PREASPIRATION IN SKOLT SÁMI

1. INTRODUCTION

Preaspiration is a well-known feature associated with several Northern European languages.[1] It has also long been acknowledged that preaspiration occurs in several North-American Indian languages.[2] The phenomenon of preaspiration itself is recognized as being one of the pronunciation characteristics of voiceless stops in these languages. The phonetic correlates of preaspiration are quite varied, for preaspiration may be manifested as [x], [f] sometimes, even an [C]-like sound in addition to the most obvious [h]-like manifestations.[3] But what they are precisely, and what the durational and intensity characteristics of preaspiration depend on, are questions not as yet studied in sufficient depth. In his paper on preaspiration in a Norwegian dialect[4] Wolter rightly quotes Haugen[5] who claims: "The phoneticians have had their eyes trained too exclusively on the end of the sound where aspiration traditionally occurs."[6]

Although Sámi (or Lappish),[7] a Finno-Ugric language, is well-documented as containing preaspiration, it has not been sufficiently studied as yet with regard to its phonetic properties. The term "preaspiration" has been denoted by such terms as "the voiceless vowel"[8] or "voice offset time"[9]: both terms needing to be reviewed

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1 In addition to Icelandic, which is probably one of the most thoroughly studied languages with regard to preaspiration, Farose, Scottish Gaelic and certain Norwegian dialects are also known to contain preaspirated voiceless stops (Péturson 1972, Shuken 1979, Ni Chasaide 1985, Wolter 1965).

2 Trubetzkoy (1939) refers to Fox and Hopi when analyzing preaspirated consonants.

3 Wolter (1965:595), Hasselbrink 1944:102-104.

4 Wolter (1965).

5 Haugen (1958).

6 Wolter (1965:594).

7 In recent literature the term "Sámi" has been preferred to the former "Lappish", the latter having acquired a pejorative meaning in most dialects.

8 Liberman (1971).

9 Engstrand (1987).

in order to establish a proper understanding of the phonetic realizations of preaspiration.

The purpose of the present paper is to examine preaspiration in Skolt Sámi (an Eastern Sámi dialect). An acoustic analysis of the duration of preaspiration was undertaken in order (i) to investigate the conditions upon which preaspiration duration may depend, and (ii) to seek an answer to the apparent segmentation dilemma -- namely, should the duration of preaspiration be associated with the duration of the consonant that follows, or the duration of the vowel that preceeds it, or should it even be considered as an independent segment? Following a brief description of the experiment, these two issues will be discussed. In connection with the first it will be argued that (i) short prevocalic duration is most likely to be followed by a longer period of preaspiration, (ii) the place of consonant articulation differences does not seem to affect preaspiration duration significantly, and (iii) high back rounded vowel articulation is followed either by preaspiration of very short duration with low intensity, or (as is more often the case) by no preaspiration at all. In connection with the second issue I shall claim that preaspiration is to be associated with voiceless stops, but that durational and intensity differences are to be considered as consequences of preceding vowel duration and/or vowel quality.

2. THE EXPERIMENT

During my field trips in 1983 and 1984 in Northern Finland (to the Sevettijärvi and Nellimö communities as well as several settlements between in the Ivalo-Nellimö-Sevettijärvi area), I selected two Sámi speakers with whom I decided to make recordings suitable for acoustic analysis. One informant, H.S. (female, 60 years of age at the time of the recording) is a speaker of the Suonikylä dialect; the other, K.J. (female, 55 years of age at the time of the

recording) speaks the Petsamo dialect.[10] Both subjects were prepared during several training sessions prior to the recordings that were made at the University of Manitoba in 1987.

The number of test-words given to the speakers was 550. Of these words it is relevant for the present study to note that there were 63 where preaspiration was apparent or was to be expected. The subjects were asked to place each word in the sentence frame 'say ... again'. Each test-word was repeated three times (at different recording sessions) by both subjects. The total number of test-words suitable for an acoustic analysis of preaspiration was 322.

The recording was made with a Scully Full-Track Broadcast Machine tape recorder; the tape speed was 7.5" per second. The microphone was placed about 18 inches from the subject. The test-words were read by the subjects from 3" x 5" filing cards. The reason for putting the test words on cards was to eliminate any noise that might be caused by turning pages; thus, background noise was negligible. The material was recorded on Ampex Audio Mastering Tape (7" reel), and simultaneously dubbed on casettes to serve as working tapes. Preliminary measurements were made using these working tapes; these were then checked against the data recorded on the reels.

