CROSS-LINGUISTIC VOWEL VARIATION IN SATERLAND: SATERLAND FRISIAN, LOW GERMAN, AND HIGH GERMAN

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ABSTRACT

This study investigates the vowel space of trilingual speakers of Saterland Frisian, Low German, and High German. The three vowel systems show differences in the number of distinct categories but share the majority of vowel qualities. The speakers were instructed to read vowels of all three languages in a /hVt/ frame. We examine whether the dispersion and size of the vowel space as well as inter-language variability of individual vowels correlate with the number of vowel categories. Additionally, systematic cross-linguistic differences were measured regarding duration and mid-vowel F1 and F2. High German monophthongs were found to be produced with longer and more variable duration. Moreover, High German monophthongs were produced with smaller F1 and larger F2 values than the respective Saterland Frisian and Low German categories. These results suggest that the subjects may use the same base-of-articulation for Saterland Frisian and Low German but not for High German.

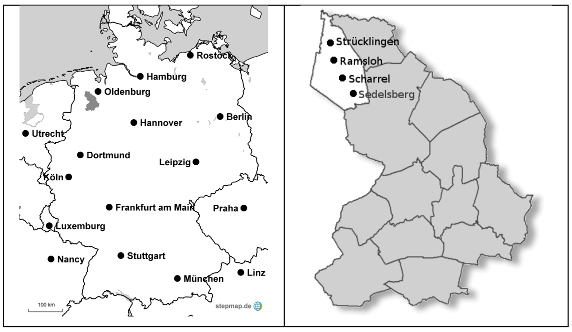
Keywords: Saterland Frisian, trilingualism, vowel space, adaptive dispersion, base-of-articulation

1. INTRODUCTION

Saterland Frisian is spoken in three small villages – Strücklingen, Ramsloh and Scharrel – in the northwestern corner of the district of Cloppenburg in Lower Saxony (see Figure 1). It is the only remaining living variety of East Frisian. Saterland is believed to have been colonized by Frisians from the coastal areas in the eleventh century. According to the most recent count, Saterland Frisian is spoken by 2250 speakers [14]. Many of these speakers are trilingual. In addition to Saterland Frisian, they speak Low German and High German.

We compared the vowel systems of the three languages as spoken in Scharrel. Table 1 shows for each language those monophthongs which were attested in closed syllables in the data we collected (see Section 2.2 below). 16, 17 and 15 monophthongs were distinguished in the respective languages.

Figure 1: Location of Saterland in the northwest of Germany (marked in gray in the map on the left) and within the district of Cloppenburg (white area in the map on the right).



According to Sjölin [13], Fort [5] and Kramer [8] Saterland Frisian has a complete set of closed short tense vowels: /i y u/. In our data set these vowels were found to be merged with the closed long tense vowels: /iː yː uː/.

Table 1: Monophthongs used in closed syllables in Saterland Frisian, Low German and High German spoken in Scharrel. Notation according to Fort [5].

Saterland Frisian			Low German			High German		
iː	yː	uː	iː	yː	uː	iː	yː	uː
eː	øː	oː	eː	øː	oː	eː	øː	oː
ɪ	ʏ	ʊ	ɪ	ʏ	ʊ	ɪ	ʏ	ʊ
ɛː	œː	ɔː	ɛː	œː	ɔː	ɛː		
ɛ	œ	ɔ	ɛ	œ	ɔ	ɛ	œ	ɔ
			aː			aː		
a			a			a		

13 diphthongs were attested for Saterland Frisian, seven for Low German and three for High German in closed syllables. The High German diphthongs /ai̯/, /au̯/ and /ɔy̯/ are shared by all three languages.

Adaptive dispersion theory [9, 11, 12] states that the distinctive sounds of a language tend to be positioned in phonetic space so as to provide sufficient perceptual contrast, and therefore to minimize the potential for perceptual confusion between the distinct categories. The contrast between vowels can be maximized by increasing the vowel space and by spreading the vowels over the whole area, i.e. by moving vowels away from the center.

