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Finnish Noun Inflection

PAUL KIPARSKY

1 Introduction

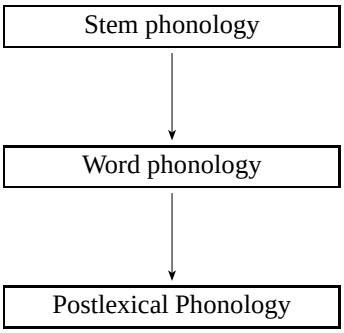
Inflected words in Finnish show a range of interdependent stem and suffix alternations which are conditioned by syllable structure and stress. In a penetrating study, Anttila (1997) shows how the statistical preferences among optional alternants of the Genitive Plural can be derived from free constraint ranking. I propose an analysis which covers the rest of the nominal morphology and spells out the phonological constraints that interact to produce the alternations, and show how it supports a stratal version of OT phonology.[1]

In the model of stratal OT that I will be assuming, stems, words, and phrases are subject to distinct parallel constraint systems, which may differ in the ranking of constraints. These levels interface serially: the output of the stem morphology and phonology is the input to the word morphology and phonology, and the output of the word morphology and phonology is the input to the syntax and postlexical phonology.

[1]I am deeply indebted to Arto Anttila for discussing this material with me over many years, and for commenting on this latest effort of mine to make sense of it.

Generative Approaches to Finnic and Saami Linguistics.
Diane Nelson and Satu Manninen (eds.).

(1)



I assume that the constraint system of level *n+1* may differ in ranking from constraint system of level *n* by promotion of one or more constraints to undominated status. These may be faithfulness constraints as well as markedness constraints. No crucial ranking among the promoted constraints is required, at least in the cases studied so far.

The stem phonology corresponds to Lexical Phonology's level 1 and the word phonology corresponds to Lexical Phonology's level 2; together they constitute what is traditionally called the lexical phonology. The Finnish data to be examined mostly have to do with word-internal phonological processes, so it is the distinction between the stem and word levels within the lexical phonology which will carry the explanatory burden.

Diverging from previous approaches to level-ordering, I will assume three types of affixes:

(2) a. Stem-to-stem affixes: $[\ [\ X\ ]_{Stem} + Affix\ ]_{Stem}$
b. Stem-to-word affixes: $[\ [\ X\ ]_{Stem} + Affix\ ]_{Word}$
c. Word-to-word affixes (lexical clitics): $[\ [\ X\ ]_{Word} + Affix\ ]_{Word}$

Stems must satisfy the stem phonology, and words must satisfy the word phonology. The levels and categories are assumed to be universal, but the allocation of morphemes to them is not predictable, and not all languages necessarily have all types. For example, inflectional endings are attached to words in English, but to stems in Finnish.

Opacity effects (counterfeeding and counterbleeding) result from masking of the constraint system of one level by the constraint system of a later level. Therefore, stratal OT entails the following restrictions on the interaction of processes:

(3) • Constraints are transparent, except that
• postlexical processes can mask stem-level and word-level processes, and
• word-level processes can mask stem-level processes.

2 Stress

2.1 The Finnish stress system

The descriptive generalizations. Speaking for the moment in derivational terms, Finnish stress is assigned by laying down binary feet from left to right. Final syllables are not stressed if they are light, and only optionally if they are heavy. An important phenomenon is the LH̀ EFFECT: when the left-to-right scansion encounters a Light-Heavy sequence, the light syllable is skipped, with the result that a ternary foot is formed. At the left edge of a word, the LH̀ effect is superseded by the inviolable requirement that a word must have initial stress.

The basic alternating stress pattern is shown in (4):

(4) a. *(ká.las)(tè.let)* 'you're fishing'
b. *(ká.las)(tè.le)(mì.nen)* 'fishing'
c. *(íl.moit)(tàu.tu)(mì.nen)* 'registering'
d. *(jǎ̋r.jes)(tè.le)(mä̀t.tö)(mỳy.des)(tä̀n.sä)* 'from his lack of systematization'

The ternary feet resulting from the LH̀ effect are seen in (5) (the relevant LH sequences in boldface):

(5) a. X́ X L H̀ X: *(ká.las.**te)(lèm**.me)* 'we're fishing'
b. X́ X X̀ X L H̀ X: *(íl.moit)(tàu.tu.**mi)(sès**.ta)* 'registering' (Elat.Sg.)
c. X́ X X̀ X L H̀ X X̀ X: *(jǎ̋r.jes)(tèl.mäl.**li)(sỳy**.del)(lä̀.ni)* 'my systematicity' (Adess.Sg.)
d. X́ X X̀ X X̀ X L H̀ X: *(jǎ̋r.jes)(tèl.mäl)(lìs.tä.**mä)(tö̀n**.tä)* 'unsystematized' (Prt.Sg.)
e. X́ X L H̀ X L H̀ X: *(vói.mis.**te)(lùt**.te.**le)(màs**.ta)* 'having caused to do gymnastics' (Elat.Sg.)

The constraints. In constraint-based terms, Finnish can be characterized by the system in (6) (building on Hanson & Kiparsky 1996 and on Elenbaas & Kager 1999, which should be consulted for more detailed information and references).

(6) a. *CLASH: No stresses on adjacent syllables.
b. LEFT-HEADEDNESS: The stressed syllable is initial in the foot.
c. ALIGN(PRWD, LEFT; FT, LEFT) ("The left edge of every Prosodic Word coincides with the left edge of a foot.") Abbreviated as ALIGN-LEFT.
d. FOOT-BIN: Feet are minimally bimoraic and maximally disyllabic.
e. *LAPSE: Every unstressed syllable must be adjacent to a stressed syllable or to the word edge (Elenbaas and Kager 1999).

f. NON-FINAL: The final syllable is not stressed.
g. STRESS-TO-WEIGHT: Stressed syllables are heavy.
h. LICENSE-σ: Syllables are parsed into feet.
i. ALIGN(FOOT, LEFT; PRWD, LEFT) ("The left edge of every foot coincides with the left edge of some Prosodic Word".) Abbreviated as ALL-FT-LEFT.

The LH̀ effect is here taken to be a manifestation of STRESS-TO-WEIGHT: a light syllable rejects a secondary stress if it can be placed on the following heavy syllable instead (without violating the higher-ranked *CLASH and *LAPSE, of course).[2]

(7)

	*CLASH	ALIGN-L	*LAPSE	NON-FINAL	STRESS-TO-WEIGHT	LICENSE-σ	ALL-FT-LEFT
Input: /opiskelija/							
1a. ☞ (ó.pis)(kè.li)ja					**	*	2
1b. (ó.pis)ke(lì.ja)					**	*	3
1c. o(pís.ke)(lì.ja)		*			*	*	1,3
1d. (ó.pis)ke.li.ja			*		*	***	
1e. (ó)(pís)(kè.li).ja	*				**	*	1,3
Input: /opetta-ma-ssa/							
2a. ☞ (ó.pet)ta(màs.sa)					*	*	3
2b. (ó.pet)(tà.mas)sa					**		2
Input: /kalastele-t/							
3a. (ká.las)te(lèt)				*	*	*	3
3b. ☞ (ká.las)(tè.let)					**		2
3c. (ká.las)te.let			*		*	**	

[2] Some light inflectional endings, such as Essive Singular *-na* and the possessive suffixes (e.g. *-ni* 'my') are preaccenting, as though they made the preceding syllable heavy. The *CLASH constraint then blocks secondary stress on the syllable before it, e.g. /opetta-ja-na/ *(ó.pet.ta)(jà.na)* 'teacher' (Ess.Sg.). When two such preaccenting suffixes occur in a row, the regular phonological pattern reappears, e.g. /opetta-ja-na-ni/ *(ó.pet)(tà.ja)(nà.ni)* 'my teacher' (Ess.Sg.). On the proposed analysis, *CLASH prevents both preaccents from appearing, and FOOT-BIN together with LICENSE-σ decide in favor of the second.

Tableau (7) shows how ternary feet result from the interaction of (6g-i).[3]

Final heavy syllables can optionally be stressed. See Elenbaas and Kager 1999:305 for an account of the basic option in terms of free constrant ranking. The frequency of this alternative seems to be proportional to the heaviness of the syllable, e.g. *(rá.vin)to(làt)* ≺ *(rá.vin)to(làa)* ≺ *(rá.vin)to(làan).*

2.2 Lexical vs. rhythmic secondary stress

Long stems and the LH̀ effect. Polysyllabic stems in Finnish fall into two accentual types, MOVABLE and FIXED. They are most clearly distinguishable by the morphological and morphophonological properties that we shall investigate below, but there are also more direct, albeit somewhat elusive, phonological differences between them. Movable polysyllables have a rhythmic secondary stress which oscillates between the third or fourth syllable, normally according to the weight of those syllables, in line with the LH̀ effect. Fixed polysyllables have a lexical secondary stress which is invariant on a given syllable of the stem. Although the nominative singulars of movable and fixed stems have the same output stress pattern, their inflected forms (Inessive and Ablative Singulars, in these examples) diverge as follows.

(8) Movable stress (LH̀ effect in inflection):

a.	*Kálevàla*	?**Kálevàlassa*	*Kálevalàssa*	'Kalevala'
b.	*Ámerìkka*	?**Ámerìkassa*	*Ámerikàssa*	'America'
c.	*ártikkèli*	?**ártikkèlissa*	*ártikkelìssa*	'article'
d.	*ápteekkàri*	?**ápteekkàrilla*	*ápteekkarìlla*	'pharmacist'

(9) Fixed stress (no LH̀ effect):

a.	*Álabàma*	*Álabàmassa*	?**Álabamàssa*	'Alabama'
b.	*pálsternàkka*	*pálsternàkassa*	?**pálsternakàssa*	'parsnip'
c.	*ésplanàdi*	*ésplanàdilla*	?**ésplanadìlla*	'esplanade'

Marking stem-level stress with the IPA accent mark (ˈ), we have /ˈalaˈbama/, /ˈpalsterˈhakka/ etc.

Other examples of this stress contrast in polysyllabic loanwords are given in (10).

(10) a. Stems with fixed penult stress (inflected like disyllabic stems):

1. Four syllables: *barrikadi, paragrafi, portugali, serenadi, aladobi, sarkofagi, ortopedi, privilegi, kalomeli, kapitteli, filosofi, etanoli, ekonomi, megafoni, makaroni, invalidi, pyramidi, melaniini, margariini, molekyyli, mannekiini,*

[3] The undominated foot-wellformedness constraints LEFT-HEADEDNESS and FOOT-BIN are omitted from the tableau. Violations of ALIGN(FOOT, LEFT; PRWD, LEFT) are assessed, as usual, by toting up the number of syllables that separate each foot from the left edge of the word; almost any other method would do as well.

amatööri, pulituuri

2. Five syllables: *adrenaliini, antropologi, kolesteroli, konkvistadori, magnetofoni, pyramidoni, asetyleeni*

b. Movable stems (inflected like trisyllabic stems):

1. Four syllables: *asessori, hantlankari, salpietari, triangeli, artikkeli, partikkeli, monokkeli, tuberkkeli, konstaapeli, meanderi, kalenteri, silinteri, sylinteri, oraakkeli, korridori, makrospori, professori, senaattori*
2. Five syllables: *alabasteri, gladiaattori, plagiaattori, provokaattori, oleanteri*

Six-syllable stems normally break down into three feet, e.g. Prt.Pl. *íntellèktuèlleja* (not **íntellèktuèlleita*) 'intellectuals', Gen.Pl. *éksistèntialìstien* (not **éksistèntialìsteiden*) 'existentialist', unless the LH̀ effect dictates a trisyllabic first foot, e.g. *kátalysàattori* 'catalyst', in which case the word inflects like a three-syllable word.

The essential distinction between rhythmic and lexical stress is that the rhythmic stress is invisible to the morphology and to the stem-level (morpho)phonology, while lexical stress is visible. It is not a matter of distinctiveness or predictability; in fact, Anttila (1997 and p.c.) has shown that the distribution of lexical secondary stresses is largely predictable from weight and sonority, although there seems to be a residue of variation. Most heavy penults in long stems are lexically stressed, with movable stems like *Amerikka* being the exception. Light penults tend to be lexically unstressed, but there is a substantial class of lexically stressed light penults in "learned" loanwords.[4] Anttila (p.c.) points out that vowel quality, and even the weight and quality of the preceding and following syllables, determine the place of the stress. His generalization is roughly that if the second stem syllable is light, the third syllable is lexically stressed even if it is light, unless it is followed by a syllable with a more sonorous vowel.

Vowel harmony. Another phonological criterion for distinguishing between rhythmic and lexical secondary stress comes from the harmonic alternation between front vowels *ä,ö,ü* and back vowels *a,o,u* in suffixes. Stems containing only neutral vowels regularly take front vowels, while words containing a mix of back vowels and the neutral vowels *i, e* regularly take back vowels. However, *lexical* secondary stress may optionally initiate a new domain of vowel harmony: if such a secondary stress falls on a neutral vowel, and all following stem vowels are neutral, the ending may have front harmony, as if

[4]Many of them used to have long vowels, but this is considered incorrect now, perhaps because it looks like Swedish influence. Examples of such older, now disreputable spellings, still common in pronunciation, are *barrikaadi, esplanaadi, serenaadi, filosoofi, invaliidi, pyramiidi.*

the entire stem contained *only* neutral vowels. In other words, harmony then takes its cue only from the second half of the stem, beginning with the lexically accented syllable. For example, *arkkitehdi-lla* 'architect' (Adess.Sg.) has a fully acceptable alternant *arkkitehdi-llä*, comparable to an all-neutral word like *lehdi-llä* 'leaves' (Adess.Pl.) (see Ringen and Heinämäki 1999).[5]

(11) a. Lexical stress often initiates a vowel harmony domain:

árkkitèhdilta	*árkkitèhdiltä*	'architect' (Ablat.Sg.)
bólševìkilla	*bólševìkillä*	'bolshevik' (Adess.Sg.)
káramèlleja	*káramèllejä*	'candy' (Prt.Pl.)
pýramìdista	*pýramìdistä*	'pyramid' (Elat.Sg.)

b. Rhythmic stress very seldom initiates a vowel harmony domain:

ártikkelìlla	*?*ártikkelìllä*	'article' (Adess.Sg.)
prófessorèita	*?*prófessorèitä*	'professor' (Prt.Pl.)
strátegisèsta	*?*strátegisèstä*	'strategic' (Elat.Sg.)
kálenterìsta	*?*kálenterìstä*	'calendar' (Elat.Sg.)

On the basis of their harmonic behavior, fixed stems have often been analyzed as QUASI-COMPOUNDS, i.e. as compounds from the prosodic point of view, though not from the morphological point of view.[6] The quasi-compound analysis can be linked to the above observations about stress, though I believe the connection is a somewhat indirect one, in the following sense. Since compounds consist of at least two phonological words or stems, each of which must have a stress, stems are good candidates for reanalysis as prosodic compounds if they contain two stem-level stresses. That is why fixed polysyllables are much more likely to be analyzed as compounds than movable polysyllables. However, the double stress merely *invites* the compound reanalysis, it does not force it. Fixed polysyllables *can* very well be treated as single prosodic words, as their harmonic variation confirms.

