

On Subglottal Pulses

The existence of subglottal pulses has been implicitly acknowledged in many studies on such languages as English where words like *treey* (< noun stem *tree* + adjective suffix *-y*) and, in some dialects *power* as well, are pronounced without intervening semivowels or consonants between the syllabic nuclei. The two final syllables in such North Saami words as *fertejit* ‘they (pl.) have to’ are sometimes pronounced without an intervening /j/ with two consecutive syllabic vowels /-i.i-/ as a result ([.] = pulse/syllable boundary). In Finnish, poetic meter sometimes calls for a trisyllabic pronunciation of words like *puheet* ‘speech nom.pl.’ (*/pu.he.et/*) instead of the normal bisyllabic pronunciation (*/pu.heet/*).

As proposed by Stetson already in 1928 (“chest pulse”, Stetson 1951), the concept of subglottal pulse has rarely interested phonologists and there is little or no reference to it in textbooks or phonological studies (cf. Goldsmith 1990). Syllable studies usually leave the concept of syllable boundary undefined, concentrating on the phonetic and phonological phenomena around the syllable boundary which remains uninteresting in itself. Ladefoged (1982) summarizes the situation by stating that no phonetic definition of the syllable has yet been agreed upon. Poetry studies, however, make frequent use of the term syllabic pulse, but there it is used to mean the pulsation and different stress patterns of verse. Some textbooks such as Suomi et al. 2006 maintain that the syllable is a mental unit by which speakers organize the production of speech (Suomi et al. 2006: 110–111).

In all approaches to the syllable, the decisive indicator of its borders seems to be a drop in amplitude. If the amplitude drop is produced with internuclear consonants or semivowels constricting the airway (cf. Giegerich 1992: 132), there is no need for a separate pulmonic gesture. If, however, there are no intervening consonants or semivowels, the syllable is indicated by a pulmonic gesture called the subglottal pulse. In languages like English and Finnish, syllable borders are placed automatically according to these principles. If a language distinguishes intervocalic geminates from single consonants, the first component of a geminate is assigned to the same syllable as the preceding vowel and the second component is tautosyllabic with the following vowel.

In some languages syllable borders cannot be defined automatically with reference to internuclear consonants or their sequences. Intervocalic consonant sequences and sometimes single consonants may differ as to the placement of syllabic boundaries in relation to them; to my knowledge, such differences are

found only in the Saami languages. In North Saami the placement of the syllable boundary within a cluster seems to be the only distinguishing factor in such pairs as /*paa-r.tne-*/ (as in *bárdnemánná* ‘male child’; [ˈ] = main stress) vs. /*paa-rt.ne-*/ (as in *bártneguovttos* ‘two boys’), which are otherwise identical in stress and phoneme composition and differ only as to the distribution of the consonants over subglottal pulses. Another similar opposition is /*paa.j.hke-*/ (as in *báikegoddi* ‘locality’) vs. /*paa-jh.ke-*/ (as in *báikkeisit* ‘master of the house’, a variant of *báikki-isit* id.) where the syllabic placement of /h/ varies.

Another context where subglottal pulses play a distinctive role is the consonant center, i.e. the consonants between a stressed and a non-stressed vowel. The consonant center may be distributed over one, two or three subglottal pulses. In cases with three subglottal pulses, the mid pulse is weaker than those before or after it. The weak pulse has no significance in poetic meter and it will henceforth be called a non-syllabic subglottal pulse to distinguish it from the syllabic subglottal pulses which count metrically. The first reference to an “additional syllabic pulse [...] clearly discernible on spectrograms as an additional increase in amplitude” in Saami can be found in R.T. Harms (1975: 436). Sammallahti 1977 makes ample use of the concept of syllabic pulse in accounting for the oppositions of consonant quantity and their historical background in the East Enontekiö dialect of North Saami (Sammallahti 1977: 56–71, 247–249).

The consonant center in the nominative singular *gol’li* ‘gold’ in North Saami is distributed over three subglottal pulses. These pulses are discernible to the naked ear when the word is played back at a reduced tempo (a 33% reduction is sufficient) and one clearly hears the consonant center as *gol-l-li* with three consecutive [l]-sounds with some kind of pulse boundary in between. According to acoustic measurements of an Alaska Saami (a variant of North Saami) specimen the first pulse is the heaviest. It peaks at 80.3 dB during the first syllable vowel, then descends to 75.8 dB which indicates the beginning of the non-syllabic pulse within the consonant center *-l’-*. The non-syllabic pulse peaks at 77.2 dB and decreases to 75.8 dB where the second non-syllabic pulse begins, still within the consonant center. The consonant center of the accusative form *golli* id. has only one pulse boundary and is heard as *gol-li* with two consecutive [l]-sounds when played back at reduced tempo.

