Acoustic Phonetics

Lesson 9a

- What is coarticulation
- Basic principles of coarticulation

Movement coordination

- When we speak we move our lips, our tongue and our jaw very rapidly
- The brain coordinates the movements of the articulatory organs very accurately, to the point that the movements for each vowel and consonant are produced simultaneously

Dynamics of Speech production

- Speech is a dynamic rather than a static phenomenon
  - the articulators are in a state of constant movement during speech
- Individual speech sounds are described in terms of target positions; ongoing speech is better thought of in terms of movement

Dynamics of Speech production

- Sounds in a word don't follow each other like printed letters
- spoken sounds overlap with each other
  - this is referred to as CO-ARTICULATION

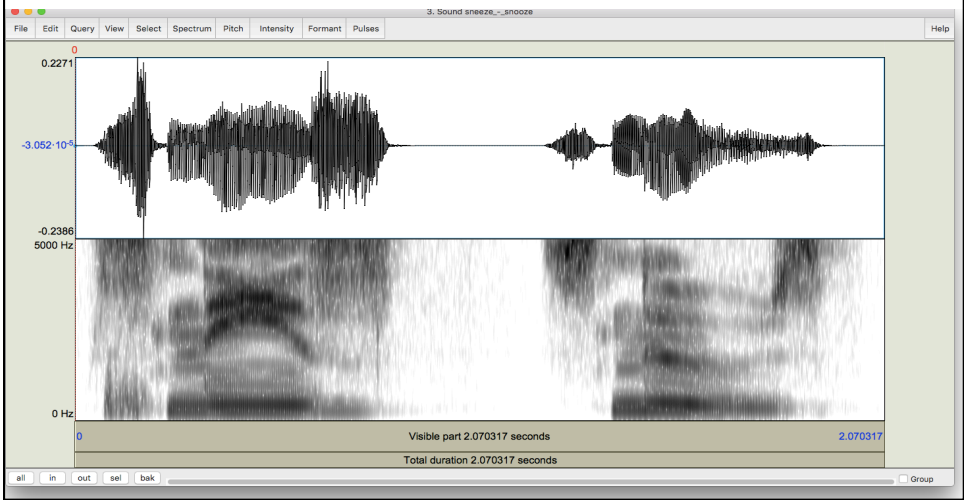
Co-articulation

- as the articulators are in the process of forming one sound, their positioning prepares them for the sound that follows
- speech sounds influence and are influenced by other sounds within a phonetic environment

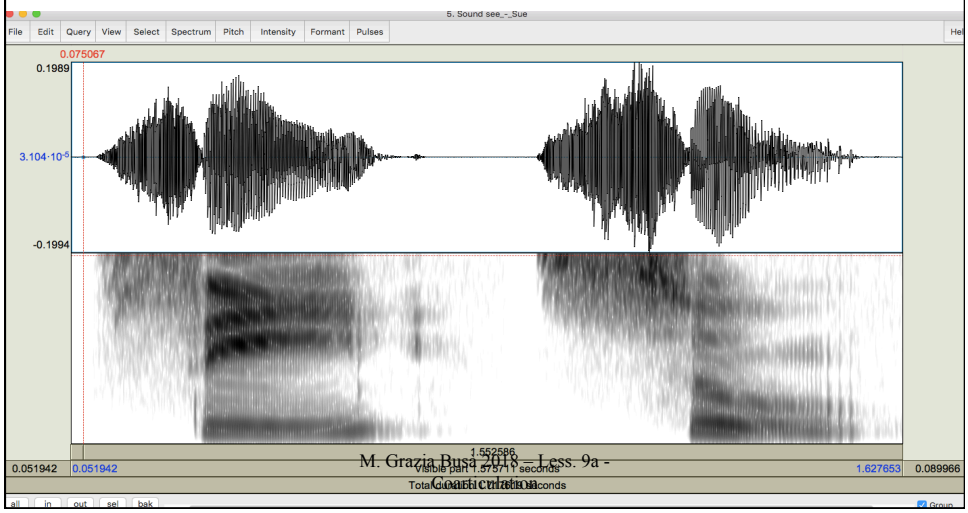
Examples of co-articulation

- sneeze ~ snooze; see ~ Sue

sneeze ~ snooze



see ~ Sue



Planning sound sequences

- the dynamic nature of speech means that we are planning events before they occur
- we may articulate one segment before completing another
  - we may be as many as several segments ahead or behind in our motor activity

Why do we have coarticulation?

demands on the speech mechanism:

- normal conversation is produced at a rate of between 10-20 segments/second which implies a maximum of 100msec/segment
- however, it takes much longer than this to complete any speech gesture and then return to the starting point

→ **compromise gestures**

How can coarticulation phenomena be explained?

