On Affix Allomorphy and Syllable Counting

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1. Introduction

At issue in this paper is the interaction between prosody and morphology; specifically, the way in which metrical foot structure conditions allomorphs of affixes. I will propose an analysis of various affix allomorphies in Estonian, which are apparently conditioned by the number of syllables in the base to which the allomorphs attach. As I will show, it is not syllable number that matters, but rather the foot parsing of the complete base-plus-affix combination. This analysis will produce evidence for the relevance of metrical feet in morphological phenomena, and for a constraint-based (rather than rule-based) model of the morphology-phonology interface.

It has been observed for various languages that allomorphs may be conditioned by prosodic structure of the base, such that one allomorph occurs with bases of a certain prosodic type, while the other allomorph is in complementary distribution, occurring with bases of all other prosodic types. Three familiar examples are sensitivity to (i) syllable structure (e.g. a distinction between bases ending in a consonant vs. those ending in a vowel), (ii) syllable count (e.g. a distinction between even-numbered vs. odd-numbered bases), and (iii) to stress (e.g. a distinction between bases ending in a stressed syllable vs. those ending in an unstressed syllable). Complementary distribution of prosody-dependent allomorphs is attested in two types that I will refer to as *fully*-conditioned and *partially*-conditioned. In the former, complementary distribution follows completely from prosodic principles (e.g. the avoidance of ill-formed syllables), without any need for supplementary morphological statements. In partially-conditioned allomorphy, prosody accounts for the distribution of only one allomorph, while the distribution of the other allomorph must be due to morphological principles (e.g. a preference for one allomorph over another).

An example may serve to clarify the notion of partially-conditioned allomorphy. In Djabugay (Patz 1991), the genitive is marked by either:

(1) /-n/ after bases ending in a vowel, e.g. ɡuludu ‘dove’, Gen. ɡuludu-n, or by:
/-ŋun/ after bases ending in a consonant, e.g. ɡaɲal ‘goanna’, Gen. ɡaɲal-ŋun

The choice of the proper allomorph is partially predictable from CV shape, in particular from the way in which it syllabifies with the base into a PrWd. Djabugay has no syllables that end in a consonant cluster, and therefore the single consonant allomorph -n cannot be attached to a base that is itself consonant-final:

(2)	/-n/	ɡu.lu.dun	*ɡa.ɲaln
	/-ŋun/	(?ɡu.lu.du.ŋun)	ɡa.ɲal.ŋun

In short, allomorphy never produces ill-formed syllables. Notice that prosody predicts the complementary distribution of allomophs only partially, since syllabification alone is insufficient to explain why the allomorph /-ŋun/ cannot be adjoined to vowel-final bases. That is, although the genitive allomorph /-n/ may be for *morphological* reasons preferred over the allomorph /-ŋun/, it may not adjoin when it would violate *prosodic* principles.

In Optimality Theory (Prince & Smolensky 1993, McCarthy & Prince 1993) such prosodically governed allomorphy can be seen as *output optimalisation* (see McCarthy and Prince 1993, Mester 1994, Bolognesi 1995, Anttila 1995 for similar ideas). For each form the function ‘*Gen*’ generates all logically possible base-plus-allomorph combinations as *candidate* outputs. Among all candidate outputs the function ‘*Eval*’ selects the *optimal* candidate (c.q. ‘optimal allomorph’) by general output constraints. As always, constraints are *universal*, but *ranked* in a language-specific order. Lower-ranked constraints may be violated in order to satisfy higher-ranked constraints.

To see what is special about ‘partially-prosodically-conditioned’ allomorphy, let us find out how such a model accounts for Djabugay. The prosodic constraint is readily identified as *ComplexCoda (“No complex codas are allowed”), which is unviolated in Djabugay. This dominates the morphological requirement that /-n/ is the ‘best’ genitive affix, e.g. Genitive=/-n/ (“The genitive is marked by /-n/”). Quite plausibly, this is just an instantiation of a universal constraint favoring the phonologically minimal (shortest) morpheme to mark a morphological category. The constraint ranking *ComplexCoda » Genitive=/-n/ is illustrated in the tableaux below:

(3)

(i) {gaɲal, [Genitive]}	*ComplexCoda	Genitive=/-n/
a. ☞ ga.ɲal.-ŋun		*
b. ga.ɲal-n	*!	

(ii) {guludu, [Genitive]}	*ComplexCoda	Genitive=/-n/
a. ☞ gu.lu.du-n		
b. gu.lu.du.-ŋun		*!

The allomorphy itself is due to the language-specific fact that Djabugay happens to have two ‘morphs’ specified as [+Genitive], hence both satisfy the morphosyntactic feature requirement in the input. In sum, partially-conditioned allomorphy is just another type of ‘Prosodic morphology’, or domination of prosodic constraints over morphological ones, summarized in the scheme *Prosody » Morphology* (McCarthy & Prince 1993).