We are especially interested in the effect of the inventory size on the acoustic vowel spaces of the three different languages. Jongman et al. [7] compared the German vowel space (14 monophthongs) with the Greek vowel space (five monophthongs), and found that the German vowel space was expanded compared to the Greek vowel space. Bradlow [3] compared English (11 monophthongs) with Spanish and Greek (both languages have five monophthongs). For closed-syllable words she found that the English vowel space was expanded compared to the other two languages.

Adaptive dispersion theory also states that variability of individual vowels is inversely related to the number of phonemes in the vowel inventory, i.e. vowel formant values should vary to a larger extent in smaller than in larger systems [10]. This prediction is based on the idea that since the potential for perceptual confusion is lower in less crowded vowel spaces, speakers have the freedom to vary more. However, Flege [4] was not able to confirm this prediction for English and Spanish.

Furthermore, when comparing the locations of the common vowels of English and Spanish, Bradlow [3] found that the English vowels are all significantly higher in the F2 dimension than their Spanish counterparts. According to Bradlow [3] this suggests that the English vowels are all articulated with a fronted tongue position compared to Spanish vowels. Similar results were found for bilingual speakers of Spanish and Quichua by Guion [6]. Because of the systematic difference for all of the shared vowels of the two languages, Bradlow refers to the notion of a language-specific base-of-articulation, which means that vowels belonging to the same phonological category may have different phonetic realizations across different languages. Since different shifts were found for the formants, the observed F2 difference could not be explained by differences in the vocal tract length between the two groups of speakers.

We investigated whether the number of monophthongs in Saterland Frisian, Low German, and High German correlates with vowel space, vowel dispersion, and inter-language variability of vowels. In addition, we looked for systematic differences in duration and spectral properties between the three languages. The following research questions are addressed: (1) Do the three languages' vowel systems differ in vowel space and dispersion? (2) Does the inter-language variability of individual vowels correlate with the number of vowels in the vowel systems of the three languages? (3) Are there systematic differences between the three languages in duration and in mid-vowel F1 and F2, which are relevant for a language-specific base-of-articulation effect?

2. METHOD

2.1. Speakers

The experiments were carried out with eleven trilingual male speakers, aged between 51 and 75 years. All speakers were born and raised in Scharrel and have lived in this village for all or the majority of their lives.

2.2. Procedure

We elicited all shared vowels in a /hVt/ context for each of the three languages. The vowels were obtained in three separate sessions, with interim periods of two to three months. Each session was instructed by a native speaker of the respective language to ensure the intended language mode. /hVt/ words were cued by reading aloud real rhyming monosyllabic words in the respective language immediately preceding the production of the /hVt/ target word [2]. For example, in order to obtain [eː] in Saterland Frisian, first the Saterland Frisian word *leet* 'late' was shown, together with its High German translation. The subject read [leːt]. Subsequently, the frame H_t was added below *leet* and the translation disappeared. Since *leet* is pronounced as [leːt], the subject built the rhyming target word and pronounced H_t as [heːt]. Each such sequence was presented twice, thus two /hVt/ samples were obtained per speaker and per vowel. Sequences were presented in controlled randomized order. The elicitation via rhymes and thus self-built instead of read target words was preferred over a reading task because both Saterland Frisian and Low German orthography were unknown to our speakers and the written form may have had a direct influence on the production data.

We used monosyllabic trigger words ending with [t] in the three languages. If this was not possible, an intermediate form was shown between the trigger and the target word. For example in order to obtain the Saterland Frisian [œ] from the trigger *löskje* 'extinguish', the intermediate form *lött* was added in a second step. The intermediate form then led to the production of the rhyming target word [hœt].

Both series of words obtained in two steps and three steps were preceded by practice words, so that informants became familiarized with the test.

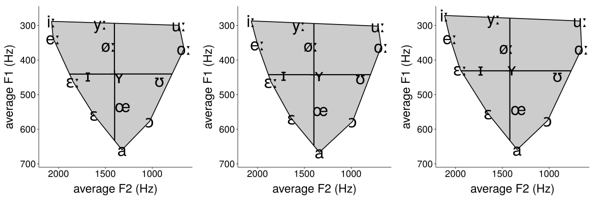
2.3. Acoustic variables

Acoustic variables were measured with PRAAT [1]. For each vowel we measured the vowel duration and mid-vowel F1 and F2 (in Hertz).[1]

3. RESULTS

All analyses were based on the 14 shared vowel categories of the three languages. Furthermore, we distinguished between monophthongs and diphthongs. Within monophthongs we further distinguished subgroups of front and back vowels as well as subgroups of closed and open vowels. The subgroups were determined relative to the gravity center of the vowels, which has average F1 and F2 as coordinates. Vowel spaces and subgroups of vowels for the three languages are shown in Figure 2.

