KÜLLI PRILLOP (Tartu)

FINNIC STOP GRADATION
AS AN EFFECT OF MORA SHARING

Abstract. Finnic radical stop gradation affected stop consonants in the onset position of unstressed syllables. The stops were weakened before closed syllables, and remained unweakened before open syllables. Stop gradation, conditioned by whether the following syllable was open or closed, is cross-linguistically extremely rare. In this paper, gradation is argued to be a phonetically natural intervocalic weakening process, which was blocked only in the onsets of open unstressed syllables due to restrictions on moraic structure. Under the proposed account, differences between Finnic languages in terms of gradation depend on the extent to which a specific language tolerated heavy unstressed syllables.

Keywords: Finnic, gradation, stops, geminate gradation, single stop gradation, Optimality Theory, mora sharing.

Introduction

The weakening of obstruents in sonorous environments, especially between vowels, is a very common phenomenon in languages all over the world. Stop gradation, historically conditioned by the presence or absence of a coda, appears to occur only in Uralic languages, being a characteristic feature of most Finnic and Saami languages, and a few Samoyedic languages. According to the view shared by most researchers, stop gradation developed independently in Finno-Saamic languages and in Samoyedic languages over three thousand years ago (Itkonen 1969; Laanest 1982; Gordon 1997 and others). However, since the gradation systems in Finnic and Saami languages differ considerably in detail, several researchers have suggested a strong likelihood of their independent development (Sammallahti 1998; Bye 2001).

Since gradation is a rare phenomenon in languages, providing an explanation of its causes is a challenge to any universalist linguistic theory. In the present paper, I will use moraic theory to outline the conditions which have triggered the development of stop gradation, and which may account for differences between Finnic languages in terms of its realization. The paper will cover the Finnic gradation of single stops and of geminates, but not quantity gradation, which emerged much later and only in Estonian.

The first chapter of the paper provides an overview of earlier theories of the development of gradation in Finnic languages. The second chapter demonstrates that a simple explanation for the emergence of stop gradation can be offered by mora sharing, and highlights similarities between Finnic gradation and other similar phenomena observed cross-linguistically. The third chapter presents an Optimality Theoretic analysis of gradation. I will also provide a brief description of different types of gradation.

1. Earlier descriptions of the emergence of gradation

Originally, consonant gradation was not a phonological phenomenon. The occurrence of a strong or weak stop word-medially depended on the sounds surrounding it, on stress conditions and on syllable structure. The conditions giving rise to stop gradation were first described by Matthias Aleksanteri Castrén already in the middle of the 19th century (1839 : 15—16). Weak stops occurred (a) after a stressed syllable at the beginning of a closed syllable between two vowels or a sonorant and a vowel (radical gradation), and (b) after an unstressed syllable intervocalically (suffixal gradation). Elsewhere, the stops were strong. Similarly to single stops, geminates alternated as well, at least when preceded by stressed syllables (Viitso 2003 : 165).

The following examples are from the Estonian language. Periods mark syllable boundaries. Segment durations which bear no relevance to stop gradation are not indicated.

(1)   **Weak grade**   **Strong grade**

a. **jal.ǩan* (> *jala*) 'foot, gen.sg'   **jal.ka* (> *jalɢ*) 'foot, nom.sg'
   *ri.ťan (> *rea*) 'row, gen.sg'   **ri.ta* (> *riɒa*) 'row, nom.sg'

b. **val.ke.ťa.ta* (> *valɢet*) 'white, part.sg'

c. **kät.ťen* (> *käťte*) 'hand, gen.pl'   **kät.tä* (> *kät̄*) 'hand, part.sg'

In the Finnic period, gradation was merely a quantitative phenomenon, i.e. it only affected the duration of stops. Voicing and spirantization of stops emerged later, taking different forms in different languages (see Laanest 1982 : 107; Viitso 1981 : 176—177; 2008 : 120—121). Languages that feature similar differences in the quantity of stops, and in which other properties such as voicedness, intensity or presence of aspiration are of secondary importance, can also be found in other language families. Perhaps the best known example is Swiss German (Kraehenmann 2001).

A controversial question is whether gradation originally involved all consonants, as it does in Saami languages, or only stops, as in Finnic languages. The dominant theory at the beginning of the previous century was that of Eemil Nestor Setälä, according to whom stop gradation originally involved all consonants. Setälä's theory was subsequently revived by Matthew Gordon, who describes gradation in Finnic and Saami languages as a lengthening of consonants which serves to balance the foot (Gordon 1997). According to the predominating view, however, the only consonants originally involved in gradation were stops, and in Saami languages the gradation of other consonants developed on the basis of analogy (Pikamäe 1957; Ravila 1960; Korhonen 1988 and others).

The development of stop gradation can be viewed either as a process of fortition or a process of lenition. In both cases it can be analysed as a phenomenon that was triggered by specific contexts, or one which involved all stops, but was blocked in certain environments. In the case of Finnic languages, it is generally considered to have been a process of lenition, not of fortition (Posti 1953; Laanest 1982 : 106; Korhonen 1988); or primarily a process of lenition, later complemented in some Finnic languages by the gemination of single consonants which were preceded by a short stressed vowel (Viitso 1981 : 178; 2008 : 122).

The majority of accounts treat gradation as primarily a lenition process. A possible trigger of the mutation could have been an excessively long syllable in a weak (i.e. unstressed) position. Another possibility is to account for the lenition of closed syllable onsets by referring to foot isochrony (Viitso 2003 : 162; Eek, Meister 2004 : 345). According to Mikko Korhonen (1988), radical gradation was caused by the need for greater articulatory energy in closed syllables (compared to open ones) following the primary stressed syllable. Greater articulatory energy causes a drop in intensity at the preceding syllable juncture and a weakening of the preceding consonant (Korhonen 1988 : 275).

Arvo Eek and Toomas Help (1986) describe early consonant gradation as a result of an increase in the prominence of primary stress. In Indo-European languages primary stress can fall on different syllables, requiring special attention. According to Eek and Help, under Indo-European influence, Finnic peoples tried to increase the prominence of primary stressed (i.e. initial) syllables in their language, too. In order to retain phonetic coherence in the word, every non-initial syllable had to be weaker than the initial one. Excessively strong syllables following the primary stress had to weaken. This primarily concerned closed syllables which started with a stop consonant and were therefore too strong. At the same time, open syllables were not considered as strong as to upset the foot. Thus, only the onsets of closed syllables shortened (Eek, Help 1986 : 11—14).

Kalevi Wiik (1997) has also considered the appearance of excessively heavy syllables in an unstressed position as the cause of the Proto-Germanic consonant change described by Verner's law. According to that law, voiceless word-medial obstruents in a voiced environment became voiced when they preceded word stress (later, the stress shifted to the first syllable), e.g. Sanskrit *pitár-* >> Gothic *faðar* 'father', Sanskrit *snusá* >> Old English *snoru* 'daughter-in-law' (Campbell 1999 : 143—145). Kalevi Wiik has suggested that Verner's law is connected with the shift of stress to the first syllable. Long syllables starting with a voiceless obstruent were too strong in an unstressed position, since voiceless obstruents are relatively long and they tend to raise the fundamental frequency of the following vowel, making the listener more likely to perceive such syllables as stressed. To ensure that the listener would perceive the stress in its correct new position, the voiceless obstruent in the onset had to undergo voicing (Wiik 1997 : 273—274).