Below, I will discuss prosodically governed allomorphy in Estonian, which I will argue to be fully-conditioned in the sense outlined above. Estonian will prove to be a very strong case of the ‘output optimalisation’ model that accounted for Djabugay as well.

2. Syllable counting allomorphy in Estonian

Estonian (Mürk 1991) has several morphological categories whose allomorphs depend on the number of syllables of the base. I first discuss the Genitive plural and Partitive plural, both of which are formed on the base of the Gen.sg., a stem form which is always vowel-final. The *Genitive plural* is marked by a suffix /-te/ after bases of two or four syllables, and by a geminate consonant suffix /-tte/ after bases of three syllables (Mürk 1991:281). The *Partitive plural* is marked by a consonant-initial suffix /-sit/ after bases of two or four syllables, or alternatively, by a mutation of the final vowel of the base (e.g. /a/ → /u/ or /a/ → /e/). It is marked by a vowel-initial suffix /-it/ after bases of three syllables (Mürk 1991:295-296).

(4)

	Nom.sg.	*Gen.sg.*	*Gen.pl.*	*Part.pl.*
2 σ	visa	visa	visa-te	visa-sit *or* vis**u**
	pesa	pesa	pesa-te	pesa-sit *or* pes**i**
3 σ	paras	paraja	paraja-tte	paraja-it
	raamatt	raamattu	raamattu-tte	raamattu-it
4 σ	atmiral	atmirali	atmirali-te	atmirali-sit *or* atmiral**e**
	telefon	telefoni	telefoni-te	telefoni-sit *or* telefon**e**

The consonantal length alternations between genitive plural /-te/ and /-tte/ reflect genuine allomorphy rather than a productive phonological process of gemination or degemination. (Although historically, the allomorphy developed from suffixal consonant gradation, cf. Mürk 1991:59[1]). Similarly Estonian has no productive deletion or insertion of /-s-/ that would account for the alternation between partitive plural /-it/ and /-sit/[2] .

As a first observation, we note that the allomorphs /-tte/ and /-it/ that follow bases of an odd number of syllables syllabify with the base-final vowel in either of two ways:

(5) a. Stem-final vowel and -*t*(*te*) syllabify into a closed syllable: pa.ra.jat.te
b. Stem-final vowel and -*i*(*t*) syllabify into a diphthong: pa.ra.ja͜it

Notice that in both cases, the outcome is a heavy syllable. This observation will be taken up below, after we have looked into the mechnism of syllable counting.

3. How to count syllables?

The question then arises of how to explain the sensitivity of allomorphy to the syllable number of the base. According to a maximally restrictive view, expressed in particular by McCarthy & Prince (1986), grammars do not count syllables nor segments. The strategy that has proved succesful is to eliminate counting by grouping the 'counted' elements into units at a higher level. Any reference to syllable parity should be reducible to grouping of syllables in *binary feet* (Halle & Vergnaud 1987, Hayes 1995).

In order to check the relevance of feet to allomorphy, we should first look into Estonian stress. Slightly simplified, Estonian has a rightward pattern of syllabic trochees[3] . Primary stress is initial, while secondary stress falls on the third syllable if it is non-final or if it is heavy. Syllable weight is defined as follows. Open short-voweled syllables are light, and syllables that are closed, or contain a long vowel or diphthong, are heavy (Hint 1973, Prince 1980, Hayes 1995, Kager

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[1] Mürk, citing Kettunen (1962), reports that the ending /-tte/ "developed in distemic nominals when the genitive plural was attached to a consonant stem ending in a stop, e.g. **kastek*+*ten* 'dew' > *kastete* (/kastette/). The genitive /-t/ assimilated the stem consonant and then the resultant geminate /-tt/ was reanalyzed as part of the genitive ending. This spread by analogy to other nominal types."

[2] According to Mürk (1991:60) the -s- of the /-sit/ ending is historically "a pleonastic formation resulting from a reanalysis of the regular /-it/ partitive plural form as it appeared on certain stems ending in -s. For example the partitive plural form for a word like *naine* 'woman' in Proto-Finnic was **naisiða*. The -s- is actually part of the stem but this was reanalyzed as belong to the plural ending and hence > -si[t]."

[3] This ignores variability of binary and ternary stress intervals, but see below.

1994). Example distributions of syllabic trochees, (σ σ) or (**H**), are given below. Feet are marked by parentheses, and PrWds by square brackets:

(6)	2 σ	[(ví.sa)]	[(kín.nas)t]
	3 σ	[(pá.ra).ja]	[(pá.ra).(jài)t]
	4 σ	[(át.mi).(rà.li)]	[(pá.ri).(màt.tel)t]

As indicated in (6), final consonants are extrametrical, which accounts for the lack of final stress in [(*pí.mes*).*tav*] vs. its presence in [(*pá.ra*).(*jài*)*t*]. I will return to 'extrametricality' in section 5 below, where I will argue for a non-finality constraint.

