# THE RELATIONSHIP BETWEEN L2 ACQUISITION AND L1 ATTRITION IN THE PHONETIC DOMAIN

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## ABSTRACT

This study explored the relationship between second language (L2) acquisition and first language (L1) attrition of speech in late consecutive English-German bilinguals living in an L2 country (Austria). We acoustically examined the bilinguals' realizations of the lax vowel /ɪ/ in both of their languages and compared their productions to monolingual productions of English and German, respectively. Despite some individual-speaker variation, results showed that those speakers who produced the L2 target vowel in a native-like manner, as manifested in a tensing of /ɪ/ towards /iː/, showed a tendency towards tensing the /ɪ/ vowel also in their L1 English, suggesting L1 attrition. This indicates that successful L2 acquisition of a pronunciation feature might entail attrition of the corresponding feature in speakers' L1.

**Keywords**: vowels, first language attrition, second language acquisition, Austrian German, English.

## 1. INTRODUCTION

A number of studies show that the first language (L1) phonetic/phonological system may change under the influence of a second language (L2) system, which often results in modifications of L1 pronunciation features in the direction of L2 norms [1–4]. Changes in L1 pronunciation experienced by late bilinguals who are long-term residents in an L2 environment are commonly referred to as *phonetic attrition* [5].

While the occurrence of L2-induced changes in speakers' native pronunciation system have been attested for segmental [1,2] and prosodic [3,4] variables, findings concerning the actual *relationship* between L2 acquisition and L1 attrition of speech are still rather inconclusive. We might expect that the longer a speaker has lived in an L2 country, the more likely their L1 pronunciation system is to be affected by L2 influences, given that length of residence is often associated with increased L2 experience and proficiency. While it has indeed been shown that advanced L2 *proficiency* might cause L1 pronunciation features to move closer to the norms of an L2 in experienced bilinguals living in a migration setting [6], length of residence has so far not been established as a reliable variable predicting attrition effects in bilinguals [7]. Furthermore, L2 influences on L1 pronunciation features are not ultimately limited to advanced, long-term immersed bilinguals, but also occur in inexperienced speakers with short-term L2 exposure at the onset of L2 learning [8,9] as well as in intermediate L2 learners [10]. Such L1 modifications are, however, not likely to represent long-term changes in a speaker's pronunciation system, but may be either completely or partially reversed [11,12] and do therefore not represent instances of attrition.

Despite the steady proliferation of studies exploring L1 attrition in the phonetic domain, only few studies *compare* segmental speech production in the L1 *and* L2 of late bilinguals immersed in an L2 setting [1,2;13–15], with only two studies to date examining L1 and L2 vowel productions [1,2]. However, to improve our understanding of how L2 acquisition of pronunciation and potential modifications of L1 pronunciation are related, we need more studies that closely investigate speech production in both languages.

The present study aims to shed light on the question of how L2 acquisition and L1 attrition are related by directly comparing L1 and L2 realisations of a specific vowel pair, i.e., the tense-lax pair /iː/–/ɪ/, in a group of L1 English speakers who acquired L2 Austrian German in adulthood upon migrating to Austria. Their L1 and L2 vowel productions were compared to monolingual productions of English and Austrian German, respectively, with the aim to identify if and to what extent the bilinguals' L2 productions have reached native (monolingual) Austrian German norms and how this has affected their L1 English.

## 2. METHODS

### 2.1. Speakers

The main group of speakers included English-Austrian German bilinguals (*BIL*, $N = 8$, 4 females, 4 males), who were raised as monolingual speakers of Standard Southern British English (SSBE) and moved to Austria in adulthood where they acquired Austrian German as an L2. Two monolingual groups served as controls: these were monolingual speakers of SSBE (i.e., MONO English) and Austrian German

(i.e., MONO German) residing in England or Austria and who have never lived outside their home counties ($N$ = 8, 4 females, 4 males per group). They reported no more than high-school level knowledge of other languages.

The bilinguals had all participated in an earlier global accent rating experiment [16] in which their L1 speech was rated by monolingual SSBE listeners in terms of perceived nativeness. The eight bilinguals selected for the present study were perceived as moderately accented in their L1 in the rating study, suggesting that listeners perceived deviations from the SSBE norm in the bilinguals' L1 pronunciations. As previous studies show that bilinguals who are rated as sounding non-native in their L1 do not *inevitably* also show divergences of L1 segments [17], modifications of the bilinguals' L1 vowels were not expected from the start in the present investigation.