The consonant center in the accusative form *golli* is similar to the geminate *-ll-* in standard Finnish *palloon* ‘ball ill.sg.’. Such a relation between languages of the same family indicates that the Saami grade alternation may have originated as a phonetic phenomenon when an extra subglottal pulse was added to consonant centers before an open syllable. The phonetic difference became phonological when reductions, such as the loss of word-final consonants and simplification of certain clusters after non-stressed vowels, happened in those Saami languages whose morphophonological system feature grade alternation.

Subglottal pulses and grade alternation

There seems to be no alternative to the view that grade alternation developed separately in Saami and Finnic. In Saami, the strong grade became lengthened by the addition of an extra subglottal pulse to all consonant centers. In Finnic, on the other hand, the weak grade was either shortened or underwent lenition only in stops (with marginal examples of the lenition of **s*, which are probably secondary developments).

There are similarities between the Finnic and Saami grade alternations, such as the weak grade of **t* which is a voiced dental spirant (**ð*) in both Finnic and North, Inari and Skolt Saami. In Saami, however, the lenition of the original intervocalic single stop into a spirant happened after the disintegration of Proto-Saami, therefore it is of late origin and not a product of the same historical processes which yielded **ð* in Finnic. This similarity cannot be interpreted as evidence for a common origin of the grade alternations in Finnic and Saami; much of the discussion about the origin of grade alternation in Saami and Finnic has concentrated on this relatively late common feature and is therefore irrelevant (cf. the summary in Terho Itkonen 1997: 236–237 and the rebuttal in Sammallahhti 1998: 3). Other similarities, such as the connection of the strong grade to the following open syllable and of the weak grade to the following closed syllable, are common features but point only to similar preconditions for grade alternation in both branches of the Finnic-Saami protolanguage, not to its common original development.

As pointed out by Bergsland, the Ume Saami dialect of Northern Tärna as recorded by N. Moosberg at the beginning of the 20th century still had a quaternary quantity system in original tenues in the consonant center after non-short vowels (Bergsland 1973: 51–52). The dialect had retained the original four quantities resulting from the addition of a subglottal pulse in the strong grade ([.] = pulse boundary, superscript = non-syllabic pulse; [ː] = main stress):

Proto-Finno-Saami	Proto-West-Saami	Northern Tärna
<i>*.t</i>	<i>*kaa.Doom</i>	<i>/ka·a.tuop/</i> ‘to be absent sg.1.prs.’
	<i>*kaa.^h.toot</i>	<i>/ka·a.^h.tuot/</i> ‘id. inf.’
<i>*.t.t</i>	<i>*kaah.toon</i>	<i>/ka·ah.tuon/</i> ‘cat gen.sg.’
	<i>*kaah.^h.too</i>	<i>/ka·ah.^h.tuol/</i> ‘id. nom.sg.’

In most Saami varieties, the mid quantities were neutralized and the result was a ternary quantity system as in Lule Saami:

gádov ‘to disappear sg.1.prs.’

gáhtot ‘id. inf.’

gáhto ‘cat gen.sg.’

gáhtto ‘id. nom.sg.’

The same kind of ternary system is also found in the present-day Ume Saami dialects, Pite Saami, Western North Saami, some old dialects of Kildin Saami and Ter Saami. In Skolt, as well as in the eastern inland dialects of North Saami, only two quantities contrast, but even here the strong grades of geminates and consonant clusters contain the extra subglottal pulse after a short vowel center. These examples are from the Suonikylä dialect of Skolt Saami:

[jɛ̃ː.ɲ.ɲ^a] ‘mad nom.sg.’
[jɛ̃ːɛ.ɲ.ɲ^a] ‘id. nom.pl.’

[č̣ä̃ː.l.^m.m^e] ‘eye nom.sg.’
[č̣ä̃ːä̃ː.l.^m.m^e] ‘id. nom.pl.’

The organization of the Skolt Saami consonant center is parallel to that found in eastern North Saami (examples from the Upper Deatnu dialect):

[j̣ä̃ː.l.^l.la] ‘mad nom.sg.’
[j̣ä̃ː.ä̃ː.l.la] ‘id. nom.pl.’

[kü̯̃.̣.l.^{le}.Ga] ‘hair nom.sg.’
[kũ̯.̣.olG.Ga] ‘id. gen.sg.’

In neither Skolt nor Eastern North Saami is the non-syllabic pulse a distinctive feature of the consonant center after a short vowel center.

In Inari Saami, however, all four quantities have been retained, but only three quantities contrast in each context (cf. Itkonen 1971a: 55–59):

After a short vowel center: /pi.no/ ‘pile gen.sg.’
/pi.ⁿ.no/ ‘id. nom.sg.’
/ti.ⁿ.no/ ‘flint gen.sg.’
/ti.n.ⁿ.no/ ‘id. nom.sg.’
/r̥ũ̯.l.^l.lâ/ ‘the devil nom.sg.’

After a long vowel center: /ki.e.lâ/ ‘language gen.sg.’
/ki.e.^l.lâ/ ‘id. nom.sg.’
/ru.o.^l.lâ/ ‘the devil gen.sg.’
/ru.ol.lâst/ ‘id. loc.sg.’
/ki.el.lân/ ‘language ess.’

