Phonetics

General Linguistics

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(Some slides: Petra Hendriks)

Levels of language

• Text/Dialogue	ð	Pragmatics	(lecture 11)
• Sentences	ð	Syntax	(lectures 5 en 6)
		Sentence semantics	(lecture 10)
• Words	ð	Morphology	(lecture 4)
		Lexical semantics	(lecture 9)
• Syllables	ð	Phonology	(lecture 3)
• Sounds	ð	Phonetics	(lecture 2)

Language sounds

- What characteristics do language sounds have?
  - è Acoustic phonetics
- How are language sounds produces?
  - è Articulatory phonetics
- How are language sounds recognized?
  - – Perceptive phonetics

Sounds vs. letters

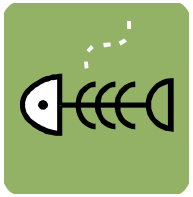
- Sounds ≠ letters:
  - The same letter can be pronounced in many different ways: vergeten
  - The same sounds can be written in several different ways: lont – hond, vlaggen - lachen

Read this word

ghoti

What does this spell?

ghoti



- According to G.B. Shaw:
  - Engelse woord *fish* è ghoti
    - "gh" as in "cough", "o" as in "women", "ti" as in "nation".

How about this?

ghoughpteighbteau

How about this?

ghoughpteighbteau

- P as in hiccough , O as in though , T as in ptomaine , A as in neigh , T as in debt and O as in bureau

Letters-sound mismatch

- Point: Letters and sounds mismatch

- Every language also has its own way of assigning sounds to letters or groups of letter, depending on the sounds in the language
- We need a way to represent sounds that is independent of the language described

International Phonetic Alphabet

- 1888: International Phonetic Alphabet (IPA)
  - French and English language teachers
- 1-to-1 relationships between sounds and IPA symbols
- Every sound has its own symbol
- Advantages: Makes it simpler to talk about sounds
- IPA-symbols are usually written between brackets, e.g.
- [ ].

Some IPA symbols

- [g]: goal
- [ɣ]: hagel (+stem)
- [x]: zag (-stem)
- [ʔ]: lang
- [ʃ]: douchen
- [ʒ]: jury
- [a]: raad
- [ɑ]: bak
- [i]: dief
- [ɪ]: pit
- [e]: beek
- [ɛ]: pet
- [ʔ] (sjwa): de
- [ʌ]: put
- [u]: boek
- [y]: muur
- [ø]: beuk

Kinds of sounds

Three kinds of sounds:

- Vowels (klinkers)
- Consonants (medeklinkers)
- Half vowels or glides (approximantes): [w] and [j]

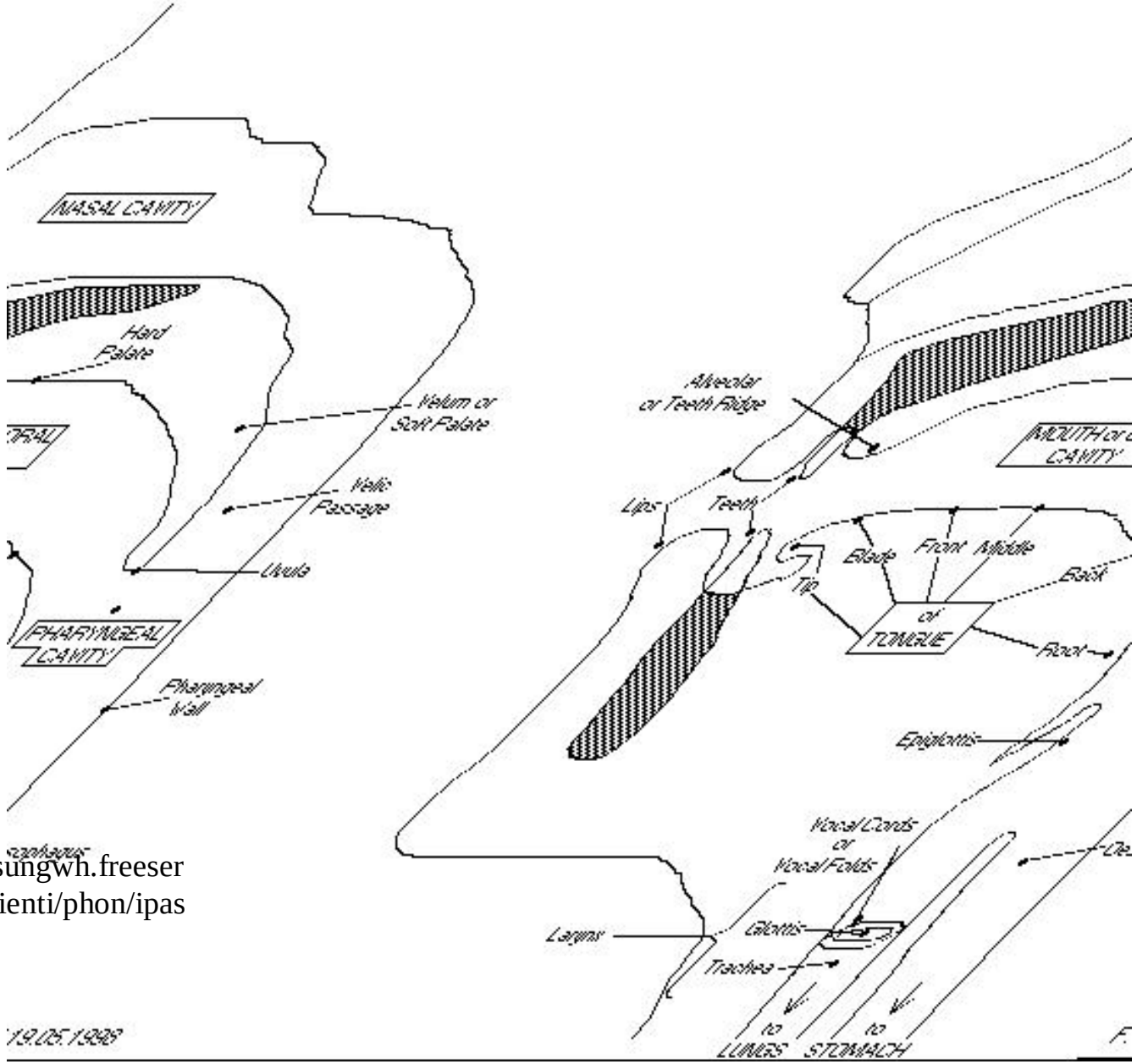
è Each type of sounds contributes to syllables in different ways

How do people produce language sounds?

