THE BASE-OF-ARTICULATION EFFECT IN A SECOND LANGUAGE

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ABSTRACT

A comparison of vowel locations in the acoustic space between American English and German indicates that language-specific factors dictate the phonetic realization of phonemically equivalent vowels. Data are examined to determine whether and how beginning learners of German as a second language (L2) utilize their native English (L1) base of articulation in production of both equivalent and novel segments in L2. Acoustic results from native German, L2 German and L1 English productions shed more light on the issue. Beginning L2 learners transfer the relational distances among their equivalent L1 vowels, which act as general reference frames for placement of L2 categories, whereas novel segments are created without clear reference to L1.

1. INTRODUCTION

In German, two vowel subsystems are evenly distributed over two upper levels of vowel height: high vowels function as tense /i, y, u/ and lax /I, Y, U/ variants in the lexicon, and so do the mid-vowels /e, ø, o/ and /ɛ, œ, ɔ/. The main distributional difference between the two subsystems is that the tense vowels /i, y, u, e, ø, o/ can occupy a position in a stressed open syllable whereas the lax vowels /I, Y, U, ɛ, œ, ɔ/ occur only in closed syllables. As a consequence of such distribution, the two subsystems show differences in their durational and acoustic characteristics. As a general rule, the formant pattern for tense vowels places them in a peripheral position in the acoustic space relative to the lax vowels which are slightly lowered and more centralized.

American English tense /i, u/ and lax /I, U/ high vowels as well as tense /e, o/ and lax /ɛ, ɔ/ mid-vowels have similar distributional restrictions imposed by the lexicon although their phonetic realization is different than in German. Most relevant for the present study, however, is the absence of front rounded vowels in English, which poses a problem for native speakers of American English learning German as their L2. Namely, having established an articulatory base for the execution of segments in English, *beginning* L2 learners need to accommodate the German front rounded vowels into their existing articulatory frame.

Three possibilities arise: (i) the English base of articulation is 'reset' to the German values at the very beginning of learning, (ii) the English base is maintained and front rounded vowels show an articulatory approximation of existing L1 segments, (iii) the English base is maintained and front rounded vowels are not influenced by position of L1 vowels in the acoustic space. Since the first possibility does not seem feasible in light of extensive research on L2 speech learning [3], it is of particular interest how and to what extent L2 learners utilize their L1 base of articulation in L2. An acoustic experiment was conducted to investigate this issue.

2. ACOUSTIC STUDY

2.1. Experimental Procedure

German lax vowels /I, ɛ, Y, U/ and English /I, ɛ, U/ were selected for investigation. Limiting the number of vowels from the lax subsystem to four in German and to three in English allows for more careful observation of the high vowels /I, Y, U/ in L2 production and for a direct comparison of /ɛ/ in both languages. The choice of lax vowels rather than tense has an additional advantage of eliminating the English nuclear offglides for a comparison with the German data.

The German vowels were produced in disyllables and preceded by the neutral context /h/. The English vowels were produced in monosyllabic words and preceded by /h/. The choice of di- and monosyllables was dictated by their overall frequency of occurrence in the lexicon of both languages [5] which assured naturalness in subjects' production. The German tokens /hIkən/, /hɛkən/, /hYkən/, /hUkən/ were recorded in the frame sentence "Sag ___ für mich", and the English tokens /hId/, /hɛd, /hUd/ in the carrier "Say ____ again".

12 male native speakers of American English who were beginning learners of German served as informants for the study. All speakers represented the same midwestern variety of English, having been born and having spent most of their lives in Wisconsin. They were enrolled in the second-semester German at the UW-Madison and their contact with German was less than one year.

The informants first recorded 6 repetitions of each German frame sentence in random order. The same procedure was followed throughout the English samples. The recordings were performed in a sound attenuated booth. The subsequent process of digitizing, editing, and analyzing the vowel tokens took place in the Phonetics Laboratory of the Dept. of Linguistics at the UW-Madison. The speech analysis software used was CSpeechSP.

For a comparison with the German data, a carefully selected male native speaker of standard northern German (Hamburg area) produced the German vowels following the same recording procedure as the English speakers. Data from this speaker were compared with other published data [1, 4, 6] to assess how representative his vowel tokens were as for the northern variety of German. No significant difference in F1 for any of the vowels was found using a two-sample t-test. In F2, the values from the present speaker were slightly higher for /Y/ [t= -2.60, p= .048].