Returning to the distribution of allomorphs, we are now able to state this in terms of the foot structure of the base, without reference to specific numbers of syllables in the base. Even-numbered bases are those that can be exhaustively parsed into disyllabic feet. Odd-numbered bases are those that cannot be exhaustively parsed by disyllabic feet. This latter result follows from the fact, stated above, that the base (the Gen.sg.) always ends in a short vowel, hence a light syllable, which cannot form a degeneratate foot. Then the resulting generalisations on the distribution of allomorphs are that the 'even-numbered' allomorphs (/-te/, /-sit/) always occur at the right edge of a foot in the base (cf. 7a). 'Odd-numbered' allomorphs (/-tte/, /-it/) join the unparsed final base syllable in a secondary stress foot (cf. 7b).

(7)		*Gen.sg.*	*Gen.pl.*	*Part.pl.*
a.	2 σ	[(ví.sa)]	[(ví.sa).-te]	[(ví.sa).-sit]
	4 σ	[(át.mi).(rà.li)]	[(át.mi).(rà.li).-te]	[(át.mi).(rà.li).-sit]
b.	3 σ	[(pá.ra).ja]	[(pá.ra).(jà-t.te)]	[(pá.ra).(jà-i)t]

There is additional evidence that feet, rather than raw syllables, are the stuff that the allomorphy is computed on. The first evidence comes from *overlong syllables*, that is, heavy syllables with additional length, Cvv: or CvC:. With some exceptions in loan words (to which I will return directly below), overlong syllables occur initially in the word. They form monosyllabic feet (σ:) by themselves (Prince 1980, Kager 1994). We therefore make two predictions. First, extra-long monosyllabic bases should behave w.r.t. allomorphy as if though they were disyllabic[4]. Second, disyllabic bases whose first syllable is extra-long should behave as though they were trisyllabic. Both predictions are confirmed, as can be seen from the examples in (8)[5]:

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[4] Interestingly, some monosyllabic stems may take the 'odd-numbered' Part.pl. allomorph /-it/ as well, but this is accompanied by a shortening of the stem vowel, e.g. *jää*: 'ice' has both *jä-it* and *jää*:*-sit* as Part.pl. forms (Mürk 1991:250). In the case of stem shortening, the generalisation on the distribution of allomorphs still holds, since the shortened stem, which is not overlong anymore, has become 'odd-numbered'. That is, *jä-it* behaves like *paraja-it.*

[5] Some overlong monosyllabic stems seem not to behave as predicted. For example, Class-III disyllabic stems (i.e. so-called 'truncated nominatives') consistently select 'even-numbered' allomorphy:

(i)	*Nom.sg.*	*Gen.sg.*	*Gen.pl.*	*Part.pl.*	
	soo:l	soola	soo:la-te	soo:la-sit	soo:l**i**
	ar:v	arvu	ar:vu-te	ar:vu-sit	ar:v**e**

However, it should be noted that here the base of the Gen.pl. and Part.pl. is not the Gen.sg. Inherently stressed suffixes (-likk etc.) are in the same Class-III ('compounding suffixes', Prince 1980:542):

(8)		*Gen.sg.*	*Gen.pl.*	*Part.pl.*	
a.	σ:	[(kúu:)]	[(kúu:).-te]	[(kúu:).-sit]	
		[(tée:)]	[(tée:).-te]	[(tée:).-sit]	
b.	σ: σ	[(áas:).ta]	[(áas:).(tà-t.te)]	[(áas:).(tà-i)t]	‘year’
		[(háa:r).me]	[(háa:r).(mè-t.te)]	[(háa:r).(mè-i)t]	

A second piece of evidence for the claim that foot structure, rather than raw syllable count, is what counts to allomorphy, resides in a large class of loan words which have idiosyncratic non-initial primary stress on an overlong syllable. The generalisation with respect to allomorphy is that the ‘syllable count’ of these words depends only on the primary stressed syllable plus any syllable(s) that follow it. That is, anything preceding the primary stress is ignored (Mürk 1991:296). (All examples below are reconstructed after paradigm membership information provided by Mürk 1991.)

(9)		*Gen.sg.*	*Gen.pl.*	*Part.pl.*
a.	σ σ:	bü.(róo:)	bü.(róo:).-te	bü.(róo:).-sit
b.	σ σ σ:	in.ter.(vjúu:)	in.ter.(vjúu:).-te	in.ter.(vjúu:).-sit
c.	σ σ: σ	or.(késs:).tra	or.(késs:).(trà-t.te)	or.(késs:).(trà-i)t
d.	σ σ σ: σ	hal.le.(lúu:).ja	hal.le.(lúu:).(jà-t.te)	hal.le.(lúu:).(jà-i)t

If syllable count rather than foot structure were relevant, then this could not be explained.

