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Phonetic Duration, Phonological Quantity and Prosodic Structure in Inari Saami

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Abstract

Inari Saami, an endangered Finno-Ugric language of Northern Finland, is reported to have a three-way surface contrast in consonant length (short, half-long and long). We studied disyllabic words (C)$V_1C_xV_2$(C) using data from 5 native speakers under two conditions, with short and long preceding vowel, V_1, and found support for the claim that Inari Saami has a ternary contrast in consonant length. The three-way length contrast is more robust following a short V_1. The duration of V_2 correlates negatively with the length of the medial consonant. However, there is one major departure from this pattern. When both V_1 and the medial consonant are long, V_2 is also longer. This finding supports the idea that disyllables of this class differ from the others in their prosodic structure in having two metrical feet rather than one. This interpretation tallies with independent evidence from synchronic morphophonology and the historical development of the prosodic system of Inari Saami.

1. Introduction

Of the nine Saami languages that are still spoken today, several are reported to have a three-way duration contrast in consonants [Lagercrantz, 1927; Collinder, 1928, 1929, 1952; Sammallahti, 1975, 1998; Bergsland, 1983; and others]. This is clearest in the western group that includes Ume Saami [Schlachter, 1958], Pite Saami [Lehtiranta, 1992], Lule Saami [Collinder, 1929; Engstrand, 1987; Morén, 2006], and North Saami [Nielsen, 1926; Ravila, 1932; Collinder, 1949; Sammallahti, 1977, 1984; Magga, 1984; Bye, 2005]. In the eastern group, Ter Saami [Itkonen, 1916] and Inari Saami [Äimä, 1918; Itkonen, 1946; Bye, 2007] have a ternary distinction while Skolt [Itkonen, 1916; Korhonen et al., 1973; McRobbie-Utasi, 1999, 2007] and Kildin Saami [Itkonen, 1916; Kert, 1971] appear to lack it. This article examines the ternary length contrast in Inari Saami, to which descriptions attribute a contrast between short, half-long and (fully) long consonants. These are the terms that are traditionally used for Inari Saami [Sammallahti and Morottaja, 1993], although the terms short, long and overlong are

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Table 1. Ternary length contrast in consonants

Short	'Half-long'	Long
pinoo	pinˈoo	
'stack, pile ACC/GEN.SG'	*id.* NOM.SG	
	tinˈoo	tinˈno
	'flintstone ACC/GEN.SG'	*id.* NOM.SG

used in the literature concerned with certain other languages that display a ternary length distinction, such as Estonian and North Saami. The three degrees of length in Inari Saami, which are only found following a vowel bearing a stress, are illustrated with the minimal pairs in table 1. Half-long consonants are transcribed here with [Cˈ]; full-length consonants are transcribed, for visual impact, with the consonant doubled with the half-length mark in between: [CˈC]. Sammallahti and Morottaja [1993] represent half-length orthographically with an underdot and full length by doubling the consonant: <pino> (short); <piṇo>, <tiṇo> (half-long); <tinno> (long). The length mark [ː] is reserved for phonologically overlong consonants (see section 4). Note the following grammatical abbreviations: ACC(USATIVE), ELAT(IVE), ESS(IVE), GEN(ITIVE), ILL(ATIVE), INESS(IVE), NOM(INATIVE), PART(ITIVE), PL(URAL), PRES(ENT), SG = SINGULAR.

Ternary length contrasts are not only extremely rare cross-linguistically [McRobbie-Utasi, 2007], but the Saami languages and Estonian are the only languages reported to have a ternary length contrast in consonants. The Saami facts are therefore of great potential importance in evaluating current phonological theories and understanding the possibilities of human language. For example, the claim of ternarity seems to go against the widely held assumption that phonological distinctions are essentially binary. For discussion of this issue see Collinder [1952], Engstrand [1987], and others. With this in mind, it is obviously important that claims regarding ternary length contrasts are adequately documented phonetically.

This paper has two main aims. The first is to provide phonetic evidence of the reality of the ternary length contrast in Inari Saami. The second is to determine how the durations of the consonant and neighboring vowels influence each other. Like many of the other Saami languages, Inari Saami also has a contrast between long and short vowels. All the logically possible combinations of short/long vowel and short/half-long/long consonant are possible in Inari Saami, giving the six disyllable types shown in table 2.

The preliminary phonemic analysis of the words in table 2 is a hybrid that combines elements from Sammallahti and Morottaja [1993] and Bye [2007]. The quantities of the consonant and V_1 receive the same treatment here as in terms of Sammallahti and Morottaja's [1993] analysis, but the quantity of V_2 is that assumed in Bye's [2007] work, which is a closer match to Itkonen's [1946] transcriptions. In the current orthography, the words in table 2 are written *mane*, *čálám*, *maṇe*, *maṇan*, *lanne*, *kannun*, *pääni*, *moonâm*, *pääṇi*, *laaṇan*, *päännin*, *kuullâđ*.

With one important exception, each disyllabic type may end in an open or closed syllable. When V_1 is long and it is followed by a consonant with full length, however, the second syllable must be closed. As we will argue in section 4, this is no accident.

Table 2. Word types

Word type	Open		Closed	
VCV(C)	/mɑnee/	'egg ACC/GEN.SG'	/tšalaam/	'write 1SG.PRES'
VC·V(C)	/mɑnˈee/	'egg NOM.SG'	/mɑnˈɑɑn/	'egg ILL.SG'
VC·CV(C)	/lɑnˈne/	'fortification NOM.SG'	/kɑnˈnun/	'jug ESS'
VVCV(C)	/paani/	'tooth ACC/GEN.SG'	/moonəm/	'go 1SG.PRES'
VVC·V(C)	/paanˈi/	'tooth NOM.SG'	/lɑɑnˈɑn/	'fortification ILL.SG'
VVC·CVC	*unattested*		/paanˈnin/	'tooth ESS'

The VVC·CVC type is aberrant both phonetically and phonologically. Independent evidence indicates that the VVC·CVC type in fact has an entirely different prosodic organization to the other five classes, and this phonological difference is crucial for understanding its phonetic properties.

