The ternary contrast of consonant duration in Inari Saami

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Abstract

The three-way distinction of quantity occurs in several Finnic and Saami languages. The paper focuses on the length contrast of consonants in Inari Saami. Similarly to Estonian and other Finno-Ugric languages where three quantities are described, in Inari Saami the distinction between single consonants, short geminates or consonant clusters, and long geminates or consonant clusters appears only on the boundary of a stressed and unstressed syllable of a disyllabic foot. Our results show that in Inari Saami the duration of consonants is inversely related to the duration of both preceding and following vowels, and there is a tendency towards foot isochrony. The results are in line with previous studies on quantity opposition in Inari Saami and in other Finnic languages, showing the ternary distinction of consonant quantities as a foot-level feature of the language.

Index Terms: Inari Saami, geminates, three-way quantity

1. Introduction

The sound system of Inari Saami reveals three phonologically distinctive quantities. The ternary duration contrast occurs in several Saami languages, including North Saami which has a central position in the Saami language area [1]–[3]. Inari Saami is an eastern Saami language spoken by about 200 native speakers in northern Finland. The Inari Saami phonology is characterized by left-headed feet, word-initial primary stress, and a distinction between short and long vowels and consonants both in stressed and unstressed syllables. The three-way distinction of quantity appears only with consonants in primary stressed feet that are left headed. The ternary contrast is realized by the distinction of single consonants, short and long geminates (traditionally called half-long and long consonants), or consonant clusters on the boundary of the stressed syllable and the following unstressed syllable, e.g. *palo* [pɑlo] ‘fear, Gen/Acc.’, *paḷo* [pɑllo] ‘fear, Nom.’, *kallu* [kɑl:lu] ‘forehead, Nom.’, *ša'lde* [ʃɑlte] ‘bridge, Gen/Acc.’, *šalde* [ʃɑl:te] ‘bridge, Nom.’, *tääḷu* [tæ:llu] ‘house, Nom.’, *täállun* [tæ:l:lun] ‘house, Ess.’. In orthography, short geminates (or half-long consonants) are marked with a dot under a single letter, long geminates (or long consonants) are written with two letters. An apostrophe before a consonant cluster indicates that the cluster is short, see [4].

The phonological distinction between short and long geminates is a productive feature of Inari Saami word prosody, i.e. it occurs with all consonants. Also the consonant clusters are prosodically short and long; short geminates and consonant clusters occur in feet of the second quantity degree (Q2), long geminates and consonant clusters occur in feet of the third quantity degree (Q3).

Previous studies have indicated that segmental durations are interrelated in Inari Saami feet and there is a tendency to foot isochrony, which means that the length of the first and second syllables are inversely related [2], [5]. However, unlike Southern Finnic languages with ternary quantity opposition, the Saami languages including Inari Saami also preserved the quantity distinction of vowels in an unstressed syllable [1], e.g. *palloon* [pɑl:lo:n] ‘fear, Ess.’.

The nature of temporal relations between consonants and surrounding vowels in Inari Saami is not completely clear. Earlier studies of Inari Saami quantities have focused on the relations of the consonants with the preceding vowel [2], [6]. Southern Finnic languages with a three-way quantity, on the other hand, have shown an inverse relation between consonants and the duration of the following vowel. Markus et al. found that this is relevant also in the case of Inari Saami [5]. In this paper we study the temporal features of all sounds in Inari Saami disyllabic feet with short consonants, short and long geminates and consonant clusters.

2. Materials and method

The data of this study were recorded using an Edirol R-09 digital recorder in 2013 from four male native speakers of Inari Saami. Two of the subjects were born in Inari, one in Syysjärvi and one in Ylivieska. Their parents were speakers of central and northern varieties of Inari Saami. Currently one speaker still lives in Syysjärvi, one has moved to Helsinki and two live in Ivalo. At the time of recording the age of the speakers was between 62 and 77 (average being 70.8). In addition to their native language, all subjects speak Finnish, three have a good knowledge of North Saami, and three also marked English or German as their foreign languages.