4. How to model prosody-dependent allomorphy?

After having shown that allomorphy depends on foot structure, I will now consider some options in enabling the morphology to look into metrical representations to determine the choice of allomorph. The first would be to refer to foot structure of the base in selectional requirements of allomorphs. The problem is that this fails to express that the allomorphs conspire towards prosodic targets. The choice of allomorph happens to predictable by generalisations that cut across Gen.pl. and Part.pl. Let us see what these are.

In ‘even-numbered’ bases we observe that both allomorphs selected (/-te/, /-sit/) are of the same segmental shape, -CV(C). The resulting syllabification and foot structure, given the vowel-final base, is such that the right edge of the stem aligns with the right edge of a foot. See (10):

(10)		*Gen.pl.*	*Part.pl*	
a.	2 σ	[(ví.s**a**)-te]	[(ví.s**a**)-sit]	[(ví.s**u**)]
b.	4 σ	[(át.mi).(rà.l**i**)-te]	[(át.mi).(rà.l**i**)-sit]	[(át.mi)(ràl**e**)]
c.	σ:	[(kú**u**:)-te]	[(kú**u**:)-sit]	

(ii)	*Nom.sg.*	*Gen.sg.*	*Gen.pl.*	*Part.pl.*
	(ə́n.ne).(lìk)k	(ə́n.ne).(lìk.ku)	(ə́n.ne).(lìk:.ku)-te	(ə́n.ne).(lìk:.k**e**)
	(hóo:g).(lìk)k	(hóo:g).(lìk.ku)	(hóo:g).(lìk:.ku)-te	(hóo:g).(lìk:.k**e**)

I propose to analyse these by pre-specifying foot structure, accounting for both inherent stress and ‘even-numbered’ allomorph pattern.

The generalisation that the right edge of the stem aligns with the right edge of a foot is not violated by vowel mutation in the Part.pl. Vowel mutation involves allomorphy of the base, since the mutated vowel is stem-specific, hence must be part of the stem. Therefore, the mutated vowel constitutes the absolute right edge of the stem, satisfying alignment.

In 'odd-numbered' bases, right stem alignment is necessarily violated due to high-ranking constraints on metrical parsing. This is because with an 'odd-numbered' base, the final stem syllable groups in a foot with the affix syllable. Here the best option is to attach allomorphs of the segmental shapes -CCV (/-tte/), or -VC (/-it/), which syllabify with the stem-final vowel into a *stressed heavy syllable.*

(11) a. 3 σ [(pá.ra).(**jà-t.**te)] [(pá.ra).(**jà-i**)t]
b. σ: σ [(áas:).(**tà-t**.te)] [(áas:).(**tà-i**)t]

Recall from the discussion of stress above that both geminate consonants and diphthongs produce syllable weight. If /-te/ and /-sit/ were selected here, there would not be a heavy syllable in the output, e.g. [(pá.ra).(**jà.-**te)], [(pá.ra).(**jà.-si**)t]. Wherever possible, stressed syllables are heavy.

The conclusion is that the particular choice of allomorph aims at prosodic targets (stem alignment, weight of stressed syllables) in the *output* form, i.e. the complete base-plus-allomorph. If the foot structure of the base were specified in the selectional frame of the allomorphs, this could not be captured.

Therefore let us consider the second option, that of evaluating complete output forms (base-plus-allomorph combinations) by prosodic constraints. Of course, this is just the optimalisation-model that I have argued for above w.r.t. Djabugay allomorphy. But in contrast to the fairly simple situation in Djabugay, where *COMPCODA did all the work, the constraints that govern allomorphy in Estonian are multiple, and their interactions are slightly more complex. Let us find out what they are.

First, the distribution of allomorphs is conditioned by four unviolated constraints on foot parsing, stated in (12). ALIGN-HD-L (12b) is from McCarthy & Prince (1993:35). It serves to fix the main stress on the initial syllable. GR-BIN (12c, Kager 1994) expresses the equivalence w.r.t. footing of a single overlong syllable (which has two grid positions, Prince 1983) to two normal (light or heavy) syllables (which have only one grid position). It effect is to impose a maximum limit of two grid positions on the main stress foot, thus ruling out a foot containing an overlong syllable plus another syllable. PARSE-2 (12d) is also due to Kager (1994), and serves to rule out sequences of unparsed syllables. It limits the maximal number of consecutive unstressed syllables to two (the first of which is part of a foot, and the second of which is unparsed).

(12) a. **FT-BIN**
Feet are binary under syllabic or moraic analysis.

b. **ALIGN-HD-L**
Align (PrWd, L, Head(PrWd), L) Effect: initial main stress

c. **GR-BIN**
Head(PrWd) has two grid positions. Effect: $(\sigma:)_{Ft}$

d. **PARSE-2**
One of two adjacent stress units (μ, σ) must be parsed by a foot.