- The movements of the articolatory organs are planned at the cerebral level
- It is possible that, at the level of motor-sensory planning, each articulator must reach a target position for each phoneme.
- This target would be the ideal articulation for each phoneme.
  - Its specific characteristics would depend on the speaker's physiology and linguistic experience.

Articulation of sounds

- The articulators that are involved in the production of sounds work according to precise temporal patterns (e.g., stops)
- The articulatory gestures involved in the production of sound sequences must be coordinated very accurately
  - E.g.: opening and closing of the velum for the pruduction of the word [mansen]

Overlapping gestures

- To produce sequences of sounds the articulatory gestures overlap
- Due to coarticulation every sound is modified by the preceding and following sound
- Coarticulation may occur within- and across- word boundaries

Effects of coarticulation

- Coarticulation assures that speech production is a continuous and not an interrupted process
- The information on the overlapping gestures allow the listener to reconstruct the articulatory gestures and thus understand the utterance

➡ Coarticulation helps us communicate

An example

- During the production of [s] in the sequences

[su] [si] [sa]

the lips are:

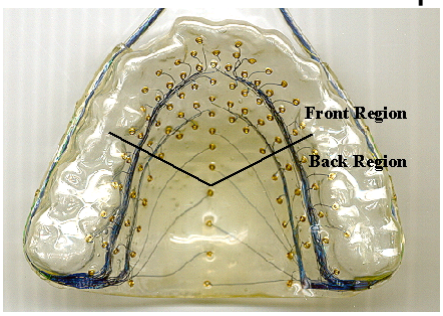
Rounded in anticipation of [u]

Flat in anticipation of [i]

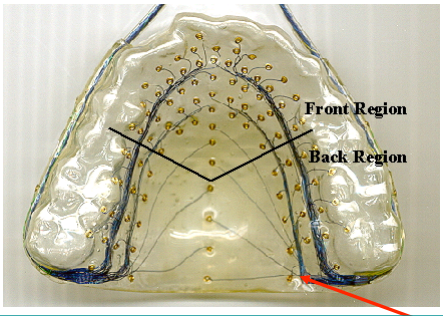
In intermediate position in anticipation of [a]

A tool used in coarticulation studies

- the palatograph



What is the palatograph



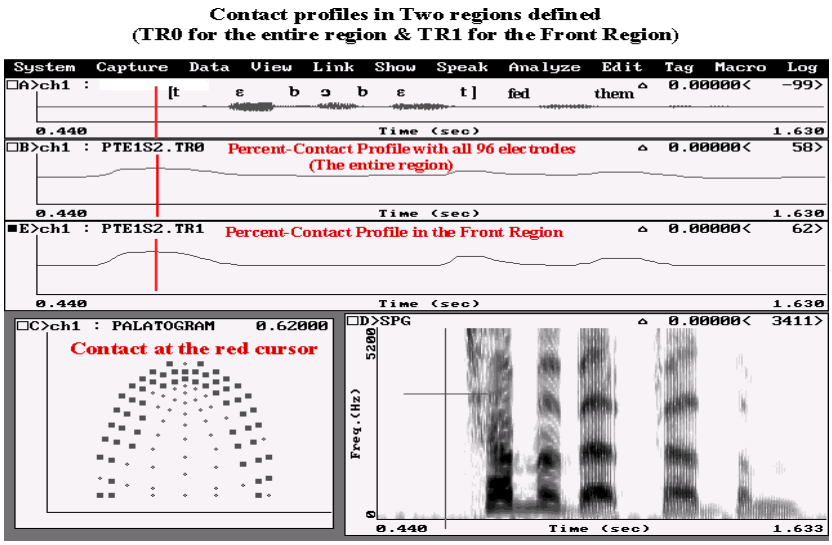
The palatograph is used in coarticulation studies

The contact of the tongue with the palate activates the electrodes on the palatograph

the number and position of the activated electrodes allows us to see how and where the articulation occurs in the selected sequence

http://www.humnet.ucla.edu/humnet/linguistics/faciliti/facilities/physiology/epg.html#3D

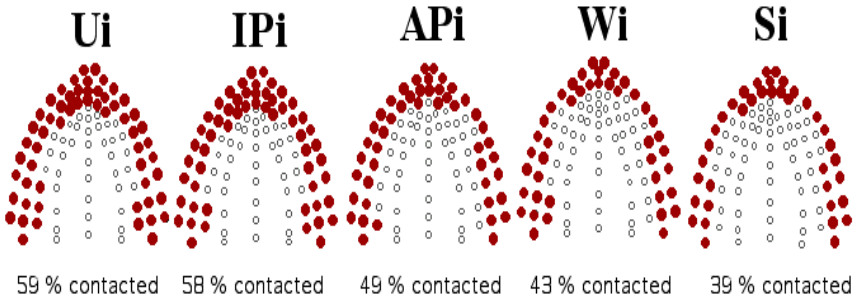
Analysis of the palatographic data



http://www.humnet.ucla.edu/humnet/linguistics/faciliti/facilities/physiology/epg.html#3D