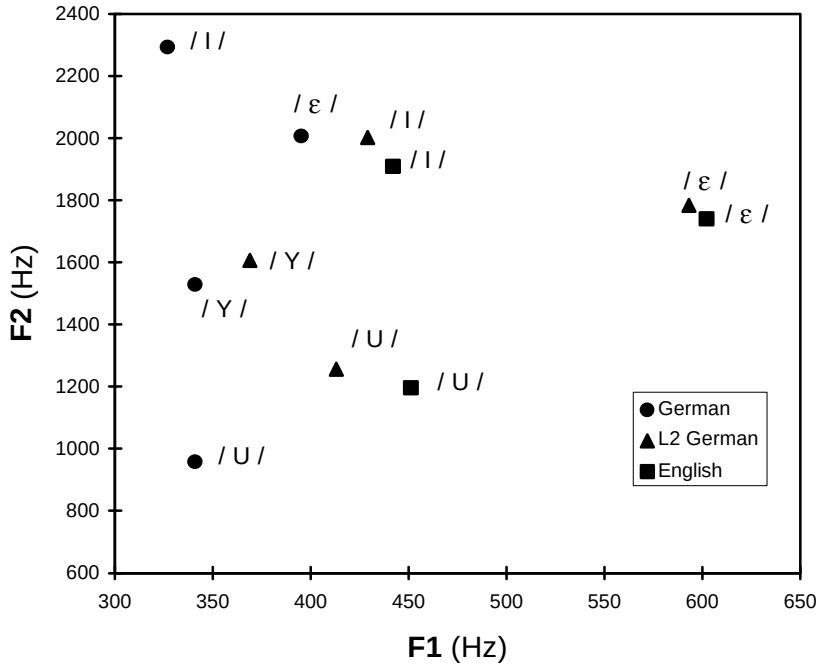

Figure 1. Native German (G), L2 German (L2), and American English (E) acoustic data. Each vowel point represents the mean F1 and F2 values of 6 (G) and 72 (L2, E) vowel tokens.

2.2. Results

Figure 1 shows results of the acoustic analysis of the data from the native German speaker and from 12 native speakers of American English. Each vowel point in Fig. 1 shows the mean of F1 and F2 values obtained for 6 tokens for the native German productions and for 72 tokens for the L2 German productions of the four target vowels /I, ε, Y, U/. The American English /I, ε, U/ represent the mean of 72 values obtained for the same 12 informants who produced the L2 German vowel tokens. All values are listed separately in Table 1.

Vowel	F1/F2	German	L2 Germ.	English
/I/	F1	327	429	442
/ε/		395	593	602
/Y/		341	369	
/U/		341	413	451
/I/	F2	2293	2002	1910
/ε/		2006	1783	1740
/Y/		1529	1605	
/U/		958	1256	1197

Table 1. F1 and F2 values for the acoustic data

As can be observed from the plot, both L2 German and English variants of /I, ε, U/ have higher F1 values than the values obtained in the native German production. Differences are also observed in F2: both L2 German and English variants of /I, ε/ have lower values than these of the native German speaker, whereas the values for /U/ are higher. In general, a comparison of vowel location in the acoustic space shows more expansion along the front versus back vowel dimension in the native German production relative to the centralization of vowels in English and L2 German. A downward shift along the F1 dimension of the English and L2 German vowels is also a robust effect. L2 German productions of /I, ε, U/ appear to correspond to the general location of their American English equivalents. The location of L2 German /Y/ seems to be consistent with the native German production.

For comparison of F1 values for /I, ε, U/ among the three groups, i.e., native German (G), L2 German (L2), and English (E), a one-way ANOVA was used followed by pairwise comparisons (Fisher's LSD) if the omnibus test was significant. Significance was obtained for /I/ [$F(2,147) = 17.30$, $p < .0001$], for /ε/ [$F(2,146) = 36.39$, $p < .0001$], and for /U/ [$F(2,147) = 19.90$, $p < .0001$]. The pairwise differences revealed that for both /I/ and /ε/, (G) differs from both (L2) and (E), but the latter two do not differ significantly from each other. For /U/, all three pairwise comparisons among (G), (L2), and (E) were significant.

The same procedure was repeated for F2 values. ANOVA yielded significant main effect for /I/ [$F(2,147) = 43.44$, p

<.0001], for /ɛ/ [$F(2,146) = 21.73$, $p < .0001$], and for /U/ [$F(2,147) = 8.13$, $p < .0001$]. All three pairwise comparisons among (G), (L2), and (E) were significant for /I/ and /ɛ/. For /U/, (G) differed from both (L2) and (E), but the latter two did not differ significantly from each other.