The software used for preliminary durational measurements was the DSPS Digital Signal Processing Software, Real Time Signal Lab. The MacSpeech Version 2 software was used for the final evaluation of the data. Both types of software were designed to produce spectrograms (narrow and wide band) together with continuous waveform displays. An ability to expand both spectrograms and wave-forms contributed to the achieving of the desired accuracy. The MacSpeech program had several additional features (among them, a multiple layout frame, expanded time

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[10] The Suonikylä Skolts comprise the majority of all Skolt Sámi speakers (Korhonen 1981:18). They live mainly around the Sevettijärvi community in North-East Finland, very close to the Norwegian border. The Petsamo Skolts live scattered between Ivalo and the Russian border. The total number of Skolt Sámi speakers is around 600.

waveform, fundamental frequency plots, and segment energy envelope). All these features proved useful when attempting to identify segment boundaries.

3. THE DURATION OF PREASPIRATION

Preaspiration appears before the bilabial, alveolar, palatal and velar voiceless stops -- [p] [t] [c] and [k] -- in Skolt Sámi. Consonant duration differs depending on grade alternation.[11] The two grades that are relevant in connection with preaspiration are the two strong grades -- Grade II and the overlong grade Grade III.[12] The test-words were grouped according to (i) the place of articulation of the stops, and (ii) the two alternating grades. The Tables that follow indicate the mean duration ($\bar{x}$) and standard deviation (SD) of the preaspiration associated with the different stop consonants.

Table 1. The duration of preaspiration and the duration of [p] in Grade II and Grade III disyllabics (H.S.)

	Preaspiration		[p]	
	$\bar{x}$	SD	$\bar{x}$	SD
GRADE II	70	13.6	144	21.4
GRADE III	86.8	12.2	275.6	26.3

[11] Gradation of intervocalic consonants -- consonants weakening in closed syllables -- was historically a phonetically motivated process. In Skolt Sámi consonant gradation has become morphologized.

[12] Historically preaspiration has been associated with the strong grade of geminate consonants. However, as a result of analogy, preaspiration has also been occurring in connection with the strong grade of single voiceless stops (Korhonen 1981:158).

Table 2. The duration of preaspiration and the duration of [p] in Grade II and Grade III disyllabics (K.J.)

	Preaspiration		[p]	
	$\bar{x}$	SD	$\bar{x}$	SD
GRADE II	58.5	9.1	169	22.5
GRADE III	78.1	13.2	273.5	21.3

Table 3. The duration of preaspiration and the duration of [t] in Grade II and Grade III disyllabics (H.S.)

	Preaspiration		[t]	
	$\bar{x}$	SD	$\bar{x}$	SD
GRADE II	66.5	10.1	158.5	20.6
GRADE III	79.4	11.5	282.3	25.2

Table 4. The duration of preaspiration and the duration of [t] in Grade II and Grade III disyllabics (K.J.)

	Preaspiration		[t]	
	$\bar{x}$	SD	$\bar{x}$	SD
GRADE II	66.8	7.4	171.5	9.7
GRADE III	80.2	14.8	276.3	28.2

Table 5. The duration of preaspiration and the duration of [c] in Grade II and Grade III disyllabics (H.S.)

	Preaspiration		[c]	
	$\bar{x}$	SD	$\bar{x}$	SD
GRADE II	62.4	14.5	171.6	14.4
GRADE III	78.1	14.7	271.5	27.2

Table 6. The duration of preaspiration and the duration of [c] in Grade II and Grade III disyllabics (K.J.)

	Preaspiration		[c]	
	$\bar{x}$	SD	$\bar{x}$	SD
GRADE II	64	14.1	164.7	15.9
GRADE III	82.2	9.3	282.5	27.1

Table 7. The duration of preaspiration and the duration of [k] in Grade II and Grade III disyllabics (H.S.)

	Preaspiration		[k]	
	$\bar{x}$	SD	$\bar{x}$	SD
GRADE II	61.8	8.8	157.6	20.4
GRADE III	82.1	7.1	292.9	22.3

Table 8. The duration of preaspiration and the duration of [k] in Grade II and Grade III disyllabics (K.J.)

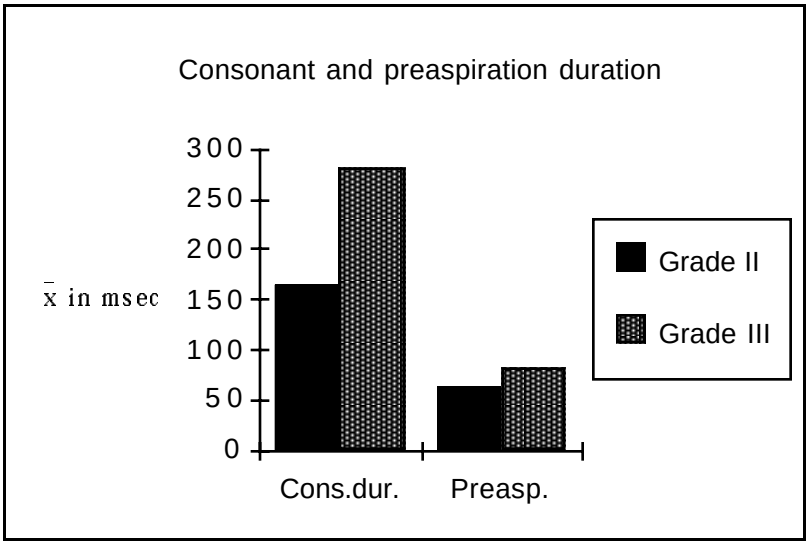
	Preaspiration		[k]	
	$\bar{x}$	SD	$\bar{x}$	SD
GRADE II	63.3	14.2	180.4	24.3
GRADE III	83.4	9.2	297.6	20.2

