CROSS-LINGUISTIC INFLUENCE IN VOWEL PROCESSING IN MULTILINGUALS: AN ERP STUDY

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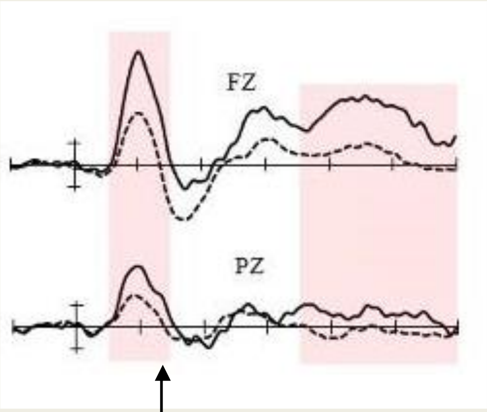
Introduction

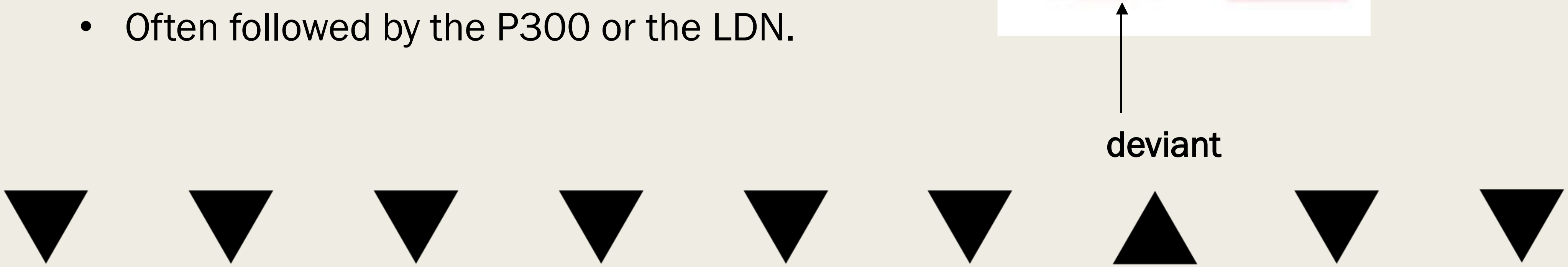
- Non-native phonemic perception is a vital component of successful language learning.
- Previous studies observed reduced phonemic discrimination mechanisms in the L2 when compared with the L1 (Jakoby et al., 2011; Liang & Chen, 2022; Song & Iverson, 2018).
- By investigating trilingual speakers we wish to contribute to an ongoing scientific debate on multiple languages interacting in the same speaker (e.g., Wrembel, 2015; Wrembel & Cabrelli Amaro, 2018).

Mismatch negativity (MMN)

- **MMN** component → an index of listeners' sensitivity to phoneme constrasts at a pre-attentional level (Näätänen et al., 1997)
  - A negative-going wave deflection of frontocentral distribution with a peak at around 150-250 milliseconds from change onset.
  - Generators located in the auditory cortex.
  - Typically elicited in **Oddball** tasks.
  - Often followed by the P300 or the LDN.



Liang & Chen, 2022, p. 9



Non-native vowel discrimination in bilinguals

- **Winkler et al. (1999)** → a similar MMN response to Finnish vowel contrast in native speakers of Finnish and a group Hungarian late learners of Finnish (a naturalistic setting).
- **Peltola et al. (2003)** → a significant difference between native speakers of English and advanced Finnish students of English (a classroom setting).
- **Díaz et al. (2016)** → MMN was attenuated in poor L2 perceivers (the importance of ***individual speech-specific capabilities***).
- **Liang and Chen (2022)** → different neural responses in adult Mandarin learners of English with high and low proficiency levels.

The current study

- Aim: to shed more light on the issue of ***non-native phonological contrasts perception.***
- Research question: Will phonological contrasts be equally easy to detect and process in L2 and L3/Ln?
- Predictions:
  - ❑ *We predict the MMN to be* ***stronger in native when compared with non-native*** *speech (Jakoby et al., 2011; Liang & Chen, 2022; Näätänen et al., 1997; Song & Iverson, 2018).*
  - ❑ *The scale of the MMN effect in L2 when compared with L3/Ln is, however,* ***impossible to predict*** *due to the lack of previous studies which would focus on such a comparison.*