Several studies of other languages have shown that the durations of adjacent vowels and consonants show a negative correlation. In Standard Finnish [Lehtonen, 1970, p. 90, 116f.], for example, a geminate is 15% longer following a short vowel in a word like *takka* 'fire place' than in *taakka* 'burden', where it follows a long vowel. There is a similar effect with singletons, although it is smaller. Wiik [1965] established that a long vowel was shortened preceding a geminate, e.g. the first vowel V_1 in *muuta* 'anything else' is longer than V_1 in *muutta* 'without anything else'. Next consider Estonian disyllables where the first syllable is overlong. There are several phonological interpretations of Estonian overlength in the literature. According to Prince [1980], overlong syllables constitute metrical feet on their own, while Hayes [1995] and Bye [1997] argue that overlong syllables are distinguished by having three moras. Here we will assume Prince's [1980] account and show monosyllabic feet delimited by square brackets. A geminate is 37% longer following a short vowel in a word like *tuppa ([tup]pa)* 'room ILL.SG' than in *kaupa ([kaup]pa)* 'merchandise PART.SG'. A long vowel is 36% longer in an open overlong syllable in a word like *loobu ([loo]pu)* 'give up 2SG.IMPERATIVE' than when the syllable is closed by a geminate as in *kaupa*. These ratios were calculated on the basis of data supplied in Lehiste [1997]. The average durations over 8 tokens of each word type for V_1, C and V_2 were 96, 85, 165 for *sada*, 252, 91, 95 for *loobu*, 88, 301, 91 for *tuppa*, and 185, 219, 88 for *kaupa*. In North Saami [Magga, 1984], short vowels are significantly longer before short consonants than before long or overlong consonants. Long vowels and diphthongs are shorter before geminates and clusters, and shorter still before overlong consonants.

Similar interactions are reported for the following vowel, V_2. In Finnish and Estonian, the length of V_2 seems to be a function of the quantity of the preceding syllable, rather than the duration of the preceding consonant. In Finnish, a phonologically short V_2 in CVCV is more than twice as long than in CVVCV or CVCCV. This is the so-called 'half-long vowel' of phonetic descriptions. In Estonian, V_2 is shortest following an overlong syllable. Following a plain heavy syllable, V_2 is about 30% longer, and after a light syllable about 80%.

Comparable effects are reported for languages in which the duration of the consonant is only a secondary feature (i.e., nonphonological). For example, voiced stops

Table 3. Native speaker consultants

	KM	IM	SK	AK	ES
Dialect area	west	west	east	east	east
Age group	65–75	65–75	65–75	55–65	55–65
Gender	female	male	female	male	female

are universally shorter than corresponding voiceless stops, and this allophonic property may influence the durations of preceding vowels in the same way as contrastive length. Vowels preceding voiceless stops are noticeably shorter in English. The shortening effect of voiceless stops on preceding vowels has been replicated in many studies [Belasco, 1953, 1958; Denes, 1955; Peterson and Lehiste, 1960; House, 1961; Delattre, 1962; Sharf, 1962; Wolf, 1978; and many others]. Gussenhoven [2004] understands this effect as enhancement in the sense of Stevens and Keyser [1989].

Our expectation was therefore that, if anything, a vowel should be shorter when preceded or followed by a long consonant. In five of the categories in table 2, VCV(C), VVCVC, VC·VC, VVCV(C) and VC·CV (C), the correlations turned out the way we expected. In general the duration of V_1 decreases as that of C increases, and V_2 is shorter after a full-length consonant. However, in the VVC·CVC category, the results were almost the opposite of what we expected. Although there was generally a decrease in the duration of V_1 before consonants with full length, instead of shortening of V_2, we find lengthening. The reason for this difference, we argue, is that the fully long consonant is the surface manifestation of two distinct phonological structures. The results highlight the importance of phonological structure for understanding phonetic facts.

2. Methodology

2.1. Native Speaker Consultants

Inari Saami is spoken by about 250 speakers in Northern Finland. Because Inari Saami is seriously endangered, finding competent speakers for a phonetic study is a challenge. Five native speakers were consulted. All 5 speakers are bilingual in Inari Saami and Finnish. They belong to two dialect groups, which we call the east and the west dialect. The speakers include two pairs of siblings: speaker KM and speaker IM are siblings, and speaker SK and speaker AK are siblings. The two pairs of siblings are highly competent speakers: they grew up in Inari Saami households and have spoken Inari Saami continuously through childhood, adolescence and adulthood. The fifth speaker, speaker ES, is a less confident Inari Saami speaker than the others. She grew up in an Inari Saami family and spoke the language as a child, but did not speak it much during adolescence. As an adult, she developed an interest in Inari Saami, and became actively involved in the speech community. She has worked as an Inari Saami language teacher, and she has also worked as an Inari Saami radio reporter. However, she reports that she does not speak the language on a daily basis. In her own assessment, she is more fluent in Finnish than in Inari Saami. Table 3 gives the age, dialect area and gender of each of the 5 speakers.

2.2. Material

The results reported in this paper are based on recordings of elicitation targets that were selected from Sammallahti and Morottaja's [1993] dictionary. Sammallahti and Morrottaja's [1993] spelling

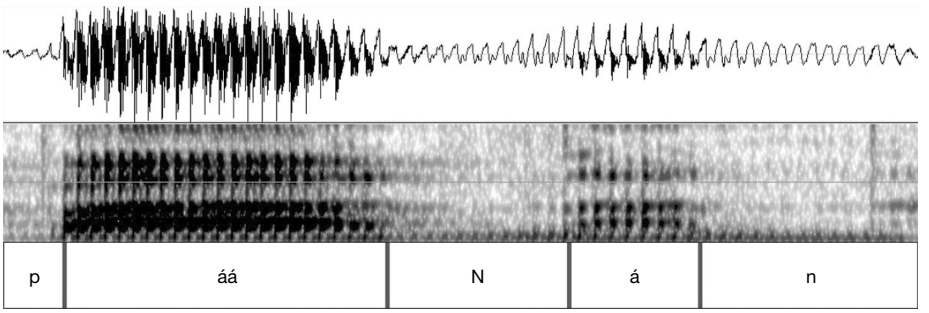


Fig. 1. Segmentation of pääṇán ‘tooth.ILL’.

convention distinguishes between long and short vowels and long, half-long and short consonants. The words selected for this study are all disyllabic (‘Appendix’, tables 1–6). The duration and f_0 of the vowel in the first syllable (V_1), the vowel in the second syllable (V_2), and the intervening consonant (C_x) were measured. In the word /lumˈo/ ‘pocket.ACC/GEN’ (orth. *luṃo*), V_1 is *u*, C_x is *ṃ* and V_2 is *o*.

The de facto written standard for Inari Saami is new, dating from the early 1990s, and most speakers are not familiar with it, since their schooling has been exclusively in Finnish. For that reason, we did not present the speakers with the words in writing. Instead, the native speaker consultants were presented with the Finnish translation of each word, and asked to first utter the corresponding Inari word in isolation and then at least twice in a carrier phrase. In research on endangered languages it is important that the speaker is not put in a situation where they feel insecure about their proficiency in the language, since this can have a negative impact on the pronunciation of the word (introducing artefacts into the results) and the speaker’s experience of working with linguists. Using Inari Saami as the language of presentation increases the risk of this, since the speaker may feel unsure about the word, not use it, or use a Finnish substitute. The speakers were asked to keep the pace even. Two carrier phrases were used: ‘say ____ to me’ or ‘say ____ to the man’ (*ââđâ _____ munjin*, *ââđâ _____ aalmai*). The words that were uttered in a carrier phrase were measured and analyzed; the words uttered in isolation were not.

