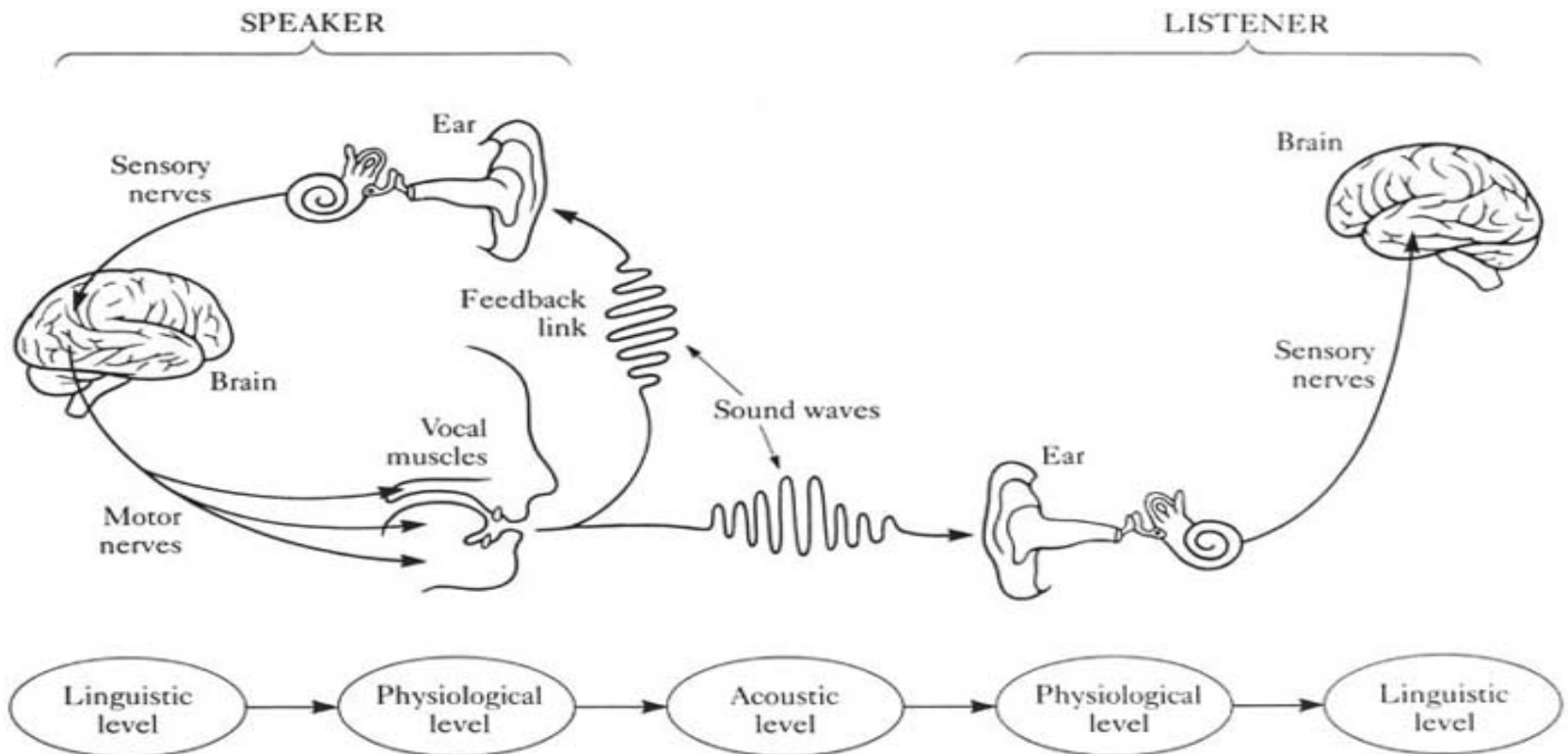# ACOUSTIC PHONETICS

# Overview

- What is acoustic phonetics?
- Introduction to PRAAT
    - →Spectrogram
    - →Oscillogram
- Spectrum
- Summary
- Correlation between acoustic phonetics and auditory phonetics

# What is acoustic phonetics?

- branch of phonetics dealing with

→ physical characteristics of sound waves which carry speech sounds between mouth and ear (transmission of sound)

