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Nonconvergence and divergence in bilingual phonological and phonetic systems: Low back vowels in Moundridge Schweitzer German and English

Abstract

This study explores the bilingual phonology of two heritage speakers of Moundridge Schweitzer German (MSG) from Moundridge, Kansas. The speakers are descendants of Mennonite speakers of German who settled in the area around Moundridge, Kansas, in the 1870s. The production of Moundridge Schweitzer German /a/ and /ɔ/ and American English /a/ and /ɔ/ were compared and no evidence of phonological or phonetic convergence was found. For one speaker, there was evidence that phonetic realizations of /a/ and /ɔ/ in the two languages were diverging with a merger or a near merger of the two vowels in the heritage variety of German but not in English.

Keywords

bilingual phonology – heritage language – German – convergence

1 Introduction

Moundridge Schweitzer German (MSG) is a moribund heritage variety of German spoken in Moundridge, Kansas. Rothman (2009: 156) defines a heritage language as “a language spoken at home or otherwise readily available to young children, and crucially this language is not a dominant language of the larger (national) society.” The current speakers of MSG are all English-dominant bilinguals whose first language is the local variety of German spoken in Moundridge, Kansas, since the time of settlement by German immigrants in the 1870s. Although heritage grammars in general have been the focus of much recent scholarship, including work on the grammar of MSG (e.g., Putnam, 2012), the phonology of heritage languages remains understudied (Montrul, 2010). Early theories of bilingual phonology predicted that convergence with the dominant language was more likely to occur at the phonetic level, whereas maintenance of phonological contrasts was expected even in cases of language attrition (Weinreich, 1963; Andersen, 1982). In one of the few studies of the phonology of a moribund heritage language, Bullock and Gerfen (2004) found that the phonological merger of the two mid front rounded vowels /ø/ and /œ/ in Frenchville French was accompanied by phonetic convergence with the rhotacized schwa of American English. Phonetic convergence has also been found between a heritage variety of Armenian and American English. Godson (2004) found that heritage speakers of Western Armenian living in the United States were approximating American English realizations of /i/ and /ɛ/ when producing the corresponding vowels in Western Armenian.

There is also evidence that languages in situations of intense language contact can undergo sound changes that are independent of the phonology of the majority language. For example, the monophthongization of /ai/ to /a/ in Midwestern Pennsylvania German (PG) is not due to contact with English, even though monophthongization is attested in the variety of English found where some of the speakers live, because (1) the conditioning of the change is different in Midwestern PG and (2) the PG speakers do not monophthongize /ai/ when speaking English (Keiser, 2001). Unlike Frenchville French, Midwestern Pennsylvania German is robustly maintained, and its speakers may be described as balanced bilinguals (Keiser, 2001).

In this paper we explore the low-back vowel contrast between /a/ and /ɔ/ in Moundridge Schweitzer German and the local variety of English. Bullock and Gerfen (2004: 103) suggest that “bilingual phonologies may become particularly permeable where they are acoustically and perceptually unstable and where they are already congruent to some degree.” MSG and American English are both West Germanic languages and have largely congruent phonologies due to their genetic relationship. Thus, varieties of English and German are often analyzed as having phonologically long and short vowels as well as a number of diphthongs. In both German and English, long vowels are typically more peripheral in the vowel space, longer in duration, and under different phonotactic constraints than their short counterparts (see, e.g., McCully, 2009; Wiese, 2000).

Historical and dialectal evidence suggests that the distinction between /a/ and /ɔ/ has long been acoustically and perceptually unstable in German and English. The merger of /a/ and /ɔ/ is reported in several German dialects and is characteristic of Bavarian (Schirmunski, 1962: 240). In American English, the merger of /a/, as in *cot*, and /ɔ/, as in *caught*, is common and spreading (see, e.g., Labov et al., 2005; Majors, 2005). Historically, it was found throughout the western United States (Metcalf, 1972; Labov et al., 2005) as well as in western Pennsylvania and eastern New England (Kurath & McDavid, 1961; Herold, 1990; Eberhardt, 2008). Closer to Moundridge, Lusk (1976) reports that the low-back merger is characteristic of speakers from Kansas City born after 1956. Labov, Ash and Boberg (2005) find occurrences of low-back merger in the area around Wichita, Kansas, which is approximately 42 miles south of Moundridge. Presumably, the re-occurring merger of these vowels in different dialects of Germanic languages is due to their acoustic and perceptual similarity (see, e.g., Ohala, 1981 and 1993). Rein (1977) reports that /a/ and /ɔ/ remain distinct in Freeman, SD, the location of Moundridge’s sister settlement of German-speaking Mennonites who immigrated from the same location in Europe as the ancestors of the subjects of this study.

Examinations of /a/ and /ɔ/ in varieties of German and American English typically focus on measurements of the first two formants at the mid-point of the vowel (see, e.g., Labov et al., 2005; Pätzold & Simpson, 1997). In both American English and German, when /a/ and /ɔ/ have not merged spectrally, /a/ has higher values for both F1 and F2 because it is lower and further forward in the vowel space (see Hillenbrand et al., 1995; Pätzold & Simpson 1997).