- Create a stream of moving air.
- Induce certain patterns of vibration in that stream of air by having it interact with different configurations of the vocal tract.
  - In many cases vocal cords allowed to vibrate
- Form and size of nose and mouth cavity's will modify the sound produced

Cross Section of the Human Head

showing the main areas associated with speech articulation



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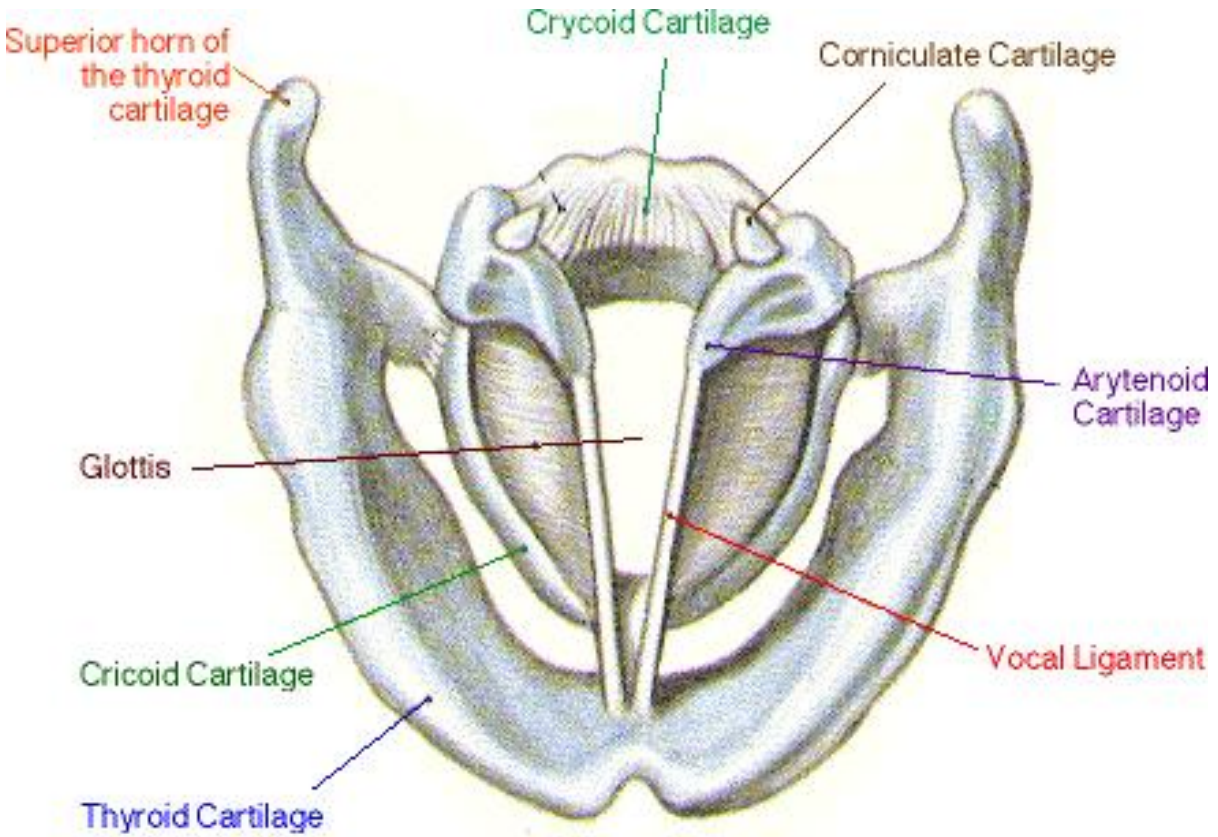
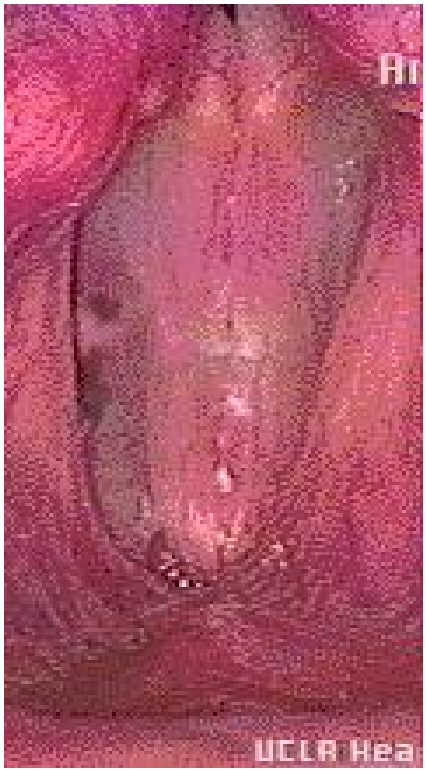


The Larynx: viewed from above

Slow-moving vocal cords



- http://www.humnet.ucla.edu/humnet/linguistics/faciliti/demos/vocalfolds/vocalfolds.htm

Mel Blanc = Bugs Bunny

=

Endoscopic film of Mel Blanc's vocal cords

Airstream mechanisms (Plosives)

- The five airstream mechanisms used in human languages:
  - Pulmonic egressive: force air outwards from lungs into the mouth
  - All the sounds that make up English words are produced using this airstream mechanism. By far the most common airstream mechanism across the world's languages.

