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Floating contrastive features in Estonian:
Underspecification and "palatalization"[1]

1 Introduction

1.1 Goals

The goals of this talk are as follows:

- To show that floating features are the best solution to account for Estonian stem vowels (which are unpredictable based purely on the citation forms)
- To use these floating features to account for Estonian "palatalization"
- To propose that they are minimally specified using a subset of the inventory's contrastive features

1.2 The Estonian language

Estonian has nine vowel phonemes, which, in initial syllables are contrastive for two degrees of quantity.[2] These are shown (in Estonian orthography) in Table 1.

	Front		Back	
	Unround	Round	Unround	Round
High	*i*	*ü*		*u*
Mid	*e*	*ö*	*õ*	*o*
Low	*ä*		*a*	

Table 1: Estonian vowel inventory (adapted from Viitso 2007:20–21)

The consonant inventory is given in Table 2, written with the Finno-Ugric Phonetic Alphabet (FUPA). Note that Estonian is said to have a series of palatalized consonants. We'll return to this below.

[1]I would like to thank Keren Rice for comments on the paper upon which this talk is based. I would also like to thank Radu Craioveanu, Ross Godfrey, and Will Oxford, for discussing with me theoretical issues of various degrees of relevance to the present topic. Of course, all errors are my own.

[2]In this talk I'll be ignoring the notion of three degrees of quantity, for which Estonian is famous, as it is not necessarily directly relevant to the analysis I present below.

	Labial	Labio-dental	Dental	Palatalized	Post-alv.	Palatal	Velar	Laryng.
Stops	*p* B		*t* D	*t́* D́			*k* G	
Nasals	*m*		*n*	*ń*			ŋ	
Laterals			*l*	*ĺ*				
Trills			*r*					
Sibilants			*s z*	*ś ź*	*š ž*			
Spirants		*f*						*h*
Semivowels		*v*				*j*		

Table 2: Estonian consonant inventory (adapted from Viitso 2007:22)

2 The problem[s]

2.1 Disappearing vowels!

Estonian has a phenomenon which I term the Unpredictable Stem Vowel (USV).[3] The citation form (the nominative case) of many nominals is a monosyllable of the shape CVVC or CVCC. In other case forms, such as the genitive and the partitive, however, there is a stem vowel in the second syllable which is not predictable based on the vowel in the first syllable.

Of the nine qualities and two quantities for which Estonian vowels are contrasted, only five qualities are available in non-initial syllables, and length is not contrastive (1) (adapted from Viitso 2007:21).

(1) Non-initial vowels

i	u
e	o
	a

Of these vowels, only /a/, /e/, /i/, and /u/ are available as USVs, and so only a small subset of the inventory is contrastive in the USV context. Some examples of USV pairs are in (2).

(2)

	Nominative	**Partitive**
a.	*silm* 'eye'	*silma*
b.	*juust* 'cheese'	*juustu*
c.	*värv* 'colour'	*värvi*

The exact patterns for the paradigms with /e/ are a bit more complicated, so I won't deal with them here.

[3] I choose this term because there seems to be no term used for it in the literature. The vowel in the second syllable is simple referred to as the "stem vowel", but I have not come across a generative analysis of the vowel-zero alternation observed.

2.2 "Palatalization"

2.2.1 The contrastive status of palatalization

Recall that Estonian has a series of palatalized consonants, shown in Table 2. These correspond to contrastively palatalized varients of four phonemes in Standard Estonian: /t/, /n/, /l/, and /s/.

What is the distribution of "palatalization" as a contrastive phenomenon?

We do find surface minimal pairs for palatalization (marked with an accute accent on the ćońśońańt́), as in (3). However, when these forms are put into other case forms, for example, the partitive, we find that the USV for the palatalized items is almost always /i/.

(3)

	Nominative	**Partitive**
a.	*kruus* 'gravel'	*kruusa*
b.	*kruuś* 'cup, mug'	*kruuśi*
c.	*nutt* 'crying'	*nuttu*
d.	*nut́t* 'round object'	*nut́ti*
e.	*hall* 'frost'	*halla*
f.	*haĺl* 'grey'	*haĺli*

I argue that the contrast in the first column in (3) is represented not by an additional palatalized series in the inventory, but by an extra [+high] feature linked to the consonant, which affects the quality of the preceding vowel.