Figure 2: Vowel spaces and subgroups of vowels averaged over the speakers.



Saterland Frisian   Low German   High German

3.1. Vowel space and dispersion

Vowel space sizes were computed on the basis of the averaged locations of the vowels in the F1/F2 plane. For each language and speaker, the subset of vowels which lie on the hull of the vowel points[2] as well as the area within the hull[3] was measured.

Two dispersion measures were considered: dispersion in F1 and dispersion in F2. Dispersion in F1 is measured as the average distance to the vowel space center in the F1 dimension. Similarly, dispersion in F2 is measured as the average distance to the vowel space center in the F2 dimension. Dispersion measures were measured for all monophthongs and for the subgroups of monophthongs. Vowel space sizes and dispersion were measured per language and per speaker. Two languages were compared to each other by comparing vowel space sizes or dispersion measures per speaker.[4]

Neither significant differences between vowel spaces nor dispersion differences in either F1 or F2 were found at the 5% level.

3.2. Inter-language variability of vowels

For each variable – duration, F1 and F2 – we measured the standard deviation of the 11 speakers per vowel and per language. For any pair of languages the standard deviations of corresponding vowels were compared.[5]

Table 2 shows that in several cases High German vowels have a higher standard deviation than Saterland Frisian and/or Low German vowels. This concerns inter-language variability of vowel duration for monophthongs as well as diphthongs. High German also shows more F1 variability than Saterland Frisian among close vowels, but less variability than Low German regarding the diphthongs. In the F2 dimension High German front vowels vary stronger than Saterland Frisian front vowels.

Significant differences between Saterland Frisian vowels and Low German vowels were found for the subgroups of front and back vowels in different directions.

Table 2: Comparison of vowel standard deviations between languages. H=High German, L=Low German, S=Saterland Frisian. Significances at the $\alpha = 0.05$ level are indicated by $>$ or $<$, meaning that the first language has respectively larger or smaller standard deviations than the second language).

	mono	front	back	close	open	diph
dur.	H>L H>S	H>L H>S L<S	H>S L>S	H>L H>S		H>S
F1				H>S		H<L
F2		H>S				

3.3. Differences in duration and language-specific base-of-articulation

Duration as well as F1 and F2 were measured per language, per speaker, and per vowel instance. Figure 3 shows the mean data distributions for vowel duration of monophthongs and diphthongs of the three languages. Figure 4 illustrates the location of Saterland Frisian, Low German and High German vowels in the F1/F2 plane. Especially for the vowels /iː/, /yː/, /ɪ/, /ʏ/ and /ɛː/, High German vowels are more closed and more fronted than Saterland Frisian and Low German vowels.

A linear mixed model was used for each acoustic variable and per category.[6] *Language* is a fixed factor, random intercepts are included for *speaker* and *vowel*. *Language* is a random slope of *vowel*[7] only when this improves the model.[8] Results are shown

Figure 3: Mean data distributions for vowel duration of monophthongs (left panel) and diphthongs (right panel) of High German, Low German and Saterland Frisian

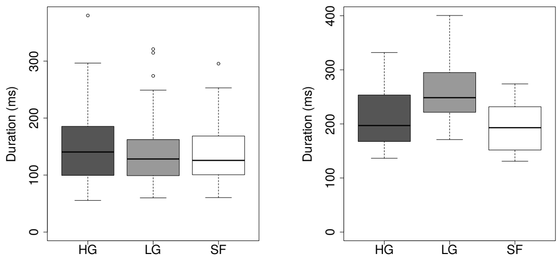
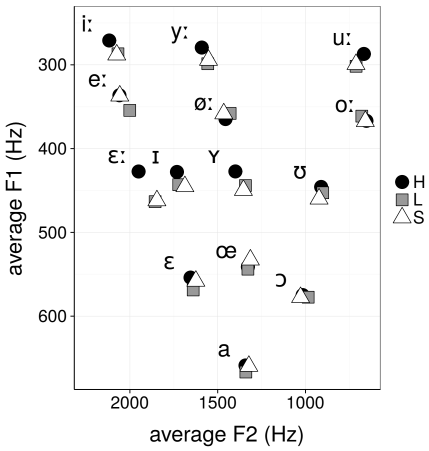