Pulmonic Ingressives

- Suck air inwards into lungs
- only attested use lateral fricative in Damin, a ritual language formerly used by speakers of Lardil in Australia
- Swedish and Ewe use it as an *interjection*

THE INTERNATIONAL PHONETIC ALPHABET (revised to 1993)

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	N		
Trill	B			r					R		
Tap or Flap				ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Ejectives

- Glottalic egressive: glottis is raised while the forward articulation is held, raising air pressure in the mouth, so that when the [k] is released, there is a noticeable burst of air.
- Sounds produced with this airstream mechanism are called *ejectives*
- “spat consonants”

Implosives

- Glottalic ingressive: close mouth at one end; close glottis; rarify air in mouth by lowering glottis
- Sounds produced with this airstream mechanism are called *implosives*
- *In order to produce an implosive b, do as follows:*
  1. *Close your lips together so to as pronounce a [b].*
  2. *Move your glottis downward as if you were swallowing. You should be able to feel it move with your fingers; if you have a noticeable adam's apple, you should also be able to see it move in a mirror.*
  3. *While 'swallowing', open your lips and say [ba]. Try doing this quickly so that the air flows into your mouth while you pronounce the [b]. There should be a deep hollow sound, and the [a] should follow smoothly.*

Velaric egressives

- Velaric egressive: Push tongue dorsum against velum; use tongue tip or lips to create an area of trapped air inside the mouth; move tongue to compress this air; release forward closure to let air flow out

- Click consonants found in the Khoisan languages of southern Africa are produced with this airstream mechanism.

!Ora
(southern Africa)

- Yes, I salute you, you the sons of the sea, you who lie beyond the sea. I do not know you. I have not seen you with my eyes. You have not experienced me that you may know me, that you may realize that the people in this country speak a beautiful language (if I may say so to you, these Europeans catch and punish a man); so that you may also know that there are people living in this country. You do not know what nation we are. Listen, listen, just for once how they speak so that you should not again be ignorant. In turn I do not know your language as you do not know mine. I do not know your language you sons of the sea. Let me be happy, very happy. If you can do this you will be glad: actually there are people in that country. If you would say something, if you would write back, if you would write to these two Europeans a message for me. Yes, glad Europeans of the sea, if in turn you can give these Europeans a message, so that for my part I will be very happy about that matter. For this matter I beseech you. This, I don't know about you. Today you will get to know me through my tongue. Although you cannot see me with your own eyes we may see each other through God in heaven. Thus far I shall speak.

- Adapted from a translation by W. Haacke and E. Eiseb
  Audio recording by Anthony Traill
  http://www.nationalgeographic.com/ngm/0102/online_extra.html

Non-pulmonic sounds

CONSONANTS (NON-PULMONIC)

Clicks		Voiced implosives		Ejectives	
ʘ	Bilabial	ɓ	Bilabial	’	as in:
ǀ	Dental	ɗ	Dental/alveolar	pʼ	Bilabial
ǃ	(Post)alveolar	ʄ	Palatal	tʼ	Dental/alveolar
ǂ	Palatoalveolar	ɠ	Velar	kʼ	Velar
ǁ	Alveolar lateral	ʛ	Uvular	sʼ	Alveolar fricative

Consonants

Consonants can be distinguished according to the following characteristics:

- Voicing (Stemhebbendheid)
- Place of Articulation
- Manner of Articulation

Voicing vs. voiceless consonants

Voiced:

- [b]
- [d]
- [z]
- [v]
- [g]
- [?$
- …

Voiceless:

