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Acoustic Characteristics of Word-Final Vowel Reduction in Skolt Saami

1. Introduction

Word-final vowel reduction plays an important role in the prosody of Skolt Saami rhythmic units. The optional phonological rule that reduces or drops second syllabic vowels has significant consequences with regard to the prosodic structure of the disyllabic stress-group.¹ The present study provides an account of the acoustic characteristics of vowel reduction by examining the durational and spectral properties of disyllabics in a large data base.

The data were obtained from two speakers of Skolt Saami. The degree of second syllabic vowel reduction differs according to the speaker's dialect. In the speech of one of the speakers (a representative of the Sevetijärvi, formerly Suonikylä, dialect) the process of vowel reduction appeared to be at a more advanced stage, in terms of both the durational and spectral properties of the reduced vowel. In fact, second syllabic vowel drop appears to be more common than the reduction of that vowel in this speaker's corpus. The word-final vowels of the second speaker (a representative of the Paatsjoki/Pettsamo dialect) manifested a lesser degree of reduction with regard to both duration and formant structure. Word-final vowel drop, although it does occur, is infrequent.

The present paper is part of a larger project aimed at identifying the acoustic characteristics of vowel reduction in Skolt Saami through examining data obtained during the course of controlled experiments as well as in connected speech. Here only the differences observed during the course of the controlled experiment will be reported on, focussing on the durational and spectral properties associated with the different degrees of vowel reduction in the two sub-dialects of Skolt Saami.

Previous research has established that unstressed vowels may move towards a more central position, frequently approaching a schwa, the neutral position of vowel articulation.² The role of duration has also been acknowledged in most studies on vowel reduction, attributing primary importance to duration as determining the degree of reduction.³

In Skolt Saami, second syllabic short vowels in the open syllable of disyllabic words are unstressed (with the exception of historically contracted vowels).⁴ Short vowels have an average duration of 87 msec.⁵ In the present study it is these unstressed vowels that undergo the reduction process or are subject to be deleted that are examined in terms of their acoustic characteristics.

2. Durational and spectral characteristics of the reduced vowels

¹ A detailed account on the effect of durational changes in the second syllable resulting from vowel reduction or vowel drop may be found in McRobbie-Utasi 1999.

² For example, Lindblom 1963, Nord 1987.

³ *Ibid.*

⁴ Historically contracted second syllabic vowels have secondary stress, see Korhonen 1971, 1975. The developments of these vowels do not undergo reduction.

⁵ McRobbie-Utasi 1999.

Recordings of the disyllabics examined were made according to required standards in a sound-proof phonetics laboratory. The recording was made with a Scully-Full-Track Broadcast Machine (tape speed: 7.5'' per second). The software used for analyzing the duration of the reduced vowels was the Signalyze program, Version 3.12. FFT spectra were examined for formant patterns (see below); the actual formant measurements were taken with the Praat software, Version 8.24. Formant frequency values were taken in the cycle when the amplitude reached its maximum displacement (the point of time is indicated in the figures below). The test words analyzed for the present study numbered 950 (461 and 489 for the Sevettijärvi and the Paatsjoki/Pettsamo speakers respectively). The test words were placed in a sentence frame.