The generalisations stated above suggest that two further constraints are relevant to the distribution of allomorphs. First, a constraint that aligns the right edge of the stem with the right edge of a foot. This is ALIGN-ST-R, stated in (13a). Second, a constraint preferring stressed syllables to be heavy. This is PK-PROM, stated in (13b) after Prince and Smolensky (1993).

(13) a. **ALIGN-ST-R**
Each right stem edge coincides with a right foot edge.

b. **PK-PROM**
Peak(x) › Peak(y) if |x| > |y|.

There is some independent evidence for PK-PROM from *preferences* in optionally binary vs. ternary rhythmic patterns (Hint 1973). That is, rhythmic patterns are preferred in which stressed syllables are heavy, e.g. [(*pá.rat*).*ta*.(*màt.tu*)*s*] ‘inevitability (Iness.sg.)’ is preferred over [(*pá.rat*).(*tà.mat*).*tus*].

Finally, Estonian has a number of undominated constraints on syllabification:

(14) a. **ONSET**
Syllables must have onsets.

b. ***μ-ONS**
Onsets are non-moraic.

These constraints figure in the choice of allomorphs in the following way. ONSET (14a) is the constraint that forces the syllabification of a vowel-initial affix (e.g. /-it/) with the final base vowel in pa.ra.ja͜it etc. As we will see below, it is relevant to selection of allomorphs in overlong bases such as kuuː, e.g. kuuːsit (*kuu͜it, *kuu.it). The constraint *μ-ONS has the function of forcing the syllabification of the geminate (moraic) consonant in /-tte/ with the preceding stem vowel in pa.ra.jat.te etc. Its relevance is clear in disyllabic bases, since it rules out the long consonant allomorph, e.g. visa, *vi.sa.tte.

Lexical representations of the affix and stem allomorphs are given below:

(15) a. *Gen.Pl.*
μ   μ μ
| | |
t e   /-te/   vs.   t e   /-tte/

b. *Part.pl.*
μ   μ
| |
s i t   /-sit/   vs.   i t   /-it/

c. *Stems, e.g.*
μ μ   μ μ
| | | |
visa   /visa-/   vs.   visu   /visu-/

Let us first consider the proper choice of the Gen.pl. allomorph in words based on ‘even-numbered’ bases. Given the unviolated constraints on metrical parsing, ALIGN-ST-R is easily satisfied by selecting the allomorph /-te/, but would be impossible with /-tte/:

(16) /visa, [gen.pl.]/	Ft-Bin	Align-Hd-L	On-set	*μ Ons	Align-St-R	Pk-Prom
a. ☞ [(ví.sa)-te]						L
b. [(ví.sa-t).te]					*!	L
c. [(ví.sa).-tte]				*!		L
d. [vi.(sá-t.te)]		*!			*	H
e. [(ví).(sà-t.te)]	*!				*	L, H

(17) /atmirali,[gen.pl]/	Ft-Bin	Align-Hd-L	On-set	*μ Ons	Align-St-R	Pk-Prom
a. ☞ [(át.mi).(rà.li)-te]						H, L
b. [(át.mi).(rà.li-t).te]					*!	H, L
c. [(át.mi).ra.(lì-t.te)]					*!	H, H
d. [(át.mi).(rà.li)-tte]				*!		H, L

The same outcome results in words that have monosyllabic overlong bases:

(18) /kuu:, [gen.pl.]/	Ft-Bin	Align-Hd-L	On-set	*μ Ons	Align-St-R	Pk-Prom
a. ☞ [(kúu:)-te]						H^+
b. [(kúu:-t).te]					*!	H^+
c. [(kúu:)-tte]				*!		H^+

Proceeding to the Part.pl., we must address the fact that here two allomorphs are possible, i.e. /-sit/ and stem vowel mutation. Since, as shown in (10), both satisfy Align-St-R, what determines the choice between these? Interestingly there is lexical variation, depending upon stem. Some stems allow both forms (e.g. /visa-/: visa-sit or visu). Some stems allow only one allomorph (e.g. /kogu-/ kogu-sit; /maja-/ maju). To account for this lexical variation, I propose that the ranking between the following constraints is lexically determined by stem:

(19) a. **Parse-Syll**
“All syllables must be parsed by feet.”

b. **Align-Wd-R**
Align (GrWd, R, PrWd, R)

Satisfaction of the former would produce a form with the stem mutation (such a form has no unparsed syllables), while satisfaction of the latter would produce a form with an overt Part.pl. allomorph /-sit/. This is illustrated in the tableaux below, where ‘*?’ indicates a violation that is dependent on lexically-determined ranking of constraints. In both cases in (20-21), the ranking between Parse-Syll and Parse-Aff can actually be left unspecified (i.e. free), since both stems occur with either stem vowel mutation or the affix /-sit/:

