

# Speech perception in adverse listening conditions

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# Welcome

- Your name?
- University?
- What do you study?
- Why this course?

## What to expect this week

Day	Topic	Additional remarks
Monday	What is speech?	<ul style="list-style-type: none"><li>• Hand in assignment 1</li></ul>
Tuesday	How do we recognise speech?	
Wednesday	How do we investigate speech perception?	<ul style="list-style-type: none"><li>• Lab tour</li></ul>
Thursday	The effect of adverse listening conditions on speech processing	<ul style="list-style-type: none"><li>• Hand in assignment 2</li></ul>
Friday	The flexibility of the perceptual system	<ul style="list-style-type: none"><li>• Discussion of assignment 2</li></ul>

# Assignment: Design a psycholinguistic experiment

## Assignment 1

1. Pick a topic that you are interested in
2. Define a research question

## Assignment 2

3. Choose a methodology that will (help) answer your research question (could be a combination of methodologies)
4. Specify the experimental design (task, stimuli, number of sessions?)
5. Friday
  - a) Prepare a 1 minute presentation of your idea (without slides)
  - b) Some students will be invited to present their idea (you can volunteer)
  - c) Receive questions, feedback, and suggestions from all of us

## Assignment 3

- Describe possible outcomes of the experiments (related to your hypotheses) and discuss these in the light of (existing literature on) speech comprehension
- Final report of no more than 3 A4 contains a revised version of the reports written for Assignments 1 + 2 (revised on the basis of feedback obtained during the course of the week from the lecturer, other students, the course materials) and the discussion to be written for Assignment 3

⇒ Deadline: Friday February 17, 2017

**More information:** <http://odettescharenborg.ruhosting.nl/winterschool/>

# What is speech?

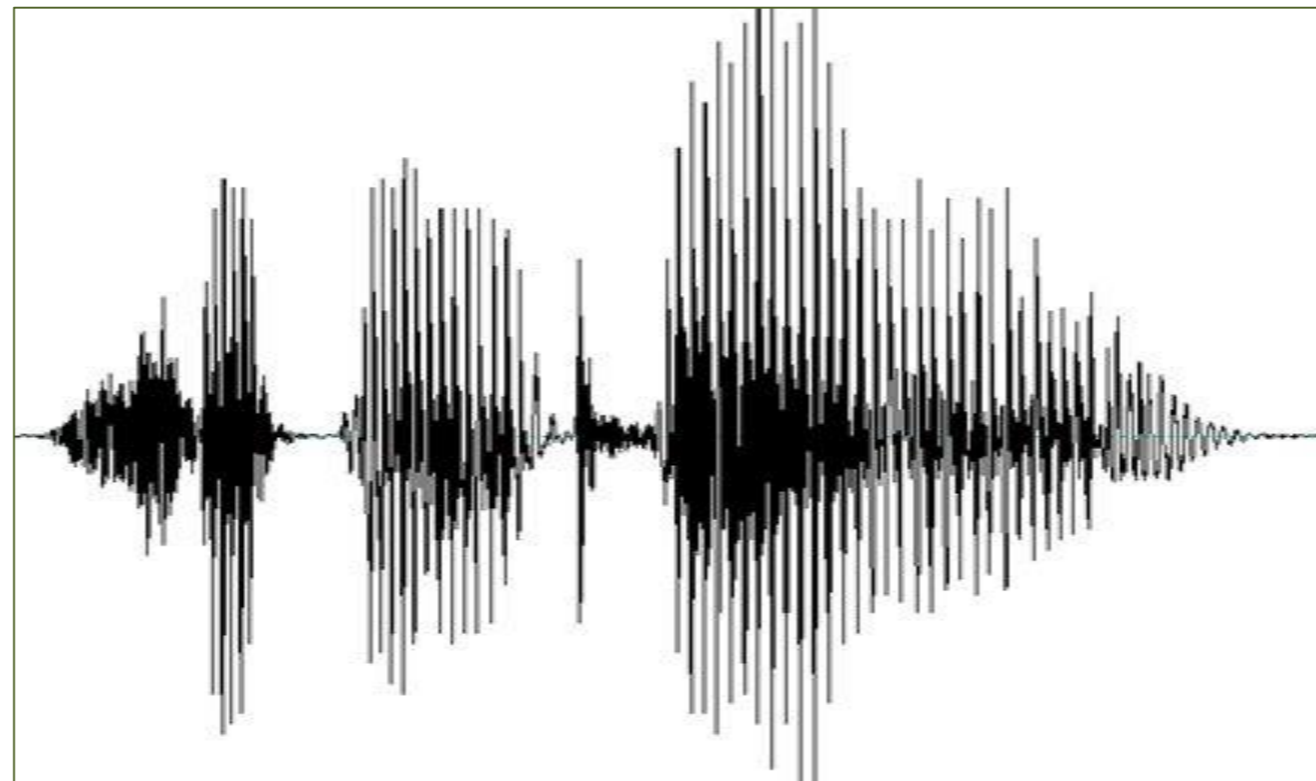
## Overview today: What is speech?

1. Sounds and their production
2. Three important aspects of speech





- Speech = sound
- Sound = differences in air pressure
- Air pressure waves perceived as different sounds