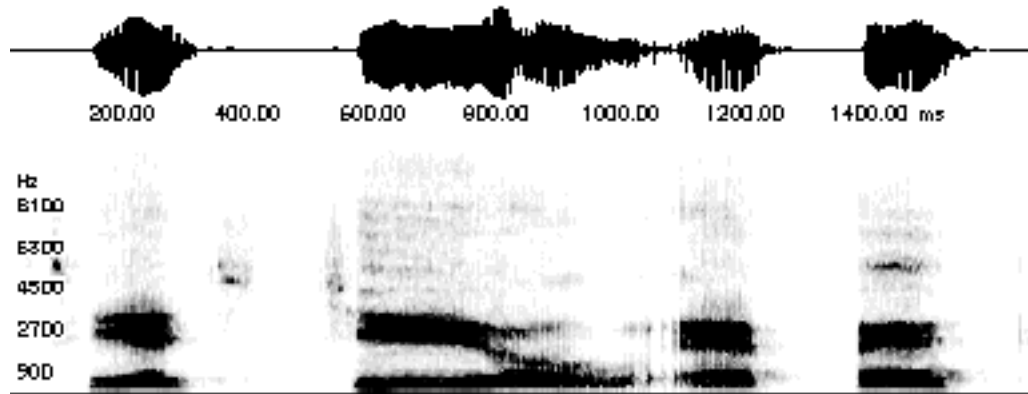


Figure 1. Wave-form and broad-band spectrogram of the test word *kĩõll* 'snare' (Nom.Sg.) placed in a carrier sentence. There is no vowel in the second syllable of the test word.

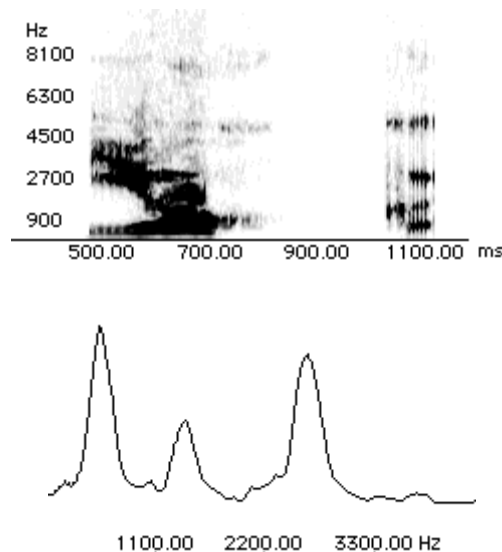


Figure 2. Broad-band spectrogram and spectrum (taken at 20.14 msec) of the test word *jokk* 'river' (Nom.Sg.). The duration of the reduced vowel is 41.09 msec.

F1 = 545 Hz, F2 = 1413 Hz, F3 = 2645 Hz.

2.1 Vowel reduction in the Sevettijärvi dialect

Most second syllabic unstressed vowels are dropped in the speech of the representative of the Sevetijärvi dialect. In those instances where a vowel is present, a considerably high degree of reduction can be observed. The resulting reduced vowel has an average duration of 36 msec. Formant frequency values average 565 Hz (F1), 1465 Hz (F2) and 2625 Hz (F3), thus approximating the frequency values associated with the neutral position. In *Figures 1* and *2* instances of vowel drop and vowel reduction are illustrated. There are sporadic occurrences of the second syllabic vowel being maintained; the duration of those vowels, however, is shorter (15 - 25 msec) than the duration of the second syllabic unstressed short vowels in closed syllables.⁶ An example of this is shown in *Figure 3*.