The mediating role of morphology is supported by two further points. *Trisyllabic* words are never treated as quasi-compounds, presumably because a single syllable could never be mistaken for one half of a compound. Their four-syllable inflected forms are also as a rule treated like single words for

[5]These judgments are based on the data cited in Ringen and Heinämäki 1999 and Välimaa-Blum 1999, as well as on a corpus of words occurring in the 1987 issues of the magazine *Suomen Kuvalehti*, approximately 1,3 million words. The corpus is available on the University of Helsinki Language Corpus Server, Department of General Linguistics, University of Helsinki.

[6]The idea is traditional, though I am not sure who originated it. For discussion see e.g. Kiparsky 1993, and most recently Ringen and Heinämäki 1999 and Välimaa-Blum 1999.

purposes of vowel harmony.[7]

(12) Stem-final rhythmic stress never initiates a vowel harmony domain

/paperi-i-ssa/	*páperèissa*	**páperèissä*	'paper' (Iness.Pl.)
/kaveri-lla/	*káverìlla*	**káverìllä*	'guy' (Adess.Sg.)

Secondly, polysyllabic words which are transparently composed of a stem plus a derivational suffix (such as ¨*iitti* '-ite', ¨*iivi* '-ive', and especially the suffix ¨*isti* '-ist', which is productive in Finnish) are unlikely quasi-compounds for morphological reasons, even though they have a lexical secondary stress. They too are almost always treated as single words for purposes of vowel harmony:

(13) Lexical suffix stress very seldom initiates a vowel harmony domain

a.	*vókatìivi-lla*	*?*nóminatìivi-llä*	'vocative' (Adess.Sg.)
b.	*áteìsti-lla*	*?*áteìsti-llä*	'atheist' (Adess.Sg.)
c.	*kápitalìsti-lla*	*?*kápitalìsti-llä*	'capitalist' (Adess.Sg.)
d.	*háitarìsti-lla*	**háitarìsti-llä*	'accordionist' (Adess.Sg.)

If the form is built on a free stem, as (13d) *háitarìsti* from *haitari* 'accordion', front harmony is totally out of the question. The explanation is that the quasi-compound analysis **haita-risti-llä* is so obviously contraindicated by the morphology.

In sum: variation in vowel harmony shows that stems with fixed stress can be treated like compounds to the extent that they otherwise look like them in the stem-level phonological representation. Their output phonological shape is not what counts. This provides an independent argument for lexical secondary stress.

3 Segmental alternations

3.1 Stop Deletion and Consonant Gradation

The distribution of stops. Two central morphophonological processes govern the distribution of its single stops *p,t,k* and geminated stops *pp,tt,kk*. They are stated in informal processual terms in (14) (where $\mathring{V}$ represents an unstressed vowel).

(14) a. STOP DELETION: $t \rightarrow \emptyset$ / $\mathring{V}$__V

b. CONSONANT GRADATION: $\left\{\begin{matrix} tt,pp,kk \rightarrow t,p,k \\ t,p,k \rightarrow d,v,\emptyset \end{matrix}\right\}$ / [+son]__VC

Stop Deletion (called *t*-Deletion in Keyser & Kiparsky 1984) deletes single intervocalic stops after a light unstressed syllable. Consonant Gradation re-

[7] For a possible special case, see fn. 22 below.

duces geminate voiceless stops to single voiceless stops, and single voiceless stops to voiced stops (under certain conditions to voiced fricatives and to zero) when a vowel or sonorant consonant precedes and a branching (VC) rhyme follows. (Here I will only be considering the degemination branch of the Consonant Gradation process.) For example, affixes of the form -CCV and -C regularly trigger Consonant Gradation under these conditions. (15) illustrates the operation of Stop Deletion and Consonant Gradation with forms from the declensional paradigm of *lakko* 'strike'.[8]

(15)	a.	/lakko/	*lak.ko*	Nom.Sg.	
	b.	/lakko-na/	*lak.ko.na*	Ess.Sg.	
	c.	/lakko-ta/	*lak.ko.a*	Prt.Sg.	(Stop Del.)
	d.	/lakko-i-ta/	*lak.ko.ja*	Prt.Pl.	(Stop Del., G.F.)
	e.	/lakko-n/	*la.kon*	Gen.Sg.	(Cons.Grad.)
	f.	/lakko-ssa/	*la.kos.sa*	Iness.Sg.	(Cons.Grad.)

Both processes apply almost without exception in derived environments.[9] But, as Anttila 1994 notes, the processes also characterize the structure of native *stems*: even in underived environments, violations are practically confined to unassimilated loans and names, such as:

(16) a. Stem-internal exceptions to Stop Deletion: *senorita, vibrato, inkognito, Kimito*
b. Stem-internal exceptions to Consonant Gradation: *pikkelsi* 'pickle', *okkulttinen* 'occult', *opportunismi* 'opportunism', *appelsiini* 'orange', *rottinki* 'rattan'

The distribution of stops in stems shows that the constraint behind Stop Deletion applies also to *p* and *k*. Although actual alternations only involve /t/, sequences of the form [V̊kV] and [V̊pV], like [V̊tV], are essentially restricted to unassimilated loanwords and names such as (17a). Most loanwords accommodate to the constraint, and they do so by geminating the obstruent, not by deleting it, as the examples in (17b) illustrate.[10]

[8]Examples are cited in Finnish orthography, with stress and syllabification added where necessary. Syllables ending in short vowels (-V) are light, syllables ending in -VC, -VV, -VVC are heavy. The vowel sequences *ei, äi, yi, öi, ai, ui, oi, au, ou, eu, iu, ey, äy, öy, ie, yö, uo, iy* are diphthongs. Other vowel sequences, such as *ia, ua, ea, oa,* are disyllabic.

[9]There is no Consonant Gradation before the ending *-is*, because this ending imposes templatic expressive gemination, superseding the Consonant Gradation constraint, e.g. *julkkis* 'celebrity, public figure', from *julkinen* 'public'. A systematic class of exceptions to Consonant Gradation are certain stems in /-s(e)/, which furnish the oblique stems of words whose nominative ends in *-nen*, e.g. *Kekkonen*, Prt.Sg. *Kekkos-ta*.

[10]Presumably in order to minimize the difference between the Finnish and original pronunciations. A related gemination process applies in Fenno-Swedish (Kiparsky, to appear).

(17) a. *judoka* 'judo practitioner', *paprika* 'bell pepper, paprika', *karakteristika* 'characteristic' (in mathematics), *rokokoo* 'rococo', *Aleko, Alepa, heteka* 'a type of bed'

b. *profeetta* 'prophet', *mammutti* 'mammoth', *apotti* 'abbot', *Eurooppa* 'Europe', *sinappi* 'mustard'

Stop Deletion, then, reflects a broad distributional restriction on $\mathring{V}$[p,t,k]V sequences, although, because no suffixes begin with a single /p/ or /k/, the alternations it governs all happen to be of the form /t/ $\sim \emptyset$. This said, I will continue to use the term Stop Deletion to refer to its processual effects.

Examples. Numerous stems and endings alternate in accord with Stop Deletion and/or Consonant Gradation (CG), often interacting with other process, as the examples in (18)-(22) illustrate for a variety of inflectional and derivational suffixes.[11]

(18) Partitive Singular /-ta/

a.	/puu-ta/	*puu.ta*	'tree'	
b.	/voi-ta/	*voi.ta*	'butter'	
c.	/si-tä/	*si.tä*	'that'	
d.	/palttoo-ta/	*palt.too.ta*	'overcoat'	
e.	/puku-ta/	*pu.ku.a*	'suit'	(Stop Del.)
f.	/katiska-ta/	*ka.tis.kaa*	'fish trap'	(Stop Del., V-Contr.)

(19) Partitive Plural /-i-ta/

a.	/puu-i-ta/	*pui.ta*	'trees'	
b.	/he-i-tä/	*hei.tä*	'them'	
c.	/palttoo-i-ta/	*palt.toi.ta*	'overcoats'	
d.	/puku-i-ta/	*pu.ku.ja*	'suits'	(Stop Del., G.F.)
e.	/katiska-i-ta/	*ka.tis.ko.ja*	'fish traps'	(Stop Del., G.F.)

(20) Genitive Plural /-i-ten/

a.	/puu-i-ten/	*pui.den*	'trees'	(Cons.Grad.)
b.	/voi-i-ten/	*voi.den*	'butter'	(Cons.Grad.)
c.	/nuo-i-ten/	*noi.den*	'those'	(Cons.Grad.)
d.	/palttoo-i-ten/	*palt.toi.den*	'overcoats'	(Cons.Grad.)
e.	/puku-i-ten/	*pu.ku.jen*	'suits'	(Stop Del., G.F.)
f.	/katiska-i-ten/	*ka.tis.ko.jen*	'fish traps'	(Stop Del., G.F.)

(21) Infinitive /taC/

[11] For simplicity I incorporate vowel harmony into the underlying representations.

a.	/nouse-taC/	*nous.taC*	'rise'	(Cons.Grad.)
b.	/tuo-taC/	*tuo.daC*	'bring'	(Cons.Grad.)
c.	/hakk-at-taC/	*ha.ka.taC*	'to chop'	(Cons.Grad.)
d.	/tule-taC/	*tul.laC*	'to come'	(Cons.Grad., Assim.)
e.	/mene-täC/	*men.näC*	'to go'	(Cons.Grad., Assim.)
f.	/laula-taC/	*lau.laaC*	'to sing'	(Stop Del., V-Contr.)

(22) Verbalizer /-at/

a.	/hakk-at-kaa/	*ha.kat.kaa*	'chop!' (2Pl.)	(Cons.Grad.)
b.	/hakk-at-taC/	*ha.ka.taC*	'chop' (Inf.)	(Cons.Grad., twice)
c.	/hakk-at-a/	*hak.kaa*	'chops' (3Sg.)	(Stop Del., V-Contr.)
d.	/hakk-at-u/	*hak.kuu*	'chopping' (N.)	(Stop Del., V-Contr.)

The ghost consonant. A comment is in order about the final /-C/ in (21) and (22b), an underlying consonantal element with no segmental melody of its own. The evidence for this "ghost" segment is extensive, but a few of the main points may be summarized here. First, it regularly triggers Consonant Gradation, e.g. /liikkeC/ *liike* 'movement, shop' (see also (21b-e), (22b)). Secondly, it blocks the regular raising of word-final *e* to *i*, e.g. Nom.Sg. /kuore/ *kuori* 'rind', but /liikkeC/ *liike*, not **liiki* or **liikki*. Third, it blocks Stop Deletion, e.g. Prt.Sg. /liikkeC-tä/ *liikettä*, not **liikkeä*. Fourth, it triggers stem-final *-e* epenthesis before all -CCV and -C endings, as well as a subset of -CV endings, e.g. Iness.Sg. /liikkeC-ssä/ *liikkeessä*, Gen.Sg. /liikkeC-n/ *liikkeen*, Ess.Sg. /liikkeC-nä/ *liikkeenä*.[12] Fifth, when the next segment is a consonant, the -C materializes as a copy of it. This happens before those -CV endings which retain the unepenthesized -C stem,[13] as in Prt.Sg. /liikkeC-tä/ *liikettä* as well as before clitics such as *-ko/-kö* (e.g. *liike[kk]ö* 'the shop?'), in compounds (e.g. *liike[kk]atu* 'shopping street'), and in external sandhi as long as there is close contact between the words (e.g. *liike[mm]enestyi* 'the shop flourished'). The examples in (23) show how words ending in /-C/ contrast with words ending in vowels.

(23)
a. /ei se tuo-tta-C voi-ta/ *ei se tuota[v v]oita* 'it does not produce butter'
b. /ei se tuo-ta voitta-C/ *ei se tuota voita* 'it won't beat THAT ONE'
c. /ei se voitta-C tuo-ta/ *ei se voita[t t]uota* 'it won't beat that one'
d. /ei se voi-ta tuo-tta-C/ *ei se voita tuota* 'it does not produce BUTTER'

[12] Ultimately, the *-e* is probably part of the underlying form, for the empirical reasons presented in in Keyser & Kiparsky 1984. Thus, the "ghost consonant" is really a "ghost syllable", in conformity with the constraint that all Finnish stems end in vowels (the Stem Constraint motivated in section 5).

[13] Or, if we adopt the analysis of fn. 12, before those -CV endings which allow stem-final *-e* to be deleted.

3.2 Optionality and complementarity

Movable polysyllabic stems. A stem-final vowel combines with the plural suffix /i/ into a diphthong.[14] After underlying diphthongs, Stop Deletion is always blocked: e.g. *lauantai-ta* 'Saturday' (Prt.Sg.). After morphologically derived diphthongs, stops are optionally deleted in a subclass of polysyllabic stems, and the second half of the diphthong becomes an onset, taking the place of the deleted stop. This is exactly the class of stems we have already identified through their stress and vowel harmony behavior as MOVABLE POLYSYLLABLES.

(24) Diphthongs optionally trigger Stop Deletion in movable polysyllables:

a.	/korjaamo-i-ta/	*kór.jaa.mò.ja* *kór.jaa.mòi.ta*	'repair shops' (Prt.Pl.)
b.	/kalevala-i-ta/	*Ká.le.và.lo.ja* *Ká.le.va.lòi.ta*	'Kalevalas' (Prt.Pl.)
c.	/professori-i-ta/	*pró.fes.sò.re.ja*[15] *pró.fes.so.rèi.ta*	'professors' (Prt.Pl.)
d.	/artikkeli-i-ta/	*ár.tik.kè.le.ja* *ár.tik.ke.lèi.ta*	'articles' (Prt.Pl.)

(In this section I mark primary and secondary word stress, for reasons which will soon become apparent.)

In movable polysyllables, the diphthong formed by combining the stem-final vowel with the plural suffix /i/ has another unexpected property. It optionally triggers Consonant Gradation of its onset stop, as in the essive and illative plurals in (25).

(25) Diphthongs optionally trigger Consonant Gradation in movable polysyllables:

a.	/ullakko-i-na/	*úl.lak.kòi.na* *úl.la.kòi.na*	'attic' (Ess.Pl.)
b.	/ullakko-i-hin/	*úl.lak.kòi.hin* *úl.la.kòi.hin*	'attic' (Ill.Pl.)
d.	/amerikka-i-na/	*Á.me.rìk.koi.na* *Á.me.ri.kòi.na*	'America' (Ess.Pl.)
e.	/amerikka-i-hin/	*Á.me.rìk.koi.hin* *Á.me.ri.kòi.hin*	'America' (Ill.Pl.)

[14] Under certain conditions the stem-final vowel is deleted instead, e.g. /matala-i-ta/ *matalia* 'low' (Prt.Sg.); see Anttila 1997.

[15] Note the lowering of /-i/ to *-e* in (24c,d). When Stop Deletion applies in the genitive plural, stem-final /-i/ and /-e/ instead appear as /-i/, and the glide is absorbed, e.g. /professori-i-ten/ *professorien* ∼ *professoreiden*.

In contrast, Consonant Gradation never applies before a derived diphthong in the second syllable of disyllabic stems.

(26) Diphthongs do not trigger Consonant Gradation in disyllabic stems:

a.	/lakko-i-na/	*lák.koi.na*	**lá.koi.na*	‘strike’ (Ess.Pl.)
b.	/lakko-i-hin/	*lák.koi.hin*	**lá.koi.hin*	‘strike’ (Ill.Pl.)

When the diphthong is followed by a tautosyllabic consonant, as in (27a-c), Consonant Gradation is obligatory regardless of the syllable count. And, of course, Consonant Gradation is obligatory before a simple VC rhyme, whatever the length of the stem, e.g. (27d).