This feature is analagous to the floating features I posit for the rest of the USVs, except that when it appears in the environment of a "palatalizable" consonant, it is linked instead of floating.

2.2.2 The phonetics of palatalization

The actual phonetic realization of palatalization manifests itself acoustically as a raised F1 towards the end of the vowel preceding the palatalized consonant. This is accompanied by a raised tongue body during the hold of the consonant (Lehiste 1965).

Palatalization seems to center itself between the consonant and the vowel, as slight diphthongization of the vowel, while wearing off over the duration of the consonant; there is no palatal release:

> "Phonetically, palatalization is accompanied by an *i*- onglide. Consonants in lengths 2 and 3, when palatalized, lose their palatalization gradually during the hold of the consonant." (Lehiste 1960:37)

Furthermore, it is apparently possible in some dialects to "palatalize" any consonant (Kask 1967:117–118). Given the rather predictable distribution of "palatalization", it would be difficult to assume that these dialects have almost twice the consonant phoneme inventory, if palatalization is a phenomenon which can be analyzed as simple vowel raising.

3 Floating features

I propose that the best way of accounting for USVs is with floating features specifying the vowel in the second syllable of non-nominative case forms. That is, each stem with a USV has in its underlying representation a single floating feature capable of uniquely identifying the USV.

3.1 Why not delete?

One might wonder why the nominative case forms should not be analyzed as the deletion of the stem-final vowel (similar to some analyses of French final consonants). There are several reasons to prefer a floating feature analysis:

- It would make it difficult to account for palatalization; how can an elegant solution delete all vowels except for a single feature of a single phoneme? (/i/)
- We need not stipulate a deletion process in order to get from the stem of a more marked form (the partitive) to the citation form (the nominative)
- Floating features allow a unified analysis of USVs and palatalization

3.2 Contrasting a subset

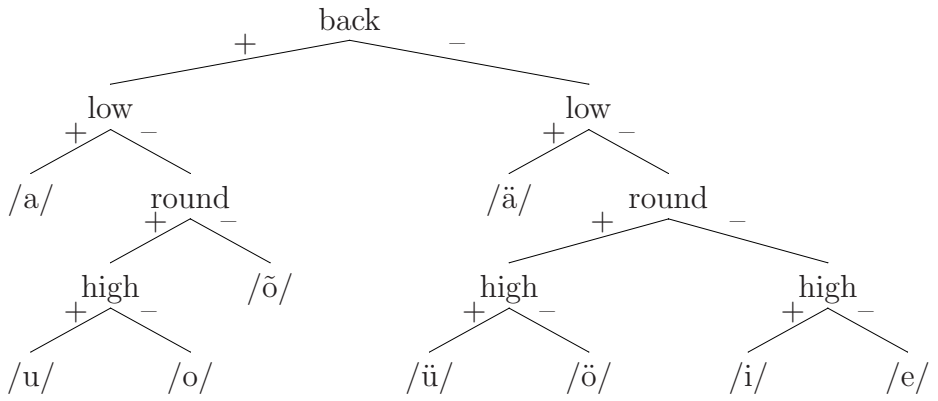
In order to be able to use single features to reference the four possible USVs individually, we first need to establish what features can uniquely identify these phonemes.

Using the system of contrastive hierarchies (Dresher 2009), it becomes somewhat trivial to divide an inventory so that individual phonemes can be identified only by their contrastive features.

Thus, we can divide the Estonian vowel inventory as in (4), for example, in a contrastive use of the distinctive features tree of Eek and Meister (1994:87). Their tree can be seen in Figure 3.2 for reference.

With the hierarchy [back] > [low] > [round] > [high], we get the contrastive feature tree in (4):

(4)



However, in this hierarchy, no phoneme can be identified by a single feature:

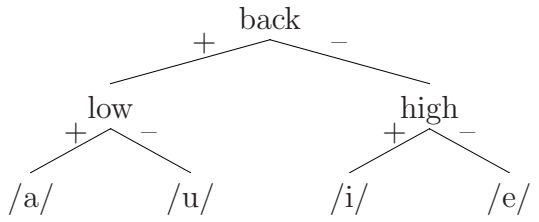
(5) Contrastive feature specifications for Estonian vowels

	i	ü	u	e	ö	õ	o	ä	a
back	−	−	+	−	−	+	+	−	+
low	−	−	−	−	−	−	−	+	+
round	−	+	+	−	+	−	+		
high	+	+	+	−	−		−		

In the contexts where there can be USVs, there are only four possible vowel phonemes: /a/, /e/, /i/, and /u/. That is, our contrasts are quite limited relative to the full inventory.

