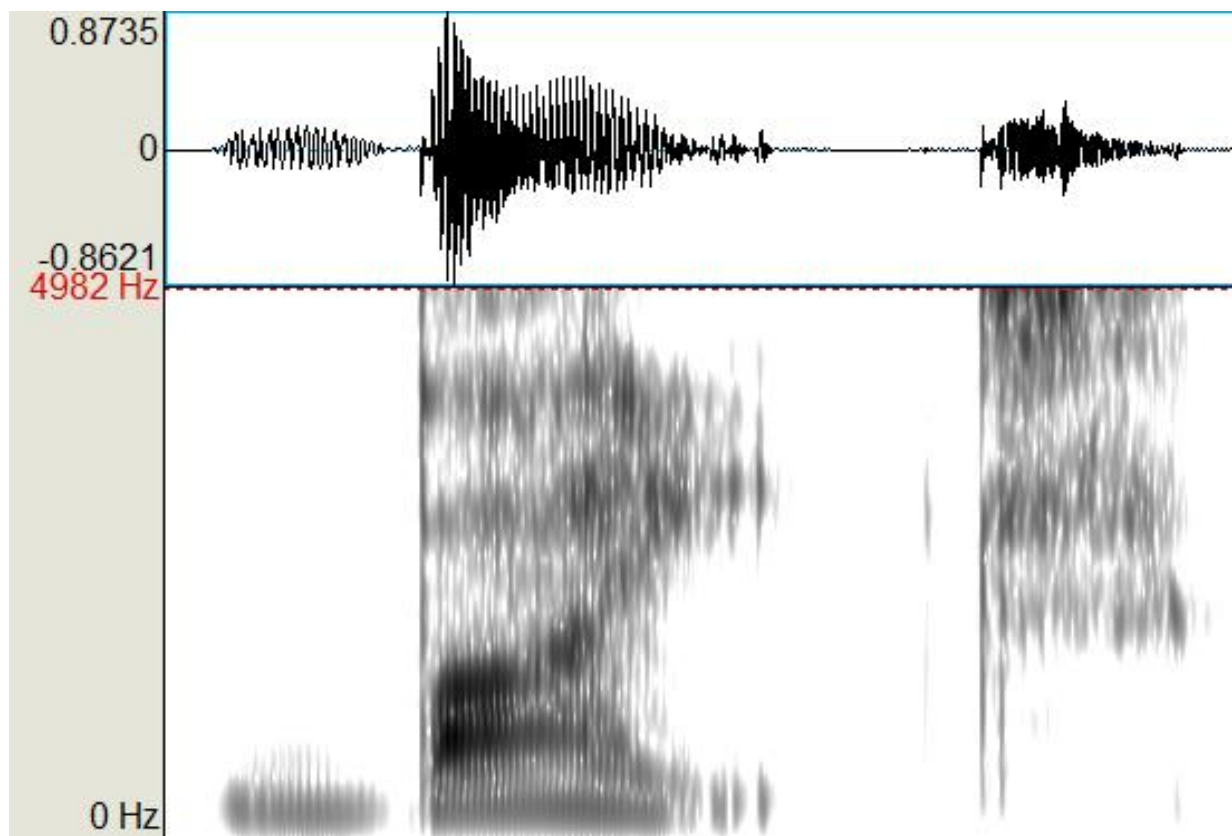
eat, ate

Infinitive and Past Simple forms



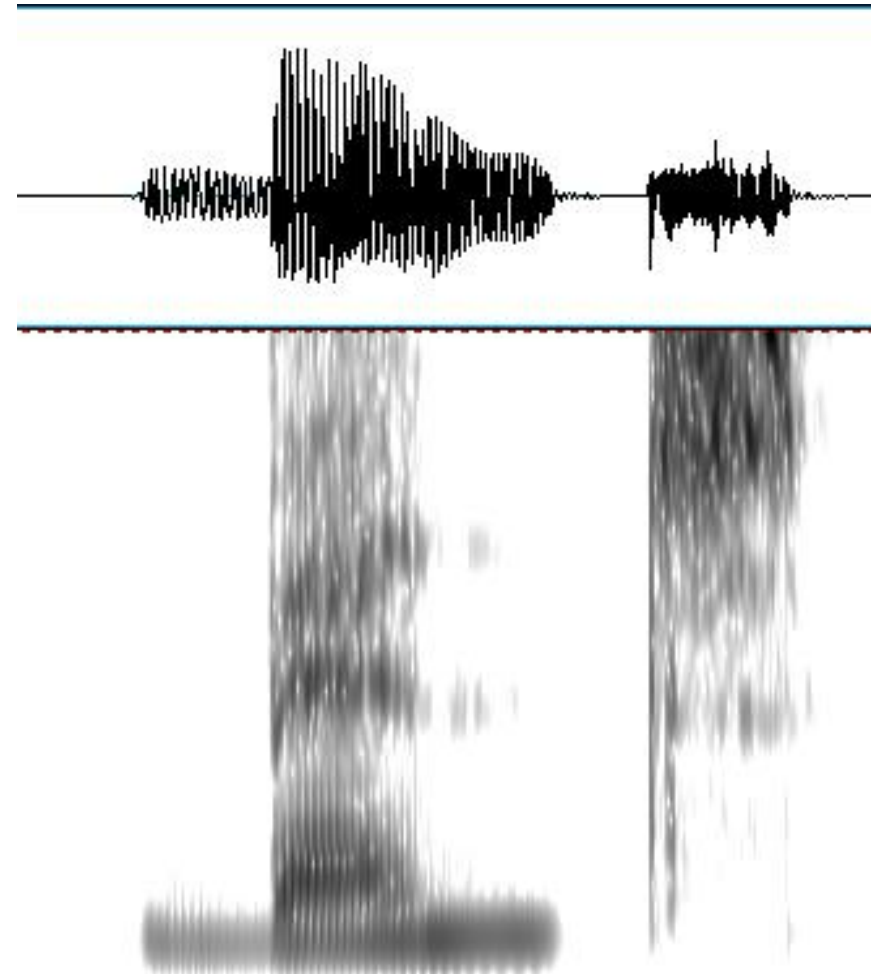
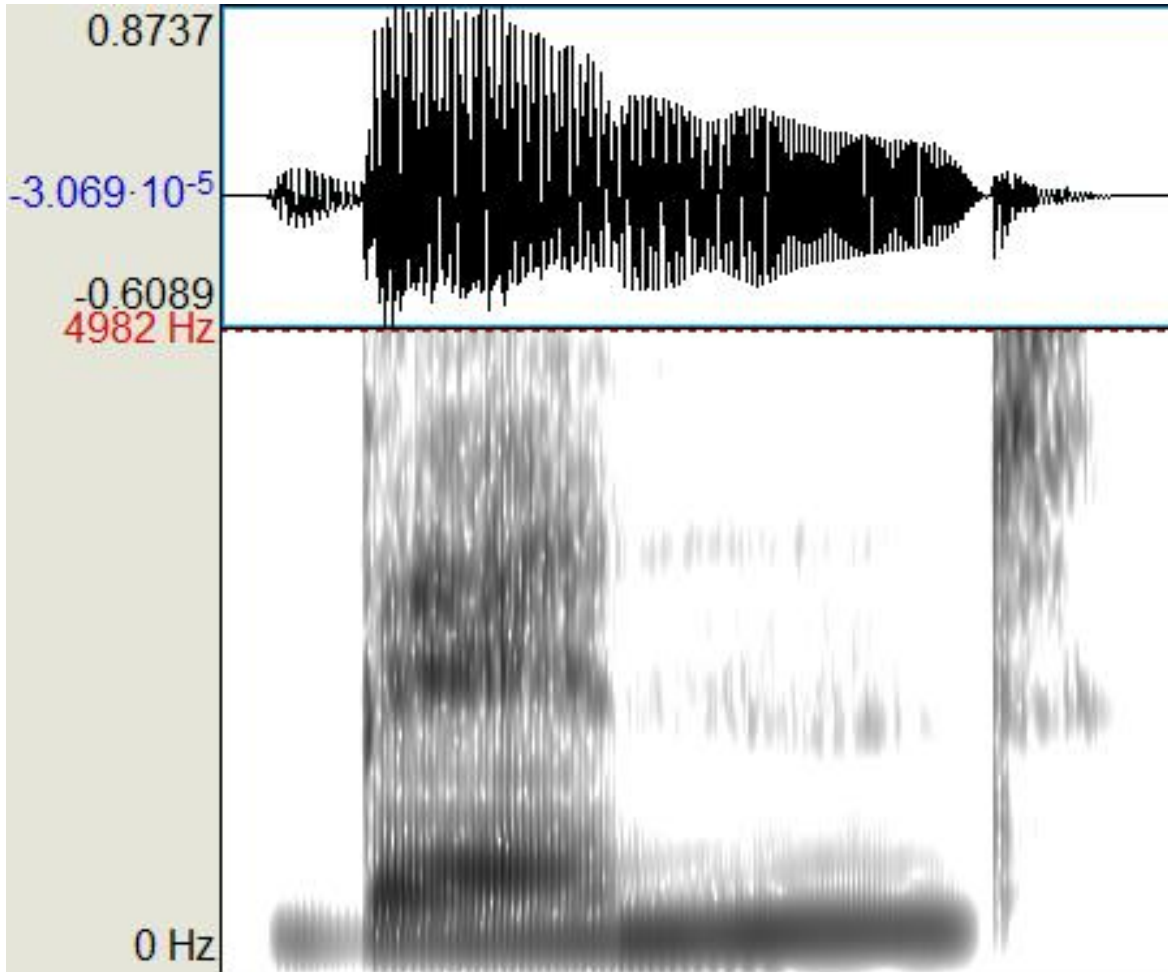
pay, paid

Infinitive and Past Simple forms



bite, bit

Infinitive and Past Simple forms



build
built

draw_drew_drawn

0.214047261

0.865566324

5000

Frequency (Hz)

0

0.214

0.8656

Time (s)

draw
drew

5000

Frequency (Hz)

0

1.286

1.938

Time (s)

Reading

- Ashby M., Maidment J. (2005) Introducing Phonetic Science. CUP.
- Johnson K. (2012) Acoustic and Auditory Phonetics. Wiley-Blackwell.
- Online reading with pictures [here](#) and [here](#).
- Videos about [vowels](#) and [consonants](#), reading practice [1](#) and [2](#).