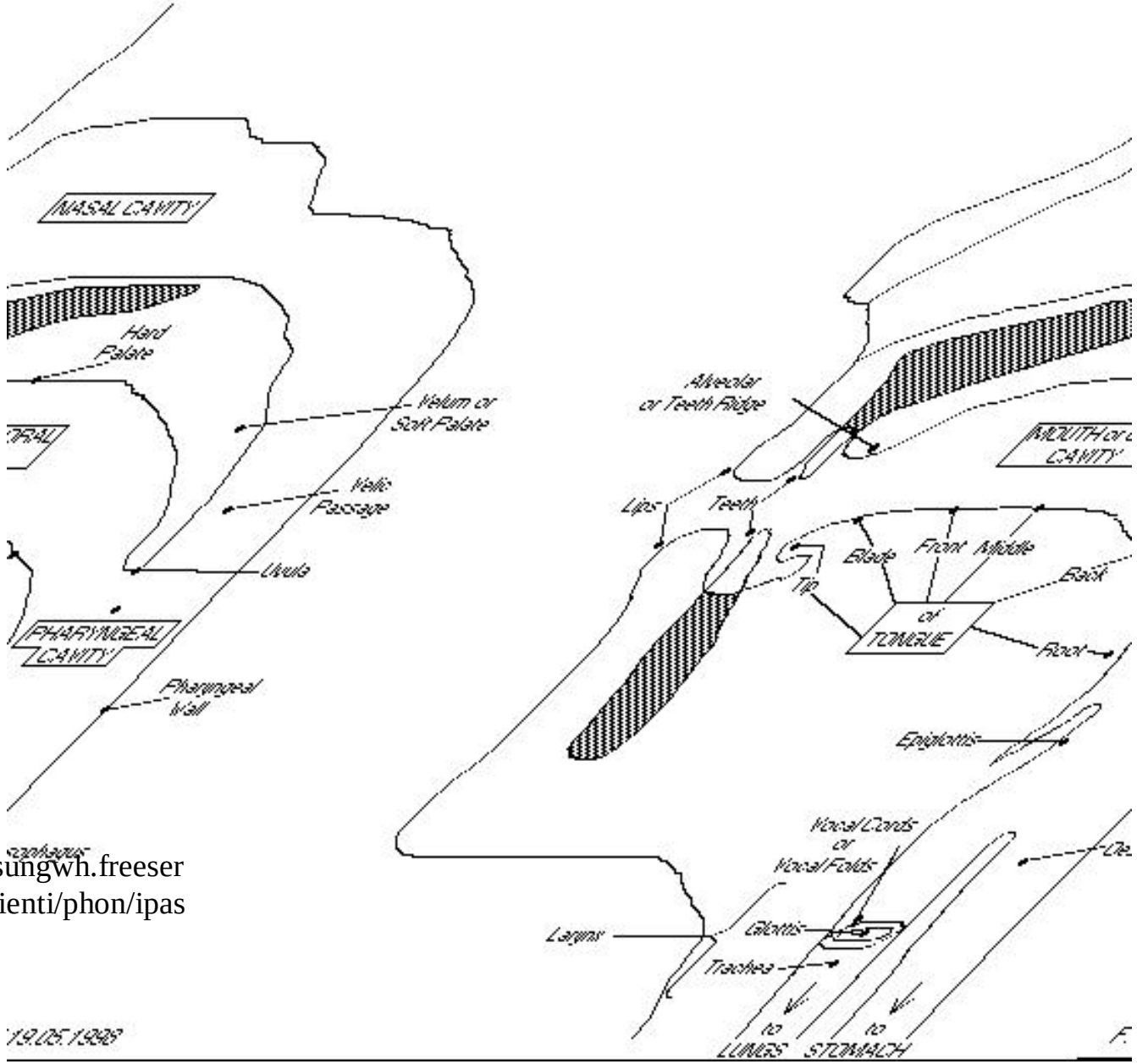
- [p]
- [t]
- [s]
- [f]
- [k]
- [x]
- …

Place of articulation

- Bilabial; e.g. [p], [b], [m].
- Labiodental; e.g. [f], [v].
- Dental; e.g. Eng. th. ([ð] , [ΟΫ́])
- Alveolair; e.g. [t], [d], [s], [z], [n], [l].
- Alveopalatal; e.g. [ʔĘ, [ʔĘ
- Palataal; e.g. [j].
- Velair; e.g. [k], [g], [x], [ʔɣ, [ʔɣ
- Uvulair; e.g. huig-r [R].
- Glottaal; e.g. [h], glottal.

Cross Section of the Human Head

showing the main areas associated with speech articulation



http://www.sungwh.freeserve.co.uk/sapienti/phon/ipasymb.htm

Manner of articulation

- Plosives (Plofklanken):
  - Air flow is kept until release, e.g. [p], [b], [t], [d], [k], [g], glottal
- Fricatives (Wrijfklanken):
  - Air flow is restricted e.g. [f], [v], [s], [z], [ʃ], [ʒ], [h].
- Liquids (Vloeiklanken):
  - Airflow escapes via the side of the tongue, nl. [l] and [r].
- Nasals
  - Airflow travels through the nasal passages and is released e.g. [m], [n], [ŋ]
- Trills (Trilklanken):
  - Airflow The airstream is interrupted several times as one of the organs of speech (usually the tip of the tongue) vibrates, closing and opening the air passage, e.g. [r].
- Taps and flaps
  - Like a trill but has just one brief interruption of airflow.
  - In American English *rider* or *butter*.

Vowels

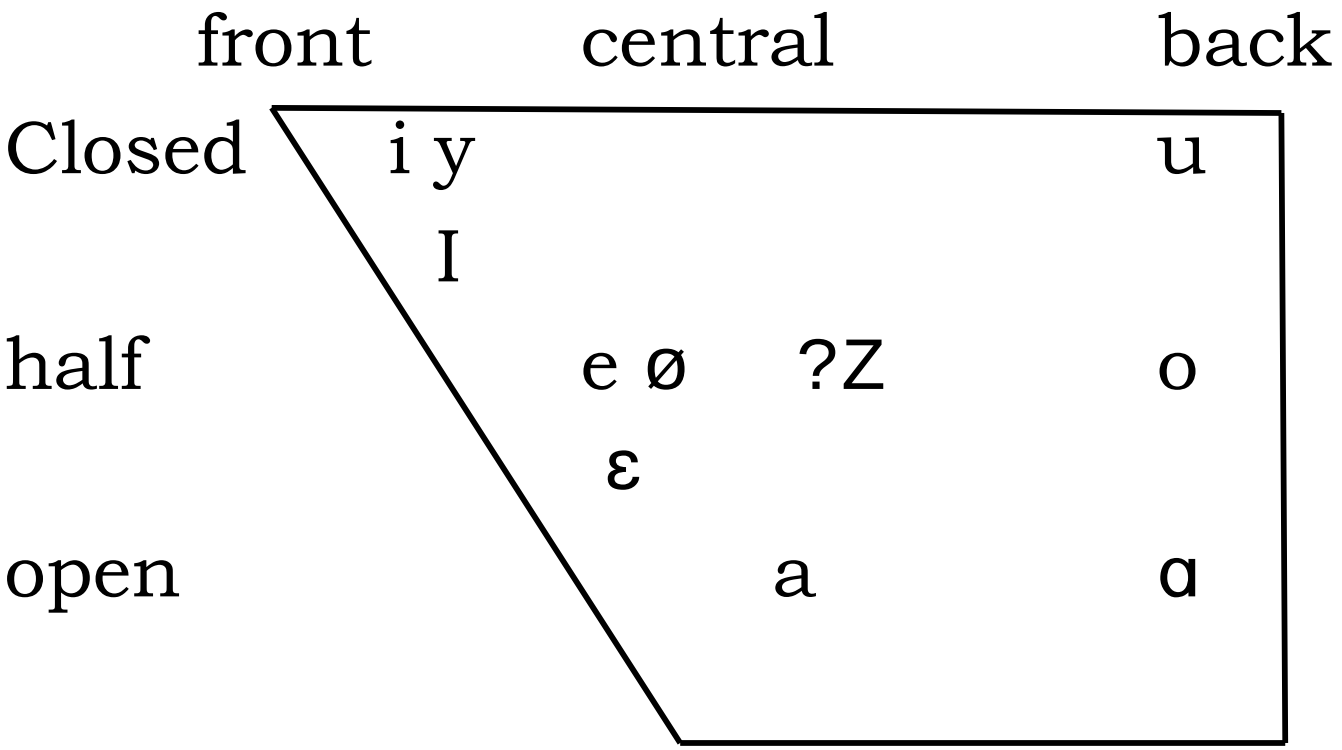
- Are produced with little obstruction in vocal tract
- Have greater sonority
  - Richer sound
  - Perceived as louder and longer lasting
- Often Nucleus of a syllable
  - The way in which sounds make up syllables is key

