SYSTEMIC DRIFT OF L1 VOWELS IN NOVICE L2 LEARNERS

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ABSTRACT

Studies of proficient second-language (L2) learners have often noted phonetic drift of their native language (L1) vis-à-vis monolingual norms. Such drift has been attributed to perceptual linkage between similar sounds in L1 and L2. This study provides evidence that L1 phonetic drift is limited neither to advanced L2 learners, nor to cross-language influence at a segmental level. During the first weeks of an elementary Korean class, adult native English speakers were found to shift their English vowel space in approximation to the Korean vowel space, suggesting that in adult L2 learners phonetic drift of L1 vowels occurs in a rapid, systemic, and assimilatory fashion.

Keywords: phonetic drift, L2 learners, vowel systems, English, Korean

1. INTRODUCTION

The notion of native-language (L1) fossilization following a critical period [14] is one that has been challenged by many studies demonstrating that phonetic representations drawn upon in speech production remain highly malleable in adulthood [6, 7, 11, 16, 21]. Among these are studies showing that, in the long term, the L1 production of adults tends to change as a consequence of acquiring a second language (L2) [3, 18].

L2-influenced developments in L1 are thought to arise from the perceptual linkage of similar L1 and L2 sounds. According to the Speech Learning Model (SLM) [4], L1 phonetic categories "evolve over the life span to reflect the properties of all L1 or L2 phones identified as a realization of each category." The linkage of a novel L2 sound with a familiar L1 category occurs via the categorization mechanism of equivalence classification. This becomes increasingly likely as age of L2 learning increases and leads to phonetic convergence between the perceptually linked L1 and L2 sounds. On the other hand, when an L2 sound precipitates the formation of a new category, it may be produced accurately; however, there may also be divergence between the new L2 category and nearby L1 categories to enhance contrast within a shared phonological space.

In accordance with the view that "a L2 that is hardly mastered should not have much influence on L1, while a L2 which is mastered to a high degree should exert more influence" [18], L1 phonetic drift in late L2 learners has only been documented in highly proficient L2 speakers. This bias in the literature, however, does not follow from the SLM's postulate of continuous L1 development, which predicts instead that phonetic drift should begin at an early stage of L2 learning. Moreover, other findings suggest that L1 phonetic drift does indeed occur in the short term [23].

Following from the SLM's formulation of cross-language linkage as being between similar sound categories, research on L2 learners has generally documented L1 phonetic drift at the level of individual phonemes. For example, French /t/ and French /u/ were found to drift toward English /t/ and English /u/ in native French-speaking L2 learners of English [3]. However, L1 production changes also show a level of generalization that cannot be accounted for in terms of links between corresponding L1 and L2 segments [20]. Drift of an entire vowel system, for instance, was found in early Quichua-Spanish bilinguals, who produced all L1 Quichua vowels as significantly higher than monolinguals—a result attributed to a system-level dissimilation from L2 vowels creating sufficient dispersion between L1 and L2 vowels [8].

Thus, this study addressed the temporal and structural gaps in the literature on L1 phonetic drift via a longitudinal examination of vowels in native English speakers beginning to learn Korean. It was hypothesized that L1 phonetic drift would begin early in L2 acquisition, and that it would occur via L1-L2 linkage at the level of the vowel system.

2. BACKGROUND

The present study focused on monophthongal vowels—namely, the 11 non-rhotacized English monophthongs /i, ɪ, e, ɛ, æ, ɑ, u, ʊ, o, ɔ, ʌ/, in comparison to the 7 Korean monophthongs /i, ɛ, a, u, ɨ, o, ʌ/ [12, 13]. The vowels of American

English are the locus of much dialectal variation, which could result in a different arrangement of English vowels relative to Korean vowels for different dialects. Published phonetic norms for four dialect areas [9, 10, 22, 24] suggest that some English vowels (e.g. /i, ɛ, ʊ/) are positioned in a similar way relative to Korean vowels across dialects, while other English vowels differ between dialects in terms of proximity to Korean vowels. Across dialects, however, the English and Korean vowels differ at a systemic level: there are more front and non-high vowels in English, such that the English vowel system is consistently higher in overall first formant frequency (F_1) and overall second formant frequency (F_2) than the Korean vowel system, as shown in Table 1.

Table 1: Overall F_1 and F_2 levels (in Hz) of the American English and Korean vowel systems.

Language	Dialect	F_1	F_2
American English	Mid-Atlantic	583	1700
	Northern Midwest	624	1776
	South & Southwest	600	1843
	Southern California	634	1982
Korean	Standard	558	1572

Therefore, if drift in L1 vowels during L2 acquisition occurs on the basis of segment-level linkage between close L1 and L2 vowels, it is expected that learners' English vowels will drift in various directions approximating the nearest L2 vowel, and that there will be dialectal variation in the direction of drift for certain vowels. On the other hand, if drift in L1 vowels occurs on the basis of system-level considerations, it is expected that—across dialects—the English vowels will move in concert, in general approximation to features of the L2 vowel system.