(20) /visa-, **u**-, [part.pl.]/	Ft-Bin	Align-Hd-L	On-set	Align-St-R	Pk-Prom	Parse-Syll	Parse-Aff
a. ☞ [(ví.**su**)]					L		#
b. ☞ [(ví.sa)-sit]					L	#	
c. [(ví.sa-i)t]				*!	L		
d. [(ví.sa).-it]			*!		L	*	
e. [vi.(sá-i)t]		*!		*	H		
f. [(ví).(sà-i)t]	*!			*	L, H		

(21)/atmirali, **e**-, [part.pl.]/	Ft-Bin	Align-Hd-L	On-set	Align-St-R	Pk-Prom	Parse-Syll	Parse-Aff
a. ☞ [(át.mi).(rà.l**e**)]					H, L		#
b. ☞ [(át.mi).(rà.li)-sit]					H, L	#	
c. [(át.mi).(rà.li-i)t]				*!	H, L		

Overlong bases select the same allomorphs as disyllabic bases in much the same way. The overlong syllable is footed on its own because of Gr-Bin, requiring the primary stress foot to have precisely two grid positions. That is, an overlong syllable is equivalent to a sequence of two regular syllables. (In tableau 22, this is not crucial since Align-St-R would, by itself, already rule out the rivalling candidate 22c; however, Gr-Bin will become crucial in tableaux 25-26 below.)

(22) /kuu:, [part.pl.]/	Gr-Bin	Ft-Bin	Align-Hd-L	On-set	Align-St-R	Pk-Prom	Parse-Syll	Parse-Aff
a. ☞ [(kúu:)-sit]						H^+	*	
b. [(kúu:).-it]				*!		H^+	*	
c. [(kúu:-i)t]	*!				*	H^+		

I now turn to odd-numbered bases. As explained above, Align-St-R cannot be satisfied here, as doing so would violate one of the undominated constraints, e.g. Ft-Bin, Align-Hd-L, *μ-Ons, etc. Therefore Pk-Prom selects the allomorph that maximizes the weight of a stressed syllable, hence syllabify with the final stem vowel: /-tte, -it/.

(23) /paraja, [gen.pl]/	Ft-Bin	Parse-2	Align-Hd-L	On-set	*μ-Ons	Align-St-R	Pk-Prom
a. ☞ [(pá.ra).(jà-t.te)]						*	L, H
b. [(pá.ra).(jà-te)]						*	L, L!
c. [pa.(rá.ja)-te]			*!				L
d. [(pá.ra).ja-te]		*!				*	L
e. [(pá).(rà.ja)-te]	*!						L, L
f. [(pá.ra).(jà)-te]	*!						L, L
g. [(pá.ra.ja)-te]	*!						L

(24)	/paraja, [part.pl]/	Ft-Bin	Parse -2	Align -Hd-L	On-set	*μ-Ons	Align -St-R	Pk-Prom
a.	☞ [(pá.ra).(jà-i)t]						*	L, H
b.	[(pá.ra).(jà-si)t]						*	L, L!
c.	[(pá.ra).(jà-.i)t]				*!		*	L, L
d.	[pa.(rá.ja)-sit]			*!				L
e.	[(pá.ra).ja-sit]		*!				*	L
f.	[(pá.ra).ja-it]		*!				*	L
g.	[(pá).(rà.ja)-sit]	*!						L, L
h.	[(pá.ra).(jà)-sit]	*!						L, L
i.	[(pá.ra.ja)-sit]	*!						L

The same allomorphs are selected with bases that have an overlong syllable plus another syllable. Notice the crucial role of Gr-Bin in ruling out the candidates (25e) and (26f), both of which satisfy Align-St-R.

(25)	/aas:ta, [gen.pl]/	Gr-Bin	Ft-Bin	Parse-2	Align-Hd-L	On-set	*μ-Ons	Align-St-R	Pk-Prom
a.	☞ [(áas:).(tà-t.te)]							*	H^+, H
b.	[(áas:).(tà.-te)]							*	H^+, L!
c.	[(áas:).ta-te]			*!				*	H^+
d.	[(áas:).(tà)-te]		*!						H^+, L
e.	[(áas:.ta)-te]	*!							H^+

(26)	/aas:ta, [part.pl]/	Gr-Bin	Ft-Bin	Parse-2	Align-Hd-L	On-set	*μ-Ons	Align-St-R	Pk-Prom
a.	☞ [(áas:).(tà-i)t]							*	H^+, H
b.	[(áas:).(tà-si)t]							*	H^+, L!
c.	[(áas:).(tà.-i)t]					*!		*	H^+, L
d.	[(áas:).ta-it]			*!				*	H^+
e.	[(áas:).ta-sit]			*!				*	H^+
g.	[(áas:).(tà)-sit]		*!						H^+, L
f.	[(áas:.ta)-sit]	*!							H^+

This analysis of Estonian allomorphy leads to two conclusions. First, the choice of the Gen.pl. and Part.pl. allomorphs is predictable from the prosody of the output. Second, this observation can be captured adequately in an ‘optimal allomorphy’ model in OT.