# Acoustic phonetics in context of phonetics and phonology

- **Phonetics** refers to the physiological and acoustic parts of the following diagram, while **phonology** resides in the brain
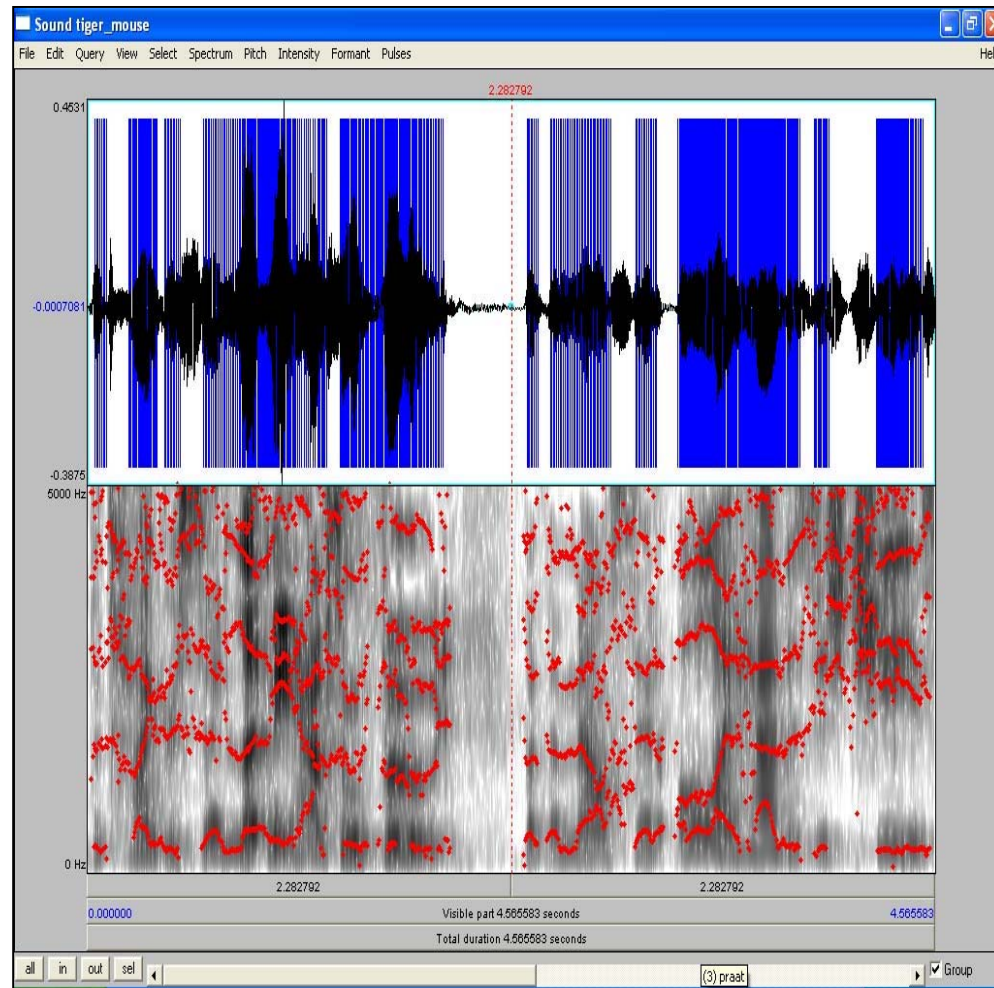


SPEAKER — LISTENER

Sensory nerves — Ear — Brain

Feedback link

Brain — Vocal muscles — Sound waves — Ear — Sensory nerves

Motor nerves

Linguistic level → Physiological level → Acoustic level → Physiological level → Linguistic level

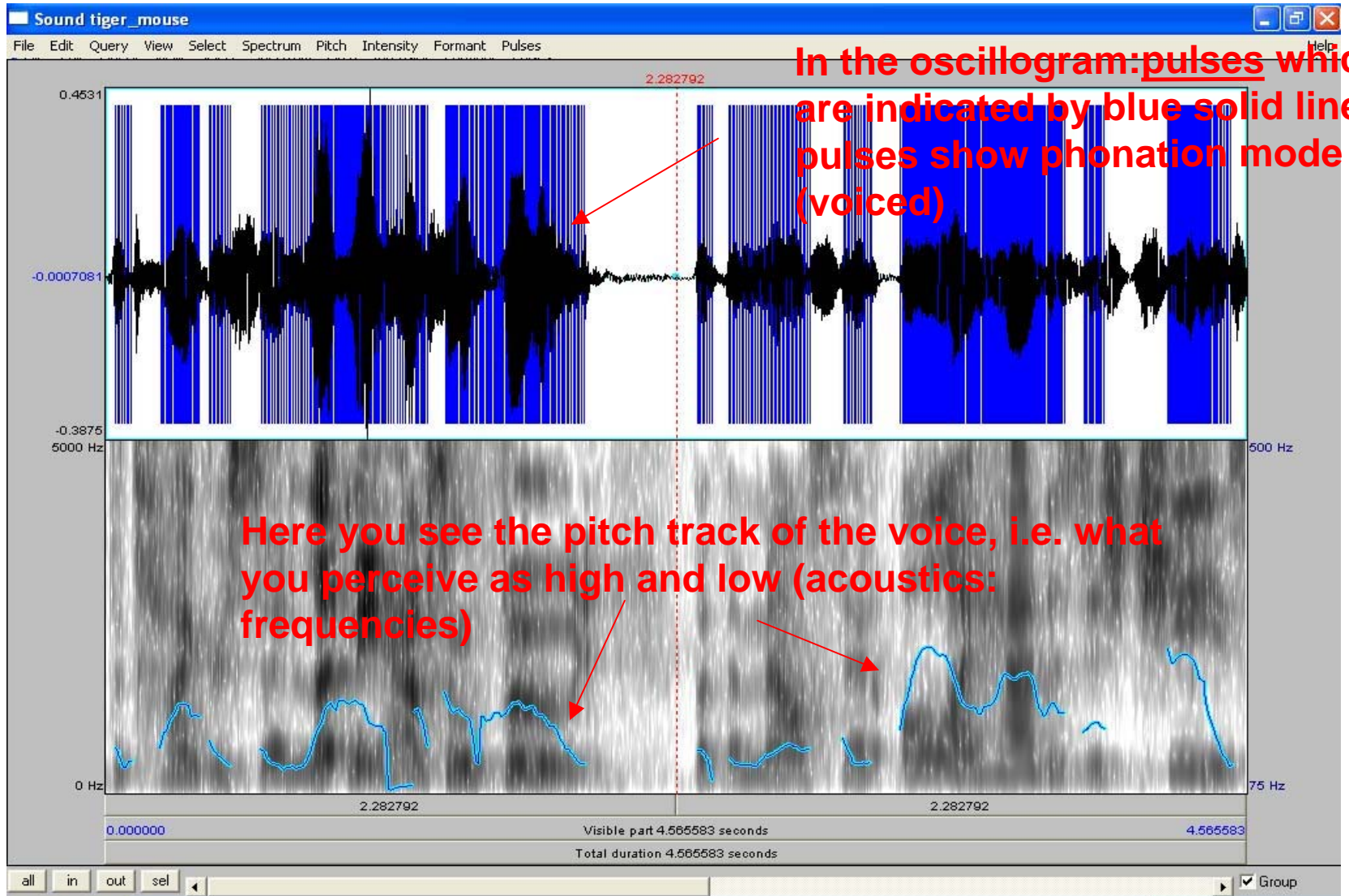(URL: http://www.ling.upenn.edu/courses/Spring_2001/ling001/phonology.html)