After a short vowel center, the distinctive quantities are /C/ vs. /^C.C/ vs. /C.^C.C/, while after a long vowel center they are /C/ vs. /^C.C/ vs. /C.C/. Historically, both /^C.C/ and /C.C/ represent neutralizations between the strong grade of original single consonants and the weak grade of original geminates.

Inari Saami clusters show three phonetic quantities, two of which contrast after a short vowel center. After a long vowel center there is only one quantity:

After a short vowel center: /a:l.^l.ge/ ‘boy nom.sg.’
 /a:^l.ge/ ‘id. gen.sg.’
 /pe:l.^l.gi/ ‘thumb nom.sg.’
 /pe:^l.gistis/ ‘thumb nom.sg. + 3.px.’

After a long vowel center: /pe-el.gist/ ‘thumb loc.sg.’

Skolt Saami seems to have gone through a quantity system similar to Inari Saami, as witnessed by the following shortened cases where the quantity relations of the consonant center are the same as in Inari Saami (cf. Inari Saami /ti.ⁿ.no/ ‘flint gen.sg.’ and /a:^l.ge/ ‘id. gen.sg.’):

[kũẽ.^s.ŋ^eŋ.ʧeŋ] ‘guest loc.sg. + sg.3.px.’
 [čã.^l.m^eŋ.ʧeŋ] ‘eye loc.sg. + sg.3.px.’

In such cases, single consonants and short geminates (with a non-syllabic pulse) contrast in Skolt Saami in the same way as in Inari Saami. They can be given the same phonetic description as in Inari Saami:

[jĩẽ.ⁿ.ŋ^eŋ.ʧeŋ] ‘mother loc.sg. + sg.3.px.’
 [mã.ⁿ.ŋ^eŋ.ʧeŋ] ‘egg loc.sg. + sg.3.px.’

These forms alternate with non-shortened forms where the geminates and clusters are distributed over two syllabic pulses:

[ku.eŋ.ŋ^eŋ.ʧeŋ] ‘guest loc.sg. + sg.3.px.’
 [čã.ã.l.m^eŋ.ʧeŋ] ‘eye loc.sg. + sg.3.px.’
 [ji.ɛ.ŋ.ŋ^eŋ.ʧeŋ] ‘mother loc.sg. + sg.3.px.’
 [mã.ã.ⁿ.ŋ^eŋ.ʧeŋ] ‘egg loc.sg. + sg.3.px.’

It has been shown that the non-syllabic pulse can be distinctive as in Ume, Pite, Lule, Western North Saami and Inari Saami, marginally distinctive as in Skolt Saami and present but non-distinctive in the eastern inland dialects of North Saami. The presence of the non-distinctive non-syllabic pulse after short vowel centers is also reflected in how many older native speakers of the aforementioned varieties of North Saami speak Finnish: in their pronunciation, clusters and geminates are especially long after short stressed vowels. This extra quantity comes from the unconscious transference of the non-syllabic pulse onto their pronunciation of Finnish in words such as [kos.^s.ki] ‘rapids, whitewater’ or [sil.^l.ta] ‘bridge’. This unique phonetic detail is sometimes referred to as the Utsjoki accent.

Quantity relations in clusters

The quantity relations of strong and weak grade clusters vary in the Saami languages. By employing the non-syllabic pulse as an analytic tool, it is possible to give a uniform description of this variation. The grade alternation of clusters beginning with a voiced sonorant fall into the following general types in the Saami languages (X and Y stand for consonants):

- (1) [X.^X.Y] vs. [XY.Y]

This is the pattern in Kildin and most North Saami dialects. In the strong grade the initial component is very long, while the second component is very short as syllable-initial consonants usually are. In the weak grade the first component is very short because it is not syllable-final, and the second component is distributed over two syllabic pulses. The following example represents the Eastern Enontekiö dialect:

/va-al.^l.tiih/ ‘to take inf.’ vs. */va-alt.tij/* ‘s/he took’

The following example is from Kildin:

[kuu-m.^m.pâr] ‘mushroom nom.pl.’ vs. *[ku-ump.pâr]* ‘id. nom.sg.’
(stress placement in the vowel center is hypothetical and uncertain).

Ter Saami has basically the same pattern but shows some historical innovations in the weak grade which cannot be dealt with in this context: */vaal.^l.te/* ‘to take’ vs. */vaalt.ti/* ~ */vaal.dij/* ‘s/he took’.