(27) Obligatory Consonant Gradation:

a.	*lá.koi.ssa*	**lák.koi.ssa*	‘strike’ (Ins.Pl.)
b.	*Á.me.ri.kòis.sa*	**Á.me.rìk.kois.sa*	‘America’ (Ins.Pl.)
c.	*úlla.kòis.sa*	**úllak.kòis.sa*	‘attic’ (Ins.Pl.)
d.	*úlla.kòs.sa*	**úllak.kòs.sa*	‘attic’ (Ins.Sg.)

The problem, then, is why the systematic variation in (24) and (25) occurs, and why precisely with diphthongs in a subclass of polysyllabic stems.

Fixed polysyllabic stems. FIXED POLYSYLLABLES do not show variation in either Consonant Gradation or Stop Deletion (cf. Anttila 1997:20).

(28) Diphthongs trigger Stop Deletion in fixed polysyllables:

a.	*ká.ra.mèl.le.ja*	**ká.ra.mèl.lei.ta*	‘candy’ (Prt.Pl.)
b.	*ká.ra.mèl.li.en*	**ká.ra.mèl.lei.den*	‘candy’ (Gen.Pl.)
c.	*Á.la.bà.mo.ja*	**Á.la.ba.mòi.ta*	‘Alabama’ (Prt.Pl.)
d.	*Á.la.bà.mo.jen*	**Á.la.ba.mòi.den*	‘Alabama’ (Gen.Pl.)

(29) Diphthongs do not trigger Consonant Gradation in fixed polysyllables:

a.	*páls.ter.nàk.koi.na*	**páls.ter.nà.koi.na*	‘parsnips’ (Ess.Pl.)
b.	*páls.ter.nàk.koi.hin*	**páls.ter.nà.koi.hin*	‘parsnips’ (Ill.Pl.)
c.	*ból.še.vìk.kei.na*	**ból.še.vìk.ei.na*	‘bolsheviks’ (Ess.Pl.)
d.	*ból.še.vì.kei.hin*	**ból.še.vì.kei.hin*	‘bolsheviks’ (Ill.Pl.)

In fact, fixed polysyllabic stems pattern just like disyllabic stems; compare (28) and (29) with (30):

(30)

a.	/sama-i-ta/	*sá.mo.ja*	**sá.moi.ta*	‘same’ (Prt.Pl.)
b.	/sama-i-ten/	*sá.mo.jen*	**sá.moi.den*	‘same’ (Gen.Pl.)
c.	/lakko-i-na/	*lák.koi.na*	**lá.koi.na*	‘strike’ (Ess.Pl.)
d.	/lakko-i-hin/	*lák.koi.hin*	**lá.koi.hin*	‘strike’ (Ill.Pl.)

So we have a second mystery compounding the first: why do stems of four or more syllables stems fall into two different types, movable (patterning like trisyllables) and fixed (patterning like disyllables)?

Complementarity of Stop Deletion and Consonant Gradation. The two alternations of Stop Deletion and Consonant Gradation are strictly COMPLEMENTARY: when the conditions for both are present, one or the other must apply, but both may not. Thus, when a movable potentially gradating stem is combined with a suffix in *-t*, there are always only two forms, never four:

(31) Complementarity of Stop Deletion and Consonant Gradation:

a.	/ullakko-i-ta/	*úl.lak.kò.ja*	*úl.la.kòi.ta*
		**úl.lak.kòi.ta*	**úl.la.kò.ja*
b.	/amerikka-i-ten/	*Á.me.rìk.ko.jen*	*Á.me.ri.kòi.den*
		**Á.me.rìk.koi.den*	**Á.me.rì.ko.jen*

And when a fixed potentially gradating stem, such as *papiljotti*, is combined with a suffix in *-t*, there is always only one form, never two.

(32) /papiljotti-i-ta/ *pápiljòtteja* **pápiljòteita* 'hair curlers' (Prt.Pl.)
**pápiljòteja* **pápiljotèita*

This is remarkable considering that each process on its own is optional (e.g. *ullakoina* ∼ *ullakkoina*, *korjaamoja* ∼ *korjaamoita*).

So we have two more mysteries: when both Stop Deletion and Consonant Gradation are applicable, why must at least one of them take effect? And why do both of them never take effect together?

3.3 Another systematically opaque context

Diphthong shortening. As already stated, long vowels trigger neither Consonant Gradation before them (see (33)), nor Stop Deletion after them (see (34)).

(33)	a.	/palttoo-ssa/	*palt.toos.sa*	**pal.toos.sa*	'overcoat' (Ins.Sg.)
	b.	/hakkatV-u-n/	*hak.kuun*	**ha.kuun*	'chopping' (Gen.Sg.)
	c.	/rakkasV-lla/	*rak.kaal.la*	**ra.kaal.la*	'dear' (Ads.Sg.)
(34)	a.	/palttoo-ta/	*palt.too.ta*	**palt.too.a*	'overcoat' (Prt.Sg.)
	b.	/hakkatV-u-ta/	*hak.kuu.ta*	**hak.kuu.a*	'chopping' (Prt.Sg.)
	c.	/suklaa-ta/	*suk.laa.ta*	**suk.laa.a*	'chocolate' (Prt.Sg.)

Superheavy (three-mora) diphthongs are categorically excluded in Finnish, and when they arise in the morphology they are always shortened, as when the plural /-i/ is added to /-VV/ stems:

(35)	a.	/puu-i-ssa/	*puis.sa*	**puuis.sa*	'tree' (Ins.Pl.)
	b.	/voi-i-ssa/	*vois.sa*	**voiis.sa*	'butter' (Ins.Pl.)
	c.	/suklaa-i-ssa/	*suk.lais.sa*	**suk.laais.sa*	'chocolate' (Ins.Pl.)

The behavior of shortened diphthongs. The shortened diphthongs are pronounced like original short diphthongs. Still, a following tautosyllabic consonant triggers no Consonant Gradation before them, and a following single

stop does not undergo Stop Deletion after them.

(36)	a.	/palttoo-i-ssa/	*palt.tois.sa*	**pal.tois.sa*	‘overcoats’ (Ins.Pl.)
	b.	/hakkat-u-i-ssa/	*hak.kuis.sa*	**ha.kuis.sa*	‘choppings’ (Ins.Pl.)
	c.	/rakkasV-i-lla/	*rak.kail.la*	**ra.kail.la*	‘dear’ (Ad.Pl.)

(37)	a.	/palttoo-i-ta/	*palt.toi.ta*	**pal.toi.ta*	‘overcoats’ (Prt.Pl.)
	b.	/hakkat-u-i-ta/	*hak.kui.ta*	**ha.kui.ta*	‘choppings’ (Prt.Pl.)
	c.	/rakkasV-i-ta/	*rak.kai.ta*	**ra.kai.ta*	‘dear’ (Prt.Pl.)

This contrasts with ordinary diphthongs formed with a short vowel plus a plural *i*. For example, the retained geminates in (36) are in exactly the same output environments as the degeminated ones in (38), and the retained stops in (37) are in exactly the same output environments as the deleted stops in (39) .

(38)	a.	/taltta-i-ssa/	*tal.tois.sa*	**tal.ttois.sa*	‘chisels’ (Ins.Pl.)
	b.	/akku-i-ssa/	*a.kuis.sa*	**ak.kuis.sa*	‘batteries’ (Ins.Pl.)
	c.	/lakko-i-lla/	*la.koil.la*	**lak.koil.la*	‘strikes’ (Ad.Pl.)

(39)	a.	/taltta-i-ta/	*tal.tto.ja*	**talt.toi.ta*	‘chisels’ (Prt.Pl.)
	b.	/akku-i-ta/	*a.kku.ja*	**ak.kui.ta*	‘batteries’ (Prt.Pl.)
	c.	/lakko-i-ta/	*la.ko.ja*	**lak.koi.ta*	‘strikes’ (Prt.Pl.)

This gives mystery number five: why are Stop Deletion and Consonant Gradation opaquely conditioned? Why do shortened diphthongs block these processes, in contexts phonetically indistinguishable from those that otherwise trigger them?

A stratal OT solution. We concluded first that polysyllabic stems in Finnish fall into two subclasses, fixed stems such as *palsternakka*, and movable stems such as *Amerikka*. Fixed polysyllables always keep their secondary stress on that syllable. Movable polysyllables receive a rhythmic secondary stress on the third or fourth syllable, depending on syllable weight in accord with the LH̀ effect. Now we have seen that the two types of polysyllables differ with respect to two other core processes of the stem phonology: Stop Deletion and Consonant Gradation. Fixed stems display no optionality with respect to these processes, whereas movable stems show systematic optionality with respect to both.

The analysis proposed here is that fixed polysyllables differ from movable polysyllables in having an obligatory fixed secondary stress at the stem level. All the differences between the two types of polysyllables follow from this basic stress difference. Some of them are conditioned by stress directly, others indirectly via syllable structure. The key point is that rhythmic secondary stress by (6) is assigned optionally (subject to certain weight constraints) in the stem phonology, and obligatorily (regardless of syllable weight) in the

word phonology. Stop Deletion and Consonant Gradation are conditioned by *stem-level* stress and by *stem-level* syllable structure. In the output, stem-level stresses and stem-level syllabification are masked by word-level rhythmic stress and resyllabification, which are irrelevant to Stop Deletion and Consonant Gradation. These conclusions translate directly into evidence for stratal OT and against parallelism, for the separation between stem-level and word phonology on which the analysis depends is not available in fully parallel OT.

In sum, word-initial stress and fixed medial stress always assigned at the stem level, while movable medial stress may be assigned either at the stem level or at the word level. It would be desirable to base this generalization on some principle (rather than simply on the data of the language). Distinctiveness is irrelevant: initial primary stress, visible in the stem phonology, is as predictable as rhythmic secondary stress, which is not. One reason why initial main stress is obligatorily assigned in the stem phonology may be that prosodic phonology requires a word to consist of at least a foot, which is its prosodic head (peak). This is a very common and perhaps universal prosodic licensing requirement. On the other hand, many languages (for example, Cairene Arabic) reportedly do *not* require that words be parsed into binary feet by secondary stresses ("conflation", Hayes 1995:119). The option lies precisely in whether Finnish imposes this requirement at the stem level, or not. Formally, the variation results from free ranking in the stem phonology of the constraint that prohibits secondary stress with a constraint demanding alternating stress. For present purposes, let us assume that the constraint against secondary stress is simply *STRESS (for more sophisticated alternatives, see Crowhurst 1996 and de Lacy 1998). The antagonistic constraint that forces a full metrical parse of the word is presumably *LAPSE (or LICENSE-σ, in concert with undominated FOOT-BIN). In the word phonology, the ranking is fixed so that alternating rhythmic stress is obligatory.

Additional differences between the stem phonology and the word phonology will emerge as we go on to develop the constraint system behind these descriptive generalizations.

3.4 Stress and syllable structure

Stress-to-Weight. In the stem phonology, STRESS-TO-WEIGHT ("stressed syllables are heavy") dominates the constraints that assign alternating secondary stress. They are themselves dominated by the constraint that requires the word-initial syllable to bear primary stress. They are also dominated by *CLASH and by the Faithfulness constraint MAX(Stress).

(40) *CLASH, LEFT-HEADEDNESS, ALIGN-LEFT, MAX(Stress) ≫ STRESS-TO-WEIGHT

The ranking in (40) has important corollaries, to which I now turn.

The dominant status of STRESS-TO-WEIGHT precludes light syllables from getting rhythmic stress in the stem phonology (except in initial position, where ALIGN-LEFT forces it). Being always word-level, the rhythmic stress of light syllables is invisible to stem phonology, and so cannot block Stop Deletion. That is why Stop Deletion is obligatory after short vowels even if they bear rhythmic secondary stress:[16]

(41)	a.	/paperi-ta/	*paperia*	**paperita*	'paper' (Prt.Sg.)
	b.	/ullakko-ta/	*ullakkoa*	**ullakkota*	'attic' (Prt.Sg.)
	c.	/salama-ta/	*salamaa*	**salamata*	'lightning' (Prt.Sg.)

When a stem-final short vowel is combined with the plural marker *-i*, a diphthong results, which is eligible to bear stress. Optional assignment of rhythmic stress in the stem-level phonology then generates the systematic alternation treated above, and illustrated again in (42), where the optional Stop Deletion reflects the stress option.

(42)	/ullakko-i-ta/	*ullakkoja*	*ullakoita*	'attic' (Prt.Pl.)

We have now uncovered yet another difference between lexical and rhythmic secondary stress. Rhythmic stress is assigned in the stem phonology only to heavy syllables, because of high-ranking STRESS-TO-WEIGHT. Lexical stress, however, can be lexically marked on light syllables as well, as in (10a), in consequence of the ranking MAX(Stress) $\gg$ STRESS-TO-WEIGHT.[17]

WEIGHT-TO-STRESS and the structure of nuclei. As for the complementary constraint WEIGHT-TO-STRESS, its high rank in the stem-level phonology excludes unstressed long nuclei in the stem phonology. Somewhat shockingly, it turns out that apparent unstressed diphthongs in Finnish are phonologically monomoraic, and apparent unstressed long vowels are phonologically disyllabic sequences. This is the key to understanding the complementarity between Stop Deletion and Consonant Gradation.

Recall that the output of /mellakka-i-ta/ is either *mellakkoja*, with Stop Deletion, or *mellakoita*, with Consonant Gradation, but not **mellakoja* or **mellakkoita*. When both processes have scope, one of them must apply, but both cannot apply together — even in environments where each is otherwise optional. The reason is that both processes are obligatory, but require incompatible structural conditions, whose presence is itself subject to variation. The

[16]The statement in the text holds strictly for contemporary standard Finnish. In certain dialects and sometimes in the standard language of the 19th century and earlier, *-t* is retained after polysyllabic stems in /-a/ and /-ä/, e.g. *salamata*, but not **paperita*, **ullakkota*. Since *a, ä* are the most sonorous of the vowels, this dialectal variation adds support for our analysis which ties the blocking of Stop Deletion to stem-level stress controlled by STRESS-TO-WEIGHT.

[17]Of course, light *final* syllables cannot have lexical stress because NON-FINAL is undominated, so that no monomoraic feet are permitted anywhere in Finnish.

parameter of variation was identified in Wiik 1967 as the syllabification of the stem-final diphthong, which (in line with the phonological theory of the time) he represented as *oi* and *oj*, respectively. In Keyser & Kiparsky 1984 these alternative syllabifications were analyzed in terms of rhyme structure, itself derived from the independently motivated variation in secondary stress described above. Specifically, we argued that stressed diphthongs (Wiik's *oi*) have two moras, while unstressed diphthongs (Wiik's *oj*) have one mora, and we showed that this structural difference explains the incidence of Consonant Gradation and Stop Deletion.