Theories which explain Finnic gradation as a process of weakening of excessively strong non-initial syllables are problematic in many ways. First, they do not explain why it was the syllable onset that shortened, and not the nucleus or coda. The supposedly too strong contrast between the obstruent and the following vowel does not explain the different development

of open and closed syllables. If the second syllable of the form **jal.**kan***
'foot, gen.sg' is regarded as too strong, while that of the form **jal.**ka*** 'foot,
nom.sg' is not, then the reason behind the excessive strength was obvi-
ously not only the stop consonant in the syllable onset, but the coda as
well. Syllables without a coda, even when they began with a stop, did not
weaken (unlike Verner's law).

Secondly, initial stops of open heavy syllables containing diphthongs
did not shorten. A diphthong was created in the non-initial syllable by
adding markers starting with *i* to stems which ended with a vowel (e.g.
*jalka + i + ta → *jal.**koi**.ta* 'foot, part.pl'). It is true that there are languages
where certain diphthongs are regarded as monomoraic. Still, those modern
dialects, where instead of a V*i*-diphthong there is a long vowel (e.g. the
Finnish South Pohjanmaa dialect: *annoin > annoon* 'I gave', *antoi > antoo*
's/he gave'), which has not affected consonant gradation, do not support
the hypothesis of light V*i*-diphthongs in Proto-Finnic dialects. A long vowel
is bimoraic by definition and the addition of a mora in an unstressed syllable
would be difficult to justify.

The southwestern dialects of Finnish contain inflected forms where the
stop consonant has weakened before a diphthong, such as **an.toi > anno*
's/he gave' (cf. the Estonian **an.tan > annan* 'I give' and standard Finnish
antoi 's/he gave') (Laanest 1982 : 110). The fact that the same change did
not occur in standard Finnish — apparently because syllables consisting
of the same sounds were regarded as light ones — raises a legitimate ques-
tion: why did the moraic *i* disappear from h e a v y diphthongs in south-
western dialects (**an.toi > anno*), whereas it was preserved in l i g h t diph-
thongs in standard Finnish (*an.toi,* not **an.to*)? After all, a simpler expla-
nation would be that in southwestern dialects the *i* was a glide which
functioned as a syllable-closing consonant (see Laanest 1982 : 110).

Matthew Gordon (1997) has described consonant gradation as a process
of fortition. According to his hypothesis, what happened first was the length-
ening of the open vowel at the end of the foot. In order to balance the
foot, this was followed by the lengthening/gemination of the stop conso-
nant preceding the lengthened vowel. According to Gordon, the vowel of
a closed syllable did not lengthen (cf. the half-long vowels at the end of
certain words in modern Estonian, e.g. *luɢù* 'story'), consequently the conso-
nant in the onset of the closed syllable did not lengthen either. Gordon
admits that such a scheme of development would presuppose the lack (or
infrequent occurrence) of long stressed vowels in the language, since a long
vowel would be sufficiently heavy to block the foot balancing process
(Gordon 1997 : 55—58). At the same time, Gordon does not explain why
a word with a lengthened stop consonant (e.g. **[lɑpˑɑˑ][1]* 'flat') should be
regarded as acceptable, whereas a word with a geminate consonant (e.g.
*[pɑppɑˑ] 'priest') is not, such that in the latter the stop consonant had to
lengthen even more due to the lengthened *a*, resulting in **[pɑppˑɑˑ]*.

The examples that Gordon (1997 : 59—60) gives of consonant lengthening
in different languages due to the length of the following vowel in fact only
concern single consonants preceded by a short stressed vowel: the Votic

---

[1] I have not changed Gordon's (1997) transcriptions here. ˑ indicates a segment
intermediate in duration between a short segment and a long one. Long segment
is indicated by :.

ellää 's/he lives', the Ingrian *tulloo* 's/he comes', the Savo *kalloo* 'fish, part.pl', the South Estonian *kannaa*² 'chicken, part.sg'. All these examples represent subsequent developments in Finnic languages and relate to the period in which long vowels had appeared in non-initial syllables, because the intervocalic **d* had been lost. Theoretically, it cannot be ruled out that similar lengthening took place in front of long vowels also during the preceding period (Finnic-Saami), yet it is only common when preceded by a CV syllable, and does not explain weakening after a heavy initial syllable, e.g. **lau.t̆an* > Standard Estonian *laua*, Standard Finnish *laudan* 'board, gen.sg'.

For instance, measurements of consonant duration in the Soikkola dialect of Ingrian (Gordon 2009 : 93—96) showed that a lengthened consonant only has the same duration as a lexical geminate when it is preceded by a short vowel: the lengthened *l* in the form *kalaa → kallaa* 'fish, part.sg' has a duration that is approximately double the duration of the *l* in the form *kala* 'fish, nom.sg'. A lengthened consonant preceded by a closed syllable or one that includes a long vowel has a duration inferior to that of a lexical geminate and may actually have the same duration as a consonant in the same position which has not undergone lengthening. For instance, the duration of the stop in the forms *riipuu → riippuu* 'kerchief, part.sg' and *riipu* is the same (Gordon 2009 : 93—96). The data collected by Arvo Laanest (1986 : 33, 57—59) concerning the lengthening potential of single consonants in Ingrian dialects are slightly at variance with those of Gordon, yet they too indicate that the gemination of single stops occurs consistently only when the stop is preceded by a stressed CV syllable, and that the variation of the duration of the geminates following such syllables only appears as a rare fluctuation which Laanest does not consider worthy of a more detailed discussion.

The other problem with an account based on the balancing of foot is the inevitable gemination of intervocalic consonants, which in Finnic languages, unlike the Saami ones, has not taken place due to early stop gradation. Geminates are considered to straddle the syllable juncture. Regardless of whether the lengthening of open final syllables meant addition of moras or some other change, compensation for that lengthening had to manifest in the short initial syllable and not in the onset of the already long second syllable. Since, according to Gordon (1997), additional weight was attributed to the intervocalic consonant and not to the vowel of the initial syllable, the consonant had to geminate. Word-medial geminates have one link to the coda of the preceding syllable and another to the onset of the following one (see Hayes 1989 : 259). The structure in Figure 1b is unacceptable because moraic onsets are prohibited in moraic theory, and it stretches the long second syllable even more. The structure 1c is empirically flawed, because languages prefer onsetful syllables over onsetless ones.

In many cases, an analogy to the account advanced by Gordon has been used to explain gemination. For instance, in Livonian, in which gradation developed later than in other Finnic languages and took a slightly different route, long vowels were already present in medial syllables by the time gradation appeared, because the intervocalic **d* had been lost, cf. **tubada* >> **tubā* 'room, part.sg'. The stop on the boundary between the first and the second syllable geminated as a counterbalance to the long vowel in the

---

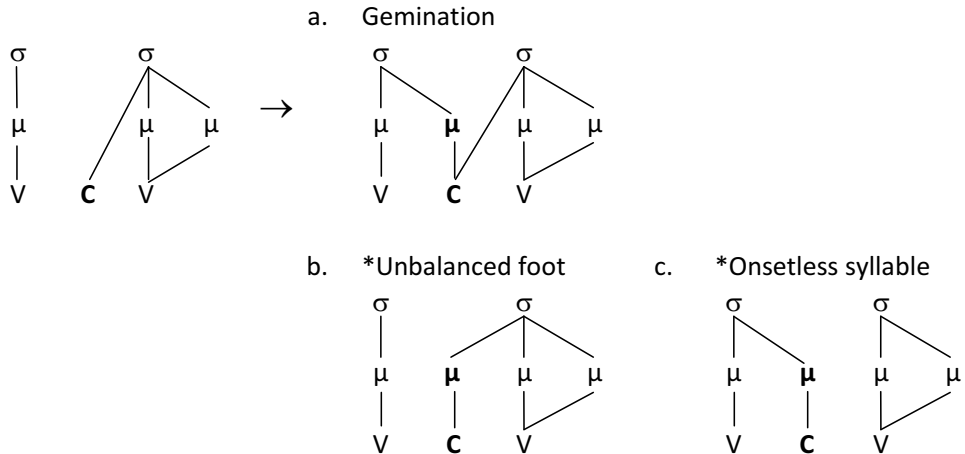² I have not changed Gordon's (1997) transcriptions here.