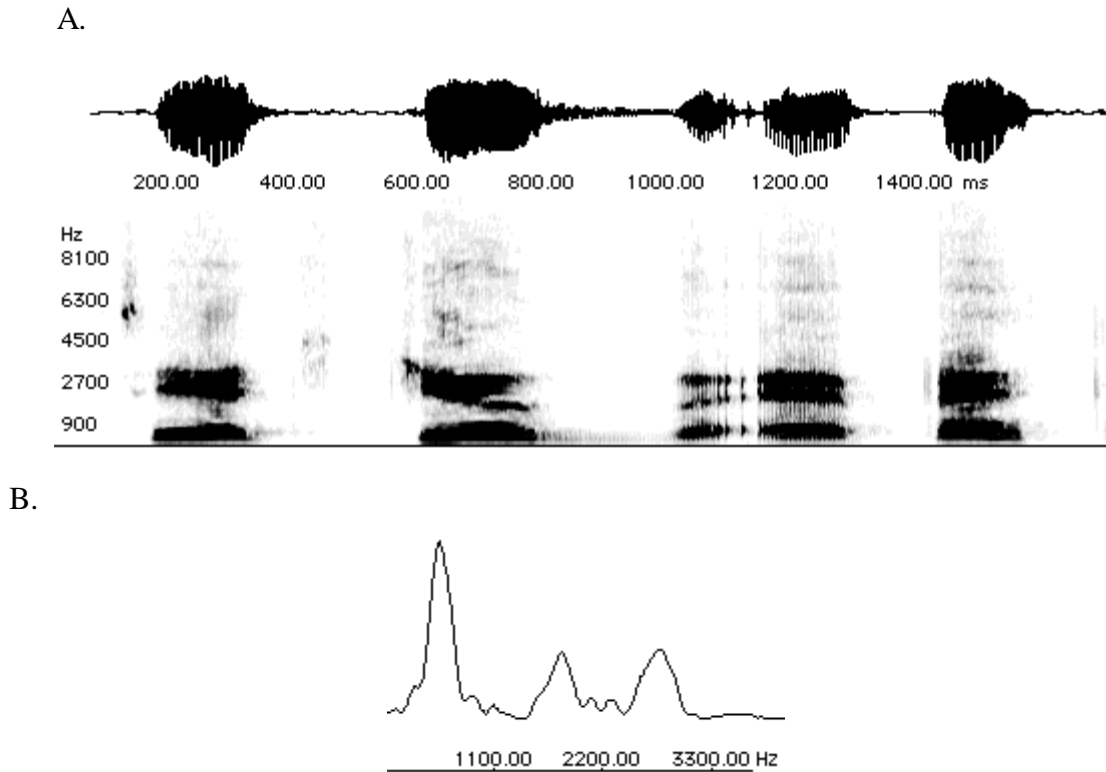


Figure 3. A. Wave-form and broad-band spectrogram of the test word *kidä* 'spring' (Nom.Sg.) placed in a carrier sentence. The duration of the second syllabic vowel is 70.28 msec. B. Spectrum of the second syllabic vowel (taken at 21.71 msec). F1 = 690 Hz, F2 = 1697 Hz, F3 = 2786 Hz.

2.2 Vowel reduction in the Paatsjoki/Pettsamo dialect

In the speech of the representative of this dialect, although instances of vowel drop do occur, as mentioned above, they are infrequent. The occurrences of vowel reduction cannot be characterized in a uniform way such as those shown above in connection with reductions typical of the Sevetijärvi dialect. The most striking features evident with regard to vowel reduction in the Paatsjoki/Pettsamo dialect are the noticeably longer duration of the reduced vowel and the differing degrees of centralization of this vowel. Reduced vowels in the speech of the subject have an average duration of 62 msec. On the basis of spectral characteristics, reduced vowels can be viewed here as forming three distinctive groups: (i) those approximating the neutral position (formant frequency values averaging F1 = 600 Hz,

⁶ The average duration of second syllabic unstressed short vowels in closed syllables is 87 msec. See *ibid*.

F2 = 1650 Hz, F3 = 2700 Hz); (ii) those approximating a more frontal, upper-mid to high position (formant frequency values averaging F1 = 350 Hz, F2 = 2765 Hz, F3 = 3375 Hz); and (iii) those approximating a more back, lower-mid position (formant frequency values averaging F1 = 665 Hz, F2 = 1680 Hz, F3 = 2720 Hz). The latter two positions correspond to the quality of the stem vowel, i.e., the stem vowel /e/ when reduced is realized as the position described in (ii), and the two back stem-vowels when reduced are realized as the position described in (iii). It is interesting to note that there were only sporadic occurrences of vowel reduction approximating the neutral position in the speech of the Paatsjoki/Pettsamo speaker; this may be explained by the relatively longer duration of the reduced vowel (see discussion below). *Figures 4 and 5* illustrate the spectral properties of the different manifestations of vowel reduction. An example of the rare occurrence of vowel drop is shown in *Figure 6*.

