Segmental and prosodic cues to vowel identification: The case of /ɪ i iː/ and /ʊ u uː/ in Saterland Frisian

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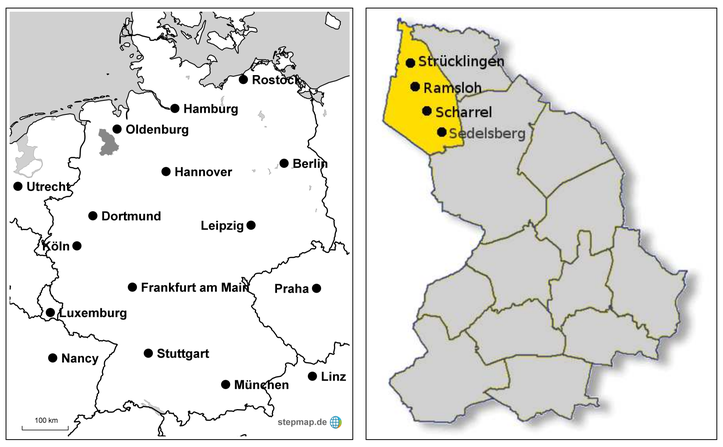
Introduction

Saterland is found in the north-west of Germany (map on the left) in the north-western corner of the district of Cloppenburg (map on right). Saterland Frisian is spoken in Strücklingen, Ramsloh and Scharrel. Saterland Frisian has a complete set of closed short tense vowels: /i y u/ (Fort 1980). Together with the short lax vowels /ɪ ʏ ʊ/ and the long tense vowels /iː yː uː/ they constitute series of phonemes that differ by length and/or tenseness.



Research question

We studied two Saterland Frisian triplets:

vowel	Sat. Fr.	English
/ɪ/	*Smitte*	'forge'
/i/	*smiete*	'to throw'
/iː/	*Smíete*	'throws' (pl.)

vowel	Sat. Fr.	English
/ʊ/	*ful*	'full'
/u/	*fuul*	'rotten'
/uː/	*fúul*	'much'

Which acoustic cues distinguish the (stressed) vowels within two triplets? We considered *normal speech* and *clear speech*.

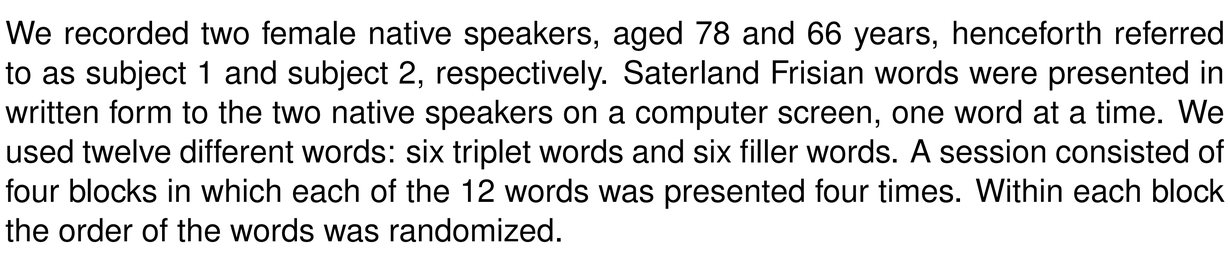
Normal speech

We recorded two female native speakers, aged 78 and 66 years, henceforth referred to as subject 1 and subject 2, respectively. Saterland Frisian words were presented in written form to the two native speakers on a computer screen, one word at a time. We used twelve different words: six triplet words and six filler words. A session consisted of four blocks in which each of the 12 words was presented four times. Within each block the order of the words was randomized.

Clear speech

Clear speech was obtained by a listener-directed task, which maximized the discrimination between words. In this experiment triplets were presented as a 'triangle'. One of the three words was encircled and pronounced by the speaker. The other subject marked the triplet word she thought she heard. Speaker and listener were separated by a screen. The speaker was told to pronounce the word so that the listener would recognize the word correctly. One session consisted of four blocks. Each of the triplet words was presented eight times per block. Within a block, 24 words of the /ʊ u uː/ triplet were presented first, followed by 24 words of the /ɪ i iː/ triplet. The subjects changed roles after each block.

