

Speech recognition and synthesis

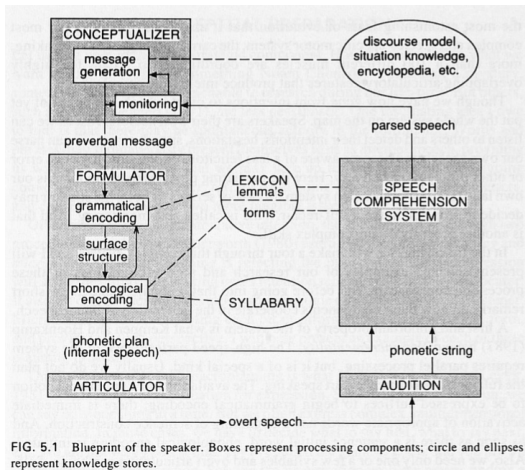
1 Speaking and hearing

- The soundchain
- Phonetics and Phonology
- Speech
- Source-filter model of speech production
- Hearing
- Speech sounds
- Dutch consonants
- Dutch vowels
- Assignment
- Bibliography

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The soundchain

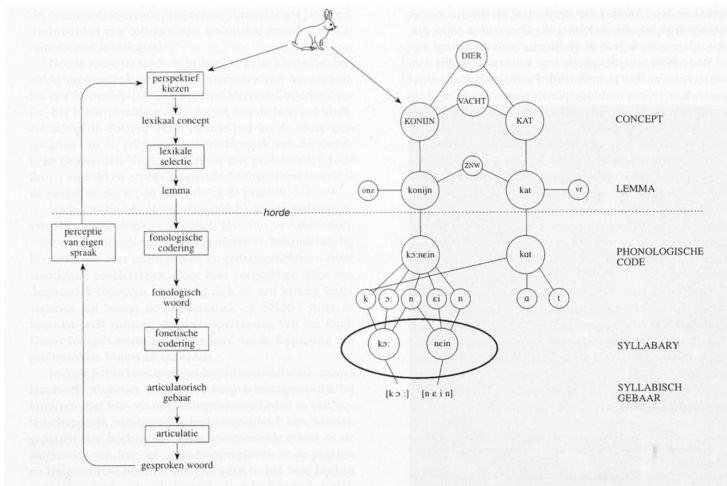


From idea to sound to perception to idea to sound...

[Levelt(1994)]



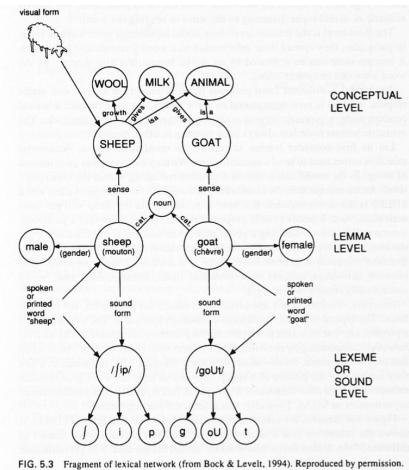
The soundchain: Production



From idea to sound...

[Levelt(1996)]

The soundchain



From idea to lexicon (and phonemes)...

[Levelt(1994)]



Phonetics and Phonology

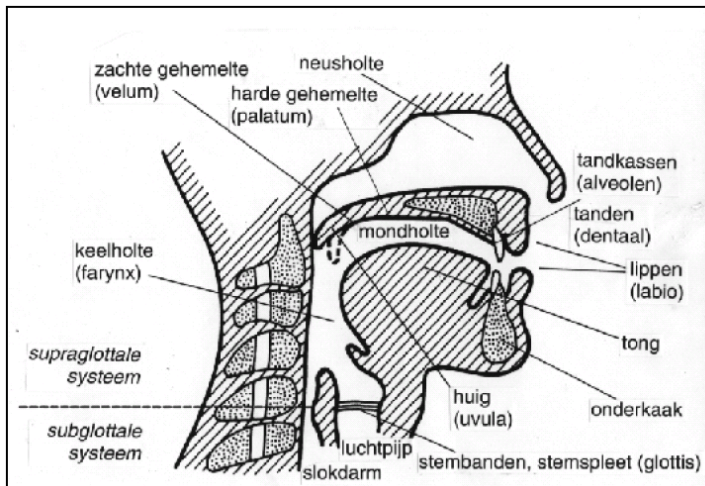
- **Phonetics:**
 - Physics of speaking, sound, and hearing
Production, signal characteristics, differences...
 - analysis speech signal
- **Phonology:** sound systems
 - Vowel and consonant system: **Phones & Phonemes**
 - Allowed combinations: **Phonotactics**
 - Sound changes: **Assimilation** and **Coarticulation**
 - **Prosody**