For the comparison of values for /Y/ among (G) and (L2), a one-way ANOVA was also used. The main effect was not significant for the F1 values [$F(1,76) = 1.32$, $p = .255$] nor for the F2 values [$F(1,76) = .30$, $p = .586$] indicating that in both native German and L2 German productions, the F1 and F2 values for /Y/ did not differ significantly.

To summarize the results with reference to location of the vowels in the acoustic space (Fig. 1), the locations of both /I/ and /ɛ/ in L2 German and English do not differ from each other in F1, but differ in F2 values. They differ from the position of the native German variant in both F1 and F2. For /U/, the L2 variant differs from both the native German and English in F1, but it is equivalent to the English /U/ along the F2 dimension. The location of L2 German /Y/ in the acoustic space does not differ from the location of the native German /Y/.

2.3. Discussion

In the subset of vowels investigated, the comparison of acoustic results shows consistent differences in F1 and F2 values across equivalent vowel categories: the L2 German /I/, /ɛ/, and /U/ are located considerably lower and less peripherally in the acoustic space than the variants produced by the native German speaker. Comparing the location of L2 German vowels with the position of the English vowels in production of the same informants, the F1 values for /I/ and /ɛ/ are almost identical whereas slight differences in F2 place both L2 vowels more peripherally than their English variants. In the case of /U/, the opposite effect is observed in that the L2 German variant agrees with its English equivalent if F2 but not in F1. The location of the novel segment /Y/ shows no evidence of articulatory place assimilation to any English vowel and its position does not differ from the position of the native German /Y/ in the acoustic space.

The possibility that the native language articulatory base established for production of vowel categories in American English is adjusted to that in German at an early stage of learning German as an L2 has no support in the present data. Clearly, the present informants utilized their English articulatory frame for production of the equivalent vowels in L2 German. This was evident in the smaller dispersion area of L2 German /I, ɛ, U/ relative to that in native German. Similar effect of utilizing the native language base of articulation was reported for monolingual productions of the English and Spanish phonemically equivalent vowels /i, e, u, o/ [2].

The second possibility, i.e., that the English base is maintained and the front rounded /Y/ shows an articulatory approximation of an existing English vowel does not have support in the present data either. Although the L2 German /U/ has a lower F1 value compared to that in English, it is still well separated from the L2 /Y/ which obtained similar F1 and F2 values to the variant in the production of native German speaker. As a third possibility, the L2 /Y/ seems not to be influenced by position of any English vowel although the English base of articulation is generally maintained. If this is indeed the case, the question arises as to why L2 learners do not accommodate the novel segment /Y/ directly into their English articulatory frame.

2.3.1. What is transferred? The observed higher F2 values for both L2 German /I/ and /ɛ/ relative to their English variants indicate a beginning of an expansion of the English articulatory base toward a more fronted peripheral position in native German. This significant fronting of /I/ and /ɛ/ does not correspond to a comparable backing of L2 German /U/ which would suggest a similar expansion of the English base in the direction of native German /U/. Therefore, it can be tentatively asserted that the front unrounded vowels and the back vowel /U/ do not synchronize their F1 and F2 dimensions at the initial stages of L2 development: the /U/ expands more in F1 than in F2 whereas both /I/ and /ɛ/ show a shift in F2.

Since all informants were male which eliminates the problem of normalization for gender in acoustic comparison of the results, the distances among the equivalent vowel categories in English, L2 German, and native German shed more light on the issue. Table 2 displays the calculated differences in Hz in F2 between /U-I/ and /U-ɛ/, and in F1 between /ɛ-I/ and /ɛ-U/. The values used for calculations are taken from Table 1.

	F2 /U-I/	F2 /U-ɛ/	F1 /ɛ-I/	F1 /ɛ-U/
English	713	543	160	151
L2 Germ.	746	527	164	180
German	1335	1048	68	54

Table 2. Acoustic distances (in Hz) among selected vowels

As can be observed from Table 2, the difference in Hz from /U/ to /I/ along the F2 dimension for L2 German is in accord with that in English (above 700 Hz). The same applies to the /U-ɛ/ distance along F2 (above 500 Hz). Since the respective differences in native German are almost twice that large as these in L2 German, it can be concluded that the beginning L2 learners transfer the relational distances between their native language vowels into L2.

