Lebanese Arabic listeners find Australian English vowels easy to discriminate

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Abstract

The present study investigated the role of acoustic similarity in predicting bilingual Lebanese Arabic-English (LA) listeners discrimination of Australian English (AusE) vowels. The findings are in line with predictions based on acoustic similarity. In particular, LA listeners use duration as a cue to facilitate vowel discrimination which seems to yield few problems with AusE contrasts, regardless of their L2 proficiency. Furthermore, for LA listeners, discrimination difficulty is only apparent for two contrasts where the vowels do not align with the LA counterparts and when partial acoustic overlapping is identified.

Index Terms: L2 speech perception, vowel discrimination, acoustic similarity

1. Introduction

Second language (L2) learners often struggle with the acquisition of a new sound system. Vowels are particularly difficult to perceive due to the influence of their own native (L1) vowel inventory. Theoretical models such the Perceptual Assimilation Model (PAM) [1], its extension PAM-L2 [2] and the Second Language Linguistic Perception Model (L2LP) [3] posit that L2 learners and naïve listeners perception of non-native or L2 sounds is filtered by their L1, which can lead to difficulties in acquiring the L2.

The L2LP theoretical framework considers three types of learning scenarios that a learner may face in their acquisition of L2 vowels. These scenarios can be identified by investigating the acoustic similarity between the L1 and target L2 [3, 4]. The first scenario, known as the new scenario in L2LP [3, 4] and single category assimilation in PAM [1] occurs when two L2 sounds are mapped to one single native contrast. This generally occurs in learners whose L1inventory is smaller than that of the target language and results in poor discrimination. In contrast the similar scenario in L2LP [5] and two-category assimilation in PAM [1], occurs when the two sounds in the L2 contrast are mapped to two different L1 categories and is generally easy to discriminate. The third scenario, known as the subset scenario in L2LP [6] and uncategorized assimilation in PAM [1], occurs when two non-native vowels in a binary contrast are perceived as belonging to more than two native vowel categories, which is common when the non-native vowel inventory is smaller than that of the native vowel inventory. In this scenario, the L2LP model predicts that discrimination may be problematic when this scenario leads to a "subset" problem where a learner needs to realize on the basis of positive evidence alone that some features or categories in their native language do not exist in the target language and may find it difficult not to perceive an "extra" L1 category [6]. Furthermore, cases of the subset scenario may be particularly difficult to discriminate when both vowels in the L2 contrast are mapped to the same multiple L1 categories, resulting in a perceptual overlap.

While PAM and PAM-L2 [1, 2] typically rely on perceptual assimilation results to predict discrimination accuracy, the L2LP model explicitly states that non-native vowel discrimination can be predicted by a detailed acoustic comparison between the native and target language [3, 4]. In the L2LP framework, a listener's perception and production of non-native or L2 sounds at the initial state of learning should match the acoustic properties of the sounds in their native language [3, 4]. Recent studies have shown acoustic similarity to successfully predict non-native and L2 vowel perception. For example, [7] showed that the cross-language comparison of acoustic properties to successfully predict discrimination accuracy for naïve Iberian Spanish and Australian English listeners of the Brazilian Portuguese.

