



Temporal patterns of geminates in Inari Saami trisyllabic words

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Abstract

This paper studies the temporal structure of Inari Saami trisyllabic words with a focus on consonantal quantity distinctions at the boundary of the first and second syllable vs. the second and third syllable. We investigate whether the third syllable affects the ternary quantity distinction at the boundary of the first and second syllable and how quantity is realized at the boundary of the second and third syllable of trisyllabic words. The results are compared to earlier findings from Inari Saami disyllabic words, and to Estonian, which exhibits a ternary consonantal quantity distinction similar to Inari Saami. For the purpose of the study, the durations of all segments in trisyllabic words with different structures were measured. The results showed that while there is a three-way distinction in consonant duration (singletons, half-long geminates and long geminates) at the boundary of the first and second syllable, the distinction is binary (singletons vs. long geminates) at the boundary of the second and third syllable. These results are in line with earlier findings from Estonian.

Index Terms: Inari Saami, Estonian, quantity, geminates, word prosody

1. Introduction

The three-way consonantal quantity distinction is a rare phonological phenomenon that knowingly only exists in Finno-Ugric languages, such as Estonian [1], Livonian [2], Ingrian [3], and Saami languages – in Inari Saami [3]–[5], North Saami [6], [7], Lule Saami [8], and Skolt Saami [9]. Earlier descriptions of quantity mainly deal with the distinction between the first (S1) and second (S2) syllable of a word, where consonants can belong to three categories: short (referred to as Q1), long (Q2), and overlong (Q3). Sometimes long and overlong categories are referred to as half-long and long geminates or short and long geminates, respectively [10], [11].¹ There are numerous studies on the three-way length distinctions in disyllabic words. For instance, in several studies on Estonian quantity it has been shown that quantity operates in a disyllabic foot and is best described by the duration ratios of stressed and unstressed syllables [1], [12]–[16]. However, quantity distinctions have not been studied in great detail for words longer than two syllables.

Ilse Lehiste [17] investigated Estonian consonantal quantity contrasts in trisyllabic words and stated that between the second and third (S3) syllable, binary length opposition can occur, whereas the duration of the geminate in this position is

somewhere between Q2 and Q3 geminates. Therefore, Lehiste refers to this as an ‘ambiguously long’ length category [17].

The three-way consonantal quantity distinction in Inari Saami has previously been studied on the basis of disyllabic test words as quantity is manifested in the intervocalic position between the stressed and unstressed syllables. Vowels and diphthongs in stressed syllables can have two distinctive lengths: short or long. In unstressed syllables, vocalic length is not distinctive [10]. Earlier experimental-phonetic studies have shown that the ternary consonantal quantity contrast in Inari Saami is realized after a short stressed vowel of a disyllabic word [3]–[5]. According to [5], the duration ratio of short consonants to half-long geminates is 1.53, while the ratio of half-long to long geminates is greater, being 1.82. The duration ratio of short consonants to long geminates is 2.78. In addition to the durations and duration ratios of consonants, the ternary quantity distinction in Inari Saami is also manifested in the inverse relations between intervocalic consonants and the surrounding vowels. While consonant durations increase, the durations of the surrounding vowels decrease [5].

So far, Inari Saami quantity distinction has been studied in disyllabic words. Therefore, as a logical next step, the purpose of this study is to investigate consonantal quantity distinctions in Inari Saami trisyllabic words, as has been done for Estonian. For Estonian trisyllabic words, fundamental frequency and intensity measures have been studied along with the durational properties [17], but for Inari Saami trisyllabic words the current paper focuses only on temporal aspects of quantity, since earlier research has shown that, unlike in Estonian, fundamental frequency and intensity play a marginal role in the realization of quantity in Inari Saami [5].

In this study, the following questions are asked: 1) whether and how the three-way quantity distinction is manifested at the boundary of S1 and S2; 2) whether adding a third syllable affects the temporal patterns within S1 and S2, or is the quantity distinction similar to that in disyllabic words; 3) how is quantity manifested at the boundary of S2 and S3; 4) whether and how the realization of three-way quantity in Inari Saami trisyllabic words is similar to or different from Estonian?