Although duration is usually not considered in studies of low back merger in American English, Fridland, Kendall and Farrington (2014) find that duration can play a contrastive role in distinguishing realizations of /a/ and /ɔ/ in dialects of American English where other cues, such as F1 and F2, are not fully disambiguating. They state: “[I]t appears from these data that in American English, regardless of region, a durational distinction maintains the contrast between the low back vowel classes during spectral merger. Speakers with greater spectral differentiation of /ɑ/ [transcribed in this study as /a/] and /ɔ/ show smaller durational distinctions between the two vowels than speakers showing merger” (Fridland et al., 2014: 345).

In contrast, /a/ and /ɔ/ are both phonologically short, lax vowels in German varieties and duration plays an important role in contrasting them with their long counterparts. In a study of vowel duration in German, Strube and Antoniadis (1984: 73-74) find that /a/ has an average duration of 78.2 milliseconds and /ɔ/ has an average duration of 75.7 milliseconds, whereas /aː/ has an average duration of 183.7 milliseconds and /oː/ has an average duration of 155.0 milliseconds. The vowels /a/ and /aː/ are both classified as lax, and duration is the primary phonetic cue that distinguishes the two vowels (Wiese, 2000). Since both /a/ and /ɔ/ are lax and short in German, one would not expect duration to play a role in disambiguating the two vowels in German as it does in different varieties of American English. As is the case with American English and as found by Pätzold and Simpson (1997) in German, one would anticipate differences in F1 and F2 for realizations of /a/and /ɔ/ in MSG if the vowels have not merged.

As noted by Hopp and Putnam (2015: 182), studies of heritage grammars provide converging evidence that phonology and syntax are relatively stable, whereas heritage speakers show greater variability in the areas of inflectional morphology, semantics and the syntax-discourse interface (see, e.g., Polinsky, 2006, 2008; Montrul, 2009; Rothman, 2009). In summary, Hopp and Putnam (2015: 182) state:

> The generalization emerging from these findings is that phenomena are particularly unstable in heritage grammars (a) which never fully develop in early acquisition under reduced input conditions (i.e. incomplete acquisition) and/or (b) which regress as a byproduct of lower degrees of use of the L1 and sustained exposure to or transfer from the dominant community language (i.e. attrition).

Rather than attribute the lack of a grammatical feature in a heritage grammar as the result of either incomplete acquisition or attrition, Putnam and Sánchez (2013) argue that the change in the variability found in heritage grammars is due to the limited activation of the heritage grammar over the course of the heritage speaker's life. In the case of MSG, this has led to the loss of passive voice constructions which have been replaced by impersonal constructions (Putnam & Salmons, 2013).

Within the domain of phonology, the work of Bullock and colleagues has shown that even the phonology of heritage speakers whose grammars are severely attrited resists convergence with the phonology of the dominant language (see, e.g., Bullock & Gerfen, 2004, Bullock et al., 2006). Bullock, Dalola and Gerfen (2006: 13) state:

> The picture that is emerging is one in which the outcome of convergence between two systems appears to be remarkably conservative. That is, despite some salient English-like properties, in [Frenchville French] pronunciation, the phonology and, indeed, the phonetic system of the language remain resolutely French.

In our study, we aim to further explore the stability of the phonology and phonetic systems of heritage grammars and the interaction of the sound systems of the heritage and dominant languages among heritage speakers. In the case of /a/ and /ɔ/, convergence might be exhibited in one of two ways. First, if /a/ and /ɔ/ show spectral merger in the English of our speakers, convergence of the two sounds systems could result in the spectral merger of /a/ and /ɔ/in MSG as well. Second, if there are significant differences in the duration of /a/ and /ɔ/ in the English of our speakers, duration may be recruited as an additional phonetic cue for the maintenance of the contrast between /a/ and /ɔ/ in MSG.

2 Moundridge Schweitzer German

Moundridge Schweitzer German (MSG) is a heritage dialect of German spoken in Moundridge, Kansas. Moundridge is one of two settlements populated by Anabaptist immigrants who originated from the northwestern region of Switzerland. After leaving Switzerland in the late 1600s, the community settled in the Eastern Palatinate region of Germany, where they remained for nearly one hundred years, before moving to Russia, where they stayed another hundred years before moving to the United States in the late 1800s and forming two settlements, one in Moundridge, Kansas and one in Freeman, South Dakota (Putnam, 2012). Despite the varied geographical history of this population, MSG reflects "an Eastern Palatinate heritage. […] It shares most morpho-syntactic and phonological traits with Eastern Palatine dialects" (Putnam, 2012: 42).

There are currently approximately twenty speakers of MSG remaining in the community. The age of the speakers ranges from 62-97 years. Speakers report learning MSG as their first language in the home, and then having their first exposure to English at the age of 5 or 6 upon entering school. In order to communicate at school, with friends, and later find jobs, English became the dominant language for these speakers. Today, speakers report speaking MSG less than an hour per week, primarily at gatherings organized for the purpose of practicing and celebrating the language. However, speakers report that English is being increasingly used at these functions.

The MSG community was identified as having the potential for merger of /a/ and /ɔ/ for several reasons. First, it was noted that /a/ and /ɔ/ were highly variable and sometimes indistinguishable in previous recordings. Second, Labov et al. (2005) report that the area around Moundridge, KS, displays the low-back merger in American English. Next, in a phonetic description of Moundridge's sister settlement in South Dakota, these two vowels are reported to be distinct, and this area of South Dakota does not display the low-back merger in English (Rein, 1977). Therefore, since there is a reported merger in the English of Kansas, there is a potential that the merger would transfer to German.