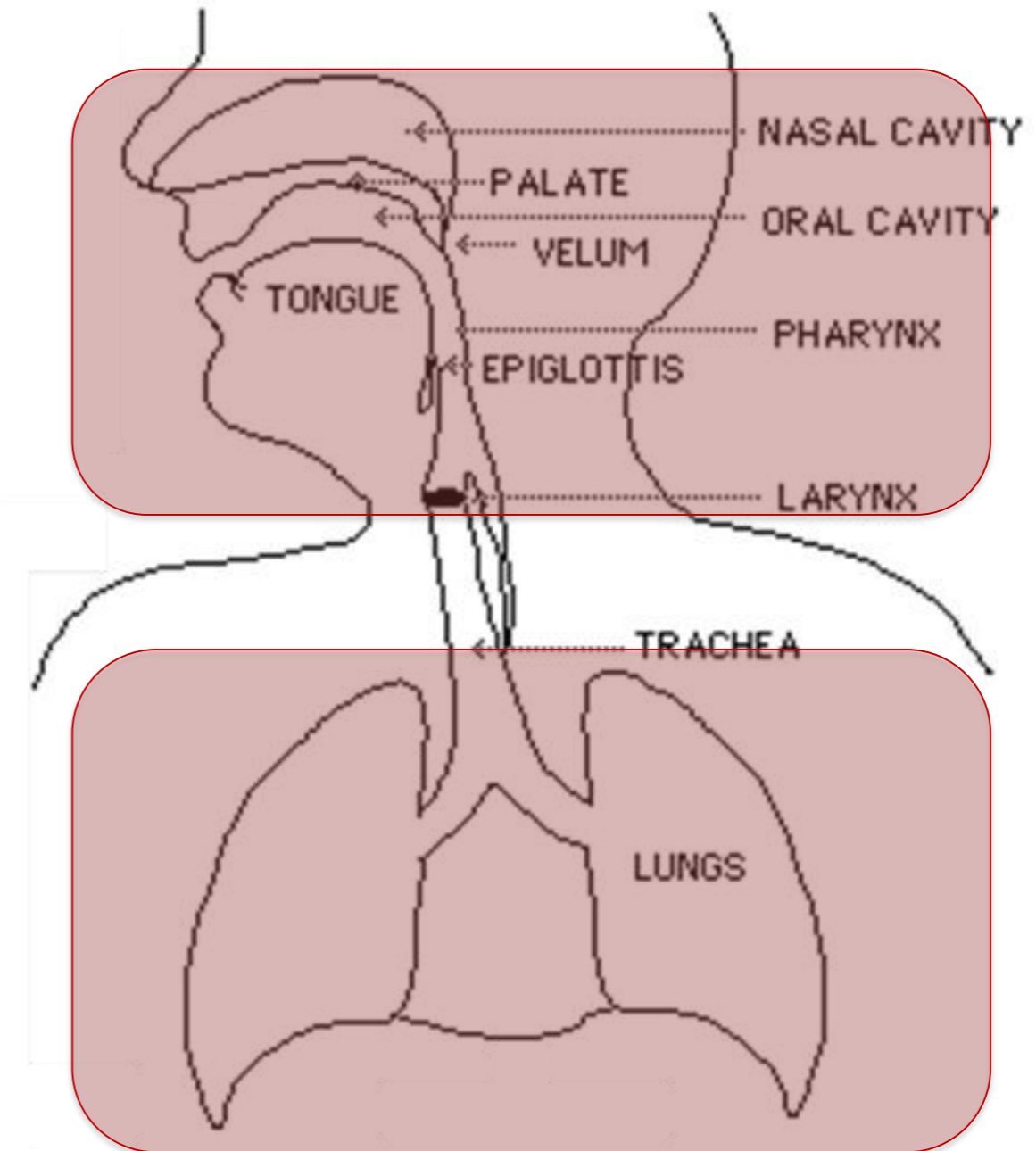
speech signal

# The speech production system

## Vocal tract

- Area between vocal cords and lips
- Pharynx + nose cavity + mouth cavity

and lungs

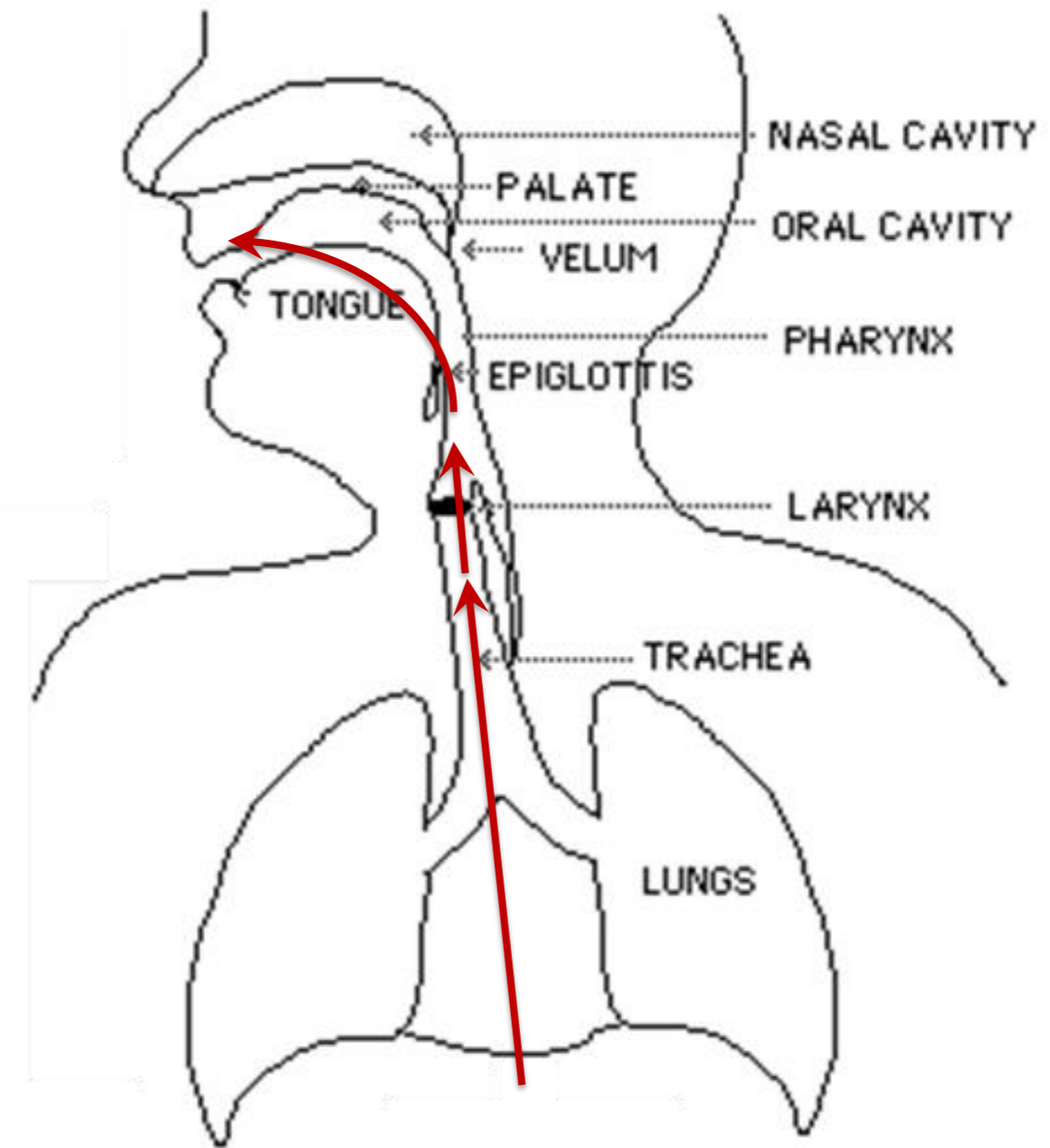