As may be seen from Tables 1-8 the durational values of the two subjects are very similar, any differences being negligible. It is then justified to consider these results as representative of the duration of preaspiration with regard to the duration of the relevant voiceless stops of Skolt Sámi disyllabics. Thus the data shown in the Tables suggest the following regularities:

(i) The average duration of preaspiration in Grade II disyllabics is 64.78 msec, while the average duration for Grade III disyllabics is 82.21 msec. The difference is thus approximately 20 msec -- the average is 17.43 msec -- a similar figure for the durational

difference occurring in connection with all the relevant Grade II and Grade III test-words (*Figure 1*).

Figure 1. The duration of Grade II and Grade III consonants in relation to preaspiration duration



(ii) Longer preaspiration seems to cooccur with longer consonant duration for as we see from the values shown in the Tables, duration of consonants in Grade III is considerably longer than that of Grade II consonants by an average of 133.94 msec.

(iii) The place of articulation of the voiceless stops does not seem to affect the duration of preaspiration.

Of the above three points, the second needs to be discussed in more detail for it looks as though considerably longer consonant duration would automatically be associated with preaspiration of longer duration. Before acknowledging this apparent interdependency, however, we need to consider another possible conditioning factor, the duration of the preceding vowel. For previous research has shown that there is indeed a regularity to be observed here, i.e. shorter vowel duration is associated with longer

preaspiration values.[13] It is essential then to examine whether similar durational interdependencies may exist in Skolt Sámi between the preceding vowel and preaspiration. Table 9 presents the duration of the vowel preceding consonants in Grade II and Grade III respectively as well as the duration of preaspiration associated with these vowels. There are no significant differences in vowel duration with regard to individual vowel quality differences.[14] With the exception of one vowel -- the high back rounded vowel [u] -- after which preaspiration is manifested differently (see below), all cases of individual vowel duration may safely be averaged and examined in the two grades with regard to the duration of the following preaspiration.

Table 9. The duration of preaspiration and the duration of the preceding vowel

	Preaspiration duration		Duration of the preceding vowel	
	$\bar{x}$	SD	$\bar{x}$	SD
GRADE II	64.78	11.4	197.5	21.3
GRADE III	82.21	11.5	108.6	13.5

From Table 9 we may conlude that longer preaspiration is associated with shorter vowel duration (*Figure 2*). The question is, then, which determines the duration of preaspiration: the longer duration of the folowing consonant (as indicated above, 133.92 msec longer in Grade III than in Grade II disyllabics), or the considerably shorter duration of the preceding vowel (88.9 msec shorter in Grade III words)? In Skolt Sámi there exists a

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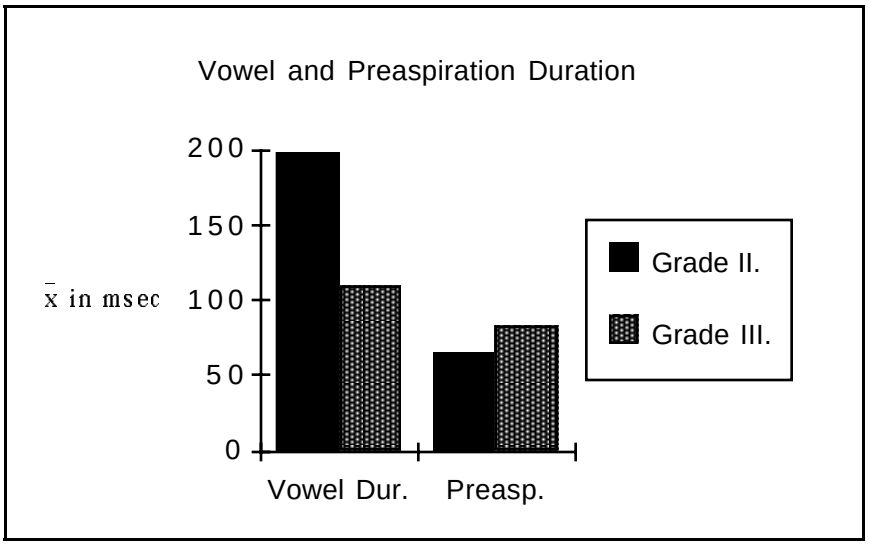
[13] For example, Garnes (1973:279) mentions that durational values for preaspiration decrease with increasing duration of the corresponding vowel. This accords with the tendency in Icelandic to maintain constant duration from the onset of the vowel to the onset of the consonant.