Phonetic reps: [a]

Phonological reps: /a/



The parts involved in speaking



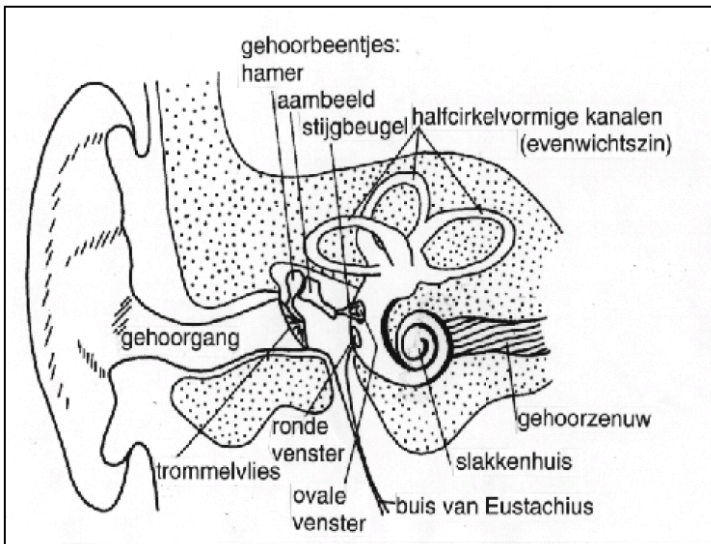
Source-filter model of speech production

Each speech sound has a source of sound which is filtered by the vocal tract

- The source can be glottal vibrations, airflow noise from a constriction, or a trill
- In general, the source sound has a flat (pink) spectrum
- The filter is the complete oral and/or nasal cavities or the part following a constriction
- It can in general be assumed that source and filter act independently



The ear



Basic speech sounds

Two categories

- 1 **Vowels**
Hardly any constriction in the vocal tract
- 2 **Consonants**
Constriction in the vocal tract

Classification

- **Manner of articulation** (sound source)
Fricative, plosive, nasal, ...
- **Place of articulation** (filter shape)
Constriction at the lips, teeth, **alveolar ridge**, **palate**, ...
- **Voicing**
Vibrating **vocal folds** or not

Manner of articulation

- **Plosive:** p, t, k
Complete closure, pressure building up, release
- **Fricative:** f, s
Almost complete closure
- **Liquids:** r, l
Air escapes laterally from the tongue
- **Nasals:** m, n
Air escapes through the nose
- **Approximants:** w, j
Constriction without turbulence



Place of articulation

p, t, k are different

- **Labial:** b
Both lips (bilabial)
Lower lip and the upper teeth (labiodental)
- **Dental:** d
Tongue against the upper teeth
- **Alveolar:** s
Tongue against or close to the superior alveolar ridge
- **Palatal:** j
Body of the tongue raised against the hard palate
- **Velar:** k
Back part of the tongue (the dorsum) against the soft palate
- **Uvular:** huig-r
Back of the tongue against or near the uvula
- **Glottal:** h
Consonants articulated with the glottis

dental+alveolarl = coronal

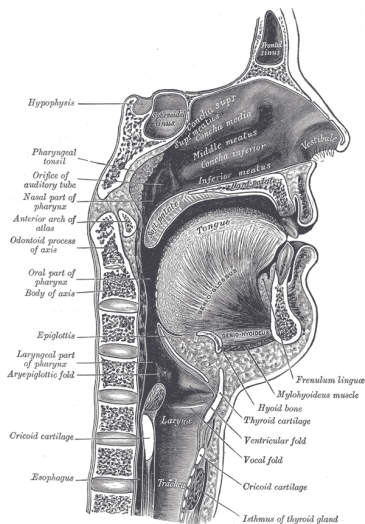
velar+uvular = dorsal



Voicing

Are the **vocal folds** vibrating?