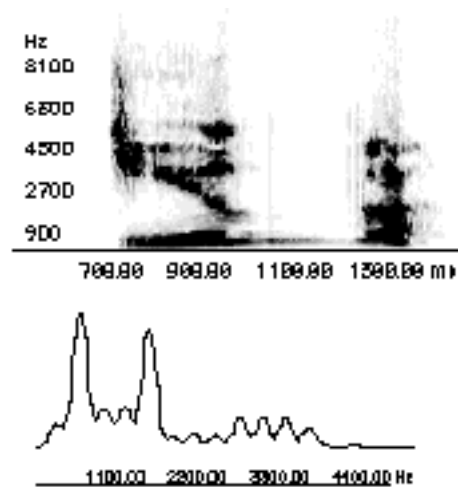


Figure 4. Broad-band spectrogram and spectrum (at 28.84 msec) of the test word *k'idd* 'spring' (Nom.Sg.). The duration of the reduced vowel is 65.14 msec. F1 = 686 Hz, F2 = 1734 Hz, F3 = 2786 Hz.

3. Discussion

After examining the reduced vowels in disyllabics (occurring in unstressed open second syllables) in the two sub-dialects of Skolt Saami, it may be stated that the generally held view concerning the role of duration with regard to the degree of reduction accords with the results of the present analysis. When comparing durational measurements in relation to the degree of approximating the neutral position, it is evident that schwa-like reduced vowels that are typical of the speech of the representative of the Sevettijärvi dialect co-occur with short durations (averaging 36 msec). The reduced vowels identified in the speech of the representative of the Paatsjoki/Pettsamo dialect approximate a position in the vowel continuum that is more clearly recognizable in terms of both backness and height. These reduced vowels have an average duration of 62 msec -- thus being considerably longer than the reduced vowels manifesting a schwa-like quality.

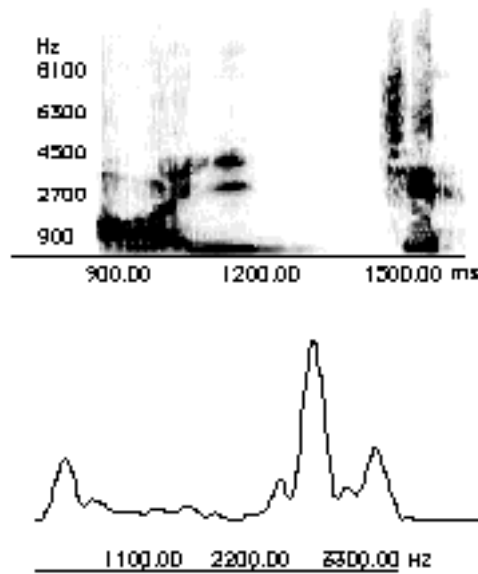


Figure 5. Broad-band spectrogram and spectrum (at 38.87 msec) of the test word *â'lgg* 'boy' (Nom.Sg.). The duration of the reduced vowel is 57.30 msec. F1 = 343 Hz, F2 = 2786 Hz, F3 = 3412 Hz.