## 3 steps to produce sounds

step 3: *articulation* = distortion of air  
= speech

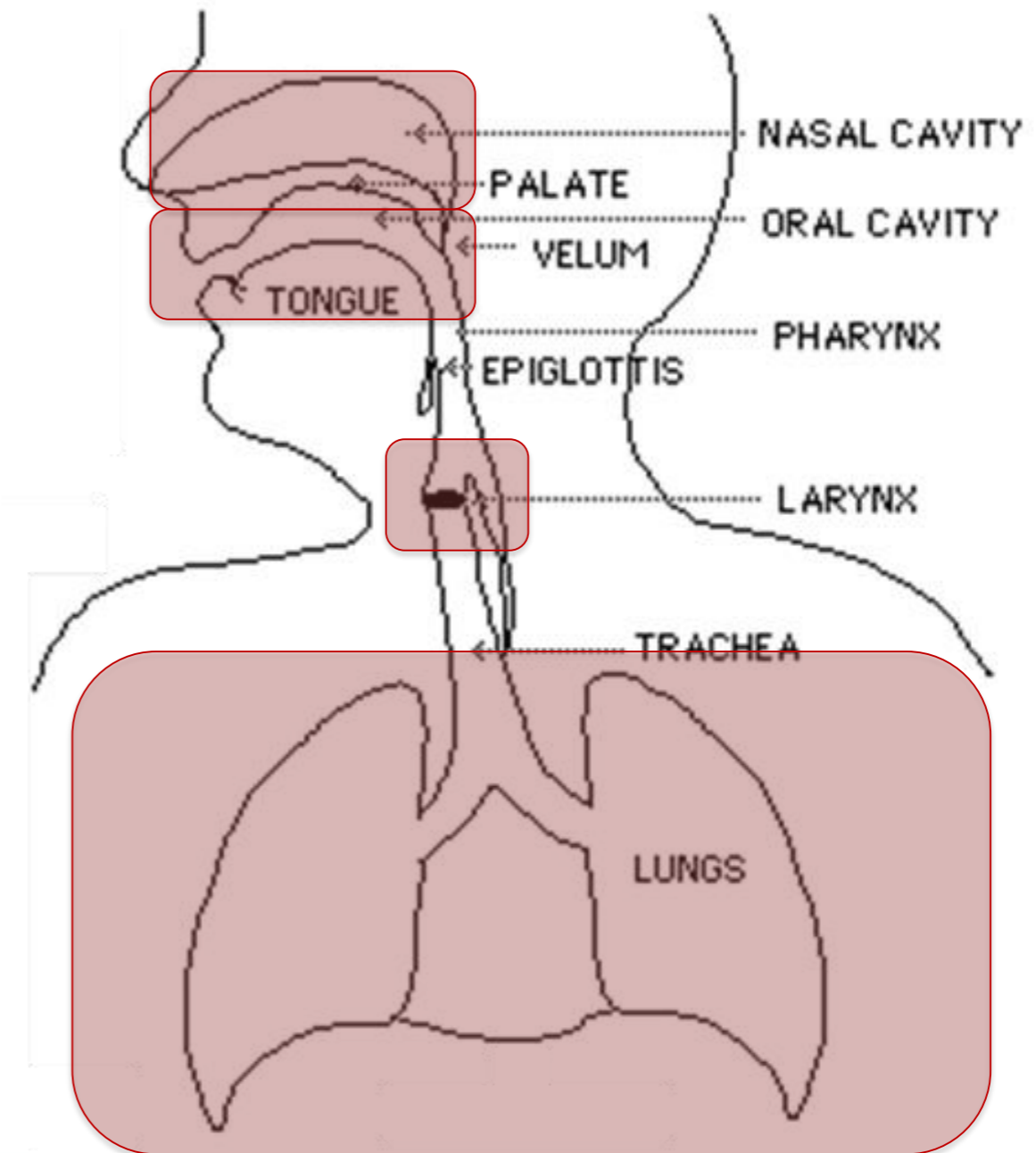
step 2: *phonation*

step 1: *initiation*



## Note

None of the speech production components are specifically made for speaking!