# -Acoustic phonetics and PRAAT- What is PRAAT?

- speech sound waves can be analysed in terms of its acoustic properties →

PRAAT: computer program →enables visualizing, playing, annotating, and analyzing of sound object in terms of its acoustic properties (e.g. frequency, pitch, etc.)
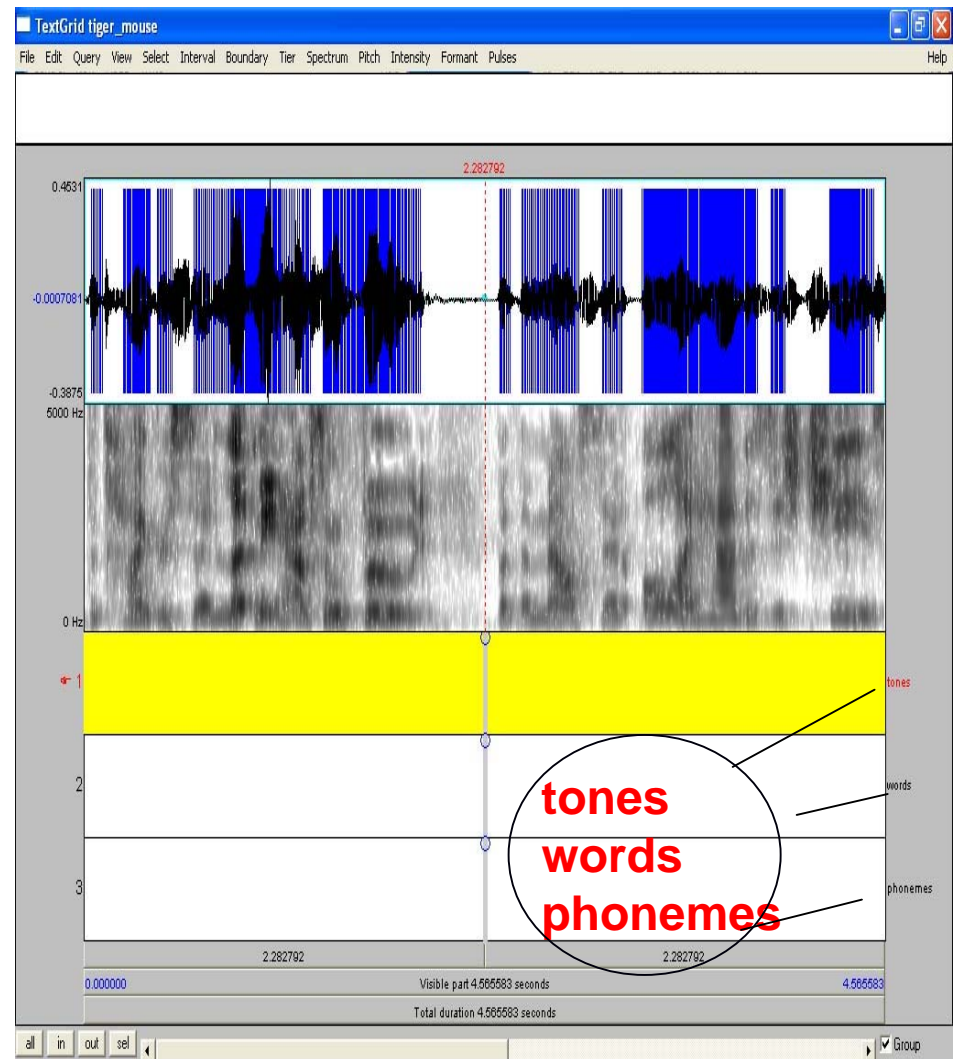
# Pulses and pitch



In the oscillogram:pulses which are indicated by blue solid lines= pulses show phonation mode (voiced)