### 2.1. Speech Materials

The selection of materials was based on the nativeness ratings in [16] which were accompanied by listeners' comments on the pronunciation features that made them believe that a speech sample sounded non-native. The most frequently mentioned segmental comment had been on /ɪ/ (Wells' [18] standard lexical set: KIT), which was described as being too /iː/-like (i.e., approaching the standard lexical set FLEECE). A known feature of Austrian Standard German (in opposition to German Standard German) is the neutralization of quality, but not quantity of high vowel pairs [19], irrespective of surrounding consonantal context [20]. This suggests a difference in the implementation of the tensity contrast between Austrian and German Standard German, with the latter being very similar to the same contrast in English, which maintains a tense-lax distinction [21, 22]. To investigate the acoustic properties that might cause the auditory perception of /ɪ/ taking on the quality of /iː/, and in order to compare tense and lax high front unrounded vowels acoustically in both languages, we analysed English and German words containing both vowels. We chose instances of /ɪ/ occurring in stressed syllables in 30 English and 10 German words that were recorded embedded in the carrier sentences "Say [target word] again" and "We said [target word] together" (target words were: *bit, bitter, chill, filled, fin, hid, his, hiss, Jill, lip, miss, in, myth, Phil, picks, pigs, pill, rich, ship, sick, sin, sinking, sit, thick, thin, things, thinking, wick, will,* and *winter*) in the English set and in the carrier sentence "Ich habe [target word] gesagt" (target words were: *Knittelfeld, Krippe, Lippe, Mitte, Stiftung, Winter, bitter, Innkreis, Ritter,* and *bitte*) for the German set.

Additionally, other materials from the same recording sessions were used in order to obtain words with the tense, high front unrounded vowel /iː/, and the tense, low back unrounded vowel /ɑː/, both occurring as syllable nuclei of the stressed syllables. These vowels were later used as anchor vowels (see section 2.3).

### 2.2. Recording Procedure and Pre-processing

Bilinguals recorded both sets, with the English set always occurring before the German one, while monolinguals only recorded a single set in their respective language. Each word was read aloud twice in each carrier sentence, resulting in four repetitions per vowel, context and speaker. Speech recordings took place online due to Covid-19 restrictions, using the software Wikispeech [23]. This system allows participants to complete unsupervised online recordings, using their own recording devices. Participants were instructed to avoid noisy environments and adjust recording levels after listening to the first few test items to avoid poor audio quality. All recordings were prepared for further analyses by normalizing maximal amplitude and sampling size (16kHz). The texts of the prompts and the audio data were then sent to BAS WebServices [24], a service for automatic forced alignment; the resulting segment boundaries were manually corrected. These corrections and the analyses were conducted in EMU-SDMS [25]. Formants were calculated with *Praat*'s [26] *To Formant (burg)* method [27], with standard settings.

### 2.3. Data analysis

We measured F1 and F2 in /ɪ/, /iː/ and /ɑː/ at the temporal midpoints of the vowels. A method called orthogonal projection [28,29] was used, which normalizes the vowel spaces by using the vowels /iː/ and /ɑː/ as anchor vowels that represent the upper left and lowest right corners of each speaker's vowel space, allowing for normalization of the vowel spaces, and for a quantification of the closeness of the lax high front vowel to the tense high front vowel. The closeness of /iː/ to /ɪ/ was then determined by calculating the relative position of every /ɪ/ vowel between the anchor vowels /iː/ and /ɑː/ using the orthogonal projection parameter *op*, the so-called orthogonal projection ratio using (1):

$$op(\vec{\imath}) = 1 - 2\frac{(\vec{\imath}-\vec{c}_{iː}) \odot (\vec{c}_{iː}-\vec{c}_{ɑː})}{(\vec{c}_{iː}-\vec{c}_{ɑː}) \odot (\vec{c}_{iː}-\vec{c}_{ɑː})}. \quad (1)$$

