Using the MMNm to explore second-language speech sound acquisition: Links between vowel production, perception and MEG responses

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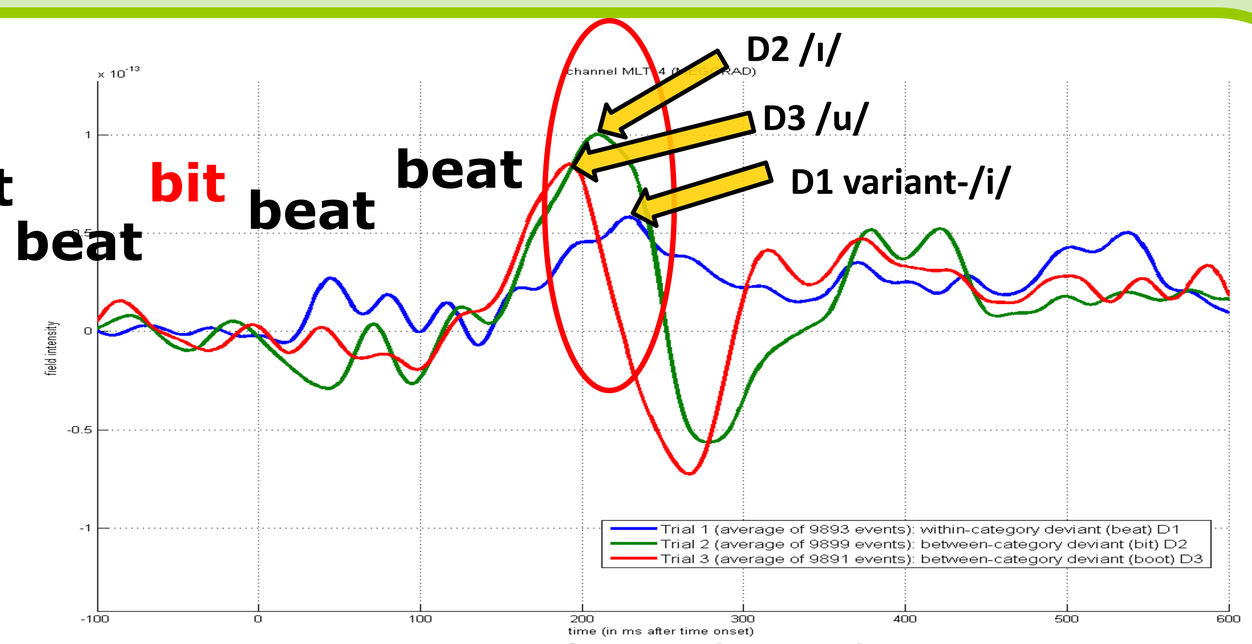
QUESTIONS

- Which underlying language abilities are linked to the Mismatch Response (=MMNm)?
- Does the MMNm reflect…
  - …auditory processing
  - …phonetic categorisation
  - …or speech sound processing?
- Which behavioural measures are most highly linked with the MMNm?
- Are there differences between L1 and L2 speakers in the MMNm?
- Do relationships between language abilities and MMNm differ depending on L1 or L2 speaker status?
- Are individual differences in L2 language proficiency between subjects reflected in the MMNm?



MMNm for L1 and L2 speakers

SUBJECTS

L1 controls

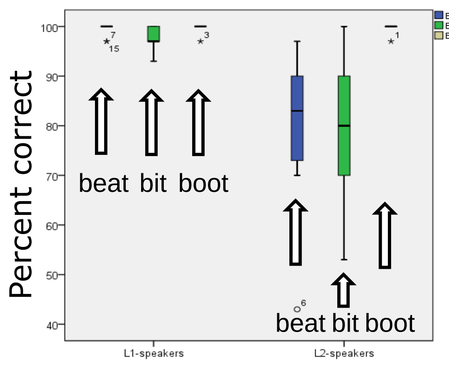
9 English native speakers
- 3 female, 6 male
- Age range: 23-43 years
- Mean age: 28 years

L2 speakers

13 French native speakers
- 9 female, 4 male
- Age range: 22-40 years
- Mean age: 28 years
- Age of acquisition: 7-16 years
- Exposure to L2: 1 month - 9 years

