Effects of consonantal contexts on L2 English tense-lax vowel perception and production

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Studies that examine cross-language speech perception and production often use stimuli with the target segments embedded in single or limited phonetic contexts [1]. However, L2 perceptual and production accuracy have been found to vary greatly as a function of the phonetic contexts where the target L2 sounds occur (e.g., [2, 3]). Therefore, as argued in Beddor et al. ([4]), generalizations made based on perception and production patterns of the target sound in one phonetic context, without systematically exploring contextual effects, may be problematic. In this light, this study used the case of English tense and lax vowels, which Mandarin speakers generally find difficult to learn (e.g., [5, 6]), to examine whether L2 vowel perception and production performances vary as a function of consonantal contexts.

Fifteen native speakers of Taiwan Mandarin (between 19-20 years of age) participated in this study. The stimuli were 58 CVC real words in English, produced by two native American English speakers (1 male; 1 female). The stimuli contained one of the tense /i, e/ vowels or their lax counterparts /ɪ, ɛ/, flanked by consonants of different places (bilabial, alveolar, velar) and manners of articulation (liquid, nasal, sibilant, stop). The perception test was an AX discrimination task, where listeners judged whether the two words they heard were the same or different. The 58 words were arranged into 116 AX trials; within each trial, the two words were always produced by different native speakers. The perceptual accuracy was automatically logged in E-Prime 3. The production test was a repetition task, where the listeners repeated what they heard through the headphones. The production accuracy was determined by whether a given token was correctly identified by two native American English listeners. Any disagreement between the two listeners was resolved by resorting to a third listener's judgment.

The perceptual and production accuracy data were separately analyzed with generalized logistic mixed-effects regression models. The full model included vowel, onset consonants' place of articulation (POA), onset manner of articulation (MOA), coda POA, coda MOA, and their interactions as fixed effects, and the participant intercept as the random effect. The results for the perceptual data analysis revealed a significant coda MOA effect and a coda MOA*coda POA interaction effect. Post-hoc comparisons showed that vowels followed by alveolar nasal codas were discriminated with significantly lower accuracy than all other place-manner combinations (see Figure 1). The results for the production data analysis indicated significant vowel and coda MOA effects and their interaction. In particular, the accuracy of /e/+nasal coda and /ɪ/+nasal coda productions was significantly lower than any other vowel+consonant combinations (see Figure 2).

Nasalization as a result of coarticulatory influences of nasal consonants modifies vowel formant frequencies (e.g., [7, 8]) and can cause certain vowels in pre-nasal position to be less distinct from neighboring vowels. While native speakers may compensate for nasality-related changes in formant structure by recruiting variation in additional acoustic properties [9], this study shows that the nasal context (i.e., coda) was where Mandarin-speaking learners had most trouble discriminating and producing English tense and lax vowels. These findings are in line with [1] that cross-language perception and production of vowels is context-dependent and cannot be predicted from patterns observed in single or limited contexts. The findings also have pedagogical value in that target vowel contrasts that differ in difficulty levels can be generated for teaching or training stimuli.
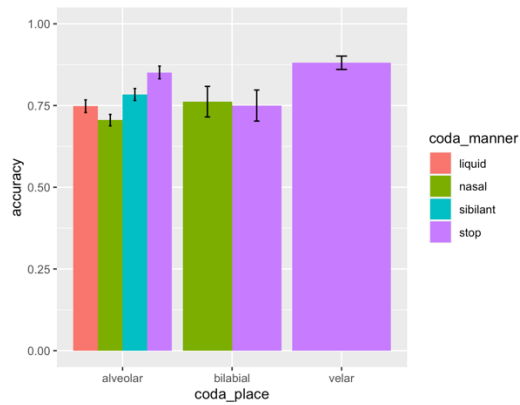
Fig.1. Vowel perception accuracy by coda consonants' place and manner of articulation
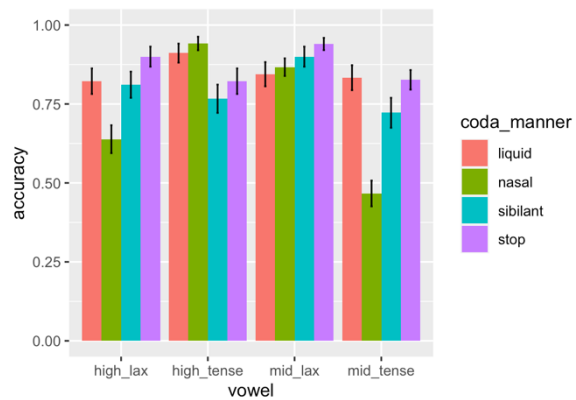

Fig.2. Vowel production accuracy by vowels and coda consonants' manner of articulation

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