3 Participants

The data set comprises two speakers, an 82-year-old female and an 86-year old man, who are married. Both of the speakers are classified as attrited heritage speakers. Neither of the speakers had received any formal instruction in German, and each speaker reported minimal or no ability to read or write in German. They report speaking MSG primarily with each other and occasionally with a handful of close friends and family. They report speaking MSG for less than an hour a week on average. The speakers also self-rated their ability in MSG in the areas of speaking and listening comprehension on a scale of 1-10. Since MSG is not written, speakers were not asked about their reading or writing ability in MSG. The results of the self-ratings are presented in Table 1.

[Insert Table 1 here]

4 Materials and procedure

Interviews were conducted with the participants. The interviews included a narration task using the picture book "Frog, Where Are You?" (Mayer, 1969) in both MSG and English, a linguistic background questionnaire conducted in English, and free discussion in English and German. The elicited data used in this study were entirely unscripted.

The interviews were recorded using a Marantz Recorder (Model PMD660 44,000Hz). Words containing the vowels under investigation were identified during transcription in eLAN, then extracted from these recordings and exported to the acoustic analysis software PRAAT. Using PRAAT, duration, F1, F2 and F3 were measured.

The formants for both speakers were then normalized with the procedure employed by Guion (2003), O'Rourke (2010) and Lipski (2015). This technique uses comparisons based on the F3 value for the vowel /a/. F3 values indicate vocal tract length, which is the primary factor responsible for differences in formants between men and women. The subjects primarily speak MSG with each other and occasionally with mutual friends. They have each lived their entire lives in Moundridge, and there is no indication of substantial sociophonetic variation that would require a different normalization procedure (Lipski, 2015). Participant 102, who provided the most tokens and was generally considered to be the more fluent speaker, was taken as the baseline for the formant normalization. Only tonic vowels were measured, and all tokens shorter than 50ms in duration were removed from the data set. The tokens were categorized by following phonological environment. Labov and colleagues found that /a/ often shifted to /ɔ/ before nasals and voiceless fricatives (Labov et al., 2005: 56-57). We classified the phonological environment by the phoneme immediately following the relevant vowel (cf. Hall-Lew, 2010). Due to open syllable lengthening in the history of German and the synchronic process of final fortition in MSG, the short vowels /a/ and /ɔ/ are only found in closed syllables and before voiceless obstruents, nasals, laterals, and rhotics in MSG. Any tonic vowel followed by an /r/ were eliminated from the data. We then compared duration and normalized values for F1, F2, and F3 in production by speakers in English and in German. We also used the measurements of F1 and F2 to plot all realizations of /a/ and /ɔ/ in both MSG and American English and to measure the degree of spectral overlap of the two vowels in each language. All statistical analyses were conducted in SPSS 22.

5 Results

Figure 1 shows the normalized formant values of F1 and F2 for all productions of /a/ and /ɔ/ in MSG by speaker 102. As shown in Figure 1, there is a great deal of overlap in the normalized F1 and F2 values of MSG /a/ and /ɔ/ for this speaker.

[Insert Figure 1 here]

For the same speaker, Figure 2 displays the normalized values of F1 and F2 for /a/ and /ɔ/ in American English. The formant plots of the two vowels in American English in Figure 1 show very little spectral overlap in comparison to the productions of /a/ and /ɔ/ in MSG by speaker 102.

[Insert Figure 2 here]

In order to statistically measure the spectral overlap of F1 and F2, we performed a multivariate analysis of variance (MANOVA) to generate a Pillai score using F1 and F2 as the dependent variables and vowel and phonological environment as the independent variables. The results are in Table 2. Pillai scores always range from 0 to 1. A score of 1 indicates no similarity between the two clusters, whereas a score of 0 indicates no difference between the two clusters (Nycz and Hall-Lew, 2013). The MANOVA also provides the advantage of controlling for phonological environment as a variable. In our study, phonological environment is defined maximally conservatively as the phoneme immediately following the vowel being measured. In addition to the Pillai score, the MANOVA generates a p-value for the Pillai score that indicates whether the difference between the two vowel clusters is significant (Hall-Lew, 2010; Nycz and Hall-Lew, 2013). The use of the Pillai score is well-suited for the estimating the amount of spectral overlap in unscripted data because of the ability to control for phonological environment. The Pillai score also permits the researcher to directly compare the degree of spectral overlap across different speakers and, in the case of the bilingual speaker, by the same speaker across two languages (see Fridland et al., 2014; Nycz and Hall-Lew, 2013).

[Insert Table 2 here]

As shown in Table 2, the Pillai score for MSG /a/ and /ɔ/ is .136, indicating a large degree of spectral overlap for speaker 102. However, the difference in the distribution of F1/F2 values for the two vowels is significant. There is less spectral overlap between /a/ and /ɔ/ in American English (AE) for speaker 102, as indicated by a Pillai score of .594 for AE /a/ and / ɔ/. The difference between the two vowel clusters in AE is also significant.

Tables 3 and 4 provide an overview of the mean values of F1, F2 and F3 and duration for /a/ and /ɔ/ in MSG and AE for speaker 102. As would be expected, the mean values of F1 and F2 in MSG /a/ are higher than the corresponding mean values in MSG /ɔ/. This indicates that MSG /a/ is more forward and lower in the vowel space and MSG /ɔ/. The mean duration of /a/ is also approximately 12 ms shorter than the mean duration of MSG /c/.