Here you see the pitch track of the voice, i.e. what you perceive as high and low (acoustics: frequencies)
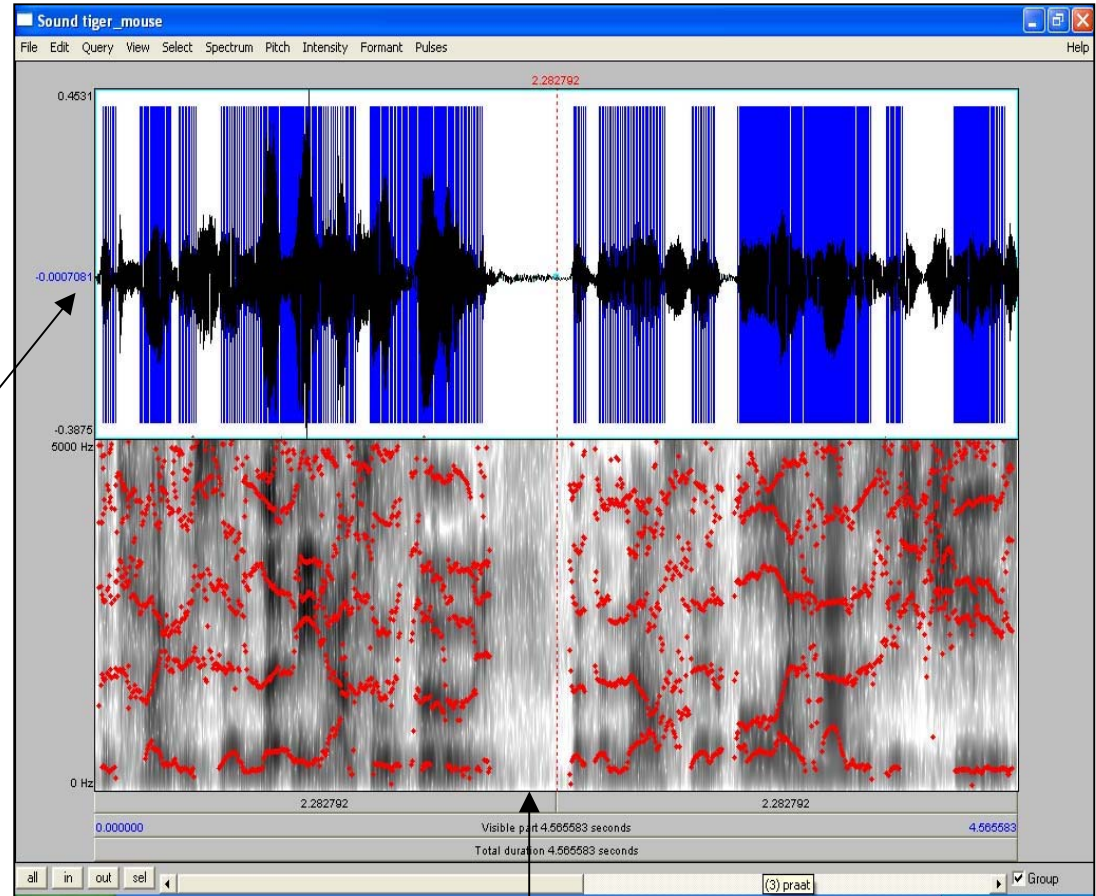
# PRAAT-tiers (layers/levels)-

- tiers are used to segment a speech waveform and attach labels for each segment for further processing

# What does PRAAT show?

- **Speech acoustic analysis can be realized by using:**

→ **spectogram & oscillogram**

oscillogram



Sound tiger_mouse

File  Edit  Query  View  Select  Spectrum  Pitch  Intensity  Formant  Pulses          Help

0.4531

2.282792

-0.0007081

-0.3875
5000 Hz

0 Hz

2.282792                                          2.282792

0.000000                          Visible part 4.565583 seconds                          4.565583

Total duration 4.565583 seconds

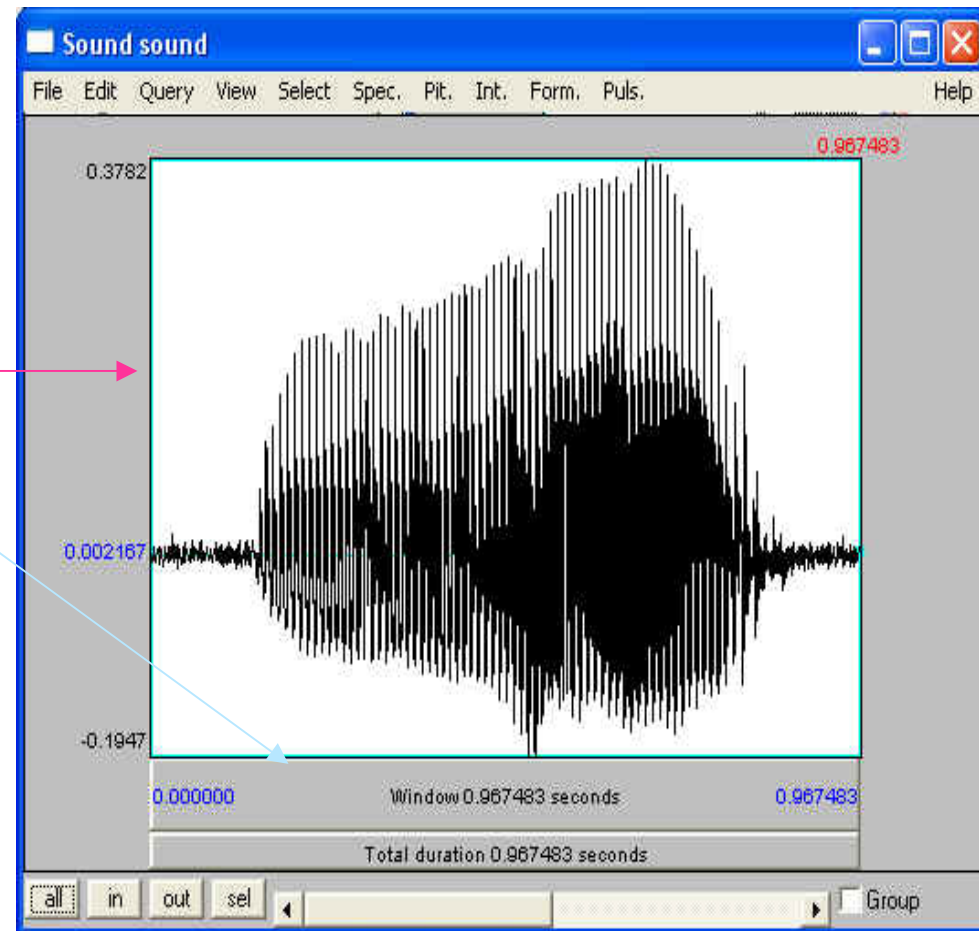all  in  out  sel                                        (3) praat                    ☑ Group

spectogram

# What is an oscillogram?

- **represents speech signals**

→vertical axis: amplitude

→horizontal axis: time

(total duration)