The data was recorded using a Tascam portable DAT recorder and subsequently transferred onto a computer, where it was analyzed with the PRAAT phonetics software [Boersma and Weenink, 2005]. The segment boundaries were marked in a time-aligned label tier (TextGrid), using the onset and end of vowel formants as cue. The waveform was also considered, and each interval was played and listened to. An example is given in figure 1.

To extract the duration, we used a PRAAT script created by Katherine Crosswhite, and to extract the f_0 values we used a PRAAT script created by Mietta Lennes. (See, for example, http://www.linguistics.ucla.edu/faciliti/facilities/acoustic/praat.html.)

Several complicating issues arose due to the nature of the speech community and the nature of the phenomenon we are interested in. First, it was difficult to identify a sufficient number of words for each of the six types. The entire dictionary of Sammallahti and Morottaja [1993] was searched for appropriate data. There simply are no minimally distinct sextuplets of the relevant kind in Inari Saami. In principle we could have attempted to fill gaps by using nonsense words, but this was not possible because of the unfamiliarity of the orthography (see above). We determined certain criteria for words to be included: the words are all disyllabic and begin with a consonant, the first vowel is low and/or back, the middle consonant is [l], [m] or [n], and only words written with a short second vowel were selected. Potential confounding factors were controlled for in the statistical analysis (see section 2.3).

A second complicating issue concerns lexical variation. Different speakers do not necessarily use the same word to correspond to a word presented in Finnish. A speaker may use a word that differs

dialectally from that given in the dictionary. Code switching is also common, and speakers of Inari Saami frequently adopt lexical items from both Finnish and North Saami. Speakers therefore sometimes reported that they use the Finnish or North Saami word and that they don't know the 'proper' Inari Saami word, or else, they know it, but never use it naturally. It was deemed important to record only words the speakers use naturally, so we did not attempt to tell them which word they 'ought to' use.

A third issue is that the data were recorded in people's homes, not in a laboratory. Background noise sometimes occurs in the recordings and interruptions are quite frequent. Anticipating the possibility of poor sound quality in some recordings, we asked the informants to repeat the words several extra times, unless they reported being bored or tired. During segmentation, the recording of a word was discarded if there was background noise disturbance. Words were also discarded if the speaker showed hesitation, coughed, laughed, or spoke uncharacteristically slowly or fast. All these factors have made it difficult to obtain balanced data, despite making recordings over a series of trips to the field. For example, we have fewer tokens for speaker ES (103 words) than for the other speakers, but we are now confident that we have enough tokens for each type of word for each speaker in order to make solid comparisons. In order to balance out the imbalances of the sample itself we have controlled for potentially confounding factors in the statistical analysis (see section 2.3). The total sample size is 1,003 word tokens, and the smallest cell contains 13 observations. An example 'cell' would be all recorded and analyzed utterances of words (types and tokens) with a short V_1 and short C_x as spoken by speaker AK.

2.3. Statistical Analysis

For the statistical analysis we used the R software [R Development Core Team, 2006] to perform linear regression analysis. We utilized a series of ordinary least squares linear regression models. Results reported as significant all have a p value of $p < 0.01$.

Sagulin [2008] used our data for her undergraduate thesis in statistics in the Department of Mathematics at Uppsala University. She uses a linear model (lm) regression analysis to examine the data. In Sagulin [2008] outliers are removed, using the standard criteria for handling outliers presented in Fox [1997]. The results reported here do not exclude potential outliers, but a comparison between our study and Sagulin [2008] reveals that outliers are irrelevant for the results we report in this article. Despite the slightly different statistical methods employed, the results of the present study and Sagulin [2008] are the same: when a difference is reported as significant or not significant here, the same result is shown in Sagulin [2008].

A stepwise procedure was used to determine which variables were relevant. The models were fitted by hand. We started with a saturated model, and examined the analysis of variance (ANOVA) table and removed factors that did not reach significance (backward elimination). Sagulin [2008] examined the summaries of the *lm* models instead of ANOVA tables. This analysis allowed us to control for a variety of factors. V_1 type (short vs. long V_1) turned out to be a very important factor. Separate models were therefore eventually fitted for long and short vowels in order to gauge their effects separately. Separate models were also eventually fitted for each of the 5 speakers. In addition, the regression models allowed us to control for the quality of each segment (V_1, C_x, V_2). That is, we controlled for potential effects from intrinsic duration of different sounds; for example, low vowels tend to be intrinsically longer than high vowels [see, e.g., Lehiste, 1970]. We also coded and included in the models whether the final syllable of the word is open or closed. Finally, we included the duration of each segment that was not tested. For example, when we examined the duration of C_x, we included the duration of all V_1 and V_2 in the model. This was done in order to further control the potential effect of speech rate, beyond using a carrier phrase and instructing informants to speak at a steady pace.

3. Results

Our primary concern is to investigate whether there is a ternary distinction in consonant duration in Inari Saami. The short answer is yes. However, as we shall see below, this answer is an oversimplification, as it is not true for all speakers in words with long V_1. The average durations of the raw data are 78 ms for short consonants, 144 ms for

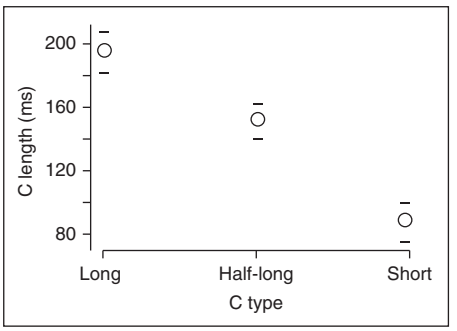


Fig. 2. The ternary distinction in consonants, all speakers.

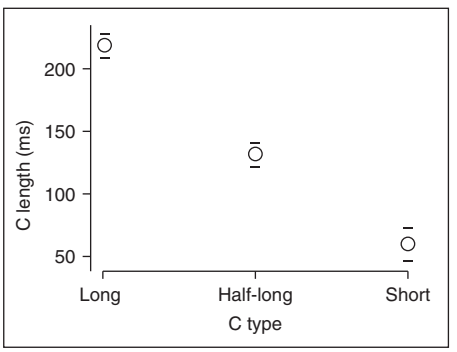


Fig. 3. Consonants after short V_1, all speakers.

half-long consonants and 191 ms for long consonants. For the reasons outlined in section 2, the data are not perfectly balanced, so these averages cannot be given too much weight. However, our linear regression analysis controlling for potentially confounding factors shows the ternary distinction to be significant. This is illustrated in figure 2. In this article, 'short C', 'half-long C', 'short V_1', etc., do not refer to the actual length of the segment but to the categories in Sammallahti and Morottaja's [1993] description.

Figure 2 does not take potential interactions into account. There is a significant interaction between V_1 type (whether the vowel is short or long) and C_x type in predicting consonant length, so let us consider words with short V_1 and words with long V_1 separately. Figure 3 illustrates the length of short, half-long and long C_x in words with short V_1. Figure 4 illustrates the length of the short, half-long and long C_x in words with long V_1.

