

Production & Perception in a second language the case of French learners of German:

*Evidence from large speech corpora,
electroencephalography, and teaching*

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Modèles, Dynamiques, Corpus
UMR 7114
Sciences du langage.



Introduction

- German pronunciation is not frequently taught in high school or university classes
- Correct pronunciation
→ key element to communicate successfully
- Only little research in German pronunciation
(Kaltenbacher, 1998; Gut, 2003/2012; Nimz, 2011; Smith and Peterson, 2012; Kasuya and Arai, 2013; Zimmerer and Trouvain, 2015)
- Population: French learners of German
- Investigating production and perception difficulties for French learners of German

Production and perception studies in L2

Phonetics

- Production in an L2
 - acoustic analyses
- Perception tests with native speakers
 - labelling, identification

(Flege and Hillenbrand, 1984;
Hayes-Harb et al., 2008)

Psycholinguistics

- Production in an L2
 - rating of accentedness, comprehensibility
- Perception in non-native listeners
 - identification, discrimination

(Ingram and Park, 1997;
Tsukada et al., 2005)

→ production and perception skills in second language learners

Research questions

- Predictions of Flege's *Speech Learning Model*:
are these production difficulties observed in German L2 speech?
 - To what extent French learners production of German differs from German native production?
- To what extent formal instruction in a classroom situation helps with production skills in a second language?
- Are the production difficulties linked to inaccurate perception?

Studies

What production difficulties do French learners of German encounter?

- Study 1 – Speech production
 - 20 German native speakers
 - 20 French learners of German (A2 – C2)
 - FLACGS corpus (*French Learners Audio Corpus of German Speech*)

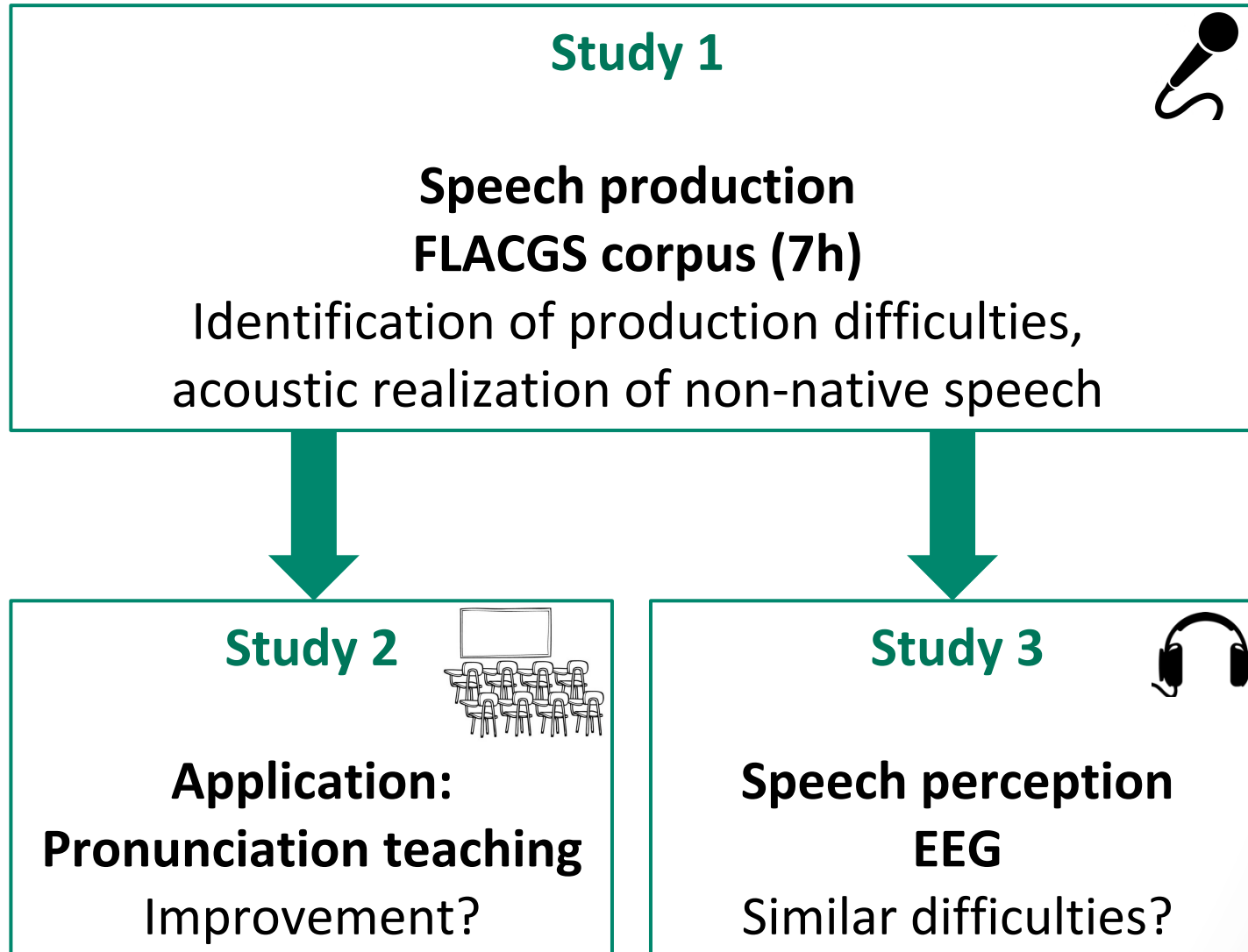
To what extent formal instruction in a classroom situation helps ...?

- Study 2 – The impact of formal instruction in the classroom
 - production: 4 German natives
30 French learners of German
 - perception: 16 French learners of German
 - ProFee-FLACGS corpus (*Progression and Feedback FLACGS*)

Are the production difficulties linked to inaccurate perception?

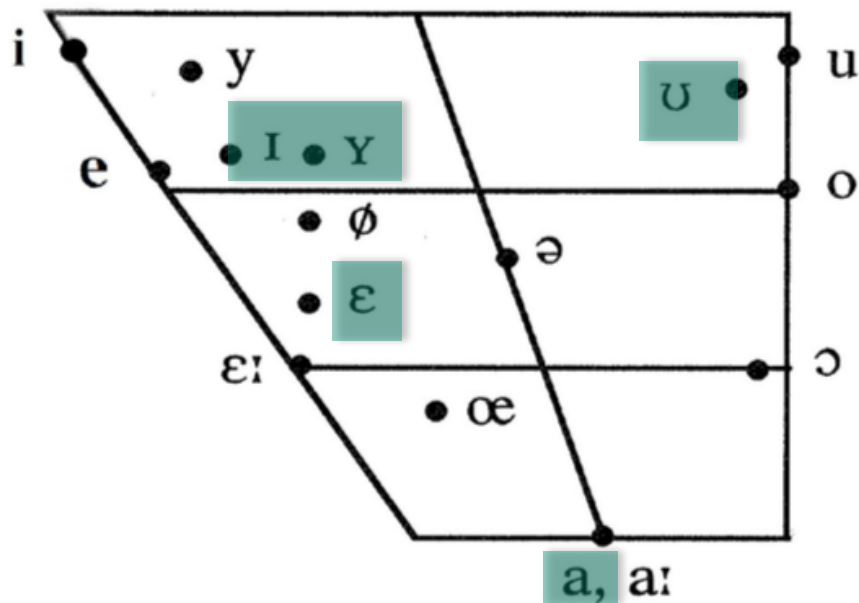
- Study 3 – Speech perception
 - 20 German native speakers
 - 20 French learners of German (B1/B2 – C2)