2. Material and method

For answering the research questions raised in the previous section, experimental-phonetic analyses of Inari Saami trisyllabic words were carried out. The data were recorded in 2013 with an Edirol R-09 digital recorder at a sampling rate of 48 kHz and with 16 bits per sample. The data were collected from four elderly (aged 62, 68, 76, 77 years) Inari Saami native

¹ The terms ‘short consonants’ or ‘singletons’, ‘half-long geminates’ and ‘long geminates’ are used in this paper.

speakers from the northern and western areas of Inari Saami territory. In addition to Inari Saami, they all spoke Finnish, and three of them had good knowledge in North Saami.

The speakers were asked to read carrier sentences from a sheet of paper. The examples of the carrier sentences are as follows:

- (a) *Sust láá ennuv **paketteh**, mut sist láá ennuv **puttâleh**.*
‘He/she has a lot of packages, but they have a lot of bottles.’
- (b) *Must lii ohtâ **purrâmâš**, mut sust lii ohtâ **pajalâš**.*
‘I have one dish, but he/she has one dessert.’

The carrier sentences contained test words (marked in bold in the examples (a) and (b)) that were placed in phrase-final and sentence-final positions, and had five different structures: 1) CVCVCVC(C) – a short consonant between both S1 and S2, as well as between S2 and S3; 2) (C)CVCCVCVC(C) – a half-long geminate between S1 and S2, a short consonant between S2 and S3; 3) (C)VC:CVCVC(C) – a long geminate between S1 and S2, a short consonant between S2 and S3; 4) CVCVCCVC(C) – a short consonant between S1 and S2, a geminate between S2 and S3; 5) CVCCVCCVC(C) – a half-long geminate between S1 and S2, a geminate between S2 and S3.

In all of the word structures, V1, V2, and V3 are phonologically short vowels or diphthongs. The first three word structures differ in the length of the consonant between S1 and S2 where there is a singleton, half-long geminate, or long geminate. At the boundary of S2 and S3, there are short consonants in these three word structures. The fourth and fifth word structures have a singleton or a half-long geminate between S1 and S2, and a geminate consonant between S2 and S3. The fifth word structure in the data appeared due to variation between speakers. Some speakers pronounced some of the words with a short consonant between S1 and S2, while some used a half-long geminate in these words (in 11 cases). In addition to idiolectal differences, this variation could be explained by the fact that in the orthography, half-long geminates are marked with a dot under a single letter for sonorants, but not for plosives and sibilants.

Examples for the five trisyllabic word structures are presented in Table 1. Altogether, 251 words were analyzed.

Table 1: Number of tokens and examples for the five trisyllabic word structures analyzed.

Word structure	Tokens	Examples
CVCVCVC(C)	74	<i>čohomid</i> ‘comb, part.sg’
(C)CVCCVCVC(C)	80	<i>kaperân</i> ‘hat, ill.sg’
(C)VC:CVCVC(C)	60	<i>puttâlid</i> ‘bottle, part.sg’
CVCVCCVC(C)	26	<i>pakettist</i> ‘package, loc.sg’
CVCCVCCVC(C)	11	<i>potâkkid</i> ‘potato, part.sg’

For the analyses, all the test words were annotated and the durations (in milliseconds) for each segment in a word were measured with Praat [18]. Statistical analysis was carried out in R [19] with the LME4 package [20]. The log-scaled durations of intervocalic consonants (C2 and C3) and the surrounding vowels (V1, V2, V3) were tested with mixed effects models for three factors and their interactions: phrasal position (levels: phrase-medial, phrase-final), C2 length (levels: Q1, Q2, Q3), and C3 length (levels: short, long). In the models, a speaker and

a test word were considered as random factors. Models were compiled in an incremental fashion. Two subsets of data were tested: 1) the first three word structures (VCVCV, VCCVCV, VC:CVCV) where C3 was always a singleton; 2) word structures four and five (CVCVCCV, VCCVCCV) where C3 was a geminate.