The aim of the present study is to investigate bilingual Lebanese Arabic-English (LA) listeners' discrimination of Australian English (AusE) vowels. Unlike previous studies investigating native Arabic speakers, e.g. [8], the participants in this study were of a homogeneous background, namely LA, with AusE as their L2. The LA variety that we use to make our acoustic predictions in the present study is the colloquial Arabic spoken in Israel, in the Galilee region [9]. The Israel Arabic belongs to the Levantine dialect group as does LA and have the same five vowel pairs [10]. We use the vowels reported in [9] because these Arabic varieties are very similar. The vowels reported in [9] provide the best approximation to LA vowel acoustics including formant values, as LA is a dialect which is very much understudied and the descriptions which are currently available are either outdated or incomplete, e.g. [11]. The LA vowel inventory consists of ten monophthongs /i, iː, a, aː, u, uː, e, eː, o oː/ [9] and the AusE vowel inventory consists of twelve monophthongs, namely, /iː, ɪ, e, eː, ɜː, ɐ, ɐː, æ, oː, ɔ, ʊ, ʉː/ [12]. Both languages employ phonemic length to distinguish short and long vowels (e.g. /a/-/aː/ in LA and /ɐ/-/ɐː/ in AusE) [9, 12]. Importantly, LA has five vowel contrasts that differ by length only, while many AusE vowels differ by both vowel quality and phonemic length. Thus, this study will also investigate whether LA listeners' use duration as a cue to discriminate AusE vowel contrasts, as studies [e.g., 5] have shown L2 learners to use durational differences in L2 vowel categorization.

Given that studies [e.g, 7] have shown that acoustic similarity between the native and target language successfully predicts L2 and non-native vowel discrimination, we apply a similar method of prediction to the present study. Figure 1 shows the F1 and F2 values for LA and AusE monophthongs.

In this preliminary study, predictions based on acoustic similarity for the six target AusE contrasts /iː/-/ɪ/, /e/-/eː/, /ɜː/-/æ/, /ɐ/-/ɐː/, /oː/-/ɔ/ and /ʊ/-/ʉː/ were made by visually comparing the AusE and LA vowels in the acoustic space.

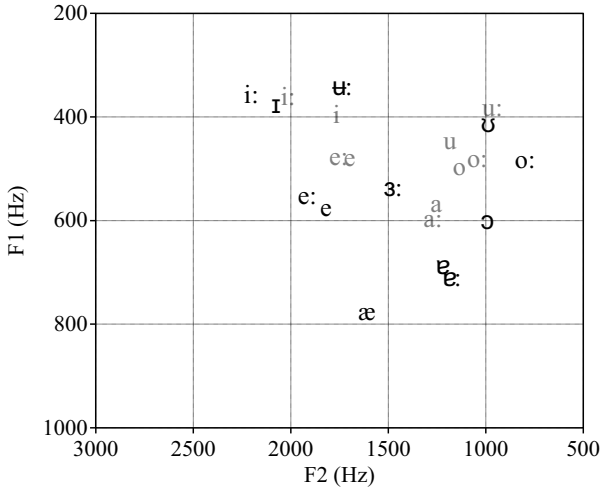

Figure 1: *Average F1 & F2 acoustic values for vowels produced by native AusE males in black [13] and LA males in grey [9].*

As shown in Figure 1, the AusE contrasts /ɐ/-/ɐː/and /e/-/eː/ seem to be acoustically similar to the LA vowel contrasts /aː/-/a/ and /e/-/eː/, which also differ by length only and this should facilitate the discrimination of these vowel contrasts. For the AusE /æ/-/ɜː/ contrast, although AusE /æ/ seems acoustically distant from most LA vowels, it is potentially acoustically similar to the LA vowels /a/ and /aː/. On the other hand, AusE /ɜː/ appears to be in close acoustic proximity to LA /aː/, /aː/, /eː/ and /e/. The fact that there is acoustic overlap with both vowels in the AusE /æ/-/ɜː/ being acoustically similar to LA /a/ and /aː/, discrimination accuracy may be lower for this vowel contrast. However, the lip rounding of AusE /ɜː/ and if the participants use duration as a cue, may result in fewer discrimination difficulties for this contrast.

Duration may be used as a cue to facilitate the discrimination of the AusE /iː/-/ɪ/, but both vowels are acoustically closer to LA /iː/ than /i/. This may result in discrimination difficulties for LA listeners if they perceive both vowels in the contrast as LA /iː/. In the case of AusE /oː/-/ɔ/, we expect fewer discrimination difficulties as AusE /oː/ appears acoustically close to a similar LA long vowel /oː/ and is also acoustically similar to the LA long vowel /uː/, while AusE /ɔ/ is in acoustic proximity to LA short vowels /a/ and /o/.