Link between the studies



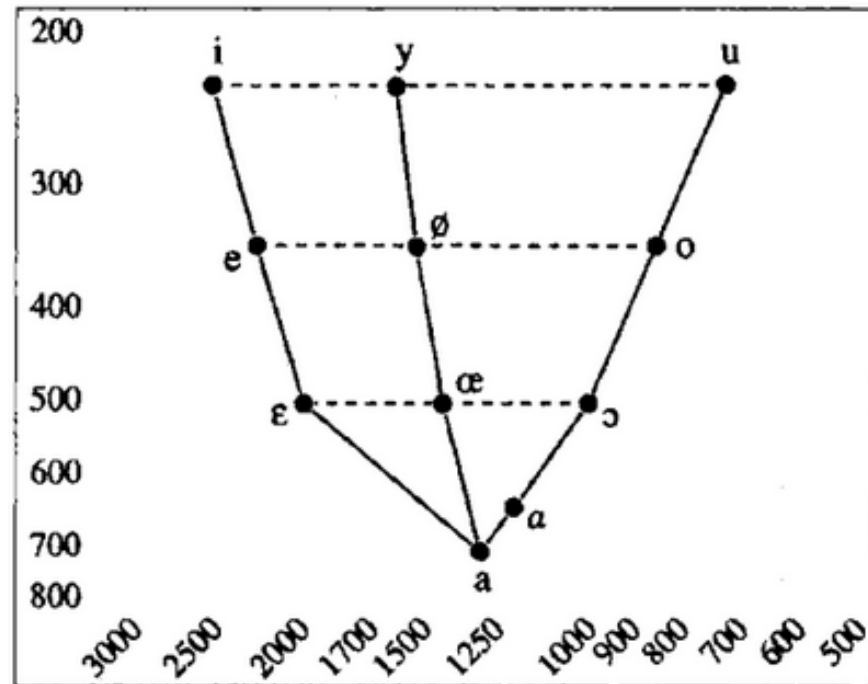
Comparison of German/French oral vowels

German



after Kohler (1999)

French



after Delattre (1966)

Comparison of German/French consonants

German

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d				k g			ʔ
Nasale	m			n				ŋ			
Trill				r					R		
Tap oder Flap											
Frikative		f v		s z	ʃ ʒ		ç	x	ʁ		h
Lateral-Frikative											
Approximanten							j				
Lateral-Approximanten				l							

Kohler (1999)

French

	Bilabial	Labio-dental	Dental	Palato-alveolar	Palatal	Velar	Uvular
Plosive	p b		t d			k g	
Nasal	m		n		ɲ	(ŋ)	
Fricative		f v	s z	ʃ ʒ			ʁ
Lateral Approximant			l				

	Palatal	Labial-Palatal	Labial-Velar
Central Approximants	j	ɥ	w

Fougeron and Smith (1999)

Flege's *Speech Learning Model* (SLM)

(Flege, 1995/2007)

- Based on the acoustic similarity between L1 and L2
- Predictions on a segmental level
 - “similar” phones → difficult to learn
 - “new” phones → easy to learn

Predictions of the *Speech Learning Model* for French learners of German

little production difficulty:

- [h]

high(er) production difficulty:

- vowel duration contrast
- [ç]
- [ŋ]

STUDY 1 – SPEECH PRODUCTION






Wottawa, Adda-Decker, and Isel (2018)

What impact has increased production complexity on word initial /h/ and vowel duration contrast realizations in German L2 speakers with French as a native language?

Dans Elena Babatsouli and David Ingram, *Phonology in Protolanguage and Interlanguage*. Equinox.

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Corpus design

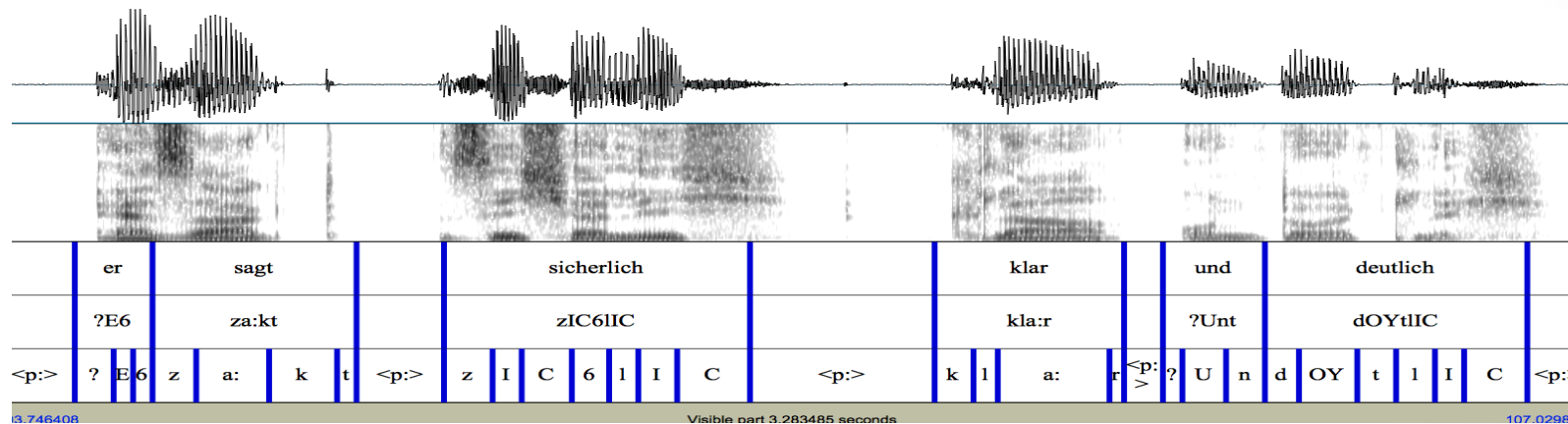
- Identification of production difficulties
- 3 speech production tasks of increasing production difficulty
 - imitation (auditory model) 
 - reading (conflicting orthographic conventions) 
 - picture description (lexical access) 
- Participants
 - German natives (N=20)
 - no noticeable regional accent
 - late French learners of German (N=20)
 - at least five years of German during high school



FLACGS corpus - summary



NAME	<i>French Learners Audio Corpus of German Speech (FLACGS)</i>
LANGUAGE	German
SPEAKERS	40 speakers (20 female)
	- 20 L1 German (age: 31.3, 22-47)
	- 20 L1 French (age: 25.8, 20-32)
VOLUME	ca. 7h of speech (35 250 words)
CONTENT	imitation, reading, picture description
TRANSCRIPTION	manually using the German orthography
ALIGNMENT	MAUS-webservice (automatic) and manual checking



8.746408

Visible part 3.283485 seconds

107.029893

Acoustic analyses carried out on the FLACGS corpus

- Duration measures
 - short and long vowels, [h], [ŋ], [ʃ] and [ç]
- Formant analyses
 - short and long vowels, [ʃ] and [ç]
- Centre of gravity (CoG)
 - [ʃ] and [ç]
- Intensity measures
 - [ʃ] and [ç]