Monosyllabic and disyllabic stems exhibit no variation because their stress pattern is fixed. The initial (or only) syllable of a word always bears main stress, so a diphthong in the *first* syllable of a word is always bimoraic. Because of *CLASH, the second syllable is always unstressed, so a diphthong in the second syllable is always monomoraic. This determines the shape of both the onset and of the following desinence. As stated in (14), Consonant Gradation takes place before branching (VC) rhymes, and Stop Deletion takes place after light unstressed syllables. An unstressed diphthong, forming a simple rhyme, does not trigger Consonant Gradation by itself (see (43a,b,e,f)). Of course, if it is followed in the rhyme by a consonant which closes the syllable, Consonant Gradation takes place (see (43c,d,g,h)). By the same token, an unstressed diphthong obligatorily triggers Stop Deletion (see (43i,j)):

(43)	a.	/lakko-i-na/	*lák.koi.na*	(No C.G.)	'strikes' (Ess.Pl.)
	b.	/lakko-i-hin/	*lák.koi.hin*	(No C.G.)	'strikes' (Ill.Pl.)
	c.	/lakko-i-n/	*lá.koin*	(C.G.)	'strikes' (Instr.Pl.)
	d.	/lakko-i-ssa/	*lá.kois.sa*	(C.G.)	'strikes' (Iness.Pl.)
	e.	/sattu-i/	*sát.tui*	(No C.G.)	'happened' (3.Sg.)
	f.	/sattu-i-vat/	*sát.tui.vat*	(No C.G.)	'happened' (3.Pl.)
	g.	/sattu-i-t/	*sá.tuit*	(C.G.)	'happened' (2.Sg.)
	h.	/sattu-i-mme/	*sá.tuim.me*	(C.G.)	'happened' (1.Pl.)
	i.	/lakko-i-ta/	*lák.ko.ja*	(Stop Del.)	'strikes' (Prt.Pl.)
	j.	/lakko-i-ten/	*lák.ko.jen*	(Stop Del.)	'strikes' (Gen.Pl.)

The behavior of polysyllabic stems is also predicted. Polysyllabic stems with fixed lexical stress on the penult syllable function exactly like disyllabic stems with respect to Consonant Gradation and Stop Deletion, as was already documented in (28) and (29). Polysyllabic stems of the movable type have a one-mora or two-mora final diphthong in the stem phonology, depending on whether rhythmic stress is assigned in the stem phonology or not, an option which yields the respective structures in (44).

(44) a. Stressed diphthong, two moras: mél.la.k[ò$_\mu$i$_\mu$]-
b. Unstressed diphthong, one mora: mél.lak.k[oi]$_\mu$-

On the stress option (44a), diphthongs trigger Consonant Gradation (e.g. Prt.Pl. *méllakòita*). On the no-stress option (44b) they trigger Stop Deletion (e.g. Prt.Pl. *méllakkòja*). Since these are the only two options, one of the two processes must apply: the reason there are not two more partitive plurals (**méllakkòita*, **méllakòja*) is that stress obligatorily determines syllable structure and the syllabic conditions on Consonant Gradation and *i*-Deletion are mutually incompatible. Both their apparent optionality, and their complementarity, are thus explained.

To complete the story, it remains to show how exactly WEIGHT-TO-STRESS governs syllable structure, and to generalize the analysis from diphthongs to long vowels.

Deriving the syllable structure of diphthongs and long vowels. The generalization that stressed noninitial diphthongs in Finnish have two moras and unstressed diphthongs have one mora in the stem phonology is a consequence of a constraint which prohibits unstressed bimoraic nuclei, a special case of WEIGHT-TO-STRESS.

(45) WEIGHT-TO-STRESS

*Nuc$_w$
/\
μ μ (where Nuc$_w$ denotes an unstressed syllable nucleus)

The stem-level prohibition of unstressed two-mora nuclei is enforced for long vowels as well. However, there it is implemented in a different way. Whereas unstressed diphthongs are compressed into short nuclei, long vowels are *expanded into two syllables*.[18]

(46) The implementation of WEIGHT-TO-STRESS

a. Unstressed diphthongs Stressed diphthongs

b. Unstressed long vowels Stressed long vowels

Why are unstressed diphthongs accommodated to (45) by becoming monomoraic, whereas unstressed long vowels are accommodated to (45) by becoming disyllabic? Because the bimoraicity of long vowels is distinctive, being the defining property of length itself. A "monomoraic long vowel" is a contradiction in terms. Bimoraicity is not a defining property of diphthongs, however. In most languages diphthongs are redundantly bimoraic, and some languages have "monomoraic diphthongs", short vocalic nuclei affiliated with two melodies, e.g. English (Harris 1994:278), Icelandic (Árnason 1992), and Gere (Paradis 1997:532). Therefore, the constraint MAX-Vμ, which postulates that an input vocalic mora must be have an output correspondent, prevents long vowels and long diphthongs from shortening, but it does not

[18]The splitting of long vowels into two syllables under the compulsion of metrical constraints is familiar from Southern Paiute and other languages.

prevent regular diphthongs from being realized as monomoraic. This is the desired outcome.

In sum: in the stem-level syllabification of Finnish, all unstressed diphthongs are monomoraic, and all stressed diphthongs are bimoraic, in satisfaction of WEIGHT-TO-STRESS and STRESS-TO-WEIGHT. These constraints are however dominated by MAX-Vμ. The only way unstressed long vowels can satisfy WEIGHT-TO-STRESS without violating MAX-Vμ is by being split into two short syllables, even though this incurs an ONSET violation. Diphthongs, on the other hand, can be reconciled with the constraints simply by being assigned one mora rather than two.[19]

Thus, the structure of unstressed syllables is given by the three constraints in (47), where (47a,b) ≫ (47c).[20]

(47) a. WEIGHT-TO-STRESS
A heavy nucleus must be stressed.

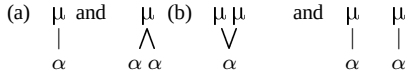
b. MAX-Vμ
An input vocalic mora must be realized in the output.

c. ONSET
A syllable must have an onset.

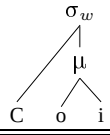
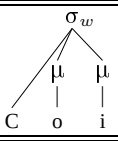
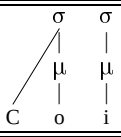
Unstressed diphthongs, long vowels, and long diphthongs (the latter two specified as bimoraic in the input), are respectively syllabified as in (48).

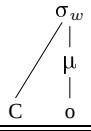
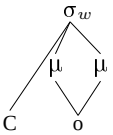
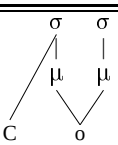
[19]Note that the diphthongs we are concerned here are derived from a stem-final vowel plus the plural affix *-i-*. Diphthongs formed by stem-final vowels plus the past tense affix *-i-*, and underlying diphthongs, behave differently, as we will see below.

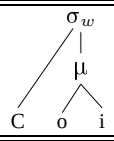
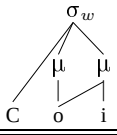
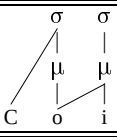
[20]The pairs of representations (a) and (b) (where α is a set of features defining a segment) are assumed to be indistinguishable (OCP):



(48)

Diphthongs: /oi/	WT-TO-STR	MAX-Vμ	ONSET
a. ☞ 			
b. 	*		
c. 			*

Long vowels: /oo/	WT-TO-STR	MAX-Vμ	ONSET
a. 		*	
b. 	*		
c. ☞ 			*

Long diphthongs: /ooi/	WT-TO-STR	MAX-Vμ	ONSET
a. 		*	
b. 	*		
c. ☞ 			*

Consonant Gradation reformulated. The above result has another immediate payoff. It explains all seemingly arbitrary properties of Consonant Gradation. The opaque conditioning in (36) and (38), which brings about surface contrasts such as *palttoissa* vs. *taltoissa*, is due to the fact that Consonant Gradation is defined on the *stem-level* syllabification. In the stem-level syllabification, unstressed long diphthongs form separate short nuclei, and consequently do not trigger Consonant Gradation, even when followed by a syllable-closing consonant. For example, the cited examples are respectively syllabified as *palt.to.ois.sa* and *tal.tois.sa* at the stem level, so that the environment of Consonant Gradation is satisfied only in the latter.

In fact, we can now clean up the right context of Consonant Gradation and remove the arbitrary stipulations from it. Instead of the previous messy context (49a), we now have simply (49b).

(49) a. *Old formulation:* In the onset of a syllable whose rhyme ends in a consonant, except if it has a long vowel or a shortened diphthong, or which consists of a diphthong with lexical stress, and optionally in the onset of a syllable whose rhyme consists of a diphthong with rhythmic stress.

b. *New formulation:* In the onset of a heavy syllable.

Defined at the stem level, (49b) captures the exact conditions under which the process applies. It is no longer necessary to exclude long vowels from the triggering environment of Consonant Gradation, or to list the contexts in which diphthongs trigger it.

So simplified, Consonant Gradation (at least the degemination part of it) can be seen to be a special case of the quantititive dissimilation constraint *HH, which is proposed, and extensively motivated for Finnish, by Anttila

1997.

Stop Deletion reformulated. The context of Stop Deletion also becomes simpler and more natural. Instead of the messy formulation (50a) we can have (50b).

(50) a. *Old formulation:* Between an unstressed short vowel and a vowel, or between an unstressed underlying short diphthong and a vowel, and optionally between a short diphthong with rhythmic stress and a vowel.
b. *New formulation: (i)* Between a short unstressed vowel and a vowel. (Or even: *(ii)* Between short unstressed vowels.)

Further simplifications are probably possible. The reason the preceding vowel must be short is that onsetless syllables are excluded after long syllables in Finnish stems (as Anttila points out). For example, Stop Deletion applies in /puku-ta/ *pu.ku.a* but not in /puu-ta/ *puu.ta* (see (18)) because *pu.ku.a* conforms to the canonical shape of stems (e.g. *saippua* 'soap', *pors.tu.a* 'porch', while **puua* is not a possible stem.

3.5 Interim summary

The analysis in outline. The distinction between stem stress and word stress is essential to understanding Finnish morphophonology. Initial main stress and fixed secondary stress are always visible in the stem-level phonology, while rhythmic secondary stress is optionally visible in the stem phonology, and then only on heavy syllables, because of high-ranking STRESS-TO-WEIGHT. Optional rhythmic stress in the stem phonology results from movable ranking of LICENSE-σ. In addition to triggering the LH̀ effect, the constraints STRESS-TO-WEIGHT and WEIGHT-TO-STRESS cause unstressed diphthongs to be parsed as single Vs, and unstressed long vowels to be parsed as disyllables. In the word phonology, rhythmic stress is obligatory because *LAPSE dominates *STRESS.

Consonant Gradation *(pp, tt, kk → p, t, k,* and *p, t, k → v, d, ∅)* applies in the onset of a heavy syllable. E.g. /lakko+n/ → *la.kon*, /méllakkò-i-na/ → *mél.la.kòi.na* (*oi* is stressed, therefore bimoraic) but /lákko-i-na/ → *lákkoina* (*oi* is unstressed, therefore monomoraic by WEIGHT-TO-STRESS, so gradation fails).

Stop Deletion applies after a short unstressed nucleus. E.g. /lakko+ta/ → *lakkoa*. Prt.Pl. /méllakkò-i-ta/ → *mél.la.kòi.ta* (*oi* is stressed, so Stop Deletion fails) but /lákko-i-ta/ → *lakkoja* (*oi* is unstressed, and parsed into a single V slot, so Stop Deletion applies).

We derive the variability of Consonant Gradation and Stop Deletion from the optionality of secondary stress via syllable structure, and explain their complementarity by the fact that they require inconsistent syllable structures.

Functionally, lexical secondary stresses pattern with predictable word-initial primary stresses in being obligatorily visible in the stem phonology and morphology. Rhythmic secondary stress stands apart in being optionally visible in the stem-level phonology and morphology, due to the free ranking of *LAPSE and *STRESS.

Illustrative tableaux. (51) shows the invariant patterning of disyllabic words and of fixed polysyllabic stems, on the (convenient but nonessential) assumption that the latter have an underlying lexically marked stress. How the free ranking generates variation in movable polysyllables is seen in (52) and (53) (where the two freely ranked constraints are boldfaced). Keep in mind that (in observance of the constraints in (47), omitted from the tableaux), unstressed diphthongs are monomoraic and stressed diphthongs are bimoraic.

(51) Derivation of *lakkojen* 'strikes' (Gen.Pl.) and *almanakkojen* 'almanacs' (Gen.Pl.) under the ranking ***STRESS** ≫ ***LAPSE**:

Stem-Level		*CLASH	ALIGN-L	MAX-STRESS	UNI-PK	***STRESS**	***LAPSE**	CONSGRAD	STOPDEL	STR-TO-WT	MAX-SEG	ALL-FT-L	MAX-Cμ
Input: lakko-i-ten													
1a.	lák.kòi.den	*				**		*				1	
1b.	lá.kòi.den	*				**				*		1	*
1c.	lák.kò.jen	*				**					*	1	
1d.	lá.kò.jen	*				**				*	*	1	*
1e.	lák.koi.den					*			*				
1f.	lá.koi.den					*			*	*			*
1g. ☞	lák.ko.jen					*					*		
1h.	lá.ko.jen					*				*	*		*
Input: almanákka-i-ten													
2a.	ál.ma.nàk.koi.den					**			*			2	
2b.	ál.ma.nà.koi.den					**			*	*		2	*
2c. ☞	ál.ma.nàk.ko.jen					**					*	2	
2d.	ál.ma.nà.ko.jen					**				*	*	2	*
2e.	ál.ma.nàk.kòi.den	*				***		*				2,3	
2f.	ál.ma.nà.kòi.den	*				***				*		2,3	*
2g.	ál.ma.nàk.kò.jen	*				***				*	*	2,3	
2h.	ál.ma.nà.kò.jen	*				***				**	*	2,3	*
2i.	ál.ma.nak.koi.den			*		*	*	*	*				
2j.	ál.ma.na.koi.den			*		*	*	*	*				*
2k.	ál.ma.nak.ko.jen			*		*	*	*			*		
2l.	ál.ma.na.ko.jen			*		*	*	*			*		*
2m.	ál.ma.nak.kòi.den			*		**		*				3	
2n.	ál.ma.na.kòi.den			*		**						3	*
2o.	ál.ma.nak.kò.jen			*		**				*	*	3	
2p.	ál.ma.na.kò.jen			*		**				*	*	3	*
2q.	al.ma.nák.ko.jen		*			**					*	2	
2r.	ál.ma.nák.ko.jen				*	**					*	2	

In this case, the opposite ranking ***LAPSE** ≫ ***STRESS** would yield the same result. In other word types, the ranking of these constraints makes a difference, as the next tableaux show.