- Voiced: b, d, g
- Voiceless: p, t, k



Dutch consonants

Plosive	p	b	t	d			k	g
	<u>p</u> aal	<u>b</u> aal	<u>t</u> aal	<u>d</u> op			<u>k</u> ok	<u>g</u> oal
Fricative	f	v	s	z	ʃ	ʒ	x	ɣ
	<u>f</u> iets	<u>v</u> ies	<u>s</u> ier	<u>z</u> ier	<u>ʃ</u> jaal	<u>ʒ</u> ouge	<u>x</u> cht	<u>ɣ</u> e
Nasal		m		n		ŋ		ŋ
		<u>m</u> aar		<u>n</u> aar		<u>ŋ</u> orane		<u>ŋ</u> ring
Liquid				l				
				<u>l</u> euk				
				r				
				<u>r</u> ter				
Affricate		ʋ				j		
		<u>ʋ</u> week				<u>j</u> jeuk		



Dutch consonants

Plosive	p <u>paal</u>	b <u>baal</u>	t <u>taal</u>	d <u>dop</u>		k <u>kok</u>	g <u>goal</u>	
Fricative	f <u>fiets</u>	v <u>vies</u>	s <u>sier</u>	z <u>zier</u>	ʃ <u>sjaal</u>	ʒ <u>rouge</u>	x <u>acht</u>	ɣ <u>gele</u>
Nasal		m <u>maar</u>		n <u>naar</u>		ŋ <u>oranje</u>	ŋ <u>ring</u>	
Liquid				l <u>leuk</u>				
				r <u>ter</u>				
Affricate		ʋ <u>week</u>				j <u>jeuk</u>		



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	<u>f</u> iets	<u>v</u> ies	<u>s</u> ier	<u>z</u> ier	<u>ʃ</u> jaal	<u>ʒ</u> ouge	<u>x</u> acht	<u>ɣ</u> ege
Nasal		m		n		ŋ		ŋ
		<u>m</u> aar		<u>n</u> aar		<u>ŋ</u> oranje		<u>ŋ</u> ring
Liquid				l				
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Nasal		m		n		ŋ		ŋ
		<u>m</u> aar		<u>n</u> aar		<u>ŋ</u> oran <u>je</u>		<u>ŋ</u> ri <u>ng</u>
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	<u>f</u> iets	<u>v</u> ies	<u>s</u> ier	<u>z</u> ier	<u>ʃ</u> jaal	<u>ʒ</u> ouge	<u>x</u> cht	<u>ɣ</u> e
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Fricative	f <u>f</u> iets	v <u>v</u> ies	s <u>s</u> ier	z <u>z</u> ier	ʃ <u>s</u> jaal	ʒ rou <u>g</u> e	x <u>a</u> cht	ʎ <u>g</u> e
Nasal		m <u>m</u> aar		n <u>n</u> aar		ŋ oran <u>j</u> e	ŋ <u>r</u> ing	
Liquid				l <u>l</u> euk				
				r <u>r</u> ter				
Affricate		ʋ <u>w</u> eek				ɰ <u>j</u> euk		