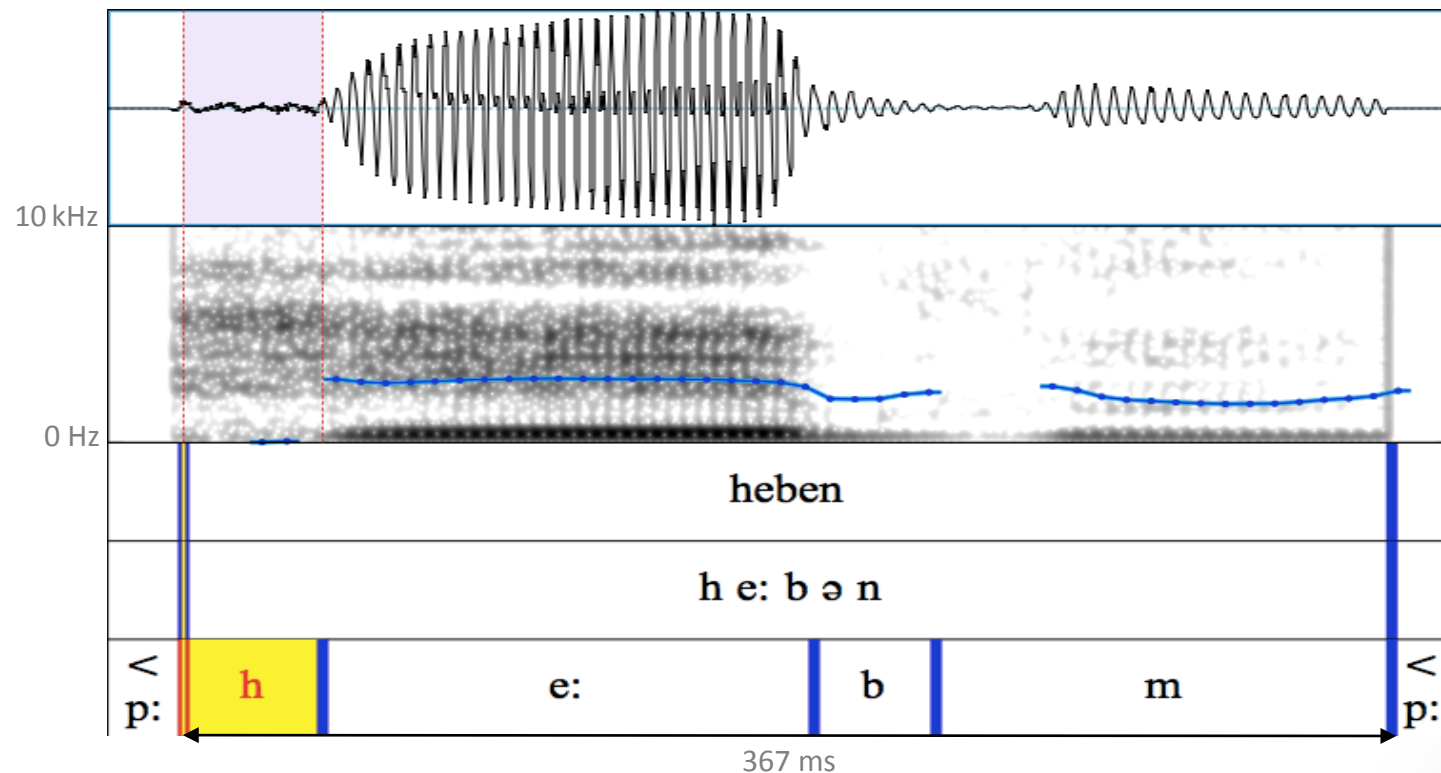
→ in the following focus on [h], [ŋ]



German /h/: German natives (GG)



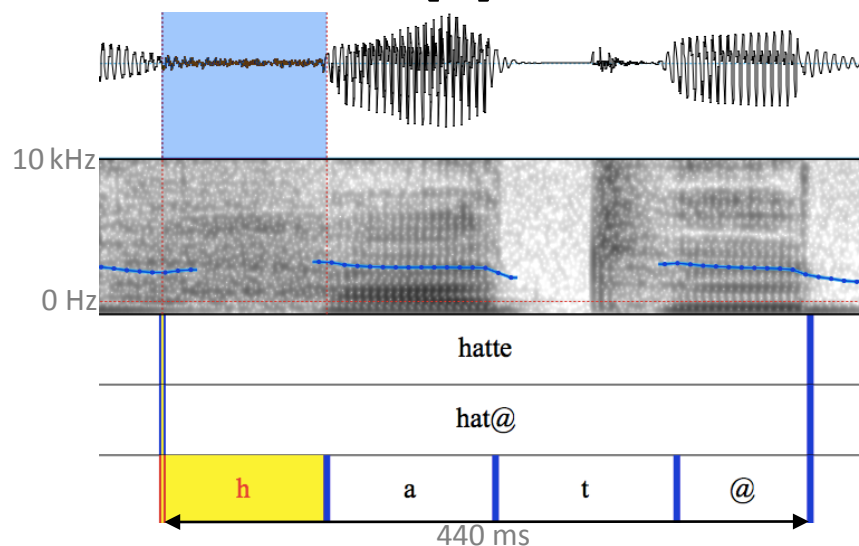
- Syllable initial:
heben ['he:bən] (to lift); *gehoben* [gə'hobən] (to lift participle)
- Stressed syllables
- No regional variation ([h] is not deleted)



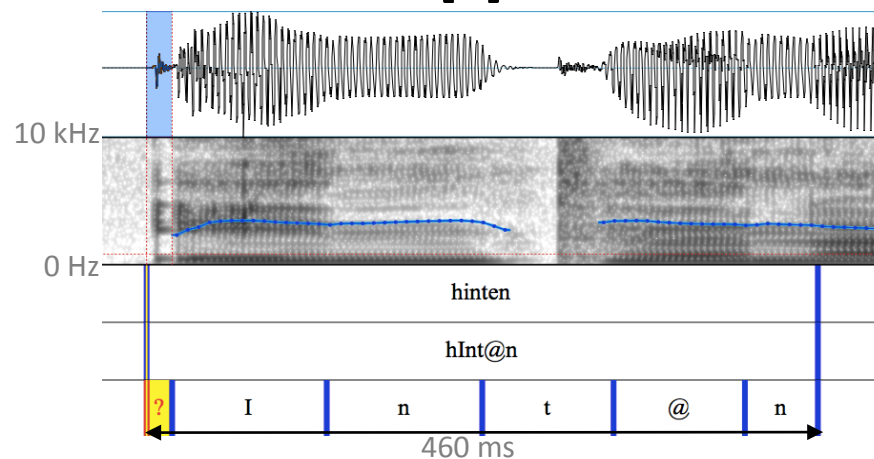


German /h/: French learners (FG)

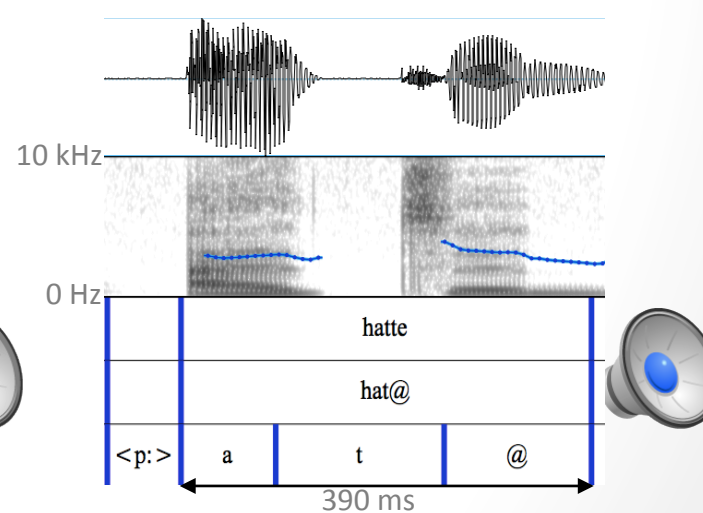
[h]



[ʔ]



deletion




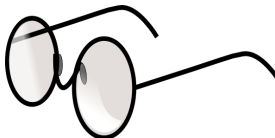

German /h/ across tasks in the FLACGS corpus



Phone realizations	Overall	
	GG	FG
[h]	100%	79%
[ʔ]	0%	11%
deletion	0%	10%
Tokens	411	252

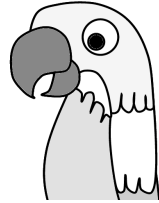
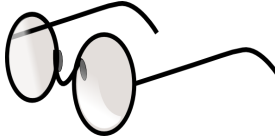