In words with short V_1 (fig. 3), there is a ternary length distinction in C_x. However, the distinction in words with long V_1 (fig. 4) is binary: there is no significant difference in length between half-long and long consonants in words with long V_1. However, there are significant interactions between speaker and C_x type in predicting the duration of C_x. In other words, there is variation between speakers regarding the distinction they make in consonant duration. These differences between speakers cannot be attributed to the fact that the data are not perfectly balanced (see section 2).

Linguistic variation is found within all speech communities, and it has been argued that language is especially likely to vary between speakers in endangered language

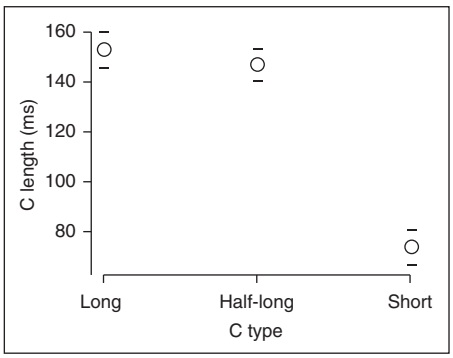


Fig. 4. Consonants after long V_1, all speakers.

communities [Dorian, 1978, 1994; Cook, 1989; Connell, 2002; Elordui, 2003]. Some possible reasons for this include the absence of a recognized norm, and also fewer opportunities to use one's native language, which results in less community feedback. Since Inari Saami is seriously endangered, variation between speakers is perhaps expected. For our purposes, this variation is highly interesting. If the ternary distinction is nonexistent or very weak for most speakers, then perhaps it should be concluded that the duration distinction is not really present in the language. The linguistic distinction may actually be signaled in some other way, with consonant duration as a (weak) secondary effect. The remainder of this article is devoted to studying the duration patterns in individual speakers.

The durations of C_x, V_1, and V_2 are examined below, comparing words with short, half-long and long C_x. Since there are significant interactions between V_1 type and C_x type in predicting duration, the results for words with a short V_1 and words with a long V_1 are reported in separate subsections below.

3.1. Words with Short First Vowel

3.1.1. Consonants after Short V_1

All 5 speakers make a ternary distinction in consonant duration after a short V_1: short consonants are significantly shorter than half-long consonants, and half-long consonants are significantly shorter than long consonants for all 5 speakers. This is shown for speaker KM in figure 5.

3.1.2. Short V_1

Two of the 5 speakers, speakers KM and SK, display a negative correlation between the duration of short V_1 and the following consonant. The durations of short V_1 before all three consonant types (short, half-long, long) are shown in figure 6 for speaker KM. Short V_1 is longer before half-long C than before long C, and longer still before short C. This is the expected negative correlation.

Speaker ES shows no inverse effects whatsoever. There is no significant difference in duration of V_1 before short C and before half-long C. And V_1 is in fact longer before long C than before half-long C, contrary to what would be expected. The remaining 2

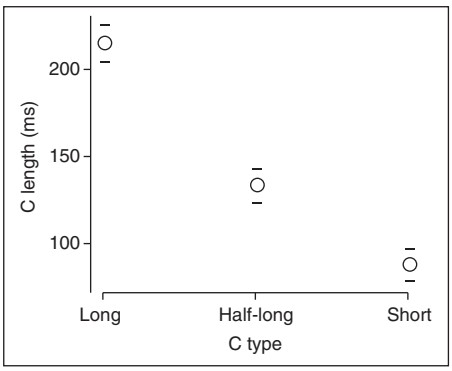


Fig. 5. Consonants after short V_1, speaker KM.

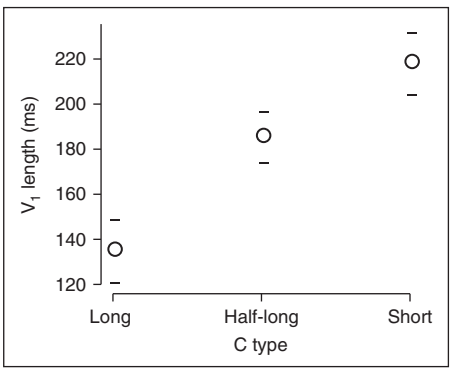


Fig. 6. Short V_1 before long, half-long and short C, speaker KM.

speakers, IM and AK, display no significant difference in V_1 length when comparing V_1 before short C to V_1 before half-long C. However, their V_1s are, as expected, shorter before long C than before half-long C.

In sum, the duration of C has clear effects on the duration of V_1. This is especially clear when comparing V_1 before half-long C to V_1 before long C, where we see the inverse effects in 4 of the 5 speakers (all except ES). However, only 2 speakers produce shorter V_1 before half-long C than before short C. We can conclude that the ternary effect is clearer in the consonant itself than in the preceding vowel.

3.1.3. V_2 in Words with Short V_1

Only 1 speaker, KM, displays a ternary inverse duration relationship between C and V_2, shown in figure 7. The other 4 speakers make a distinction in V_2 duration after half-long C and after long C only; they do not distinguish between V_2 after short C and V_2 after half-long C.

3.1.4. Summary of Study of Words with Short V_1

This section has only discussed words with short V_1. In such words, all 5 participants in our study make a ternary distinction in consonant duration. There are also inverse

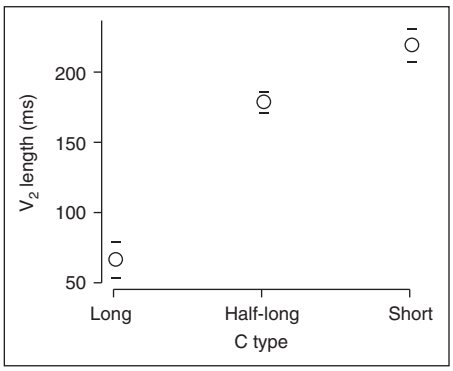


Fig. 7. V_2 after long, half-long and short C in words with short V_1, speaker KM.

Table 4. Words with short V_1

	Speakers				
	KM	IM	ES	SK	AK
Consonant					
C < C·	✓	✓	✓	✓	✓
C· < C·C	✓	✓	✓	✓	✓
V_1					
___C > ___C·	✓			✓	
___C· > ___C·C	✓	✓	✗	✓	✓
V_2					
C___ > C·___	✓				
C·___ > C·C___	✓	✓	✓	✓	✓

effects on the surrounding vowels, most notably so when comparing vowels flanking half-long consonants to vowels flanking long consonants. The findings of this subsection are summarized in table 4. In table 4, a check (✓) means that there is a significant difference, and a blank space means there is no difference. For example, consider speaker IM's V_1. V_1 is shorter before a long consonant than before a half-long consonant. However, V_1 is the same length before short consonants as before half-long consonants. The cross (✗) in the column for ES means there is a difference, but the difference is not in the expected direction: there is a positive correlation in V_1 and C duration here.