Külli Prillop

a. Gemination

b. *Unbalanced foot   c. *Onsetless syllable

Figure 1. **Intervocalic lengthening to balance the foot.**

second syllable, cf. **tubā > *tu'bba >> tu'bbõ* (see Viitso 2007 : 57—59). Such balancing may be interpreted as an avoidance of ĹH feet, as has been suggested in respect of Livonian by Paul Kiparsky (2006 : 11). In addition to Ingrian and Livonian, similar geminates, formed due to the influence of long medial syllables, are very common also in the Võru dialect of Estonian (Iva 2010 : 162). Since gemination does not represent the same phenomenon as Finnic stop gradation and is thus irrelevant to the discussion here, I will not deal with alternative accounts of gemination any further.

In the approaches to consonant gradation discussed above, change is seen as resulting from the context in which the consonants appear. The approaches that focus on lenition see it as resulting from excessive syllable weight. Approaches focusing on fortition regard open syllables as triggers. In the following sections, I will present an analysis showing that context may facilitate the blocking of stop lenition without at the same time becoming a direct cause of fortition.

2. Gradation — sharing moras to avoid lenition

2.1. Single stops

In moraic theory, distinguishing between short and long stops in a syllable onset is only possible if we allow the syllable onset to be linked to a mora. Moraic theory does not allow syllable onset to be linked to its own mora, since syllable onsets play no role in assessing the syllable as heavy or light, i.e. determining the location of stress (Hyman 1985 : 15—16; Hayes 1995 : 51—53), and the loss of the onset does not trigger compensatory lengthening (Hayes 1989). However, a syllable onset can share a mora with the nucleus.

There are three common ways to represent monomoraic CVC syllables: (a) the coda is not linked to any mora (Figure 2a; Zec 2007 : 175), (b) the coda shares a mora with the preceding vowel (Figure 2b; Hayes 1989 : 254; Kager 1999 : 147), or (c) the syllable onset is linked to the same mora as the syllable nucleus (Figure 2c; Hayes 1995 : 53; de Lacy 2002 : 14). Larry M. Hyman (1985 : 17) links all segments to moras. Researchers usually select one of these representations and use it exclusively.
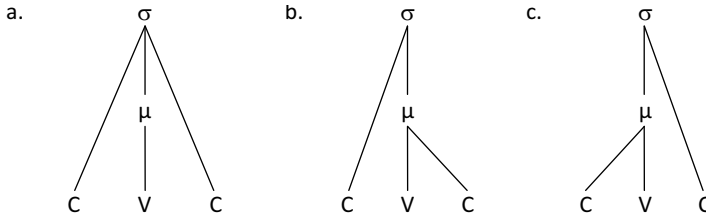
166

a.   σ   b.   σ   c.   σ

        μ   μ   μ

C   V   C   C   V   C   C   V   C

Figure 2. **Monomoraic closed syllables.**

The need for mora sharing in describing phonological systems has been highlighted by scholars such as Ian Maddieson (1993), Bruce Hayes (1995 : 337—338), Janet C. E. Watson (2007), among others. The need for mora sharing becomes especially pronounced in the case of so-called short geminates, whose appearance does not result in the preceding syllable being regarded as heavy (Sprouse 1996; Broselow, Chen, Huffman 1997). The concept of mora sharing has been applied by Patrik Bye (2005) in his description of Saami languages, and by Arvo Eek, Einar Meister (1997 : 94) and Martin Ehala (2003 : 68) in their descriptions of the Estonian quantity system.

The mora is not a purely abstract unit of structure. Moraic structure is reflected in segment duration. Since Ian Maddieson (1993), several measurements have confirmed that there are languages where a mora shared by two segments affects the duration of both segments. The shortening of a vowel in a closed syllable is a very common phenomenon in languages. Broselow, Chen and Huffman (1997) ascribe this to the syllable structure described in Figure 2b: the mora shared by the nucleus and coda causes the vowel in the nucleus to shorten and the consonant in the coda to lengthen.

For example, in Levantine Arabic, the coda consonants following a long vowel share a mora with the syllable nucleus, but the ones following a short vowel do not. This has also been confirmed by measurements (Table 1). Since mora sharing affects the duration of segments, long vowels in closed syllables are shorter than in open syllables, whereas the duration of short vowels is not affected by the syllable being either closed or open. At the same time, a consonant following a long vowel is also shorter than a consonant that follows a short vowel and that is linked to an unshared mora. The effect of mora sharing on the duration of a segment was also evident in Hindi and Malayalam (Broselow, Chen, Huffman 1997 : 55—60).

Table 1

Dependence of V and C durations on moraic structure (average durations in milliseconds, standard deviation in brackets) (Broselow, Chen, Huffman 1997 : 59)

	V duration	C duration	Sample
μ │ V	1μ 80.2 (9.0)		ʔin.**na**.bi 'the prophet'
μ μ │ │ V C	1μ 79.9 (6.6)	1μ 88.4 (10.3)	ʕi.**nab**.hum 'their grape'
μ μ │ ╱ V V C	1,5μ 131.6 (5.5)	0.5μ 67.6 (9.4)	ki.**taab**.hum 'their book'
μ μ │ │ V V	2μ 161.0 (9.9)		ki.**taa**.bi 'my book'

Matthew Gordon (2002) does not share the view of Broselow, Chen and Huffman (1997) that phonetic duration depends directly on the moraicity of the segment. He refers to Khalkha Mongolian, where CVC syllables are light in terms of stress — i.e., the nucleus and the coda should share a mora, yet the measurements indicate that the vowel is of the same duration in both CV and CVC syllables (Gordon 2002 : 69). Gordon's goal is to establish the phonetic differences of light and heavy CVC syllables, which, of course, need not consist only in different ratios of the duration of the nucleus and the coda, since in both light and heavy CVC syllables the vowel can either share a mora or not. Khalkha Mongolian may have the syllable structure described in Figure 2a. Thus, Gordon's study does not refute the claims of Broselow, Chen and Huffman (1997), but complements them.