Characterizing Vowels

Vowels can be characterized by:

- The degree to which the cavity of the mouth is open (closed vs. open)
- The places where the cavity is made more narrow (front, central, back)
- The rounding of the lips
- Their length
  - Long and short vowels

Position of the tongue

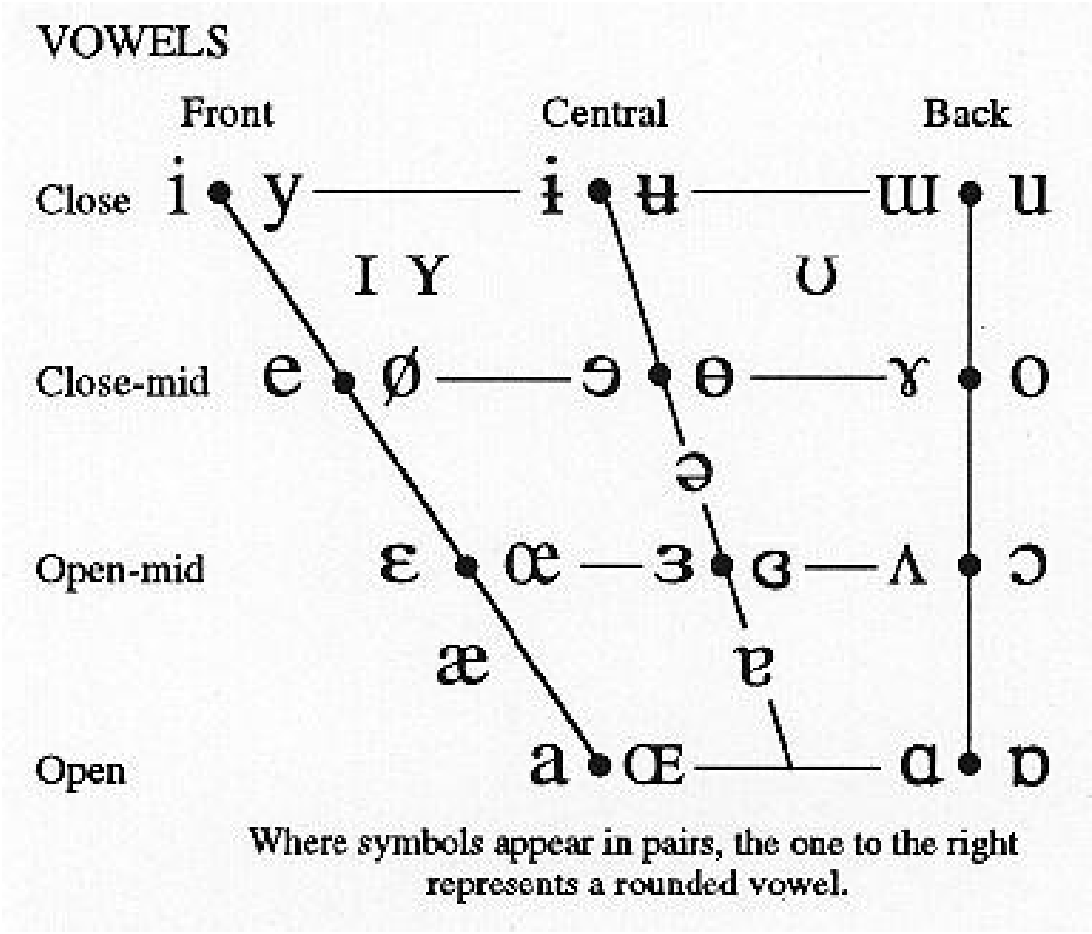


Other characteristics of vowels

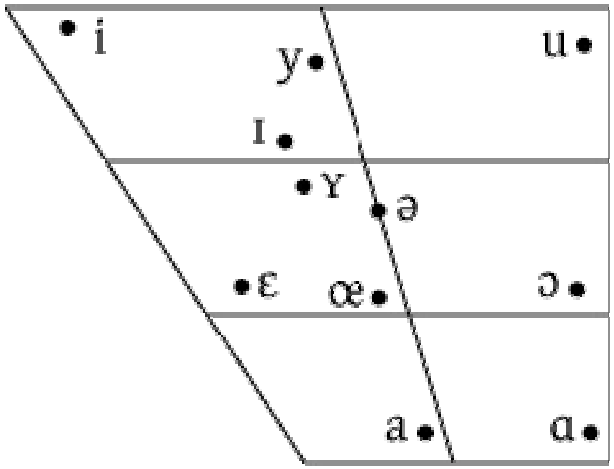
- Rounding:
  - Rounded lips, e.g. [u]
  - Unrounded lips, e.g. [i]
- Length:
  - Long vowels, e.g. [a]
  - Short vowels, e.g.[ɑ]
- Nasality

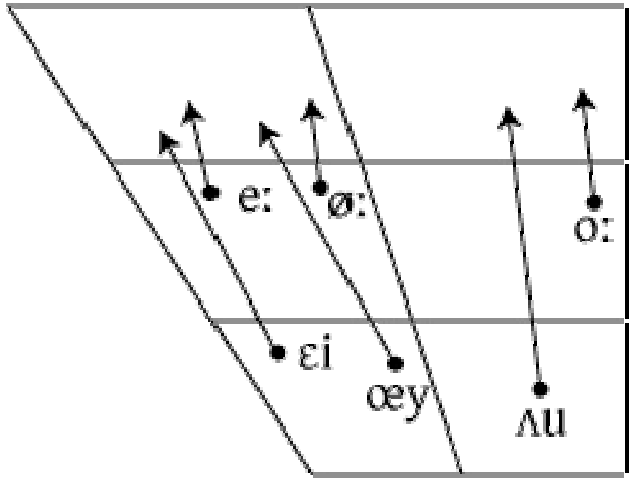
Most neutral vowel is the schwa: [ʔə̈](sjwa)