dax jonəs ɛn meɪfəs



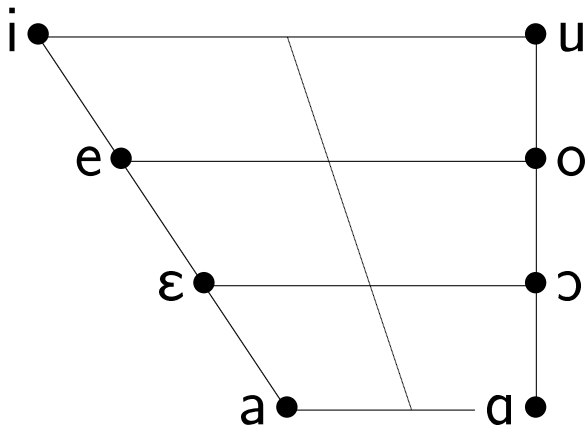
Vowels

Place of articulation

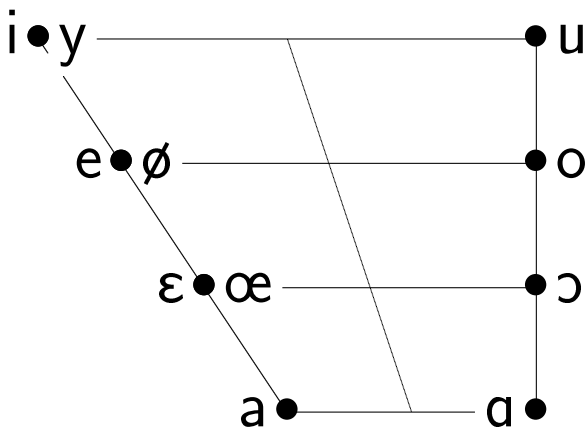
- Position tongue blade
 - Front-back: /i/, /u/
 - High-low (closed-open): /u/ - /a/
- Lips spreading/rounding: /i/, /y/



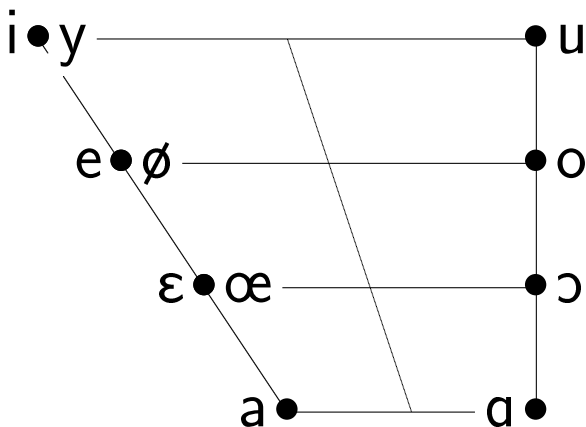
Dutch vowels



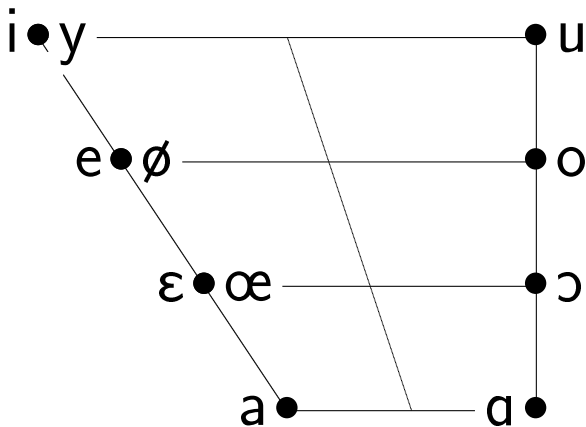
Dutch vowels



Dutch vowels



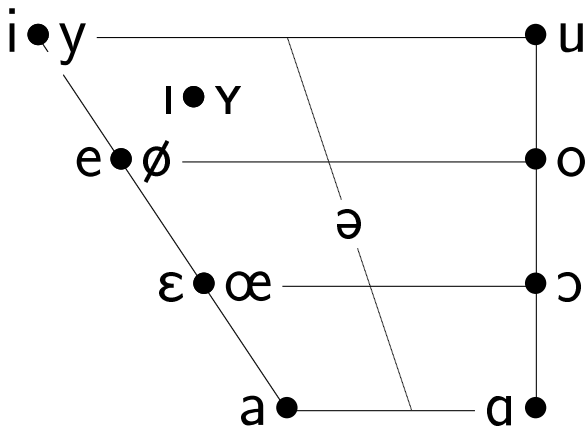
Dutch vowels



Any vowels we forget?



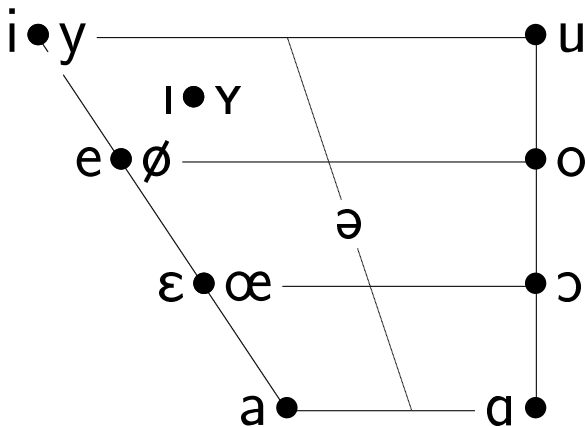
Dutch vowels



Any vowels we forget?