[14] In McRobbie (1991) there is a detailed analysis of vowel duration and a consideration of possible divergencies due to different vowel qualities. It was concluded there that these differences are not significant enough to hinder distinguishing between the six main structural types of disyllabics in Skolt Sámi.

compensatory relationship between the first syllabic vowel and the consonant(s) following it. I have discussed this relationship in considerable detail elsewhere, so here I will simply state this as one of the characteristic features of Skolt Sámi prosody.[15] It would therefore seem arbitrary to choose either the vowel preceding preaspiration or the consonant following it, as conditioning the duration of preaspiration, for longer consonant duration is associated with shorter vowel duration. Research on preaspiration as manifested in other languages may, however, be able to assist in resolving this dilemma without resorting to an arbitrary choice in this respect. On the basis of examining Icelandic preaspiration,[16] where the duration of preaspiration seems to be conditioned with more certainty by the preceding vowel, we may be entitled to choose the shorter vowel duration as affecting preaspiration duration in Skolt Sámi also.

Figure 2. Vowel duration of Grade II and Grade III disyllabics in relation to preaspiration duration



15 McRobbie (1991).
16 Haugen (1958), Garnes (1973).

4. THE CASE OF EXCEPTIONS

Preaspiration appears in the vast majority of cases in Skolt Sámi when Grade II and Grade III words that contain voiceless stops. From the above discussion, the regularities present in the manifestations of preaspiration concerning duration are also relatively easy to see. As was stated above, the duration of preaspiration may also be predicted on the basis of the duration of the preceding vowel, shorter vowel duration being associated with longer duration for preaspiration. There is one instance, however, where preaspiration does not appear at all, or, if occasionally appearing, is of considerably shorter duration and of low intensity. This kind of preaspiration -- or rather lack of it -- is noticeable after the vowel [u] in Skolt Sámi. Out of 69 relevant recordings, 16 contain preaspiration of durations between 30 and 40 msec with considerable lower intensity than preaspirations display in general; the rest of the test-words contain no preaspiration at all (see *Figures 3* and *4*).

Figure 3. Broad-band spectrogram (300 Hz bandwidth) of the word [ju:k:ʊm] 'drink' (Past.Part.) as spoken by subject H.S. The segments measured: [u] 157.5 msec., [k] = 187.5 msec.

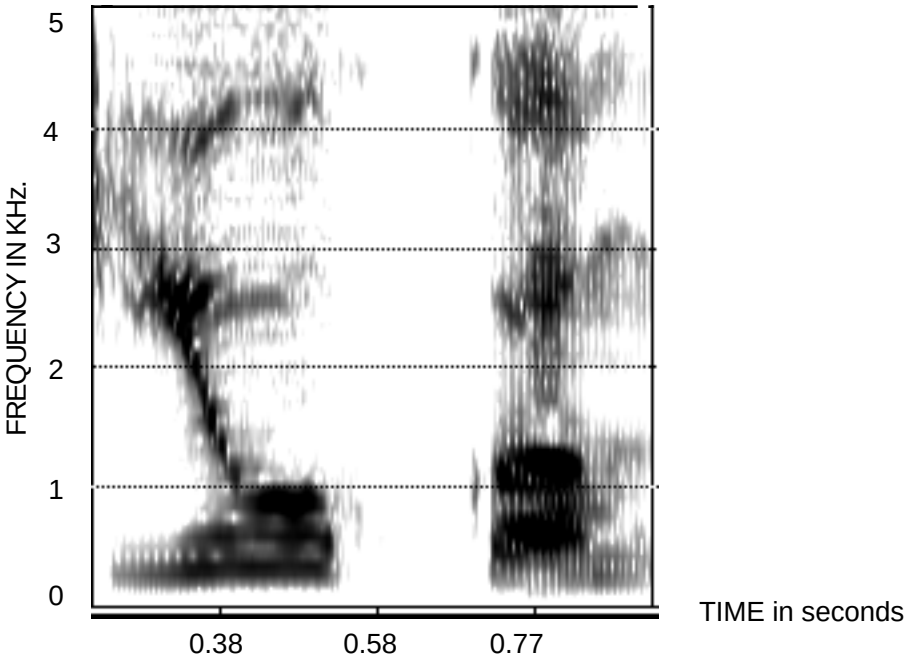
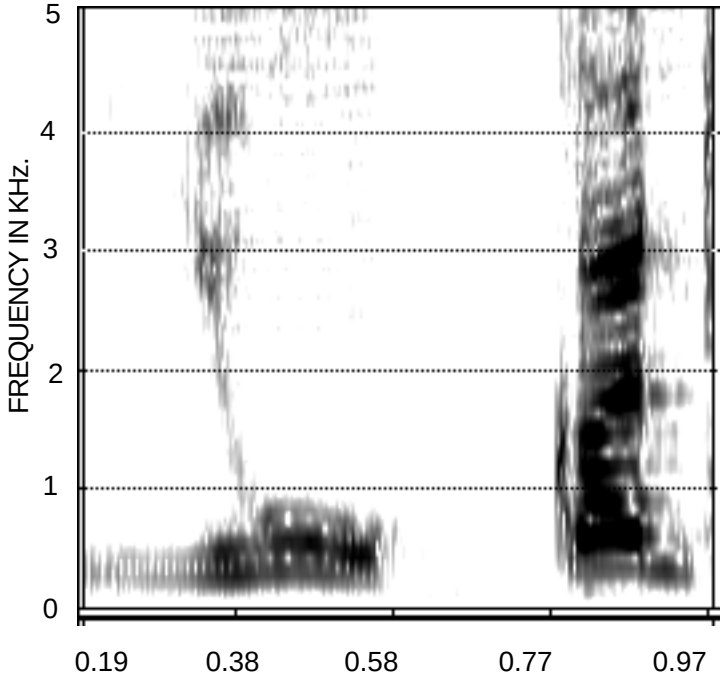