3. METHODS

3.1. Participants

The study sample included 16 functionally monolingual female native speakers of American English learning Korean in South Korea (mean age 22.1 years, range of 21–26). A control group of 7 female native speakers of Standard Korean also participated (mean age 27.8 years, range of 22–34). These were learners' Korean teachers and the resident assistant in the dormitory where learners were living during their Korean language program, an intensive six-week course that constituted the vast majority of the time they heard and spoke Korean during the study.

3.2. Procedure and stimuli

Over the course of the language program, learners participated in a weekly production experiment that elicited citation speech via a reading task. The experiment was run a total of five times, each time in the space of 48 hours between the end of one week of classes and the beginning of the next week to control for amount of L2 instruction.

The reading materials were the same in every week and consisted of English monosyllabic words beginning with /h/ and ending with a stop, along with filler words. These items were randomized and presented four times in DMDX [5], and responses were recorded at 44.1 kHz and 16 bps.

3.3. Acoustic and statistical analysis

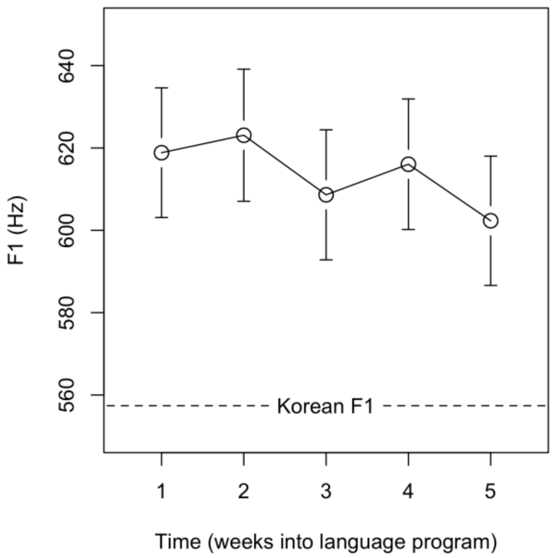
Using linear predictive coding analysis in Praat [2], acoustic measurements were taken of F_1 and F_2 over the middle 50 ms of each vowel. Measurements were taken on a wide-band Fourier spectrogram with a Gaussian window shape (window length: 5 ms, dynamic range: 50 dB, pre-emphasis: 6.0 dB/oct) annotated by hand for vowel onset and offset. Formant tracking was manually inspected for each spectrogram to ensure accurate tracking, and a series of tests showed that the acoustic data were highly reliable.

In order to control for inter-speaker differences, linear mixed-effects models were fit to the formant data, with Participant as a random effect and Vowel, Time, and their interaction as fixed effects.

4. RESULTS

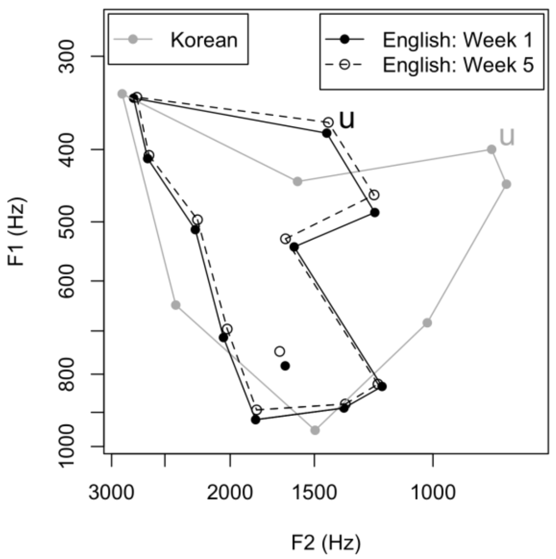
During their Korean language program, learners' English vowels showed a significant decrease in F_1 of 17 Hz (i.e. vowel raising), which approximated the lower F_1 of the Korean vowel system (Figure 1). Model results indicated that, after the effects of Vowel and Participant were accounted for, there was still an effect of Time on F_1 [$F_{(4, 3409)} = 12.36$, $p < 0.0001$], but not on F_2 [$F_{(4, 3409)} = 0.08$, *n.s.*]. Post-hoc comparisons of consecutive weeks using Tukey's HSD test showed that while increases in F_1 between Weeks 1 and 2 and Weeks 3 and 4 were not significant, the decreases between Weeks 2 and 3 and Weeks 4 and 5 were each highly significant [$p < 0.001$].

Figure 1: Mean F_1 of the English vowel system over time vs. mean F_1 of the model Korean vowel system. Error bars indicate 95% confidence intervals.