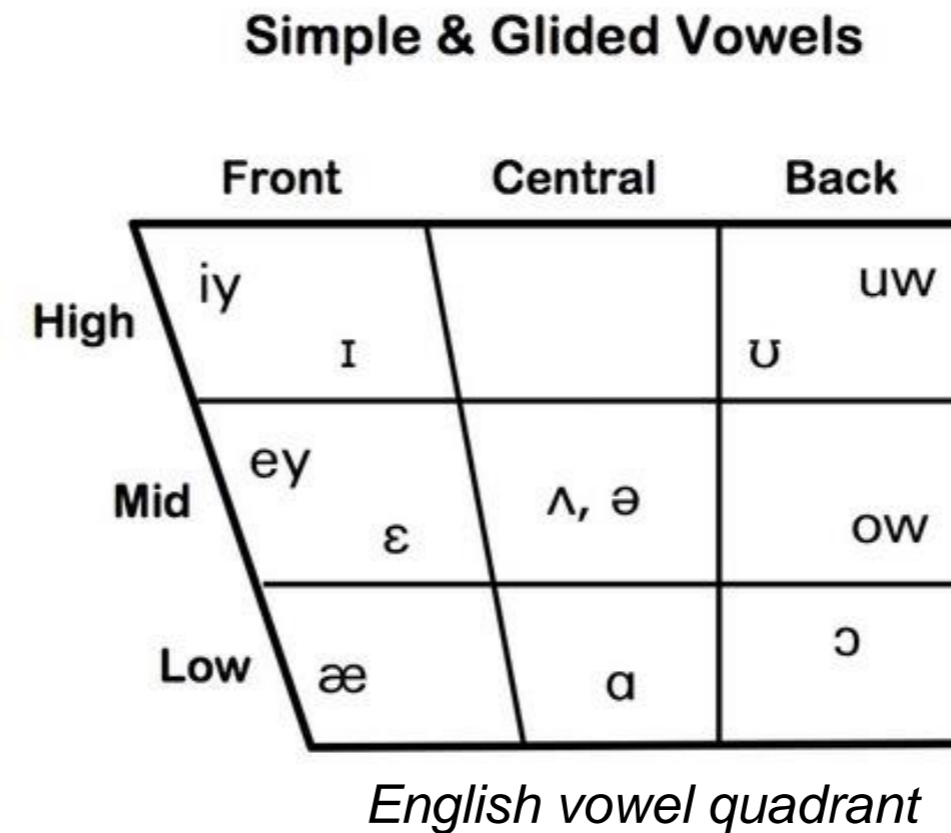


## Speech sounds

- Vowels: unblocked air stream
- Consonants: constricted or blocked air stream

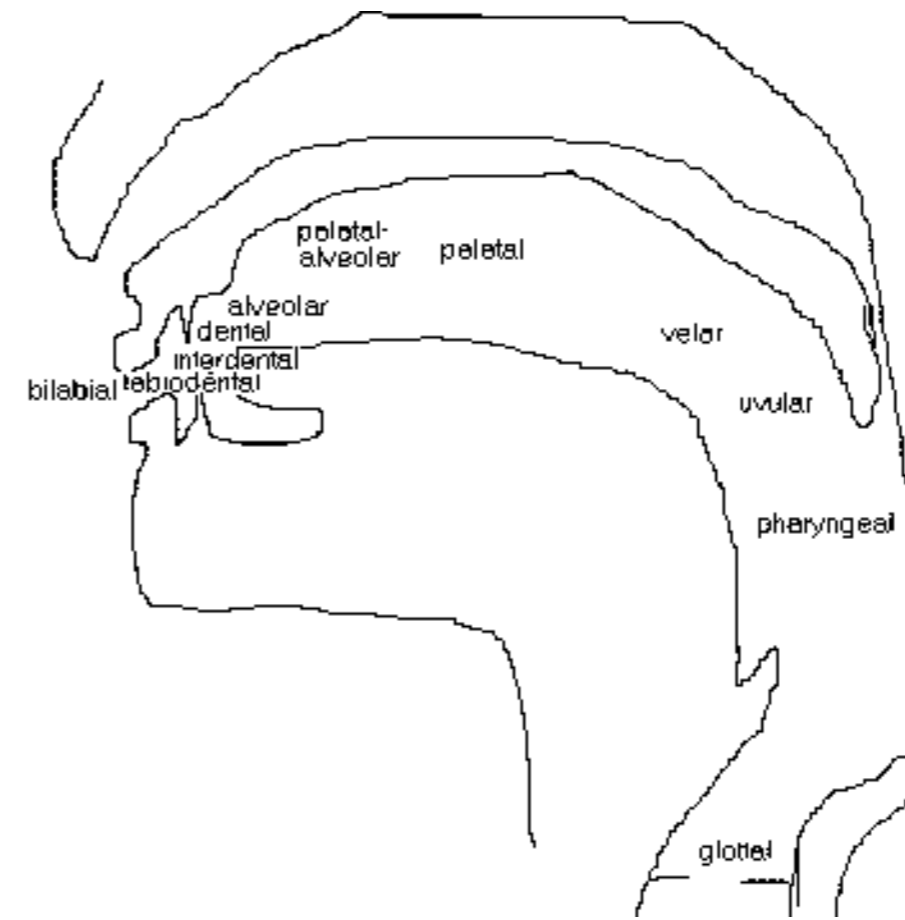
## Different sounds: Vowels

- Tongue height:
  - Low: e.g., /a/
  - Mid: e.g., /e/
  - High: e.g., /i/
- Tongue advancement:
  - Front : e.g., /i/
  - Central : e.g., /ə/
  - Back : e.g., /u/
- Lip rounding:
  - Unrounded: e.g., /ɪ, ɛ, e, ə/
  - Rounded: e.g., /u, o, ɔ/
- Tense/lax:
  - Tense: e.g., /i, e, u, o, ɔ, ɑ/
  - Lax: e.g., /ɪ, ɛ, æ, ə/



## Different sounds: Consonants

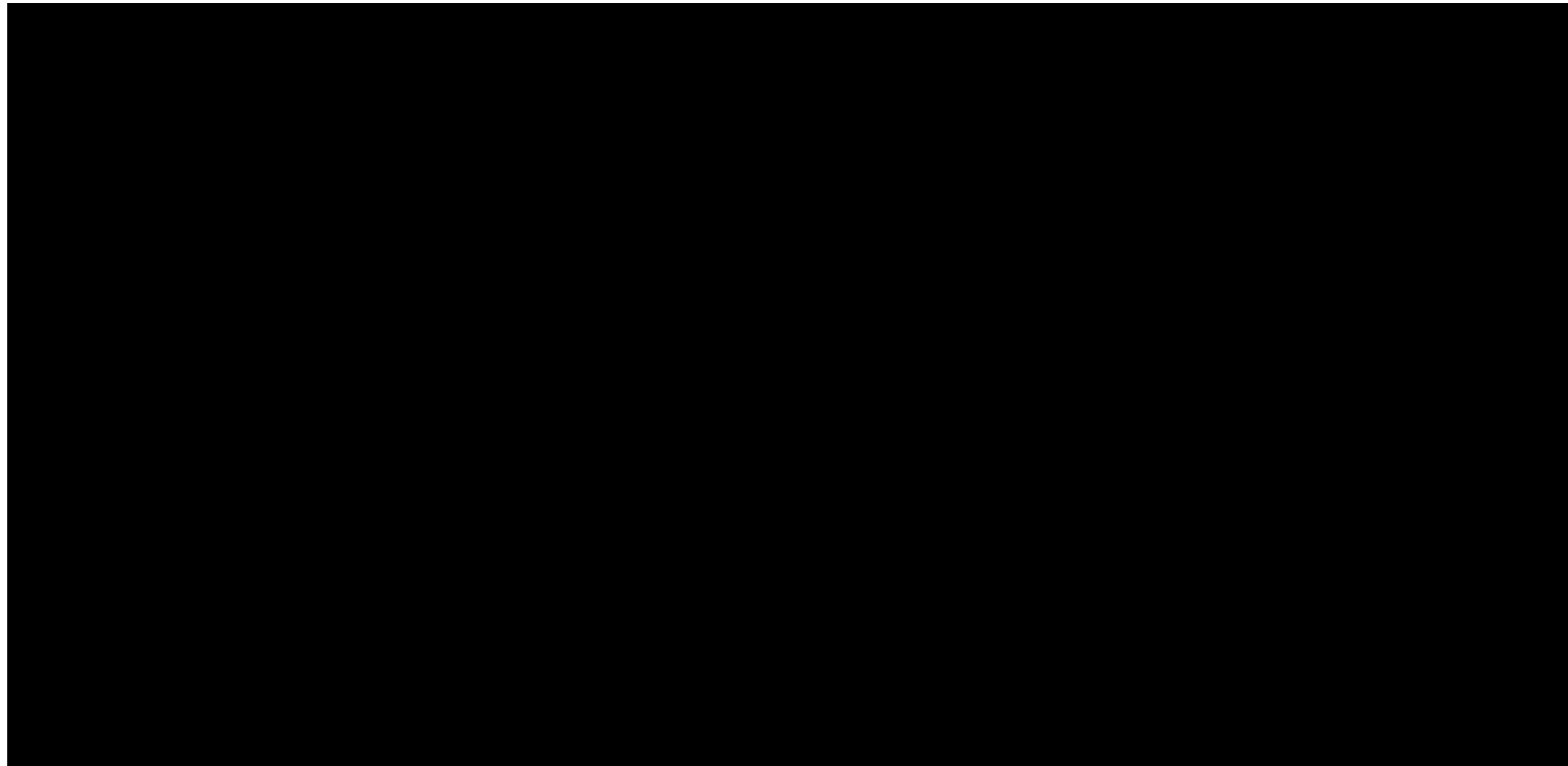
- Place of articulation  
Where is the constriction?
- Manner of articulation
  - Stops: /p, t, k, b, d, g/
  - Fricatives: /f, s, ʃ, v, z, ʒ/
  - Affricates: /tʃ, dʒ/
  - Approximants/Liquids: /l, r, w, j/
  - Nasals: /m, n, ŋ/
- Voicing