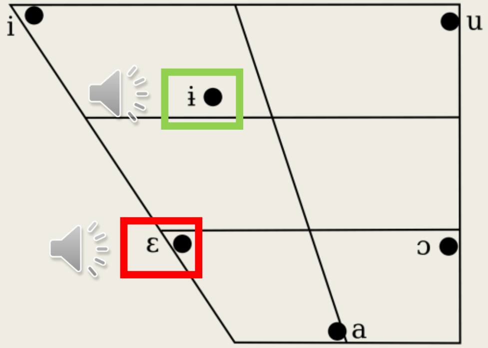
The current study

- **Participants:**
  - Trilingual speakers with L1 Polish, L2 English and L3 Norwegian.
  - Mostly students recruited at the Department of Scandinavian Studies (Adam Mickiewicz University and Poznan College of Modern Languages).
  - The participants will probably be less proficient in Norwegian than in English.
  - All need to be right-handed, with no hearing or language impairments.
  - <u>Tests/tasks:</u> the **Oxford Placement Test** and the **Norwegian Placement Test**, language history questionnaire, a gating task (to assess individual speech-specific capabilities).

The current study

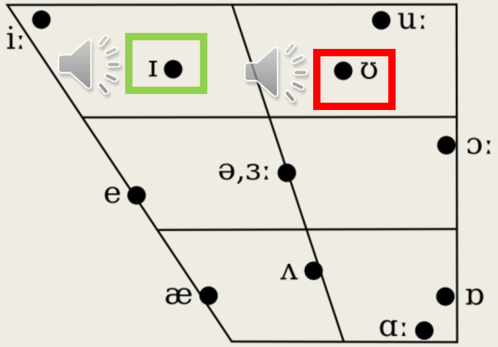
- **Materials:**
  - We presented isolated vowels (listeners are believed to process isolated vowels as speech thanks to the pre-attentive ability to extract the relevant F1/F2 formant ratio).
  - We took into account the differences between the sound systems of the three investigated languages, also those involving vowel density.

POLISH



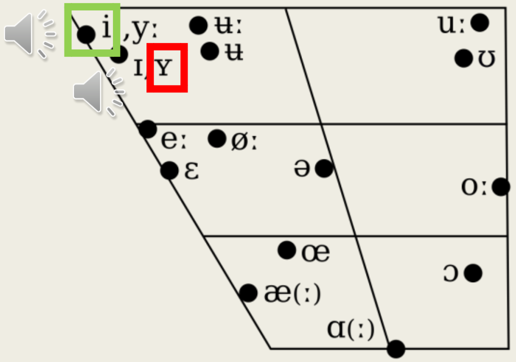
Polish Vowels (Source: https://pl.wikipedia.org/wiki/Plik:Polish_vowel_chart.svg#filelinks)

ENGLISH



RP English monophthongs (Source: Wikimedia Commons – https://commons.wikimedia.org/wiki/File:RP_English_monophthongs_chart.svg)

NORWEGIAN



Urban East Norwegian vowel chart (Source: https://pl.m.wikipedia.org/wiki/Plik:Urban_East_Norwegian_vowel_chart.svg)

The current study

- **Materials:**
  - The Polish /ɨ/-/ɛ/ contrast was mainly manifested in ***height*** and also exists in the other investigated languages.
  - The English /ɪ/-/ʊ/ contrast was mainly manifested in ***backness*** and is also present in Norwegian, but absent in Polish.
  - The Norwegian /i/-/ʏ/ contrast was mainly manifested in ***roundness*** and is absent in Polish and English, in which there are no front rounded vowels.
  - The vowels were all synthesized with the aid of the PRAAT software (Boersma, 2001).
  - Formant frequencies of Polish and English vowels were defined on the basis of previous literature (Weckwerth & Balas, 2019 for Polish; Bjelaković, 2016 for English); Norwegian vowels were generated based on the average values obtained from four native speakers of Norwegian (living in the Trondheim region).

