PARADIGMATIC LENGTH ALTERNATIONS IN ESTONIAN
AN AUTO-SEGMENTAL/METRICAL ANALYSIS
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Two theories that in the last few years have been attracting attention are the METRICAL THEORY of stress and the theory of AUTO-SEGMENTAL phonology. The basic premise of the metrical theory is that stress patterns can be derived from hierarchical tree structures which may or may not be derived by rules on a string of segments. The auto-segmental theory postulates that there can be two or more non-hierarchical levels called tiers which consist of segments and/or supra-segmentals in the underlying representation of a lexical item. The theory has been used to account for things like tone patterns, vowel harmony, and the vowels of Semitic languages. This paper, which in its essentials is a portion of the author's Forum paper (1981), will examine aspects of both of these theories and by an amalgamation of the two present a model that seems to account for two broad classes of paradigmatic length alternations in Estonian.

Estonian is a complex language that is characterized by the interaction of a surface ternary opposition of length with an elaborate morphologic system. Thus the paradigms of a vast majority of lexical items are based on the alternations between the various surface lengths, which we will label Q1 (short segment), Q2 (long or geminate segment), and Q3 (extra-long segment). In this paper I will present a model of Estonian phonology which postulates only two underlying lengths and the incorporation of the stress tree structure as an auto-segmental tier in the lexicon. The interaction of the stress tier and the segmental tier results in the three surface lengths in Estonian that have for so long been a bone of contention among linguists.

Before proceeding to the data that we will be looking at, a few words on the transcription:
short segments will be marked with a single letter; e.g. [a], [n], etc.

long segments with a double letter; e.g. [oo], [tt], etc.

extra-long segments with a double letter followed by a diacritic ':'

e.g. [uu:], [ei:] (extra-long diphthong), [ll:], etc.

With respect to extra-long consonants, if a syllable boundary falls in the middle of the segment in question the diacritic will be placed between the double letter; e.g. [rːr], [pːp], etc.

Q1, Q2, and Q3 will be used with reference to only the surface lengths.
Underlying lengths will be referred to as simply short and long segments.
The symbol '§' represents the mid back unrounded vowel, in accord with the standard orthography.

In this paper we will be concentrating on two subclasses of substantives (nouns and adjectives). I will be dealing with substantives rather than verbals simply because the morphology of substantives is that much easier to deal with in general in Estonian.
It must be kept in mind, though, that the same principles can apply to verbals as well, only certain details will be different.

Broadly speaking Estonian substantives may be divided into three classes on the basis of the alternations exhibited in their paradigms.
Substantives may exhibit no alternations at all or else they may exhibit a qualitative alternation, which is the alternation of an obstruent with a glide or ː. This last is a fossilized relic of something called grade alternation, which was a phonological process in Proto-Western Finnic. The third class, and this is the class that
we will be looking at in this paper, consists of substantives which exhibit a QUANTITATIVE ALTERNATION. This is a very productive type of alternation in Estonian and a large majority of substantives undergo this type of alternation. Quantitative alternation is characterized by the alternation of one segment between two lengths within the paradigm of a given substantive: Q3 alternates with either Q2 as in konna ~ konina 'frog, genitive case ~ partitive case' or with Q1 as in külma külma 'cold, gen. ~ part.'. There are no cases where a segment will alternate between all three lengths within the paradigm of the same morpheme. Within this class are two subclasses, which are based on the two patterns formed by the alternations. Sub class one consists of those items whose nominative and partitive cases contain a Q3 segment and whose genitive contains either Q2 or Q1:

\[\begin{array}{ll}
\text{nöm.} & \text{sepp: Q3 'smith'} \quad \text{metts: Q3 'forest'} \\
\text{gën.} & \text{seppa Q2} \quad \text{metssa Q1} \\
\text{përt.} & \text{seppa Q3} \quad \text{mettsa Q3} \\
\end{array}\]

Sub class two consists of those items exhibiting a diametric pattern to the one in sub class one; the genitive case contains Q3 while the nominative and partitive cases contain either Q2 or Q1:

\[\begin{array}{ll}
\text{nöm.} & \text{mötte Q2 'thought'} \quad \text{kärme Q1 'quick'} \\
\text{gën.} & \text{mötte Q3} \quad \text{kärme Q3} \\
\text{përt.} & \text{mötett Q2} \quad \text{kärmett Q1} \\
\end{array}\]

Throughout the rest of this paper we need consider only these three cases. The other eleven cases and all plural cases are formed by the addition of agglutinative suffixes onto the genitive or partitive
singular.