If we are to expand on the ideas of Broselow, Chen and Huffman (1997), assuming that mora sharing also influences the duration of the onset, yet not disputing the principle that the onset cannot be linked to its own mora, short CVC syllables can have many possible realisations: each structure depicted in Figure 2 can exist in a set of languages. Hence, there is no need to attempt to determine which of these is universally right. What the difference of CVC syllables from CV syllables implies for stop gradation is that both the coda and the onset "crave" to be linked to a mora, yet the syllable has to stay monomoraic and priority is given to the coda (Figure 3b). The sharing of a mora between three or more segments would shorten the nucleus vowel too extensively and supposedly was not an acceptable alternative.
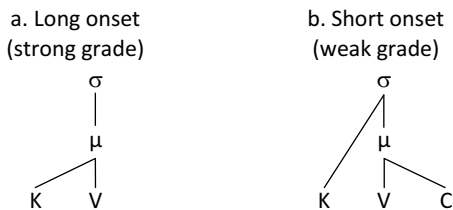
a. Long onset
(strong grade)

b. Short onset
(weak grade)

σ

|

μ

K   V

σ

μ

K   V   C

Figure 3. **Stop gradation.**

The question arises whether Finnic languages are the only languages whose description requires the syllable onset to be linked to a shared mora. If so, the reliability of this analysis would be significantly reduced. Unfortunately, to my best knowledge currently no such studies exist, since moraic theory does not take an interest in syllable onsets. It is conceivable, however, that shared onset moras could be pertinent in descriptions of languages where word-initial geminates occur.

The effect of the syllable onset on the duration of the following vowel has received little treatment in phonetic literature. The relations between the sonority of initial stops and the duration of following vowels have been the best studied. Typically, the vowel which follows a voiced stop is longer than the vowel which follows a voiceless stop (Allen, Miller 1999; see also the references provided by them). The effect of other consonants has been studied, for example, in Japanese, where sonority is also an important factor: the vowel which follows a voiced consonant is longer than the vowel which follows a voiceless consonant (Vendetti, van Santen 1998 : 2045). In English, the vowels which follow certain consonant clusters are shorter than the vowels which follow single consonants (van Santen 1992).

Moras are preferably linked to voiced segments (Morén 2003 : 289). In the syllable onset, the relation between a mora and sonority seems to be

reversed: it is rather voiceless consonants than voiced consonants which share a mora with the following vowel. According to Nina Topintzi, who is convinced that syllable onsets should be allowed to be linked to their own moras, a voiceless stop is indeed a typical moraic onset (Topintzi 2010 : 15).

The moraicity of voiceless stops in the syllable onset may be induced by the need to distinguish them from respective voiced stops. Short stops in a sonorous environment have a tendency to become voiced (LaVoie 2001 : 30—32; Smith 2008 : 524 and others), long stops are preferably voiceless (Hayes, Steriade 2004 : 7—8). If the phonetic similarity of positional allophones is important in a language, the speakers may try to lengthen the stops in sonorous environments, so as to avoid their becoming perceptibly voiced and thus significantly different from the same stops in non-sonorous environments. The contextually voiced part of the stop becomes relatively short as the stop itself lengthens. According to another explanation, the linking of the syllable onset to the mora of the following vowel would be mandatory. In the case of voiceless stops, the resulting difference in duration would be perceptible, while in the case of voiced sounds this would not be the case necessarily. Several phonological systems avoid sonorous geminates, since these do not differ sufficiently from single sounds (Kawahara, Pangilinan, Garvey 2011).

The lengthening of an intervocalic stop is in most cases caused by the requirement that a stressed syllable must be bimoraic. However, there are languages where gemination indeed occurs to preserve the sonority contrast. For example, in Malayalam English, voiceless stops between vowels are always geminated (*packet* [pæækket]), voiced stops are not (*baboon* [bææbuun]) (Mohanan, Mohanan 2003 : 16).

The influence of the syllable coda on the syllable onset is a rare (or at least little studied) phenomenon, yet still not entirely unheard of. In British English, measurements have shown that the onset *l* is longer in syllables with a voiced coda than in those with a voiceless coda (Hawkins, Nguyen 2004). Mora sharing would provide an explanation to the relationship between coda and onset in a language such as Huichol, where a complex onset is possible only in an open syllable. Huichol permits syllable structures such as CVC and CCV, but not CCVC, a closed syllable with a complex onset (McIntosh 1945 : 32). Each sound in a syllable in Huichol must be linked to a mora but the sharing of coda mora is not allowed. Systematic links between onsets and codas play a role in word recognition (Hawkins, Nguyen 2004 : 202).

The likely original cause of gradation is the attempt to increase the duration of stops to avoid their becoming voiced in a sonorous environment. Giving longer duration to stops was impossible in closed syllables, where the nucleus vowel had to share a mora with the coda. At the same time, pressure to preserve the voicelessness of stops was insufficient to cause mora insertion in unstressed syllables. The syllables which were underlyingly light had to remain monomoraic also on the surface level.

2.2. Geminates

If we can interpret gradation as stop lengthening in order to keep stops unvoiced, we would have to find a different reason for the gradation of geminates, since geminates are long enough not to become perceptibly voiced. Geminates are also preferably voiceless between vowels (Kirchner

2004 : 326) and there is no need to link them to additional moras in order to avoid their weakening.

In moraic theory, a geminate is defined as a consonant underlyingly linked to a mora. In the surface representation the geminate is syllabified in a configuration consisting of a moraic-coda and a non-moraic onset (see Figure 4). If a moraic consonant belonged entirely to the preceding syllable, the following syllable would lack an onset (yet, languages prefer syllables with onset over onsetless ones). If a moraic consonant belonged entirely to the following syllable, the onset of that syllable would have its own mora, which is prohibited in moraic theory (Hayes 1989 : 257).
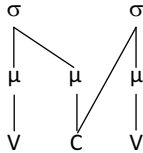

Figure 4. **A schematic representation of geminates.**

A moraic geminate (as in Figure 4) will cause the preceding syllable to be heavy in any case. However, it is known that in Selkup and in Malayalam all closed syllables, even those closed by the first part of a geminate, are light. In Malayalam, syllable weight is determined entirely by vowel length. Syllables with long vowels attract stress, but syllables closed by geminates do not (e.g. *pá.ra.ti* 'searched', *pa.ráa.ti* 'complaint', *pá.rat.ti* 'scattered'). Thus, geminates in Malayalam should be treated as non-moraic (Tranel 1991). This fact, as well as the existence of syllable-initial geminates, has forced the researchers to accept that there are other possible realizations of geminates in addition to the one depicted in Figure 4.

Just as a single consonant, a surface geminate may also acquire part of its length from sharing a mora with neighbouring vowels. Broselow, Chen and Huffman (1997 : 68—70) demonstrate that geminates with a structure depicted in Figure 5a solve the problem for such languages as Malayalam where syllables ending with a geminate are light.
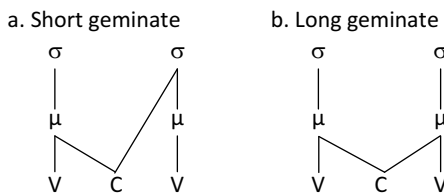
Figure 5. **Gradation of geminates.**

The scheme depicted in Figure 5b would not be possible in a light closed syllable if moras cannot be shared between three sounds. Thus, the gradation of geminates may be triggered by the prohibition of linking a voiceless sound to an unshared mora. In an attempt to preserve the difference in the duration of geminates and single stops, the moras of neighbouring vowels will be linked to the geminate stop if possible.

If it is prohibited in a language to link voiceless stops to unshared moras, then we may doubt whether the structure depicted in Figure 5b is a better representation than the ordinary geminate in Figure 4. If two half-moras add up to one full mora, then, in either case, the geminate will be monomoraic in the end. Nevertheless, in the case of an ordinary geminate,

the entire weight is on one syllable, whereas a geminate with shared moras distributes its weight over two syllables.

