Predicting Cypriot Greek Listeners' Perception of Dutch Vowels using Acoustic and Perceptual Similarity

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Although there has been a great number of studies investigating the perception of nonnative sounds by listeners with different first language (L1) backgrounds (e.g., Aoyagi & Wang, 2022; Georgiou, 2022) research needs to expand to underresearched sets of languages and incorporate predictions conducted using computational algorithms and new speech models. The purpose of this study is twofold: First, it aims to investigate the perception of Dutch vowels by Cypriot Greek listeners and, second, to assess the capacity of a linear discriminant analysis (LDA) model in predicting the classification/discrimination of nonnative sounds based on crosslinguistic acoustic similarity and the ability of the Universal Perceptual Model (UPM) in making accurate empirical predictions about the discrimination accuracy of nonnative sound contrasts based on perceptual similarity. Twenty-one Cypriot Greek speakers (females = 13) in the age range of 19-35 (*M* = 25.62) participated in a classification and an AXB classification task; the stimuli were produced by two Standard Dutch speakers (1 male, 1 female) in /hVd/ target words as part of the carrier phrase "Hoor je <target word>". Another group of 10 Dutch speakers (age range 23-38; *M* = 29.27; females = 6) served as controls and completed only the AXB task. The classification/discrimination predictions were conducted using an LDA algorithm, which was trained on the first three formant frequencies and duration of Cypriot Greek vowels as elicited by the productions of 12 adult female native speakers. The testing set including the same measurements for Dutch vowels as elicited by 20 adult female Dutch speakers was supplied to the trained model (the target words were monosyllabic words before coda [s] in both languages). The predictions of the UPM model were based on the results of the AXB task and relied on the concept of overlap, that is how acoustically close two nonnative contrast members are perceived to be to each other depending on their classification in terms of one or more L1 sounds (complete, partial, and no overlap). The findings indicated that listeners classified each nonnative vowel as one or more L1 vowels, while the discrimination accuracy over the nonnative contrasts was moderate (see Figure 1) as all of them presented with partial overlap. The results verified that crosslinguistic acoustic similarity predicted to a large extent the classification of nonnative sounds with the highest proportion and that both the acoustic and perceptual similarity predicted the discrimination accuracy of all contrasts. Concluding, although listeners are at the zero stage of language learning, they may potentially activate novel phonetic categories easier for vowels that were classified as more than one L1 category since they do not acoustically equate them with a particular dissimilar L1 vowel. In addition, being in line with prior findings, these findings demonstrate that acoustic and perceptual cues are reliable predictors of nonnative contrast discrimination and that the UPM model can make accurate estimations for the discrimination patterns of nonnative listeners, which can be also compared to those of other popular speech models such as PAM (Best, 1995) and L2LP (Escudero, 2009).

Keywords: acoustic similarity, perceptual similarity, speech perception, nonnative language

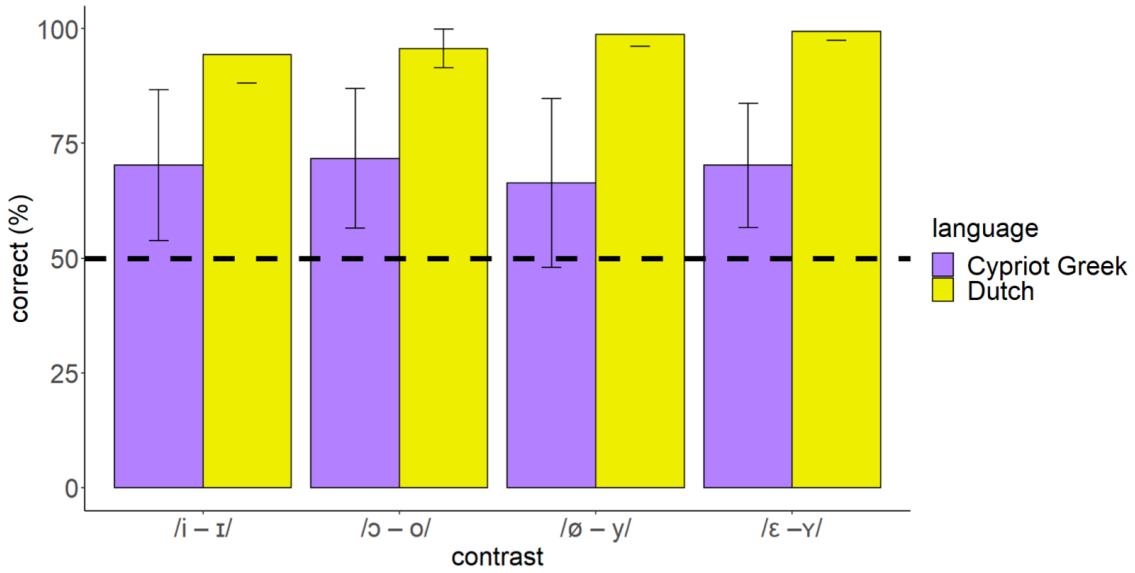

Figure 1. Correct discrimination of the Dutch vowel contrasts by Cypriot Greek listeners and Dutch speakers (dashed line shows chance level)

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