5. Partitive singular

Estonian has another morphological category that displays syllable-counting allomorphy. The Partitive singular, which again takes the Gen.sg. as its base, is realised after vowel-final stems (Mürk 1991:52-54) in two ways. After ‘even-numbered bases’, there is a zero zero allomorph, or a single consonant allomorph /-t/, which occurs in monosyllables only. After ‘odd-numbered bases’, it is marked by a geminate consonant allomorph /-tt/.

(27) ‘Even-numbered bases’ ‘Odd-numbered bases’

σ:	maa:-t	‘land’	σ: σ	aas:ta-tt	‘year’
	kuu:-t			haa:rme-tt	
2 σ	visa-∅		3 σ	paraja-tt	
	ema-∅	‘mother’		raamattu-tt	‘book’
4 σ	atmirali-∅	‘admiral’	5 σ	haavalumikku-tt	‘Admiral butterfly’
	telefoni-∅	‘telephon’		numismaatikku-tt	‘numismatics’

Again, the generalisation is that in even-numbered bases, Align-St-R is satisfied, either by a zero allomorph, or by the ‘extrametrical’ single consonant /-t/. And again, the choice of allomorph in odd-numbered bases produces a stressed heavy syllable. The geminate allomorph /-tt/ adds weight to stem-final syllable, which is parsed as monosyllabic heavy foot. To illustrate this, I give the footed structures below, where boldface /-**t**/ indicates a moraic consonant (written earlier as /-tt/):

(28)	a.	σ:	[(máa:)-t]	b.	σ: σ	[(áas:).(tà-**t**)]
		2 σ	[(ví.sa)]		3 σ	[(pá.ra).(jà-**t**)]
		4 σ	[(át.mi).(rà.li)]		5 σ	[(háa.va).(lù.mik).(kù-**t**)]

I assume that the moraic consonant in /-tt/ must be parsed by a syllable because of high-ranked Parse-μ (29a). ‘Extrametricality’ of nonmoraic consonants is due to another constraint Non-Final-Wd (29b), which prohibits final consonants from being syllabified. This is a member of the *Nonfinality* family (cf. Hung 1994).

(29) a. **Parse-μ**
Input moras must be parsed by syllables.

b. **Non-Final-σ**
A syllable must be non-final in the PrWd.

Given a ranking Parse-μ » Non-Final-σ, the proper effects are obtained as illustrated in the tableaux below.

(30a) /ta**t**/	Parse -μ	Non-Final-σ
a. ☞ (ta**t**)$_{\sigma}$]$_{Wd}$		*
b. (ta)$_{\sigma}$**t**]$_{Wd}$	*!	

(30b) /tat/	Parse -μ	Non-Final-σ
a. ☞ (ta)$_{\sigma}$t]$_{Wd}$		
b. (tat)$_{\sigma}$]$_{Wd}$		*!

The single remaining question is that of the complementary distribution of the /-t/ allomorph, which occurs after overlong bases, and the zero allomorph, which occurs after all other ‘even-numbered’ bases. I have no satisfactory explanation for this distribution. It can be observed, however, that the choice of allomorphs is reminiscent of that found in the Part.pl. which is marked after ‘even-numbered’ bases either by /-sit/ or by stem vowel mutation.

To wind up this section, I present a summary of the syllable counting allomorphs in Estonian.

(31)

	Even-numbered (align stem)		*Odd-numbered* (make weight)
Gen.pl.	**-te**		**-tte**
Part.pl.	**-sit**	or V stem mutation	**-it**
Part.sg.	Ø		**-tt**

6. Illative singular

The final case of syllable-counting allomorphy of Estonian that I will discuss is the Illative singular. This category is formed by the suffix /-sse/, regardless of syllable count. But it is reported by Mürk (1991:55) that certain derivational affixes (e.g. /-lise/) optionally select a truncated form (e.g. /-li/) before the Ill.sg. suffix in even-numbered bases: “With stems containing an even number of syllables containing derivative suffixes whose genitive form ends in *-se*, the stem is contracted with the addition of *-sse*. Thus, *roheline* ‘green’, genitive *rohelise* has the regular illative form *rohelisesse* as well as a contracted form *rohelisse*.”