If we allow syllable onset to be linked to the mora of the following vowel, we will have another interesting possibility of surface-level realization of underlying moraic consonants. In closed syllables, if the coda and the nucleus are linked to the same mora, the nucleus vowel, in order to preserve its length, may share another mora with the onset (see Figure 6). Such an option is not possible in open syllables, if changes in vowel duration are prohibited: the vowel in a monomoraic CV syllable with a shared mora shortens, and the vowel in a bimoraic CV syllable lengthens.
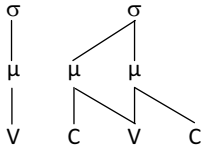

Figure 6. **Mora-preserving degemination.**

Thus, we have one more option to describe the gradation of geminates: ordinary geminates (as seen in Figure 4) may alternate with lengthened single stops (as seen in Figure 6). Indeed, in most Finnic languages the geminates alternate with single stops (e.g. Finnish and Karelian *tuk.ka* : *tu.kan* 'hair, nom.sg/gen.sg.'). The main cause for the emergence of consonant gradation is still the same as in the first case — the closed syllable. Patrik Bye has used structures similar to the one depicted in Figure 6 (but without a moraic onset) to describe the overlength in Saami languages (e.g. Bye 2001 : 165).

3. An Optimality Theory analysis of gradation

Optimality Theory (below, OT; Prince, Smolensky 1993/2004; McCarthy, Prince 1993; 1995) postulates that any surface form is the result of an interaction between universal constraints that are violable and that are ranked vis-à-vis one another in a manner particular to the language in question. The generation of surface forms in OT involves two functions, *Gen* and *Eval*. *Gen* takes an input (underlying form) and generates a set of output (surface) candidates. *Eval* chooses the candidate that best satisfies the set of ranked constraints. This optimal candidate becomes the output (surface form). The operation of *Eval* can be viewed as choosing the subset of candidates that best satisfies the top-ranked constraint, and, of this subset, selecting the sub-subset that best satisfies the second-ranked constraint, and so on.

There are two types of constraints. The function of markedness constraints is to prohibit the marked, i.e. complex, hard-to-pronounce or hard-to-perceive surface structures. Faithfulness constraints ensure similarity between input and output forms.

Table 2 illustrates output selection in OT. The first column of the table lists a series of output candidates in random order. Constraints are listed horizontally, in a descending ranking from left to right. Violations of constraints are marked by asterisks in table cells. If a violation eliminates the candidate, the asterisk is followed by an exclamation point and the following cells are shaded. The optimal candidate is indicated by ☞.

The voicing of stops in a sonorous environment depends on the order of the constraints *D and *{V,N}TV. Both constraints are required in widely

Table 2

A schematic OT table

/input/		C_1	C_2	C_3	C_4
a.	*candidate a*	*!			
b.	*candidate b*		*!	*	
c. ☞	*candidate c*			*	*
d.	*candidate d*		*!		

different languages, see for instance, the typologies in Wetzels, Mascaró 2001; Kirchner 2004; Smith 2008. If constraint *D outranks *{V,N}TV, all intervocalic stops will be voiceless, while in the case of the predominance of constraint *{V,N}TV, such stops will be voiced. This, however, will only be true if the lengthening of the onset, i.e. its link-up with the mora, is prohibited (that is, if constraints *SHARED-μ and *[son]/μ are present at the top of the hierarchy). Table 3 describes a language in which stops in a sonorous environment are voiceless. If the lowest-placed constraint were *{V,N}TV, the stops would also be voiceless, although depending on the rate of speech listeners might perceive them as voiced. Should the lowest-level constraint be *[-son]/μ, intervocalic stops would geminate.

(2) a. *{V,N}TV
   No nonmoraic stops in the context V_V or N_V
   (see Kirchner 2004 : 329—331)

   b. *D
   No voiced stops (see Kager 1999 : 40)

   c. *SHARED-μ
   Moras are linked to single segments
   (Broselow, Chen, Huffman 1997 : 65)

   d. *[-son]/μ
   The head of a mora must be a sonorant, i.e., each mora that is linked to a non-sonorant should also be linked to a sonorant
   (cf. Morén 2003 : 289)

Table 3

A language that avoids voiced stops

/VTV/	*D	*[-son]/μ	*{V,N}TV	*SHARED-μ
a. μ VTV			*!	
b. μ VDV	*!			
c. μ μ VTV		*!		
d. ☞ μ VTV				*

Differences (depending on whether the syllable is closed or not) in the duration of syllable-initial stops are an inevitable consequence of a system in which the coda consonants must be linked to a mora (constraint CODA-μ).
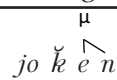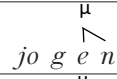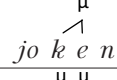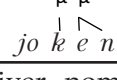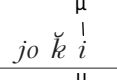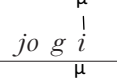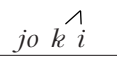
Table 4 provides an illustration of the non-strengthening of stops in closed syllables. We should also consider that the insertion of moras into unstressed syllables is prohibited. In the course of further development of the language the constraints *D ja *{V,N}TV swapped places in the hierarchy, which resulted in syllable-initial consonants of closed syllables becoming voiced (*jo.ǩen > *jo.gen ~ jo.γen 'river, gen.sg').

(3) CODA-μ
   All coda consonants are dominated by a mora
   (Broselow, Chen, Huffman 1997 : 64)

Table 4

Single stop gradation

/joken/ 'river, gen.sg'	CODA-μ	*D	*[-son]/μ	*{V,N}TV	*SHARED-μ
a. ☞ μ / jo ǩ e n				*!	*
b. μ / jo g e n		*!			*
c. μ / jo k e n	*!				*
d. μ μ / jo k e n			*!		
/joki/ 'river, nom.sg'	CODA-μ	*D	*[-son]/μ	*{V,N}TV	*SHARED-μ
a. μ / jo ǩ i				*!	
b. μ / jo g i		*!			
c. ☞ μ / jo k i					*

In closed syllables, reduction applies to diphthongs precisely as it does to single vowels, because the second component of a diphthong shares its mora with the syllable coda. The first component of the diphthong, on the other hand, cannot share a mora with the initial stop of a syllable, because this would leave the diphthong too short (half the mora plus another half, see Table 5).

(4) *SHORTVV
   No monomoraic diphtongs (Yip 1996 : 768)

Table 4 does not include the possibility of a single intervocalic stop taking the mora that it needs in order to lengthen from the preceding as opposed to the following vowel, thus becoming a short geminate (see Figure 5a above). Such gemination cannot be blocked by a subsequent closed syllable. There are several solutions to this problem. The simplest way is to prohibit segment division between syllables (constraint ONESYLL). This does not prevent stops which are linked to a mora in the input from being divided between two syllables in the output, because faithfulness constraints (MAX-μ-LINK and IDENT-C-μ) require duration contrast to be maintained in the output. The migration of a moraic consonant into the second syllable is prevented by WSP.