[Insert Table 3 here]

[Insert Table 4 here]

The mean values of F1 and F2 for AE/a/ are also higher than the corresponding values for AE /c/ for speaker 102. This indicates that AE /a/ is lower and further forward in the vowel space than AE /ɔ/, as is also the case for MSG /a/ and /ɔ/. The difference of approximately 236 Hz between mean values of F2 in AE /a/ and /c/ is much greater than the difference of approximately 92 Hz between mean of F2 for MSG /a/ and /ɔ/. The Euclidean distance between /a/ and /ɔ/ as measured by the mean values of F1 and F2 is 106.8 Hz in MSG and 345.6 Hz in AE for speaker 102.

The results of the MANOVA tests and the associated Pillai scores presented in Table 2 indicate that F1 and F2 taken together are significantly different for /a/ and /ɔ/ in both MSG and AE for speaker 102. However, the MANOVA does not indicate whether the differences are significant for both formants or just one. It is also possible that differences in F3 and duration may be significant between MSG /a/ and /ɔ/ or between AE /a/ and /ɔ/. In order to determine whether the differences in F1, F2, F3 and duration are statistically significant in MSG and in AE for speaker 102, a separate Wilcoxon rank-sum test was run in SPSS for each of the four variables with each Wilcoxon rank-sum test evaluated at an alpha level of .0125. The median values of F1, F2, F3 and duration together with the results of the Wilcoxon test is reported in Tables 5 and 6.

[Insert Table 5 here]

[Insert Table 6 here]

For speaker 102, the Wilcoxon rank-sum test indicates that the differences in F1 and F2 for MSG /a/ and /ɔ/ are significant, whereas the differences in F3 and duration between MSG /a/ and /ɔ/ approach significance. The differences in F1, F2 and duration between AE /a/ and /ɔ/ are all significant for speaker 102, whereas the difference in F3 between the two vowels in AE is not.

Figures 3 and 4 display plots of F1 and F2 for /a/ and /ɔ/ in MSG and AE for speaker 104. Figure 3 shows a large degree of spectral overlap between the two vowels in MSG. In comparison, Figure 4 indicates less spectral overlap between /a/ and /ɔ/ in AE.

[Insert Figure 3 here]

[Insert Figure 4 here]

In order to compare the spectral overlap between /a/ and /ɔ/ in MSG and AE for speaker 104, we performed a MANOVA to generate a Pillai score using F1 and F2 as the dependent variables and vowel and phonological environment as the independent variables. Phonological environment was defined maximally conservatively as the phoneme immediately following the relevant vowel. The results are shown in Table 7.

[Insert Table 7 here]

The Pillai score of .047 in MSG indicates a high degree of spectral overlap between /a/ and /ɔ/ for speaker 104. The difference in distribution is insignificant, p=.199. In comparison to MSG /a/ and /ɔ/, AE /a/ and /ɔ/ show less spectral overlap for speaker 104 with a Pillai score of .317. The difference in distribution between AE /a/ and /ɔ/ is significant, p=.001.

A summary of the mean values of F1, F2, F3 and duration of /a/ and /ɔ/ in MSG and AE is given in Tables 8 and 9. The mean value of F1 is higher for MSG /a/ than MSG /ɔ/, indicating that /a/ is lower in the vowel space than /ɔ/ as expected. Surprisingly, the mean F2 of /ɔ/ is slightly higher than the mean F2 of MSG /a/, indicating very little difference in tongue advancement between the two vowels. The difference between the mean values of F3 for MSG /a/ and /ɔ/ is only 18.5 Hz and the difference in mean duration for MSG /a/ and /ɔ/ is a mere 1.1 ms. The Euclidean distance between /a/ and /ɔ/ as measured by the mean values of F1 and F2 is 48.9 Hz in MSG and 249.3 Hz in AE for speaker 104.

[Insert Table 8 here]

[Insert Table 9 here]

Table 9 also contains a surprise as AE /ɔ/ has a higher mean value for F1 than AE /a/ for speaker 104, indicating that AE /ɔ/ is lower than AE /a/in the vowel space. As expected, AE /ɔ/ has a lower mean F2, indicating that AE /ɔ/is further back than AE /a/ for speaker 104. As is typical in AE, /ɔ/ also has a longer mean duration than AE /a/ for speaker 104.

For speaker 104, the MANOVA results indicate that F1 and F2 taken together are not significantly different for MSG /a/ and /ɔ/. However, the MANOVA does not indicate whether differences in F3 or duration might be significant for the two vowels. Therefore, a separate Wilcoxon rank-sum test was run in SPSS on the differences in medians for F3 and duration between MSG /a/ and/ ɔ/ for speaker 104 and evaluated at an alpha level of .025. The median values of F3 and duration for MSG /a/ and /ɔ/ and the results of the Wilcoxon rank-sum test are displayed in Table 10.

[Insert Table 10 here]

As seen in Table 10, a Wilcoxon rank-sum test revealed no significant difference in F3 or in duration between MSG /a/ and /ɔ/ for speaker 104. Taken together, the results of the MANOVA shown in Table 7 and the Wilcoxon rank-sum test in Table 10 indicate that speaker 104 does not distinguish MSG /a/ and /ɔ/ along F1, F2, F3 or duration. It therefore appears that MSG /a/ and /ɔ/ may be merged or nearly merged for speaker 104.