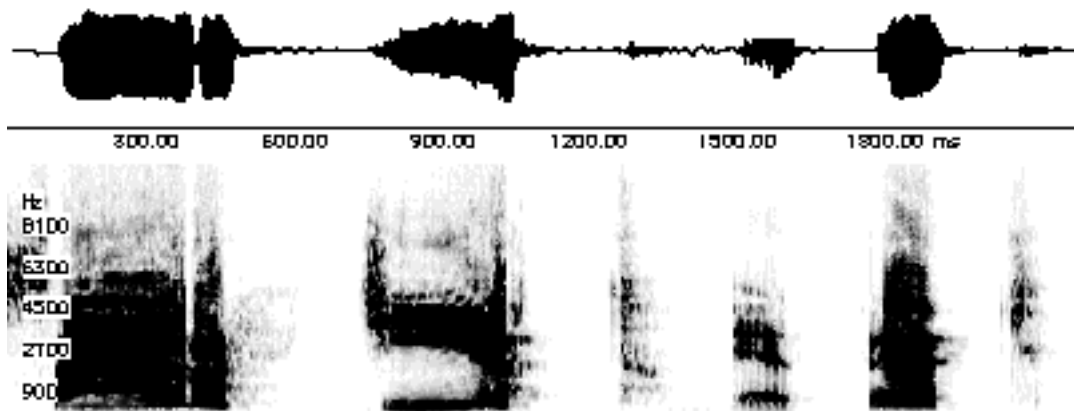


Figure 6. Wave-form and broad-band spectrogram of the test word *ķiōtt* 'hand' (Nom.Sg.) placed in a carrier sentence. There is no vowel in the second syllable of the test word.

On the basis of a comparison of vowel reduction associated with the two sub-dialects, the different stages of the *short unstressed vowel* > *reduced vowel* > *vowel drop* change can be observed. The pattern emerging from the phonetic realizations of unstressed second syllabic vowels in word-final position reveals that the process of vowel reduction is at a very advanced stage in the speech of the representative of the Sevetijärvi dialect, a fact that is reflected in the orthography developed for Skolt Saami.⁷ A lesser degree of the reduction process is evident in the speech of the representative of the Paatsjoki/Pettsamo

⁷ Korhonen *et al.* 1973.

dialect, in terms of both the durational and spectral characteristics associated with the reduced vowel. The two different manifestations of the vowel reduction process thus may be interpreted as representing different stages of a historical change in progress, a change that through vowel reduction eliminates short unstressed vowels word-finally. Table 1 summarizes the results of the acoustic analysis of durational and spectral properties of the reduced vowel in the speech of the two subjects representing the two sub-dialects of Skolt Saami.

Table 1. Average durations and formant frequency values of the reduced vowels

<i>Sevettijärvi speaker</i>			<i>Paatsjoki/Pettsamo speaker</i>		
Duration:	Spectral Pattern:	%	Duration:	Spectral Pattern:	%
36 msec	F1 = 565 Hz F2 = 1465 Hz F3 = 2625 Hz	33%	59 msec	F1 = 665 Hz F2 = 1680 Hz F3 = 2720 Hz	42%
			65 msec	F1 = 350 Hz F2 = 2765 Hz F3 = 3375 Hz	46%
Vowel Drop		64%			6%
Full Vowel		3%			6%

NOTE: Percentages are calculated for 950 disyllabics (461 and 489 for the two speakers respectively, see p. 2).

4. Conclusion

The analysis presented above describes the durational and spectral properties of the second syllabic reduced vowel in two Skolt Saami dialects. The results definitely point to the relevance of the vowel reduction process to the historical change which aims at eliminating the second syllabic unstressed vowel in Skolt Saami disyllabics. The tendencies described above with regard to the varying degrees of vowel reduction should be interpreted by taking into consideration the following: (i) only data obtained during the course of the controlled experiment were considered in the present study; it is expected that the faster tempo associated with connected speech results in shorter duration and a greater degree of centralization even for the Paatsjoki/Pettsamo speaker. The greater impact of contextual assimilation on the formant structure will also have to be taken into consideration when analyzing vowel reduction in connected speech; (ii) the adjacency of two vowels due to the position of the test word in the sentence frame (*ciel' k̄k̄... epet* and *saar ... e'pet* 'say ... again' respectively for the two speakers), may contribute to the obtaining of a large number of second syllabic vowel deletions; (iii) because there were only two participants in the experiment, the results most likely reflect individual articulatory idiosyncrasies, suggesting that the study should certainly be expanded to accommodate a larger data base involving additional speakers.

Accordingly, taking the above points into account, further analysis of vowel reduction in connected speech with additional speakers in a non-laboratory setting is in progress.

Literature

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