Table 5
Stops in the onset of syllables with long vowels

/antoi/ 's/he gave'	CODA-μ	*SHORTVV	*D	*{V,N}TV	*SHARED-μ
a. *a n t̆ o i*		*!		*	*
b. *a n t̆ o i*				*!	
c. *a n d o i*			*!		
d. ☞ *a n t o i*					*

/antoin/ 'I gave'	CODA-μ	*SHORTVV	*D	*{V,N}TV	*SHARED-μ
a. *a n t̆ o i n*	*!			*!	
b. *a n t o i n*		*!			**
c. ☞ *a n t̆ o i n*				*!	*

(5) a. ONESYLL
   A segment is a member of exactly one syllable (Green 1997 : 137)

   b. MAX-μ-LINK
   A segment that is linked to a mora in the input is also linked to a mora in the output (Morén 2003 : 294)

   c. IDENT-C-μ
   A consonant in the output must not be shorter than it is in the input

   d. WSP
   Heavy syllables are stressed (Kager 1999 : 155)

In OT, the output structure of geminates depends on the hierarchy of constraints that defines the language. Exactly as in the case of single stop gradation, the link between coda and mora is more important than retention of the full underlying length of the stop, which results in geminates preceding a closed syllable being shortened (see Table 6). In the appropriate part of the table, the constraints ONESYLL and WSP have been inserted to show that they do not preclude the division of input geminates between two syllables in the output.

Where, instead of the constraint *[-son]/μ, the top of the hierarchy is occupied by a positional markedness constraint which prohibits stressed vowels from shortening when they share a mora (*SHARED-μ/σ́), and requires conservation of vowel length (IDENT-V-μ) a different type of geminate alternation occurs: geminates before open syllables alternate with lengthened singletons before closed syllables. Closed syllables of the aforementioned type are bimoraic (see Figure 6). In the case of this type of geminate alternation, too, the insertion of moras into unstressed syllables must be prohibited if gradation is to appear.

Alternation of geminate duration I

/vaₘkₘaₘ/ 'bushel, nom.sg'	CODA-μ	*[-son]/μ	MAX-μ-LINK	WSP	IDENT-C-μ	ONESYLL	*{V,N}TV	*SHARED-μ
a. (σ σ, μμμ, *vaka*)		*!				*		
b. (σ σ, μ μ, *vaka*)			*!		*		*	
c. (σ σ, μ μ, *vaka*)					*!	*		*
d. ☞ (σ σ, μ μ, *vaka*)						*		**
/vaₘkₘaₘn/ 'bushel, gen.sg'	CODA-μ	*[-son]/μ	MAX-μ-LINK	WSP	IDENT-C-μ	ONESYLL	*{V,N}TV	*SHARED-μ
a. (σ σ, μμμ, *vakan*)		*!				*		*
b. ☞ (σ σ, μ μ, *vakan*)					*	*		**
c. (σ σ, μ μ, *vakan*)	*!					*		**
d. (σ σ, μμμ, *vakan*)				*!				**
/vaₘkaₘn/ 'pious, gen.sg'	CODA-μ	*[-son]/μ	MAX-μ-LINK	WSP	IDENT-C-μ	ONESYLL	*{V,N}TV	*SHARED-μ
a. ☞ (μ, *vakan*)							*	
b. (μ μ, *vakan*)						*!		
c. (μ, *vakan*)	*!							
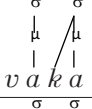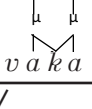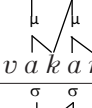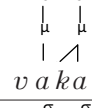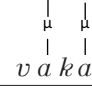
(6) a. SHARED-μ/σ́

    There are no shared moras in a stressed syllable

  b. IDENT-V-μ

    The vowel in the output is not shorter than in the input

Table 7

Alternation of geminate duration II

/va$_\mu$k$_\mu$a$_\mu$/	*SHARED-μ/ó	*{V,N}TV	IDENT-V-μ
a. ☞ [σ σ / μ μ μ / v a k a]			(shaded)
b. [σ σ / μ μ / v a k a]		*!	(shaded)
c. [σ σ / μ μ / v a k a]	*!	(shaded)	**
/va$_\mu$k$_\mu$a$_\mu$n/	*SHARED-μ/ó	*{V,N}TV	IDENT-V-μ
a. [σ σ / μ μ μ / v a k a n]			*!
c. [σ σ / μ μ / v a k a n]	*!	(shaded)	**
d. ☞ [σ σ / μ μ μ / v a k a n]			
/va$_\mu$ka$_\mu$/	*SHARED-μ/ó	*{V,N}TV	IDENT-V-μ
a. ☞ [σ σ / μ μ / v a k a]			* (shaded)
b. [σ σ / μ μ / v a k a]		*!	(shaded)

There is no simple way of determining whether different types of geminate gradation evolved side by side or whether either one can be traced back to the other one. Most probably, the choice of the type of gradation depends on the extent to which the language tolerated heavy unstressed syllables. In contemporary Standard Finnish, the diphthongs of medial syllables have been preserved and geminates alternate with single stops; in Standard Estonian, unstressed diphthongs have been lost and long geminates alternate with short ones.

Tiit-Rein Viitso (1981 : 178; 2008 : 122) distinguishes two principal types of gradation in Finnic languages — the type in which the weak grade of the geminate is phonologically similar to the strong grade of a single stop (or obstruent), cf. Votic, Ingrian, Finnish, North Karelian, and the type in which this is not the case, cf. South Karelian, Lude. Estonian could be classified as belonging to the first group, if we consider alternations of the type *vak̀.ka* : *vǎk.kas* 'bushel' as quantity gradation and *look.ka* : *loo.ɢas* 'shaft bow' as stop gradation.

Leaving aside the dependence of the weak grade of geminates on the sounds in the previous syllable (these distinctions have been discussed in detail by Viitso 1981; 2008), the differences between types can be adequately described by the six constraints *[-son]/μ, *SHARED-μ/σ́, IDENT-C-μ, IDENT-V-μ, *{V,N}TV and WSP. The following analysis was performed using the application OTSoft (Hayes, Tesar, Zuraw 2003).

A language in which the weak grade of a geminate is the same as the strong grade of a single stop (see Example 8) would result from the following hierarchies (the constraints whose relative order is free are separated by a comma):

(7) a. *SHARED-μ/σ́ > *{V,N}TV > IDENT-V-μ > IDENT-C-μ, *[-son]/μ, WSP

   b. *[-son]/μ > IDENT-C-μ > *SHARED-μ/σ́ > *{V,N}TV, WSP > IDENT-V-μ

In the first case (7a), the strong grade of the geminate appears as an ordinary geminate possessing an independent mora (see Figure 4 above), in the second case (7b) it takes the form of a geminate that shares its moras (see Figure 5b above). As a development of the initial type, the weak grade of single stops, which were not linked to a mora (see Figure 3a above), became voiced. Then, the strong grade of the single stop and the weak grade of the geminate could be released from the link with mora, and to become half-voiced (as in Ingrian), while in the case of geminates, abandoning the mora link may have at first been prohibited (as in South Karelian).

(8) North Karelian   *tuk.ka* : *tu.kan* 'hair, nom.sg/gen.sg',
                     šu.ka : *šu.van* 'comb, nom.sg/gen.sg'
                           (see Viitso 1981; 2008 : 126)
    Ingrian (Soikkola) *säk.ki* : *sä.ɢiD* 'sack, nom.sg/nom.pl'
                     koDi : *koin* 'house, nom.sg/gen.sg'
                           (Laanest 1986 : 33)
    South Karelian   *tuk.ka* : *tu.kan* 'hair, nom.sg/gen.sg'
                     šu.ga : *šu.van* 'comb, nom.sg/gen.sg'
                           (see Viitso 1981; 2008 : 126)

Languages in which the weak grade of geminates did not degeminate (see (9)), were characterised by hierarchy (10), whose only difference from hierarchy (7) consists in the presence of the WSP constraint. If WSP would be a rank lower, alternation of long and short geminates would not be possible.

