The influence of lip-reading on aphasic comprehension

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Background

Speech perception is a multimodal process:

- using auditory and visual input (Rosenblum, 2008)
- in which seeing the speaker facilitates comprehension

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 - in aphasia (Shindo et al., 1991)

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- using auditory and visual input (Rosenblum, 2008)
- in which seeing the speaker facilitates comprehension
 - in a noisy environment (Sumby & Pollack, 1954)
 - with demanding contents (Reisberg et al., 1987)
 - in aphasia (Shindo et al., 1991)
 - in normal comprehension (McGurk & MacDonald, 1976)

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The McGurk Effect

McGurk effect = proof that auditory and visual information are both part of perception!

- Dubbing of different auditory and visual information
 - auditory: /ba/
 - visual: /ga/

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- Dubbing of different auditory and visual information
 - \bullet auditory: /ba/
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 - perception: /da/
- can only be explained by influence of seen on heard speech!

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McGurk Example

Can be found on

http://ilabs.washington.edu/kuhl/research.html#Auditory-Visual

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Auditory perception in neuropsychological models:



Phonetic Features

Every phoneme consists of 3 phonetic features:

- place of articulation(/t/ vs. /p/)
- \bullet manner of articulation (/t/ vs. /s/)
- voicing (/t/ vs. /d/)

Phonemes can differ in 1, 2 or all 3 features:

- house mouse (3 features)
- lice mice (2 features: place & manner)
- key pea (1 feature: place)
- bath path (1 feature: voicing)

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Phonetic features II

Phonetic features influence the perception of speech:

 smaller differences (1 feature) more difficult to detect than bigger ones for English aphasic listeners (Blumstein et al., 1977)

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Phonetic Features III

Features seem differently affected in Dutch aphasia (Klitsch, 2008)

- place of articulation seemed most affected
- but: material used (PALPA, Dutch Version) not designed to investigate that difference:
 - voicing contrasts occured initially
 - other contrasts finally or in metathesis
- Csépe et al. (2001) found for Hungarian that *voicing* was most affected

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Study 1 Study 2 Studies 1 & 2 Discussion & Conclusion

Voicing II

Voicing Distinctions in Dutch, Hungarian and English¹:



¹taken from Lisker & Abramson (1964)

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McGurk Effect and Aphasia

Campbell et al. (1990):

- 4 subjects with braindamage (1 with aphasia)
- aphasic subject had difficulties in auditory processing, lip-reading fine
- showed McGurk effect for consonants

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McGurk Effect and Aphasia II

Youse et al. (2004):

- 1 aphasic subject
- problems identifying syllables in all conditions
- 100% McGurk responses (/di/), but

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McGurk Effect and Aphasia II

Youse et al. (2004):

- 1 aphasic subject
- problems identifying syllables in all conditions
- 100% McGurk responses (/di/), but
- answer bias: answered /di/ almost always in all conditions

Study 1 Study 2 Studies 1 & 2 Discussion & Conclusion

McGurk Effect and Aphasia III

Klitsch (2008):

- 6 aphasic patients
- investigation of influence of lexical status
 - more McGurk responses if "input" = nonword & "output" = real word
- and age
 - $\bullet \ \ {\sf aphasia} = {\sf age-matched} > {\sf students}$

Study 1 Study 2 Studies 1 & 2 Discussion & Conclusion

My Study - Questions

- which phonetic features are integrated in audiovisual processing
- how does AV-integration work in aphasic subjects
 - maybe less influence of visual information

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Study 1 Study 2 Studies 1 & 2 Discussion & Conclusion

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 - or maybe even more?

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Study 1 Study 2 Studies 1 & 2 Discussion & Conclusion

My Study - Questions

- which phonetic features are integrated in audiovisual processing
- how does AV-integration work in aphasic subjects
 - maybe less influence of visual information
 - or maybe even more?
- how is integration accomplished by the brain

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My Study - Overview

- 2 experiments and a pilot study:
 - Pilot: Evaluation of material

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- Study 1
- Study 2
- Studies 1 & 2

Discussion & Conclusion



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Study 1 Study 2 Studies 1 & 2 Discussion & Conclusion

My Study - Overview

- 2 experiments and a pilot study:
 - Pilot: Evaluation of material
 - Discrimination Experiment
 - Identification Experiment
 - ERP Experiment

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Study 1 Study 2 Studies 1 & 2 Discussion & Conclusion

My Study - Overview

- 2 experiments and a pilot study:
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Introduction Study 1 Study 2 Studies 1 & 2

Discussion & Conclusion

Materials

Generally:

- nonwords with CVC(C) structure
- conditions: auditory only, audiovisual, visual only, McGurk
- recording of videos
 - male native speaker of Dutch
 - quiet room
 - audio via extra microphone
- editing of videos
 - each video: 3 seconds long, speaker 480 ms in rest position initially
 - $\bullet\,$ removing of picture or sound for AO/VO conditions
 - dubbing of different AO & VO stimuli for McGurk items

Pilot Study - Results

- amount McGurk answers comparable to Klitsch (2008)
- 4 (of 39) items without any McGurk response
- 7 items with comments about quality

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Discrimination - Aims

The current study investigates:

- whether Dutch aphasic subjects can also detect wider distinctions more easily than narrow ones
- which phonetic features are most vulnerable (if manipulated in the same position)
- the influence of lip-reading on (aphasic) perception of speech

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Discrimination - Procedure

Nonword discrimination task:

- videos of speaker articulating 2 syllables
- decision whether both were same or different
- button press to answer

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Discrimination - Procedure

Nonword discrimination task:

- videos of speaker articulating 2 syllables
- decision whether both were same or different
- button press to answer
- 3 conditions of presentation:
 - auditory only (AO)
 - visual only (VO)
 - audiovisual (AV)

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Discrimination - Procedure



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Discrimination - Material

phonologically possible but non-existing CVC-syllables

- fixed place of difference (initial)
- amount and type of features differing within a pair controlled

Discrimination - Material



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E-Prime Example 1

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Discrimination - Participants

All participants:

- Dutch, right-handed, with normal hearing and (corrected to) normal vision
- \Rightarrow 14 non-brain-damaged controls
- \Rightarrow 6 aphasic subjects

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Discrimination - Participants

Initials	Age	Gender	Type	Months	PALPA
			of	post onset	Nonword
			Aphasia		Discrimination
WB	57	male	Wernicke	148	56/72
BB	64	male	Global	5	53/72
ΕK	48	male	Amnestic	16	58/72
TB	47	female	Global	8	68/72
JH	51	female	Mixed	44	66/72
MB	47	female	Global	4	64/72

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Discrimination - Results

Control Subjects:

- scored at ceiling in AO and AV conditions
- VO worse than AO or AV (Wilcoxon: p<0.01)
 - concerning mainly voicing and manner

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Control Subjects:

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Aphasic Subjects:

- worse than controls in all 3 conditions (Mann-Whitney-U: p < .001)
- performance differed between the 3 conditions (Friedman: p < .01):
 - AV better than AO and VO (Wilcoxon: p<.05)
 - AO better than VO (Wilcoxon: p<.05)

Discrimination - Results

Condition	Controls (avg. correct)	Aphasic subj. (avg. correct)	Z-Score	p-value
Auditory only condition Audiovisual condition Visual only condition	99% 99% 83%	$87\% \\ 90\% \\ 63\%$	-3.521 -3.545 -3.387	$\begin{array}{l} p < .001 \\ p < .001 \\ p < .001 \end{array}$

Statistic analyses with Mann-Whitney-U Test, 2-tailed

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Discrimination - Results

Performance of aphasic listeners in 'different' condition:

Condition	Same (avg. correct)	Different (avg. correct)
Auditory only condition	94%	80%
Audiovisual condition	94%	85%
Visual only condition	78%	48%

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Discrimination - Results



Statistic analyses with Wilcoxon, 2-tailed: *:p<.05

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Discrimination - Results



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Discrimination - Results

Individual Results:

Traitiala	Auditory only				Audiovisual		
minais	Place	Manner	Voicing	Place	Manner	Voicing	
WB (Wernicke)	100%	100%	50%	83%	100%	67%	
BB (Global)	50%	50%	17%	67%	60%	17%	
EK (Amnestic)	83%	67%	67%	83%	100%	17%	
TB (Global)	67%	100%	50%	100%	100%	83%	
JH (Mixed)	100%	67%	83%	100%	100%	67%	
MB (Global)	50%	50%	17%	50%	67%	100%	

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Discrimination - Discussion

- additional lip-reading improves performance
 - replicating results of e.g. Shindo et al. (1991)

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Discrimination - Discussion

- additional lip-reading improves performance
 - replicating results of e.g. Shindo et al. (1991)
- most difficulties occur with small differences
 - as previously shown by Blumstein et al. (1977) for English

Discrimination - Discussion

Differences in voicing are most difficult to perceive

- \bullet contrary to Klitsch (2008) \rightarrow but: difference in materials
- in line with the results for Hungarian by Csépe et al. (2001)

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Differences between *place of articulation* and *voicing*:

Discrimination - Discussion

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Differences between *place of articulation* and *voicing*:

- place of articulation is conveyed by spectral cues
- voicing is conveyed by temporal cues

Discrimination - Discussion

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Differences between *place of articulation* and *voicing*:

- place of articulation is conveyed by spectral cues
- voicing is conveyed by temporal cues
- \Rightarrow This difference could explain the different performance

Identification - Aims

- replicate previous findings: McGurk also in Aphasia
- show that identification benefits from lip-reading
- determine probability McGurk in specific patient group

Identification - Procedure



Lip-reading in Aphasia

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Identification - Material



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Identification - Example

E-Prime Example 2



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Identification - Participants

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- same controls as in discrimination
- only 4 out of the 6 patients, namely:

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Identification - Results



Identification - Results



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Identification - Discussion

- patients are worse than controls
- for patients: AV better than AO
- scores lower than on discrimination
- generally: amount McGurk answers rather small

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Correlations - Results



all correlations are significant (Spearman: AO: R=.479, p=.044; AV: R=.634, p=.005; VO: R=.567, p=.014)

Correlations - Discussion

Results of both experiments correlate with each other! However: Improvement by lip-reading (discrimination) does not correlate with McGurk amount(Identification), but... not enough participants yet!

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Summing up...

Aphasic subjects have problems in perception:

- more with AO than AV stimuli (Ident. & Discr.)
- increasingly with smaller differences (Discr.)
- especially of 'voicing' (Discr.)

McGurk is comparable to healthy subjects (Ident.)

...and looking forward

Next:

ERP-study to investigate the brain activity during audiovisual integration!



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Questions & Comments

Thank you for your attention! e-mail: d.a.hessler@rug.nl website: www.doerte.eu

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