Time did not interact with Vowel in its effect on F_1 [$F_{(40,\ 3409)}$ = 1.08, *n.s.*], suggesting that the overall decrease in F_1 was not due to one vowel in particular. In fact, mixed-effects models built by vowel showed Time to be a significant or marginal predictor of F_1 for every vowel except /i/, /ɑ/, and /ɔ/. Thus, upward drift occurred in the English vowel system generally (Figure 2). Furthermore, no consistent differences were found between talkers of different dialects.

Figure 2: Phonetic drift of the English vowel system relative to the model Korean vowel system. For each language, /u/ is labeled as a reference point.



This upward drift of the English vowels was found to result in closer spacing between English and Korean vowels. Calculations of the mean acoustic distance in F_1 x F_2 space between English and Korean vowels (i.e. the average of the distances between every possible English-Korean vowel pair) showed that cross-language vowel dispersion decreased over time, a trend that was marginally significant [$F_{(4,\ 60)}$ = 2.24, p < 0.1].

5. DISCUSSION AND CONCLUSION

This study produced evidence supporting the hypothesis that phonetic drift of L1 vowels during L2 acquisition would occur in a rapid and systemic manner. Instead of drifting in disparate directions, the English vowels moved upward in similar fashion, approximating the Korean vowel system in accordance with basic differences between the two languages' vowel inventories. That this movement was systemic, rather than simply the sum total of assimilatory changes in individual L1 vowels, is clear from a close examination of the drift patterns of L1 vowels vis-à-vis L2 vowels. For instance, while the raising of English /o/ was convergent with the nearby Korean /ɨ/, the raising of English /u/ was divergent from both Korean /ɨ/ and /u/, the two closest L2 vowels (Figure 2). The existence of many such contrasts indicates that the observed vowel shifts cannot be accounted for coherently in terms of vowel-to-vowel influence.

This begs the question of why phonetic drift in L1 vowels occurred at a macro level—the level of the entire vowel system—rather than at a micro level targeting individual vowels. One possibility is that systemic pressures towards maximum vowel dispersion [15] exerted their influence while L1 vowels were drifting, consistent with the interconnected nature of vowels documented in studies of L2 speech, e.g. [17]. This is the sort of explanation that was provided for the systematic raising of L1 Quichua vowels in Quichua-Spanish bilinguals [8]. The raising observed in the present study, however, could not have been motivated by maximization of vowel dispersion in a shared L1-L2 phonetic space, since it actually resulted in decreased vowel dispersion.

Far from dissimilation between vowels for the sake of maximizing dispersion, the proposal of this study is that the systemic drift of L1 vowels found here was ultimately an instance of assimilation to the L2 vowel system. The discrepancy with [8] is likely due to differences in age of L2 acquisition: participants in [8] who manifested dissimilatory drift were relatively early bilinguals (thus increasing the likelihood of cross-language dissimilation per the SLM), whereas participants in the present study were late L2 learners.

As for the basis of assimilatory phonetic drift at the level of the vowel system, this sort of shift seems to occur via cross-language links at a global level (e.g. overall F_1 and F_2 levels), but the nature of the structure linked across languages in this way is not yet clear. Perhaps L2 learners, tracking a long-term average spectrum of L2 in comparison to L1, link the F_1 of the L2 spectrum, for example, with that of the L1 spectrum, and in this way production of L1 shifts in the direction of L2 at the level of overall F_1. Alternatively, as was implied above, the comparison between grand spectral means may occur at a higher level—for instance, averaging over vowel types rather than tokens. Further work on languages with vowel inventories that have different frequency profiles is necessary to distinguish these two accounts.

Notably, though learners' L1 vowels drifted toward the lower F_1 of the L2 vowel system, they did not drift toward its lower F_2. There are two possible explanations for this asymmetry. First, due to fundamental properties of human audition [1, 19], frequency differences are generally less perceptible in the range of F_2 than F_1, as well as when the frequency change is descending as opposed to ascending. Second, drift in F_2 may have been prevented by the decreased degree of vowel dispersion resulting from the drift in F_1.

In conclusion, it should be observed that although the motivation for L1 vocalic drift differed between this study and [8], both cases of drift happened to result in the same direction of movement—vowel raising. As such, it would be useful to extend this work combining the type of L1-L2 pairing investigated by [8] with the population investigated in the current study (and vice versa) in order to determine whether the observed patterns of L1 vowel raising do in fact derive from the principles of the SLM, as opposed to some universal tendency for vowels to be raised in contact situations. Controlled studies of L1 vocalic drift in these situations would improve our understanding of the basis of this phenomenon and the ways in which it is constrained by structural, auditory, and perceptual biases.

6. REFERENCES

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