Similar results are obtained along the F1 dimension. The difference between /ɛ-I/ is almost the same in L2 German as in English, and the /ɛ-U/ difference is even larger in L2 German due to the lower F1 values for L2 /U/. This is clearly at odds with small differences of around 60 Hz for native German. Again, the transfer of relational distances among the English vowels along F1 dimension into L2 German is evident. As it appears, the beginning L2 learners utilize their native language base of articulation for production of equivalent vowel categories in L2. Since it is the *relations* among the vowels in this general acoustic frame that are transferred, it can be concluded that the lax vowels /I, ɛ, U/ are treated as a *system* by L2 learners.

The location of the novel segment /Y/ in the acoustic space is clearly outside of the native English system. Assuming a transfer of the native language base of articulation into L2, the location of L2 German /Y/ falls outside the developing L2 vowel system as

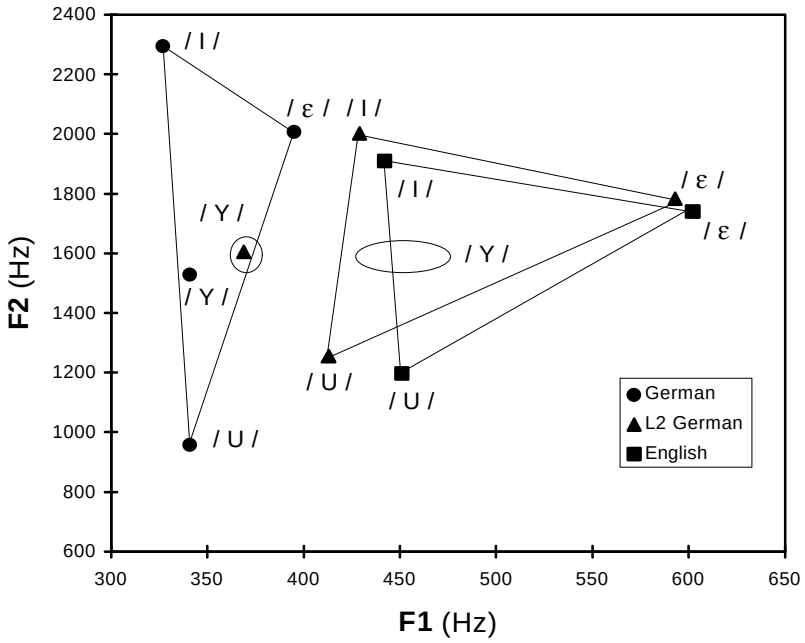

Figure 2. Relational distances in Hz among native German, L2 German, and English vowels

well. Taking into account the acoustic distances in native German, L2 German, and English, the predicted position of L2 /Y/ would most likely be in the region of 420-460 Hz along the F1 dimension (see Fig. 2). This location would be within the acoustic area of the equivalent vowels /I, ɛ, U/, and its phonetic realization would be closer to the German [œ] or the English [ʌ]. Since this is not the case, the mechanism (whether articulatory, perceptually-driven, or motivated in yet another way) which controls the articulatory execution of the L2 /Y/ by directing it to a close proximity of the native German /Y/ must perform its function with a high degree of precision.

Evidence for this comes from the location of L2 /Y/ along the F2 dimension. The F2 value of 1605 Hz places the L2 /Y/ in the same relative position on the F2 difference between /U/ and /I/ as the value of 1529 Hz places the German /Y/. That is, calculating
the F2 difference for /U-Y/ in native German (571 Hz) and in L2 German (349 Hz) and dividing it by the /U-I/ difference in German (1335 Hz) and L2 German (746 Hz) respectively, we arrive with a relative percentage position for native German /Y/ of 43%, and for L2 German /Y/ of 47% on the difference between /U-I/. This means that the relative position of L2 /Y/ on the F2 /U-I/ difference is exactly as that in native German. This implies that the difficulties in pronouncing the /U/-/Y/ contrast which L2 learners may encounter are related to the high position of L2 /U/ along the F2 dimension rather than to a lack of precision in production of L2 /Y/.

3. CONCLUSION

Beginning L2 learners utilize their established native language base of articulation for production of vowel categories in L2. The results of the present study shed more light on how the base-of-articulation effect applies to phonemically equivalent and novel segments which are constructed in the developing L2 vowel system. The beginning L2 learners transfer the relational articulatory-acoustic distances among the equivalent vowels in L1 which act as general reference frames for location of L2 categories. Novel segments, as observed in the case of the German /Y/ produced by native speakers of American English, do not show evidence of articulatory assimilation to any vowel in L1. To the extent the present data allow us to generalize, novel segments are created without clear reference to the native language.

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