Acoustic Phonetics I: Introduction

3rd February 2009

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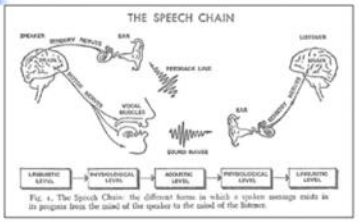
The speech chain



from Denes & Pinson (1993)
http://aanugraha.wordpress.com/2008/02/25/the-speech-chain-and-phonetics/

Phonetics

- Articulatory phonetics
  - ... accounts for the changing configurations and other actions of the speaker's vocal apparatus
- Acoustic phonetics
  - ... consists of statements about the physical consequences of articulatory actions in terms of vibratory patterns of air molecules within the vocal apparatus and in the air between the speaker and the listener.
- Auditory phonetics
  - ... concerns the perceptual impressions of the listener receiving the acoustic information.

(Laver, 2003: 156)

Why study acoustic phonetics?

- Confirms what we think we hear.
- Helps us classify sounds with greater sensitivity than investigations based on articulation.
- Quantify speech objectively.
- Speech displays are used to provide learners with feedback in a number of pieces of popular software

TellMeMore French
from *Auralog*

What is sound?

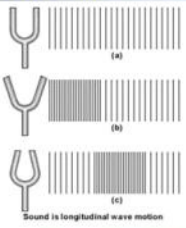
Watch again at:
http://uk.youtube.com/watch?v=MFLeGJclQJI&feature=related

What are sounds?

- Sounds are longitudinal pressure waves
- Particles move in a chain reaction

Image: http://www.jcbenergy.com/node/18

Particle movement in a sound wave



Sound is longitudinal wave motion

http://www.educationalelectronicsusa.com/p/wave-II.htm

Particle movement in a sound wave (2)

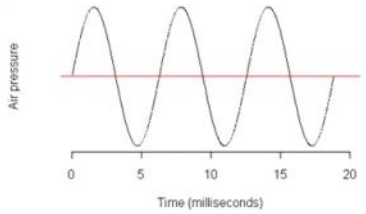
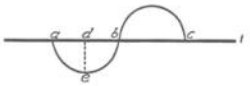


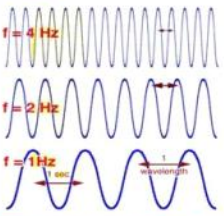
Image: http://home.cc.umanitoba.ca/~krussll/phonetics/acoustic/sound-waves.html

Properties of waveforms



- Amplitude
  - Maximum pressure change (d to e)
  - Maximum displacement of air particles
  - Also referred to as intensity, corresponds to perceived volume
  - A sound with twice the amplitude is not perceived as twice as loud
  - The larger the pressure change or displacement, the louder the sound; the smaller the pressure change or displacement, the quieter the sound
- Period
  - Time taken to complete one cycle (a to c)
  - Measured in seconds

Frequency

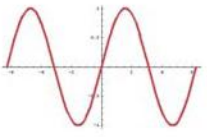


- Cycles per second
- Measured in Hertz (Hz)
- Corresponds to perceived pitch
- Calculation:
  - $f = 1 \div \lambda$
  - Where λ is the period of the wave measured in seconds

https://bbamusic.wikispaces.com/Three+Components+of+Sound

Simple waves

- Pure sounds, e.g. tuning fork
- Simple regular shape
- Sine wave (sinusoidal)
- Single source



Complex waves

- The sound produced by a string is a complex wave
- Different parts of the string can vibrate in different ways at the same time
- Speech is a complex wave
- There are multiple sound sources: vocal cords, tongue, etc.
- Different parts vibrate simultaneously at different frequencies

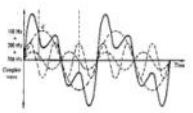


Image: http://www1.appstate.edu/~kms/classes/psy3203/SoundPhysics/waveaddition1.jpg

Adding waves

- The complex wave results from adding the amplitude values of the simple waves at each moment in time.

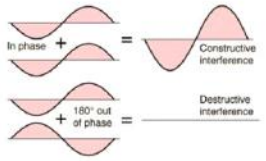
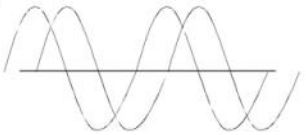


Image: http://www1.appstate.edu/~kms/classes/psy3203/SoundPhysics/phase_interference.gif

Phase

Phase refers to whether waves are in synchronization with each other



These waves have the same frequency and amplitude, but different phase

Complex waves

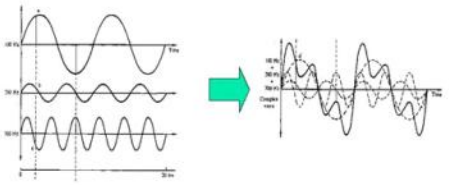
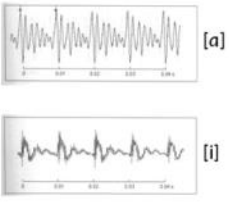


Image: http://www1.appstate.edu/~kms/classes/psy3203/SoundPhysics/waveaddition1.jpg

Distinguishing speech sounds

- Speech sounds can differ in:
  - Amplitude or volume/loudness
  - Frequency or pitch
  - Timbre or quality



Ladefoged (2005)

Timbre: Periodic vs aperiodic waves

- Periodic
  - Wave shape is repeated
  - Voiced speech sounds, e.g. vowels "ah"
- Aperiodic
  - Wave shape is not repeated
  - Voiceless speech sounds
  - Fricatives "sh"

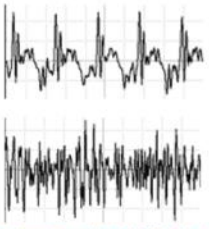


Image: http://www.vias.org/physics/bk3_03_05.html

Summary

Longitudinal wave, Amplitude, Cycle, Period, Frequency, Pure tone, Sine wave, Complex wave, Phase, Timbre, Quality, Periodic, Aperiodic

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