IPA-kaart vocalen

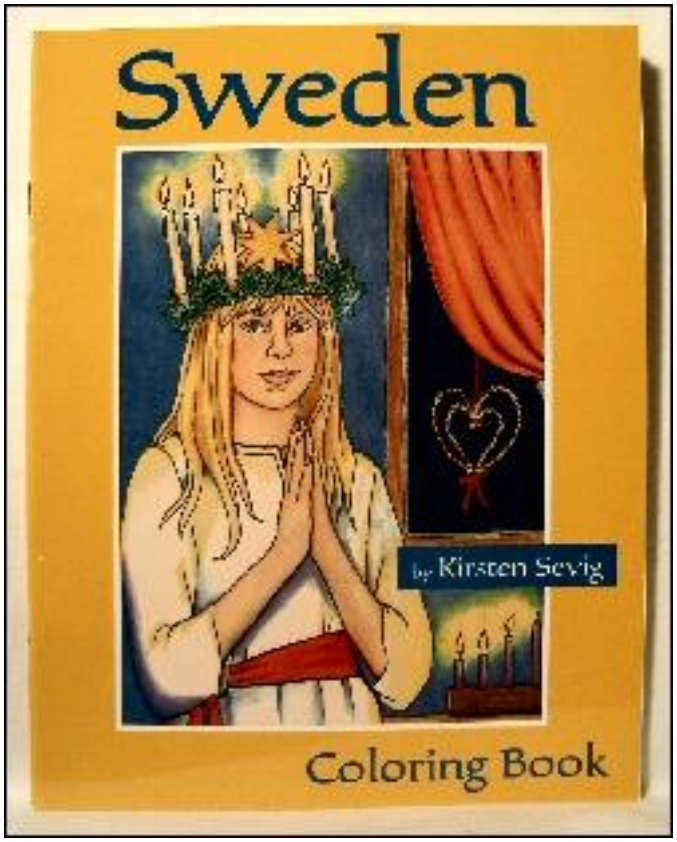


Monothongs & Dipthongs in Dutch





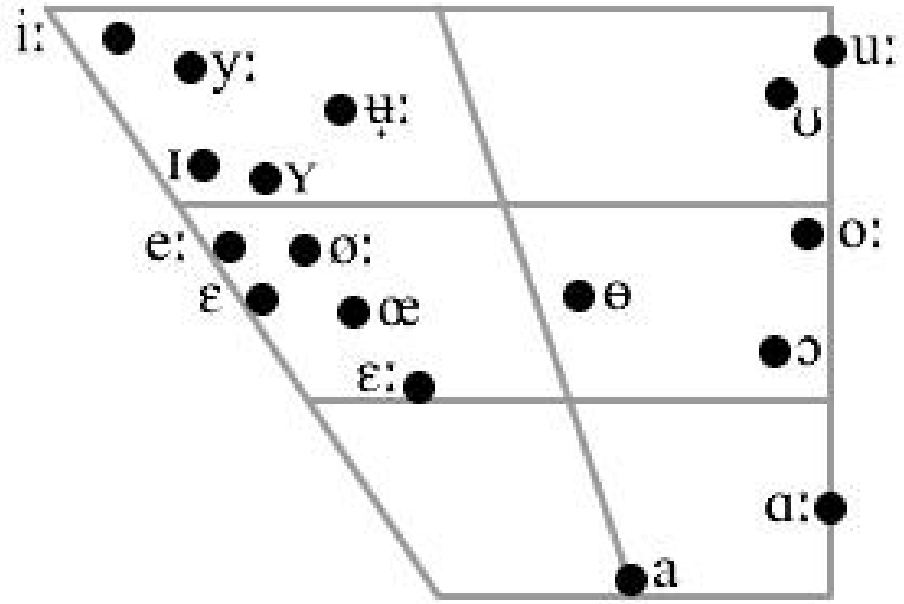
Swedish phonology



Swedish has a large vowel inventory, with 9 vowels that are distinguished in quality and to some degree quantity,

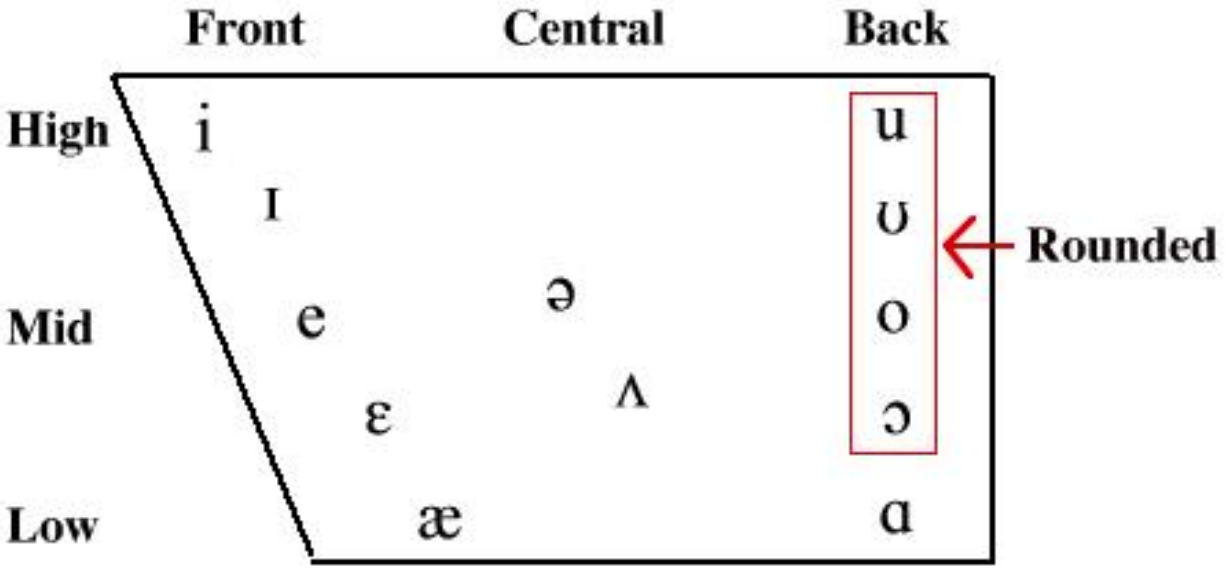
- making up 17 vowel phonemes, all of them being monothongs
- Also, the most common realizations of [ɧ] as a voiceless palatal-velar fricative is not known to exist in any other language.