# Spectogram

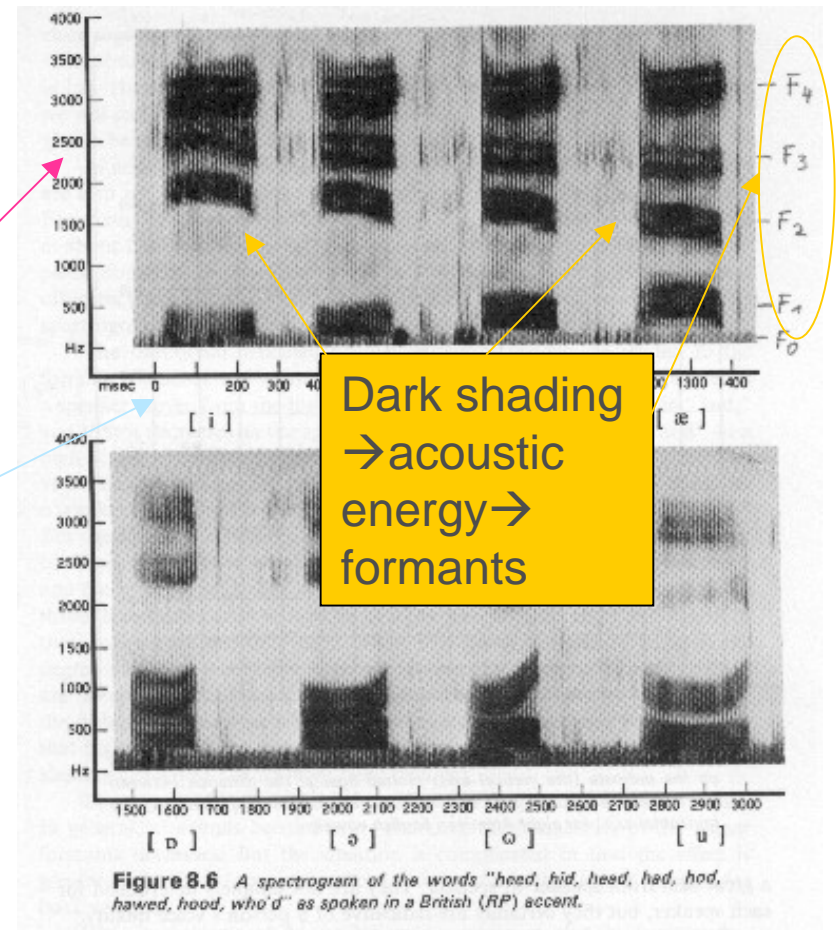- **graphic representation of sounds in terms of their component frequencies**

Three dimensions:

→vertical axis: frequency

→horizontal axis: time

→dark shading (third dimension): acoustic energy (formants F1, F2, F3)

Dark shading →acoustic energy→ formants

**Figure 8.6** *A spectrogram of the words "heed, hid, head, had, hod, hawed, hood, who'd" as spoken in a British (RP) accent.*

# What is frequency?

- **number of cycles completed per second; measured in Hertz (Hz)**

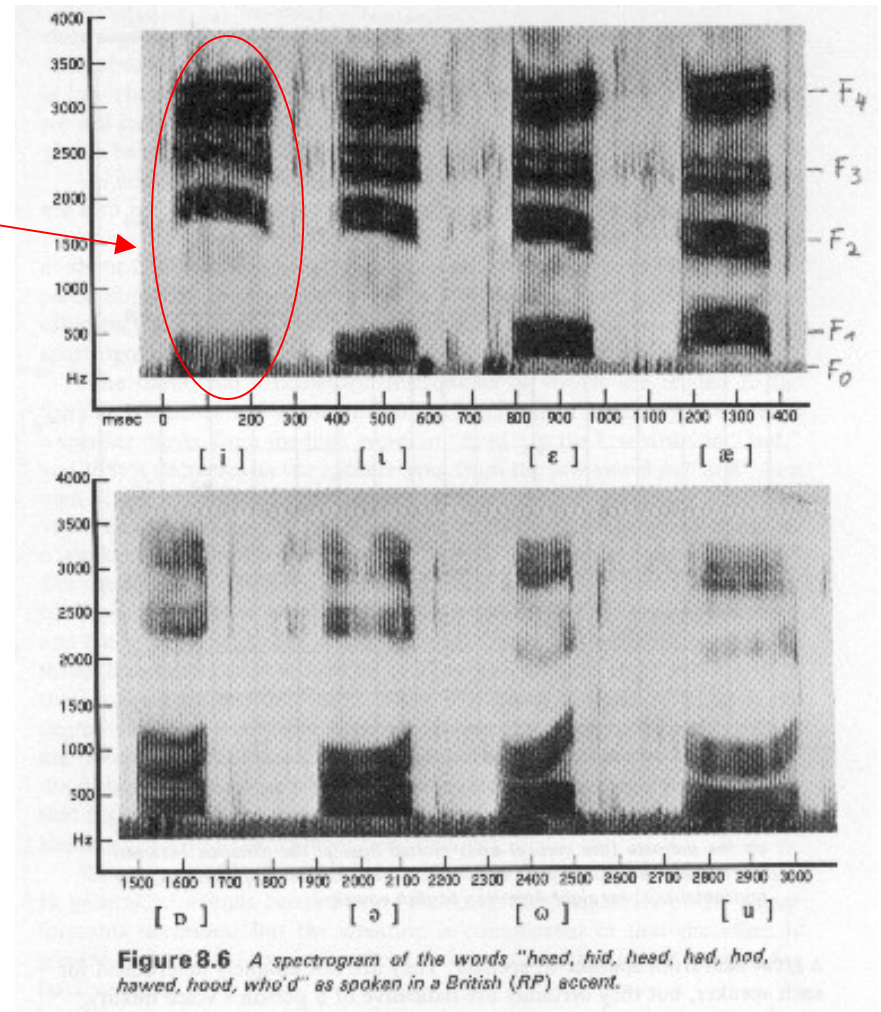- **when the cycle meets the axis for the second time, one cyle is completed: one cycle**
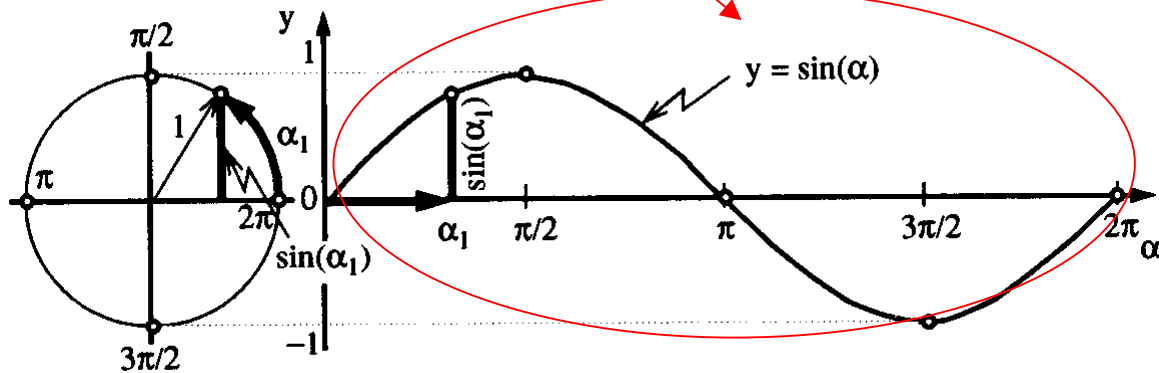