German /h/ across tasks in the FLACGS corpus



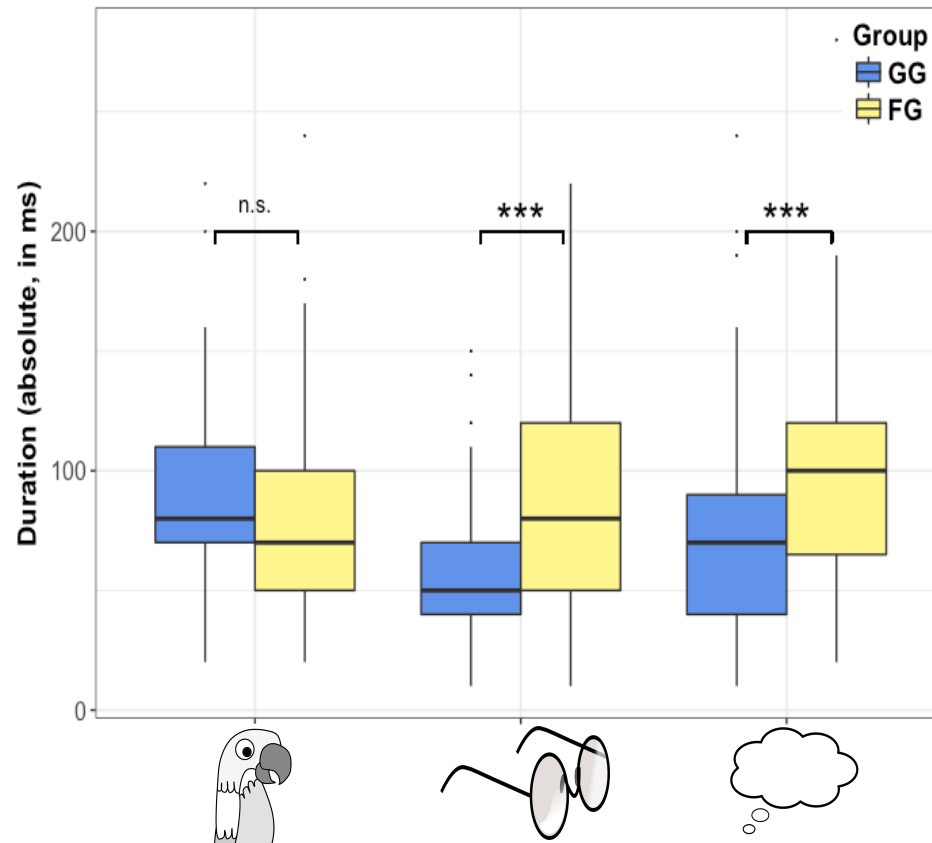
Phone realizations	Overall				
	GG	FG			
[h]	100%	79%	85%	78%	75%
[ʔ]	0%	11%			
deletion	0%	10%			
Tokens	411	252			

German /h/ across tasks in the FLACGS corpus





Phone realizations	Overall				
	GG	FG			
[h]	100%	79%	85%	78%	75%
[ʔ]	0%	11%	1%	20%	9%
deletion	0%	10%	14%	2%	16%
Tokens	411	252	77	104	71

German [h]: duration



Blue:
German natives

Yellow:
French learners

- Duration of [h] across the 3 speech tasks
- Longer durations in French natives in  and 

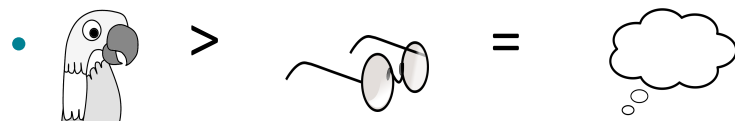


German /h/: discussion

- SLM predictions /h/: little production difficulties

- French learners of German

- majority of [h]



- [h] longer durations than in German native speakers

- do French learners try to be unambiguous?

- also substitutions [ʔ] and deletions (empty onset)

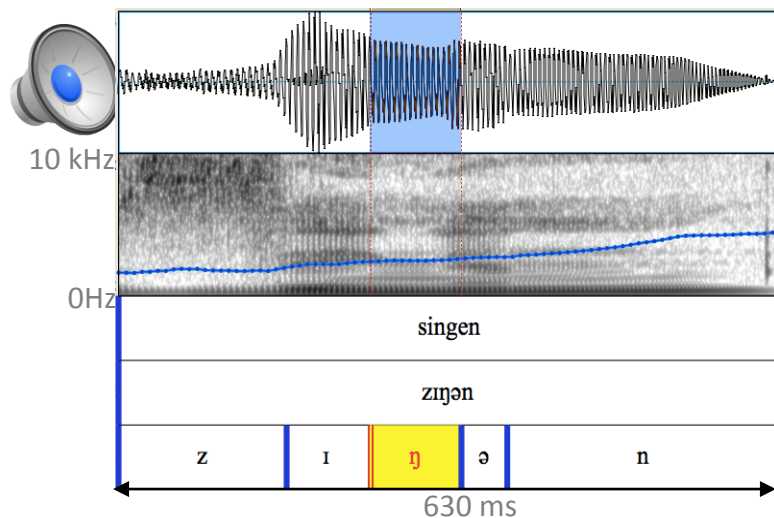
-  most substitutions, linked to orthography?

German /ŋ/

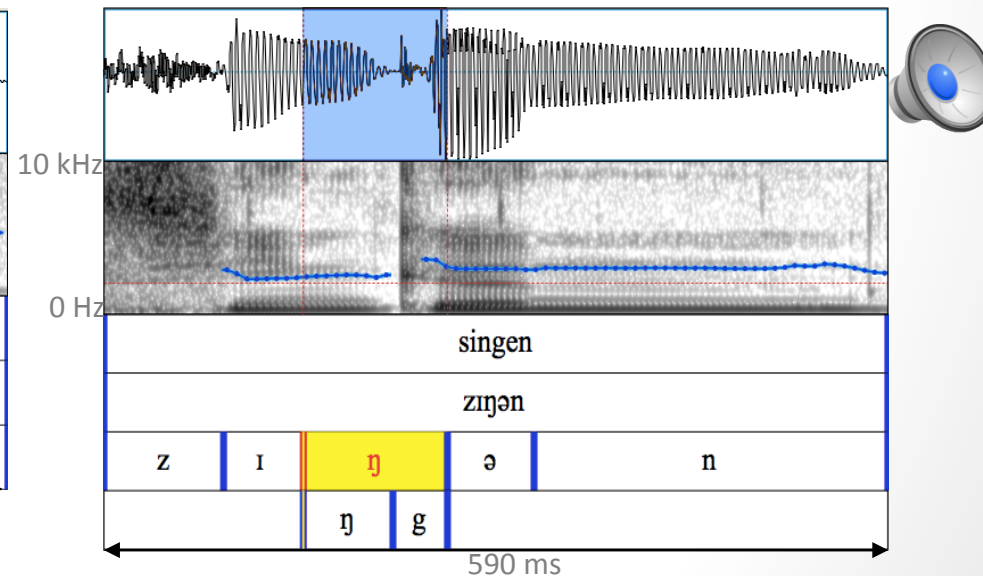
German

- Stressed and unstressed syllables
 - Schwingung
- Appears in syllable final positions
 - Zeitungng, Zeitungen
- Focus on intervocalic positions
- French learners of German
 - tend to add a homorganic stop consonant [g]

German native



French learner of German




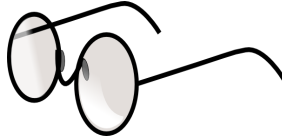
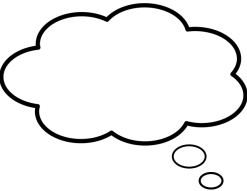
German /ŋ/ across tasks in the FLACGS corpus




Phone realizations	Overall	
	GG	FG
[ŋ]	100%	44%
[ŋg]	0%	56%
Tokens	239	218

German /ŋ/ across tasks in the FLACGS corpus



Phone realizations	Overall				
	GG	FG			
[ŋ]	100%	44%	55%	32%	45%
[ŋg]	0%	56%	45%	68%	55%
Tokens	239	218	80	60	78

German /ŋ/: discussion

- SLM predictions /ŋ/: high production difficulties
- French learners of German
 - majority of [ŋg]
 - most occurrences in 