(52) Derivation of *mellakkojen* ‘riots’ (Gen.Pl.) and *Amerikkojen* ‘Americas’ (Gen.Pl.) under the ranking ***STRESS** ≫ ***LAPSE**:

Stem-level	*CLASH	ALIGN-L	MAX-STRESS	UNI-PK	***STRESS**	***LAPSE**	CONSGRAD	STOPDEL	STR-TO-WT	MAX-SEG	ALL-FT-L	MAX-Cμ
Input: mellakka-i-ten												
3a. mél.lak.kòi.den					**		*				2	
3b. mél.la.kòi.den					**						2	*
3c. mél.lak.kò.jen					**				*	*	2	
3d. mél.la.kò.jen					**				*	*	2	*
3e. mél.lak.koi.den					*	*		*				
3f. mél.la.koi.den					*	*		*				*
3g. ☞ mél.lak.ko.jen					*	*				*		
3h. mél.la.ko.jen					*	*				*		*
Input: amerikka-i-ten												
4a. á.me.rik.kòi.den					**		*		*		3	
4b. á.me.ri.kòi.den					**				*		3	*
4c. á.me.rìk.koi.den					**			*	*		2	
4d. á.me.rì.koi.den					**			*	**		2	*
4e. á.me.rìk.ko.jen					**				*	*	2	
4f. á.me.rì.ko.jen					**				**	*	2	*
4g. á.me.rik.kò.jen					**				**		3	
4h. á.me.ri.kò.jen					**				**	*	3	*
4i. á.me.rik.koi.den					*	*		*	*			
4j. á.me.ri.koi.den					*	*		*	*			*
4k. ☞ á.me.rik.ko.jen					*	*			*	*		
4l. á.me.ri.ko.jen					*	*			*	*		*

(53) Derivation of *mellakoiden* ‘riots’ (Gen.Pl.) and *Amerikoiden* ‘Americas’ (Gen.Pl.) under the ranking ***LAPSE** ≫ ***STRESS**:

Stem-level		*CLASH	ALIGN-L	MAX-STRESS	UNI-PK	***LAPSE**	***STRESS**	CONSGRAD	STOPDEL	STR-TO-WT	MAX-SEG	ALL-FT-L	MAX-Cμ
Input: mellakka-i-ten													
3a.	mél.lak.kòi.den						**	*				2	
3b. ☞	mél.la.kòi.den						**					2	*
3c.	mél.lak.kò.jen						**			*	*	2	
3d.	mél.la.kò.jen						**			*	*	2	*
3e.	mél.lak.koi.den					*	*		*				
3f.	mél.la.koi.den					*	*		*				*
3g.	mél.lak.ko.jen					*	*				*		
3h.	mél.la.ko.jen					*	*				*		*
Input: amerikka-i-ten													
4a.	á.me.rik.kòi.den						**	*		*		3	
4b. ☞	á.me.ri.kòi.den						**			*		3	*
4c.	á.me.rìk.koi.den						**		*	*		2	
4d.	á.me.rì.koi.den						**		*	**		2	*
4e.	á.me.rìk.ko.jen						**			*	*	2	
4f.	á.me.rì.ko.jen						**			**	*	2	*
4g.	á.me.rik.kò.jen						**			**		3	
4h.	á.me.ri.kò.jen						**			**	*	3	*
4i.	á.me.rik.koi.den					*	*		*	**			
4j.	á.me.ri.koi.den					*	*		*	*			*
4k.	á.me.rik.ko.jen					*	*			*	*		
4l.	á.me.ri.ko.jen					*	*			*	*		*

Conclusion. The upshot is that the core alternations seen in Finnish inflection are governed by phonological constraints relating to stress and syllable structure. The data already show clearly that they are located specifically in the stem phonology, but in the next section I add two pieces of evidence that should remove any lingering doubt on this score. The first is that stem-level secondary stress conditions what is unquestionably an allomorphic alternation. The second is that it is sensitive to the morphological composition of the affected diphthong.

3.6 Morphological and lexical evidence

Stress-conditioned illative allomorphy. The illative case ending displays a distribution of allomorphs which independently confirms the above analysis of stress. There are two basic forms, the short form (the elsewhere allomorph), and the long form. The short form is /-hVn/, with a variant /-Vn/ due to phonological deletion of *h* after unstressed simple vowels. Chameleon-like, the short form's V always matches the color of the preceding vowel. The long form is /-sVVn/, where V matches a preceding /i/, else is /e/. This distribution is illustrated by the Illative Singular forms in (54).

(54) Short form of the Illative: *-hVn, -Vn*

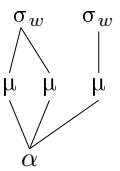
a. *maa-han* 'land', *puu-hun* 'tree', *tee-hen* 'tea', *tie-hen* 'road', *hai-hin* 'shark'
b. *mi-hin* 'into what', *tä-hän* 'into this'
c. *sama-an* 'same', *latu-un* 'ski trail', *talo-on* 'house', *salama-an* 'lightning', *ullakko-on* 'attic', *Amerikka-an* 'America'

The long form of the illative appears after "contracted stems", that is, stems whose output form ends in a long unstressed vowel, which as shown in 3.4 is a disyllabic sequence in the stem-level phonology. It has two morphologically conditioned allomorphs, /-seen/ in the singular and /-siin/ in the plural.

(55) Long form of the Illative: *-seen, -siin*

a. Sg. /-VV-seen/: *vapaaseen* 'free', *terveeseen* 'healthy', *palttooseen* 'overcoat'
b. Pl. /-VV-i-siin/: *vapaisiin* 'free', *terveisiin* 'healthy', *palttoisiin* 'overcoats'

In view of the stem-level disyllabicity of unstressed vowels, we can say that the long form is selected after two syllables which are affiliated with the same vowel melody, and the short form is selected elsewhere. Considering the fact that the short form's vowel is obligatorily affiliated with the stem's vowel melody, the basis of this distribution seems to be a constraint which prohibits the configuration

(56) 

where α is a feature complex defining a vowel. Whatever the formulation, the descriptive generalization is in any case not in doubt. It is independently motivated by the allomorphy of the third person possessive suffix. The suffix has two allomorphs, *-nsa* and *-(h)Vn*. In the latter, just as in the short form

of the illative, *h* is deleted except after primary stress, and *V* is a copy of the preceding vowel. The form *-nsa* occurs in all contexts, and *-(h)Vn* occurs as an optional variant after case endings ending in vowels, e.g. *talo-ssa-nsa* ∼ *talo-ssa-an* 'in his/her/their house' (but not after bare stems, e.g. *kissa-nsa*, **kissa-an* 'his/her/their cat'). The point of interest is that, just like the *-(h)Vn* allomorph of the illative, the *-(h)Vn* allomorph of the 3.Sg. possessive also does not appear after an unstressed long vowel (even if the second mora of the long vowel is a case ending). For example, the 3.Sg. possessive form of /tupa-ta/ *tupaa* can only be *tupaansa*, not **tupaahan* or **tupaaan*. This is another instantiation of the constraint (56).

Moreover, the distribution of the long and short forms of the illative is sensitive to a stylistic vowel contraction process, exemplified by the free variants in (57a) (Anttila 1999). As (57b) shows, case allomorphy obligatorily depends on the stem's output form.

(57) a. *kor.ke.a* (three syllables) ∼ *kor.kee* (two syllables) 'high', *le.ve.ä* ∼ *le.vee* 'broad' (Nom.Sg.)
b. *kor.ke.a-an* ∼ *kor.kee.-seen* 'high', *le.ve.ä-än* ∼ *le.vee.-seen* 'broad' (Ill.Sg.)

The Illative Plural. After diphthongs formed by the combination of stem-final vowels with plural *-i*, the distribution of *-hin* and *-siin* is reveals the effect of optional rhythmic stress in the stem phonology. After stressed diphthongs and after short unstressed diphthongs, the form *-hin* is obligatory (see (58a,b)). But after long diphthongs, /-siin/ and /-hin/ are both possible (see (58c)).

(58) Illative plurals:
a. /CVV-i-/: /puu-i-hin/ *puihin* 'trees', /tie-i-hin/ *teihin* 'roads', /tee-i-hin/ *teihin* 'teas', /hai-i-hin/ *haihin* 'sharks'
b. /-CV-i-/: /tapa-i-hin/ *tapoihin* 'customs', similarly *latuihin* 'ski trails', *taloihin* 'houses', *korjaamoihin* 'repair shops'
c. /-VV-i-/: /vapaa-i-hin/ ∼ /vapaa-i-siin/ *vapaihin* ∼ *vapaisiin* 'free', similarly *terveihin* ∼ *terveisiin* 'healthy', *palttoihin* ∼ *palttoisiin* 'overcoats' (contracted -VV stems)

The pattern in (58) is exactly what is predicted by our proposal about secondary stress. Consider *vapaaseen* and its plural variants *vapaihin* ∼ *vapaisiin*. Underlying /vapaa/ receives initial stress; /-paa/ cannot be a stressed syllable because of *CLASH, and it cannot be an unstressed syllable because of WEIGHT-TO-STRESS. So it must be two syllables, both of them unstressed by STRESS-TO-WEIGHT (see (46)), the former also by *CLASH. Thus the output of the stem phonology is *vá.pa.a*. This is an instance of the context that requires the long illative /-sVVn/. The respective nominative and illative

singular forms surface in the word phonology as *vá.paa*, *vá.paa.seen*.

In the plural, the affix /-i/ combines with the third syllable of the stem *vá.pa.a-* into a diphthong *-ai-*, which according to the constraint system developed above receives optional secondary stress in the stem phonology. the resulting plural stem is either *vá.pa.ai-* (CV́.CV.V-, a context requiring the long illative) or *vá.pa.ài-* (CV́.CV.V̀V-, a context requiring the short illative). The respective illative plural output forms are *vá.pai.siin* and *vá.pai.hin*.

The data in (59) epitomize the illative pattern discussed in the preceding paragraphs with the Illatives of *vapaa* 'free', *raitis* 'sober', and *maa* 'land'.

(59)		Illative Singular		Illative Plural	
	a.	**vapaahan*	*vapaaseen*	*vapaihin*	*vapaisiin*
	b.	**raittiihin*	*raittiiseen*	*raittiihin*	*raittiisiin*
	a.	*maahan*	**maaseen*	*maihin*	**maisiin*

Inherently heavy nuclei. Certain stems ending in unstressed long vowels or diphthongs, mostly non-native, behave like stems ending in stressed long vowels or diphthongs. The data in (60) demonstrate their behavior with respect to illative allomorphy. The stems *rokokoo* 'rococo', *revyy* 'revue', and *blinii* 'pancake' in (60a,b,c)) show this pattern obligatorily, and the stems *kamee* 'cameo', *veesee* 'toilet', and *suklaa* 'chocolate' in in (60d,e,f) show it optionally.

(60)		Illative Singular		Illative Plural	
	a.	*rokokoohon*	**rokokooseen*	*rokokoihin*	**rokokoisiin*
	b.	*revyyhyn*	**revyyseen*	*revyihin*	**revyisiin*
	c.	*bliniihin*	**bliniiseen*	*bliniihin*	**bliniisiin*
	d.	*kameehen*	*kameeseen*	*kameihin*	*kameisiin*
	e.	*veeseehen*	*veeseeseen*	*veeseihin*	*veeseisiin*
	f.	*suklaahan*	*suklaaseen*	*suklaihin*	*suklaisiin*

The stems *Tokoi* (name), *Petroskoi* 'Petrozavodsk', *samurai* 'samurai', *lauantai* 'Saturday', and *maumau* 'maumau' in (61) show that stem-final underlying diphthongs behave consistently like heavy syllables.

(61)		Partitive Singular		Genitive Plural	
	a.	*Tokoita*	**Tokoja*	*Tokoiden*	**Tokojen*
	b.	*Petroskoita*	**Petroskoja*	*Petroskoiden*	**Petroskojen*
	c.	*samuraita*	**samuraja*	*samuraiden*	**samurajen*
	d.	*lauantaita*	**lauantaja*	*lauantaiden*	**lauantajen*
	e	*maumauta*	**maumaua*	**maumauiden*	**maumaujen*[21]

[21]For phonological reasons, stems that end in a -Vu diphthong, such as (61e), have no plural forms at all. This is the case even if the diphthong is stressed; for example, there is no such form as **tiuissa* for the Inessive Plural of *tiu* 'a collection of 20'.

Such word-final long vowels and diphthongs must be lexically marked as bimoraic, either directly, or indirectly by a lexical stress.[22]

Invariant short diphthongs. In verb inflection, diphthongs always count as short nuclei, triggering Consonant Gradation only when the syllable is closed by a consonant.

(62)	a. /suuttu-i-mme/	*suutuimme*	'we got angry'
	b. /suuttu-i-vat/	*suuttuivat*	'(they) got angry'
	c. /katu-i-mme/	*kaduimme*	'we repented'
	d. /katu-i-vat/	*katuivat*	'(they) repented'
	e. /ase-ttu-i-mme/	*asetuimme*	'we placed ourselves'
	f. /ase-ttu-i-vat/	*asettuivat*	'(they) placed themselves'
	g. /rankaise-ta/	*rangaista*	'to punish'
	h. /rankaise-vat/	*rankaisevat*	'(they) punish'

The past tense ending *-i* thus differs from the homonymous plural ending in being obligatorily nonmoraic.

4 Variation: trends and preferences

4.1 The trend to word-level rhythmic stress

One of the most remarkable aspects of the variation in Finnish noun inflection is the fine-grained pattern of preferences among the options, first explored by Itkonen 1957, and analyzed in greater depth in OT terms on the basis of massive corpus data by Anttila 1997. The preferences depend on several factors, including the height of the stem-final vowel, the place of articulation of the preceding consonant, and, most of all, the penult's weight. These preferences interact with a global trend that cuts across all categories, which disfavors stem-level assignment of rhythmic stress. That is, the "conflation" system is gaining ground in the stem phonology.

The shift away from stem-level rhythmic stress is manifest in a historical drift of the preferences among the variant plurals. In Standard Finnish usage, this drift has been uniform at least over the last century or so (Itkonen 1957, Paunonen 1974a, 1974b).

[22] Positing a lexical stress on a disyllable such as *Tokoi* (a surname) would of course require the ranking MAXSTRESS ≫ *CLASH in the stem-level constraint system. This ranking would also allow a straightforward treatment of a strange group of loanwords which have primary stress on the second syllable in the donor language (usually Swedish) and behave as though they had a latent lexical accent on the that syllable. This is shown (among other things) in that they occasionally initiate a harmonic domain in the second syllable (see p. 114 for the relation of harmony and lexical stress). For example, in addition to the expected Prt.Pl. *kónfliktèja* 'conflicts', the SK corpus also attests *?kónfliktèjä*.

(63)			Innovating type	Older type	
	a.	Prt.Pl.	*kórjaamòja*	*kórjaamòita*	‘repair shops’
	b.	Gen.Pl.	*kórjaamòjen*	*kórjaamòiden*	‘repair shops’
	c.	Ess.Pl.	*méllakkòina*	*méllakòina*	‘riots’
	d.	Short Ill.Pl.	*méllakkòihin*	*méllakòihin*	‘riots’
	e.	Long Ill.Pl.	*vápaisiin*	*vápaihin*	‘free’

The innovating forms are those that, according to the analysis proposed here, are derived when rhythmic stress is deferred to the word phonology. Thus, the unifying theme behind (63a-e) is that the ranking *STRESS ≫ *LAPSE is gaining ground at the stem level. As rhythmic stress gradually becomes a purely word-level phenomenon, it ceases to interact with morphophonology and allomorphy. My interpretation of the change differs fom the traditional view, according to which the drift in (63) is heterogeneous. That view holds that (63a-d) originate in interparadigmatic analogy which transfers the inflection of disyllabic stems to polysyllabic stems (e.g. Prt.Pl. *méllakkòja* on the analogy of Prt.Pl. *lákkoja*), whereas (63e) originates in *intraparadigmatic* analogy which transfers the singular inflection to the plural (e.g. Ill.Pl. *vá.pai.siin* on the analogy of Ill.Sg. *vá.paa.seen*). Our analysis provides a welcome unification of these changes as effects of the loss of stem-level rhythmic stress. If our interpretation of the historical change is correct, it adds a measure of support for the synchronic analysis, and with it for stratal OT.

The next question is *why* the changes go in this direction, and not in the other. An answer will be proposed in section 5.

4.2 The preference for alternating weight

(63) is about a trend, not about a preference. Although many instances of the expanding types in (63) are more frequent than their recessive counterparts in the modern language, by no means all of them are. But all of them have been steadily gaining favor in modern literary usage. The actual frequencies of particular instances of the expanding and receding types in discourse varies widely depending on the other factors. One of these factors is the weight of the second syllable, just as in the longer words we discussed earlier in section 2.2.