In contrast to MSG /a/ and /ɔ/, the MANOVA results for AE /a/ and /ɔ/ for speaker 104 are significant. However, they do not reveal whether speaker 104 distinguishes the vowels along both F1 and F2 or along just one of the formants. In addition to F1 and F2, it is also possible that there are significant differences in F3 or duration between the two vowels. Therefore, differences between the medians of F1, F2, F3 and duration of AE /a/ and /ɔ/ were assessed with a Wilcoxon rank-sum test and evaluated at an alpha level of .0125. The median values of F1, F2, F3 and duration of AE /a/ and /ɔ/ for speaker 104 together with the results of the Wilcoxon test are reported in Table 11.

[Insert Table 11 here]

As shown in Table 11, there is a significant difference in F2 for speaker 104 with AE /a/ having a median value of 1306.5 Hz versus a median F2 value of 1062 Hz for AE /ɔ/, p=.000. The difference in duration between AE /a/ and /ɔ/ is near significance, p=.039. The differences in F1 and F3 between AE /a/ and / ɔ/ are not significant for speaker 104. It therefore appears there is only a significant effect of vowel for F2. In sum, speaker 104 distinguishes between AE /a/ and /ɔ/ along F2, whereas the same speaker merges or nearly mergers MSG /a/ and /ɔ/ with no significant difference in any of the four parameters examined in this study.

6 Discussion

There is common ground in the results of speakers 102 and 104. First, both had lower Pillai scores for MSG /a/ and /ɔ/ than for AE /a/ and /ɔ/, indicating greater spectral overlap along the dimensions of F1 and F2 for the two vowels in MSG than in AE. In addition, the Euclidean distance between the two vowels as measured by the mean and median values of F1 and F2 is less in MSG than in AE. For both speakers there was also a significant difference in F2 between AE /a/ and /ɔ/. As pointed out by a reviewer, the robust contrast between AE /a/ and /ɔ/ for both speakers may be attributable to their age. Lusk (1976) reports that the low-back merger in Kansas City is characteristic of speakers born after 1956. Both speakers in our study were born before 1935 and have spent their entire lives in a rural area.

With regard to the results for MSG /a/ and /ɔ/, it must be noted that measurements of vowel duration and of F1, F2 and F3 at the midpoint of a vowel do not capture all the ways in which vowels may be contrastive. Differences in vowel trajectories or voice quality may also play an important role in distinguishing vowels (see, e.g., Di Paolo and Faber, 1990; Di Paolo 1992; Majors, 2005; Gordon, 2013). In addition, we have not presented any data on MSG speakers' ability to perceive a difference between MSG /a/ and /ɔ/. Our participants were elderly and hard of hearing. Therefore, the collection of perception data was not practical, and we do not know whether or not the speakers in the study are able to perceive a difference between phonetic realizations of MSG /a/ and /ɔ/.

A closer examination of speaker 102's data reveals similarities in the implementation of the contrast between /a/ and /ɔ/ across AE and MSG but also a lack of convergence. Thus, there are significant differences between the medians of F1 and F2 for /a/ and /ɔ/ in both languages as measured by the Wilcoxon rank-sum test. Such a difference is to be expected in each language (e.g., Hillenbrand et al, 1997; Pätzold & Simpson, 1997). However, a MANOVA using F1 and F2 as dependent variables generates a Pillai score of .136 for MSG versus a Pillai score of .594 for AE. Although the difference in the clustering of the two vowels is significant in both cases, there is clearly much more spectral overlap between /a/ and /ɔ/ in MSG than in AE. Consistent with the greater degree of spectral overlap in MSG, the Euclidean distance between /a/ and /ɔ/ as measured by mean values of F1 and F2 is much less in MSG than in AE. Thus, the Euclidean distance between the two vowels is 106.8 Hz in MSG and 345.6 Hz in AE for speaker 102.

In addition, the difference in median duration between /a/ and /ɔ/ is significant in AE but not in MSG for speaker 102, although the difference does approach significance in MSG. In this regard, we also note that the difference in median duration between the two vowels is 49.5 ms in AE and only 16 ms in MSG. On the other hand, differences in F3 are not significant in AE but approach significance in MSG. In terms of spectral overlap, Euclidean distance and difference in duration, the contrast between /a/ and /ɔ/ is more robust in AE than in MSG for speaker 102. The only variable where there was greater contrast between the two vowels in MSG than in AE is F3, and in that case the difference in median values of F3 in MSG did not reach statistical significance in a Wilcoxon rank-sum test.

The results for speaker 104 are more dramatic and provide evidence of divergence between the two languages. The Pillai score of .047 shows a great degree of spectral overlap between MSG /a/ and /ɔ/ for speaker 104 with no significant difference when F1 and F2 are taken together (*p*=.199). In contrast, the Pillai score of .317 (*p*=.001) shows much less spectral overlap between AE /a/ and /ɔ/and a significant difference in the distribution of the two vowels (*p*=.001). Moreover, the Euclidean distance between the two vowels as measured by mean values of F1 and F2 was only 48.9 Hz in MSG versus 249.3 Hz in AE. Wilcoxon rank-sum tests reveals no significant differences in the median values of F3 and duration between MSG /a/ and /ɔ/. We note that the difference in median duration between MSG /a/ and /ɔ/ was only 4 ms with /a/ actually having a longer median duration. By contrast, the median duration of AE /ɔ/ was 37.5 ms longer than the median duration of AE /a/ for speaker 104, though a Wilcoxon rank-sum test revealed that the difference only approached significance (*p*=.039). In short, rather than converging, the sound systems of MSG and AE appear to be diverging in the phonetic realizations of /a/ and /ɔ/ in speaker 104's speech.

