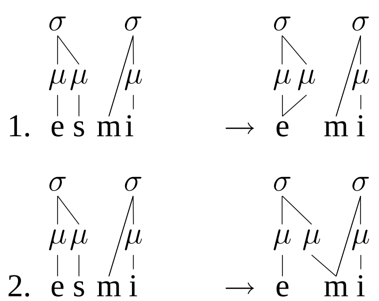
Compensatory lengthening

1 A challenge for OT

1.1 Compensatory lengthening as weight conservation

Compensatory lengthening occurs when the featural content of a nucleus or moraic coda is deleted, or becomes reaffiliated with a nonmoraic position — typically an onset — and the vacated mora, instead of being lost, is retained with new content (Hayes 1989).

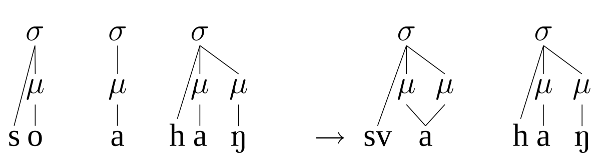
Compensatory lengthening is most often triggered by the deletion of a weight-bearing coda consonant. In ancient Greek, when an *-s-* in coda position is lost, its mora survives as a lengthening of a neighboring segment — the preceding vowel in the majority of dialects, the following consonant in Lesbian and Thessalian: /es-mi/ *ēmi*, *emmi* 'I am' (cf. /es-ti/ *esti* 'is').

(1) 

(Attic)

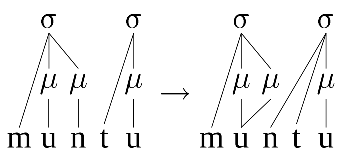
(Lesbian and Thessalian)

When the original features associated with the mora are completely replaced by those of a neighboring segment, as in (1), compensatory lengthening is hardly distinguishable from total assimilation. But there are types of compensatory lengthening where the weight-bearing element is not lost but rather resyllabifed, and these cannot be considered assimilations, but must be understood as weight conservation effects. In one such type, a nucleus loses its weight by becoming an onset, while retaining its segmental features, and its former mora is then manifested as vowel lengthening. For example, in Pāli prevocalic *o* can be desyllabified to a glide or approximant *v*. Being an onset, it becomes weightless. But its mora is preserved as a lengthening of the following vowel: /so ahaŋ/ *svāhaŋ* 'that I', /so ajja/ *svājja* 'today' (Rhys Davids & Stede 1921-5: 655).

(2) 

Similarly, when moraic codas are resyllabified as onsets, the preceding nucleus can be compensatorily lengthened. Hayes 1989 illustrates it with the vowel lengthening that occurs in (East) Ionic

Greek when postconsonantal *w* is lost in the next syllable, and the preceding consonant is forced into the onset: e.g. *arwā́* → *ārā́*, *ksénwos* → *ksḗnos* (versus Attic *arā́*, *ksénos*). In the most remarkable scenario of all, the resyllabification is not triggered by deletion. In Luganda, nasals are reassigned from coda to onset (perhaps as prenasalization), leaving behind its mora in the form of a lengthening of the vocalic nucleus, e.g. /muntu/ → *mun.tu* → *muu.ntu* (Clements 1986).

(3) 

Compensatory lengthening is both a type of sound change, and a type of synchronic phonological process. The compensatory lengthening processes cited in (1)–(3) originate as sound changes, but they must also be part of the synchronic grammars of the respective languages, since they result in systematic predictable phonological alternations. Because the trigger of synchronic compensatory lengthening is not visible on the surface, it raises the specter of phonological opacity.