3.2. Words with Long First Vowel

3.2.1. Consonants after Long V_1

Speakers KM and IM make a ternary distinction in consonant duration after long V_1. This is illustrated in figure 8, which shows KM's averages in consonant duration

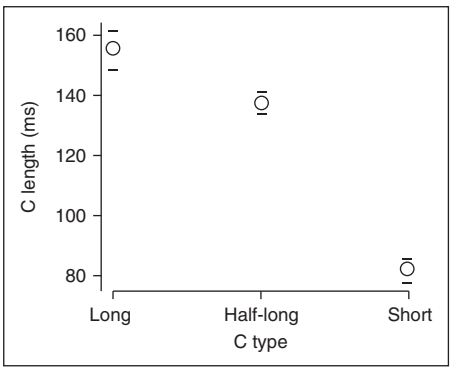


Fig. 8. Consonants after long V_1, speaker KM.

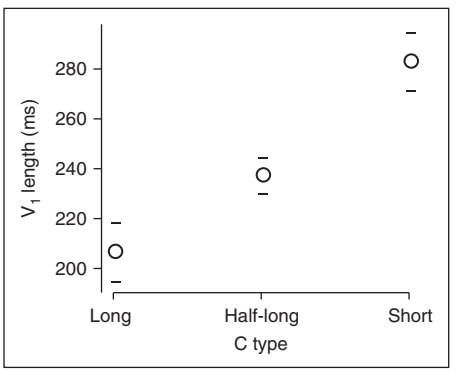


Fig. 9. Long V_1 before long, half-long and short C, speaker KM.

after long V_1. The other 3 participants, ES, IK and AK, distinguish in length between short and half-long C_x, but not between half-long and long C.

3.2.2. Long V_1

For 4 of the 5 participants, long V_1 divides into three significantly different groups according to the classification of the following consonant. V_1 is shorter before half-long C_x than before short C_x, and shorter before long C_x than before half-long C_x. This can be seen in the graph for KM given in figure 9. The graph shows the duration of long V_1 before long, half-long and short C_x.

Speaker AK does not make a ternary distinction in long V_1 according to the consonant type of the word. V_1 is longer before short C_x than before half-long C_x. However, V_1 is not longer before half-long C_x than before long C_x.

3.2.3. V_2 in Words with Long V_1

The speakers do not display an inverse relationship in V_2 duration in words with long V_1. None of the 5 participants distinguish between V_2 after short C_x and V_2 after half-long C_x. Speaker ES and AK also do not distinguish between V_2 after half-long C_x and V_2 after long C_x. Speakers KM, IM, and SK have a longer V_2 after long C_x than after half-long C_x,

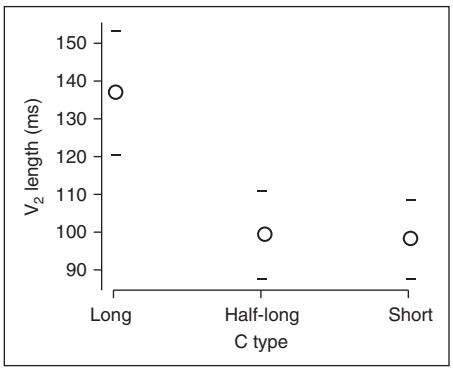


Fig. 10. V_2 after long, half-long and short C in words with long V_1, speaker KM.

Table 5. Words with long V_1

	Speakers				
	KM	IM	ES	SK	AK
Consonant					
C < C·	✓	✓	✓	✓	✓
C· < C·C	✓	✓			
V_1					
___C > ___C·	✓	✓	✓	✓	✓
___C· > ___C·C	✓	✓	✓	✓	
V_2					
C___ > C·___					
C·___ > C·C___	✗	✗		✗	

contrary to what would be expected under a hypothesis that the length of V_2 is inversely correlated to the length of C_x. In other words, there is no evidence that the duration of V_2 and the duration of C_x are inversely correlated in words with long V_1. The duration of V_2 in words with long, half-long and long C_x is shown in figure 10 for speaker KM.

3.2.4. Summary of Study of Words with Long V_1

The results of the study of words with long V_1 are summarized in table 5. The results do not exactly mirror the results of the study of words with short V_1; there are several differences. Perhaps most striking is the finding that only 2 speakers (KM and IM) make a ternary duration distinction in consonants after long V_1. A preliminary study shows that ES, AK, and SK may make use of pitch contour in addition to duration as a cue for quantity. Speakers KM and IM (the speakers of the western dialect) consistently pronounce their words with a higher fundamental frequency in the first syllable, whereas ES, AK, and SK (speakers of the eastern dialect) do not. In future work on Inari Saami we will study the role of this factor in more detail.

Also noteworthy is the finding that 4 speakers make a ternary distinction in length in V_1, where V_1 is inversely correlated in length to the length of C_x. Recall here that we are not talking about the actual length of the consonant, but its classification in the writing system.

Two speakers, speaker ES and speaker SK, seem to make the distinction between long and half-long C_x in the (inverse) duration of V_1 rather than in the duration of C_x itself. AK does not distinguish between half-long and long C_x in segment duration: there is no effect in V_1, C_x, or V_2.

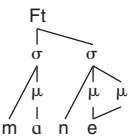
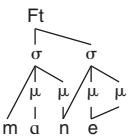
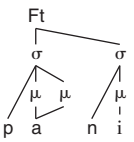
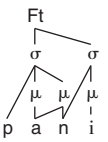
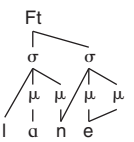
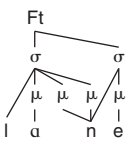
A further finding is that V_2 seems to play no role in distinguishing between the three types of consonants in words with long V_1. Although there are no inverse effects in the length of V_2, we find that 3 speakers have a longer V_2 after long C_x than after half-long C_x.

4. Discussion

Speakers KM and IM make a ternary distinction in consonant duration after short V_1 and also after long V_1. Speakers ES, SK and AK make a ternary distinction after short V_1, but not after long V_1. The distinction correlates with geographical dialect distinction: speakers KM and IM speak the western dialect and speakers ES, SK, and AK speak the eastern dialect.

Our starting point for this article has been the phonemic analysis implicit in the orthography of Sammallahti and Morottaja [1993]. Their analysis treats the VC·CV(C) *(lanne)* and VVC·CVC *(päännin)* types as a natural class – they both have fully long C, and so the expectation should be that they behave the same way both phonologically and phonetically. Our results clearly show that they do not behave in the same way phonetically. This we take to be diagnostic of a phonological difference. As we can see in table 4, V_2 is shorter in VC·CV(C) than in VC·V(C) when V_1 is short. This is expected given the negative correlations that obtain in Finnish and Estonian between an unstressed vowel and a preceding heavy stressed syllable. In table 5, however, we see that when V_1 is *long*, the expected negative correlation does not hold. In VVC·CVC, V_2 is either no shorter or actually longer than in VVC·V(C). This is unexpected given the phonological analysis implicit in the orthography of Sammallahti and Morottaja [1993], which is that the fully long consonant is a single phonological category. First, it is inconsistent with what we know about Finnish and Estonian. Second, it is also internally inconsistent, because we do find the expected negative correlation with *short* V_1. Finally, it is unexpected on functional grounds, since the positive correlation after long V_1 compromises the perception of a fully long consonant as fully long. The solution we believe lies in a difference in the phonological representation of full length in addition to (or instead of) the difference between short and long V_1. The most expositorily convenient way of illustrating the alternative phonological analysis is by showing how the categories developed diachronically. Inari Saami full length derives from two diachronic sources, and the difference in origin persists as a synchronic difference in phonological representation. Words of the VC·CV(C) type, such as *lanne*, derive historically from Proto-Saami disyllables, whereas words of the VVC·CVC type, such as *päännin*, are originally trisyllabic. Thus, *päännin* derives from an earlier form which may be reconstructed as **paannee-nee* 'tooth-ESS' (reconstructed according to Sammallahti [1998]); cf. South Saami /pææni-ne/ [Bergsland, 1994, and Ove Lorentz, pers. commun.].