The lack of any significant differences between MSG /a/ and /ɔ/ as measured by F1, F2, F3 and duration indicates a possible vowel merger or a near merger for speaker 104. Given that AE /a/ and /ɔ/ are clearly contrastive for speaker 104, contact with English is not responsible for the apparent low-back merger in MSG. As one reviewer pointed out, it would be interesting to investigate variation of the two vowels in other Palatine dialects of German to see if there are parallel developments in closely related dialects. In this regard, it is important to note that Rein (1977) reports a contrast between /a/ and /ɔ/ in the Palatine dialect spoken by Mennonites in Freeman, SD. The Mennonite immigrants to Freeman, SD, and Moundridge, KS, both came to the United States in the 1870s from Russia (see Rein, 1977; Putnam, 2012). However, Rein (1977) does not report any acoustic measurements for the vowels so it is not possible to compare precisely MSG /a/ and /ɔ/ with the findings in Rein's (1977) study.

Our findings also differ from those of Godson (2004), who found that heritage speakers' realizations of /i/ and /ɛ/ in Western Armenian were converging with their realizations of the corresponding vowels in American English. Western Armenian has a seven-vowel system, whereas American English and German are both noted for their crowded vowel space (see, e.g., Kewley-Port & Zheng, 1999). American English and German vowels are often split into tense (or long) and lax (or short) vowels. In both languages, /a/ is considered to be a lax vowel whereas /ɔ/ is classified as lax in German (e.g., Wiese, 2000) and as tense in American English (e.g., Labov et al., 2005; McCully, 2009). It is possible that the classification of /a/ and /ɔ/ in different vowel subsystems in American English but in the same vowel subsystem in MSG mitigates against phonetic convergence in the phonetic realizations of /a/ and /ɔ/ in AE and MSG. From this perspective, it is especially not surprising that there are significant differences in duration between /a/ and /ɔ/ in American English but not in MSG for speaker 102. The lack of convergence is also consistent with the realization of MSG /r/ as an alveolar tap and not as a bunched approximant as in the production of AE /r/ for the speakers in our study.

7 Conclusion

Phonological systems are considered to be one of the most stable components of the grammar of heritage languages and to be relatively impermeable to convergence with the speakers' dominant language. In our study of two elderly speakers of Moundridge Schweitzer German, we found no evidence of convergence of the phonetic realizations of /a/ and /ɔ/ in MSG with the phonetic realizations of the corresponding vowels in American English. For the speaker who maintained a contrast between MSG /a/ and /ɔ/, phonetic realizations of AE /ɔ/ had significantly longer durations than AE /a/, whereas there was no significant difference in duration between realizations of MSG /a/ and MSG /ɔ/. She also showed greater spectral overlap between MSG /a/ and /ɔ/ than between AE /a/ and /ɔ/. Moreover, the other speaker in the study showed divergence insofar as AE /a/ and /ɔ/ were clearly contrastive whereas MSG /a/ and /ɔ/ appeared to be merged or nearly merged with no significant differences between F1, F2, F3 or duration between the two vowels. The apparent merger of MSG /a/ and /ɔ/ for one speaker suggests that phonemic contrasts in heritage languages may not be as stable as commonly assumed and that convergence with the dominant language need not play a role in variability found in the phonetic and phonological systems of the heritage language. For the bilingual heritage speakers in this study, the sound systems of their heritage and dominant languages appear to be largely independent from one another.

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References

Andersen, Roger W. 1982. Determining the linguistic attributes of language attrition. In Richard D. Lambert and Barbara F. Freed (eds.), *The Loss of Language Skills*, 83-118. Rowley, MA: Newbury.

Bullock, Barbara E., Amanda Dalola, and Chip Gerfen. 2006. Mapping the patterns of maintenance versus merger in bilingual phonology: The preservation of [a] vs. [A] in Frenchville French. *New Perspectives on Romance Linguistics* 2: 15-30.

Bullock, Barbara E. and Chip Gerfen. 2004. Phonological convergence in a contracting language variety. *Bilingualism: Language and Cognition* 7(2): 95-104.

Di Paolo, Marianna. 1992. Hypercorrection in response to the apparent merger of (ɔ) and (a) in Utah English. *Language and Communication* 12: 267–292.

Di Paolo, Marianna, and Alice Faber. 1990. Phonation differences and the phonetic content of the tense-lax contrast in Utah English. *Language Variation and Change* 2(2): 155-204.

Eberhardt, Maeve. 2008. The low-back merger in the Steel City: African American English and Pittsburgh Speech. *American Speech* 83(3): 284-311.

Fridland, Valerie, Tyler Kendall, and Charlie Farrington. 2014. Durational and spectral differences in American English vowels: Dialect variation within and across regions. *Journal of the Acoustical Society of America* 136(1): 341-349.

Godson, Linda. 2004. Vowel production in the speech of Western Armenian heritage speakers. *Heritage Language Journal* 2: 45-70.

Gordon, Matthew J. 2013. Investigating Chain Shifts and Mergers. In J.K Chambers and Natalie Schilling (eds), *Handbook of Language Variation and Change*, 2d ed. 203-219. Chichester, UK: Wiley-Blackwell.