An example of coarticulation detected with the palatograph (from French)

- Ui = Utterance-initial,
- IPi = Intonational Phrase-initial (= Ui-medial)
- APi = Accentual Phrase-initial (= IP-medial)
- Wi = Word-initial (= AP-medial)
- Si = Syllable-initial (= W-medial)

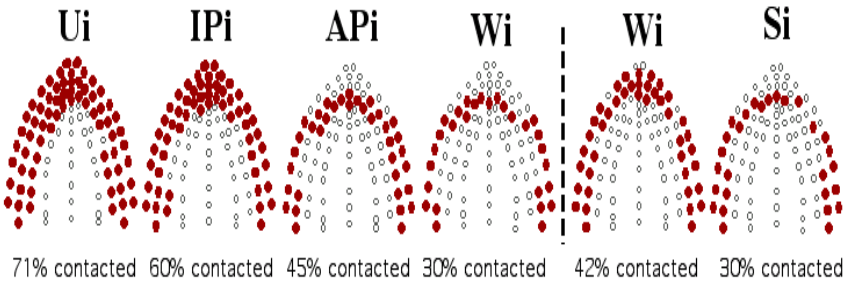


Differences in linguopalatal contact for French [n] as a function of prosodic position.

http://www.humnet.ucla.edu/humnet/linguistics/faciliti/facilities/physiology/epg.html#3D

An example of coarticulation detected with the palatograph (from Korean)

•Ui = Utterance-initial,
•IPi = Intonational Phrase-initial (= Ui-medial)
•APi = Accentual Phrase-initial (= IP-medial)
•Wi = Word-initial (= AP-medial)
•Si = Syllable-initial (= W-medial)

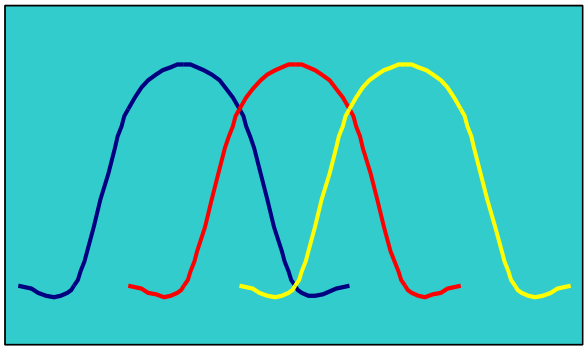


Differences in linguopalatal contact for Korean [n] as a function of prosodic position.

http://www.humnet.ucla.edu/humnet/linguistics/faciliti/facilities/physiology/epg.html#3D

Representation of a sequence of phonemes…

as a sequence of gestures overlapping in time



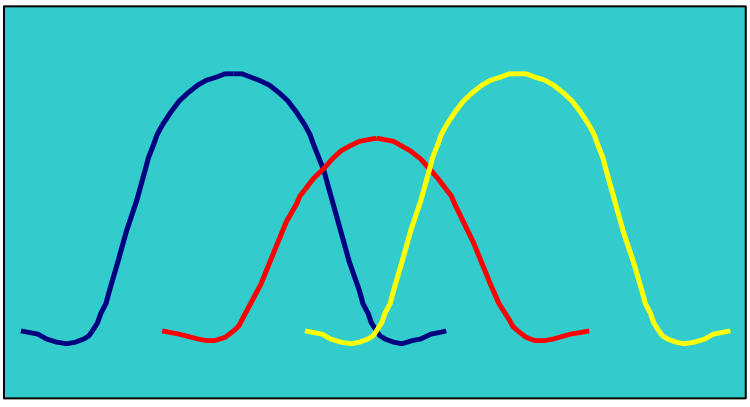
C V C

Source: Alexei Kochetov, Contrast in Phonology, University of Toronto, May 3-5, 2002

"undershoot"