Study 1: general discussion



Little production difficulty:

- [h]

High(er) production difficulty:

- vowel contrast
- [ç]
- [ŋ]

- Errors
 - substitutions
 - deletions
- Longer segment durations than German natives

- Vowel duration
→ little production difficulty
- Vowel quality
→ high(er) production difficulty

Study 1: general discussion



Phones of interest

Imitation



- /h/ [ʔ] or empty: 15%
- /ŋ/ [ŋg]: 45%
- [ʃ] and [ç] difficult separation
- V contrast duration: good
quality: medium

Reading



- [ʔ] or empty: 22%
- [ŋg]: 68%
- —
- duration: good
quality: difficult

Description

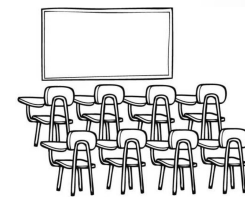


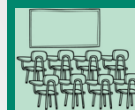
- [ʔ] or empty: 25%
- [ŋg]: 55%
- —
- —

increasing production difficulty
due to production mode

{ 26 }

STUDY 2 – THE IMPACT OF FORMAL INSTRUCTION IN THE CLASSROOM





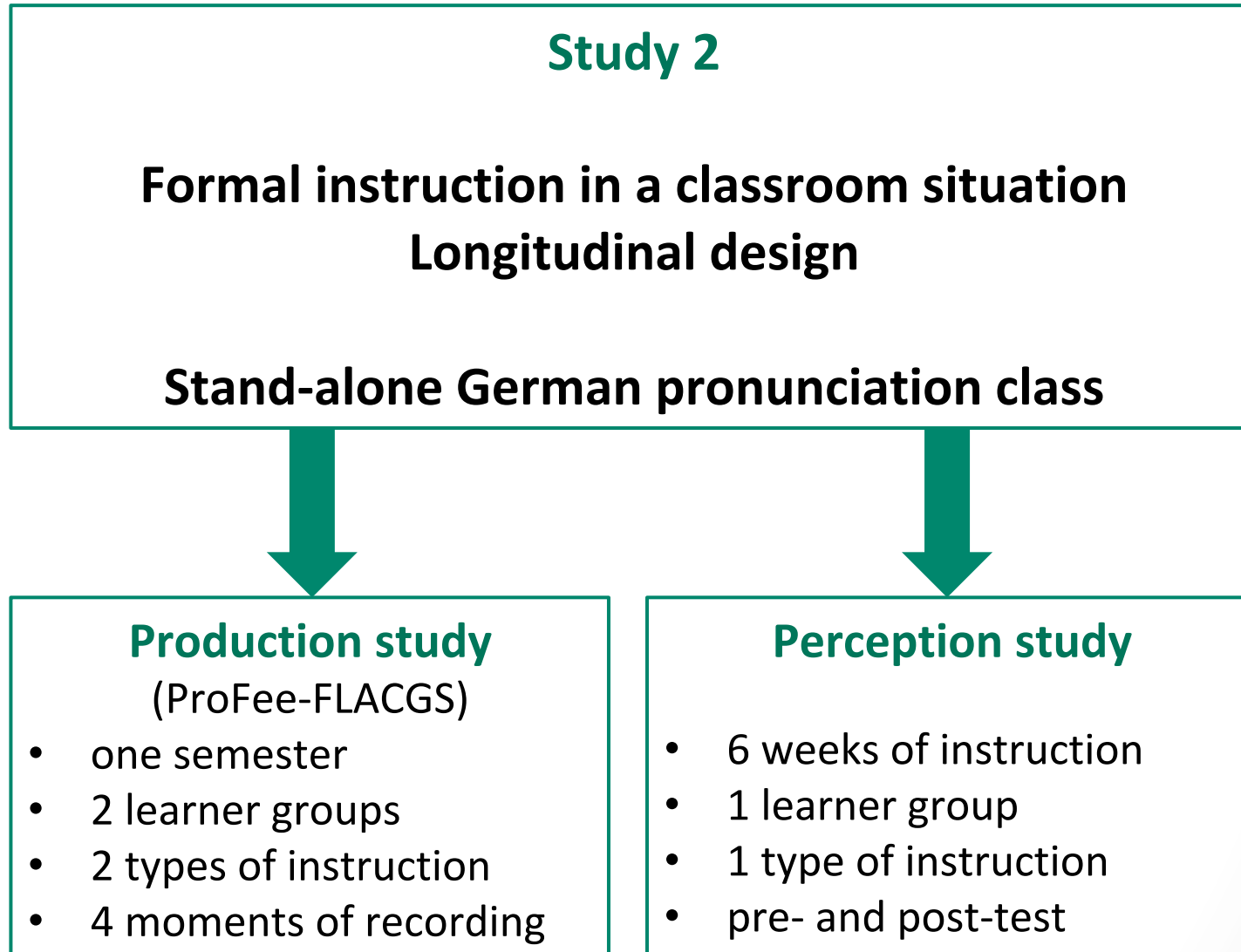
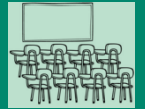
Pronunciation teaching

- Informs learners of potential difficulties with L2 pronunciation
- Content transmission: phonological rules, phonetic variants, etc.
- Exercises
 - increased awareness

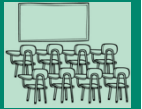
Gattegno (1976):

“awareness provides the dynamics that scan the field to be known and is, therefore, both a condition and a means of knowing”

Study design



ProFee-FLACGS Corpus



Group 1

Input:
Audio Only (AO)

Group 2

Input:
Audio & Visual (AV)

Reading

Description

Reading

Description

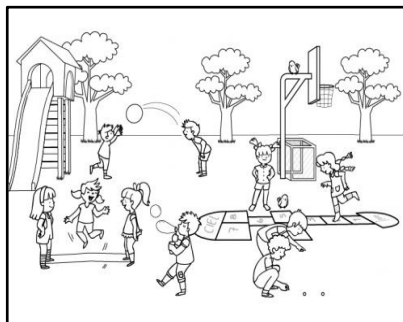
Sep.

Oct.

Nov.

Dec.

**Willkommen
und
Abschied**
J.W. Goethe



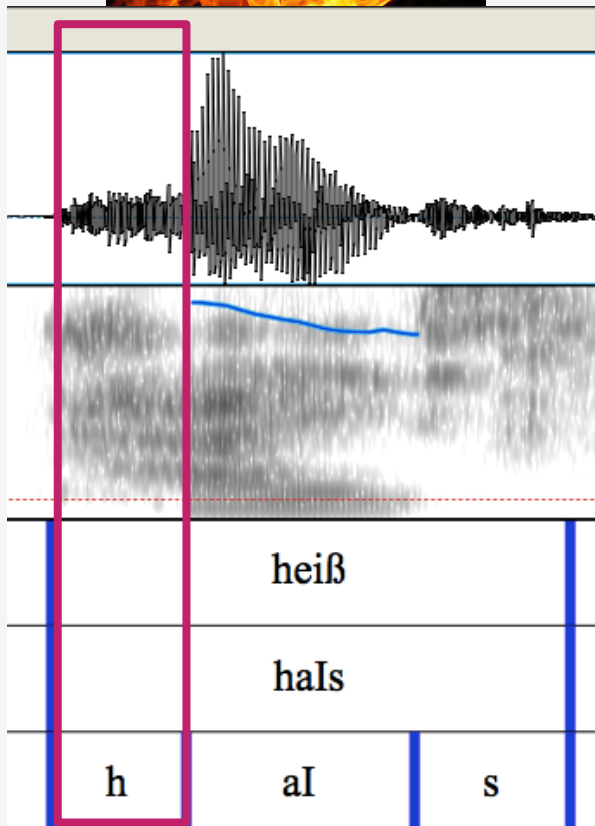
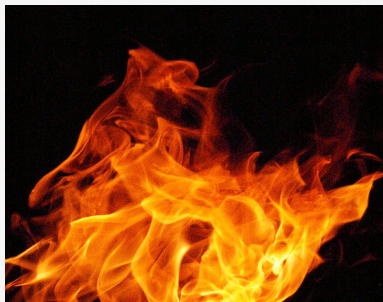
**Letztendlich
sind wir dem
Universum egal**
David Levithan