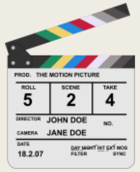
The current study

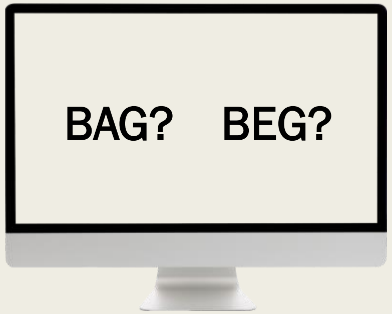
- **Procedure:**

600 /ɨ/ 60 /ɛ/ } PL

600 /ɪ/ 60 /ʊ/ } EN

600 /i/ 60 /ʏ/ } NO





consent, surveys

the ERP preparation

ERP stimuli presentation during cartoon watching

3 language blocks with short breaks in between, counterbalanced block order

movie comprehension test, ***gating task***, proficiency tests

3 h – 3.5 h

The current study

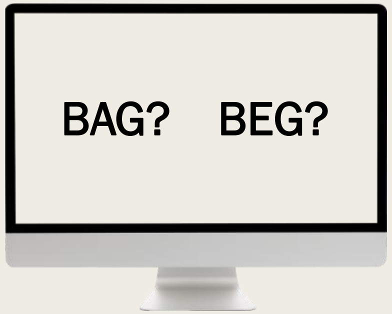
- Gating task:
  - Aim: the assessment of the participants' speech-specific capabilities, which have been demonstrated to affect non-native phoneme discrimination (Díaz et al., 2016).
  - Four monosyllabic AmE word pairs included the **/æ/-/ɛ/ contrast** (i.e., BAG-BEG, LAUGHED-LEFT, SHALL-SHELL, GAS-GUESS).
  - Material was recorded by a native speaker of American English and presented at an intensity of 75dB.
  - ***The alineation point*** (i.e., the point where the two members started to diverge) was determined on the basis of the visual inspection conducted with the aid of the PRAAT software.

The current study

- **Gating task:**
  - After the alineation point identification, the words were divided into other gates (i.e., fragments) by adding or subtracting 10 ms from the alineation point, e.g.:

Word	AP	Duration	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
beg	0,108	0,4463	0,088	0,098	0,108	0,118	0,128	0,138	0,148	0,158	0,168	whole

  - The two members of the minimal pairs (e.g., BAG and BEG) were displayed on the computer screen.



The current study

- **Gating task:**
  - One second later, the first gate of the first word was presented and the participant has to decide whether the fragment which they had heard corresponded to the word on the right (‘L’ key) or on the left (‘A’ key).
  - In the written instructions presented before the task, the participants were encouraged to guess, even if they were not sure of their answer.
  - The participant also had to evaluate their confidence of the response on a 7-point Likert scale.
  - Then, the remaining gates were presented. This procedure was repeated for the all the words.
  - Each member of the minimal pairs was presented two times, which resulted in 160 trials (4 pairs x 2 words x 10 gates x 2 presentations), with an optional break after 80 trials.

Result analysis

Gating task

- We will take into account the answers satisfying the following criteria: (a) the decision concerning the selected word cannot be changed afterwards, (b) the level of confidence needs to be assessed as at least 4 in a 7-point Likert scale.
- In order to compare the results with those achieved by native speakers of English, the same gating task is being conducted independently on a group of native English speakers via Pavlovia.

ERPs

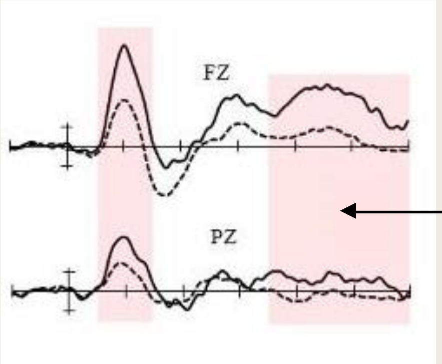
- We will analyse mean amplitudes of the ERP epochs time-locked to the onset of investigated phonemes.
- Statistical analyses will be performed in three main time windows, defined for the **MMN**, for the **P3b** and for the **LDN**.
- We plan to consider the following factors: **language** (L1 vs. L2 vs. L3) × **deviancy** (standard vs. deviant) × **brain region** (frontal vs. parietal).

Expected ERP effects (other than MMN)

- **The P300 component:**
  - ❑ P3a → associated with attentional switching,
  - ❑ P3b → associated with memory storage.
- Liang and Chen (2022) found the P3b component followed by late positive component (LPC) as a response to vowel contrasts in ***low proficiency bilinguals.***
- Low L2 proficiency bilinguals may need to rely on additional memory processing.

- **The late discriminative negativity (LDN):**
  - ❑ A negativity observed in frontocentral brain region at around 350-600 ms after change onset.
  - ❑ LDN is typically associated with pre-attentive cognitive evaluation of the stimulus (Jakoby et al., 2011).

Liang & Chen, 2022, p. 9



- *auditory-deviance rule extraction?*
- *attention reorienting?*
- *extracting the phonological difference between STANDARD and DEVIANT?*

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