Swedish vowels

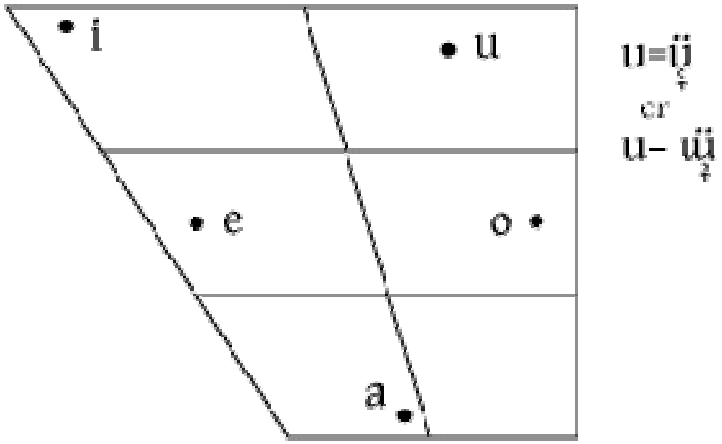


- Jeffrey Connell

American vowels



Japanese vowels



Other aspects of speech sounds

Suprasegmental aspects

There are other aspects of language that have nothing to do with different sounds, but how the sounds are pronounced:

- Pitch (Toonhoogte)
- Amplitude
- Length

Tones

In tonal languages a difference in pitch can be meaningful:

- Mandarin Chinese:
  - maÚ= mother
  - m¯á = hennep (?)
  - màá = horse
  - mâ = old hag (feeks)

Many languages use tone, even some dialects of Dutch, (e.g. Maasbrachts)

Intonation

Intonation: changes in pitch that do not lead to changes in meaning.

- Word accent
  - In Dutch this is normally on the last syllable
- Sentence intonation
  - Marks constituents, rising intonation by questions, falling intonation for declaratives (*downdrift*), etc.

Coarticulation

Consonants are influenced by the sounds that precede and follow them: *coarticulation:*

- beet - beer
- stroop – streep
  - In het eerste geval zijn de lippen al getuit bij de /s/, ter voorbereiding op de /o/, in het tweede geval niet.

Long and short vowels

- Ojisantachi (uncles) 
- Ojiisantachi (grandfathers) 

Auditory phonetics

- How do we recognize and decode speech?

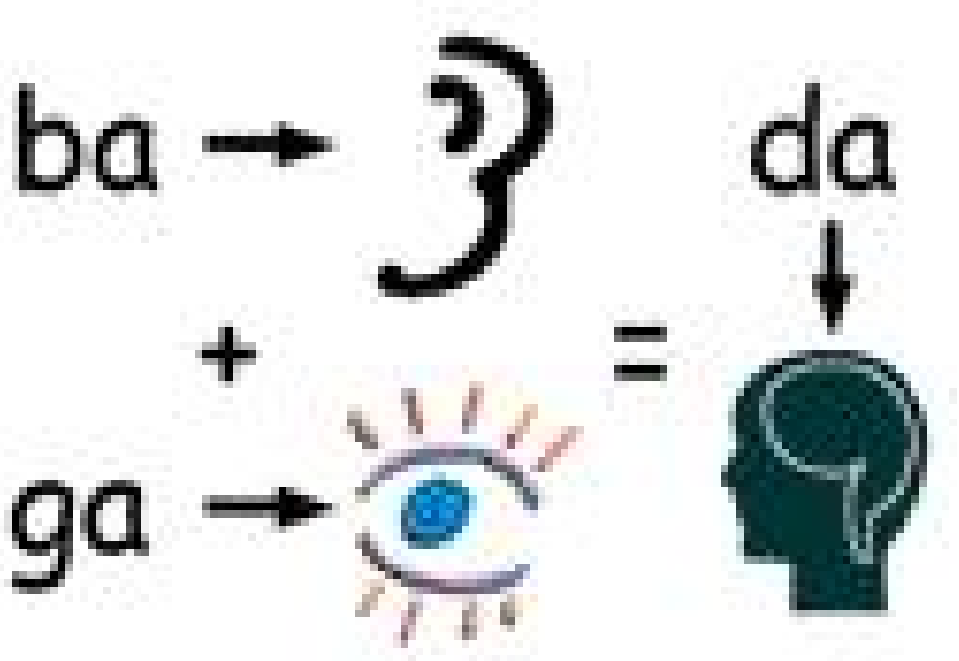
What information do you use in listening?

- What do you hear?

- What do you hear if you don't look?

-effect

You hear with your eyes as well!



Perceptive phonetics

- Do we all categorize the sounds we hear the same way?

Categorical perception of speech sounds

- http://psych.rice.edu/mmtbn/

- "ga" and "da" differ on a continuous dimension. (the second formant)
- there is a continuum of sounds from "da" to "ga."
- Ten sounds were generated with computer speech in equal steps from "da" to "ga."
- The experiment uses sounds numbered 1, 4, 7, and 10.
- Sounds 1 and 4 are both heard as "da“
- 7 and 10 are heard as "ga.“
- Since Sound 4 and Sound 7 are on opposite sides of the "categorical boundary" it is easier to hear the difference between these sounds than the difference between Sounds 1 and 4.
- This occurs even though the physical difference between Sounds1 and 4 is the same as the difference between Sounds 4 and 7.

- http://psych.rice.edu/mmtbn/

When do children learn the sounds of their language?