In trisyllabic stems, when the penult is light, the diphthong formed by the stem-final vowel with plural *i* is usually treated as bimoraic, i.e. as bearing a stem-level stress according to our analysis.[23] That is, it represents the option

[23]When the onset of the third syllable is a single consonant, it is usually a sonorant, as the examples in (64a) show. This has to do with Finnish morpheme structure (a reflex of the process we are referring to as Stop Deletion, in fact). The rare stems with obstruents in this position, represented by *judoka* ‘judoka’ in the sample, pattern the same way in their inflection. A native word of this type would be *heteka* ‘a type of bed with a frame of tubular steel’ would also have the preferred partitive plural *hetekoita* rather than ?*hetekoja*.

whereby rhythmic stress may be assigned at the stem level. In (64a) I substantiate this claim with a list of the partitive plurals of such stems that I was able to extract from the *Suomen Kuvalehti* corpus (fn. 5). The incidence of Stop Deletion shows whether stress is assigned.

(64) XLL trisyllabic stems:

a. Stem-level rhythmic stress (bimoraic syllabification, no Stop Deletion):
akanoita ansioita anturoita apinoita asioita askeleita astioita aukioita avaroita bageleita brokereita dealereita dekkareita demareita dollareita duunareita enkeleitä förareita faveloita fictioneita funktioita gangstereita hamstereita henkseleitä heteroita himmeleitä hokkareita hummereita huviloita ideoita ikkunoita jääkäreitä jännäreitä judokoita julmureita jumppareita kaapeleita kaappareita kaloreita kameleita kappeleita kapseleita kavereita keisareita kiikareita kikujuita kiskureita kondareita konkareita konttoreita kortteleita lääkäreitä makkaroita manteleita markkinoita meisseleitä mestareita mongoleita moottoreita muskeleita muusikoita neekereitä olioita oscareita palsameita panssareita papereita penikoita pettureita pilareita pillereitä porkkanoita porvareita puhveleita ryaneita sektoreita sipuleita tarinoita titteleitä tohveleita tovereita voimaloita

b. Word-level rhythmic stress (monomoraic syllabification, Stop Deletion):
aplodeja arabeja arkadeja atomeja diplomeja dylaneja fasadeja gallupeja graffiteja idoleja kondomeja metodeja muslimeja neuroneja preludeja tamileja

c. Variation:
arveluita∼arveluja kollegoja∼kollegoita mitaleja∼mitaleita palveluita∼palveluja sopuleja∼sopuleita symboleja∼symboleita

The preference for the weak stem is actually even stronger than it appears, for in many of the words in (64c) and in a few of the words in (64b) the light penult may be only apparent. They are often pronounced with long vowels, and used to be so spelled (and still sometimes are, though this is considered incorrect now).[24] So pronounced, these words really belong in the XHL stems in (65.) Nevertheless, the monomoraic treatment is always a live option for XLL stems, and in a few subtypes perhaps even preferred (for example,

[24]Examples of such variant pronunciations and spellings of the words in (64b,c) are e.g. *aploodeja, arkaadeja, diploomeja, idooleja, kolleegoja, metoodeja, neurooneja, symbooleja.* Also, a word like *gallupeja* 'gallups' (Prt.Pl.) would typically be pronounced with a geminate [pp].

palveluja ‘services’ seems to be at least as good as *palveluita*).

In stems with an underlying *heavy* penult, however, the monomoraic forms are regularly preferred. For example, a form like *arkistoja* ‘archives’ is preferred to *arkistoita*, and *kranaatteja* ‘grenades’ is strongly preferred to *kranaateita*. The following data comes from the same corpus as before.

(65) XHL trisyllabic stems:

a. Stem-Level rhythmic stress (bimoraic syllabification, no Stop Deletion):
armeijoita maneereita mysteereitä turbiineita

b. Word-Level rhythmic stress (monomoraic syllabification, Stop Deletion):
abortteja abstrakteja absurdeja adresseja agentteja aktiiveja akuutteja arkistoja artisteja aspekteja asuntoja atleetteja aurinkoja banaaneja barrancoja brosyyrejä bulvaaneja desanteja duelleja efektejä eksakteja esansseja experttejä fasisteja fossiileja futuureja galakseja haupitseja hotelleja humaaneja immuuneja infarkteja instansseja intiaaneja jonglöörejä jumperseja juristeja kanaaleja kanootteja kapriiseja kapteeneja katiskoja kaupunkeja kemistejä keraameja kersantteja kirjastoja kirurgeja kolumneja kommentteja kompasseja kompleksеja konfliktejä konflikteja kongresseja konsertteja konsultteja kontakteja korrekteja kranaatteja kristalleja kritiikkejä kuponkeja meriittejä normaaleja paraateja pistooleja poliiseja reliikkejä reliktejä reseptejä sellistejä spontaaneja tekniikoita triviaaleja tulppaaneja urbaaneja vahinkoja vokaaleja

c. Variation:
bakteereja∼bakteereita hehtaareja∼hehtaareita kenraaleja∼ kenraaleita kulttuureja∼ kulttuureita kivääreјä∼kivääreitä kokeiluita∼kokeiluja kriteerejä∼kriteereitä romaaneja∼romaaneita signaaleja ∼signaaleita upseereja∼upseereita

The preference for monomoraic treatment after heavy penults, reflecting the absence of rhythmic stress in the stem phonology, is quite strong. Yet the disfavored variants, again, are unquestionably grammatical.

This usage profile reveals a preference for *weight dissimilation*: two successive light syllables and two successive heavy syllables are avoided, and a light-heavy and heavy-light alternation is preferred. For example, compare the words *logiikka* ‘logic’ and *heteka* ‘a type of bed’. In the partitive plural, *logiikkoja* (-HL-) is favored over *logiikoita* (-HH-), and *hetekoita* (-LH-) is favored over *hetekoja* (-LL-). Anttila 1997 provides an OT analysis of these effects using constraints that impose alternating weight on adjacent syllables (*HH, *LL). I adopt this idea provisionally here, although it may need to be

reformulated as a direct weight-stress relation in the light of the patterning of the lexical stress in longer words (section 2.2).

4.3 The preference for word-level rhythmic stress

The data in (64) and (65) show that adjacent syllables preferably have alternating weight (weight dissimilation). The data summarized in (63) suggests a historical trend towards word-level rhythmic stress. To test whether this trend also corresponds to a synchronic preference, we can isolate cases where weight dissimilation is not at stake.

The test cases we need are those where the diphthong is preceded by a geminate stop. The bimoraic treatment resulting from stem-level assignment of rhythmic stress entails Consonant Gradation, with an output that satisfies the weight alternation just as well as the monomoraic treatment resulting from word-level assignment of rhythmic stress. Consider the word *loogikko* 'logician'. In the partitive plural, the choice is between *loogikkoja* (-HL-, monomoraic) and *loogikoita* (-LH-, bimoraic), with an equally favored quantitative pattern. Similarly in the genitive plural, e.g. *mellakkojen* and *mellakoiden* 'riots'. Here, where the preference for weight alternation is neutralized, other preferences should decide the issue. If avoidance of stem-level rhythmic stress is a preference, it should manifest itself here. The expectation is that the bimoraic type *loogikoita* should be disfavored, and the monomoraic type *loogikkoja*, with rhythmic stress deferred to the word level, should be preferred. The corpus data show that this is the case. The frequency profile of the trisyllabic stems in /-kkV, -ttV/ shown in (66) is similar to that of (65), not to that of (64), although, as expected, the trend is not quite so strong.

(66) a. *allakoita dirikoita graafikoita penikoita teknikoita*
b. *aavikkoja ammatteja budjetteja ennakkoja hamletteja harvikkoja kadetteja kajakkeja kasetteja kasvatteja kulakkeja lemmikkejä otsikkoja paketteja poletteja taktikkoja whipettejä*
c. *fyysikkoja∼fyysikoita klassikkoja∼klassikoita muusikoita∼muusikkoja*

Forms in /-ppV/, though accidentally missing in the corpus, conform to the generalization. For example, *sinappeja* 'mustards', *anoppeja* 'mothers-in-law' are preferred to *sinapeita*, *anopeita*. These findings are summarized in (67), where the preferred variants are boldfaced.

(67) a. /paperi/ ***pá.pe.rèi.ta*** (-LH-) *pá.pe.rè.ja* (-LL-) 'paper'
b. /raketti/ *rá.ke.tèi.ta* (-LH-) ***rá.ket.tè.ja*** (-HL-) 'rocket'
c. /trapetsi/?**trá.pet.sèi.ta* (-HH-) ***trá.pet.sè.ja*** (-HL-) 'trapeze'

The variation is generated by the subsystem of constraints that includes (at least) Anttila's *HH and *LL (weight dissimilation), *STRESS (conflation),

and *LAPSE. The ranking shown below is one which generates the favored variants in (67).

(68)

Stem Level	*HH	*LL	*LAPSE	*STRESS
Input: /paperi-i-ta/				
1a. ☞ pá.pe.rèi.ta		*		*
1b. pá.pe.re.ja		**	*	
Input: /raketti-i-ta/				
2a. rá.ke.tèi.ta		*		*
2b. ☞ rá.ket.te.ja		*	*	
Input: /trapetsi-i-ta/				
3a. trá.pet.sèi.ta	*			*
3b. ☞ trá.pet.se.ja		*	*	

Other rankings deliver the rest of the options, in proportion to their observed frequency of occurrence. We know already from (51)–(53) that the ranking of *STRESS and *LAPSE is free. The desired profile of variation emerges on the assumption that *all* the rankings are free, excepting only that *HH dominates *LL. This leaves 12 constraint rankings out of the possible total of 24. A third of them favor *papereja*, half of them favor *raketteja*, and three quarters favor *trapetseja*. Namely:

- *papereja* is the optimal output if *STRESS $\gg$ *LL and *LAPSE (four rankings)
- *raketteja* is the optimal output if *STRESS $\gg$ *LAPSE (six rankings)
- *trapetseja* is the optimal output if *STRESS or *HH $\gg$ *LAPSE (nine rankings).

Assuming all rankings are equiprobable, this corresponds to the observed relative frequency of the three types, in line with Anttila's theory of variation.

Note that in the stratal OT model, as in parallel OT, the pattern in (66) cannot simply be assimilated to the pattern in (65) on the basis of its *underlying* geminate (cf. Anttila 1997:18, fn. 9). Once a stem suffixed with plural *-i* undergoes Consonant Gradation, the underlying geminate is no longer visible when secondary stress is assigned on subsequent cycles, and cannot be recovered.

Conclusion: the opacity of stress-conditioned processes. Because the two kinds of secondary stress, lexical and rhythmic, differ so radically in their phonological and morphological effects, opacity is rampant in Finnish phonology. Movable polysyllables, though lacking lexical stress, do bear an obligatory secondary stress phonetically: as detailed above, all words of more than three syllables in Finnish have, in addition to their initial primary stress, a secondary stress on their third syllable (or, by the LH̀ effect, on their fourth

if it is heavy and the third is light).[25] In the output, the rhythmic secondary stresses motivated by *LAPSE are not audibly different from the lexical secondary stresses.[26] Moreover, both kinds of secondary stresses, rhythmic and lexical, count in metrical verse. The following pentameter line contains an example of a rhythmic secondary stress in metrical strong position:

(69) s s s s s
himmein ruusuin, enkelien siivin 'with translucent roses, on angels' wings'
(Saima Harmaja, *Tähti*)

The third syllable of *én.ke.lì.en* 'angels' (Gen.Pl.) is lexically unstressed. Being unstressed, it reduces to *-i-* (see below), and triggers Stop Deletion in the following ending /-ten/. (The option of assigning stress st the stem level gives the variant *én.ke.lèi.den*.) Nevertheless, it occupies a strong position in the cited verse, and such positions are reserved for stressed syllables in Finnish (Kiparsky and Hanson 1996). This an important datum because Finnish versification is, in general, a highly reliable indicator of stress.

5 The stem constraint

Now let's return to the question why the options reflecting the monomoraic treatment of diphthongs are spreading historically. I propose that this is because they comply with a general constraint that stems must end in -V, which I call the STEM CONSTRAINT.

Finnish *words* can end either in a vowel, or in a coronal consonant:

(70) *avaime-n* 'of the key', *avaime-t* 'the keys', *alas* 'down', *kuin* 'as, like', *mars!* 'go!'.

Stems, however, must end in a vowel at the point of affixation. Before an affix (including the zero case affix), stem-final *-e* is deleted subject to metrical and syllabic constraints. To a first approximation, the descriptive generalization is that *-e* is deleted when the stem is polysyllabic and the preceding consonants form a permissible coda, or can be reduced to one (Keyser & Kiparsky 1984). These restrictions are seen in (71b).[27]

(71) a. /olute-ta/ *olutta* 'beer', /hampase-ta/ *hammasta* 'tooth', /avaime-ta/ *avainta* 'key' (Prt.Sg.), /tuhante/ *tuhat* '1000', /varikse/ *varis* 'crow' (Nom.Sg.).

[25] With the proviso that in final position, light syllables cannot be stressed at all, and the stress on heavy syllables is optional, as mentioned above.

[26] At least to my ear. Experimental work on this question would be welcome.

[27] Any vowel is however subject to deletion in word-internal hiatus: /rinta-ukse/ *rinnus* 'lapel', /korkea-uinen/ *korkuinen* 'high', /isä-uute/ *isyys* 'fatherhood'. Word-finally, /-e/ is raised to *-i*.

b. /siipe-tä/ *siipeä* ‘wing’, /suve-ta/ *suvea* ‘summer’, /kive/ *kivi* ‘stone’, /sorme/ *sormi* ‘finger’ (*e*-deletion would produce impossible clusters), /vete-tä/ *vettä* ‘water’ (Prt.Sg.), but /vete/ *vesi* ‘water’ (**vet* is prosodically subminimal), /ikkuna-ta/ *ikkunaa* ‘window’ (Prt. Sg.), *leikkisä* ‘playful’ (Nom.Sg.) (only *-e* is freely deleted).

I assume that Strict Layering forces recursive prosodic integration of stem-level affixes:

(72) $[\,[\,X\,]_\alpha\ Af\,]_\alpha \rightarrow [\,X + Af\,]_\alpha$

For example, affixing /-ta/ to the stem $[avaime]_\alpha$ yields a new stem, which can undergo *-e* deletion without violating the Stem Constraint, e.g. $[avainta]_\alpha$.

Function words (non-inflected words in general) can end in -C, but if they are monosyllabic they must be heavy in deference to prosodic minimality:[28]

(73) /joss/ *jos* ‘if’, *taas* ‘again’, /kunn/ *kun* ‘when’, *vain* ‘only’, /nytt/ *nyt* ‘now’

Casual (and poetic) speech allows apocope of other vowels, especially in suffixes. This process too respects the coda constraints just mentioned; contrast (74a) and (74b):[29]

(74) a. *olisi* → *olis*, *ois* ‘would be’, *parissa* → *paris* ‘in the company of’, *sulta* → *sult* ‘from you’, *onkos* → *onks* ‘is?’
b. *onko* ↛ **onk* ‘is?’, *oliko* ↛ **olik* ‘was?’, *olipa* ↛ **olip* ‘was!’

Borrowed words adopt to the Stem Constraint by epenthesis. Interestingly, the epenthetic vowel is usually *-i*, not the deleting vowel *-e* which might have been expected to be the most unmarked element of the language.