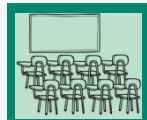
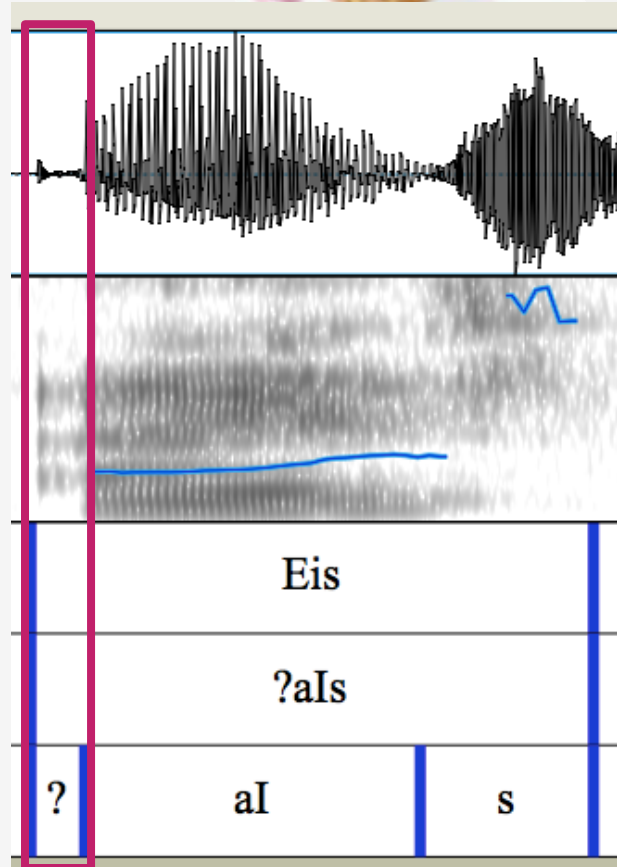
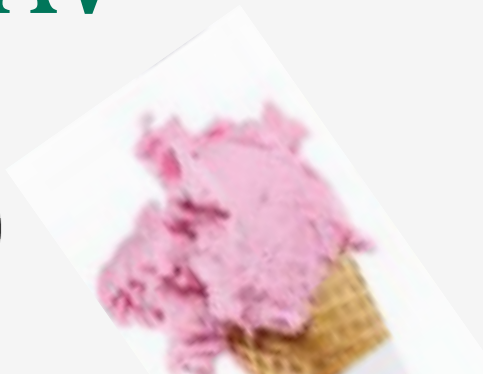
Teaching Period (one semester)

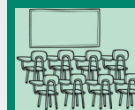
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Teaching slide - A0 vs. AV




[h] vs [ʔ]

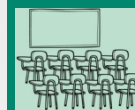




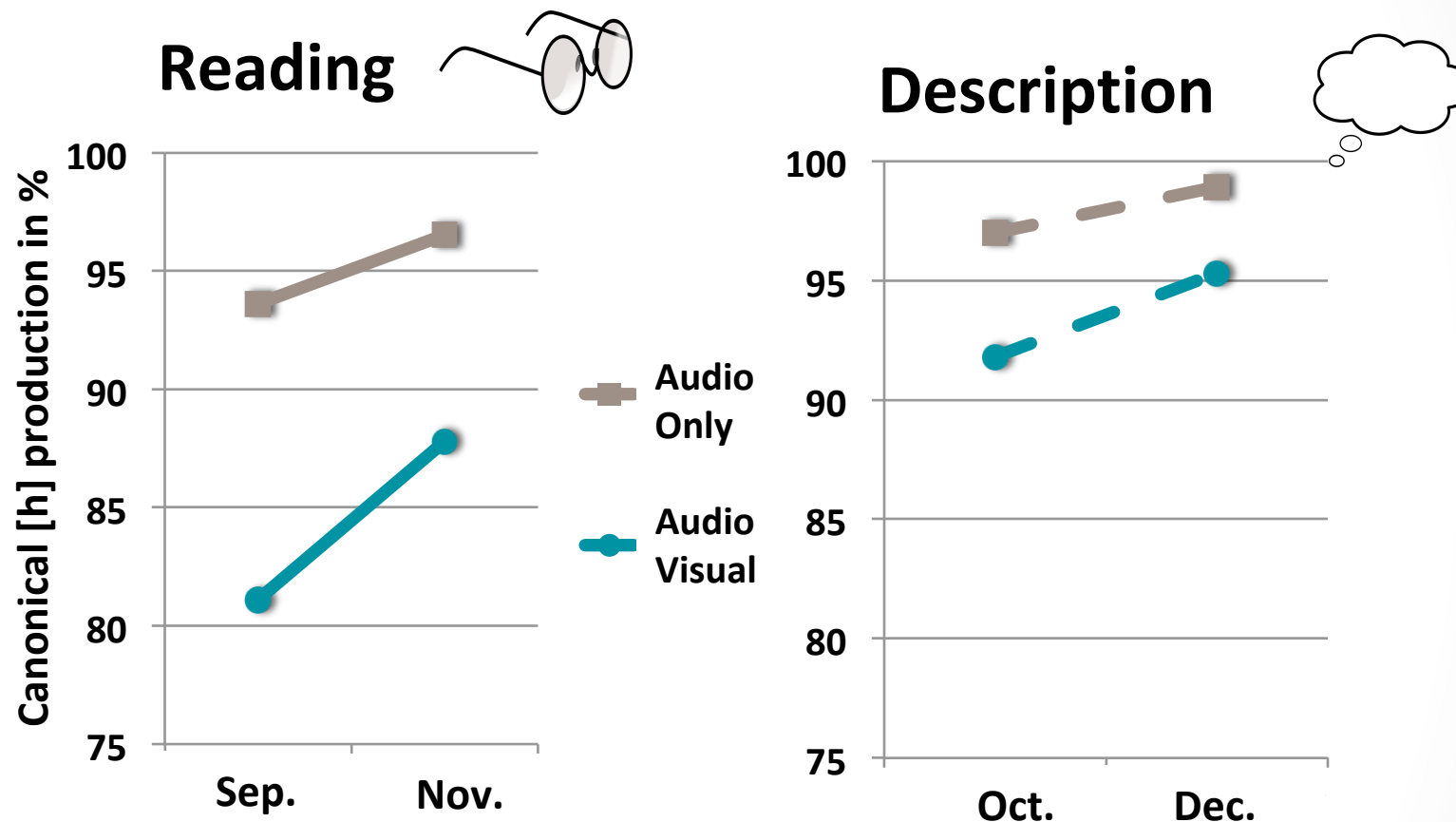
Corpus collection and annotation

- Speech production tasks ()
- Audio files were mailed to the teacher

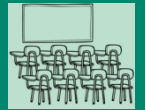
- Manual transcription – German orthography
- Automatic alignment with the web-service of *Munich Automatic Speech Segmentation (MAUS)*
<https://clarin.phonetik.uni-muenchen.de/BASWebServices/#/services>
- Manual checking of the MAUS alignment



German [h]: realization rate

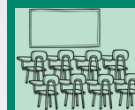


- Improvement in both groups in both tasks
- Reading more challenging than description



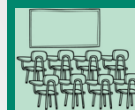
German [h] production: conclusion

- Training effect
 - less [h] deletions
 - [h] duration remains long
- AO vs. AV:
 - audio-visual group
 - improvement more spectacular
- Reading vs. description
 - grapheme to phoneme correspondence?