In addition, the Luganda case poses an even bigger puzzle. The analysis presupposes an unconditioned resyllabification of medial nasal clusters from *Vn.CV* to *V.nCV*. How can a single constraint system impose two different syllabifications on one and the same consonant cluster? In principle, Stratal OT makes available a simple analysis of Luganda compensatory lengthening because it allows different strata to have different syllabification patterns. Of course these should not have to be posited just for the sake of the compensatory lengthening data but should have independent motivation. In fact, while the *-n* in Luganda words like *muuntu* is obviously an onset in the output, Larry Hyman (p.c. cites synchronic evidence from Meinhof's Law that it is syllabified as a coda at the stem level.[1] If the cross-stratal resyllabification required by the autosegmental approach to compensatory lengthening is indeed independently motivated, then Luganda supports Stratal OT over parallel OT.[2]

In this article I develop this line of argument in detail on the basis of two instances of compensatory lengthening which are even harder than Luganda. One, from Finnish, is new to the theoretical literature. The other, from Samothraki Greek, has received several recent analyses, all vitiated by the neglect of crucial parts of the data. Both cases are of undoubted synchronic productivity. It turns out that they are resistant not only to parallel OT, but also to Hayes' rule-based autosegmental approach. I propose to show that Stratal OT deals with them handsomely, in a way that salvages the key insight behind the autosegmental theory of compensatory lengthening.

The core theoretical issues raised by compensatory lengthening have to do with: its ACTUATION, its REALIZATION in the lengthened item and in particular the locality relation between the target of lengthening and its trigger, the DISTINCTIVENESS of the resulting weight, and the possibility of apparent NON-MORAIC TRIGGERS.

1.2 Four problems

The actuation problem. When is weight preserved? For example, why does *w*-deletion entrain vowel lengthening in Ionic but not in Attic (as in (1a) vs. (1b))? Determining when a potential

[1]The gist of Hyman's argument is this: Meinhof's Law takes underlying /n+l/ to *nn* (e.g. /n+lim+a/ *nnima* 'I cultivate'. A vowel preceding this cluster has to be short (and will be shortened if long). This suggests that an input N+CV sequence is initially syllabified as N.CV.

[2]Specifically, classic parallel OT cannot derive Luganda compensatory lengthening at all, and OT-CC (nominally parallel but actually transderivational with quasi-derivations) can derive it only in a stipulative way (Shaw 2007).

process takes effect is one of the hardest problems in the study of language change, as well as in synchronic phonology. It remains as mysterious for compensatory lengthening as for any other historical or synchronic phonological process. I have no general solution to offer for the actuation problem, but I shall try to show that even here Stratal OT offers some insights, and a small step towards a solution.

The realization problem. How is weight preservation manifested? The idea that compensatory lengthening replaces the melodic content of a vacated mora implies that the mora itself should remain on the original syllable, unless something else happens to displace it. The prediction is correct on the whole. But *how* it is realized on that syllable does not seem to be predictable at all. For example, the Greek compensatory lengthening in (1) is manifested as consonant gemination in Lesbian and Thessalian and as vowel lengthening in all other dialects of Greek.

More seriously, there are cases where the preserved weight shows up at some distance from its original site, calling into question the no-crossing constraint on the autosegmental association between features and feature-bearing timing units. The Finnish case examined below is of this type. Hayes was able to deal with some cases of length displacement by "parasitic delinking" rules. As he recognized, this is a purely descriptive move that does not explain *why* the mora migrates. Even worse, we shall see that there are cases of weight displacement which unavoidably violate the no-crossing constraint.

The same problems arise in OT phonology as well, but with the promise of a solution. Compensatory lengthening is triggered by the interaction of markedness constraints that cause a mora (or other weight-bearing unit) to be relinked, and a prosodic faithfulness constraint (such as MAX-μ) that preserves the mora itself. The mora should remain in its original place *unless something forces it to move.* What might that be? I will argue that it is the avoidance of quantitative merger. In other words, weight displacement is a contrast preservation effect, and I propose to formalize it with a version of SUPER-OPTIMALITY as defined in Bidirectional OT, a theory designed to account for recoverability in form/meaning relations (Jäger 2002). I will show that this solution to the realization problem is available in Stratal OT, but not in classic OT or in transderivational OT (classic OT plus transderivational constraints such as sympathy or O/O constraints).