(9) Estonian   *kot.ti* : *kot̆.tiD* 'bag, part.sg/nom.pl'
               tu.ʙa : *toaD* 'room, nom.sg/nom.pl'

(10) *[-son]/μ > WSP, IDENT-C-μ > *SHARED-μ/σ́ > *{V,N}TV > IDENT-V-μ

The Estonian type of gradation is less common. One could not give up this type of gradation, since were Estonian to use hierarchy (7), the contemporary short stops (such as in *kot̆.tiD*) would have to have arisen as a result of gemination. In genitive forms, a gemination like this could be explained by postulating the shortening of the long vowel resulting from the dropping of the genitive ending *-n*. In all other cases, one would have to assume an analogous path.

Almost all of the other possible hierarchies neutralise gradation to a larger or smaller extent. For instance, the South Veps variant, in which single

stops have become voiced and geminates have been replaced by single stops (see (11)), gives rise to hierarchy (12).

(11) Veps *uk* (< **ukkoi*) : *u.koD*   'old man, nom.sg/nom.pl'
     raud   : *rau.dan* 'iron, nom.sg/gen.sg' (Laanest 1982 : 135)

(12) *SHARED-μ/σ́, *[-son]/μ > WSP, IDENT-C-μ, IDENT-V-μ > *{V,N}TV

The factorial typology frequently used in OT analyses (see Prince, Smolensky 1993/2004 : 105—118) will not provide any useful information in the case of closely related languages. Overgeneration may be caused by similarities in the history of the related languages and not by a mistaken selection of constraints. Still, preliminary data suggest that the six constraints listed above only generate one combination that is not encountered in any Finnic language — that of the alternation of a geminated single stop with a short single stop. Precisely this type of gradation is found in Saami languages, e.g. *lop.pe* : *lo.best* 'permission, nom.sg/elat.sg' (see Gordon 1997).

4. Conclusions

The lenition of stops between sonorants is a process that is relatively common cross-linguistically. Gradation in Finnic languages can be shown to represent a mirror image of that process — it can be analysed as an attempt to prevent lenition. In order to do that, the stop in the syllable onset was linked to the mora of the following vowel, i.e. the stop was lengthened at the expense of the vowel. It is easier to maintain the voicelessness of long stops than it is of short ones. Linking syllable onset to a vowel's mora was not an option in closed syllables, in which the vowel mora had to be linked to the coda. For the same reason, the full extent of the duration of geminates could not be preserved in front of closed syllables.

A schematic representation of the hierarchy of Optimality Theory constraints related to consonant gradation in Finnic languages is shown in Figure 7. Solid arrows denote the original type of consonant gradation which suits all Finnic languages. In such a hierarchy, long and short geminates will alternate, as they presumably did in Estonian before it developed quantity gradation, cf. **kot̆.ti* : *kŏt̆.tiD* 'bag, part.sg/nom.pl'. Arrowheads on dotted lines point to changes that lead to what may be the other original type of consonant gradation in which geminates alternate with single stops, as they do in most of the other Finnic languages, such as the Finnish and Karelian *tuk.ka* : *tu.kan* 'hair, nom.sg/gen.sg'. The principal difference between these two types is the location of the WSP constraint — that is, whether the language allowed heavy unstressed syllables or not. It is remarkable that, for instance in the case of Finnish, which to date preserves its original V*i*-diphthongs of unstressed syllables, the suitable type of consonant gradation is one in which WSP is located at a relatively low level of the hierarchy, whereas for Estonian, which has lost its V*i*-diphthongs, the suitable type of consonant gradation is one in which WSP is located at the top of the hierarchy.

The possible hierarchies of constraints used in the analysis, the gradation systems that correspond to them and their suitability to Finnic languages and dialects as well as to more distant kin languages represent an interesting subject for further investigation.
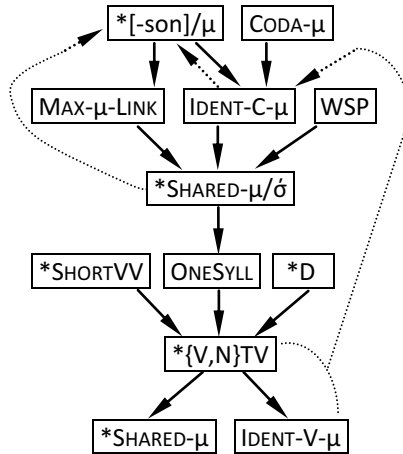
Figure 7. **A hierarchy of constraints leading to Finnic consonant gradation.**

The analysis of consonant gradation presented here turns directly on the closedness or openness of syllables, as does its traditional definition. There is no need to regard closed unstressed syllables as too heavy, or to lengthen the vowels of open non-initial syllables, which would trigger the foot balancing process. Gradation was not simply lenition or fortition — it involved both aspects at the same time. In open syllables, the duration of stops increased, while in closed syllables the stops whose duration had not increased started to shorten and eventually disappeared altogether.

Address

Külli Prillop
University of Tartu
E-mail: kulli.prillop@ut.ee

Abbreviations

C — consonant, **elat** — elative, **gen** — genitive, **H** — heavy syllable, **K** — stop, **L** — light syllable, **nom** — nominative, **part** — partitive, **pl** — plural, **sg** — singular, **V** — vowel, **σ** — syllable, **μ** — mora.

REFERENCES

A l l e n, S. J., M i l l e r, J. L. 1999, Effects of Syllable-Initial Voicing and Speaking Rate on the Temporal Characteristics of Monosyllabic Words. — The Journal of the Acoustical Society of America 106, 2031—2039.
B r o s e l o w, E., C h e n, S., H u f f m a n, M. 1997, Syllable Weight. Convergence of Phonology and Phonetics. — Phonology 14, 47—82.
B y e, P. 2001, Virtual Phonology. Rule Sandwiching and Multiple Opacity in North Saami, Tromsø (PhD dissertation (manuscript), University of Tromsø).
  —— 2005, Coda Maximisation in Northwest Saamic. — Nordic Journal of Linguistics 28, 189—221.
C a m p b e l l, L. 1999, Historical Linguistics, Cambridge, MA.
C a s t r é n, M. A. 1838, De affinitate declinationum in lingua fennica, esthonica et lapponica, Helsingforsiae.