LA listeners may not find AusE /ʊ/-/ʉː/ difficult to discriminate because a similar short-long vowel contrast exists in LA. Furthermore, we observe that AusE /ʊ/ is acoustically close to LA /u/, /uː/, /o/, /oː/, while AusE /ʉː/ is much more fronted. Although AusE /ʉː/ appears acoustically closer to LA /iː/ in terms of F1 and F2 values, it is unlikely that this vowel will be perceived as LA /iː/, as it is a rounded vowel.

In sum, LA listeners, whose native vowel inventory includes phonemic length contrasts, should use duration as a cue that facilitates L2 vowel discrimination. However, discrimination may be more difficult for those contrasts where there is a vowel quality difference between AusE and LA vowels and when both AusE vowels are mapped to one or more of the same LA categories. A summary of the possible learning scenarios for LA learners of AusE are provided in Figure 2.

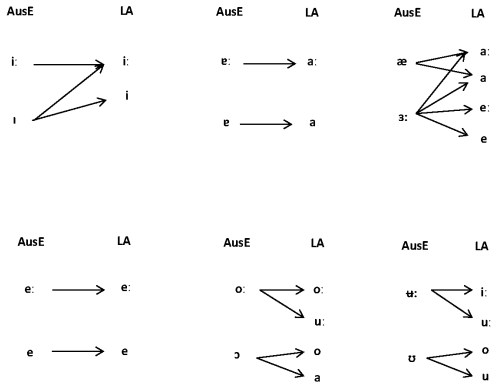

Figure 2: *Summary of possible learning scenarios for native LA listeners' discrimination of the six AusE contrasts, according to the L2LP model and based on visual acoustic comparison.*

2. Method

2.1 Participants

Listeners were 15 native LA-English bilinguals and 15 AusE monolinguals, aged between 18 and 45 (mean age 35.9 for LA, 24.8 for AusE). The LA listeners were born in Lebanon; migrated to Australia within the last 18 years and currently live in the suburbs of Western Sydney. LA participants spoke AusE as a L2 and reported either low-intermediate or advanced proficiency in English in a language background questionnaire administered prior to testing. The AusE participants were born in Australia, reported little to very basic knowledge of any foreign language and were included as our control group.

2.2 Stimuli and Procedure

Stimuli for the XAB task were 120 AusE natural isolated vowel tokens produced by 5 male and 5 female monolingual speakers of AusE from Western Sydney selected from the [14] corpus. There were 10 tokens for each of the 12 AusE vowels /iː, ɪ, e, eː, ɜ, ɐ, ɐː, æ oː, ɔ, ʊ, ʉ/ (12 AusE x 10 repetitions) extracted from nonce words that all rhymed with real words, produced in the /fVf/ context [13]. We also extracted 12 natural vowel tokens (representing each of the 12 AusE vowels) produced by 1 male and 1 female AusE monolingual speaker to use as the A and B stimuli.

As in [7], participants were presented with an auditory discrimination task presented in an XAB format. Participants completed six blocks, each containing 40 trials. These six blocks represented the six AusE long vs short vowel contrasts, /æ/-/ɜː/, /e/-/eː/, /iː/-/ɪ/, /ʊ/-/ʉː/, /ɐ/-/ɐː/ and /oː/-/ɔ/. In each trial, listeners heard three vowel sounds, one after the other and were asked to decide whether the first (X) sounded more like the second (A) or third (B), by pressing the corresponding button on the keyboard. The order of the A and B stimuli were

counterbalanced and to ensure language-specific phonological processing, the inter-stimulus interval was set to 1.2 seconds.

Participants were tested at Western Sydney University and were first presented with a practice block to ensure that they understood the task. Instructions were provided in English and the entire testing session took approximately 45 minutes to complete.