Table 6. Moraic representations of short, geminate and overlong geminate contrast

Singleton	Geminate/cluster	Overlong geminate/cluster
		
‘egg ACC/GEN.SG’	‘egg NOM.SG’	
		
‘tooth ACC/GEN.SG’	‘tooth NOM.SG’	
		
	‘prison ACC/GEN.SG’	‘prison NOM.SG’

Where the source is a Proto-Saami disyllable, Inari Saami full length corresponds to overlength in North Saami, e.g. PS *tinːnɔɔ > NS /tidːnuu/, IS /tinːno/ ‘flintstone’; PS *ullɔɔ > NS /ulːluu/, IS /ulːlo/ ‘wool’ (reconstructed forms adapted into IPA from the Finno-Ugric transcriptions in Lehtiranta [1989]). Full-length consonants in Inari Saami that derive from this source can be identified on the basis of their phonological behavior as well: they condition short V_1 and V_2. Given this, the most conservative analysis is that Inari Saami has in fact retained phonological overlength. Plain geminates in North Saami correspond to either half-long or fully long geminates in Inari Saami. Full length is the rule when both V_1 and V_2 were short in Proto-Saami, and half-length when V_1 or V_2 (or both) were long, e.g. **kiððɤ* > NS /kiðða/, IS /kiðːðə/ ‘spring (season)’; **kurrɤ* > NS /kurra/, IS /kurːrə/ ‘gulley’; **tollɤ* > NS /tolla/, IS /tulːlə/ ‘fire’; but **keellɤ* > NS /kiella/, IS /kiellə/ ‘language’; **mɛɛrrɤ* > NS /mearra/, IS /meerrə/ ‘sea’; **t́śorr*ɔɔ > NS /tšorruu/, IS /tšorroo/ ‘ridge’; **paannee* > NS /paatnii/, IS /paanni/ ‘tooth’; **maannaa* > NS /maannaa/, IS /maanna/ ‘child’.

It is possible to represent these contrasts using moraic theory. Following Bye [2005], plain geminates are associated with a single mora, overlong geminates with two. Where a plain geminate follows a long vowel, the second mora of the syllable is shared between the long vowel and the geminate. These representations, illustrated in table 6, are extensively motivated for North Saami in Bye [2005]. Similar detailed motivation for Inari Saami must await further research.

Now let us address the development in trisyllabic words. North Saami has essentially preserved the Proto-Saami pattern, while Inari Saami has implemented two crucial innovations. In languages of the western Saami group, including North Saami and South Saami and, we may assume, Proto-Saami, stress is assigned by building syllabic

Table 7. Consonant length and position in foot structure

	Foot-medial	Foot-juncture
C	(CVCV)	(CV)(CVC)
CC	(CVCCV)	**(CVC)(CVC)**
C:C	**(CVC:CV)**	**(CVC:)(CVC)**

trochees from left to right (for similar cases, see e.g. Hayes [1995]). In trisyllabic words the final syllable does not receive stress and, according to some metrical theories, is not parsed into a foot: /σσσ/→(σ́σ)σ, e.g. South Saami /paanie + ne/→ (páa.ni).ne. This strategy for parsing entails a sequence of unstressed syllables at the end of the domain, so-called 'lapse' [Elenbaas and Kager, 1999]. Lapses are avoided in many languages, and Proto-Inari Saami eliminated the word-final lapse by forcing the construction of a syllabic trochee on the right edge of the domain. Trisyllabic inputs were now dealt with in the following way: */σσσ/→(σ́)(σ̀σ), thus */paannee + nee/→**(páan)(nèenee)*. Main stress was still assigned to the first syllable, which in trisyllabic words formed a 'degenerate' foot of its own. Following the reorganization of the metrical system, Inari Saami underwent one further development: word-final vowels in trisyllables were apocopated. Crucially, apocope left foot structure intact, i.e. Proto-Inari Saami *(σ́)(σ̀σ) > Inari Saami (σ́)(σ̀), thus **(páan)(nèenee)* → **(páan)(nèen)* →(páan)(nìn). The new class of consonant-final disyllables created by apocope did not merge with the class of consonant-final disyllables Inari Saami had inherited from Proto-Inari Saami, which consisted of a single syllabic trochee, e.g. (σ́σ). The cumulative effect of metrical restructuring and apocope was thus the introduction of a new contrast that turned on the presence versus absence of a word-final monosyllabic foot: (σ́σ) vs. (σ́)(σ̀). The Proto-Saami word-medial contrast between short vs. plain geminate vs. overlong geminate became cross-classified by a distinction between foot-medial and foot-junctural. The new system is shown in table 7. Full prosodic structures are provided in table 8 for the geminates.

Bye [2007] argues that these representations allow a succinct characterization of the morphology of Inari Saami. For example, certain case suffixes consistently require a domain-final monosyllabic foot, while others consistently do not.

The distinction between long and half-long consonants in Sammallahti and Morottaja [1993] is no more than a taxonomic one. For a geminate (moraic) consonant phonetic full length is the rule whenever (a) it is overlong (associated to two moras in phonological representation) or (b) straddles a foot boundary. Elsewhere geminates are realized as merely half-long. These phonetic implementation rules are informally summarized in table 9.

These same representations also make it possible to understand the difference in behavior between VC'CV(C) and VVC'CVC words with respect to the duration of V_2. The difference in the behavior of V_2 in the two types of word thus plausibly reflects a difference in the place of V_2 in the prosodic structure in the two word types, a prosodic structure that is specified by the lexicon or the morphological rules of the language. In VVC'CVC *päännin (páan)(nìn)*, V_2 is the head of a foot, and this is interpreted phonetically as greater length. In VC'CV(C) *lanne*, however, V_2 is in the same foot as

Table 8. Prosodic representations of geminate and overlong geminate contrast

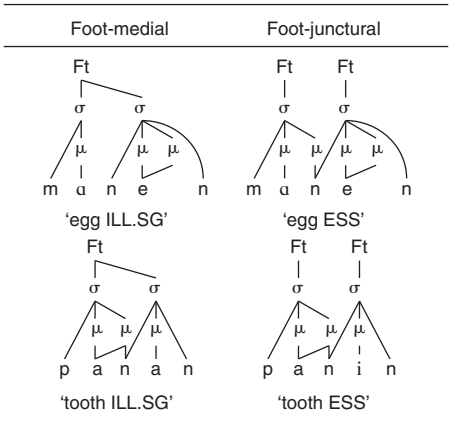


Table 9. Phonetic realization

Phonological representation	Phonetic realization
/C**ː**C/	[C·C]
/C)(C/	[C·C]
/CC/	[C·]

the preceding syllable and has no head status. The durations of adjacent segments only correlate negatively when they are in the same foot, and so phonetic interpretation has to make crucial reference to higher level prosodic structure.