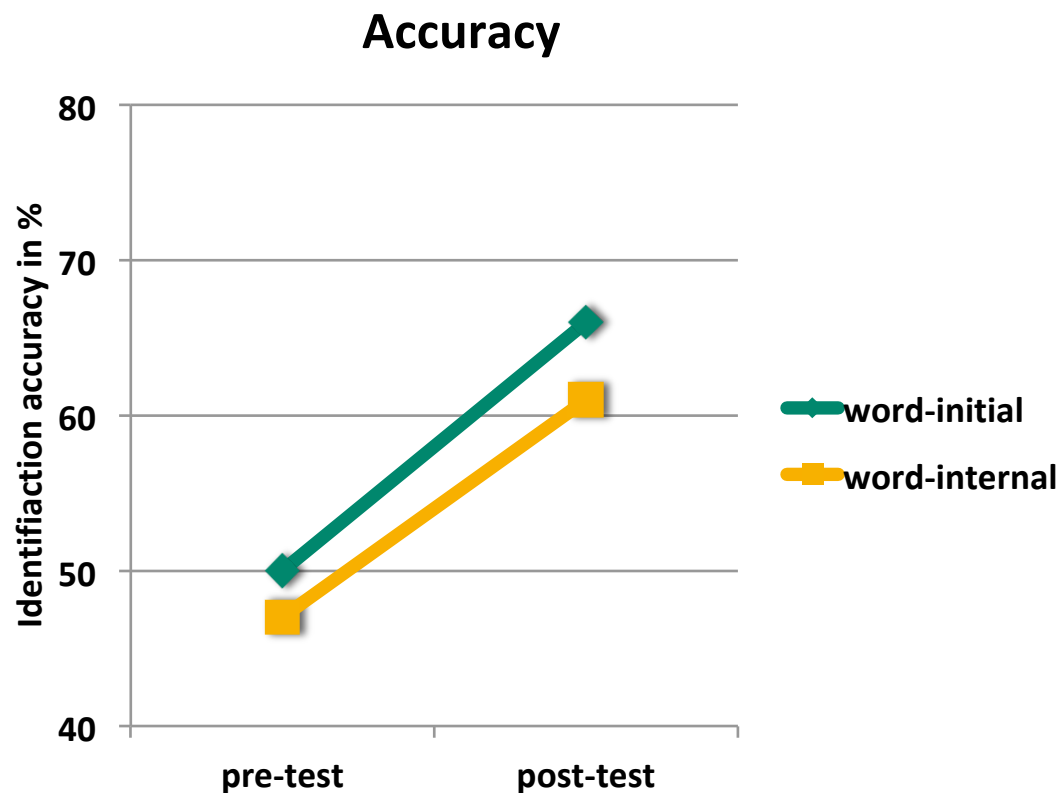


Exploratory speech perception study

- Perceptual discrimination tests (AXB)
 - pre-test: before the pronunciation teaching
 - post-test: after five weeks of training
- Participants
 - 8 students (age: 19.1, 18-21 years)
- Stimuli
 - minimal pairs, contrasts in stressed word positions
 - [h] or [ʔ] onset: *Halter* ['halte] vs *Alter* ['ʔalte],
geheilt [gə'hailt] vs *geeilt* [gə'ʔailt]
 - short and long vowels



Perception test [h]-[ʔ] : results



- Correct identification of [h] and [ʔ] (pooled) in %



Study 2: general conclusion

- Awareness seems to help more with the production of German [h] than with its perception.
- Asymmetry in production and perception might be due to the properties of [h]
 - easy articulatory gesture
 - [h] presents little salient acoustic information

STUDY 3 – SPEECH PERCEPTION





Motivations for the perception study

- Production difficulties linked to inaccurate perception?
- SLM: similar predictions for production and perception difficulties
- EEG (electroencephalography):
 - perception mechanisms in real time
 - early perception processes
 - no interference of other cognitive processes

Oddball paradigm

- EEG experiment - oddball paradigm



- Stimuli stream:
frequent (standard, i.e. 90%), rare (deviant, i.e. 10%)
- Participants:
 - 20 German native speakers (age: 24.4, 21-28 years)
 - 20 advanced French learners of German (age: 22.8, 19-34 years)

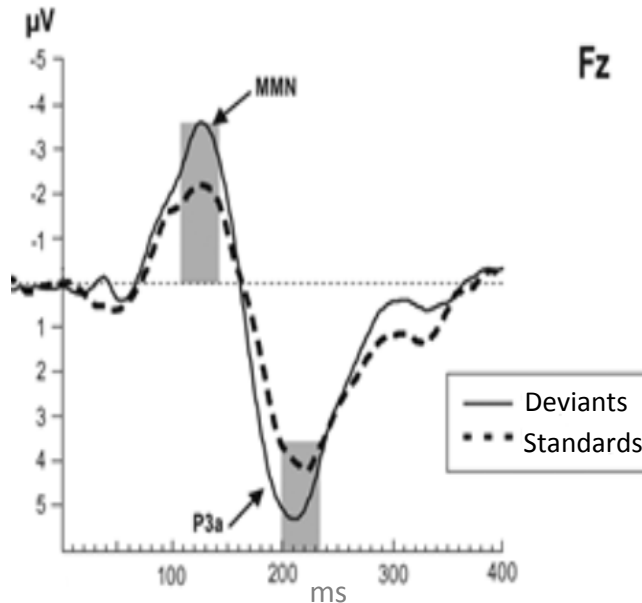


Choice of stimuli

- German words
 - short and long vowels: bitte – biete, Stadt – Staat
 - [h]-[ʔ]: Halter – Alter, verhüsst – verüsst
 - [ʃ] – [ç]: Feschel – Fechel, Gepisch – Gepich
- 7 German female speakers
 - female speakers only in order to avoid reactions to gender (Casado and Brunellière, 2016)
- Multi-speaker: categorical discrimination
 - the listener should ignore acoustical differences that are not phonetically relevant (Strange & Shafer, 2008)



Expected event related potentials (ERPs) in an oddball paradigm



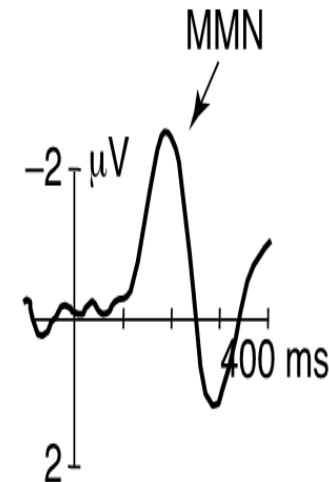
after Gumenyuk et al. (2011)

P3a

(Sutton et al. 1956)

- positive ERP component
- involuntary redirection of attention

Subtraction wave



After Van Zuijen (2006)

MMN *Mismatch Negativity*

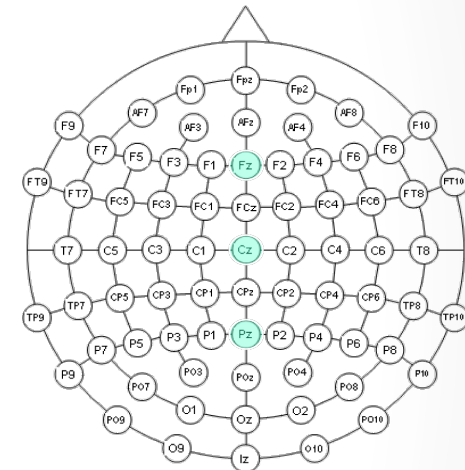
(Näätänen, 1978)

- negative ERP component
- automatic auditory response (acoustic differences)
- MMN = rare - frequent

MMN



- MMN early negative ERP (time window: 150-250 ms)
- Auditory MMN
- Process of auditory novelty detection
- Comparison of the three midline electrodes Fz, Cz and Pz
- In L2 research
- Capacities of perceptual discrimination
 - phonological or phonetic categories in L2 listeners
 - majority of studies investigated the perception of vowels