d e   L a c y, P. 2002, The Formal Expression of Markedness, Amherst (PhD disser-
          tation (manuscript), University of Massachusetts).
E e k, A., H e l p, T. 1986, Rütminihked eesti keele kujunemisloos, Tallinn.
E e k, A., M e i s t e r, E. 1997, Simple Perception Experiments on Estonian Word
          Prosody: Foot Structure vs. Segmental Quantity. — Estonian Prosody: Papers
          from a Symposium, Tallinn, 71—99.
   —— 2004, Foneetilisi katseid ja arutlusi kvantiteedi alalt. Takt, silp ja välde. —
          KK, 251—271, 336—357.
E h a l a, M., 2003, Estonian Quantity. Implications for Moraic Theory. — Generative
          Approaches to Finnic and Saami Linguistics, Stanford, 51—80.
G o r d o n, M. 1997, A Fortition-Based Approach to Balto-Fennic-Sámi Consonant
          Gradation. — Folia Linguistica Historica 18, 49—79.
   —— 2002, A Phonetically-Driven Account of Syllable Weight. — Language 78, 51—
          80.
   —— 2009, Prominence and Gemination in Ingrian. — LU XLV, 81—100.
G r e e n, A. D. 1997, The Prosodic Structure of Irish, Scots Gaelic, and Manx
          (PhD Dissertation (manuscript), Cornell University).
H a w k i n s, S, N g u y e n, N. N. 2004, Influence of Syllable-Coda Voicing
          on the Acoustic Properties of Syllable-Onset /l/ in English. — Journal of
          Phonetics 32, 199—231.
H a y e s, B. 1989, Compensatory Lenghtening on Moraic Phonology. — Linguistic
          Inquiry 20, 253—306
   —— 1995, Metrical Stress Theory. Principles and Case Studies, Chicago—London.
H a y e s, B., T e s a r, B., Z u r a w, K. 2003, OTSoft 2.1 (Software package).
          http://www.linguistics.ucla.edu/people/hayes/otsoft/.
H a y e s, B., S t e r i a d e, D. 2004, Introduction. The Phonetic Bases of Phono-
          logical Markedness. — Phonetically Based Phonology, Cambridge, 1—33.
H y m a n, L. M. 1985, A Theory of Phonological Weight, Dordrecht.
I t k o n e n, T. 1969, Zur Wertung der finnisch-ugrischen Lautforschung. — UAJb.
          41, 76—111.
I v a, S. 2010, Grade Alternation in Võro South Estonian. — LU XLVI, 161—174.
K a g e r, R. 1999, Optimality Theory, Cambridge.
K a w a h a r a, S., P a n g i l i n a n M., G a r v e y K. 2011, Spectral Conti-
          nuity and the Perception of Duration: Implications for Phonological Patterns
          of Sonorant Geminates (Submitted manuscript). http://roa.rutgers.edu/files/
          1132-0111/1132-KAWAHARA-0-0.PDF.
K i p a r s k y, P. 2006, Livonian Stød (Manuscript). http://www.stanford.edu/~
          kiparsky/Papers/livonian.pdf.
K i r c h n e r, R. M. 2004, Consonant Lenition. — Phonetically Based Phonology,
          Cambridge, 313—345.
K o r h o n e n, M. 1988, The History of the Lapp Language. — The Uralic Languages.
          Description, History, and Foreign Influences, Leiden, 264—287.
K r a e h e n m a n n, A. 2001, Swiss German Stops. Geminates all over the Word.
          — Phonology 18, 109—145.
L a a n e s t, A. 1982, Einführung in die ostseefinnischen Sprachen, Hamburg.
   —— 1986, Isuri keele ajalooline foneetika ja morfoloogia, Tallinn.
L a V o i e, L. 2001, Consonant Strength. Phonological Patterns and Phonetic
          Manifestations, New York.
M a d d i e s o n, I. 1993, Splitting the Mora. — UCLA Working Papers in Phonetics
          83, California, 9—18. http://escholarship.org/uc/search?entity=uclaling
          _wpp.
M c C a r t h y, J. 2000, The Prosody of Phase in Rotuman. — Natural Language
          and Linguistic Theory 18, 147—197.
M c C a r t h y, J., P r i n c e, A. 1993, Generalized Alignment. — Yearbook of
          Morphology, Dordrecht, 79—153.
   —— 1995, Faithfulness and Reduplicative Identity. — University of Massachu-
          setts Occasional Papers in Linguistics 18. Papers in Optimality Theory,
          Amherst, 249—384.
M c I n t o s h, J. B. 1945, Huichol Phonemes. — International Journal of American
          Linguisticsl 11, 31—35.

M o h a n a n, T., M o h a n a n K. P. 2003, Towards a Theory of Constraints in OT. Emergence of the Not-so-unmarked in Malayalee English (Manuscript). http://roa.rutgers.edu/files/601-0503/601-0503-MOHANAN-0-0.PDF

M o r é n, B. 2003, Weight Typology. An Optimality Theoretic Approach. — The Linguistic Review 20, 281—304.

P i k a m ä e, A. 1957, Tüveline astmevaheldus läänemeresoome keeltes ja lapi keeles, Tartu (TRÜT 50).

P o s t i, L. 1953, From Pre-Finnic to Late Proto-Finnic. Studies on the Development of the Consonant System. — FUF XXXI, 1—91.

P r i n c e, A., S m o l e n s k y, P. 1993/2004, Optimality Theory. Constraint Interaction in Generative Grammar, Malden, MA.

R a v i l a, P. 1960, Probleme des Stufenwechsels im Lappischen. — FUF 33, 285—325.

S a m m a l l a h t i, P. 1998, The Saami Languages. An Introduction, Káráshjohka.

S m i t h, J. 2008, Lenition and Fortition in Optimality Theory. — Lenition and Fortition, Berlin—New York, 519—560.

S p r o u s e, R. 1996, Vowels That Borrow Moras. Geminates and Weight in OT. — Proceedings of the Northeast Linguistic Society 26, 392—408.

T o p i n t z i, N. 2010, Onsets. Suprasegmental and Prosodic Behavior, Cambridge.

T r a n e l, B. 1991, CVC Light Syllables, Geminates and Moraic Theory. — Phonology 8, 291—302.

v a n S a n t e n, J. P. H. 1992, Contextual Effects on Vowel Duration. — Speech Communication 11, 513—546

V e n d e t t i, J. J., v a n S a n t e n, J. P. H. 1998, Modeling Vowel Duration for Japanese Text-to-Speech Synthesis. — Proceedings of the 5th International Conference on Spoken Language Processing, Sydney, 2043—2046.

V i i t s o, T.-R. 1981, Finnic Gradation: Types and Genesis. — СФУ XVII, 176—185.

—— 2003, Rise and Development of the Estonian Language. — Estonian Language, Tallinn (Linguistica Uralica. Supplementary Series / Volume 1), 130—230.

—— 2007, Livonian Gradation: Types and Genesis. — LU XLIII, 45—62.

—— 2008, Läänemeresoome astmevaheldus: tüübid ja tekkimine. — Liivi keel ja läänemeresoome keelemaastikud, Tartu—Tallinn, 120—127.

W a t s o n, J. C. E. 2007, Syllabification Patterns in Arabic Dialects. Long Segments and Mora Sharing. — Phonology 24, 335—356.

W e t z e l s, W. L., M a s c a r ó, J. 2001, The Typology of Voicing and Devoicing. — Language 77, 207—244.

W i i k, K. 1997, The Uralic and Finno-Ugric Phonetic Substratum in Proto-Germanic. — LU XXXIII, 258—281.

Y i p, M. 1996, Lexicon Optimization in Languages without Alternations. — Current Trends in Phonology. Models and Methods, Vol. 2, Salford, 757—788.

Z e c, D. 2007, The Syllable. — The Cambridge Handbook of Phonology, Cambridge, 161—194.

КЮЛЛИ ПРИЛЛОП (Тарту)

ЧЕРЕДОВАНИЕ СТУПЕНЕЙ СМЫЧНЫХ КАК РЕЗУЛЬТАТ ДЕЛЕНИЯ МОР В ПРИБАЛТИЙСКО-ФИНСКИХ ЯЗЫКАХ

Ослабление смычных в прибалтийско-финских языках, которое зависит от открытости или закрытости следующего слога, как чередование ступеней представляет собой редкое явление в языках мира. Может иметь место все же фонетически естественное ослабление между гласными, которому препятствует или способствует разная моровая структура слогов. В таком случае различия в прибалтийско-финском чередовании ступеней зависит от того, допустимы ли в языке тяжелые безударные слоги.