Figure 4. Broad-band spectrogram (300 Hz bandwidth) of the word

[ju:k:ʊʊ̯] 'drink' (Inf.) as spoken by subject K.J. The segments measured: [u] 195 msec., [k] = 217.5 msec.



This phenomenon was also observed and pointed out in Wolter's analysis of preaspiration in Northern Jæren, a Norwegian dialect.[17] He states that the duration of preaspiration after rounded vowels does not exceed 0.12 cs in polysyllables and 0.07 cs in monosyllables. The striking similarity in Skolt Sámi, with regard to the marked difference in the realization of preaspiration after [u], indicates that the phenomenon Wolter observed in the Norwegian dialect and that in Skolt Sámi may be considered as one of the universal properties of preaspiration. There is one refinement to be made, however, with regard to Wolter's observation concerning the feature *roundness* as an explanation of the non-occurrence or weaker and shorter realization of preaspiration. On the basis of Skolt Sámi data there are numerous instances of preaspiration following [o], [ɔ] and [ʊ] where the duration and intensity of preaspiration do not differ from those following unrounded vowels (compare *Figures 5* and *6*).

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[17] Wolter (1965:595).

Figure 5. Broad-band spectrogram (300 Hz bandwidth) of the word [jɔt:ɛ] 'walk' (Prs.Pl3.) as spoken by subject H.S. The segments measured: [ɔ] 82.5 msec., [t] = 300.5 msec., preaspiration: 67 msec.

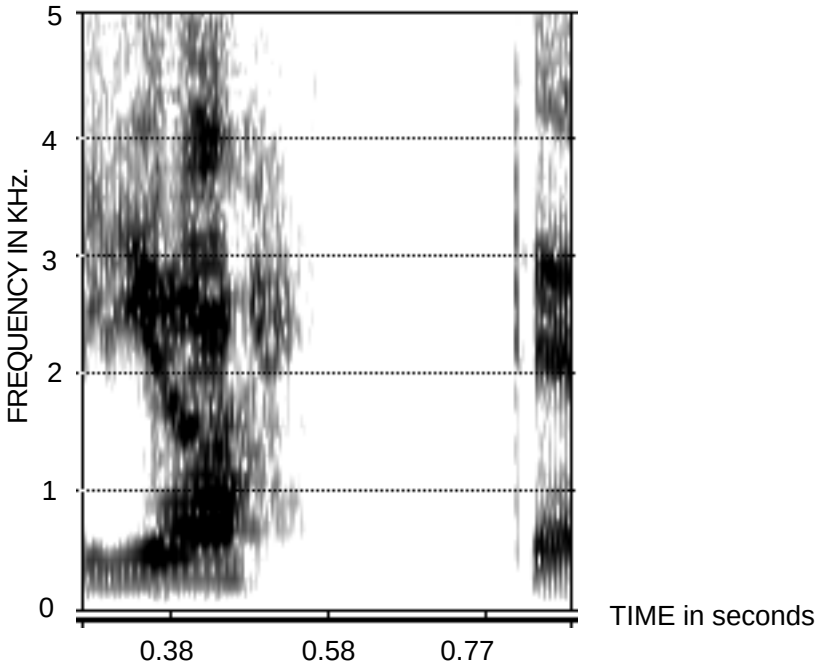
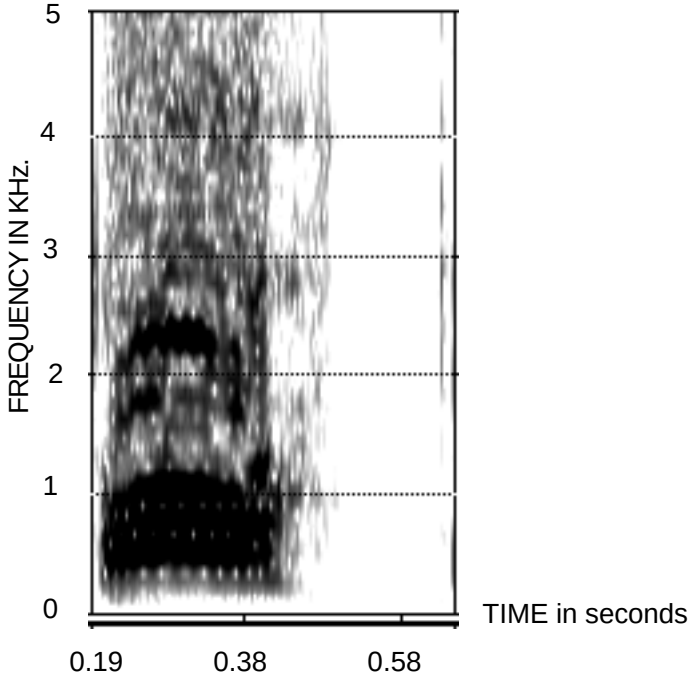