EEG cap, 64 electrodes



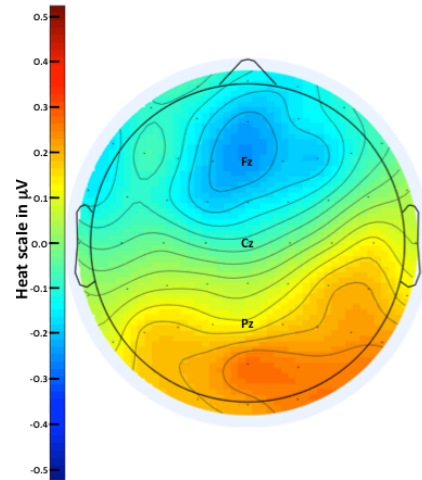
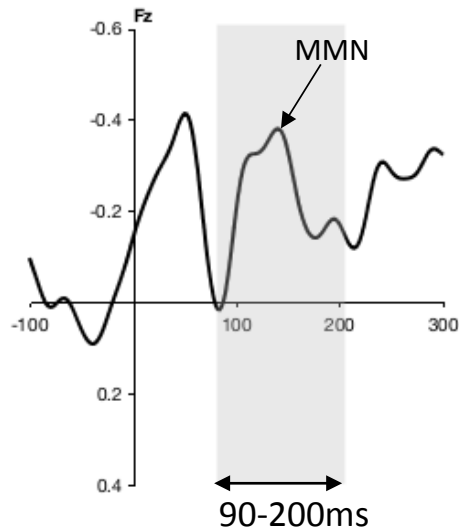
Hypotheses

- German native speakers
 - equally good perception for all the contrasts, fronto-central MMN and P3a
- French learners of German
 - short and long vowels
 - discrimination with some difficulty
 - [h]-[ʔ]
 - almost native-like discrimination
 - [ʃ]-[ç]
 - no or very little discrimination for the two phones

MMN: vowel contrast

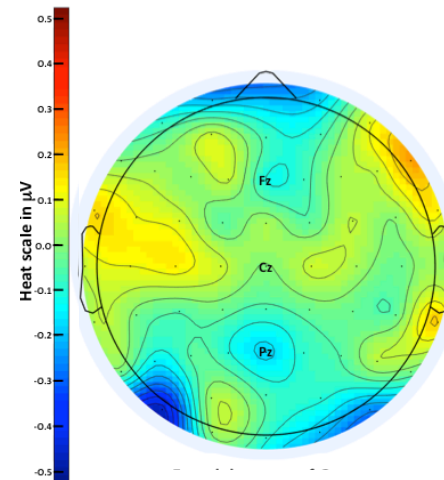
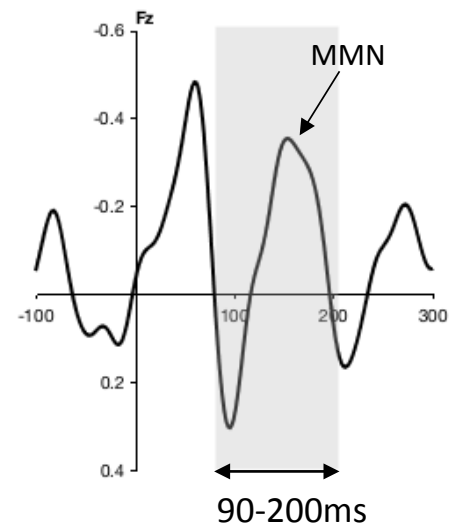


German natives



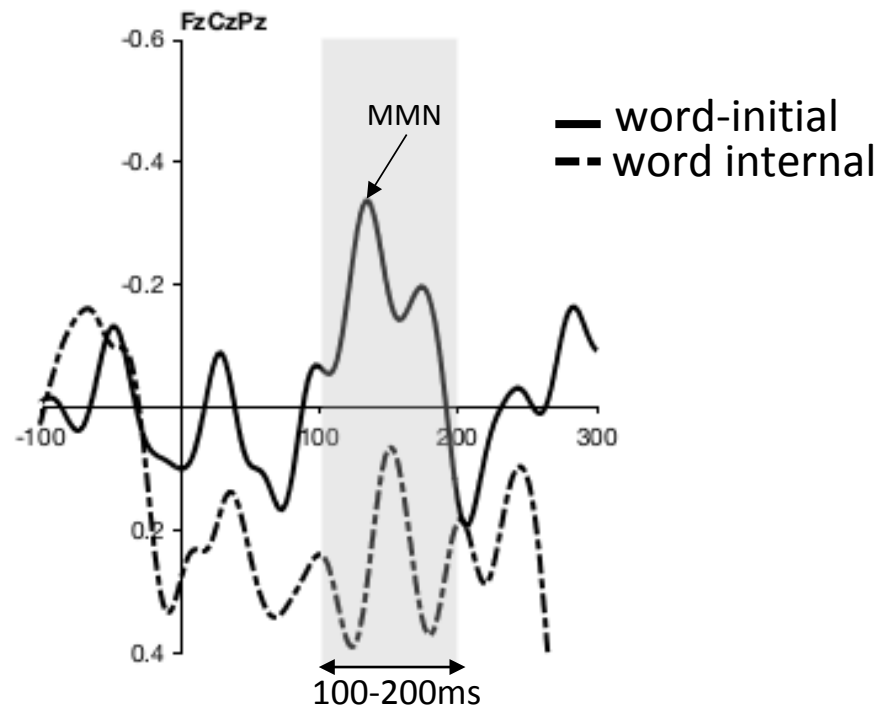
- German native speakers
 - MMN with fronto-central distribution

French learners



- French learners of German
 - MMN distributed over midline electrodes (Fz, Cz, Pz)

MMN: [h]-[ʔ] contrast



- [h]-[ʔ] in two word positions
 - word-initial
 - word-internal
- German natives
 - MMN only for word-initial position
- French learners of German
 - absence of an MMN

MMN: discussion

- French learners of German
 - presence = sensitivity to the phonetic category
 - vowel contrast
 - absence ≠ sensitivity to the phonetic category
 - [h]-[ʔ]
- Sensitivity linked to the richness of the acoustic signal?
- Topographic differences in German natives vs. French learners
 - processing differences?

Overview of P3a results

Contrast	German natives
vowel duration contrast	parietal P3a
[h]-[ʔ]	parietal P3a

Overview of P3a results

Contrast	German natives	French learners
vowel duration contrast	parietal P3a	P3a for long vowels only: frontal P3a
[h]-[ʔ]	parietal P3a	P3a with very low amplitude

- Parietal location ≠ hypothese (frontal location)
- P3a topography
(Katayama and Polich, 1998)
 - easy discrimination: parietal
 - difficult discrimination: rather frontal



Overview of N400-like results

- Additional ERP component was found
- Situated at Pz [380 - 520]: N400-like

Contrast	German natives
vowel duration contrast	higher amplitudes for deviants having a short vowel
[h]–[ʔ]	present in both word positions (word-initial, word-internal)



Overview of N400-like results

- Additional ERP component was found
- Situated at Pz [380 - 520]: N400-like

Contrast	German natives	French learners
vowel duration contrast	higher amplitudes for deviants having a short vowel	∅
[h]–[ʔ]	present in both word positions (word-initial, word-internal)	only for [h]–[ʔ] in word-initial positions

Study 3: conclusion

- SLM's predictions: not faithful
- “new” phone = least well discrimination
- “similar phone = better discrimination
 - richness of the acoustic signal better predictor?
- MMN present in L2 speakers
 - richness of the acoustic signal?
- Topographic changes = perceptual difficulties?



General conclusion

- ✧ SLM's predictions on L2 speech production
 - faithful except for vowel contrast
 - task effects
- ✧ SLM's predictions on L2 speech perception
 - globally not confirmed
- ✧ Awareness helps improving speech production & perception
 - exception: articulatory difficulties
- ✧ Production does not always mirror perception
 - [h]
 - vowel contrast

Merci beaucoup !

Thank you!

{ 54 }