Whether Q1 or Q2 alternates with Q3 is predictable on the basis of the syllable structure of the stem. There are four basic syllable types involved in the alternations:

1. **Q2 ~ Q3**
   a long vowel or diphthong will alternate between Q2 and Q3 when it is followed by a single (Q1) consonant.
   
   \[ VVC \sim VV:G \]
   
   e.g. sub class I sub class II
   nom. lau:1 Q3 'song' luule Q2 'poem'
   gen. laulu Q2 luule: Q3
   part. lau:lu Q3 luulett Q2

2. **Q2 ~ Q3**
   a long (geminate) consonant will alternate between Q2 and Q3 when it is preceded by a short vowel.
   
   \[ VCC \sim VCC: \]
   
   e.g. nom. linn: Q3 'town' mütte Q2 'thought'
   gen. linna Q2 mütte: Q3
   part. lin:na Q3 mütlett Q2

3. **Q1 ~ Q3**
   the first component of a consonant cluster will alternate between Q1 and Q3 when the second component is underlyingly a short consonant.
   
   \[ C:CC:1 \sim C:1 CC \]
   
   e.g. nom. küll:m Q3 'cold' kärme Q1 'quick'
   gen. külma Q1 kär:me Q3
   part. küll:ma Q3 kärmett Q1

4. **Q1 ~ Q3**
   an underlying long consonant will alternate between Q1 and Q3 when it is preceded by a long vowel or
diphthong or by a single (short) consonant.

\[ VVC \sim \text{VVCC}; \quad C_1 C_2 \sim \text{C}_1 \text{CC}_2 \]

<table>
<thead>
<tr>
<th>Case</th>
<th>Nom.</th>
<th>Gen.</th>
<th>Part.</th>
</tr>
</thead>
<tbody>
<tr>
<td>kimpp</td>
<td>Q3</td>
<td>kimpu</td>
<td>Q1</td>
</tr>
<tr>
<td>saate</td>
<td>Q1</td>
<td>saat:te</td>
<td>Q3</td>
</tr>
<tr>
<td>saat:tt</td>
<td>Q1</td>
<td></td>
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</tbody>
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In type four we know that the underlying segment in question is long and thus the expected alternation should be Q2 \sim Q3. However here we see the Estonian Q2 constraint (Märk 1981) in operation which disallows the occurrence of a Q2 segment preceded by a consonant, as would be the case with \textit{kimpu} 'bunch, gen.' (the expected genitive would be \textit{*kimppu} Q2), or by another Q2 segment, as would be the case with \textit{saate} 'broadcast, nom.' (the expected nominative would be \textit{*saatte} Q2).

In all cases Q3 is a feature of a heavy syllable \((C)VV\) or \((C)V(V)(C)C\), which manifests itself by the lengthening of the segment immediately to the left of the syllable boundary. Look for example at the underlying forms below. I will underline the segment that is lengthened to Q3. Syllable boundaries will be marked with '$$':

- /lau$$lu/  
  lau:l 'song, nom.'
- /lin$$na/  
  linn: 'town, nom.'
- /kîl$$ma/  
  kîl:m 'cold, nom.'
- /kimp$$pu/  
  kimp: 'bunch, nom.'
- /saat$$te/  
  saat:te 'broadcast, gen.'
Historically, moreover, we know that Q3 in fact developed as an innovation in Estonian after the language had separated from Proto Western Finnic. Classical literature on the historical development of Estonian describe Q3 as compensatory lengthening on heavy stressed syllables due to the loss of a following stressless vowel in an light syllable (CV).

These then are the facts that we need to account for. In the following model I postulate that we need to have only two underlying lengths in Estonian. Further, the phonology of Estonian consists of at least two tiers; one the segmental tier, in which there is a binary opposition in length, and the other, a stress tier, in which there is a hierarchical stress tree structure. Such a model seems to account for the length alternations in Estonian in a way that previous linear models were unable to do.