(75) Swedish *proféssor* > *professori*, *biff* > *pihvi* ‘steak’, *rom* [romm] > *rommi* ‘rum’, *kurs* [kɵrss] > *kurssi* ‘course’, Russian *car’* > *tsaari* ‘czar’, *kon’* > *koni* ‘nag’, English *gin* > *gini* [tsini], *broiler* > *broileri* ‘small chicken’, *club* > *klubi*.

The data in (76) show that epenthesis is driven by the productive *stem-level* constraint that stems must end in -V. They demonstrate in particular that epenthesis takes place even in the same phonological contexts where -V is subject to deletion at the word level in casual speech.[30]

[28] The underlying geminate is audible before a following vowel within the same phonological phrase, as in [joss-on] ‘if is’, [kunn-ei] ‘when not’, [nytt-on] ‘now is’.

[29] I owe this observation to Daniel Karvonen.

[30] Short words like *gini* always get epenthetic *i*, obviously for the sake of satisfying prosodic minimality. In longer words, epenthesis seems to occur after CVVC- and CVVC- syllables, whose weight reflects Swedish stress. E.g. *karuselli* (Swedish [karuśell]), *pistooli* (Swedish [pisťu:l]), but e.g. *bisnes*, *tennis*, Heinonen 1994, Anttila, p.c.

(76) a. Swedish *polis* > *poliisi*, but (casual speech) *olisi* → *olis* 'were'
b. *Paris* > *Pariisi*, but (casual speech) *parissa* → *paris* 'in the company of'

This is straightforwardly understandable as the activation of stem-level and word-level constraints with contradictory import in the overlapping domain. It is, however, incomprehensible on the view that the word is the minimal unit to which phonological constraints apply.

Allomorphy. Finnish assimilates loans to conform to the Stem Constraint by inserting a stem-final *-i* before overt case endings.

(77) a. Nom.Sg. *nailon* 'nylon' (or *nailoni*)
b. Gen.Sg. *nailoni-n*, Iness.Sg. *nailoni-ssa*, Prt.Sg. *nailoni-a (*nailon-ta*, contrast *laidun-ta)*

Since there is no general *i*-epenthesis or *i*-deletion process in Finnish, the alternation in (77) is perhaps best treated as allomorphy between an uninflectable -C stem which preserves the donor language's word form, and an inflectable -V stem which is adapted so as to conform to the Stem Constraint.

These data refute the "naive" theory that loanword adaptation is just a response to the borrowing language's word phonology. They show that (in inflected languages at least) constraints on stem phonology can also play a role.

The padding strategy. Another fact confirms this understanding of loanword adaptation. Intervocalic /s/ is subject to deletion between unstressed vowels in Finnish (cf. the *t*-Deletion process presented in 4), e.g. Gen.Sg. /kirvese-n/ *kirveen* 'axe' (cf. Nom.Sg. /kirvese/ *kirves*). In order to to satisfy the constraint that stems must end in vowels, while at the same time defeating *s*-deletion, loans in *-s* are usually borrowed with underlying /-kse/. This maintains the *s* throughout the declension while yet assimilating the lexeme to a regular inflectional pattern of the language.

(78) *kaktus* > /kaktukse/ Nom. *kaktus*, Gen. *kaktukse-n*.

If loanwords were simply modified in the minimal possible way to conform to the output shapes of Finnish words, the appearance of this /k/ would be inexplicable. One would expect something like Nom.Sg. *kaktus*, Gen.Sg. **kaktuun*, **kaktusen*, or **kaktusin*.

Thus the language goes to ingenious lengths to bring loans into line with the canonical requirements on stems without making their surface shapes too different from the foreign model. In view of these facts, there can be no question of a theory of loanword adaptation framed purely in terms of constraints on words per se. The properties of stems cannot be derived from properties of words but require a stem level subject to its own constraints.

The role of the Stem Constraint in Finnish morphophonology. The Stem Constraint, which requires stems to end in a vowel, plays an active role in the lexical phonology and morphology of Finnish. All stem-level suffixes, including case endings and the possessive suffixes in (79), require a vowel before them.

(79)

	Sg.	Pl.
1.	-ni	-mme
2.	-si	-nne
3.	-nsa, -Vn	

The possessive suffixes are attached to stems and make words. For example, in [[vete]$_\alpha$ mme]$_\omega$ *vete-mme* 'our water', the stem [vete]$_\alpha$ must obey the Stem Constraint and fails to undergo word-final *-e* to *-i* raising (**ves-imme*). And since [[vete]$_\alpha$ mme]$_\omega$ is a word, it does not undergo stem-level Consonant Gradation, which would give **vedemme*.[31] Note that this provides independent confirmation that case endings are stem-to-stem suffixes.

Since Finnish case endings can end both in vowels and in consonants, this is where push comes to shove. What happens when a possessive suffix is put after an inflected noun ending in -C? The violation of the Stem Constraint is avoided by a combination of three different methods, a CONSPIRACY.

(80)
a. *Phonological deletion.* Syllabic case endings (-CVC, -CVVC) lose their last consonant before possessive suffixes: (Ill. /-seen/ → *-see*, /-siin/ → *-sii*, /-hVn/ → *-hV*, Gen.Pl. /-t-ten/ → *-tte*, /-ten/) → *-de*.
b. *Morphological omission of the ending.* Structural case endings consisting of a consonant, namely Gen/Acc.Sg. /-n/ and Nom./-Acc.Pl. /-t/, are omitted before possessive suffixes. Instead, the possessive suffixes are added to the bare stem.
c. *Paradigmatic gap.* Lexical case endings consisting of a consonant, namely Instr. /-n/, simply take no possessive suffixes.

Phonological deletion. The first method is deletion of the final consonant of syllabic case endings before possessive suffixes. It is is illustrated in (81) with forms containing the illative ending *-seen* (sg.) and *-siin, hVn* (pl.) and the genitive plural ending *-den, -en, -tten* (underlying /ten/, /t-ten/).

[31] The assumption that Consonant Gradation applies at the stem level stem-level is justified by the fact that it is not fed by the word-level deletion process mentioned in (76), as in *oppisi* → *oppis* 'would learn'. This has consequences for the treatment of such alternations as *-kas* ∼ *-kkaa-*, which are perhaps best treated as syllabically conditioned allomorph selection.

(81)	a.	i.	/huonee-seen/	*huonee-seen*	‘room’ (Ill.Sg.)
		ii.	/huonee-seen-si/	*huonee-see-si*	‘your room’ (Ill.Sg.)
	b.	i.	/hattu-i-hin-si/	*hattu-i-hin*	‘hats’ (Ill.Pl.)
		ii.	/hattu-i-hin-si/	*hattu-i-hi-ni*	‘my hats’ (Ill.Pl.)
	c.	i.	/talo-i-ten-si/	*talo-j-en*	‘houses’ (G.Pl.)
		ii.	/talo-i-ten-si/	*talo-j-e-si*	‘your houses’ (G.Pl.)
	d.	i.	/saare-i-ten/	*saar-i-en*	‘islands’ (G.Pl.)
		ii.	/saare-i-ten-si/	*saarie-si*	‘your islands’ (G.Pl.)
	e.	i.	/peruna-i-ten/	*peruno-i-den*	‘potatoes’ (G.Pl.)
		ii.	/peruna-i-ten-si/	*peruno-i-de-si*	‘your potatoes’ (G.Pl.)
	f.	i.	/maa-i-ten/	*ma-i-den*	‘countries’ (G.Pl.)
		ii.	/maa-i-ten-mme/	*ma-i-de-mme*	‘our countries’ (G.Pl.)

The last two pairs are especially important in showing that the deletion of the suffix-final *-n* is phonological and that Consonant Gradation applies to the stem before the possessive suffixes are added. Consonant Gradation is a process that weakens medial onsets of closed syllables; in (81e,f) the underlying /t/ of the Genitive Plural ending is weakened to [d]. The Consonant Gradation in (81e) applies in a phonetically *open* syllable. Its closed syllable conditioning environment is met only prior to deletion of the final *-n* in *perunoi-den*. The reason Consonant Gradation takes place in this form in spite of the deletion of its triggering environment is, then, that it applies to the case-inflected form prior to the addition of the possessive suffix.

(82) /peruna-i-ten/ → (C.G.) *peruno-i-den* → (affixation, -C Deletion) *peruno-i-de-si*

The example (81f) *maide-mme* makes the same point in a less obvious way. Since possessive suffixes form words, they never trigger consonant gradation in their base, *even if they are of the form -CCV*. Contrast the effect on the boldfaced root consonant of the stem-level person/number endings in (83a,c) with that of the possessive suffixes (83b,d) (which are homonymous in the 1.Pl.).

(83)	a.	/ka**t**u-mme/	→	*ka**d**umme*	‘we regret’
	b.	/ka**t**u-mme/	→	*ka**t**umme*	‘our street(s), our street’s’
	c.	/sa**tt**u-tte/	→	*sa**t**utte*	‘you happen’
	d.	/ha**tt**u-nne/	→	*ha**tt**unne*	‘your hat(s), your hat’s’

Because possessive suffixes do not trigger Consonant Gradation, the gradation of /t/ to *d* in *maide-mme* cannot be due to the possessive suffix /-mme/. Rather, it must be due to the underlying /-n/ of the case ending /-ten/ which is deleted before /-mme/.

Omission of endings. The phonological deletion process just illustrated applies to syllabic case endings. A similar-looking but, on closer inspection, very different "deletion" before possessive suffixes applies to the set of structural case endings which consist of just a single consonant, namely Nom./Acc.Pl. *-t* and Gen./Acc.Sg. *-n*. In this case, the endings are simply not present: the possessive suffixes are added to the bare stem without a case ending. Unlike in (81), there is no Consonant Gradation in the stem, showing that there is not even a deleted consonantal ending in the base. For example, to Nom./Acc.Pl. *hatut-t* 'hats' the corresponds the possessive *hattu-ni* (not **hatuni*) 'my hats'. This is a *morphological* gap rather than phonological deletion. The base to which the possessive suffixes are added is specifically the vocalic *stem* form, and not the nominative singular form, for, as the data in (84f,i) show, the word-final raising of /-e/ to *i* that takes place in the nominative singular does *not* show up before possessive endings.

(84)	a.	/hattu-n/	*hatun*	/hattu-si/	*hattusi*	'(your) hat' (A./G.Sg.)
	b.	/hattu-t/	*hatut*	/hattu-si/	*hattusi*	'(your) hats' (N./A.Pl.)
	c.	/hattu/	*hattu*	/hattu-si/	*hattusi*	'(your) hats' (N.Sg.)
	d.	/kaikke-n/	*kaiken*	/kaikke-si/	*kaikkeni*	'(my) all' (A./G.Sg.)
	e.	/kaikke-t/	*kaiket*	/kaikke-ni/	*kaikkeni*	'(my) all' (N./A.Pl.)
	f.	/kaikke/	*kaikki*	/kaikke-ni/	*kaikkeni*	'(my) all' (N.Sg.)
	g.	/vete-n/	*veden*	/vete-nsä/	*vetensä*	'(his) water' (A./G.Sg.)
	h.	/vete-t/	*vedet*	/vete-nsä/	*vetensä*	'(his) waters' (N./A.Pl.)
	i.	/vete/	*vesi*	/vete-nsä/	*vetensä*	'(his) water' (N.Sg.)

A paradigmatic gap: the Instructive case. The sole lexical (adverbial) case whose suffix consists of a single consonant is the "Instructive" (instrumental) case. It is always formally plural, and an Instructive NP usually but not always denotes a plural entity. It functions as a VP adverbial of means or condition, always construed with the subject:

(85)	a.	*pitkin askelin*	'with long steps'
	b.	*hartain mielin*	'with devout mind'
	c.	*paljain päin*	'with head uncovered'
	d.	*seuraavin ehdoin*	'under the following conditions'
	e.	*monin suurin ponnistuksin*	'with many great exertions'

The Instructive case displays a third method of avoiding Stem Constraint violations: in the current language, words inflected in the instructive case reject possessive suffixes.

(86)	a.	/pitkä-i-n askele-i-n/	*pitkin askelin*	'with long steps'
	b.	/pitkä-i-n askele-i-n-si/	**pitkin askelisi*	'with your long steps'
	c.	/paljase-i-n pää-i-n-mme/	**paljain päimme*	'with our bare heads'

What fills in for this gap is the Comitative case, which ends in *-ne*, and which *only* occurs with possessive suffixes.

(87) a. *pitkine askelisi* 'with your long steps'
b. *hartaine mielinenne* 'with your attentive minds'
c. *paljaine päinemme* 'with our uncovered heads'
d. *seuraavine ehtoineen* 'with its following conditions'
e. *monine suurine ponnistuksineni* 'with my many great exertions'

The meaning of the Comitative partly overlaps with that of the Instructive.

(88) a. Matti juoks-i pitk-i-n askel-i-n
Matti-Nom run-Past(3Sg) long-Pl-Instr step-Pl-Instr
'Matti ran with long steps'
b. Matti juoks-i pitk-i-ne askel-i-ne-en
Matti-Nom run-Past(3Sg) long-Pl-Instr step-Pl-Instr-3Sg
'Matti ran with his long steps'

In fact, the Instructive and the Comitative are so similar in form and function and so nearly complementary in distribution that it is tempting to unify them into a single case.[32] However, there are two strong arguments in favor of the traditional case distinction between Instructive /-n/ and Comitative /-ne/. First, *-ne* cannot be a morphophonological or allomorphic variant of *-n*. It is true that *-ne* before a possessive suffix could be derived from /-n/ by *e*-epenthesis, but that is not true of bare *-ne* on modifiers (possessive suffixes are only added to the nominal head of a phrase). From underlying /-n/ we would derive (89b) instead of (89a).

(89) a. *kaikki-ne pieni-ne lapsi-ne-si* 'with all your little children'
b. **kaiki-n pieni-n lapsi-ne-si*

Thus, if we were to combine the Instructive and Comitative into a single case (call it the Instrumental), we would still have to recognize the ending as a third prong of the conspiracy to implement the Stem Constraint. Instead of saying that the Instructive is not used with possessive suffixes and the Comitative fills in for it, we would have to say either that the Instrumental ending /-n/ gets an epenthetic *-e* before a possessive suffix (rather than deleting, as the Genitive/Accusative ending /-n/ does), or alternatively that it has a separate allomorph /-ne/ before possessive suffixes. /poika-n-si/ → *poikasi* 'your son's' (Gen.Sg.), but /poika-i-n-si/ → *poikinesi* 'with your son(s)' (Instr.). Either way, the Instrumental has its own way of satisfying the stem constraint.

[32] This was suggested to me by Arto Anttila, and independently in a discussion with Heli Harrikari, Tarja Heinonen, and Marja Jäämeri at the 1997 Scandinavian Summer School in Phonology, where I presented the analysis in the text. (See now Harrikari, this volume, for a very different reanalysis of the phonology of possessive suffixes.) According to Ikola 1999, some early 19th century grammarians also considered combining the Instructive and Comitative cases.

The second argument for separating the Instructive and Comitative cases is that they are functionally distinct. While the Instructive is almost always subject-oriented, the Comitative can also refer to an accompaniment of the object (see (90a)). Also, the Instructive can attach to the 2nd infinitive to form the so-called modal construction, where it still rejects a possessive suffix(see (90b)). In this function it cannot be replaced by the Comitative.

