# Using brain-imaging to explore second-language speech sound acquisition: Links between vowel production, perception and MMN

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This study examined how second language (L2) speakers learn a non-native phoneme by investigating how L2 vowel perception and production are linked with the MMN. The subjects were 9 English native controls and 13 French L1/English L2 speakers who had lived in the UK for a varying amount of time. They performed an array of behavioural tasks designed to target vowel perception and vowel production. Additionally, the MMN to different phonemes was elicited, using an oddball paradigm in which subjects were presented with a standard /bit/, a within-category deviant D1 (acoustically deviant /bit/) and two between-category deviants (D2 /bɪt/ and D3 /but/). The results demonstrated that language background had an influence on perception and production, in that L2 speakers performed at a lower level than L1 speakers in all behavioural tasks. Results for the MEG experiment (using source space reconstructions) showed a left-hemispheric mismatch response. Each stimulus-type in the MEG experiment elicited a differentiated mismatch response. Perception and production were only mildly correlated for the L2 speakers, indicating that separate underlying abilities are necessary in order to learn an L2 vowel category. Surprisingly, there were no overall differences in the MMN for the two language groups, possibly owing to the fact that many L2 speakers were relatively highly proficient. However, individual differences in the MMN were correlated to behavioral measures of /i/-/ɪ/ category discrimination, and were less related to identification or production. This suggests that the MMN may be more strongly linked pre-categorical phonetic processing than to phonological representations.
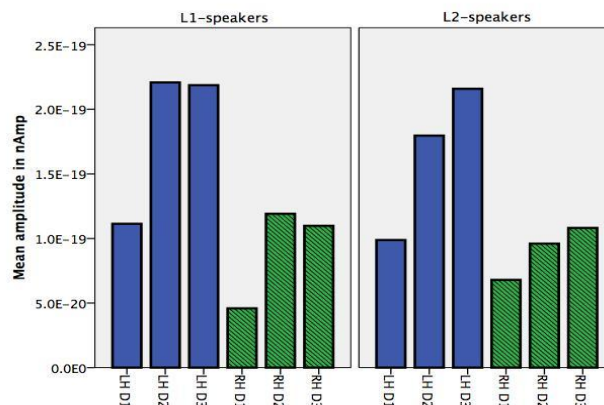
**Figure 1:** MMN amplitude by group (L1 and L2 speakers, blue= left-hemisphere/green= right-hemisphere)
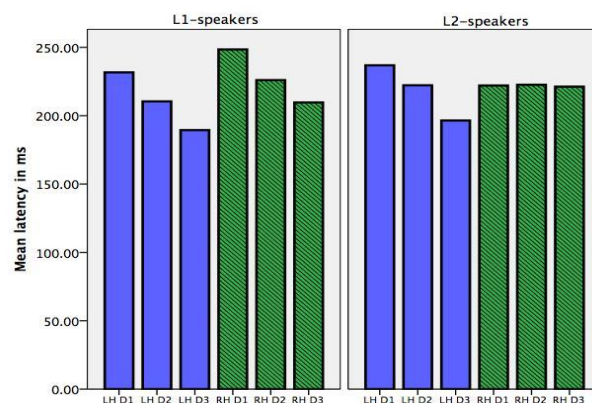


**Figure 2:** MMN latency by group (L1 and L2 speakers, blue= left-hemisphere/green= right-hemisphere)