3. Results

The results for segmental durations in Inari Saami trisyllabic words are summarized in Table 2 and illustrated in Figure 1, which present the average durations for the stressed syllable vowel (V1), the intervocalic consonant at the boundary of S1 and S2 (C2), the unstressed second syllable vowel (V2), the intervocalic consonant between S2 and S3 (C3), and for the third syllable vowel (V3). Words in two-different phrasal positions are pooled together, since there was no statistically significant main effect of phrasal position on consonant durations.

Table 2: Average segment durations and standard deviations (in brackets) in milliseconds for V1, C2, V2, C3, and V3 in the five analyzed word structures.

Structure	V1	C2	V2	C3	V3
VCVCV	126 (34)	102 (22)	133 (29)	99 (20)	77 (23)
VCCVCV	137 (29)	149 (24)	124 (30)	87 (18)	83 (17)
VC:CVCV	135 (34)	234 (65)	71 (24)	88 (21)	76 (16)
CVCVCCV	119 (17)	106 (17)	119 (18)	218 (35)	71 (19)
VCCVCCV	122 (12)	145 (11)	116 (32)	226 (32)	74 (9)

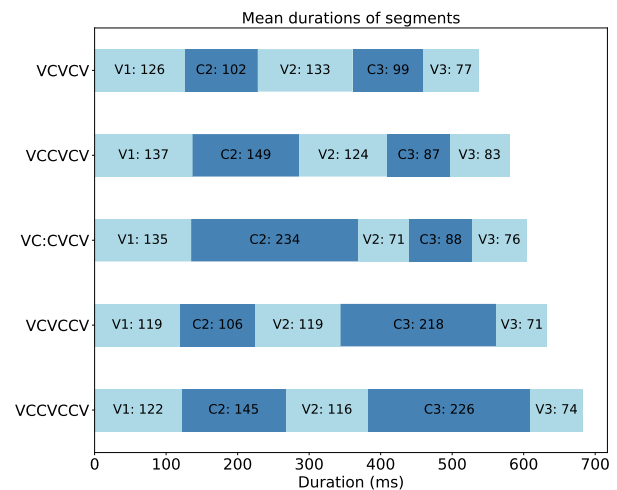


Figure 1: Mean durations of V1, C2, V2, C3, and V3 in the five word structures.

In the following, the results for the consonants between S1 and S2 are presented first, followed by the durations of consonants between S2 and S3. Figure 2 presents the durations of C2 (upper panel) and C3 (lower panel) in boxplots.

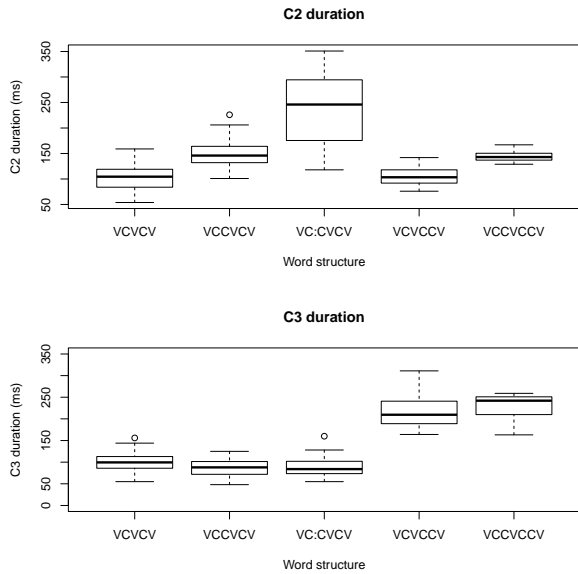


Figure 2: The durations of C2 (upper panel) and C3 (lower panel) in the five word structures.

Between S1 and S2 the duration of C2 shows a three-way distinction in words with a short C3. The main effect of C2 length is statistically significant [$\chi^2(df=2, N=214)=83.34, p<0.001$]. In these words, C2 can be a short consonant (average duration 102 ms), a half-long geminate (149 ms), or a long geminate (234 ms). The duration of V1 is not affected by C2 length, but the main effect of C2 length is significant in the case of V2 duration [$\chi^2(df=2, N=214)=85.48, p<0.001; p<0.01$ for Q1 and Q2 pair]. The duration of V2 is the longest after a short consonant (average duration 133 ms), it is shorter after a half-long geminate (124 ms), and the shortest after a long geminate (71 ms).