Some historical innovations in the West Finnmark dialects have made the quantity relations in consonant centers more complex. Allegro shortening has reduced the strong grade by deleting the non-syllabic pulse, adding oppositions between non-shortened forms like */ka-l.^l.ta/* ‘log’ and shortened forms like */pa-l.ta/* ‘s/he frightens’ (cf. non-shortened */pa-l.^l.taa/* id.) to the system. Certain weak grade clusters and geminates have received a non-syllabic pulse before original double vowels, then this pulse was made distinctive by the appearance of secondary double vowels in the second syllable, cf. */ka-lt.taah/* ‘log nom.pl.’ vs. */pa-lt.^t.taah/* ‘you (sg.) frighten’. As a result, the western North Saami clusters show four phonological quantities:

- Strong grade: (a) */pa-l.^l.teh/* ‘they (pl.) frighten’, */ka-l.^l.ta/* ‘log’
(b) */pa-l.teh/* ‘we (pl.) frighten’, */pa-l.ta/* ‘s/he frightens’
- Weak grade: (a) */pa-lt.tij/* ‘s/he frightened’, */ka-lt.taah/* ‘log nom.pl.’
(b) */pa-lt.^t.taah/* ‘you (sg.) frighten’

In present Kildin Saami the intersyllabic pulse is probably no longer distinctive for most speakers. According to Erkki Itkonen's notes on the Šonguj dialect of Kildin Saami, his informant Maksim Antonov was able to tell the difference between the nominative and genitive singular of the word for 'gold' even if the two forms were quantitatively identical (Erkki Itkonen 1971b: 108; cf. the measurements in Erkki Itkonen 1946: 264–267). In the general context of the Saami languages this can hardly be anything else than the opposition between two vs. three subglottal pulses (phonologically /kã'.l.l.l/ vs. /kã'.l.l/; ['] marks a palatalized stress group with a slightly fronted vowel center and a semi-palatalized consonant center). Erkki Itkonen also notes that the difference between the nominative and the quantitatively identical genitive-accusative singular of šie'šš 'bird noose' (present Kildin Saami *uēuuuŋ*) lies in the stress of the vowel center, which is concentrated more on the initial component of the vowel center in the genitive-accusative singular. According to his observations, this stress difference was present in diphthongs but not in long monophthongs (= double vowels).

(2) [X.^{XY}.Y] vs. [XY.Y]

This North Saami quantity pattern has been attested in the Kárášjohka dialect in East Finnmark and in the West Finnmark dialect once spoken in Alaska. In the strong grade, both components of the cluster are distributed over two pulses; the initial component is phonetically very long and the final component gives the impression of being a short geminate, cf. Alaska Saami /vaal.^l.tiith/ 'to take' vs. /vaalt.tij/ 's/he took'. The Alaska dialect has undergone the same historical processes as the West Finnmark dialects in the group (1).

(3) [X.^X.Y] vs. [.^X.Y]

This is the present Inari Saami pattern. The first component is very long in the strong grade and very short in the weak grade, while the second component is short in both grades. In the strong grade the first component is distributed over the first syllabic pulse and the non-syllabic pulse, whereas in the weak grade it is confined to the non-syllabic pulse as in /a.l.^l.ge/ 'son nom.sg.' vs. /a.^l.ge/ 'id. gen.sg.'. In the present varieties of Inari Saami the first component in the weak grade is longer after a long vowel center than after a short vowel center and seems to belong to the first syllabic pulse as in /pe-el.gi/ 'thumb gen.sg.', nom. sg. /pe-l.^l.gi/ id. Earlier varieties of Inari Saami probably had both /^X.Y/ and /X.Y/ in the weak grade as indicated by such examples in Erkki Itkonen (1971: 59, 63) as (re-transcribed here) /kã-ä.^l.gu/ 'disentangled' vs. /kã-äl.gu/ 'wife acc.sg.+3.px.' (nom.sg. /kã-l.^l.gu/ with the strong grade). The quantity relations in older varieties seem to differ from those in present-day ones, but they cannot be dealt with in this presentation.

The weak grade /.^X.Y/ in clusters is analogical. When the difference between the weak grade of geminates (/X.X/) and the strong grade of single conso-

nants (/.^X.X/) was neutralized as /X.X/ in trisyllabic stress groups and as /.^X.X/ in bisyllabic ones in Inari Saami (the latter is usually referred to as a half-long consonant), the weak grade of clusters received an analogical pronunciation: in trisyllabic stress groups it retained the original quantity /X.Y/ but was reduced to /.^X.Y/ in bisyllabic stress groups. Further analogical levellings changed /X.Y/ into /X.^X.Y/ after single vowels, and the weak grade consonant centers in such forms as /al.^l.geest/ ‘boy loc.sg.’ became identical with the strong grade consonant center in such forms as /al.^l.gen/ ‘id. ess.’.

(4) [X.^Y.Y] vs. [X.Y]

This is the Skolt Saami pattern which was also found in the now extinct Akkala Saami. In the strong grade the first component of the cluster is long, but not as long as in North or Inari Saami (and not as short as in Ume Saami, cf. below), and the second component is longer than in variety 2 of North Saami. In the weak grade the first component shows the same quantity as syllable-final consonants in general, and the second component is as short as syllable-initial consonants usually are. In terms of the subglottal pulses, the consonant centers can be transcribed as follows: /vǎ-l.^d.dam/ ‘(to have) taken’ vs. /vǎ-ǎl.dam/ ‘I take’.