(32)

Nom.sg.	*Gen.sg.*	*Ill.sg.*		
rohe-li-ne	rohe-li-se	rohe-li-se-sse	*or*	rohe-li-sse

What seems to be going on is that the complex derivational suffix whose Gen.sg. form is /-li-se/, is optionally truncated to /-li/ before the Ill.sg. suffix /-sse/, in order to satisfy a prosodic target in the output. This target can be identified in multiple ways, since the truncated form satisfies both PK-PROM and PARSE-SYLL. The cost of this truncation is a violation of PARSE-AFF w.r.t. the morph /-se/, a part of the complex suffix /-li-se/.

(32)
a. [(ro.he)-(li-s.se)] Satisfies PARSE-σ, PK-PROM
Violates PARSE-AFF in (*-se*)

b. [(ro.he)-(li-se-s).se] Satisfies PARSE-AFF in (*-se*)
Violates PARSE-σ, PK-PROM

I assume that optionality is formally expressed by equally ranked conflicting constraints (Mohanan 1993, Kager 1994). Equal ranking between the constraints in (32) provides the basis of an ‘optimalisation’ approach to truncation.

7. Conclusion

The analysis of prosodically governed allomorphy in Estonian which I have proposed in this paper has a number of theoretical consequences. First, by having shown that syllable-counting allomorphy is an output-oriented phenomenon, I have provided evidence for the phonology-morphology interface of Optimality Theory. In particular, this interface allows for the sensitivity of morphological operations to prosodic properties of not just the base, but of the complete base-plus-affix structure. Alternative theories that restrict relevance of prosody only to that of the base (e.g. cyclic theories such as Lexical Phonology), do not allow for evaluation of the complete output, and are incapable of expressing this. The second result is a deep similarity between allomorphy and reduplication, an ‘emergence of the unmarked’. In work by McCarthy & Prince (1994), this notion specifically refers to a situation in which faithfulness constraints are by-passed (as under reduplication), and the grammar is free to produce prosodically unmarked structures. The preference for stressed syllables to be heavy in Estonian is surely universal in some sense (cf. PK-PROM). Yet, Estonian does not allow the addition of weight (e.g. by productive consonant gemination) in violation of higher-ranked faithfulness constraints. Prosodically governed allomorphy is just the same kind of situation: where the lexicon supplies different allomorphs which lead to different evaluations w.r.t. prosodic constraints, the allomorphs are selected that best fit the otherwise suppressed requirements of prosody. A third consequence of the analysis is that zero-allomorphy is modelled as constraint interaction PROSODY » PARSE-AFF. It is clear that this is just the kind of situation which McCarthy & Prince (1993) identify as the basic property of prosodic morphology.

References

Anttila, Arto (1995), *Deriving Variation from Grammar: A Study of Finnish Genitives*. Ms., Stanford University.

Bolognesi, Roberto (1995), *The Distribution of Definite Articles in Italian: A Case of Interaction between Universal and Language Specific Constraints*. Ms., University of Amsterdam.

Halle, Morris, and Jean-Roger Vergnaud (1987), *An Essay on Stress*. Cambridge, Mass.: MIT Press.

Hayes, Bruce (1995), *Metrical Stress Theory: Principles and Case Studies*. Chicago: The University of Chicago Press.

Hint, Matti (1973), *Eesti Keele Sonafonoloogia I*. Tallinn, Estonia: Eesti NSV Teaduste Akadeemia.

Kager, René (1994), *Ternary Rhythm in Alignment Theory*. Ms., University of Utrecht.

Kettunen, Lauri (1962), *Eestin Kielen Äännehistoria*. Helsinki.

McCarthy, John, and Alan Prince (1986). *Prosodic Morphology*. Ms., University of Massachusetts, Amherst, and Brandeis University.

McCarthy, John, and Alan Prince (1993). *Prosodic Morphology I: Constraint Interaction and Satisfaction*. Ms., University of Massachusetts, Amherst, and Rutgers University.

McCarthy, John, and Alan Prince (1994), *The Emergence of the Unmarked*. Ms., University of Massachusetts, Amherst, and Rutgers University.

Mester, R. Armin (1994), "The quantitative trochee in Latin", *NLLT* **12**, 1-61.

Mürk, Harry W. (1991). *The Structure and Development of Estonian Morphology*. Doctoral dissertation, Indiana University. [Distributed by UMI Dissertation Services.]

Patz, Elisabeth (1991), "Djabugay", in R.M.W. Dixon and B.J. Blake (eds.), *The Handbook of Australian Languages, Volume 4*. Melbourne: Oxford University Press. 245-347.

Prince, Alan (1980). "A metrical theory for Estonian quantity", *LI* **11**, 511-562.

Prince, Alan (1983), "Relating to the grid", *LI* **14**, 19-100.

Prince, Alan, and Paul Smolensky (1993). *Optimality Theory: Constraint Interaction in Generative Grammar*. Ms., Rutgers University and University of Colorado.

Tauli, Valter (1966), "On quantity and stress in Estonian", *Acta Linguistica Hafniensa* **9**, 145-162.