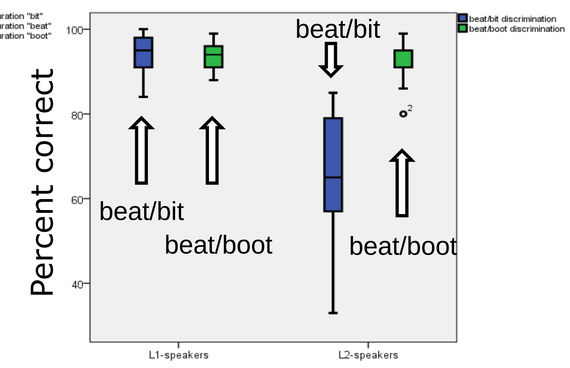
RESULTS

PERCEPTION



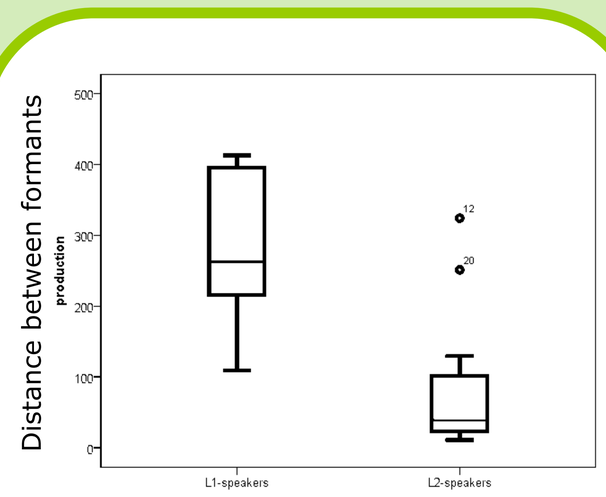
Word identification

L2 speakers varied widely in ability to identify /ɪ/ and /i/ compared to L1 speakers.



Category discrimination

L2 speakers showed more variation in ability to discriminate between sounds and were worse at identifying /i/ as compared to /ɪ/ than L1 speakers.



PRODUCTION

Wide variation between L2 speakers: widely varying ability to pronounce the two sounds in a native-like manner. Majority of L2 speakers do not differentiate much between the two speech-sounds, compared to L1 speakers.

MEASURES

Category discrimination
Identifying the odd word out ("bit", "beat", "boot", multiple speakers)

Word identification
Identifying the word heard ("bit", "beat" or "boot", multiple speakers)

/i/ /ɪ/ /u/

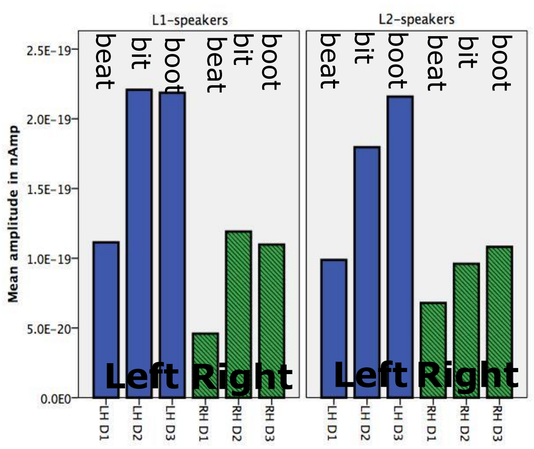
Production
Reading a short story (measurement of /i/ and /ɪ/ formant production)

MEG
Standard "beat" and 3 deviants: acoustically manipulated "beat" (D1), "bit" (D2), "boot" (D3)

MEG DESIGN

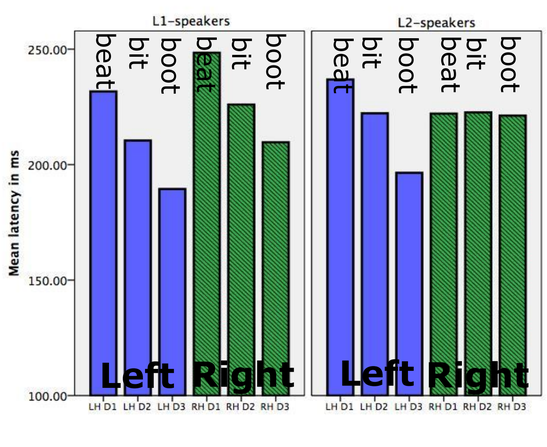
Standard: "beat"	L1 speakers expected outcome	L2 speakers expected outcome
Deviant 1: "beat"-variant	MMNm due to acoustic difference	MMNm due to acoustic difference
Deviant 2: "bit"	MMNm due to acoustic difference + different category	**?**
Deviant 3: "boot"	MMNm due to acoustic difference + different category	MMNm due to acoustic difference + different category

MMNm



Amplitude

Different amplitude for each deviant type (D1/D2/D3)



Latency

Different latency for each deviant type (D1/D2/D3)

Left-hemisphere dominancy

CORRELATIONS

Perception, production and MMNm
- Only weak links between L2 perception and production abilities
- Significant link only between left-hemispheric mismatch response for /ɪ/ and category discrimination results for /i-ɪ/

SUMMARY

CONCLUSIONS

BEHAVIOURAL
- L2 speakers worse than L1 speakers on almost all behavioural measures
- Widely varying performance in vowel production between L2 speakers
- L2 vowel production not strongly linked to vowel perception
- Weak correlations between the perception and production tasks: learning a vowel category in a second language does not consist of just one, but many underlying abilities

MEG
- An MMNm which differed according to stimulus type was evoked in all subjects
- Left hemisphere dominancy indicates the recognition of speech sounds

LINKS between measures
- Correlation for L2 speakers between mismatch response for /ɪ/ and ability to discriminate between /ɪ/ and /i/
  - Driven by sensitivity to /ɪ/ as phoneme
  - Shows phoneme status of speech sound in L2 listener's brain

NEXT STEPS

Dynamic causal modeling
- How are brain areas involved in L1 and L2 vowel perception connected functionally?
- Is connectivity the same for L1 and L2 speakers or does functional interconnectedness differ for different language groups?
- Is the type of functional interconnectedness dependent on L2 proficiency?

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