(5) [X.^X.Y] vs. [X.Y]

This is the Lule Saami pattern. In the strong grade the first component is as long as in North Saami and Inari Saami, and the second component is short. In the weak grade the quantity relations are the same as in Skolt Saami: /pol.^l.nie/ ‘small hill’ vs. /pol.nie/ ‘id. nom.pl.’.

Most dialects of present Lule Saami have coalesced the *lld* and *llt* types into a single type with an *lld* type strong grade and an *llt* type weak grade, e.g. /vaa-l.^l.tiet/ ‘to take’ vs. /va-alh.tij/ ‘s/he took’ (it is assumed that vowel sequences have final stress before consonant centers distributed over three subglottal pulses). The pulse organization of the strong grade clusters with schwa (as in *tjalmmē* ‘eye’ vs. weak grade cluster in *tjalme* ‘id. nom.pl.’) has not been studied. The northernmost dialects of Pite Saami show the same quantity patterns as Lule Saami.

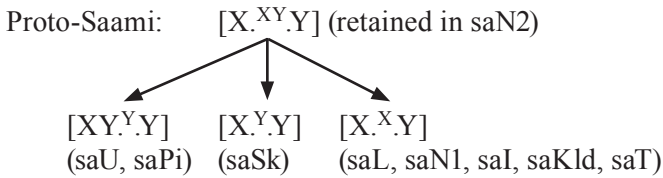
(6) [XY.^Y.Y] vs. [X.Y]

This is the pattern in Ume Saami and the central and southern dialects of Pite Saami. In the strong grade the first component is shorter than in Skolt Saami and has a quantity typical for non-syllable-final positions, and the second component is very long: Ume Saami /vaa-lt.^l.tiet/ ‘to take’ vs. /ve-el.tij/ ‘s/he took’ (it is assumed that vowel sequences have final stress before Quantity III). The quantity of the stop is the same as the quantity of the final cluster in the strong grade consonant center in /kua-jh.^h.kē/ ‘rapids nom.sg.’ (with a short /j/ and a

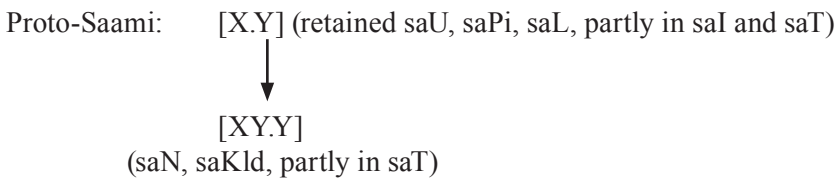
very long /h/). The strong grade cluster in /*kua:jh.^h.kë/* contrasts with the weak grade cluster in /*ku:ajh.kën/* ‘id. gen.sg.’ (where the /h/ has a quantity typical of syllable-final consonants). As there is no alternative to the analysis of the strong grade cluster in /*kua:jh.^h.kë/*, it is assumed that the stop in the consonant center of /*vaa:lt.^t.tiet/* ‘to take’ is distributed over three subglottal pulses in the same way as the final cluster in the consonant center of /*kua:jh.^h.kë/* ‘rapids nom.sg.’.

It is appropriate to assume that 1) the extra subglottal pulse in strong grade clusters originally covered parts of both the initial and final components, 2) the strong grade was similar to that in type 2 which is found in North Saami and obviously some old Inari Saami dialects and 3) the weak grade to which no subglottal pulse was added was the same as in types 4, 5 and 6. One can then reconstruct the development of the different types as follows (saU = Ume Saami, saPi = Pite Saami, saL = Lule Saami, saN = North Saami, saI = Inari Saami, saSk = Skolt Saami, saKId = Kildin Saami, saT = Ter Saami):

Strong grade



Weak grade



Skolt Saami final consonants

There are two kinds of final consonants after stressed vowels in Skolt Saami, those with a vocalic release and those without. Both are conceived as word-final by native speakers and therefore both receive the same treatment in the standard orthography: *mõõn* without the vocalic release is the genitive-accusative singular of the interrogative pronoun *mii* ‘what’ whereas *mõõn* with the vocalic release is the singular 2nd person imperative of the verb *mõõnnâd* ‘to go’. The one with the vocalic release is usually phonetically shorter than the one without vocalic release. Contrary to the intuition of native speakers, Korhonen (1971) interprets the vocalic release as a separate overshoot vowel phoneme. Feist (2010) doesn’t address the problem of the two kinds of final consonants.

The final consonants and clusters without vocalic release are mostly found in inflectional forms of monosyllabic stems such as *leäm* ‘I am’, *mõk* ‘which ones’, *tät* ‘this’, *tän* ‘this gen.sg.’, *mõõn* ‘what gen.sg.’, *jiõm* ‘I don’t/didn’t’. These represent original word-final single consonants, but the lack of vocalic release is not confined to them. Also suffixes consisting of consonant clusters usually occur without vocalic release after monosyllabic stems: *mu’st* ‘I loc.’, *tuin* ‘you (sg.) com.’, *mä’ht* ‘how’ (originally an inflectional form of *mii* ‘what’).