The total set of materials comprised 299 words with consonantal quantity embedded in 96 carrier sentences in Inari Saami. All test words were disyllabic with a phonologically short vowel as a syllable nucleus, while the intervocalic consonant was a short consonant (Q1; e.g. *sare* [sɑre] ‘blueberry, Gen/Acc.’, *kove* [kove] ‘picture, Gen/Acc.’), a short geminate (Q2; e.g. *saṛe* [sɑrre] ‘blueberry, Nom.’, *koṿe* [kovve] ‘picture, Nom.’), or a long geminate (Q3; e.g. *komme* [kom:me] ‘ghost, Nom’, *hekki* [hek:ki] ‘cage, Nom.’), a short consonant cluster (Q2; e.g. *pu'ško* [puʃko] ‘Esox, pike, Gen/Acc.’, *a'lge* [ɑlke] ‘boy, Gen/Acc.’) or a long consonant cluster (Q3; e.g. *puško* [puʃ:ko] ‘Esox, pike, Nom.’, *alge* [ɑl:ke] ‘boy, Nom.’). Different vowels and syllable boundary consonants were selected to avoid the influence of the intrinsic duration on average segment duration. The analysed word structures were as follows: CVCV, (C)VCCV and (C)VC:CV (referred to as Q1, Q2 and Q3, respectively).

The test words were placed in phrase-medial and phrase- or sentence-final position of the carrier sentence, e.g. *Ohtâ **maṇe** lii taa*, *mut ohtâ **lodde** lii tobbeen* ‘One egg is here, but one bird is there’; *Must lii ohtâ **saṛe**, mut sust lii ohtâ **juŋŋâ*** ‘I have one blueberry, but you have one lingonberry’. The distribution of the analyzed tokens is shown in Table 1. Some utterances were left out from the analysis, mainly due to background noise or because they were misread.

Table 1. *Number of analyzed tokens produced by the four speakers.*

	Sp1	Sp2	Sp3	Sp4
Q1 short	6	7	6	7
Q2 geminate	14	14	14	14
Q2 cluster	8	8	8	8
Q3 geminate	24	22	23	24
Q3 cluster	24	22	22	24

Segment boundaries were labelled in Praat [7] and the duration of each segment was extracted with a script. Using the LME4 package in R, the log-scaled segment durations were tested with a mixed effects model for three factors: Position (levels: phrase-medial, phrase-final), Quantity (levels: Q1, Q2, Q3) and Consonantal (C2) structure (levels: geminate, consonant cluster).

3. Results and discussion

First, we present the segmental durations in disyllabic words, and then we compare the duration ratios of intervocalic consonants and their surrounding vowels (i.e. the ratios of V1/C2 and C2/V2).

3.1. Duration of segments

The average segmental durations are presented in Table 2. In the table, C1 marks the word-initial consonant. V1 is a short vowel in the first syllable, C2 a short consonant (Q1), the total duration of a short (Q2) and long (Q3) geminate, or the total duration of a short (Q2) and long (Q3) consonant cluster, and V2 a short vowel in the second syllable. The total duration of the disyllabic foot is also given. In the first, second and third part of the table respectively the average segment durations of words in the phrase-medial, phrase-final position and in both positions together are given. Figure 1 illustrates an overall average of segment durations (phrase-medial and phrase-final words pooled together).

It can be seen from Table 2 that the C1 duration is roughly 100 ms in all tested quantity degrees and phrasal positions. None of the tested factors were significant for the C1 duration.

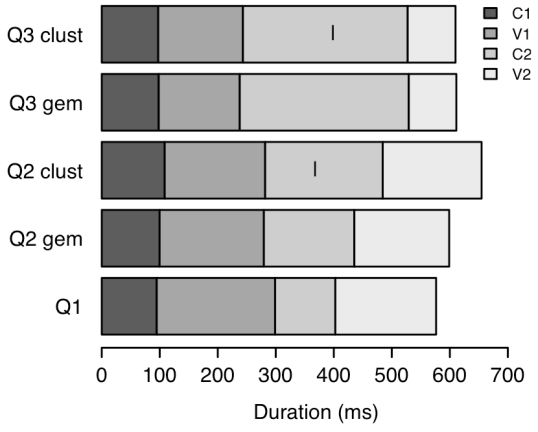

Figure 1: *Average segment durations in the analyzed word structures. The segment boundary in the consonant cluster is marked with a vertical bar.*