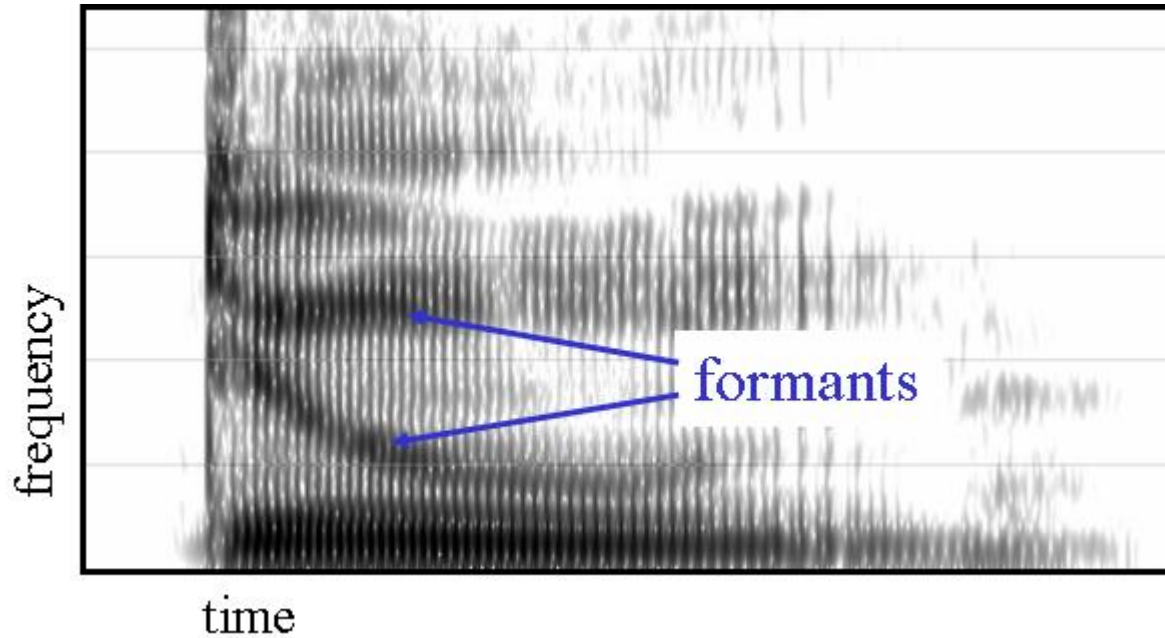Sine wave: simplest kind of periodic wave→ made by an ideal tuning fork

Lowest frequency sine wave component→fundamental frequency (fo)

# What are formants?

- **Spectogram also shows formants**

→concentration of acoustic energy

→group of overtones corresponding to a resonating frequency of the air in the vocal tract

→vowels are characterized by three formants (F1, F2, F3)