The proposed analysis finds additional support in Itkonen's [1946] transcriptions. Itkonen [1946] uses a narrow Finno-Ugric transcription that distinguishes between three vowel lengths: short V, half-long V· and long VV. These alternate, as shown in the nominal paradigm for /pinnoo/ 'stack, pile' in table 10. There are two alternations, one in V_2 between half-long and long *o* and one in V_1 between short and long *i*.

The rules governing each of these alternations become manifest once the foot structure is inserted, as in table 11. We postulate a final monosyllabic foot whenever the Proto-Saami form is reconstructed as trisyllabic as in table 12. The corresponding modern Inari Saami and reconstructed Proto-Saami paradigms are compared below.

Itkonen [1946] transcribes *o* with full length whenever it forms the head of a monosyllabic foot on the present analysis, here in the inessive-elative forms (singular and plural), and the essive and partitive. In Proto-Saami these forms were trisyllabic. Elsewhere *o* is half-long. Turning to the second alternation between short and long *i*, *i* is long whenever it forms the head of a foot made up of a single open syllable. A plausible interpretation is that the vowel is lengthened to meet the requirement that the foot be binary (contain at least two moras).

Table 10. Inari Saami disyllable stem /pinnoo/ ‘stack, pile’

	SG		PL
NOM	pinˈoˈ		pinoˈh
GEN	pinoˈ		pinoˈjj
ACC	pinoˈ		pinojjt
ILL	pinˈoˈn		piinoojt
INESS	piinoost		piinoojn
ELAT	piinoost		piinoojn
ESS		pinˈnoon	
PART		pinˈnoot	

Table 11. Inari Saami disyllable stem /pinnoo/ with footing

	SG		PL
NOM	(pinˈoˈ)		(pinoˈh)
GEN	(pinoˈ)		(pinoˈjj)
ACC	(pinoˈ)		(pinojjt)
ILL	(pinˈoˈn)		(pii)(noojt)
INESS	(pii)(noost)		(pii)(noojn)
ELAT	(pii)(noost)		(pii)(noojn)
ESS		(pinˈ)(noon)	
PART		(pinˈ)(noot)	

Table 12. Proto-Saami disyllable stem *pinnɔɔ

	SG		PL
NOM	*pinnɔɔ		*pinɔɔk
GEN	*pinɔɔn		*pinɔj
ACC	*pinɔɔm		*pinɔjtee
ILL	*pinnɔ.ɔn		*pinɔjta.an
INESS	*pinɔɔsnee		*pinɔjnee
ELAT	*pinɔɔstee		*pinɔjstee
ESS		*pinnɔɔnee	
PART		*pinnɔɔtee	

5. Conclusions

Sammallahti and Morottaja [1993] posit a phonemic distinction between short, half-long and overlong consonants in Inari Saami. This analysis has served as the null hypothesis for this article. In this article we confirmed the existence of a clear ternary duration distinction in consonants after short V_1. After long V_1, there is also a

distinction, although it is not as robust. Where V_1 is long, the relative durations of V_1 and the consonant play a major role in signaling the distinction between short, half-long and long. Based on our knowledge of other languages like Finnish and Estonian, and our understanding of the functional underpinnings of relative duration, we expected the correlations between the durations of adjacent segments to be negative. This was largely the case, with one significant exception. The relative durations of V_1 and the following consonant turned out as expected. The duration of V_1 decreased as the duration of C_x increased. This effect was clearest for long vowels, but was present for short vowels as well for some speakers. Conversely, the duration of C_x decreased as the duration of V_1 increased. When we looked at V_2, whether the preceding consonant was short or half-long did not have an appreciable effect on the duration of V_2. The behavior of V_2 following a full-length consonant, however, turned out to depend on the duration of V_1. After short V_1, V_2 shortened as expected, but when V_1 was long, V_2 was generally lengthened. This is surprising given the null hypothesis. The positive correlation between V_2 and long C following a long V_1 forces us to reject the phonological analysis implicit in Sammallahti and Morottaja [1993]. We set up an alternative hypothesis in which Inari Saami has a three-way distinction between short, plain geminate and overlong geminate, a direct legacy of Proto-Saami that is also preserved in North Saami and most of the other western Saami languages. Superimposed on that is a distinction between foot-medial and foot-junctural geminates. Inari Saami full length, as given to us by phonetic and phonological descriptions, is not a phonological natural class, but rather the phonetic realization of a geminate that is overlong, in foot-junctural position, or both of these. Half-length is the phonetic result when neither of these conditions hold. The phonological analysis is supported by facts of the Inari Saami phonology and morphology, as well as phonetic transcriptions by Itkonen [1946].

Appendix

Words Included in the Study

Table 1. VCV(C)

palo	/pɑloo/	‘fear ACC/GEN.SG’	KM, IM, SK, AK
lamaš	/lɑmɑɑš/	‘been’	KM
mano	/mɑnoo/	‘course ACC/GEN.SG’	KM, SK
mane	/mɑnee/	‘egg ACC/GEN.SG’	KM, IM, ES, SK
salom	/sɑloom/	‘embrace 1SG.PRES’	KM
humo	/humoo/	‘fool ACC/GEN.SG’	IM
čáláh	/tšalaah/	‘write 2SG.PRES’	IM, ES, AK
čálám	/tšalaam/	‘write 1SG.PRES’	KM, IM, ES, SK, AK
humos	/humoos/	‘foolish’	AK

Table 2. VC V(C)

paḷo	/pɑlˈoo/	‘fear NOM.SG’	KM, IM, SK, AK
laṇe	/lɑnˈee/	‘fortification ACC/GEN.SG’	KM, IM, ES, SK, AK
maṇo	/mɑnˈoo/	‘course NOM.SG’	KM, IM, SK
maṇe	/mɑnˈee/	‘egg NOM.SG’	KM, IM, ES, SK, AK
maṇan	/mɑnˈɑɑn/	‘egg ILL.SG’	KM, IM, SK, AK
suṃe	/sumˈee/	‘sum ACC/GEN.SG’	IM, AK
noḷa	/nolˈɑɑ/	‘nought ACC/GEN.SG’	IM, AK
maṇa	/mɑnˈɑɑ/	‘go 1SG.PRES’	IM, ES, AK
cuṃe	/tsumˈee/	‘kiss ACC/GEN.SG’	IM, ES, AK
huṃo	/humˈoo/	‘fool NOM.SG’	IM, AK
koḷe	/kolˈee/	‘gold ACC/GEN.SG’	IM, ES, AK
luṃo	/lumˈoo/	‘pocket ACC/GEN.SG’	ES, AK
koṃe	/komˈee/	‘ghost ACC/GEN.SG’	ES