Table 2. *Average segment durations and standard deviations (in milliseconds) in the phrase-medial, phrase-final position and both positions analyzed together.*

Pos.	Structure	C1	V1	C2	V2	Total
Phrase-medial	Q1 short	97	181	82	163	522
	s.d.	15	28	14	21	47
	Q2 geminate	96	166	137	148	547
	s.d.	23	26	23	21	52
	Q2 cluster	110	161	185	148	577
	s.d.	17	31	26	26	60
	Q3 geminate	97	132	242	78	532
	s.d.	27	22	68	16	82
	Q3 cluster	96	135	238	75	527
	s.d.	16	19	50	13	65
Phrase-final	Q1 short C	93	224	122	183	623
	s.d.	16	46	32	50	88
	Q2 geminate	103	194	175	179	651
	s.d.	24	35	41	44	92
	Q2 cluster	107	186	220	192	679
	s.d.	17	29	37	39	91
	Q3 geminate	100	148	342	86	658
	s.d.	31	25	73	22	95
	Q3 cluster	99	158	334	91	664
	s.d.	17	21	56	20	75
Average	Q1 short C	95	204	104	174	576
	s.d.	16	44	32	40	87
	Q2 geminate	100	180	156	164	599
	s.d.	23	34	38	37	91
	Q2 cluster	109	173	203	170	628
	s.d.	16	32	36	40	92
	Q3 geminate	98	140	291	82	594
	s.d.	29	25	87	20	109
	Q3 cluster	97	146	284	82	593
	s.d.	16	23	72	18	98

Table 2 shows that the average duration of V1 is the longest in the case of Q1 (204 ms), somewhat shorter in the case of Q2 (173–180 ms), and the shortest in the case of Q3 (140–146 ms). The main effect of Position is significant [$\chi^2(df=1, N=299)=28.9, p<0.001$], but there are no interactions with Quantity and C2 structure. The effect of Position refers to the lengthening of segments in phrase-final position. There is also a significant main effect of Quantity [$\chi^2(df=2, N=299)=63.41, p<0.001$], and post-hoc test indicates that the duration of V1 varies significantly in the opposition of Q1 and Q2 vs. Q3 ($p<0.001$). The V1 duration in Q1 vs. Q2 is not significantly different. Additionally, there is no effect of C2 structure.