The phonological difference between the two kinds of final consonants can be described as being based on their relation to syllable boundary. The consonants without release belong to the same syllable as the preceding vowel whereas those with release do not:

/mõ-õn/ ‘what gen.sg.’ vs. */mõ-õ.n/* ‘go imprt.sg.2.p.’

Skolt Saami shows what happens when word-final vowels are lost. The preceding consonant will initially remain in its original syllable as in Skolt Saami, but it will eventually be included in the preceding syllable as in languages like Estonian. Estonian also loses the quantity differences in consonants in the process, and thus the final consonants in words like *kel* ‘who adess.sg.’ and *kell* ‘watch’ or *mais* ‘corn, maize’ and *poiss* ‘boy’ are pronounced the same at least in casual speech. Estonian shows quantitative differences in cases like *raag* ‘twig’ vs. *saak* ‘crop’ but, in spite of the general opinion among Estonian phonologists, this suggests that the opposition is /g/ vs. /k/ rather than /k/ vs. /kk/. Skolt Saami has retained such word-final differences because it has also retained the syllable boundary:

/tä-äl.l/ ‘household nom.sg.’ vs. */tä-ä.l/* ‘id. nom.pl.’

Note that the heterosyllabic final /l/ with vocalic release in */tä-äl.l/* contrasts with the tautosyllabic final /l/ without vocalic release in */veä-l/* ‘still; yet’.

Even if they are the only phonemes in the syllable, the Skolt Saami final consonants with vocalic release do not form syllable nuclei but are better characterized as syllable onsets just as they were before the loss of the nuclear vowel. To my knowledge, syllables without a syllable nucleus had not been attested in any language before Skolt Saami (although languages with syncopated vowels such as Nenets are likely to have or to have had such syllables; cf. Salminen 1998: 521). That they are heterosyllabic with the preceding vowel is indicated by their vocalic release, the relative length of the preceding vowel and the shorter duration of the heterosyllabic consonants in relation to their tautosyllabic counterparts. It is also possible that the heterosyllabic consonants with vocalic release form a unit different from the syllable and that the pulse they belong to is a non-syllabic pulse.

Vocalic release is not a necessary phenomenon in cases like this, as witnessed by Kildin and Ter Saami where there are oppositions like */ki-il.l/* ‘lan-

guage nom.sg.' vs. /ki-i.l/ 'id. gen.sg.'. Whether there are or have been syllabicity differences in word-final consonants in Kildin and Ter similar to those in Skolt Saami has not been studied, and the transcription /kii.l/ remains therefore tentative. Some notations from Kildin (*ton* 'you sg.' vs. *ton^a* 'you acc.sg.', cf. T.I. Itkonen 1958: 606) seem to hint at differences between tautosyllabic (in nom.sg.) and heterosyllabic final consonants (in acc.sg.).

It is furthermore conceivable that the difference between the Skolt and Kildin Saami word-final heterosyllabic consonants (vocalic release in Skolt but not in Kildin) lies in the nature of the subglottal pulse they belong to, and that the Skolt consonants with vocalic release belong to syllabic pulses whereas the Kildin consonants without vocalic release belong to non-syllabic pulses. It might be possible to study the difference with modern equipment, but the arrangements for such studies would probably be very complicated. Much of what has been said remains therefore hypothetical and a logical necessity only.

Estonian quantities

Estonian is known to have three distinctive consonant and vowel quantities. The vowel quantities contrast before single consonants in Quantity I: *saada* 'to get' (QIII) vs. *saada* 'to accompany imprt.sg.2.' (QII) vs. *sada* 'hundred' (QI). The consonant quantities contrast in intervocalic positions after single stressed vowels: *pattu* 'sin ill.sg.' (QIII) vs. *patu* 'id. gen.sg.' (QII) vs. *ladu* 'storehouse' (QI) and *palli* 'ball ill.sg.' (QIII) vs. *palli* 'id. gen.sg.' (QII) vs. *kali* 'home-made beer' (QI). After vowel sequences (and sonorants) stops show two distinctive quantities; in addition to QI, QII follows vowel sequences in QII and QIII follows vowel sequences in QIII: *saate* 'broadcast gen.sg.' (QIII) vs. *saada* 'to get' (QI), *jääte* 'you (pl.) stay' (QII) vs. *saade* 'broadcast nom.sg.' (QI). After vowel-sonorant sequences there are two quantities as in *palki* 'beam part.sg.' (QIII) vs. *palgi* 'id. gen.sg.' (QI). Lehiste's data (Lehiste 1966) indicate that consonant quantities QII and QIII after vowel sequences are identified conventionally rather than objectively and could be characterized as ambiguous in the same way as after unstressed vowels.