Figure 8.6 *A spectrogram of the words "heed, hid, head, had, hod, hawed, hood, who'd" as spoken in a British (RP) accent.*
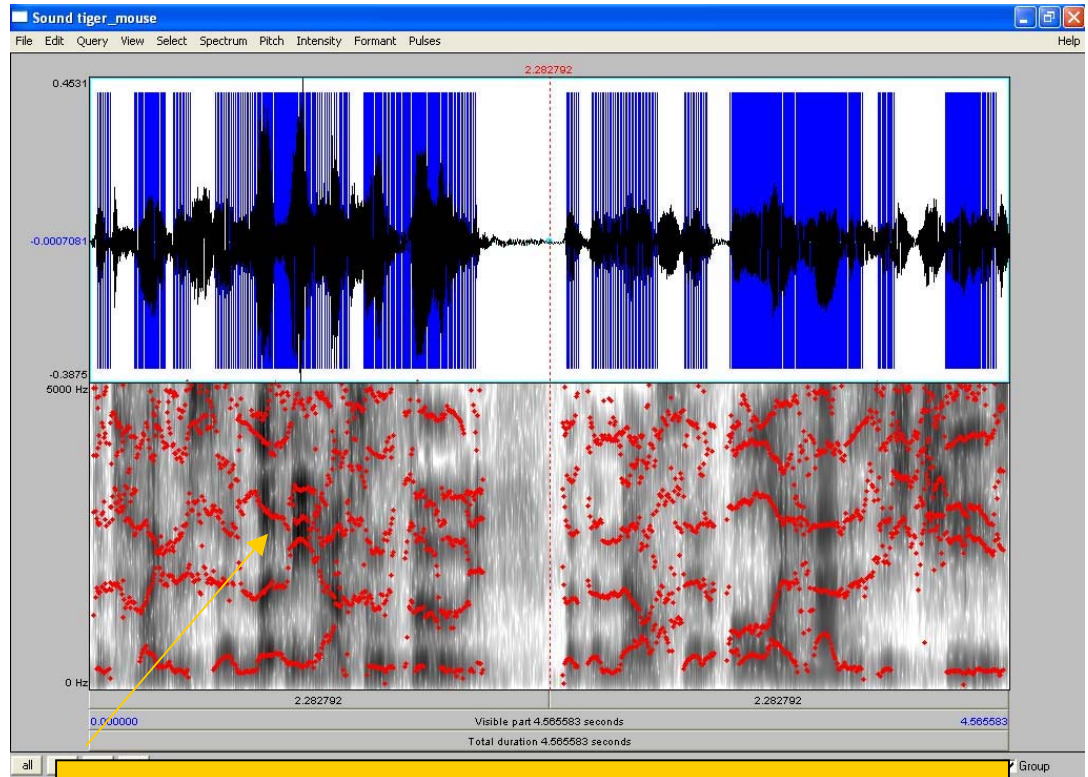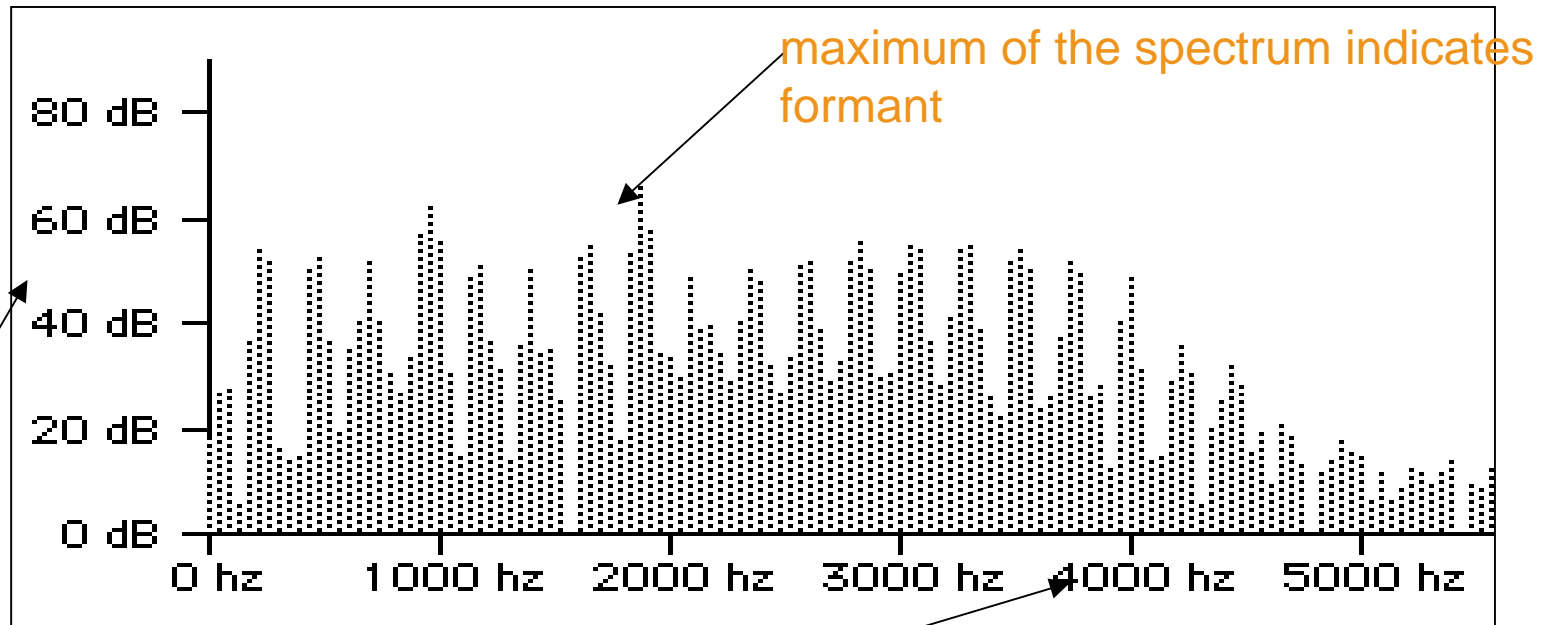
# Formants