If we divide this sub-inventory using the same contrastive hierarchy, we arrive at (6).

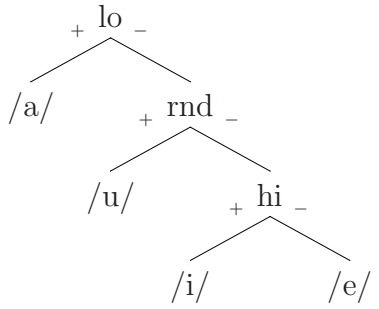
(6)



There is still a problem: The actual acoustics of the vowels do not correspond to these specifications (see below). If we only use a subset of the hierarchy and divide the subinventory, then we arrive at contrastive specifications which allow the unique identification of each of the possible USVs with a single feature.

The sub-hierarchy is shown in parentheses:

(7) ~~[back]~~ > ([low] > [round] > [high])



We are now effectively using a subset of the hierarchy to contrast a subset of the inventory.

Since either set of sub-inventory feature specifications gives us [+high] as the unique identifier of /i/, is there any evidence that points us towards the second on we have arrived at?

I propose that phonetic "enhancement" (as discussed in Hall 2011) can give us some clues as to the relationship between phonetic realization and contrastive feature specifications.

Rather than what we observe being strictly enhancement, however, it is more that the phonetic characteristics directly described by the contrastive features of a segment must hold, while other non-contrastive demensions are free to be realized.

If we look at the actual phonetics of non-initial vowels (cf. Figure 2), we see that the following more or less holds relative to the specifications we have arrived at in (7):

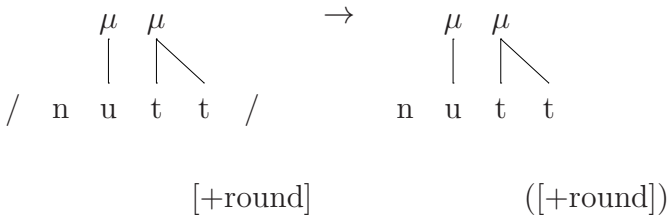
- /i/ is within the bounds of a high vowel; it is specified for [+high]
- /u/ lowers and fronts a bit; it is not contrastive for [+high] or [+back], so it doesn't stay put
- /e/ centralizes and lowers a bit; but it is not specified for [–back] and does not quite enter the bounds of a vowel which is not [–low] (it *is* specified for [–low], so it cannot be too close to a true [+low] vowel)
- /a/ centralizes, but does not move above the boundary for [+low], which is its only contrastive specification

3.3 Making the USVs surface

Now that we can uniquely identify any of the possible USVs with a single contrastive feature, it is quite simple to use these features to account for the surface patterns.

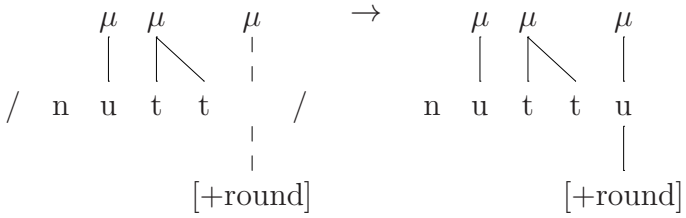
For *nutt* (partitive *nuttu*), we specify a floating [+round] feature at the right edge of the root /nutt/. In the nominative case, it is simply the root segments that surface:

(8)



When the noun is put into the partitive case, however, a suffix consisting of only some prosodic material is added (in this example, an additional mora). Because this suffix has no melodic content, it links with the floating feature, causing it to be realized as [u]:

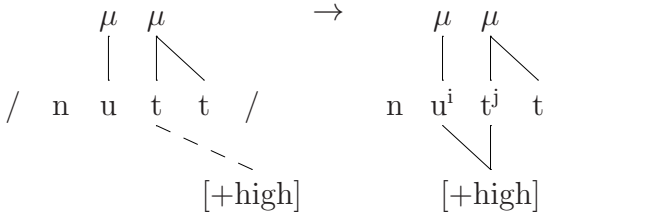
(9)



For the word *nuít* (partitive *nuíti*), the underlying feature specifications work in the same way, except the floating feature is the unique identifying feature for non-initial /i/: [+high].