Figure 6. Broad-band spectrogram (300 Hz bandwidth) of the word [po:t:] 'end' (Prs.Sg3.) as spoken by subject H.S. The segments measured: [o] 202.5 msec., [k] = 140.5 msec., preaspiration: 77 msec.



The occurrence of preaspiration after rounded vowels other than [u] suggests that the presence of lip rounding by itself may not

be a sufficient condition for predicting the non-occurrence of preaspiration. Examination of Skolt Sámi data suggests that close articulation together with lip rounding have to be regarded as causes for the lack of preaspiration. In other words, the taking into consideration of the characteristic shape and size of the vocal tract resulting from the articulatory differences associated with the different rounded vowels, may further understanding with respect to the presence or absence of preaspiration after rounded vowels. The recognition of articulatory differences as conditioning factors for the occurrence of preaspiration sheds doubts on the claims expressed by Wolter concerning the role of lip rounding as the sole reason for the non-occurrence of preaspiration.

It may be in order to mention here that Wolter finds that the auditory impression of preaspiration is stronger after rounded vowels than after unrounded vowels, even though spectrographic analysis shows no preaspiration.[18] While the data upon which he based his claims are not available to me, I can attempt to offer an explanation of this claim.

It was pointed out by Garnes that in Icelandic there is a tendency to keep the duration constant from the onset of the vowel to the onset of the consonant (see fn. 12 in this paper). A similar tendency was observed while analysing the Skolt Sámi material. Regardless of whether preaspiration is present (with 30-40 msec duration) or absent after [u], the duration from the onset of the vowel to the onset of the consonant remains constant. This may also be the case in Wolter's Norwegian dialect; because of the tendency to maintain a stable duration, the absence of preaspiration is not perceived by the listener.. It has to be doubted, however, that the actual physical properties of preaspiration could be perceived, in view of the fact that spectrograms show no evidence of preaspiration. We should therefore assume that there is a tendency to keep the temporal organization of the VC sequence that may suggest to the listener that he hears preaspiration when in fact it is not present in actual physical terms: i.e. the temporal structure of

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[18] Ibid.

the VC sequence will assure that the lack of preaspiration will be compensated for by longer consonant duration.

5. THE SEGMENTATION OF PREASPIRATION

The question whether the duration of preaspiration should be counted as part of either the duration of the consonant or the duration of the preceding vowel, or whether it should even be considered to be an independent segment, has not been resolved satisfactorily to date in the relatively scanty literature on preaspiration. Trubetzkoy (1936) and Haugen (1958) consider preaspiration to be the property of the following voiceless stop. Lehiste (personal communication) suggests counting the duration of preaspiration in with the vowel duration. Engstrand (1987) considers preaspiration to be a seperate segment, and Garnes (1973) argues likewise.

It has been mentioned earlier that the physical manifestations of preaspiration could be a variety of articulations, such as [h], [x] or even [C]. In Skolt Sámi the realization of preaspiration is a [h] sound clearly showing the formant structure of the preceding vowel together with the characteristic frication associated with the articulation of the glottal fricative (*Figure 7* and *8*).

Figure 7. Broad-band spectrogram (300 Hz bandwidth) of the word [ɛkːa] 'old woman' (Ill.Sg.) as spoken by subject K.J. The segments measured: [ɛ] 112.5 msec., [k] = 341.5.5 msec., preaspiration = 131 msec.