The distinctiveness problem. How does weight become distinctive, or, in diachronic terms, how does it become phonologized? Specifically, how can compensatory lengthening convert *redundant* weight (such as the predictable moras of short nuclei or the "weight by position" of codas) into *distinctive* vowel or consonant length? Why would the loss of a predictably moraic vowel lead to distinctive vowel length? Why would a syllable become distinctively heavy upon the loss or resyllabification of a predictably heavy coda consonant? The reason this is problematic for OT is that, in the OT reconstruction of Hayes' autosegmental/metrical analysis, the preservation of a mora (or other weight-bearing unit) is triggered by a faithfulness constraint. But faithfulness is a relation between input and output representations (whether expressed by Correspondence constraints or by Containment). Therefore, the mora to which faithfulness triggers compensatory lengthening must be present in the input. But if it is predictable, then its presence in the input cannot be guaranteed, because OT's fundamental postulates of Freedom of Analysis and Richness of the Base requires that any input whatever from GEN is mapped by the language's constraint system into a well-formed output expression of the language. Predictable properties (such as coda weight) may therefore be left unspecified, or specified arbitrarily, in lexical representations. Indeed, it is the possibility of arbitrary input specification that formally reconstructs non-distinctiveness or predictability in OT. However, when a predictable mora of a coda or nucleus is not present in the input, there can be no faithfulness to it, and therefore it shouldn't trigger compensatory lengthening in cases like (1) and (2).

Stratal OT's architecture provides an immediate answer. As in classic OT, predictable structure, including syllable weight and other prosodic information, may be freely specified in lexical representations, in conformity with the principle of the Richness of the Base. However, on the first pass through the stem-level constraint system, the predictable properties will be specified as the language's constraint system dictates, regardless of their lexical representation. From then on they are indistinguishable from distinctive properties that come fully specified from lexical representations. In particular, the word phonology receives as input a fully specified representation conforming to the stem phonology, and that the postlexical phonology in turn receives as input a fully specified representation conforming to the word level phonology. The reason compensatory lengthening can translate the predictable weight of vowels and coda consonants into distinctive length, then, is that it can operate on representations in which the moraic value of those elements are already assigned by the constraint system of a higher stratum.

The trigger problem. How can apparently weightless elements trigger compensatory lengthening? Why does compensatory lengthening sometims appear even when a prevocalic onset consonant is lost, even though onsets are non-moraic? The trigger problem can be seen as an extreme case of the distinctiveness problem. Onsets not only *need* not be assigned weight, because of Richness of the Base, but they *cannot* be assigned weight, for onsets are universally weightless. And yet there is at least one very well documented instance where the loss of an onset consonant regularly entrains lengthening of the following nucleus. In the Samothraki dialect of modern Greek, *r* is deleted in onsets, with compensatory lengthening word-initially and after a consonant (Katsanis 1996).

(4)	/róɣos/	[óoɣus]	'spider *sp.*'
	/ráxi/	[áax́]	'ridge'
	/ráfi/	[áaf]	'shelf"
	/brostá/	[buustá]	'in front of'
	/vródo/	[vóodu]	'thunder'
	/epítropo/	[pítuupu]	'bishop's representative'

In section 3.1 I show that this is a live synchronic alternation in Samothraki Greek, and propose an analysis according to which the *r* consonants which cause lengthening are initially syllabified as part of the nucleus and then deleted with compensatory lengthening. The idea of an "initial syllabification" followed by deletion makes critical use of Stratal OT's level-ordering and cannot be expressed in other versions of OT.

2 Compensatory lengthening in Finnish

2.1 Consonant Gradation as a trigger of compensatory lengthening

A lenition chain shift. Consonant Gradation lenites geminate and singleton stops in the onset of a heavy syllable, and some lenited singletons are deleted in dialectally varying contexts. [3]

[3]"In the onset of a heavy syllable" is a nonstandard formulation of the triggering context. It is proposed and defended at length in Kiparsky 2003, and I will adopt it here without further justification; the characterization of the context is in any case not essential to the present argument.

(5) 1. /mato-t/ → *madot* 'worms' /matto-t/ → *matot* 'carpets'

All dialects of Finnish have essentially the same overall chain shift pattern, conditioned by the same context. A top-level descriptive formulation is:

(6) CONSONANT GRADATION:

After a sonorant in the onset of a heavy syllable

1. geminate stops are degeminated,
2. singleton stops are lenited.