# Speech sound production

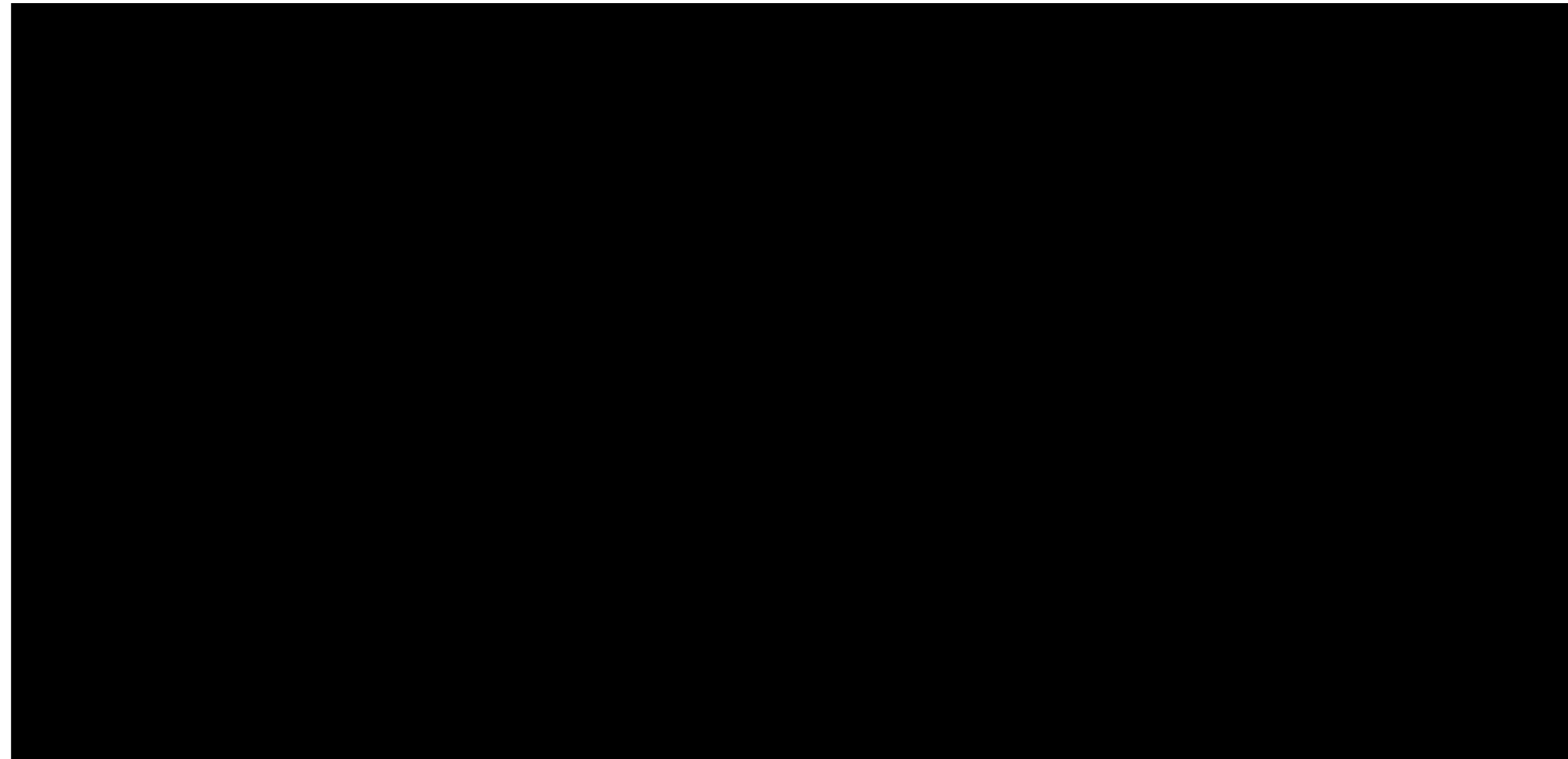
- <https://www.youtube.com/watch?v=DcNMCB-Gsn8>