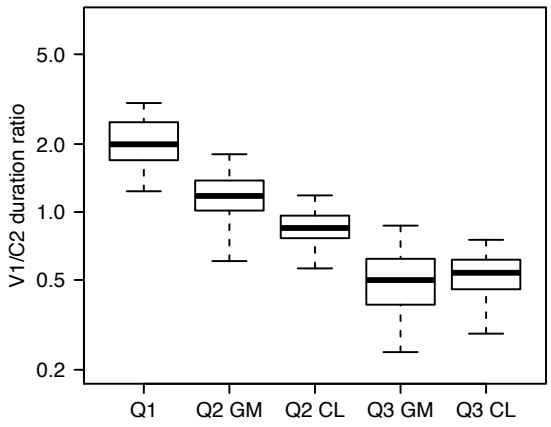

Figure 2: *Duration ratios of V1 to C2.*

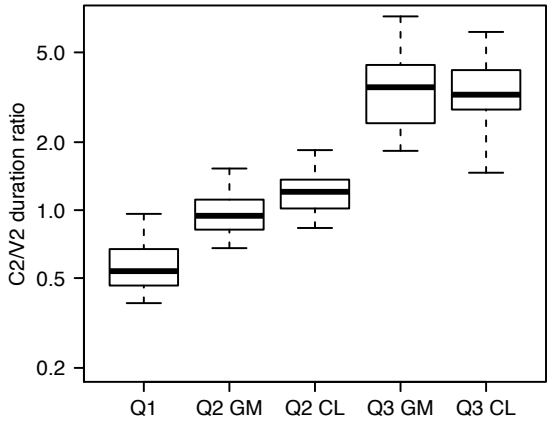

Figure 3: *Duration ratios of C2 to V2.*

As expected, the intervocalic short consonant has the shortest duration (104 ms). The short geminate is longer (156 ms) than the short consonant and the short consonant cluster is somewhat longer than the short geminate (203 ms). The long geminate and consonant cluster are the longest (291 ms and 284 ms respectively). Standard deviations show a greater variation in the duration of both long (Q3) geminate and consonant cluster. The Position has a main effect on the duration of intervocalic consonant(s) (C2) [χ^2(*df*=1, *N*=325)=71.965, p<0.001], which, as in the case of V1, indicates the phrase-final lengthening of a word. The duration of C2 in different quantities varies significantly [χ^2(*df*=2, *N*=325)=137.31, p<0.001], being the shortest in Q1 and the longest in Q3. There is also an interaction between Quantity and C2 structure [χ^2(*df*=2, *N*=325)=16.1, p<0.001]. Pairwise post-hoc testing shows a significant difference between all levels of Quantity (p<0.001), but C2 structure has a significant effect only in the case of Q2 (p<0.05) where a geminate is shorter than a consonant cluster. In Q3 a geminate and a consonant cluster are of similar duration.

V2 shows a similar pattern to V1, being the longest in Q1 (174 ms), shorter in Q2 (164–170 ms), and the shortest in Q3 (82 ms). Again, Position has a significant effect, but without any interactions [χ^2(*df*=1, *N*=299)=22.1, p<0.001]. As in the case of V1 and C2 it also points to the phrase-final lengthening. There is a significant main effect of Quantity [χ^2(*df*=2, *N*=299)=167.24, p<0.001] and post-hoc test shows the difference between Q1 and Q2 vs. Q3 (p<0.001), but no difference between Q1 vs. Q2.

The duration of the whole word varies significantly only between different phrasal positions [χ^2(*df*=1, *N*=299)=85.6, p<0.001], but quantities do not reveal a significant difference. This lack of difference between the word structures with different quantity degrees can be accounted for by a strong tendency to foot isochrony.

It can be concluded that the phrasal position influences the duration of all segments except C1. Segments are longer in the phrase-final position than in the phrase-medial position, but the phrasal position does not interact with the other tested factors. There is an interrelation between the durations of the intervocalic consonant(s) and the surrounding vowels: while the duration of C2 increases both the duration of V1 and V2 decreases. In consequence, the total duration of feet reveals a tendency to foot isochrony. The average foot durations are similar in all the quantities.

3.2. Duration ratio of segments

In Table 3 the duration ratios of V1 to C2, and C2 to V2 are presented. Figure 2 illustrates the duration ratios of V1 to C2 and the duration ratios of V2 to C2 are presented in Figure 3. As the phrasal position seems to have an overall lengthening effect and it does not interact with the different segmental patterns, the phrasal positions are pooled together in this section.

Table 3. *Average V1/C2 and C2/V2 duration ratios.*

Structure	V1/C2	C2/V2
Q1short	2.0	0.6
Q2 geminate	1.2	1.0
Q2 cluster	0.9	1.2
Q3 geminate	0.5	3.5
Q3 cluster	0.5	3.5

The average duration ratio of V1/C2 is 2 in Q1, 0.9–1.2 in Q2 and 0.5 in Q3. The first syllable vowel (V1) in Q1 words is twice as long as a single consonant (C2). Before the short (Q2) geminate and consonant cluster the vowel is shorter than before a single consonant, which in turn is shorter than a Q2 geminate and consonant cluster. In the case of Q2 the durations of the first vowel and the geminate or consonant cluster are almost equal. The V1 duration is the shortest and the C2 duration the longest in the case of Q3 and because of that the duration of a Q3 geminate and consonant cluster is twice as long as that of the first syllable vowel.

The duration of V2 is also strongly affected by the duration of the preceding consonant; there is an inverse relation. The duration ratios of C2/V2 are as follows: 0.6 in Q1, 1.0–1.2 in Q2, and 3.5 in Q3. The duration of the second syllable vowel is the longest after a short consonant: V2 is almost two times longer than C2. In the case of Q2 a short geminate and consonant cluster have almost same duration as the second syllable vowel. V2 is the shortest after the long

(Q3) geminate and consonant cluster that is more than 3 times longer than the following vowel.