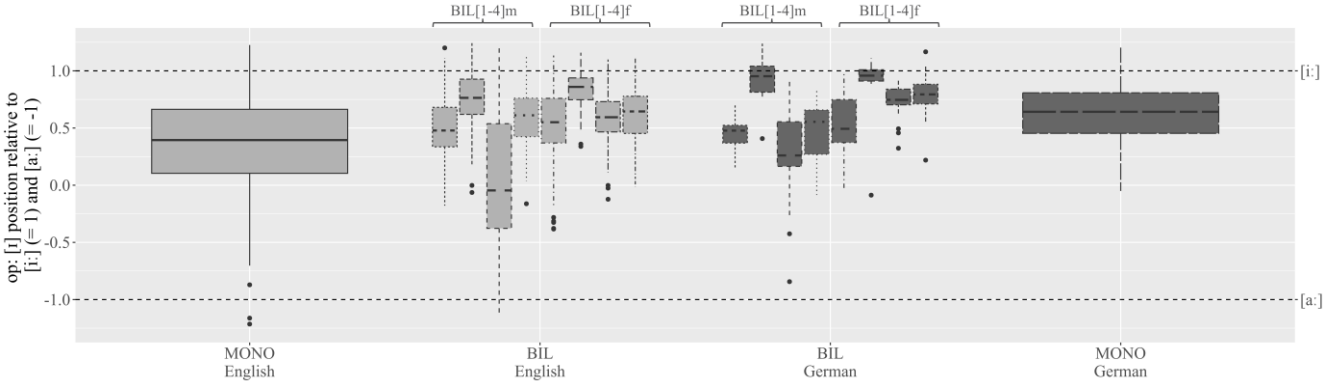


**Figure 1:** Distributions of the *op* values for [ɪ] in the different speaker groups. *Note: m=male; f=female.*

In a two-dimensional acoustic space (formed from the acoustic measurements for F1 and F2), $\vec{\imath}$ is the position of a given target vowel of the category [ɪ], $\vec{c}_{iː}$ and $\vec{c}_{\alpha ː}$ are the centroids (means) of the two anchor vowels respectively, i.e., of [iː] and [ɑː], and $\odot$ is the scalar (inner) product of two vectors. This means that a value of -1 was assigned to the formant values corresponding to the speaker-specific means of F1 and F2, respectively, of /ɑː/, and a value of 1 was assigned to formant values corresponding to speaker-specific means of F1 and F2 of /iː/. The mid-point between the two would then be reflected by the value of 0 (which roughly corresponds to F1 and F2 of a prototypical schwa vowel).

### 2.4. Statistical analysis

We applied linear mixed models with *op* values as dependent variable, *Group/Language* (four levels: *MONO English*, *MONO German*, *BIL English*, *BIL German*) as fixed factor, and *Word* as random factor (including random slopes for the *Group/Language* combinations). We did this on a.) the group-level (i.e., comparing eight speakers per Group/Language level), and b.) on a bilingual-speaker-specific level (i.e., comparing eight *MONO English* and *MONO German* speakers with one *BIL English* and *BIL German* speaker, respectively). We added an *emmeans* [30] analysis as a post-hoc comparison and then calculated whether the mean *op* values per speaker in the bilingual group for English were correlated with the same speaker's German *op* values by means of a simple linear model.

## 3. RESULTS

Figure 1 shows the distributions of the *op* values for [ɪ] (that is, the relative positions of [ɪ] vowels between speaker-specific mean positions of [iː] and [ɑː]) in English and German words produced by English and Austrian German monolinguals (*MONO English*, *MONO German*), respectively, and by English-German bilinguals in both languages (*BIL English*, *BIL German*). A linear mixed model revealed a significant main effect [$F(3, 26.1) = 31.4$, $p < 0.001$) for *Group/Language*. Estimated marginal means analyses showed significant differences between *MONO English* vs. *MONO German* ($p < 0.05$), *BIL German* ($p < 0.01$), and also *BIL English* ($p < 0.001$). There were no significant differences, though, between the *MONO German* values and *BIL German* or *BIL English*, or between *BIL German* and *BIL English*.

As can be seen in Figure 1, there are individual differences in the BIL speaker groups. The post-hoc analysis revealed that 5 out of 8 BIL speakers (BIL4m, BIL1f, BIL2f, BIL3f, BIL4f) showed no significant differences in their L2 German vowels compared to the MONO German speakers. That is, these BIL speakers showed a tendency towards tensing their L2 /ɪ/ vowel in the direction of /iː/, as shown in Figure 1. At the same time, the BIL's English productions were shown to be significantly different from MONO English (BIL4m, BIL2f, BIL3f, BIL4f: $p < 0.0001$; BIL1f: $p < 0.05$), i.e., the BIL's L1 /ɪ/ has also moved closer towards L2 /iː/ (Figure 1).

The analysis of the remaining three speakers (BIL1m, BIL2m, BIL3m) shows significant differences between both their L1 English (BIL1m: $p < 0.05$; BIL2m, BIL3m: $p < 0.0001$) and their L2 German (BIL1m, BIL2m: $p < 0.05$; BIL3m: $p < 0.01$) as compared to MONO English and MONO German, respectively. An inspection of Figure 1 reveals the following: Speaker BIL1m shows a tensing of L1 English /ɪ/ in the direction of German /iː/ and at the same time, he is closer to L1 English /ɪ/ in his L2 German. Speaker BIL2m, by contrast, shows a tendency to produce tense /iː/ in both English and German, but significantly overshoots the MONO German target in his L2. Finally, speaker BIL3m's L2 productions are closer to L1 English /ɪ/ while his L1

productions suggest that he overshoots the MONO English norm in the direction of /ɪ/.