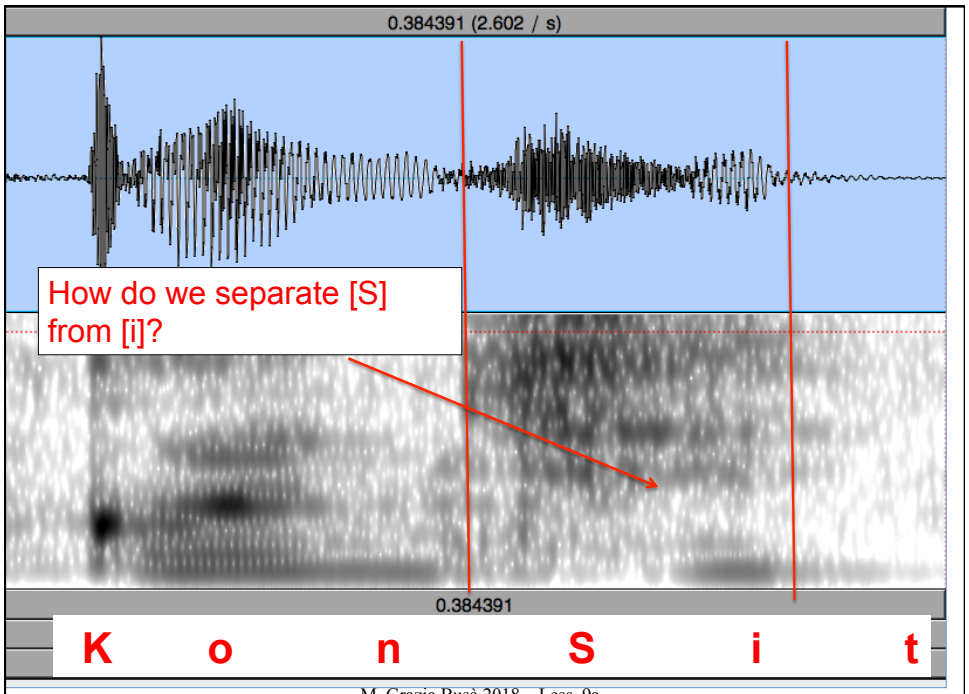
- Undershoot occurs when the articulator does not have enough time to reach its target position.
- This can occur for both vowels and consonants

Schematic Representation



C V C

Source: Alexei Kochetov, Contrast in Phonology, University of Toronto, May 3-5, 2002



Types of coarticulation

Coarticulation vs. assimilation (1)

co-articulation:

2 different sounds are being articulated simultaneously

- one tongue movement made for both sounds

Co-articulation results in non-phonemic differences

Coarticulation vs. assimilation (1)

Assimilation:

- The resulting change is a different sound (phoneme)
- In assimilation, there is a major change in the place of articulation, manner of articulation, or voicing of a segment, such that it falls into a different phonemic category
- Examples of assimilation
  - Insula → isola

Direction of the influence of the segments

'carry-over' or progressive coarticulation:

- Aspects of a segment production overlap or affect the production of the following segment

anticipatory or regressive coarticulation

- Aspects of a segment production overlap or affect the production of the preceding segment

Vowels, consonants and coarticulation

- Some sounds are more resistant to coarticulation than others.
- Some factors that have an effect on coarticulation:
  - differences in phoneme duration
  - differences in type of articulation,
  - number of phonemes in the language

Adapted from http://www.ling.mq.edu.au/ling/units/ling210-901/phonetics/coarticulation/index.html

Effect of differences in phoneme duration

- Long and stressed vowels and geminate consonants are more resistant to coarticulation
  - articolators have more time to reach the target
- Low, short and unstressed vowels are more subjected to coarticulation phenomena
- schwa, being very short, is very weak to coarticulation
  - Ex. English vowel reduction processes

Adapted from http://www.ling.mq.edu.au/ling/units/ling210-901/phonetics/coarticulation/index.html

Effect of the differences in type of articulation

- Maximum coarticulation occurs when the articolatory movement between phonemes is maximum
- Eg.:
  - [ka] vs [ki]
  - [ta] vs [ti]

Adapted from http://www.ling.mq.edu.au/ling/units/ling210-901/phonetics/coarticulation/index.html

Effect of the number of phonemes

- Coarticulation is blocked or reduced when it can give rise to perceptual confusion.
- Perceptual confusion phenomena are more frequent when a given language has many phonemes in a certain class:

- By diminishing the articulatory distance between phonemes coarticulation diminishes their distinctiveness

Adapted from http://www.ling.mq.edu.au/ling/units/ling210-901/phonetics/coarticulation/index.html

Vowels, consonants and articolatory 'spaces'

The phonemic inventory of a language determines its coarticulatory options:

- few vocalic phonemes → greater vowel coarticulation
  - Ex.: English vs. Italian vowels
    (English vowel reduction is a phonological process!)
- many distinctive places of articulation for consonants → Little consonant coarticulation.
  - In Arabic the distinction between velar and uvular stops requires a precise articulation of the consonants