Guion, Susan G. 2003. The vowel systems of Quichua-Spanish bilinguals. *Phonetica* 60(2): 98-128.

Hall-Lew, Lauren. 2010. Improved representation of variance in measures of vowel merger. *Proceedings of Meetings on Acoustics* 9: 060002.

Herold, Ruth. 1990. *Mechanisms of merger: The implementation and distribution of the low back merger in Eastern Pennsylvania*. PhD dissertation, University of Pennsylvania.

Hillenbrand, James, Laura A. Getty, Michael J. Clark, and Kimberlee Wheeler. 1995. Acoustic characteristics of American English vowels. *The Journal of the Acoustical society of America* 97.5: 3099-3111.

Hopp, Holger and Michael T. Putnam. 2015. Syntactic restructuring in heritage grammars: Word order variation in Moundridge Schweitzer German. *Linguistic Approaches to Bilingualism* 5(2): 180-214.

Keiser, Steven Hartman. 2001. *Language Change across Speech Islands: The Emergence of a Midwestern Dialect of Pennsylvania German.* PhD dissertation, The Ohio State University.

Kewley-Port, Diane, and Yijian Zheng. 1999. Vowel formant discrimination: Towards more ordinary listening conditions. *Journal of the Acoustical Society of America* 106:2945-2958.

Kurath, Hans and Raven I. McDavid, Jr. 1961. *The Pronunciation of English in the Atlantic States: Based upon the Collections of the Linguistic Atlas of the Eastern United States*. Ann Arbor: Univ. of Michigan Press.

Labov, William, Sharon Ash and Charles Boberg. 2005. *The Atlas of North American English: Phonology, Phonology and Sound Change*. Berlin: Mouton de Gruyter.

Lipski, John. 2015. Colliding vowel systems in Andean Spanish: Carryovers and emergent properties. *Linguistic Approaches to Bilingualism* 5(1): 89-119.

Lusk, Melanie. 1976. *Phonological Variation in Kansas City: A Sociolinguistic Analysis of Three-Generation Families*. Ph.D. dissertation, University of Kansas.

Mayer, Mercer. 1969. *Frog where are you*. New York: Dial Press.

Majors, Tivoli. 2005. Low Back Vowel Merger in Missouri speech: Acoustic description and explanation. *American Speech* 80:165-179.

McCully, Chris. 2009. *The Sound Structure of English: An Introduction.* Cambridge & New York: Cambridge University Press.

Metcalf, Allan. 1972. Directions of Change in Southern California English. *Journal of English Linguistics* 6: 28–34.

Montrul, Silvina. 2009. Incomplete acquisition of tense-aspect and mood in Spanish heritage speakers. *The International Journal of Bilingualism* 13: 239–269.

Montrul, Silvina. 2010. Current Issues in Heritage Language Acquisition. *Annual Review of Applied Linguistics* 30: 3–23.

Nycz, Jennifer, and Lauren Hall-Lew. 2013. Best practices in measuring vowel merger." *The Journal of the Acoustical Society of America* 134.5: 4198-4198.

Ohala, John J. 1981. The listener as a source of sound change. *Chicago Linguistic Society* 17: 178-203.

Ohala, John J. 1993. The phonetics of sound change. In Charles Jones (ed.), *Historical Linguistics: Problems and Perspectives,* 237-278. New York & London: Longman.

O'Rourke, Erin. 2010. Dialect differences and the bilingual vowel space in Peruvian Spanish. In Maria Ortega-Llebaria (ed.), *Selected Proceedings of the 4th Conference on Laboratory Approaches to Spanish Phonology*, 20–30. Somerville, MA: Cascadilla Proceddings Project. www.lingref.com,document#2363.

Pätzold, Matthias, and Adrian P. Simpson. 1997. Acoustic analysis of German vowels in the Kiel Corpus of Read Speech. *Arbeitsberichte des Instituts für Phonetik und digitale Spachverarbeitung Universität Kiel* 32: 215-247.

Polinsky, Maria. 2006. Incomplete acquisition: American Russian. *Journal of Slavic Linguistics* 14, 191–262.

Polinsky, M. 2008. Heritage language narratives. In D. Brinton, O. Kagan, & S. Bauckus (eds.), *Heritage Language Education. A New Field Emerging*, 149–164). New York: Routledge.

Putnam, Michael T. 2012. Dative case maintenance in Moundridge Schweitzer German via restructuring. *Zeitschrift für Dialektologie und Linguistik* 79(1): 43-64.

Putnam, Michael T. and Joseph C. Salmons, J. 2013. Losing their (passive) voice: Syntactic neutralization in heritage German. *Linguistic Approaches to Bilingualism* 3: 233–252.

Putnam, Michael T., and Liliana Sánchez. 2013. What's so incomplete about incomplete acquisition?: A prolegomenon to modeling heritage language grammars. *Linguistic Approaches to Bilingualism* 3: 478–508.

Rein, Kurt. 1977. *Religiöse Minderheiten als Sprachgemeinschaftsmodelle: Deutsche Sprachinseln täufersichen Ursprungs in den Vereinigten Staaten von Amerika*. Stuttgart: Franz Steiner Verlag.

Rothman, Jason. 2009. Understanding the natural and outcomes of early bilingualism: Romance languages as heritage languages. *International Journal of Bilingualism* 13: 155–163.