Figure 4: Location of Saterland Frisian, Low German and High German vowels in the F1/F2 plane.



in Table 3. For the complete set of monophthongs we found a larger duration for High German compared to Low German and Saterland Frisian. For diphthongs we found that Low German monophthongs have a larger duration than High German and Saterland Frisian monophthongs.

As for the spectral features, High German had a smaller F1 and a larger F2 than Saterland Frisian and Low German when the whole set of monophthongs was considered.

Table 3: Comparison of means between languages.

	mono	front	back	close	open	diph
dur.	H>L H>S	H>L H>S		H>L H>S	H<L	H<L L>S
F1	H<L H<S	H<L		H<L	H<L H<S	
F2	H>L H>S	H>L H>S			H>L H>S	

4. CONCLUSIONS

First, we asked whether the three languages' vowel systems differ in vowel space size and dispersion (question 1). We did not find differences between vowel space sizes; neither did we find dispersion differences.

Furthermore, we asked whether inter-language variability of individual vowels correlates with the number of vowels in the vowel systems of the three languages (question 2). For duration we found that monophthongs have larger standard deviations in High German than the other two languages. For diphthongs the standard deviation of High German is larger than the standard deviation of Saterland Frisian but not of Low German.

Finally, we investigated whether there are systematic differences between the three languages in duration and mid-vowel F1 and F2, the latter being relevant for language-specific bases-of-articulation (question 3). An overall effect was found for duration, F1 and F2. When considering the complete set of monophthongs, we found that High German monophthongs have longer durations than the corresponding Low German and Saterland Frisian monophthongs. Among the diphthongs, Low German showed the highest durational values. As for F1 and F2, High German monophthongs are more closed and more fronted than Saterland Frisian and Low German monophthongs.

When comparing our results to the studies of Jongman [7] and Bradlow [3] we have to keep in mind that for each language another group of speakers was considered in these studies, whereas in our study trilingual speakers served as subjects, i.e. for each language we considered the same set of speakers. Moreover, the differences in vowel inventory sizes are large (at least a difference of six vowels), while in our study the differences are rather small. In light of this, our finding that High German is distinct compared to the other two languages is even more meaningful.

The distinct position of High German may be explained by the fact that this language is commonly used as an official language in more formal situations and therefore maybe pronounced more carefully, while the other languages are rather used informally. As a national language, High German is not confined to the Saterland or the region of North-West Germany, but has a larger communication range, is subject to official regulation, and develops at a national level.

5. ACKNOWLEDGEMENTS

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[1] The vowel intervals were manually labeled. Duration and formant values were obtained with a script. For obtaining the formant values we used the Burg method with a time step of 0.001 seconds and a window length of 0.025 seconds. Default formant settings were adapted for each speaker individually in the script by de- or increasing the LPC order in steps of 1 (default order of 10) and/or the maximum frequency by 500 Hz (default 5000 Hz).

[2] We used the function `chull` in R package `grDevices`.

[3] The function `polyarea` in R package `pracma` was used.

[4] We used the robust functions `rmanova` and `wmcppb` which are developed by Rand Wilcox and which compare trimmed means by means of a percentile bootstrap test.

[5] The functions `rmanova` and `wmcppb` were used again.

[6] We used the R packages `lme4`, `lmertest` and `multcomp`.

[7] The random slope allows the relationship between *Language* and the acoustic variable to be different for each vowel group. For example, for one vowel Saterland Frisian and Low German may be similar and High German is more deviant, for another variable Saterland Frisian may be deviant and Low German and High German are similar.

[8] The quality of the model is measured with the Akaike information criterion (AIC). The lower AIC, the better the model.