3. Results

Figure 3 shows the accuracy scores for the LA and AusE listeners across the six AusE vowel contrasts. These results indicate that both listener groups found AusE /ʊ/-/ʉː/ the easiest to discriminate, while AusE listeners found the AusE /e/-/eː/ contrast the most difficult contrast to discriminate, whereas it seems that LA listeners found both AusE /æ/-/ɜː/ and /e/-/eː/ the most difficult. To determine whether accuracy scores differed significantly across the two groups and across the different contrasts, we ran a repeated-measures ANOVA with language as a between-subjects factor and vowel contrast as a within-subjects factor. The results indicated a main effect of contrast [F (5,140) = 44.995, p = < 0.001 η_p^2 = 0.616] and a contrast*language interaction [F (5,140) = 7.727, p = < 0.001, η_p^2= 0.616], but no main effect of language (p = 0.949).

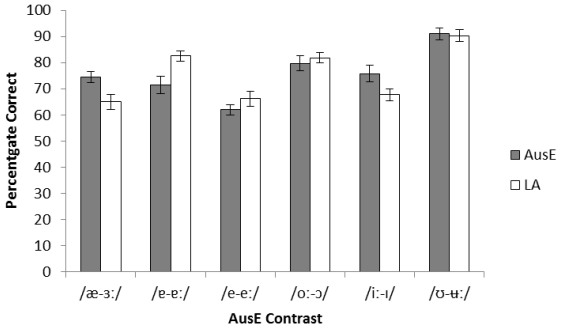

Figure 3. *Discrimination accuracy for six AusE vowel contrasts by native AusE and native LA bilingual English listeners.*

To test the predictions for each contrast stated in the introduction, we ran planned comparisons using independent-samples t-tests comparing AusE and LA listeners' accuracy. We found significant differences for the /æ/-/ɜː/, /ɐ/-/ɐː/ and /iː/-/ɪ/ vowel contrasts. In line with our predictions, LA listeners had significantly lower discrimination accuracy than AusE listeners for /æ/-/ɜː/ (t(28) = -2.661, p = 0.013) and /iː/-/ɪ/ (t(28) = -2.044, p = 0.05), while they had higher accuracy for /ɐ/-/ɐː/ (t(28) = 2.841, p = 0.008).

The results above may be influenced by the difference in L2 proficiency within the LA group. We therefore split LA listeners into two groups according to their self-evaluation of English proficiency (e.g. low, intermediate or advanced). Participants were included in the low group (LA_1) if they indicated that their English proficiency level was at an intermediate level or lower and participants included in the high group (LA_2) were those who indicated that their English proficiency was at an advanced level or higher. The LA_1 group (low proficiency) included 8 listeners and the LA_2 group (high proficiency) included 7 listeners. Figure 4 shows the two LA groups differences in discrimination accuracy of the six AusE vowel contrasts.

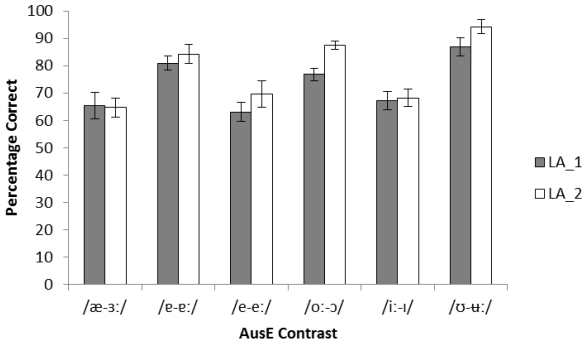

Figure 4. *Discrimination accuracy for six AusE vowel contrasts by 8 LA intermediate L2 English listeners (LA_1) and 7 LA advanced (LA_1) L2 English listeners.*