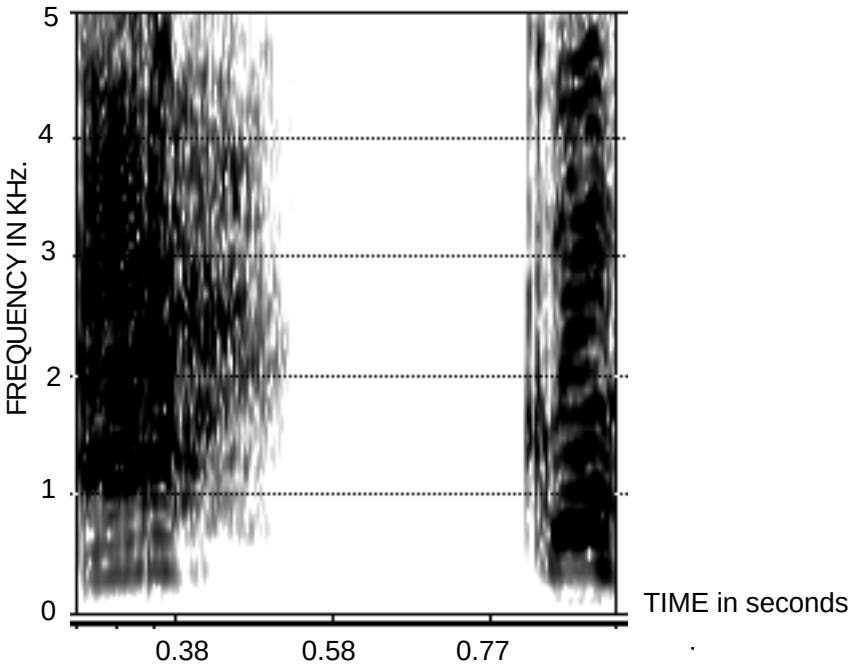
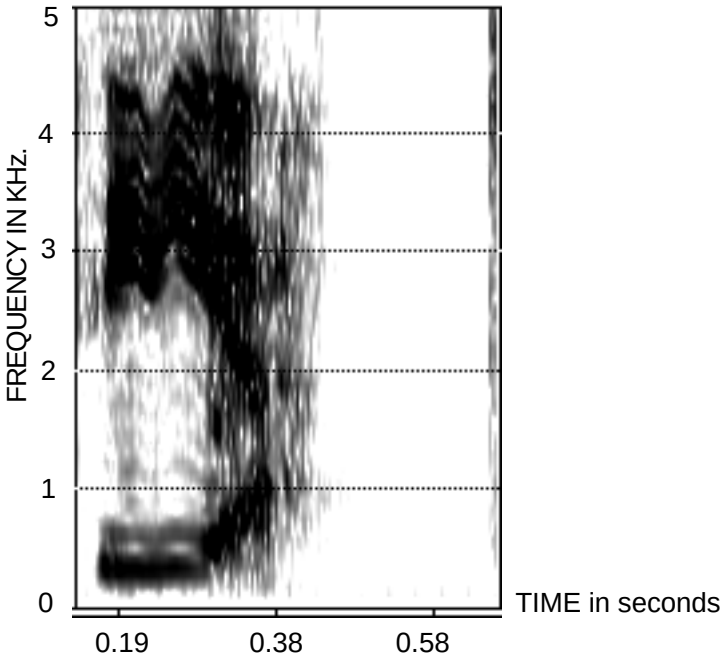


Figure 8. Broad-band spectrogram (300 Hz bandwidth) of the word [tiɛtː] 'know' (Prs.Sg3.) as spoken by subject K.J. The segments measured: [ɛ] 195 msec., [t] = 211 msec., preaspiration = 74 msec.



This characteristic realization of Skolt Sámi preaspiration has caused it to be considered a "voiceless vowel" transcribed in Finno-Ugric literature invariably as [ɔ] regardless of the type of vowel preceding it.[19] That preaspiration is, however, more than merely a voiceless vowel is clear from the recognition of frication in the spectrograms so typical of the voiceless glottal fricative.

Engstrand (1987) introduces the term *voice offset time* (VOffT). It designates the time between the offset of the voicing of the vowel and the beginning of the silent interval associated with the stop consonant following it.[20] This term is coined from the analogue of the familiar *voice onset time* (VOT) as introduced by Lisker and Abramson (1964).

Although Engstrand does not explicitly says so, his term implies that preaspiration contains a period of voicing, and that after a decrease of this voicing -- that may mean the end of the period of preaspiration -- the silent interval associated with the closure follows. The use of VOffT suggests that a certain degree of voicing may be considered to be one of the phonetic properties of preaspiration. The term *voiceless vowel*, as introduced above, that has been used for referring to preaspiration, seems to be closer to describing the preaspiration phenomenon, for indeed it is difficult to see that voicing should in any way be regarded as a property of preaspiration. Thus the term VOffT has to be used with caution, for the parallel with VOT -- where the interval between the release of the closure and the onset of voicing clearly refers to a voiceless period -- is not exactly indicative regarding the acoustic properties of preaspiration. Even though in the case of preaspiration the cessation of voicing after the vowel may not be always abrupt, the voicing period is but a short interval and definitely not to be associated with the preaspiration period itself.

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[19] The Finno-Ugric symbol has no relation to the same symbol known from IPA transcriptions.

