auditory scene analysis

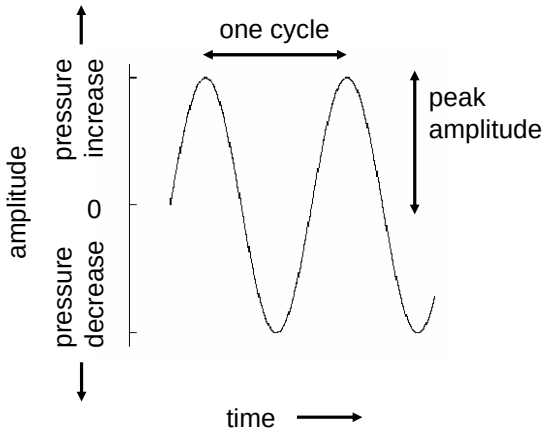
auditory information

- unique
- small movements
- survival
- communication

sound waves

- pressure fluctuations, that follow a source's movements
- a bit like waves on water
- but 3D and fast

sine waves



- cycles, frequency, f, Hz & kHz
- peak amplitude, power dB(SPL)

  f = 250 Hz, 5 dB steps

  f = 1000 Hz (1 kHz), 5 dB steps

  f = 4 kHz, 5 dB steps

frequency code

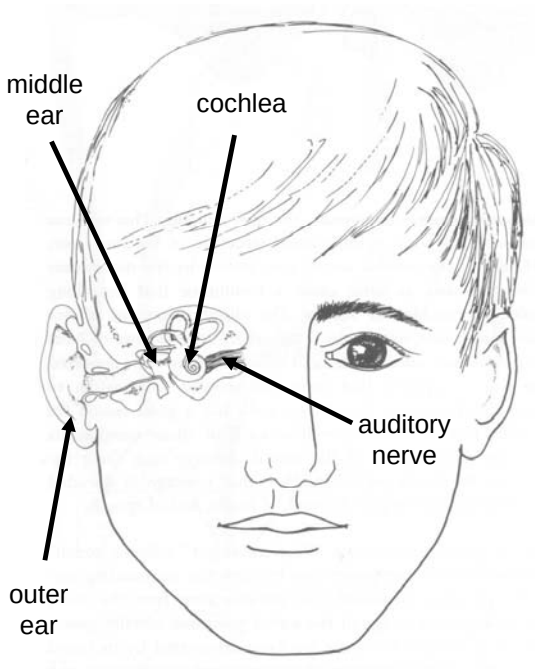
- auditory nerve
- about 25,000 fibres
- not a spatial code
- codes sounds' frequencies

frequency components

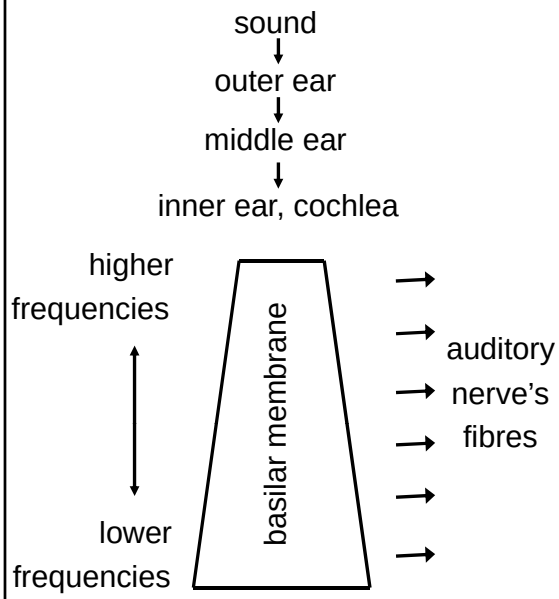
- everyday sounds
- numerous sine-wave components
- different f & dB for each one
- frequency, 'Fourier' analysis
- spectrum

Ohm's acoustical law

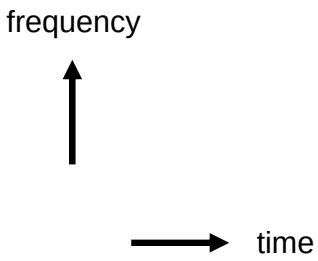
- ear does a Fourier analysis
- different frequencies in different nerve-fibres