We know that there is a deep correlation between the length alternations of Estonian and the stress system of the language. Hint (1973) mentions this in his very extensive monograph on the stress system of Estonian. Historically we know that Q3 developed on stressed syllables and that the modern day alternations also occur in conjunction with stressed syllables.

The metrical theory, to explain it very simplistically, accounts for stress placement in a string of segments by means of a hierarchical tree structure, which may or may not be rule derived onto that string. The tree itself is binary branching into strong (S) and weak (W) beats and sequences of strong and weak beats are called
feet. A foot may contain only one strong beat and one or more weak beats:

```
  S
 / \  /
S   W
/\ /\ /
S W S W
```

CV-CV-CV-CV
1 2 3 4

Main stress in a string will fall on that syllable which is wholly dominated by S nodes. Syllable one above is dominated by S which is in turn dominated by a higher S which in turn again is dominated by the highest S. Main stress will fall on syllable one. Secondary stress will fall on syllables which are immediately dominated by S nodes which in turn are dominated by a W node; syllable three. Unstressed syllables are dominated by W nodes; syllables two and four.

Now Prince (1980) demonstrates that in fact the behaviour of Q3 and certain stress patterns in Estonian can be accounted for by the metrical theory of stress. The basic premise is that a syllable containing a Q3 segment is dominated not merely by a strong beat but rather by an entire foot; \[ S W ]_S :

```
  S
 / \  /
S   W
/\ /\ /
S W
```

`kukk`:

This would explain effectively why in Estonian secondary stressed
syllables may immediately follow Q3 primary stressed syllables but not Q1 or Q2 primary stressed syllables. Compare the following:

\[
\text{Q3 } \text{mut:t-esse} \quad \text{but} \quad \text{Q2 } \text{kukk-esse} \quad \text{'thought, illative' \quad 'rooster, ill.'}
\]

This accounts very neatly for this very common stress pattern phenomenon in Estonian.

Let us digress back to the first millenium A.D. for a moment and see what light the metrical theory of stress can shed on the historical development of Estonian Q3. Just for the sake of argument let us assume that the stress trees were rule determined in Proto Western Finnic. The rules themselves do not interest us much here. Stress being so regular, the rules in any case were very straightforward. We will look at the nominative, genitive and partitive cases of sub class I for the moment. Below we will look at sub class II. Historically the genitive marker was /\+n/ and the partitive marker was /\+\check{a}/. After the stress rules have applied we have something that looks like the following:

\[
\text{*linna} \quad \text{*linnan} \quad \text{*linna\check{a}} \quad \text{'town'}
\]
I suggest that what happened was there developed a tendency for stressed heavy syllables to cause weak beats of light syllables to gravitate toward them which resulted in the following:

In the nominative case we can see that the weak beat shifted over onto the stressed first syllable leaving the final vowel without a beat.
In the genitive case the fact that the unstressed syllable dominated by W is heavy prevents the weak beat from shifting. In the partitive case there are no heavy unstressed syllables and both W beats shift one over to the left leaving the final vowel beatless. A whole foot
dominating one syllable had the effect of extending the over all
duration of of the syllable which was manifested by the lengthening
the last segment of that syllable to Q3. Beatless vowels at the same
time, by not being associated with a stress beat were deleted. Later
the [n] and the [ŋ] of the genitive and partitive cases disappeared.
The result; the modern forms found in Standard Estonian:

```
  S
 /\ 
 S W
```

linna

```
  S
 /\ 
 S W
```

linna

```
  S
 /\ 
 S W
```

linna

```
  S
 /\ 
 S W
```

lau l'uu

```
  S
 /\ 
 S W
```

lau lu

Another possible sequence of events might be that unstressed vowels
in light syllables (CV) were first deleted leaving an unassociated
W beat which gravitated to the preceding heavy syllable. The results
in any case are the same for both sequences.

We know that there has been much restructuring and analogical
leveling in Estonian as a result of vowel and subsequent consonant
deletions. I suggest that part of the restructuring that took place
involved the incorporation of the stress trees onto the underlying
representation of lexical items as an auto-segmental tier. Thus in Standard Estonian today a lexical item in the lexicon consists of two tiers; a segmental tier and a stress tier. The two tiers can act independently and the final surface representation of each item as it is taken from the lexicon depends on how the two tiers are associated with each other. Assuming that this is correct, then we can postulate the following underlying forms. I will illustrate with one example from each of the four syllable types discussed above.