Table 3. VC CV(C)

talle	/tɑlˈle/	‘then’	IM, ES
lanne	/lɑnˈne/	‘fortification NOM.SG’	KM, IM, ES, SK, AK
fälli	/faalˈli/	‘hawk NOM.SG’	KM, IM, ES, SK, AK
kállu	/kalˈlu/	‘forehead NOM.SG’	KM, IM, SK, AK
kannu	/kɑnˈnu/	‘jug NOM.SG’	KM, IM, ES, SK, AK
pállu	/palˈlu/	‘ball NOM.SG’	KM, IM, ES, SK, AK
kalle	/kɑlˈle/	‘how many?’	KM
pallađ	/pɑlˈlɑð/	‘to be scared’	KM, SK
sollâ	/solˈlə/	‘lap NOM.SG’	IM, AK
kannun	/kɑnˈnun/	‘jug ESS’	IM
summe	/sumˈme/	‘sum NOM.SG’	IM, AK
kunnâ	/kunˈnə/	‘ashes NOM.SG’	IM, ES, AK
nolla	/nolˈlɑ/	‘nought NOM.SG’	IM, AK
lunne	/lunˈne/	‘at, by’	IM, AK
lummâ	/lumˈmə/	‘pocket NOM.SG’	IM, ES, AK
nommâ	/nomˈmə/	‘name NOM.SG’	IM, ES, AK
cumme	/tsumˈme/	‘kiss NOM.SG’	IM, ES, AK
kállá	/kalˈla/	‘husband NOM.SG’	IM, ES
kulluđ	/kulˈluð/	‘to sound’	ES
monnid	/monˈnið/	‘to lay eggs’	ES
kolle	/kolˈle/	‘gold NOM.SG’	ES, AK
komme	/komˈme/	‘ghost NOM.SG’	ES
kálluh	/kalˈluh/	‘type of shoe NOM.SG’	SK
válla	/valˈla/	‘whale ACC/GEN.SG’	SK

Table 4. VVCV(C)

sääni	/saani/	‘word ACC/GEN.SG’	KM, SK
čaalâ	/tšɑɑlə/	‘writing NOM.SG’	KM, ES, SK, AK
kääni	/kaani/	‘chicken ACC/GEN.SG’	KM, IM, SK, AK
pääni	/paani/	‘tooth ACC/GEN.SG’	KM, IM, SK, AK
soolâ	/soolə/	‘lap ACC/GEN.SG’	IM, ES
kuunâ	/kuunə/	‘ashes ACC/GEN.SG’	IM, AK
moonâm	/moonəm/	‘go 1SG.PRES’	IM ES AK
noomâ	/noomə/	‘name ACC/GEN.SG’	IM, ES, AK
čoonâm	/tšoonəm/	‘bind 1SG.PRES’	IM, ES, AK
táálu	/taalu/	‘house ACC/GEN.SG’	KM, IM, SK, AK
máánu	/maanu/	‘moon ACC/GEN.SG’	KM, IM
náálu	/naalu/	‘needle ACC/GEN.SG’	KM, IM
ráánu	/raanu/	‘raanu wall tapestry ACC/GEN.SG’	KM, IM, ES, AK
faalâm	/fɑɑləm/	‘offer 1SG.PRES’	KM, IM, ES, SK
faalâh	/fɑɑləh/	‘offer 2SG.PRES’	IM
määli	/maali/	‘soup ACC/GEN.SG’	KM, IM, SK
poolâm	/pooləm/	‘fear 1SG.PRES’	ES, AK
čoonâs	/tšoonəs/	‘bond NOM.SG’	ES, AK
maalâ	/mɑɑlə/	‘paint NOM.SG’	AK

Table 5. VVC V(C)

pääṇi	/paanˈi/	‘tooth NOM.SG’	KM, IM, ES, SK
pááṇán	/paanˈan/	‘tooth ILL.SG’	IM, AK
kaaṇun	/kɑɑnˈun/	‘jug ILL.SG’	IM
suuṃán	/suumˈan/	‘sum ILL.SG’	IM
kááļu	/kaalˈu/	‘forehead ACC/GEN.SG’	KM, IM, ES, SK, AK
kááṇu	/kaanˈu/	‘jug NOM.SG’	IM, ES, AK
nááļu	/naalˈu/	‘needle NOM.SG’	KM, IM
pááļu	/paalˈu/	‘ball ACC/GEN.SG’	KM, IM, ES, SK, AK
laaṇan	/lɑɑnˈɑn/	‘fortification ILL.SG’	IM, ES
fääļi	/faalˈi/	‘hawk ACC/GEN.SG’	KM, IM, ES, SK
kääļis	/kaalˈis/	‘husband NOM.SG’	KM, IM, ES, SK, AK
kääṇi	/kaanˈi/	‘chicken NOM.SG’	KM, IM, SK, AK
sooļân	/soolˈən/	‘lap ILL.SG’	IM, AK
luuṃâ	/luumˈə/	‘pocket ACC/GEN.SG’	IM
mááṇu	/maanˈu/	‘moon NOM.SG’	KM, SK, AK
tááļu	/taalˈu/	‘house NOM.SG’	KM, SK, AK
sääṇi	/saanˈi/	‘word NOM.SG’	KM, SK
määļi	/maalˈi/	‘soup NOM.SG’	KM, SK
kaaṇu	/kɑɑnˈu/	‘jug NOM.SG’	KM, SK, AK
rááṇu	/raanˈu/	‘raanu wall tapestry NOM.SG’	KM, SK, AK

Table 6. VVC CVC

päännin	/paanˈnin/	‘tooth ESS’	IM, AK
päännid	/paanˈnit/	‘tooth PART’	IM, AK
fäällun	/faalˈlun/	‘on offer’	KM, IM, SK, AK
faallâđ	/fɑɑlˈləđ/	‘to offer’	KM, IM, ES, SK, AK
poollâđ	/poolˈləđ/	‘to fear’	ES, AK
moonnâđ	/moonˈnəđ/	‘to go’	IM, ES, AK
čoonnâđ	/tšoonˈnəđ/	‘to bind fast’	IM, ES, AK
čoonnâs	/tšoonˈnəs/	‘bond ACC/GEN.SG’	ES, AK
čäälliđ	/tšaalˈliđ/	‘to write’	KM, IM, ES, SK, AK
čäällim	/tšaalˈlim/	‘writing NOM.SG’	IM, AK
kuullâđ	/kuulˈləđ/	‘to hear’	IM

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