Figure 4 shows that the LA_2 group had higher overall discrimination accuracy and that both groups had high accuracy scores for AusE /ʊ/-/ʉː/. The results suggest that the LA_1 group found the AusE /e/-/eː/ most difficult to discriminate, whereas the LA_2 group found AusE/æ/-/ɜː/ the most difficult. To determine whether or not the results observed in Figure 4 are statistically significant, we ran a repeated-measures ANOVA with proficiency group as a between-subjects factor and contrast as a within-subjects factor. While the results indicated a main effect of contrast, [F (5,65) = 26.604, p = <0.01, η2p = 0.672], no effect of proficiency (p = 0.329) or interaction between contrast*proficiency (p = 0.404) was found. Although it appears that the LA_2 group performed better overall, this finding did not reach significance, indicating that AusE proficiency does not play a role in LA listeners' discrimination accuracy.

4. Discussion

The present study investigated LA listeners' discrimination of six AusE vowel contrasts. Following the L2LP framework, we compared the acoustic similarity between the native and target language to predict L2 discrimination difficulty.

The results indicate that LA listeners do indeed rely on duration as a cue to facilitate their discrimination between AusE short and long vowels. In fact, LA listeners performed better than native AusE listeners on the /ɐ/-/ɐː/ contrast which differs by length only. Interestingly, LA listeners' accuracy was lower than AusE listeners on the vowel contrasts that do not perfectly align to the vowels in their own native length contrasts and in which a partial acoustic overlap was identified (e.g., /æ/-/ɜː/ and /iː/-/ɪ/). These findings suggest that LA listeners' performance is equal to and in some cases better than native speakers when the contrast is similar to their own native contrasts, with no acoustic overlapping. However, duration may not be a sufficient to facilitate the discrimination of L2 vowel contrasts that contain vowel quality differences as well as an acoustic overlap. In addition, we found that the LA listeners' proficiency in AusE did not facilitate their vowel discrimination, suggesting that their perception of AusE is still strongly influenced by their L1.

The findings from the present study are in line with the L2LP model's claim that L2 perceptual difficulty can be predicted by the acoustic similarity between the native and

target language. That is, LA listeners did indeed find AusE /ʊ/-/ʉː/ easy to discriminate and AusE /æ/-/ɜː/ and /iː/-/ɪ/ the most difficult to discriminate. Although our findings were not consistent with our predictions for AusE /e/-/eː/, native AusE listeners also found this contrast difficult to discriminate and it may be that this difficulty is a result of the fVf context in which these two vowels were extracted from, namely *fairf* and *fef* where the length difference between the vowels may be subtle. That is, the vowels may be better identified in a "consonantal syllabic context" rather than as an isolated vowel, where acoustic information is not completely captured influencing identification accuracy [14].

In sum, our findings suggest that LA learners of AusE use their native vowel length contrasts to facilitate L2 vowel discrimination. This use of vowel duration differences seem to yield very few problems with AusE contrasts in LA listeners who, in fact, outperform AusE listeners in one contrast, regardless of their proficiency with AusE. For LA listeners, discrimination difficulty is only apparent for two of the six AusE contrasts where the vowels do not align with the LA counterparts and when partial acoustic overlapping is identified.

The present results can only be considered preliminary for the following reasons. First, our acoustic predictions were limited because we used published LA acoustic data, which may not entirely reflect the LA dialect of the listeners tested in this study and our predictions were based on visual inspection of the vowel plot. Further investigation is required that provides a more accurate measure of acoustic similarity that also considers vowel duration and the relative importance of formant frequencies and vowel duration in AusE and LA. Second, the difference in mean age between AusE and LA listeners may have influenced the results and should be controlled for with a new sample of AusE participants. Finally, the effect of proficiency was examined with groups of less than 10 participants each. A larger sample per proficiency group may yield an influence of L2 proficiency on the accuracy with which LA listeners discriminate AusE vowel contrasts.

5. Acknowledgements

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6. References

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