Bear in mind that the final vowel of the stem must be included in the underlying form since that vowel is unpredictable:

```
\[ S \]
\[ S \]
\[ S \]
\[ S \]

/\lin\n a/ 'town'
/\la\n u\n l u/ 'song'
/k i\n m\n a/ 'cold'
/k i\n m\n p\n p u/ 'bunch'
```

Syllables which are dominated by a whole foot \[ S \ W \] are automatically lengthened to Q3. To form the nominative there is a rule that deletes all vowels which are not dominated by a stress beat. Thus in the stress tier there is no change but in the segmental tier the final beatless stem vowel is deleted:

```
\[ S \]
\[ S \]
\[ S \]
\[ S \]

[\lin\n n:\n] [\la\n u: l] [k ü\n l: m] [k i\n m\n p:\n]
```

To form the genitive there is a rule which merely shifts the W beat from the heavy stressed syllable onto the beatless vowel immediately
to the right:

\[
\begin{align*}
S & \quad S & \quad S & \quad S \\
S & \quad W & \quad S & \quad W & \quad S & \quad W & \quad S & \quad W \\
[\text{linna}] & \quad [\text{lau lu}] & \quad [\text{kulma}] & \quad \text{kimp u} \\
\end{align*}
\]

The Q2 /p/ of kimpu
is reduced to Q1 by the
Q2 constraint.

Here there is no change in the segmental tier while in the stress tier
the W beat moves one syllable to the right. This rule for the
formation of the genitive is thus a morphologically conditioned rule.

To form the partitive I suggest that there is a partitive morpheme
which exists only in the stress tier of this auto-segmental model.
It has no segmental representation at all and is merely a W beat
which attaches itself to the only thing that it can in the
underlying representation; the final beatless vowel of the stem.
The result is:

\[
\begin{align*}
S & \quad S & \quad S & \quad S \\
S & \quad S & \quad S & \quad S & \quad S & \quad S \\
S & \quad W & \quad W & \quad W & \quad W & \quad W & \quad W \\
[\text{lin na}] & \quad [\text{lau lu}] & \quad [\text{kull ma}] & \quad [\text{kimp pu}] \\
\end{align*}
\]

The \([S W]_S\) foot remains on the heavy first syllable causing
lengthening to Q3 and now that the stem vowel is associated with
the partitive morpheme, a \( W \) beat, it does not get deleted by the rule
that deletes all vowels not associated with a stress beat.

The above accounts for the behaviour of sub class I. Let us
now look at sub class II. I will illustrate this sub class with
only one type of syllable structure. The principle will, however,
remain the same for all four types of structures. Again let us look
at the historical development of this sub class. Historically this
type developed from Proto Western Finnic consonant stems:

\[
\begin{align*}
\text{nom.} & \quad *\text{mottek} & & \text{"thought"} \\
\text{gen.} & \quad *\text{motteyen} \\
\text{part.} & \quad *\text{mottekta}
\end{align*}
\]

\[
\begin{array}{c}
\begin{array}{cc}
S & S \\
S & W \ W
\end{array} \\
\begin{array}{cc}
S & S \\
S & W \ W
\end{array} \\
\begin{array}{cc}
S & S \\
S & W \ W
\end{array}
\end{array}
\]

*\text{mottek} \quad *\text{motteyen} \quad *\text{mottekta}

In the nominative the heavy second syllable prevented the \( W \) beat
from gravitating to the heavy syllable to the left. In the genitive
the heavy stressed syllable was able to pull the \( W \) beat off of the
following light syllable and the beatless vowel is deleted:

\[
\begin{array}{c}
\begin{array}{c}
S \\
S \\
S \ W \ W
\end{array}
\end{array}
\]

*\text{mottyen}
Later the final \( [n] \) and \( [\nu] \) of the this form disappear. The whole foot over the heavy first syllable causes lengthening to Q3 resulting in the modern form found in Standard Estonian: \([\text{motte}]\). As regards the partitive there is no shifting of W beats since the unstressed syllable to the right of the heavy stressed syllable is also heavy. Finally at a later stage by analogy the final \( [a] \) of the partitive is deleted along with the W beat associated with it.