Results: duration

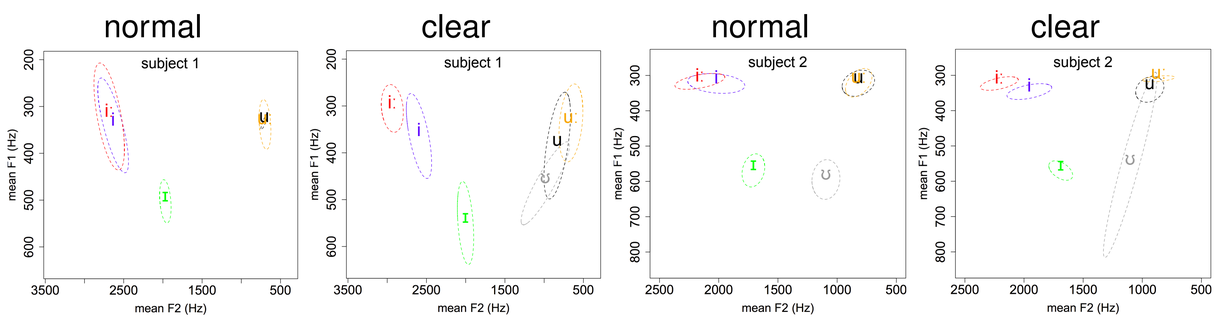


/ɪ i iː/ triplet
1=*Smitte*, 2=*smiete*, 3=*Smíete*

/ʊ u uː/ triplet
1=ful, 2=fuul, 3=fúul

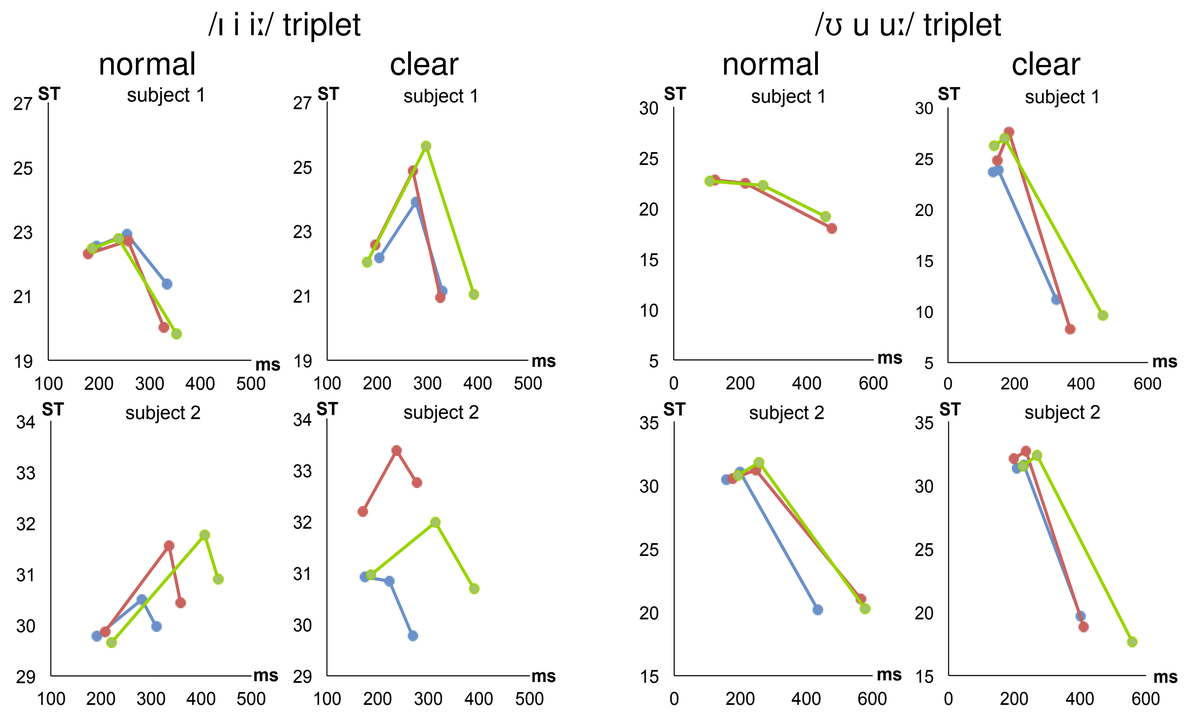
The clear speech graphs show a stronger contrast between short vowels and long tense vowels.