However, this feature does not remain floating in the surface form. Instead, it links with the palatalizable /t/ adjacent to the first syllable's nucleus, where it effect's the vowel /u/'s quality:

(10)



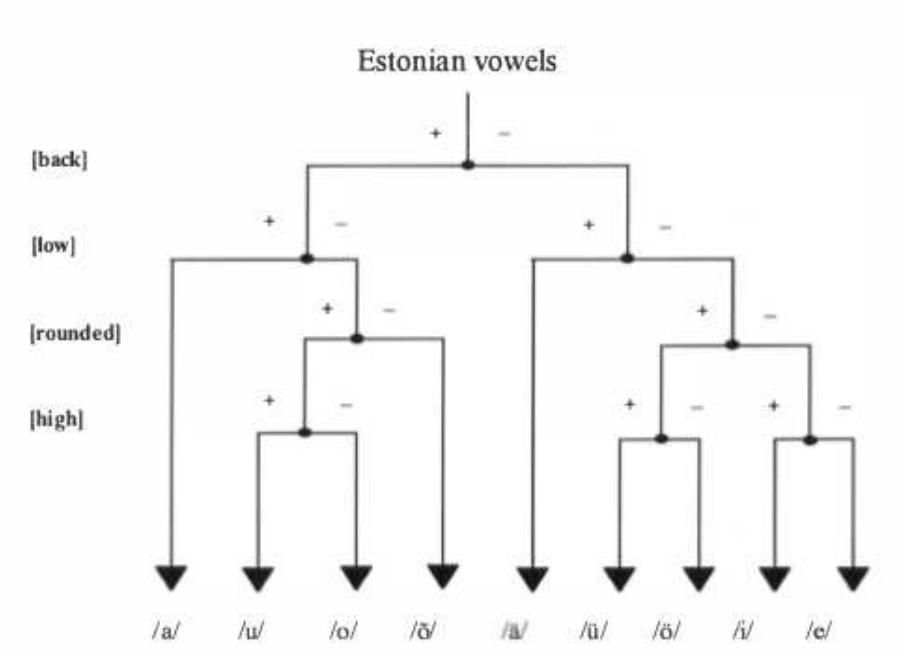


Figure 1: Familiar looking distinctive feature hierarchy from Eek and Meister (1994:87)

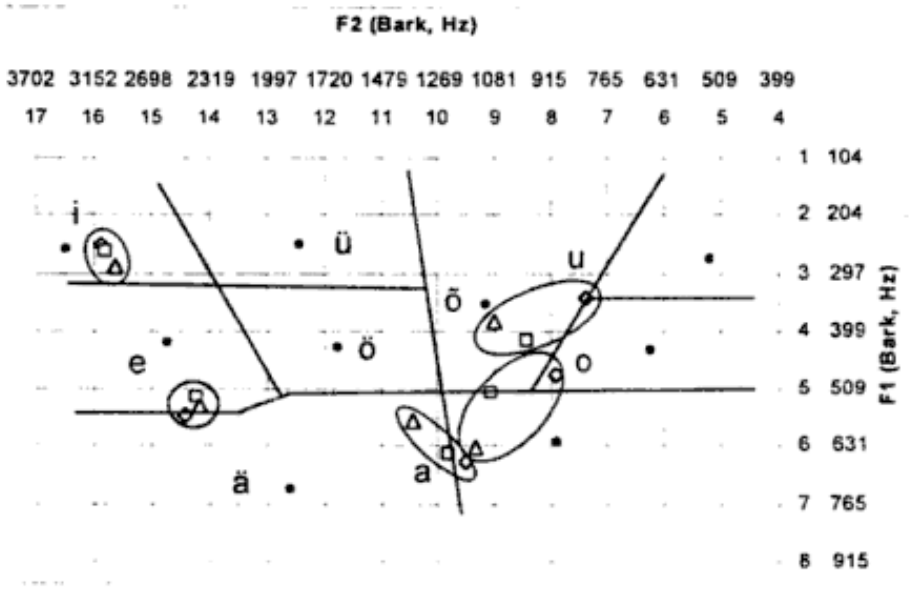
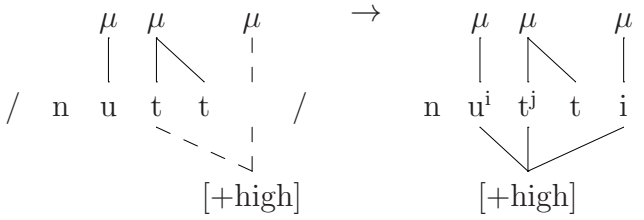