Schirmunski, Viktor M. 1962. *Deutsche Mundartkunde. Vergleichende Laut- und Formenlehre der deutschen Mundarten.* Berlin: Akademie der Wissenschaften.

Strube, Hans Werner, and Zissis Antoniadis. 1984. Untersuchungen zur spezifischen Dauer deutscher Vokale. *Phonetica* 41(2): 72-87.

Weinreich, Uriel. 1963. *Languages in contact: Findings and problems*. The Hague: Mouton.

Wiese, Richard. 2000. *The phonology of German.* Oxford & New York: Oxford University Press.

Tables:

Speaker	Age	Gender	Hours/week	Listening	Speaking
102	82	Female	< 1	10.0	8.0
104	86	Male	< 1	9.5	8.5

Table 1: Self-ratings of the five speakers in the study. Self-ratings of listening and speaking ability in MSG are on a scale of 1-10 with 1 being low and 10 being high.

MSG	Pillai = .136	F(2, 67) = 5.28	*p*=.007*
AE	Pillai = .594	F(2, 31) = 22.72	*p*=.000*

Table 2: Comparison of spectral overlap between /a/ and /ɔ/ in MSG and AE for speaker 102.

MSG - 102	a (n=45)	ɔ (n=38)
F1-mean	664.8, sd = 83.1	610.7, sd = 62.8
F2-mean	1403.0, sd = 176.4	1310.9, sd = 157.0
F3-mean	2734.5, sd = 181.6	2651.7, sd = 177.8
Duration-mean	85.3, sd = 25.6	97.4, sd = 24.4

Table 3: Mean formant and duration values of MSG /a/ and /ɔ/ for Speaker 102

AE - 102	a (n=11)	ɔ (n=32)
F1-mean	687.6, sd = 59.7	608.4, sd = 52.6
F2-mean	1413.5, sd = 172.4	1077.1, sd = 109.6.4
F3-mean	2601.0, sd = 142.0	2593.2.4, sd = 249.4
Duration-mean	112.3, sd = 30.1	161.7, sd = 43.2

Table 4: Mean formant and duration values of AE /a/ and /ɔ/ for Speaker 102

MSG - 102	a (n=45)	ɔ (n=38)	Wilcoxon result
F1-median	665	624	W = 1278, *p*=.004*
F2-median	1423	1312	W = 1312.5, *p*=.010*
F3-median	2728	2662	W = 1365, *p*=.035
Duration-median	79	95	W = 1620.5, *p*=.014

Table 5: Median values of MSG /a/ and /ɔ/ for speaker 102 and Wilcoxon results

AE - 102	a (n=11)	ɔ (n=32)	Wilcoxon result
F1-median	700	617	W = 589.5, *p*=.001*
F2-median	1398	1117	W = 542.0, *p*=.000*
F3-median	2586	2596	W = 700, *p*=.911
Duration-median	106	155.5	W = 118.5, *p*=.001*

Table 6: Median values of AE /a/ and /ɔ/ for speaker 102 and Wilcoxon results

MSG	Pillai = .047	F(2,67) = 1.66	*p*=.199
AE	Pillai = .317	F (2,39) = 9.07	*p*=.001

Table 7 = Comparison of spectral overlap between /a/ and /ɔ/ in MSG and AE for speaker 104.

MSG - 104	a (n=39)	ɔ (n=41)
F1-mean	666.9, sd = 47.5	619.6, sd = 29.5
F2-mean	1272.0, sd = 130.2	1284.6, sd = 155.6
F3-mean	2646.2, sd = 225.6	2684.7, sd = 307.0
Duration-mean	97.1, sd = 24.4	96.0, sd = 23.5

Table 8: Mean formant and duration values of MSG /a/ and /ɔ/ for Speaker 104

AE - 104	a (n=16)	ɔ (n=33)
F1-mean	595.6, sd = 81.9	623.5, sd = 51.9
F2-mean	1328.9, sd = 186.5	1081.2, sd = 153.9
F3-mean	2637.1, sd = 252.0	2646.5, sd = 255.3
Duration-mean	112.1, sd = 34.0	135.1, sd = 35.7

Table 9: Mean formant and duration values of AE /a/ and /ɔ/ for Speaker 104

MSG - 104	a (n=39)	ɔ (n=41)	Wilcoxon result
F3-median	2580	2612	W = 1512.5, *p*=.519
Duration-median	97	93	W = 1638, *p*=.828

Table 10: Median values of MSG /a/ and /ɔ/ for speaker 104 and Wilcoxon results

AE - 104	a (n=16)	ɔ (n=33)	Wilcoxon result
F1-median	632.5	619.0	W = 387, *p*=.782
F2-median	1306.5	1062	W = 632, *p*=.000*
F3-median	2638	2636	W = 822, *p*=.949
Duration-median	104.5	142	W = 303, *p*=.039

Table 11: Median values of AE /a/ and /ɔ/ for speaker 104 and Wilcoxon result

Figures:

Figure 1: Normalized values of /a/ and /ɔ/ in MSG for speaker 102, female

Figure 2: Normalized values of /a/ and /ɔ/ in AE for speaker 102, female

Figure 3: Normalized values of /a/ and /ɔ/ in MSG for speaker 104, male

Figure 4: Normalized values of /a/ and /ɔ/ in AE for speaker 104, male