The duration of C2 varies between speakers in words with a geminate in C3 position. Some realize C2 as a short consonant (the average duration is 106 ms), some as a half-long geminate (145 ms). The difference is statistically significant [$\chi^2(df=1, N=37)=25.89, p<0.001$]. The average durations of vowels surrounding C2 are similar (the durations range from 116 to 122 ms) in both cases, i.e., C2 as a short consonant or a half-long geminate.

The durations of consonants between S2 and S3 show a two-way distinction with C3 as a short consonant or a long geminate. As can be seen from the lower panel in Figure 2, the median duration for a short consonant between S2 and S3 is around 100 ms in the first three word structures with a short consonant, a half-long geminate, or a long geminate in C2 position. As a geminate, C3 duration between S2 and S3 is around 220 ms, which is similar to the duration of a long geminate between S1 and S2 (average duration 234 ms; cf. upper panel in Figure 2). The durations of V3 in all of the five word structures are the shortest segments and do not show variation between word structures, ranging from 71 to 83 ms.

In order to observe the relations between consonant durations in C2 position, ratios of Q2/Q1, Q3/Q1, and Q3/Q2 were calculated. Figure 3 presents the duration ratios of C2 in words with a short C3 (the first three word structures presented in Table 1). The ratios of C2 durations were as follows: half-long geminates were 1.5 times longer than singletons, long

geminates were 2.3 times longer than singletons, and long geminates were 1.6 times longer than half-long geminates. In words with a geminate in C3 position, at the boundary of S1 and S2 geminates were 1.4 times longer than singletons.

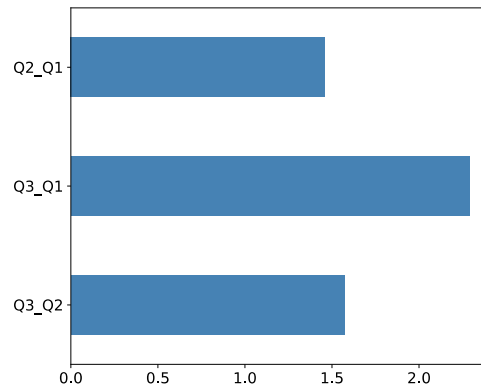


Figure 3: The duration ratios of C2 for Q2/Q1, Q3/Q1, and Q3/Q2.

The ratios of C3 durations could be compared for two pairs of word structures: geminates in VCVCCV were 2.2 times longer than singletons in VCVCV words, and geminates in VCCVCCV words were 2.6 times longer than singletons in VCCVCV words.

4. Discussion

Previous studies have shown that ternary quantity distinction is manifested in Inari Saami disyllabic words after a short stressed vowel [4], [5]. In this study, the quantity contrast was observed in trisyllabic words, where consonant durations were analyzed between the first and second syllable as well as between the second and third syllable.

The first objective of the study was to investigate how quantity is manifested at the boundary of S1 and S2 when the third syllable is added. According to the results, the three-way consonantal quantity distinction is clearly realized at the boundary of S1 and S2 of trisyllabic words, where C2 can be a short consonant, half-long or long geminate. Consonantal length also affects the vowel in the second syllable, where V2 is the longest after a short consonant, shorter after a half-long geminate, and the shortest after a long geminate.

The results for trisyllabic words in this paper can be compared to earlier results for disyllabic words [5]. Comparisons show that the durations of C2 consonants in different quantities are similar: in both disyllabic and trisyllabic words, the average duration of short C2 is 102 ms, while the average duration of half-long geminates is 156 ms in disyllabic words and 149 ms in trisyllabic words, and the average duration of long geminates is 284 ms in disyllabic and 234 ms in trisyllabic words. Between S1 and S2 a similar three-way quantity distinction is manifested in both disyllabic and trisyllabic words, but long geminates in trisyllabic words are shorter than in disyllabic words. Due to this, comparing the duration ratios of consonants in different quantities shows smaller ratios for trisyllabic words. Table 3 compares the duration ratios of Q2/Q1, Q3/Q1, and Q3/Q2 for C2 in trisyllabic words with previous results for disyllabic words [5].