basis of Ohm's law



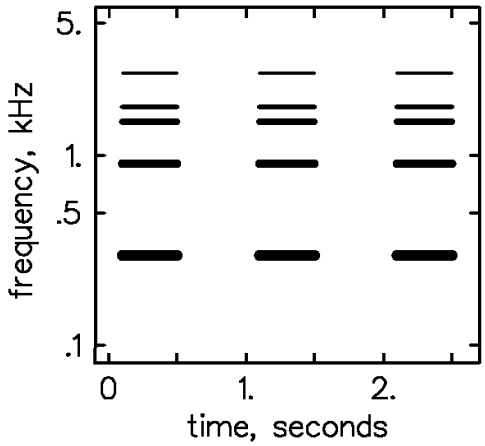
auditory scene



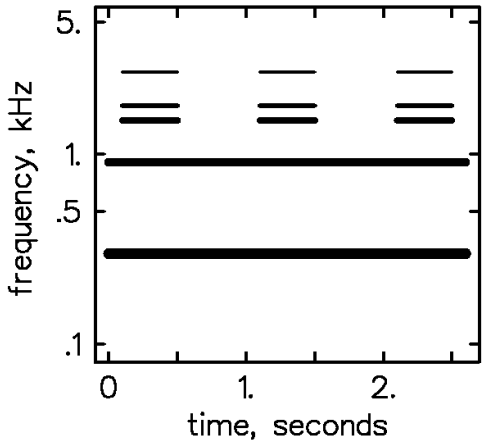
analysis

- accompanied by synthesis
- why?

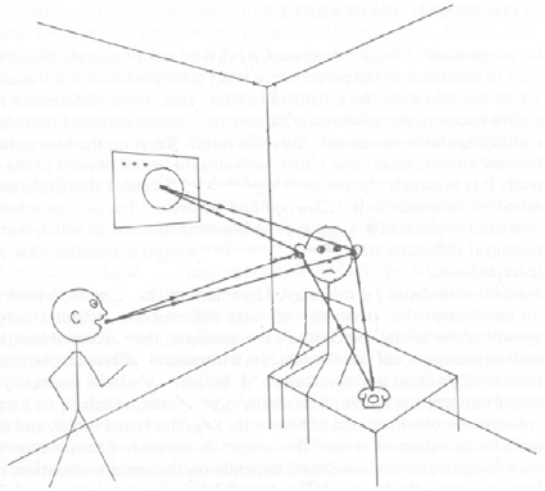
perceptual grouping



grouping and segregation



helps solve selection problem



interleaved phrases

letters interleaved horizontally:

ONTOHTEERS MOEFL OODNYES MNEOLTOEDSY

clearer with vertical separation:

N O T E S O F O N E M E L O D Y

O T H E R M E L O D Y'S N O T E S

interleaved melodies

notes interleaved in time

notes separated in frequency range

or not separated

	frequency range	
	low	high
melody 1 :		
melody 2 :		
interleaved, same frequency ranges:		

interleaved, different frequency ranges:

now a different pair

frequency range

low high

interleaved, same frequency ranges:

interleaved, different frequency ranges:

pitch of periodic complex tones

- fundamental, f
- harmonics, 2f, 3f, 4f, 5f etc
- pitch = sine wave, frequency f
- vary f, play a tune

missing fundamental

- e.g., 3f & 4f & 5f, or 6f & 7f & 8f
- pitch = f

random harmonics, e.g.:
1st note: 2f & 3f & 4f,
2nd note: 4f & 5f & 6f

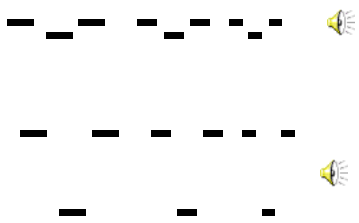
distortion hypothesis

- 'non-linear' distortion reintroduces fundamental

masking the distortion

- each note, two parts:
  1st: sine wave, frequency f
  then: 4f & 5f & 6f
- vary f, play a tune
- low frequency noise,
  masks f

streaming by a pitch difference



interleaved xylophones

similar pitch ranges

different pitch ranges

timbre

- vs loudness, duration, pitch

timbre from spectrum's 'shape'

- dB of components plotted against their frequencies
- helps distinguish among instruments

addition,
successively higher components
one at a time:

timbre from attack

- abruptness of onset
- bowed violin (smooth)
- piano tone (sharp)

notes: → ← ←

tape: → → ←

context

- also influences timbre

streaming by a timbre difference

interleaved xylophones

similar timbres

different timbres

phoneme differences

- essentially, variations in timbre
- “she” and “shoe”,
  shape of spectrum
- “shoe” and “chew”,
  attack
- ‘segmental information’

intonation and stress

- essentially, variations in pitch, loudness and duration
- ‘suprasegmental information’
- e.g. “shoe” vs “shoe?”

speech recording

synthesized version

pitch raised

football results

away team’s score deleted