(90) a. Nä-i-t minu-t laps-i-ne-ni (*laps-i-n).
see-Past-2Sg me-Acc child-Pl-Comit-3Sg (child-Pl-Instr)
'You saw me with my children'
b. Juoks-i-n laula-e-n (*laula-e-ne-ni).
run-Past-1Sg sing-2Inf-Instr (*sing-2Inf-Instr-1Sg)
'I ran singing.'

Therefore I think that the Finnish grammarians' separation of Instructive and Comitative into two cases is well founded.

Resolving the conspiracy. Returning to the Stem Constraint and its active role in the conspiracy, we now have two more puzzles to solve. First, the conspiracy problem: why is the Stem Constraint manifested in three different ways? Secondly, the problem of opaque, anti-cyclic ordering: why does -C-deletion before possessive suffixes bleed GC in (84) but not in (81)?

Let us assume that MAX and DEP constraints give privileged status to derivational morphology over inflectional morphology, and within inflectional morphology to inherent (adverbial) case over structural case. This exploits the idea that marked categories are richer in content than the corresponding unmarked categories. In the phonological domain, this increment of richness is characterizable in substantive terms at the articulatory and perceptual level. In the morphosyntactic domain, it is characterizable by the system of features and categories that classify words and affixes into types. The category hierarchy in (91) defines three types, in decreasing order of richness of content, and, by hypothesis, of markedness. Two of them exist in both free and bound form, the third only in bound form.

(91)

	free form	*bound form*
Major Cat's	N, V, A, P	derivational affixes, adverbial cases
Funct. Cat's	D, C, Infl	Tense, Mood, Def., Number, Poss.
Licensers	—	structural case, agreement

Armed with this notion of category markedness, we posit the following constraints.

(92) a. *-C]$_\alpha$ (the Stem Constraint): stems must end in -V.
b. MAX-MORPHEME: A morpheme must be phonologically expressed.

c. DEP-MARKEDCAT: A marked category (an adverbial case, in these data) must be morphologically expressed.
d. MAX-WORD: A word must be phonologically expressed.
e. DEP-CAT: A grammatical category must be morphologically expressed.

The inputs are pairs consisting of a morphological form and the most harmonic output form corresponding to it.

The following tableau shows how these constraints adjudicate among the different ways of satisfying the Stem Constraint. We consider three candidates in each case, representing respectively phonological deletion of the final -C, addition of the possessive to the bare endingless stem, and the morphological gap in the paradigm. Each of them is optimal in a different set of cases. The phonological constraints, and outputs violating them, are omitted here; they can be can be considered undominated. The morphological constraints decide between the different outputs that satisfy these phonological constraints. For clarity, I include also the input forms, based on the plural stem, respectively with and without case inflection, with the stem phonology in place.

(93)

			MAX-MORPHEME	DEP-MARKEDCAT	MAX-WORD	DEP-CAT
Gen.Pl. ☞	[maiden]$_\alpha$-mme	[maidemme]$_\omega$				
	[mai]$_\alpha$-mme	[maimme]$_\omega$				*
		∅			*	
Gen.Sg.	[veden]$_\alpha$-si	[vedesi]$_\omega$	*			
☞	[vete]$_\alpha$-si	[vetesi]$_\omega$				*
		∅			*	
Instr.Sg.	[vesin]$_\alpha$-mme	[vesimme]$_\omega$	*			
	[vesi]$_\alpha$-mme	[vesimme]$_\omega$		*		*
☞		∅			*	

In rare cases it is possible to coerce a possessive suffix onto an instructive-marked nominal (which formally corresponds to promoting MAX-WORD). The remaining constraints then tell us that the suffix must be added directly to the stem, as in the genitive. This yields the correct output, as attested in a few fixed expressions such as *omin lupinsa* 'without permission' (lit. 'with his/her own permission'). Crucially, the possessive form is built on the bare

plural stem /lupa-i-/ *lupi-*; adding it to the instructive /lupa-i-n/ *luvin* (as in the synonymous variant expression *omin luvin*, with the un-possessed noun) would predict **luvinsa*.[33]

Accounting for the direction of change. The Stem Constraint suggests a possible answer to the question why stem-level assignment of rhythmic stress is being phased out in Finnish. The stem-final bimoraic diphthongs required by secondary stress assignment clearly violate the constraint, and deferring secondary stress to the postlexical phonology makes it undominated (except for cases like *lauantai*, see (61)). *STRESS and *LAPSE are both opaque whichever way they are ranked, but the ranking *STRESS $\gg$ *LAPSE minimizes violations of the Stem Constraint. Suppose we assume that learners seek to maximize the transparency of constraints. Then there would be a bias in favor of this ranking, which would cause it to become increasingly favored over time.

6 Parallelist approaches

6.1 The options under parallelism

Could the inflectional patterns of Finnish nouns be accounted for under full parallelism? Four main types of solutions should be considered. One invokes analogical mechanisms that transfer properties from bases to derivatives (Output/Output constraints). Another type of analogical constraint penalizes allomorphy (e.g. Lexical Conservatism). A third approach invokes constraints that access underlying representations in one or another way (Sympathy, Extended Sympathy, Generalized Sympathy). A final alternative is to enrich output representations; Containment and Turbidity are the most important representatives of this approach. We shall consider them in turn.

Output/Output constraints. O/O constraints have the same format as other correspondence constraints, including I/O constraints. So, deriving the Finnish alternants by O/O constraints involves determining a base form from which one or more ranked O/O constraints transfer the relevant properties to the outputs. Also, the transfer has to be optional in specific contexts, which involves the complex interaction of phonological and morphological factors as explored above.

Let us consider the options. Given the two Essive Plural alternants *ullakkoina* and *ullakoina* ‘attics’, one is presumably derived directly by the phonological constraints, and the other by a a dominant DEP(O/O) constraint. If *ullakkoina* is the phonologically “regular” form, then *ullakoina*

[33]The example is from Penttilä 1963:122; Penttilä 1963:439 also cites two other, archaic, examples of instructives with possessive suffixes: *kaikin voimini* ‘with all my powers’ and *kaksin kämmenini* ‘with my two hands’.

must be an "analogical" form due to a dominant DEP(O/O) constraint that refers to some degeminated Base, such as Nom.Pl. *ullakot*.[34] On the other hand, if *ullakoina* is derived directly by the phonological constraints, then *ullakkoina* must be an "analogical" form due to a dominant MAX(O/O) constraint that refers to some geminated Base, such as Ess.Sg. *ullakkona* or Nom.Sg. *ullakko*.[35]

An immediate observation to be made about these options is that *neither* of them corresponds to the historical analogical process, which uncontroversially shows the influence of the disyllabic paradigm on the polysyllabic paradigm (Itkonen 1957). The actual change thus involved interparadigmatic rather than intraparadigmatic analogy, which neither O/O nor anti-allomorphy approaches are capable of representing synchronically. The stratal OT treatment proposed here reconstructs this historical scenario, and in a sense justifies it. For it posits that polysyllables are, in fact, adopting the pattern of disyllables, albeit not so much by direct transfer of the surface pattern, as in virtue of the loss of stem-level rhythmic stress, which also captures the spread of the long illative (see 4.1).

Either way, the O/O solution faces two problems, both fatal at least under current versions of O/O theory, as far as I can tell. The first is that there is no principled way to get the paradigmatic transfer to show up in the right places. This is the problem of the *opaque conditioning* of the transfer. Disyllabic -V stems retain their geminates obligatorily, as do contracted stems. How do we retrict the analogy to a subclass of polysyllables? And how does the O/O constraint distinguish fixed polysyllables from movable polysyllables? For example, *Amerikka* and *palsternakka* have the same output stress pattern in the Nominative Singular and in the Essive Singular — in *all* prospective Base forms, in fact — yet are inflected quite differently. In the former, the transfer is optional, in the latter it is obligatory.

The second problem for O/O constraints is that they have nothing to say about the variation in the form of the suffix, for example the alternation *korjaamoita* ∼ *korjaamoja*. As detailed above, suffix weakening and stem reduction are complementary, so one must be blocked by whatever triggers the

[34] De Chene 1975 proposes that degemination in diphthongal forms is analogical to degemination in the monophthongal forms. Consonant Gradation is transferred from the singular and present forms to the corresponding plural and past forms, e.g. from Adess.Sg. *ullakolla* to Adess.Pl. *ullakoilla*, and from 1.Pl.Present *suutumme* 'we get angry' to 1.Pl.Past *suutuimme* 'we got angry'. This is problematic for -CV endings such as Essive /-na/, and even more so for a case form like Instr. *ullakoin (*ullakkoin)*, which lacks a corresponding monophthongal form and yet obligatorily degeminates.

[35] To be sure, these choices involve problematic assumptions, such as that Nominative case has no case features, and that Singular number has no number features, or perhaps that these case and number features are somehow "included" in the Essive case and Plural number features, respectively. Let us assume for now that these problems with O/O theory can be solved somehow.

other. But no O/O constraint can apply to suffixes because they don't have Bases. Therefore O/O constraints do not provide a serious alternative.

Anti-allomorphy constraints. Several types of constraints have been devised to penalize allomorphic alternations. The most basic form is Kenstowicz's UNIFORM EXPONENCE constraint (1995), which enjoins that differences in the realization of a lexical item (morpheme, stem, affix, word) be minimized. The most intricate is LEXICAL CONSERVATISM (Steriade 1999), which defines a type of lexical relation and posits a constraint format based on it.

Since anti-allomorphy constraints can be formulated over morphemes of any type, not just stems, one might think that they could get a purchase on the suffix alternations, which escape the O/O approach, as just noted. This turns out to be not the case, for the question of minimizing allomorphy does not even arise here. All the allomorphs of stems and endings occur regardless of the variation at stake: it is just a matter of how they are distributed in the paradigm. Anti-allomorphy constraints, then, are not helpful either.

Sympathy constraints. Next let us consider the possibility that Sympathy constraints might be responsible. Sympathy constraints impose Faithfulness to a SYMPATHY CANDIDATE, the optimal candidate that obeys some Faithfulness constraint (McCarthy 1999a, 1999b). The actual outputs we are considering (such as *mellakkoja* and *mellakoita*) have stress on the third (stem-final) syllable. The Sympathy candidate, and therefore the underlying form /mellakka-i-ta/, must *not* have stress on that syllable. Intuitively put, the Sympathy constraint enables overtly stressed syllables to be treated as stressless by "borrowing" the stresslessness of the underlying representation.

In the present case, Sympathy runs into two problems. The first is that of ATOMISM. Because Stop Deletion, Consonant Gradation, secondary stress shift, vowel harmony, Illative allomorphy, and the pattern of preferences depend on opaque properties of the stem-level representation, a Sympathy analysis must in effect undo the whole word phonology in so far as it relates to stress and syllable structure. Faithfulness constraints like MAX, DEP, and IDENT can only do this in a piecemeal fashion because they are defined on specific features or segments. The generalization that the conditions governing allomorphy and stem-level phonological processes are defined on stem-level representations is lost.

The second problem with Sympathy concerns Richness of the Base and Freedom of Analysis: how do we guarantee the appropriate stress and stresslessness in the underlying representation in environments where they are predictable? For example, how can we prevent underlying forms with stress on the second syllable? A hypothetical word like */samá/ will come out correctly stressed as *sáma* due to undominated *CLASH, but a Sympathy con-

straint can access the underlying stress to give it an impossible declension pattern, in which the Partitive Singular, for example, will be **sáma-ta* (like *si-tä*) instead of *sáma-a*. Conversely, underlying forms *without* stress on the first syllable would have to be prevented somehow. A hypothetical unstressed stem /si/ will get correctly stressed on the first syllable in the output by (6d) ALIGN-L, but by Sympathy it will be inflected like a disyllable; e.g. with Prt.Sg. **síä* instead of *sítä*.

Thus, Sympathy can replicate the effects of ordering only up to a point. The difference between the Base and the most radical Sympathy candidate (the Input) is that the Base is guaranteed to contain all the actual output properties, while the most radical Sympathy candidate, by Richness of the Base and Freedom of Analysis, need not contain any of the word's predictable properties. In stratal OT, the inflection is determined by the shape of the stem in the stem phonology, which by the principle of cyclic application is guaranteed to reflect the stem-level constraint system.

Turbidity. Finally, what if we enrich "output" representations by adding to them certain kinds of covert, unpronounced properties? This is the central idea of the "containment" approach of Prince & Smolensky 1993 and more recently of Turbidity theory (Smolensky 1998, Goldrick 1999).[36] As Goldrick explains Turbidity, "the output of the grammar will now contain unpronounced material which can influence the 'surface' — the portion of the output which is pronounced. By utilizing a single, complex output representation, we can maintain the output-oriented approach of Prince & Smolensky (1993) while extending our descriptive coverage to include opacity effects."

Turbidity enhances outputs by allowing different coexisting analyses for segmental material: in Goldrick's terms, segments can *project* one way and be *pronounced* in another. As an example, Goldrick's proposes an analysis of German in which medial consonants project (are licensed as) as codas, and are pronounced as onsets. Certain constraints (those that are "sensitive to abstract structural relations") are triggered by the projected structure, others ("lower-level constraints") by the pronunciation. This dual structure resembles ambisyllabicity in some respects, and level-ordering in others, but is nevertheless conceptually distinct from both. An ambisyllabicity analysis claims that the segment in question is simultaneously a coda and an onset in the same representation. Serial solutions claim that the 'projected' and 'pronounced' structures belong to different levels of representation which cannot be accessed together by any rule or constraint. Turbidity holds that there are two different syllabifications but that they are always *co-present* and visible

[36] Compare also the two-level morphology of Koskenniemi and Karttunen, where all constraints (not just faithfulness constraints as in Correspondence Theory) can refer either to input representations or to output representations.

together.

For Finnish, a Turbidity analysis would presumably say that in *úl.lak.kò.ja* 'attics' (Prt.Pl.) the penult syllable is projected as unstressed but pronounced as stressed, while in the alternative output *úl.la.kòi.ta* the penult is both projected as stressed and pronounced as stressed. In *pált.tois.sa* 'overcoats' (Iness.Pl.) *-tois-* is projected as two syllables but pronounced as one. The disparity between projection and pronunciation in the former case could be implemented by constraints equivalent to those I proposed above. Roughly speaking, the stem-level constraint system would give Turbidity's projected structure, and the word-level constraint system would give Turbidity's pronunciation structure.

Turbidity partly shares its problems with other parallel approaches to opacity, but one of its distinctive characteristics is that it apparently imposes no principled restrictions on which constraints access which representation. Constraints defined on Projection might equally well be defined on Pronunciation, and vice versa. In contrast, stratal OT entails that constraints which are stem-level by other criteria (e.g. domains, interaction with other constraints, and interaction with morphology) only apply to stem-level representations, and constraints which are word-level by other criteria only apply to word-level representations. Opacity arises only from intralevel masking; full transparency obtains *within* each level. Turbidity does not have any predictions to make on this score.

Moreover, because Turbidity posits a single representation in which possibly incompatible Projection and Pronunciation structures coexist, it predicts the possibility of structures that access *both* (for example, mutual bleeding). For stratal OT, this is an impossibility, because the stem-level and word-level representations are distinct. Turbidity also seems to allow constraints which access Pronunciation to feed or bleed constraints that access Projection. For stratal OT, this is also an impossibility, because the stem-level and word-level representations are serially related. In the Finnish case, this is what allowed us to explain the complementarity of Stop Deletion and Consonant Gradation.

The stratal OT approach is thus more restrictive than Turbidity in several respects, and therefore to be preferred to it. I conclude that stratal OT's account of opacity is superior to any currently available alternative within parallel OT.

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