*Recorded in 1962, Ken Stevens*  
*Source: YouTube*

## Special cases: opera soprano and emcee/beatboxer

- <https://www.youtube.com/watch?v=M2OdAp7MJAI>

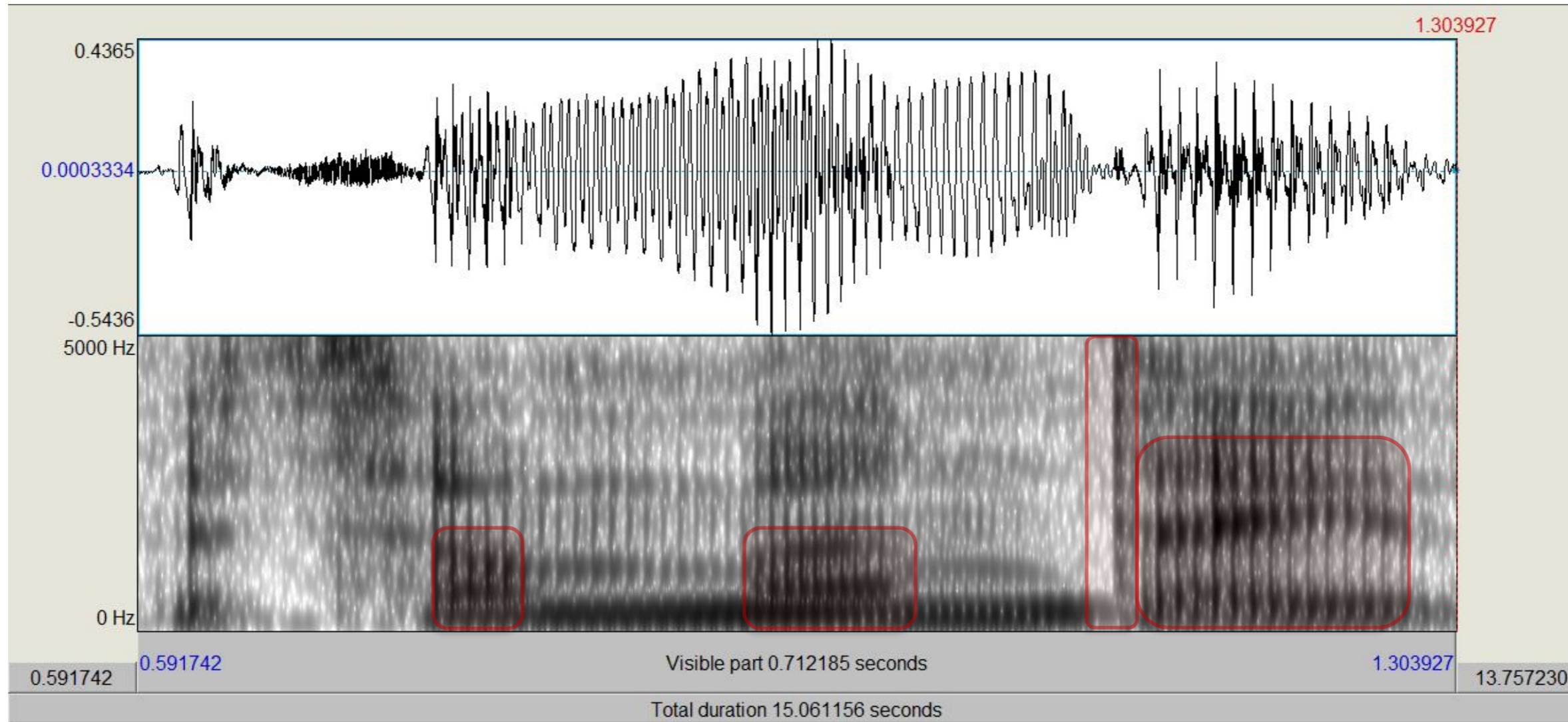


*Source: YouTube*

The physical speech signal consists of

... acoustic energy

... varying over time in amplitude and spectral shape



bu t o nM o n d a y

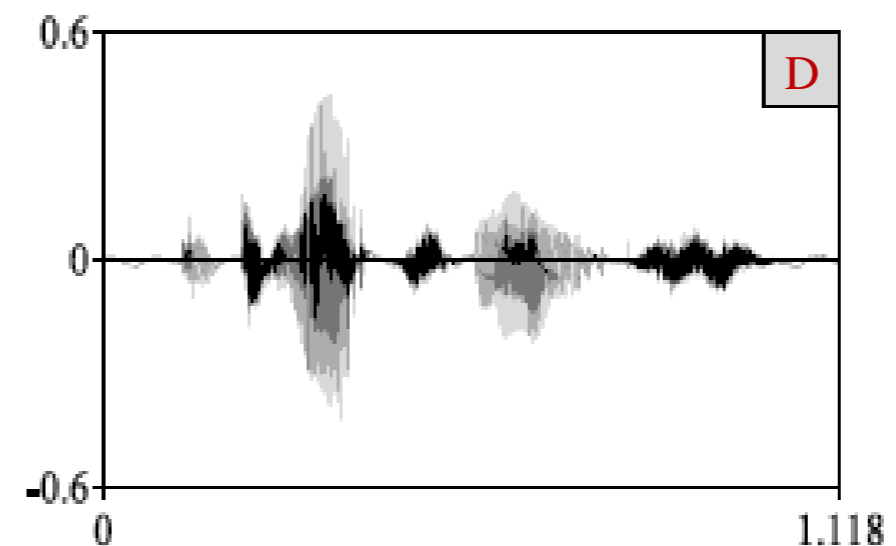
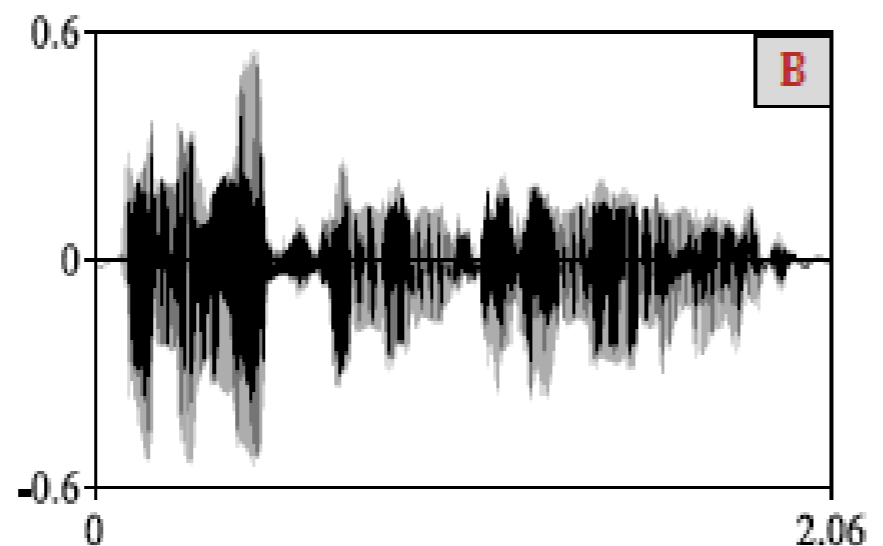
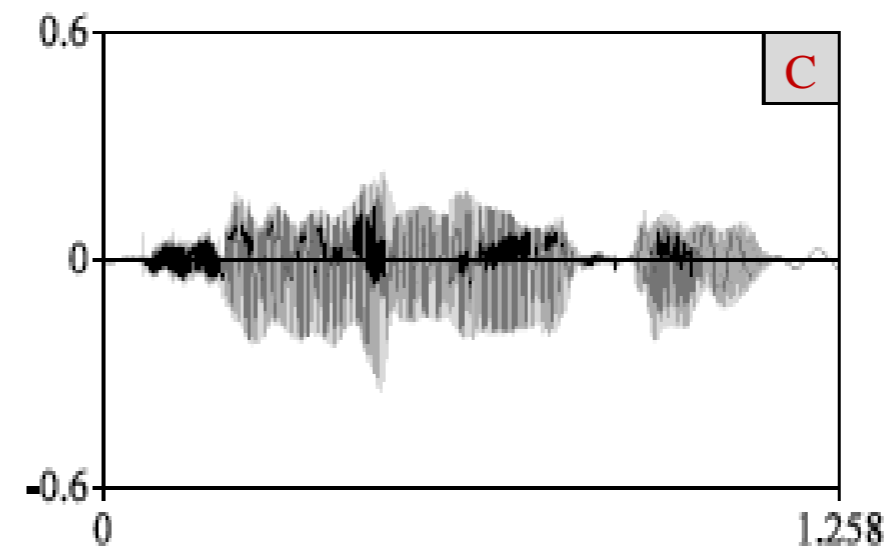
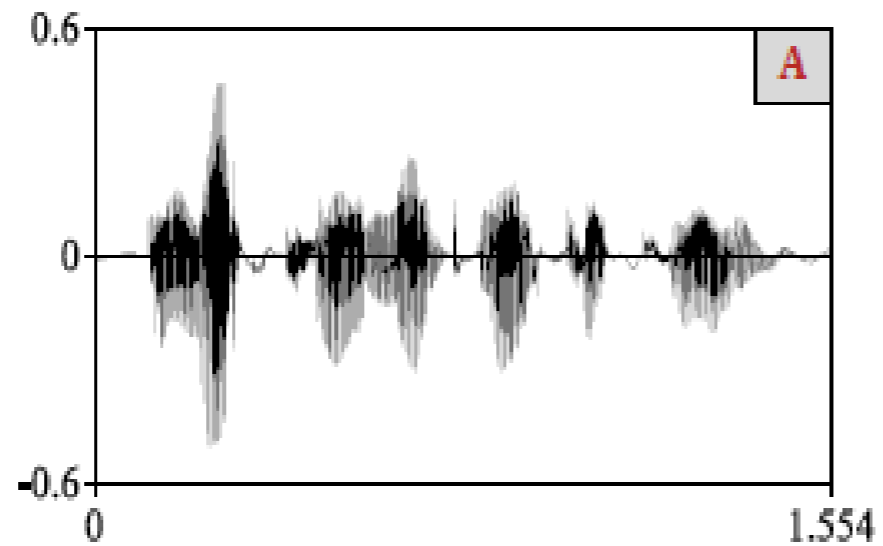
## Demos of speech sound manipulations