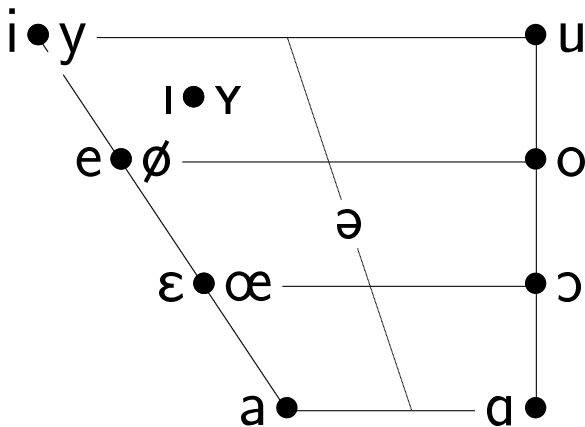
Dutch vowels



Speak aloud: /œy/



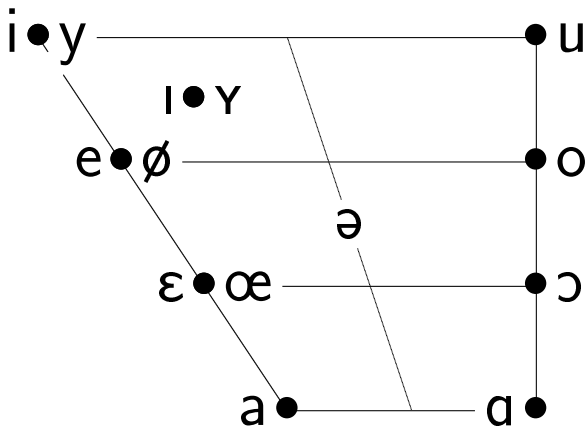
Dutch vowels



Speak aloud: /ɛi/



Dutch vowels



Speak aloud: /*au*/ /*œy*/ /*ɛi*/



Assignment- Week 1 Introduction to praat and speech

See BlackBoard for full description

- Download and install praat <http://www.praat.org/>.
- Record a sentence or download one from the [IFAcorpus](http://www.fon.hum.uva.nl/IFA-SpokenLanguageCorpora/IFAcorpus/SLspeech/sentences/fm/) (<http://www.fon.hum.uva.nl/IFA-SpokenLanguageCorpora/IFAcorpus/SLspeech/sentences/fm/>)
- Edit
- Inspect the spectrogram
- Cut out words and phonemes and listen to them
- Make a new sentence by concatenating words taken out of sentences
- Make new words by concatenating phonemes taken out of words
- Describe your experiences (concisely)
- hand in your report as a PDF

Further Reading I



P. Boersma.

Praat, a system for doing phonetics by computer.

Glot International, 5:341–345, 2001.

URL <http://www.Praat.org/>.



P. Boersma and D. Weenink.

Praat 4.2: doing phonetics by computer.

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Further Reading II



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Vowels and Consonants.

Wiley-Blackwell, Malden, 2005.

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Peter Ladefoged and Ian Maddieson.

The Sounds of the World's Languages.

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Structure of Spoken Language: Spectrogram Reading.

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URL <http://speech.bme.ogi.edu/tutordemos/SpectrogramReading/cse551html/cse551/cse551.html>.



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The Skill of Speaking, volume 1 of *International perspectives on psychological science*, pages 89–103.

Lawrence Erlbaum Associates, 1994.

URL <http://hdl.handle.net/2066/15531>.



W.J.M. Levelt.

Waar komen gesproken woorden vandaan?

De Psycholoog, 31:434–437, 1996.

URL <http://hdl.handle.net/2066/15548>.



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Version 2, June 1991

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END OF TERMS AND CONDITIONS



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Appendix: How to Apply These Terms to Your New Programs

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