Table 3: Comparison of Q2/Q1, Q3/Q1, and Q3/Q2 duration ratios of C2 in tri- and disyllabic words [5].

	Q2/Q1	Q3/Q1	Q3/Q2
Trisyllabic	1.5	2.3	1.6
Disyllabic	1.5	2.8	1.8

Another difference that appears between tri- and disyllabic words is the way in which the surrounding vowels interact with consonant durations. In disyllabic words, the durations of both vowels V1 and V2 were affected by C2 length and shortened when C2 duration increased [5]. The results of this paper showed that this was not exactly the case for trisyllabic words, where there was no effect of C2 length on V1 duration, but V2 duration decreased when C2 duration increased. However, the results for di- and trisyllabic words show similarities that enable us to say that the three-way consonantal quantity distinction is also manifested in longer words than with two syllables and therefore, adding a third syllable does not influence the ternary distinction between S1 and S2.

The second focus of this paper was on quantity realizations at the boundary of second and third syllables. The results indicated that in these positions a distinction between short consonants and long geminates occurs. The durations of geminates between S2 and S3 (the average duration is 218 ms in VCVCCV words and 226 ms in VCCVCCV words) can be compared to long geminates at the boundary of S1 and S2 (the average duration is 234 ms). The average duration of a half-long geminate between S1 and S2 is remarkably shorter (145 ms in the same VCCVCCV words and 149 ms in VCCVCV words).

The results of this study are comparable to the previous results from Estonian that also exhibits a ternary consonantal quantity distinction between S1 and S2. Ilse Lehiste's study [17] on Estonian consonantal quantity distinctions focuses on the duration of geminate plosives at the boundary of S2 and S3 of trisyllabic words. Her results indicate that the duration of these geminates is 'ambiguously long'. She claims that these geminates constitute "a separate durational category on the phonetic level" and can be assigned to the long (Q2) category in the C2 position. However, the results of this paper show that plosives in Inari Saami belong to Q3 category between S2 and S3. This is shown by the fact that the duration of these geminates is close to the duration of Q3 geminates between S1 and S2, and Q2 geminates in this position are considerably shorter in duration.

In both Inari Saami and Estonian, the three-way consonantal quantity distinction is manifested between S1 and S2. In Inari Saami, the duration ratios of C2 for Q2/Q1, Q3/Q1, and Q3/Q2 are 1.5, 2.3, and 1.6, respectively. Based on the results of [17], the duration ratio for Q2/Q1 in Estonian is 2.5, for Q3/Q1 it is 4.0, and for Q3/Q2 1.6. Thus, it can be seen that the difference between Q2 and Q3 geminates in Inari Saami and Estonian is similar, but differences between other quantities are greater in Estonian than in Inari Saami. However, it should be kept in mind that the test situations and materials differ between the studies, which can also have caused differences in the results.

5. Conclusions

In this paper, we studied the temporal aspects of the three-way consonantal quantity distinction in Inari Saami trisyllabic

words. The results showed a ternary quantity distinction between the first and second syllable, and a binary distinction between the second and third syllable of trisyllabic words.

The ternary distinction between S1 and S2 of trisyllabic words is similar to that in disyllabic words. It was shown that adding a third syllable does not affect the temporal patterns of geminates between S1 and S2. In both di- and trisyllabic words, consonants can be described as singletons, half-long and long geminates. Vowels in the second syllable are also affected by consonantal length in a similar way as in disyllabic words: when the duration of the intervocalic consonant increases, the durations of the following vowels decrease.

At the boundary between the second and third syllable of trisyllabic words the duration of geminates corresponds to the duration of Q3 geminates between the first and second syllable; they are remarkably longer than half-long Q2 geminates.

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7. References

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