Results: F1 and F2

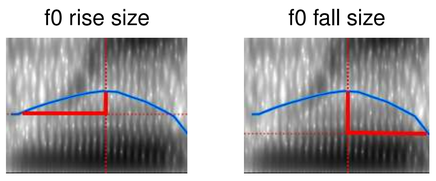


Vowel plots show the mean formant values. Ellipses enclose two standard deviations. Clear speech shows a clearer separation for the triplet sounds.

Results: f0 dynamics



Blue lines represent short lax vowels, red lines represent short tense vowels, and green lines long tense vowels. Clear speech increases f0 dynamics and especially separates the sounds of the /ɪ i iː/ triplet better.



$$f0\ dynamics = \frac{f0\ rise\ size\ (st) + f0\ fall\ size\ (st)}{duration\ sonorant\ interval\ (ms)}$$

Consensus results of subjects and triplets

For normal speech and clear speech those variables are listed which play a role for both subjects and both triplets. 1=short lax vowel, 2=short tense vowel, 3=long tense vowel. Levels of significance: *< 0.05, **< 0.01 and ***< 0.001.

speech type	pair	V dur.	F1	F2	f0 dyn.
normal	$1 \cdot 2$		***	***	
	$1 \cdot 3$	**	***	***	
	$2 \cdot 3$				
clear	$1 \cdot 2$		**		
	$1 \cdot 3$	***	***	***	
	$2 \cdot 3$	***		*	*

Conclusions

Vowel duration. Vowel duration implements the phonological feature [± long]. In normal speech short lax and long tense vowels are distinguished by vowel duration, but short and long tense vowels are not distinguished by any feature. However, in clear speech also short tense and long tense vowels are distinguished by duration, suggesting a division in short and long vowels.

F1 and F2. The feature [± tense] is implemented by spectral features. Lax vowels have a higher F1 and a lower (/ɪ i iː/ triplet) or higher (/ʊ u uː/ triplet) F2 than tense vowels, i.e. lax vowels are more centered than tense vowels. The slight additional centralization of the short tense vowels (/i/ and /u/ relative to /iː/ and /uː/ may be used to enhance the perceived durational contrast between the short and long tense vowels.

F0 dynamics. Short tense vowels were found to have larger f0 dynamics than long tense vowels and, in case of [ɪ], short lax vowels. According to Lehiste(1976) and Cumming(2011), increased f0 dynamics may enhance perceived vowel duration. As shortening of /i/ and /u/ in clear speech resulted in vowels that were hardly longer than the short lax vowels [ɪ] and [ʊ], increased f0 dynamics may increase the perceived durational difference between short lax and tense vowels, at least in the case of [ɪ] and [i]. We found that f0 dynamics have a systematic effect which contributes to the tripartite vowel contrast. The most likely interpretation of this contribution is phonetic feature enhancement.

Overall, our data suggest that the phonological contrasts between [ɪ i iː] and between [ʊ u uː] can be accounted for by the combination of two distinctive features, [± long] and [± tense]. Increased f0 dynamics of tense short vowels relative to lax short vowels, which was found for [ɪ] and [i], may be regarded as a means to make the short tense vowels sound more different from the short lax vowels.

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Literature

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