Figure 2: Estonian reduced vowels (taken from Eek and Meister 1998:231)

The same happens in the partitive, except the feature [+high] also serves to provide a vowel melody for the mora in the second syllable:

(11)



There are several advantages to an analysis using floating features:

- It doesn't require the use of morphological classes referencing non-phonological material
- We needn't stipulate that forms are derived through deletion, as discussed in section 3.1
- It does everything using contrastive features, the same phonological elements we need anyway
- This analysis shows evidence for floating features directly, in that the feature [+high] in the case of /i/ is not actually floating. We can see the feature in action in a paradigm, even when a real /i/ isn't there!

3.3.1 Why [high]?

There are a few arguments for representing "palatalization" with the feature [high] instead of, for instance, [–back] (or [coronal]). Briefly:

- Palatalization is more of a semi-diphthongization of a vowel than a consonantal phenomenon. An affected vowel is raised—its offset becomes more [high]
- It doesn't really seem to be a consonantal thing; it's clearly connected with the vowel /i/
- Acoustically, /i/ is the highest reduced vowel (cf. Figure 2), and so it should remain contrastive for this feature

Appendix: Arriving at a sub-hierarchy

Or: A non-logician's arguments from set theory

How do we arrive at the sub-hierachy in (7) from the main one in (4)?[4]

Furthermore, if we're willing to accept the idea of different hierarchies for different inventories in different positions, why should we prefer a subset hierarchy to any other ordering or re-ordering of the same features?

We might ask the question of how the ordering/ranking of a contrastive hierarchy is encoded in the first place.

[4] I may be completely on the wrong track with this idea, but perhaps it is a direction worth pursuing in future research.

Anttila (1997:53) has proposed that Optimality Theoretic constraint rankings are encoded as a sets of ordered pairs. Likewise, Kayne's (1994) Linear Correspondence Axiom, for generating linear word order from syntactic structure, relies on ordered pairs to encode linear order.

If we take the same notion for contrastive hierarchies, then our full hierarchy for vowels can be equated to ordered pairs as follows:

(12) $[\text{back}] > [\text{low}] > [\text{round}] > [\text{high}] =$
$\{< \text{back}, \text{low} >, < \text{low}, \text{round} >, < \text{round}, \text{high} >\}$

To arrive at the sub-hierarchy we have chosen, we need only delete a single ordered pair from this set:

(13) $[\text{low}] > [\text{round}] > [\text{high}] =$
$\{< \text{back}, \text{low} >, < \text{low}, \text{round} >, < \text{round}, \text{high} >\} - \ < \text{back}, \text{low} > =$
$\{< \text{low}, \text{round} >, < \text{round}, \text{high} >\}$

However, if we wanted to arrive at a different sub-hierarchy, such as [back] > [high], where the new features are not adjacent in the hierarchy (as in 14), things are more complicated.

(14) ([back]) > ~~[low]~~ > ~~[round]~~ > ([high])

To arrive at this sub-hierarchy, we must first delete all existing ordered pair relations, and then create an entirely new one. By this conception, the hierarchy in (14) is clearly more complicated.

(15) $[\text{back}] > [\text{high}] =$
$\{< \text{back}, \text{low} >, < \text{low}, \text{round} >, < \text{round}, \text{high} >\} - \ < \text{back}, \text{low} >$
$- \ < \text{low}, \text{round} > \ - \ < \text{round}, \text{high} > = \emptyset$
$[\text{back}] \rightarrow [\text{high}] = < \text{back}, \text{high} >$

If this is the right approach, then simplicity in terms of the number of operations necessary to derive a sub-hierarchy from the full hierarchy of a language might be a way of restricting the ways that sub-hierarchies can be used.

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