According to a linear model, the English mean *op* values of the bilinguals are positively correlated with the same speakers' German mean *op* values (Figure 2: Adjusted $R^2$ = 0.51, F[1 ,6] = 8.3, p < 0.05), although the relationship is not 1-to-1 (slope of the model: 0.61).

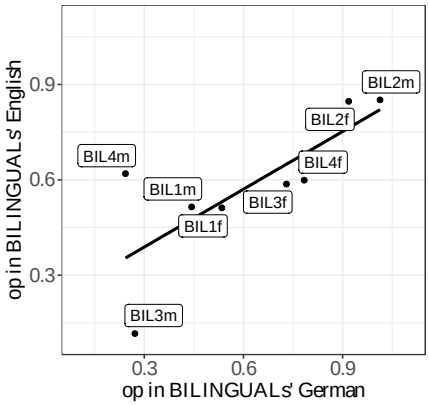


**Figure 2**: Speaker-specific mean *op* values in BIL English as a function of their BIL German mean *op* values.

## 4. DISCUSSION

In order to more closely characterize the relationship between L2 acquisition and L1 attrition of speech, we examined how late consecutive bilinguals, living in Austria, produced the tense-lax pair /iː/–/ɪ/ in their L1 SSBE and their L2 Austrian German as compared to monolingual speakers of SSBE and Austrian German, respectively.

In terms of the monolingual productions, our data revealed that the Austrian German speakers produced significantly less of a quality contrast between /iː/ and /ɪ/ compared to SSBE speakers. That is, in line with what has previously been reported for Austrian German [19] and English [21,22], Austrian German speakers' productions of /ɪ/ showed a tensing in the direction of /iː/, although there was no evidence of a merger.

The individual speaker analyses revealed that five out of eight bilinguals produced a native-like tense /iː/ in their L2 German, which suggests that these bilinguals have successfully acquired native (monolingual) Austrian German norms in their L2. At the same time, their L1 English /ɪ/ – similar to their German /ɪ/ – has moved closer towards L2 /iː/. This indicates that their L1 category has assimilated to the L2. Consequently, these five speakers' vowels have *approximated L2 Austrian German norms in both the L1 and the L2*. Similar assimilatory patterns have been observed in [1] and [2], where the bilinguals under investigation produced some of their L1 Austrian German [1] or Dutch [2] vowels acoustically closer to the L2 English target.

The analysis of the remaining three speakers reveals a different, less systematic pattern: Their vowel productions suggest that they *deviate from both L1 and L2* norms, i.e., these speakers show signs of attrition in their L1 vowels while not achieving monolingual values in their L2. In some of the speakers, we observed a tendency to *overshoot* either the L1 or the L2 monolingual target, i.e., their vowels were either too lax for English or too tense for German. Speaker BIL2m, for instance, produced L1 English vowels closer to German /iː/ (suggesting attrition) while at the same time significantly overshooting L2 German monolingual values (i.e., his L2 productions were even more /iː/-like). Speaker BIL3m, by contrast, was observed to produce English-like /ɪ/-vowels in his L2 German (showing an L1-to-L2 influence) and to overshoot monolingual English values in his L1, i.e., producing more /ɪ/-like vowels than the monolingual speakers. This might reflect an attempt to keep the L1 and L2 vowels apart, assuming that – as suggested by the Speech Learning Model [31] – a bilingual's phonetic categories exist in a shared phonetic space.

Taken together, these findings indicate that successfully acquiring an L2 pronunciation feature, in this case the tensing of /ɪ/, might entail non-native realizations of the corresponding feature in the L1. This does, however, not seem to be the case in all bilinguals, with some speakers showing a tendency to overshoot monolingual targets in their L1 or L2, resulting in non-native-like productions in both languages.

## 5. CONCLUSION

The findings of the present study suggest that the ability to produce an L2 pronunciation feature in a native-like fashion – as measured against monolingual norms – might impede successful L1 maintenance. In order to shed light on how individual speaker variation in L2 acquisition and L1 attrition of pronunciation can be explained, future studies may want to explore the relative contribution of predictor variables such as length of residence or age of arrival as well as the relation between nativeness ratings and the reduced distance between [ɪ] and [iː].

## 6. ACKNOWLEDGEMENTS

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