Considering both duration ratios, the general correlation between the durations of neighbouring segments can be stated as follows. In the case of Q1: the duration of V1 > the duration of a short consonant < the duration of V2. In the case of Q2: the duration of V1 = the duration of a short geminate or consonant cluster = the duration of V2. In the case of Q3: the duration of V1 < the duration of a short geminate or consonant cluster > the duration of V2.

The duration ratio of the short consonant to the short geminate and long geminate is 1 : 1.5 : 2.8, and to the short consonant cluster and long consonant cluster it is 1 : 2 : 2.7. The duration ratio of the short geminate to the long geminate is 1.9 and of the short consonant cluster to the long consonant cluster it is 1.4. These ratios show that the duration of short geminates is closer to the duration of the short consonants than the duration of the short consonant clusters. The short geminate is one and a half times longer than the short consonant, and almost two times shorter than the long geminate. The short consonant cluster is two times longer than the short consonant and almost one and a half times shorter than the long consonant cluster. Long geminates and consonant clusters are almost three times longer than short consonants.

The results are in line with previous studies on quantity opposition in Inari Saami and other Finnic languages showing the ternary distinction of consonant quantities as a foot-level feature of the language. Bye et al. report that all their speakers make a ternary distinction in consonant duration after a short vowel [2]. However, in their data, the duration of V1 and V2 had a greater between-speaker variation, which is explained partly with a different language background of speakers. Similarly to the speakers of the current study, some of their speakers had a reverse relation of V1 and C2: a short V1 was longer before a short geminate than before a long geminate, and yet longer before a short consonant. However, for three of their speakers the difference of V1 before a short consonant and geminate was not significant. In line with this, the present study showed that the duration of surrounding vowels is significant only between Q1 and Q2 vs. Q3 but not between Q1 vs. Q2. Bye et al. report that only one speaker displayed a ternary inverse duration relationship between consonant and V2 but for other speakers there was no significant difference in V2 duration after a short consonant and geminate [2]. The latter applies to the pronunciation of our speakers, too.

Similar temporal ratio patterns between the intervocalic consonants and the surrounding vowels have been shown to be an efficient way to describe the quantity system of other languages that have a ternary contrast of consonant duration (e.g. [5]). In Estonian the variation of the intervocalic consonant duration does not affect V1 duration, but V2 duration is the longest after a short consonant and shortest after a long geminate. In Livonian, the variation of the intervocalic consonant duration does not affect V1 duration either, but there is a significant difference in V2 duration after a short consonant and geminate vs. a long geminate. Markus et al. have also reported duration ratios of consonants in different quantity [5]. In Estonian and Livonian the duration ratio of CC/C is respectively 2.19 and 1.49 and that of C:C/CC 1.4 and 1.52. The duration ratios of Inari Saami geminates seem to resemble that of Livonian, but the ratios of consonant clusters is more similar to that of Estonian long and short geminates.

4. Conclusions

Inari Saami has a ternary contrast of consonant quantity that occurs after a short vowel. Similarly to Estonian and some other Finno-Ugric languages where three-way quantities are described, in Inari Saami the distinction between short consonants, short geminates or consonant clusters, and long geminates or consonant clusters appears only on the boundary of a stressed and unstressed syllable of a disyllabic foot. In Inari Saami the duration of consonants is inversely related to the duration of both preceding and following vowels. The duration of V1 is significantly longer before a short consonant, short geminate and consonant cluster than before a long geminate and consonant cluster. The same difference concerns the duration of V2. Consequently there is a strong tendency towards foot isochrony. Duration ratios between consonants in different quantity indicate that the duration of the short geminate is closer to the duration of the short consonant than to the duration of the long geminate (the ratios 1.5 and 1.9). However, the duration of the short consonant cluster is closer to the duration of the long consonant cluster than to the duration of the short consonant (the ratios 2 and 1.4).

5. Acknowledgements

The authors are very grateful for the Inari Saami informants for participating in this study. Our special gratitude belongs to Hans Morottaja who helped us to find speakers. We would like to thank Eva Liina Asu for proofreading this paper. The second author would also like to thank Nele Salveste and Juraj Šimko for inspiring discussions. This research was partly funded by the Estonian Research Agency grant No. IUT2-37.

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