It is generally assumed that oppositions like *pattu* vs. *patu* reflect a stage in the development of grade alternation where the weak grade of double stops was not reduced to a single stop as in Finnish (cf. Finnish *takka* 'fireplace nom. sg.' vs. *takan* 'id. gen.sg.'). What makes this assumption doubtful, however, is the fact that the same reduction into a short geminate has happened in the strong grade after a long voiced sound sequence, e.g. *saate* 'broadcast gen.sg.' and *palki* 'beam part.sg.', cf. Finnish *saatteen* 'accompanying note gen.sg.' and *palkki* 'beam nom.sg.').

The obvious conclusion is that there is no grade alternation in double stops in Estonian after short vowels and that the quantity alternation has the same historical origins as the quantity alternation in other consonants after short stressed

vowels. After long vowels and vowel-sonorant sequences, original double stops alternate in a way which has no parallel in other originally double consonants: *saate* ‘broadcast gen.sg.’ vs. *saade* ‘id. nom.sg.’ and *palki* ‘beam part.sg.’ vs. *palgi* ‘id. gen.sg.’. This alternation may go back to grade alternation, but it must be kept in mind that consonant shortening after long vowels is a common phenomenon in Estonian, and it is possible that this alternation reflects an older variation of the same kind as after short vowels which is not grade alternation. In a number of Finnish dialects, voiceless consonants retain quantity oppositions as in Estonian whereas double sonorants are shortened as in *maassa* ‘ground iness. sg.’ and *maatta* ‘id. abess.sg.’ vs. *maala* ‘id. adess.sg.’.

In comparison to Finnish, the Estonian Quantity III gives the impression of being longer than Finnish geminates whereas Quantity II in Estonian is shorter. The Estonian Quantity III is usually transcribed with a half-long initial component and the shorter geminates are said to have a very short first component: *[pät̪u]* ‘sin ill.sg.’ vs. *[pät̪u]* ‘id. gen.sg.’. The Finnish geminates, on the other hand, are transcribed with two short components as in *[hattu]* ‘hat’. The Estonian Quantity III in *palli* ‘ball ill.sg.’ is audibly similar to North Saami Quantity III in *golli* ‘gold nom.sg.’.

It seems that the overlong Quantity III in Estonian developed initially as compensatory lengthening, i.e. as an addition of a subglottal pulse, in the consonant center when a non-stressed syllable was lost in a stress group. This kind of compensatory lengthening also happened in many Saami languages with Quantity III as a result (cf. western North Saami */suo.luu/* ‘island nom.sg.’ vs. */sul.^l.loh/* ‘id. nom.pl.’ < **suol.lu.jek*). Another example is the Kainuu dialect of Finnish where compensatory lengthening has caused single consonants to become short geminates and geminates to become overlong. There is no phonological opposition between the variants, however, since the longer variants only occur before long vowels and the shorter ones before short vowels. The differences can be transcribed as follows: *[ka.la]* ‘fish’ vs. *[ka.^l.laan]* ‘id. ill.sg.’, *[vil.la]* ‘wool nom.sg.’ vs. *[vil.^l.laan]* ‘id. ill.sg.’.

At first, compensatory lengthening (and reductions in non-stressed syllables immediately following the stressed syllable) would have created oppositions like *[pat.^l.tu]* ‘sin ill.sg.’ vs. */pat.tu/* ‘id gen.sg.’ in Estonian. The difference between the two quantities was then enhanced by reducing the shorter counterpart into a short geminate, phonetically *[pa.^l.tu]*. It must be noted at this point that the so-called half long [l̪] in Inari Saami *kole* ‘gold gen.sg.’ gives the impression of being identical with the Estonian short geminate in *kalle* ‘inclination (astr.)’. A uniform transcription of the consonant centers in both cases would be [l̪]. At this stage this hypothesis is based on historical necessity and has to be validated with extensive experimental studies.

This historical explanation is practically the opposite of the standard one, given by Paul Ariste in his doctoral thesis (Ariste 1939: 146), according to which the alternation between QIII and QII is originally isochronical. A long (closed) second syllable was compensated by shortening the long first syllable. As the

distinction became phonological, the opposition between non-shortened QIII and shortened QII was enhanced by lengthening QIII, giving the present opposition between the so-called overlong consonant sequences with a long initial component and short consonant sequences with a short first component.