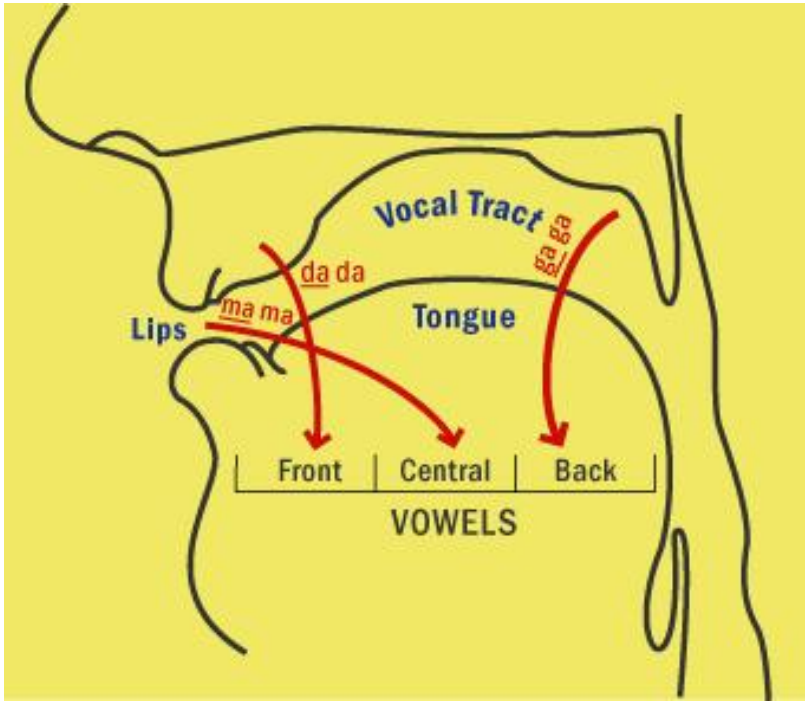
- There is a limit on the number language sounds in the world
- Languages differ according to the distinctions that they have decided to make
- The “babbling phase” of baby’s (brabbelfase)
  - Universal language sounds until 6 months
  - After that only the sounds found in the language that they are exposed to
  - Until they are 6 months old, baby’s are able to recognize distinctions between every type of language sound

Babbling Babes

- Holowka, S., & Petitto, L.A. (2002). Left Hemisphere Cerebal Specialization for Babies While Babbling. *Science, Vol 297*, page 1515.
- Evidence from films of babbling babies showed that babies' mouths opened more on the right
- Right-side of body is controlled by left hemisphere of brain
- Left-hemisphere of brain controls language!

Baby's first word

- Peter F. MacNeilage [1*] and Barbara L. Davis [2] On the Origin of Internal Structure of Word Forms *Science* 21 April 2000: Vol. 288. no. 5465, pp. 527 – 531
- babbling infants ranging in age from 6 to 18 months.
- four sequences of sound patterns—each a consonant-vowel combination—that were common to baby babble and to first words across a number of different languages



Proto-language?

- all four of these consonant-vowel combinations common in studies of Swedish, Portuguese, Korean, Japanese, French, Dutch, Berber (a language spoken in parts of North Africa, especially in Morocco and Algeria) and even in an Ecuadorian-Quichua environment
- same consonant-vowel combinations frequently appear in a list of 27 words proposed as being consistent with ancestral languages in different parts of the globe
- Suggests that spoken language could have evolved from 'baby babble.'
- speech evolved as a result of simple body mechanics

Synthesizing speech

- Useful for text-to-speech (TTS) systems

Speech synthesis
3 ways

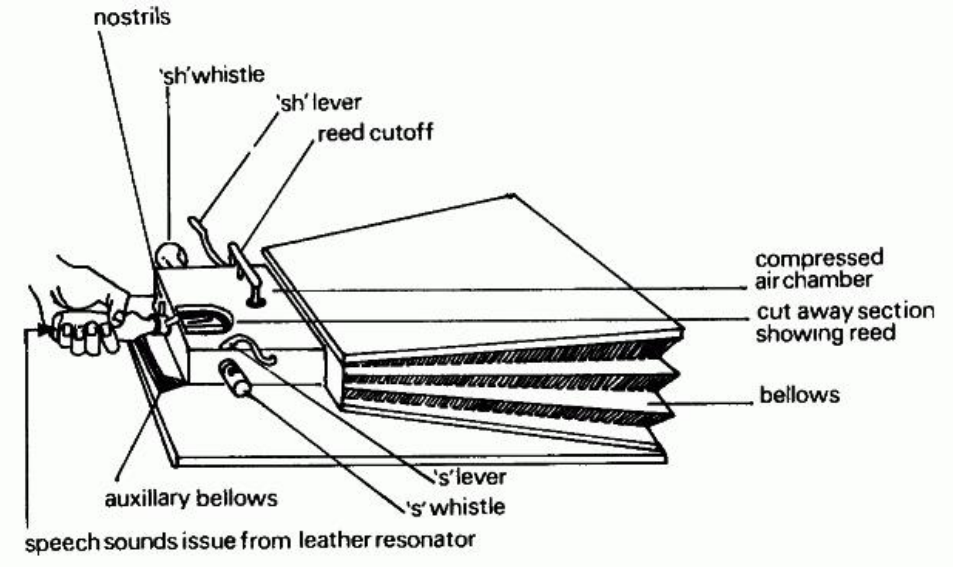
- Articulatory synthesis

- Concatenative synthesis
  - Pre-recorded sounds pasted together to make new messages, new sentences, or even new words

- Formant synthesis
  - Tries to recreate the sound waves present in speech

Synthetic Speech

- 1791: Von Kempelen's talking machine:



Reconstruction by Wheatstone (1835)

Formant synthesis

- 1939: Homer Dudley (AT&T Bell Laboratorium): VODER.
- 1951: Franklin Cooper: Pattern Playback
- Automatische text-to-speech conversie, bijv. DECtalk van Dennis Klatt.

- More modern version: TI Uni Duisburg

Concatenative synthesis

- Any pre-recorded announcement system could be considered concatenative
- Current systems tend to use diphones
  - an adjacent pair of phones. It is usually used to refer a recording of the transition between two phones
  - half phonemes\(demiphone), diphones and triphones are most frequently used units
  - concatenation at stationary parts of speech chunks are less problematic for most of the phonemes.
  - Festival British English diphone synthesis 

Next lecture….

- Phonology