- [http://jontalle.web.engr.illinois.edu/Public/InterspeechDemosAug25.13/da\\_to\\_ga\\_f103.m4v](http://jontalle.web.engr.illinois.edu/Public/InterspeechDemosAug25.13/da_to_ga_f103.m4v)
- [http://jontalle.web.engr.illinois.edu/Public/InterspeechDemosAug25.13/ka\\_to\\_ta\\_f103.m4v](http://jontalle.web.engr.illinois.edu/Public/InterspeechDemosAug25.13/ka_to_ta_f103.m4v)
- <http://jontalle.web.engr.illinois.edu/Public/InterspeechDemosAug25.13/Sa2sa2cha2za2Da.m4v>



## Quiz 1: How many words are there?

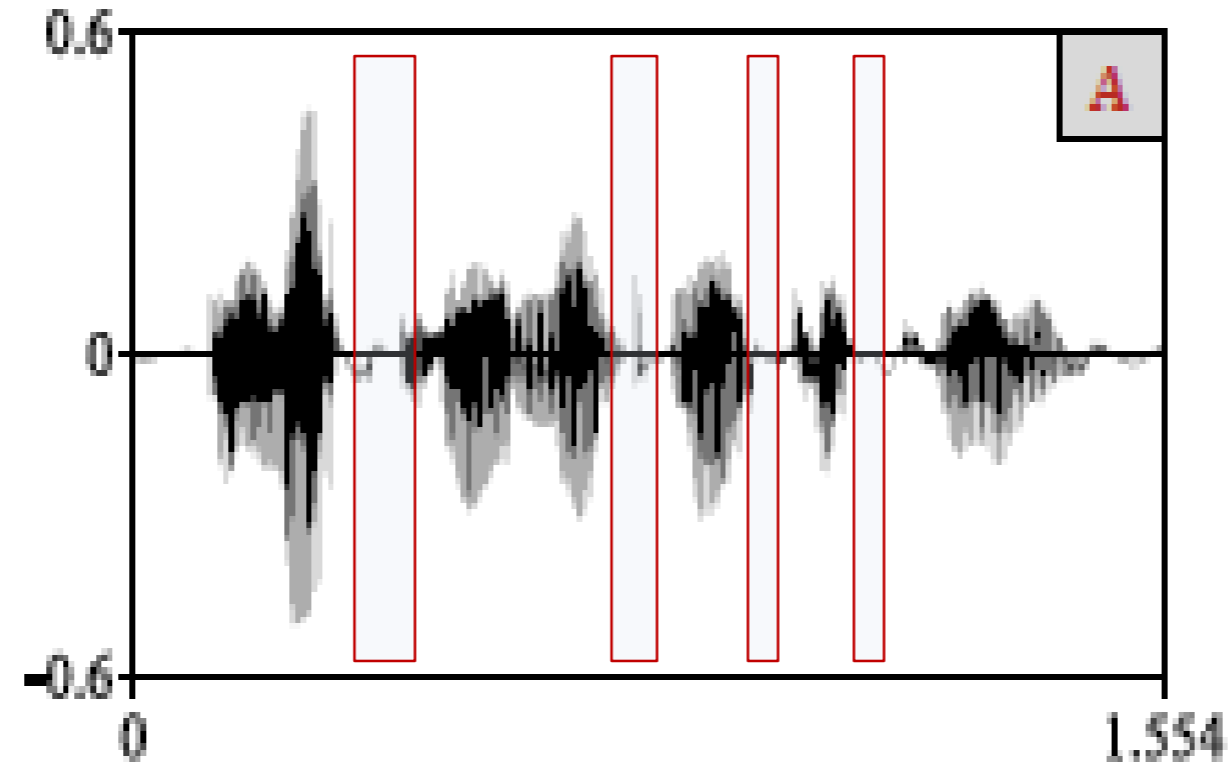
Each picture shows a waveform of a short stretch of speech:



- A: Electromagnetically (1)
- B: Emma loves her mum's yellow marmelade (6)
- C: See you in the evening (5)
- D: Attachment (1)

# Electromagnetically

Why is it so hard to determine the number of words?