[20] Engstrand also refers to liquid + voiceless stop sequences where VOffT is relevant (1987:105).

In view of the above, then, it seems advisable to consider employing the term *preaspiration* instead of either *voiceless vowel* or *voice offset time* .

Having established the characteristic properties of preaspiration, there still remains to be discussed the question relating to the segmentation of preaspiration. Preaspiration occurs only before voiceless stops in Skolt Sámi,[21] which may suggest that it should be associated with the consonant following it. It had been stated earlier in this paper, however, that the duration of preaspiration is definitely determined by the duration of the preceding vowel. Also, it was pointed out that the articulatory properties of the preceding vowel may cause preaspiration not to be manifested even though the vowel is followed by a voiceless stop. In acknowledging these facts it would seem reasonable to argue that preaspiration should be associated with the vowel preceding it. I shall claim, however, that preaspiration is indeed the property of the voiceless stops, and that when proceeding with segmentation its duration is to be counted in with the consonant duration. Two arguments will be presented here in support of this claim. The first is simply acknowledgement of the fact that preaspiration does not occur before any other consonants: the VC sequence where preaspiration is relevant must contain a voiceless stop as the second member of this sequence. The second argument may be stated as follows. It was acknowledged that after [u] there is no preaspiration attestable before the voiceless stop. However, consonant duration measured from the end of the vowel up to the release of the closure is the same after the [u] as durations measured with the *including* of the preaspiration period present after all the other vowels. Should preaspiration be counted within the duration of the preceding vowel it would mean that all vowels would be of similar duration (197.5 + 64.78 msec for Grade II words, and 108.6 + 82.21 msec for Grade III

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[21] Engstrand reports that preaspiration is present before voiced stops also in Lule Sámi (a Southern Sámi dialect). He concludes that VOffT plays an important role in the distinguishing of voiced and voiceless stops in Lule Sámi (1987:115).

words) but only 197.5 msec (Grade II) or 108.6 (Grade III) msec for the vowel [u] -- an unlikely assumption.

It may be councluded, then, that counting preaspiration together with the duration of the voiceless stop implies (i) acknowledgement of the primary condition for the manifestation of preaspiration, i.e. there has to be a voiceless stop associated with it, and (ii) that characteristic durational values associated with the end of the vowel and the onset of the following consonant remain constant regardless of the presence or absence of preaspiration.

6. SUMMARY

On the basis of the acoustic analysis of preaspiration in Skolt Sámi three findings have emerged. First, duration of preaspiration does not depend on the place of articulation of the voiceless stops that condition the manifesting of preaspiration. Second, there is an inverse relationship between prevocalic duration and the duration of preaspiration, shorter prevocalic duration being followed by a longer preaspiration period. Third, close rounded vowels cause either preaspiration with considerably shorter than expected duration or no preaspiration at all. In conclusion, concerning segmentation criteria involving preaspiration periods it seems reasonable to count the duration of preaspiration in together with the duration of the following voiceless stop.

REFERENCES

ENGSTRAND, O. (1987). Preaspiration and voicing contrast in Lule Sámi, *Phonetica* 44, 103-116.

GARNES, S. (1973). Phonetic evidence supporting a phonological analysis, *Journal of Phonetics* 1, 173-183.

HAUGEN, E. 1(958). The phonemics of modern Icelandic, *Language* 34, 55-88.

KORHONEN, M. 1(981). *Johdatus lapin kielen historiaan*. [Introduction to the history of the Lappish Language] Helsinki: Suomalaisen Kirjallisuuden Seura.

LIBERMAN, A.S. (1971). The voiceless vowel in Lapp again, *Sovetskoe Finno-Ugrovedenie* VII, 269-276.

LISKER, L. & ABRAMSON, A.S. (1964). A cross-language study of voicing in initial stops: acoustical measurements, *Word* 20, 384-422.

McROBBIE, Z. (1991). *An acoustic analysis of duration in Skolt Sámi disyllabics*. Ph.D. dissertation, The University of Manitoba.

NI CHASAIDE, A. (1985). *Preaspiration in phonological stop contrasts*. Ph.D. dissertation, University College of North Wales.

PÉTURSSON, M. (1972). La preaspiration en islandais moderne. Examen de sa réalisation phonetique chez deux sujets. *Studia Linguistica* 26, 61-80.

SHUKEN, C.R. (1979). Aspiration in Scottish Gaelic stop consonants, in R. Hollien (ed.) Current Issues in the Phonetic Sciences I. Amsterdam: Benjamins. 451-458.

TRUBETZKOY, N.S. (1939). *Grundzüge der Phonologie*. Travaux de Cercle Linguistique de Prague VII. Prague.

WOLTER, H. (1964). On preaspirated stops in a Norwegian dialect, *Proceedings of the 5th International Congress of Phonetic Sciences*. Basel - New York. 594-597.