

## Cortical activation correlates of first- and second-language discrimination during vowel contrast discrimination.

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The current study examines native language neural commitment (NLNC) (Kuhl, 2010) during category discrimination tasks in learners 'first (L1) and a second language (L2) and explores whether the discrimination stimulates different brain regions. L1 experience has been found to form neural architecture that detects the linguistic patterns in individuals' L1 (Kuhl et al., 2005), and by adulthood, L2 learners find some L2 phonetic contrasts difficult to distinguish, which could be attributed to interference between L1 and L2 phonological systems (e.g., Iverson et al., 2003). However, it remains uncertain whether such interference can be explained by neurophysiological evidence identifying the neural regions recruited during discrimination processing in L1 and L2, and whether this interference arises from the recruitment of a shared neural network. While some studies suggest that L1 and L2 are processed by common neural mechanisms (e.g., Perani & Abutalebi, 2005), others report distinct neural substrates for the processing of L1 and L2 (e.g., Xu et al., 2017).

The current study used functional magnetic resonance imaging (fMRI) to further investigate the neural commitment to L1 by examining the neural activities associated with discriminating seven English vowels (/ɑ:, ε, ɪ, ɔ:, ʌ, ɒ, ʊ/). These vowel contrasts have been previously identified as challenging for Arabic learners of English (Evans & Alshangiti, 2018). Neural responses elicited during English vowel discrimination were compared with those observed during Arabic vowel discrimination. Twenty native Arabic speakers completed two phonetic category discrimination tasks: one in Arabic and one in English, while undergoing fMRI scanning. In each trial, participants indicated whether two presented audio stimuli were the same or different by clicking on buttons with their less dominant hand. They also completed a vowel identification and an oddity task outside the scanner to assess perceptual accuracy. These behavioural measures were used to examine whether patterns of neural activation were associated with relative perceptual difficulty or ease.

The results showed significant bilateral activation in brain regions associated with speech processing, including the supramarginal gyrus (SMG), insula, middle temporal gyrus (MTG), and superior temporal gyrus (STG). A language-specific lateralisation pattern emerged: Arabic stimuli elicited predominantly right hemispheric activation, whereas English stimuli primarily engaged the left hemispheric regions. A linear model showed a significant widespread activation during the English task compared to the Arabic task. Furthermore, performance on the oddity task indicated that the accuracy of certain vowel contrasts was at a chance level, possibly suggesting increased cognitive demand during the perception of English vowels, see figure 1. These findings suggest that bilinguals exhibit functional separation in neural mechanisms underlying phonetic category discrimination across languages, supporting the NLNC theory. The results also suggest that the perceptual interference may not arise from the recruitment of the same neural network during phonetic category discrimination in L1 & L2.

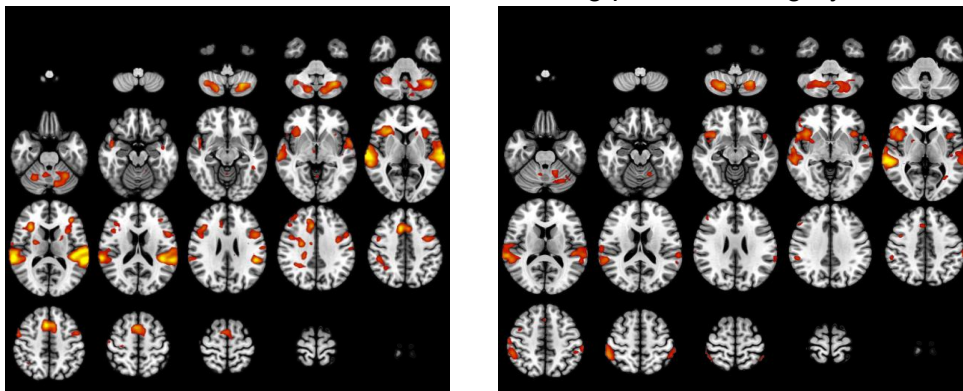


Figure 1: Heat map showing the lateralisation during vowel discrimination in English (on the left) and in Arabic (on the right)

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