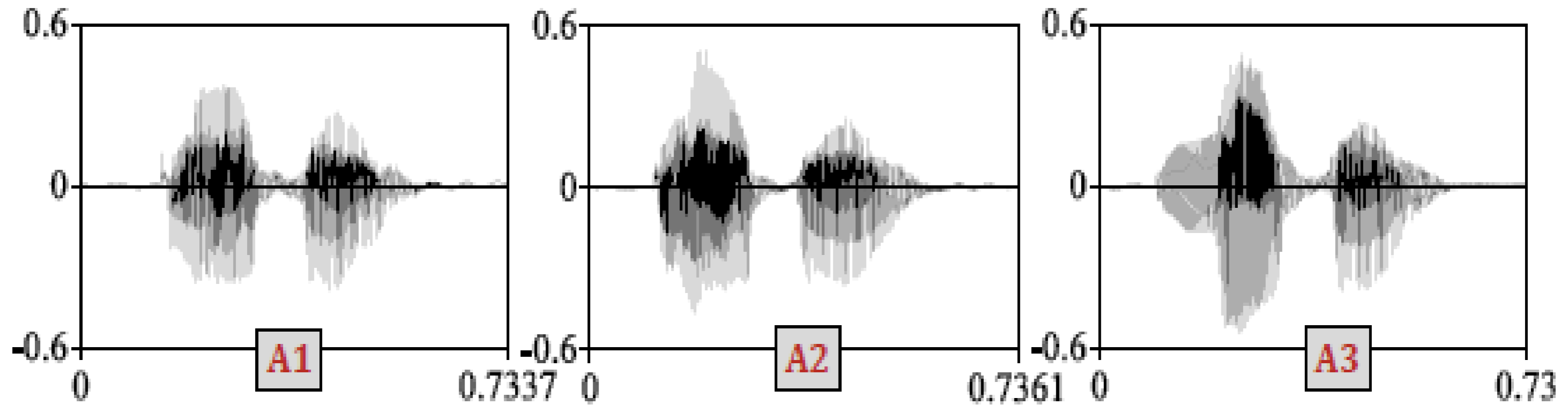
/i l ε kt romæ g nɛ t ɪ k ə l i/

silence ≠ word boundary



## Quiz 2: Can you spot the odd one out?

- Each row shows three waveforms containing a single word:



*Every time you produce a word it sounds differently*

## Enormous variability: speaker-dependent

- Speaker differences, e.g., gender, vocal tract length, age
- Speaker idiosyncracies , e.g., lisp, creaky voice
- Accent: dialects, non-nativeness

## Enormous variability: speaker-independent

- Coarticulation: production of a speech sound becomes more like that of a preceding/following speech sound, e.g.
  - Place of articulation: garden bench → garde**m** bench (*anticipatory* or *regressive* coarticulation)
  - Voicing: cats**s** vs. dog**z** (*carryover* or *perseverative* coarticulation)
- Speaking style
  - Formal
  - Read
  - Informal, conversational → reductions

# Reductions

Ze staat hier op deze computer he?

'puter'



Het ergste is nog, als de wedstrijd dus afgelopen is

'wes'



*Source: Spoken Dutch Corpus*

## Reductions (2)

**natuurlijk** (of course)

/natyrl@k/

/naty l@k/

/ ty l@k/

/ ty k/

**eigenlijk** (actually)

/Eix@nl@k/

/Eix@ l@k/

/Eix l@k/

/Ei k/



## Summary of 3 important aspects

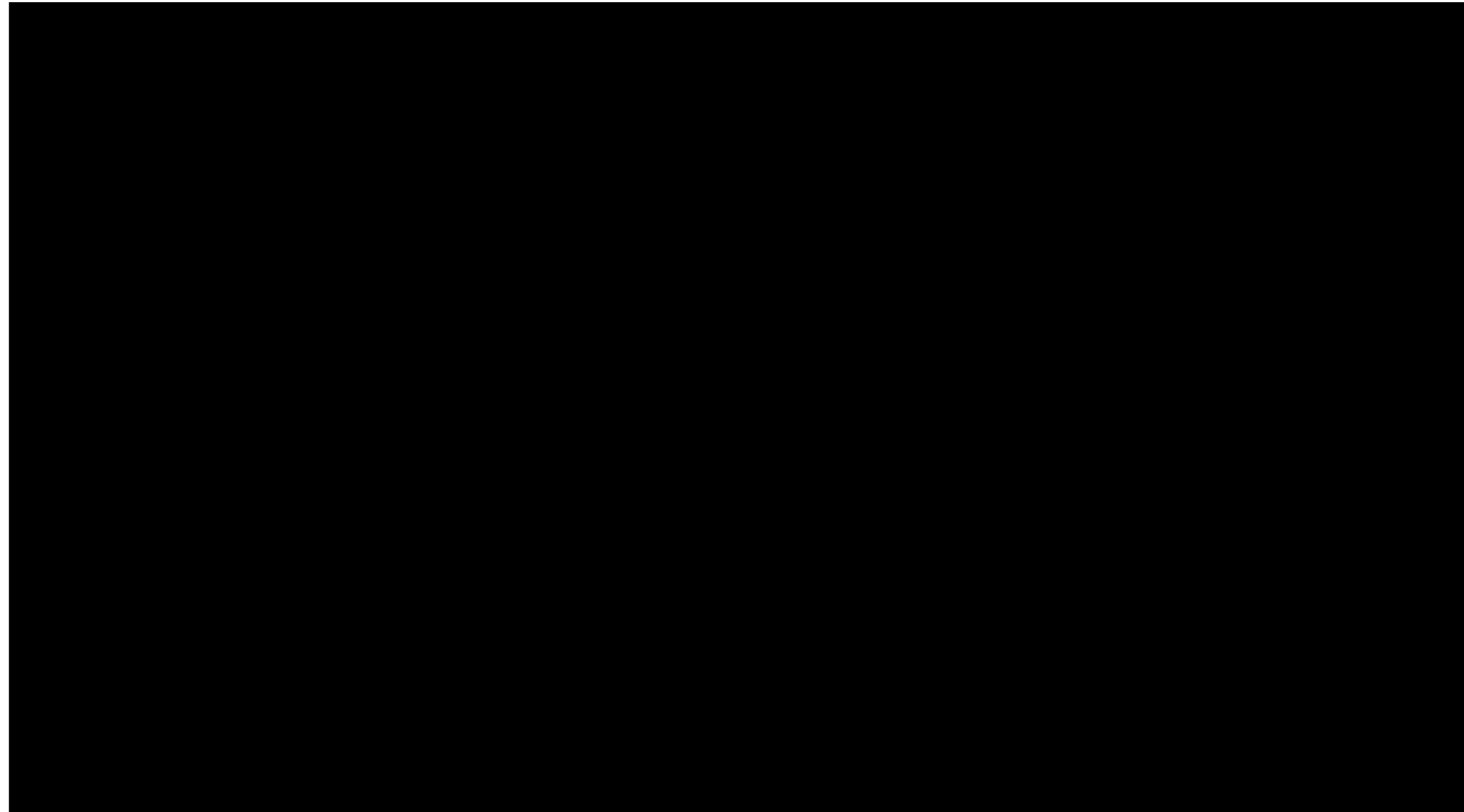
- Speech signal is continuous
- No clear pauses between words
- Highly variable

Task for the listener:

- Map the highly variable, continuous speech signal onto discrete units such as words  
→ **tomorrow**

## Video: summary of phonetics

- [https://www.youtube.com/watch?feature=player\\_embedded&v=zREIDzvf9Wo](https://www.youtube.com/watch?feature=player_embedded&v=zREIDzvf9Wo)



*Source: YouTube*