Synchronically this sub class behaves like the following:

\[
\begin{array}{c}
S \\
\downarrow \\
S \quad W
\end{array}
\]

\(\text{\texttt{m\~o\texttt{\texttt{t\texttt{\texttt{t}}}}} \text{\texttt{e\texttt{t}}} /}\)

In the underlying representation the metric foot is spread over the two syllables of the stem. The rule for deleting beatless vowels applies vacuously and the intervocalic dental stop remains in the nominative as Q2. There is a rule for deleting the final stop from the UR to give the correct surface form \([\text{motte}]\).

The genitive morpheme for this sub class is a W beat without a segment. The W beat pushes itself onto the stem and forces the existing W beat to shift over onto the preceding heavy syllable which then gets lengthened to Q3 by virtue of the fact that it is now dominated by a complete foot. The final stop of the stem is again deleted:
The partitive morpheme is simply /t/ which is added to the stem with no change in either of the two tiers. The result of all this is the pattern of sub class two substantives:

nom. mötte 'thought'
gen. möttte
Part. möttett

Above I have presented a model to account for the two sub classes of one of the most important classes of alternations in Estonian substantives. Under this model it is quite clear that at least on the phonemic level we need consider only two underlying lengths in Estonian, which are then realized as three distinct meaningful lengths in the surface through the interaction of the two tiers set up in the underlying representations in the lexicon. Very briefly to summarize the important points:

In their underlying representations lexical items consist of two
tiers; a segmental tier and a stress tier. Case morphemes may be either segment or stress beats. Q3 is a manifestation of one whole syllable being dominated by a whole metrical foot $[S \ W]_S$.

One last point that I wish to address is the question of tone. Many linguists have noted that in many dialects and for many speakers of the standard language Q3 is accompanied by some sort of rising-falling tone. Moreover often the duration of Q2 and Q3 are falling together with only the tone marking the difference between the two. This seems to be an interesting development in the prosodic system of Estonian where Q3 is accompanied by tone. One wonders in fact whether Estonian might not be developing into a tone language.

It is possible that the development of tone in Estonian can also be explained by the auto-segmental model that I have presented above. Can it be that the extra W beat of Q3 heavy syllables is becoming acoustically more concrete by becoming a tone. As a tone, given the auto-segmental framework, this extra beat (tone) may be in the process of leaving the stress tier. By leaving the stress tier the extra beat-tone ceases to have its lengthening effect on the syllable and the original long segment which was realized as Q3 can now revert back to its original length. The new tone may also be forming a tonal tier in Estonian phonology. In any case interesting changes are in process in Estonian today.
One aspect that I have not looked at in this paper, which nonetheless bears scrutiny, is the question of how subsequent stress is assigned to suffixes as they are added to stems. I have demonstrated that stress should already be indicated on the stem in the lexicon. This was to account for the different patterns of alternations in the language. Now, can suffixes also have stress already indicated in the lexicon? Often whether a suffix is stressed or not (i.e. dominated by S or W) is dependent on its position in the string with relation to the stress pattern of the rest of the string. There are as well other suffixes, mostly derivational, that have a bound secondary stress. One solution would be to postulate that all suffixes have some stress beat in the lexicon and that there is a set of adjustment rules that change the stress beats where necessary. There is evidence for the existence of such adjustment rules in the fact that often one word can exhibit two different stress patterns on the suffixes that it takes:

\[
\begin{align*}
\text{línːlaːsɛle} & \quad \text{'}to the city dweller' \\
\text{línːlaːsɛlɛ} \\
\text{kúːlmattulekɪ} & \quad \text{'}to even the unlistening one' \\
\text{kúːlmattulekɪ} \\
\end{align*}
\]

This is the next task; to examine how the model that I have presented must be expanded to account for the rest of the stress system. This, however, will be for another time.

Granting that the auto-segmental/metrical model is a correct account
of the length alternation phenomenon in Estonian then this paper if
nothing else provides further evidence that a model of phonology
based on more than one level is not only permissible but also a
necessity in order to account for natural language phenomena. One
of the problems with the auto-segmental model of course is that it
is still in its infancy. People are still working on refining it and
applying it to a wider range of problems. In this situation it is all
too easy to take great liberties with the model and to allow it to
do almost anything. Clearly the principles behind the theory must be
laid out much more clearly and explicitly than hitherto has been the case.
As more and more work is done with this model of phonology such
defects will be resolved.

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