Estonian vowel quantities in open stressed syllables are auditive close or even similar to those in western North Saami: Estonian QIII (as in *saada* ‘to get’) gives the same impression as the initially stressed vowel sequences (as in North Saami *mága* /*ma-a.ka*/ ‘brother-in-law gen.sg.’), Estonian QII (as in *saada* ‘accompany imprt.sg.2.’) can be identified with finally stressed vowel sequences (as in North Saami *čále* /*čaa.le*/ ‘write imprt.sg.2.’), and Estonian QI (as in *sada* ‘hundred’) with single stressed vowels (as in *sala* /*sa.laa*/ ‘fathom gen.sg.’). This suggests a similar phonological analysis, but the historical backgrounds of the quantity systems are different. Saami QII resulted from centralization which shortened the second syllable vowel and shifted the stress of the first syllable vowel sequence to its second component. In Estonian, however, QIII involves the addition of a subglottal pulse to the end of long stressed syllables, and the consistent analysis turns out as follows:

<i>saada</i> ‘to get’	/ <i>sa-a.^a.ta</i> /
<i>saada</i> ‘accompany imprt.sg.2.’	/ <i>saa.ta</i> /
<i>sada</i> ‘hundred’	/ <i>sa.ta</i> /
<i>saate</i> ‘broadcast gen.sg.’	/ <i>sa-at.^t.te</i> /
<i>saate</i> ‘you (pl.) get’	/ <i>saa.^t.te</i> /
<i>saade</i> ‘airing’	/ <i>saa.te</i> /
<i>palli</i> ‘ball part.sg.’	/ <i>pa-l.^l.li</i> /
<i>palli</i> ‘id gen.sg.’	/ <i>pa.^l.li</i> /
<i>kali</i> ‘home-made beer’	/ <i>ka.^l.li</i> /

Whether Estonian syllabic vowel sequences in QIII and QII are finally or evenly stressed remains an open question.

Conclusion

It has been shown that unlike most other languages, the placement of what is usually interpreted as syllable boundary is not automatic in many varieties of Saami and that some languages distinguish between three phonological quantities of consonant length and two different kinds of word-final consonants. To combine Stetson’s chest pulse theory (Stetson 1951) and Giegerich’s sonority theory (Giegerich 1992: 132), it is suggested that syllable boundaries are indicated either by intervocalic consonants or by syllabic pulse boundaries, both of which manifest as an amplitude drop. (There is no amplitude drop if the syllable

boundary is located within a voiceless stop, but a drop in pulmonic pressure should be present since there are such phonological oppositions as /p.p/ vs. /.p/ in many languages.)

It is obvious that the only explanations for morphophonological alternations are provided by historical linguistics, and that those provided by synchronic process approaches such as most varieties of generative phonology are pseudo-explanations and confuse description with explanation. Historical innovations are the cause of dialectal variation but it is more than obvious that the very same innovations are also the source of idiolectal morphophonological variation. Therefore, the same explanations which are valid for dialectal variation are also valid for morphophonology. This is another argument against using non-observable elements such as basic forms in linguistic description (cf. endnote 22 in Sammallahti 2009: 22).

Subglottal pulses are a necessity for describing quantitative differences in such consonant centers as /l.^l.l/ vs. /l.l/ vs. /.l/ in North Saami and in such organizational differences as between /ii/ and /i.i/ in cases like North Saami /pok.^{kh}.htiih/ ‘to wake (tr.)’ vs. /lok.^{kh}.hti.ih/ ‘they (pl.) lift’ (the latter a phonetic variant of /lok.^{kh}.hti.jih/ ~ /lok.^{kh}.hte.jih/; orthographic *boktit* vs. *loktejiti*).

What, then, is the psychological counterpart of the physiological subglottal pulse? What immediately comes to mind is the mora which is used for expressing syllable length (cf. Hayes 1995). A typical initially stressed double vowel (as in *mága* /ma.a.ka/ ‘brother-in-law gen.sg.’) in North Saami consists of two intensity peaks, the first of which is a few decibels higher than the second, and according to Antti Iivonen (oral communication) this is also true of Finnish stressed long vowels. The second peak seems to be the acoustic counterpart of the second mora of the syllable. Likewise it is possible to think that the mid subglottal pulse in North Saami consonant centers in cases like *golli* /ko-l.^l.lii/ ‘gold nom.sg.’ represents the second mora of the consonant center and the final mora of the first syllable which consists of three morae. This means that syllabic pulses may contain one or more moraic pulses, and both syllabic pulses and moraic pulses belong to the category of subglottal pulses.

According to Paul Ariste (1939: 65), the overlong vowels in the Hiiumaa dialects of Estonian also have two peaks and this forms the main difference between overlong and half-long vowels. This may indicate that in the Hiiumaa dialects, stressed vowels may be analysed in the same way as in western North Saami where long and half-long vowels consist of two morae but differ in stress placement. Whether this analysis is better than the one given above cannot be determined without further research.

The Saami languages suggest strongly that neither phonological quantity oppositions in consonants nor phonetic duration differences in postvocalic consonants (and obviously also in vowels) are distinctive segmental properties. One should rather base these differences on the distribution of segments over subglottal pulses or on the placement of segments in relation to subglottal pulses – or

something else which gives the impression of subglottal pulses being involved in the differences. The lack of quantity differences in syllable-initial consonants is strong evidence in favor of this view. Furthermore, it has been shown that quantity systems can be uniformly described and their historical development accounted for through reference to (syllabic and moraic) subglottal pulses.

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