# Formants in PRAAT

- formants in PRAAT are also shown by 'red dotted lines' in the spectogram



The 'red dotted lines' and especially dark shadings show the formants

# Spectrum

- **spectrum: only shows frequency and amplitude→no relation to time**
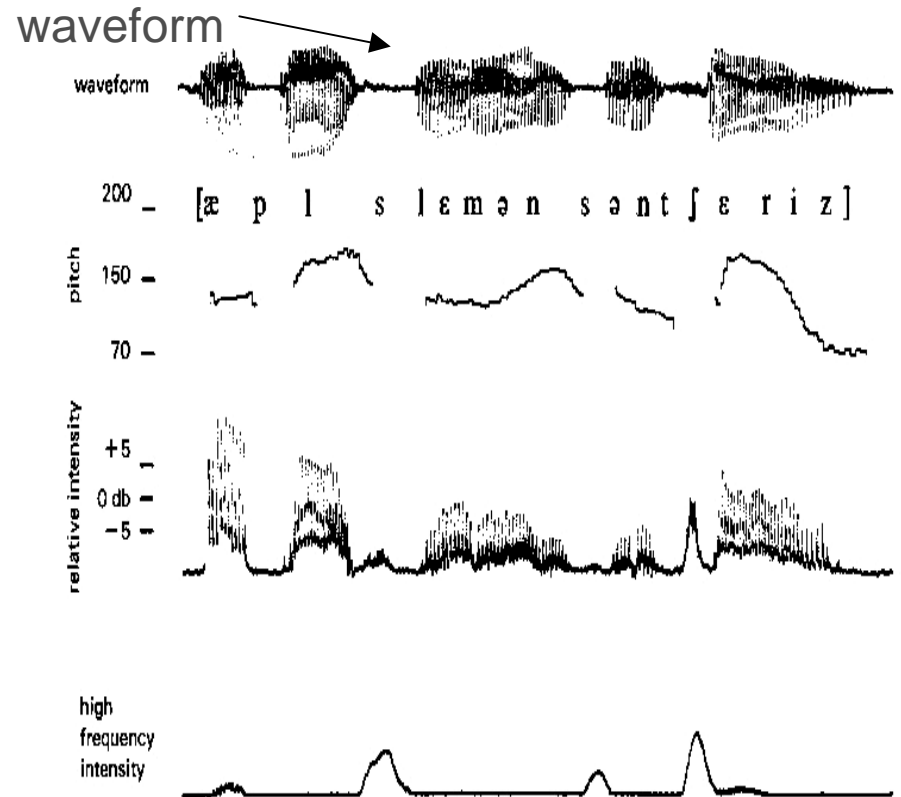
maximum of the spectrum indicates formant

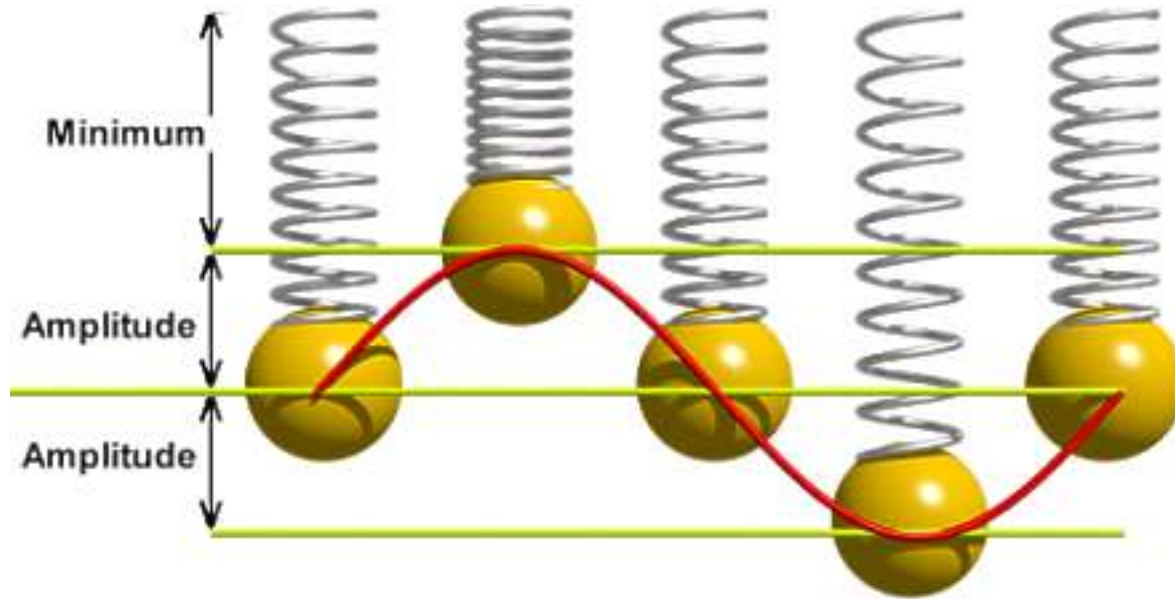vertical position shows amplitude

horizontal position shows frequency

# What is amplitude?

- given in an oscillogram

- displacement of the vibrating medium from its rest position (example: tuning fork)

- measured in relation to time, measured in dB

# Amplitude

# Summary

spectogram
(representation in PRAAT)

y-axis: frequency (Hz)

x-axis: time (sec)

third dimension: dark shading (intensity➔ formants; dB)

oscillogram
(representation in PRAAT)

y-axis: amplitude

x-axis: time

spectrum
(no representation in PRAAT)

y-axis: amplitude

x-axis: frequency

# Correlation between acoustic phonetics and auditory phonetics

| Acoustic phonetics | Auditory phonetics |
|---|---|
| frequency (measured in Hz) | perceived as pitch |
| amplitude (measured in dB) | perceived as loudness |
| duration (measured in time) | perceived as speech tempo |