The contextual condition "after a sonorant" excludes initial stops and stops in obstruent clusters. We may assume that initial stops are exempted by a dominant positional faithfulness constraint. The failure of obstruents in clusters to undergo lenition follows partly from independent constraints on output syllable structure (e.g. **sd, *sj*), though additional constraints (subject to some dialect variation) are required for some cases.[4] Assuming then that the restrictions on the left context are imposed by dominant constraints, we can formulate the constraints that drive Consonant Gradation itself as follows:

(7) 1. DEGEMINATION: $*T_{\mu}\mu\mu$ (no moraic stop in the onset of a heavy syllable)

2. LENITION: $*T\mu\mu$ (no stop in the onset of a heavy syllable)

Degemination never feeds lenition: see (5b) /matto-t/ → *matot* (not **madot*) 'carpets'. The two parts of Consonant Gradation form a CHAIN SHIFT: the contrast is not merged but transposed. Chain shifts are a prima facie descriptive challenge for OT because they involve opacity by definition; in this case, the problem is to prevent LENITION from appplying to the output of DEGEMINATION. At the level of explanation, chain shifts raise cross-theoretical questions for all of phonology, synchronic and diachronic. Before proceeding to the compensatory lengthening data, I will propose an idea for dealing with chain shifts in OT. The same idea will turn out to solve the core of the realization problem for compensatory lengthening.

Chain shifts and Super-Optimality. There are two main ways to deal with phonological chain shifts in OT. An older approach uses gradient faithfulness constraints (Kirchner 1997). A recently more popular one uses anti-neutralization constraints, which forbid the merger of contrasts (Flemming 2003, Padgett 2003, Kawahara 2003, Kiparsky 2008). Here I propose a new version of the latter approach, based on Bidirectional Optimization as proposed for the syntax-semantics interface by Blutner 2000 and Jäger 2000 (see Blutner, de Hoop, and Hendriks 2006 for an overview). Jäger defines an Input-Output pair (I, O) is SUPER-OPTIMAL if there is no more harmonic super-optimal input-output pair with either I or O.

(8) The Input-Output pair (I, O) is SUPER-OPTIMAL iff

1. there is no super-optimal (I, O′) ≻ (I, O), and

[4] For example, the absence of Consonant Gradation in a word like /putke-t/ *putket (*putjet)* 'tubes' does not reflect any hard constraint on *-tj-* clusters, which occur in words like *ketju* 'chain', *budjetti* 'budget'.

2. there is no super-optimal (I′, O) $\succ$ (I, O)

Although the definition has an air of circularity, Jäger (2002) shows that as long as the relation $\succ$ ("more harmonic than") is well-founded, there is a unique super-optimal candidate for a given I/O pair.

The semantics/pragmatics literature does not address the question how (if at all) super-optimality should figure in grammatical systems with multiple ranked violable constraints. In phonology, we cannot get very far without addressing this question. A natural idea is to introduce a rankable violable constraint (9).

(9) S(UPER)-OPT(IMIZE)

An Input-Output pair (I, O) is super-optimal.

The effect of this constraint is to impose a limited bidirectionality on constraint evaluation. Tableau (10) illustrates how this works for Finnish.

(10)

	Finnish			S-OPT	$^*\mathrm{T}_{\mu}\mu\mu$	$^*\mathrm{T}\mu\mu$	MAX-μ	ID(voi)
A	1.	/ottin/	[odin]	* B1			*	*
	2. ☞	/ottin/	[otin]			*	*	
	3.	/ottin/	[ottin]	* A2	*	*		
B	1. ☞	/otin/	[odin]					*
	2.	/otin/	[otin]	* B1		*		

Writing "a better match for" as an abbreviation for "a more harmonic super-optimal input-output pair with the same input (or output) as", we have:

(11)
1. A1 is not super-optimal, for (B1) is a better match for [odin].
2. A2 is super-optimal, for there is no better match for /ottin/ or for [otin].
3. A3 is not super-optimal, for (A2) is a better match for /ottin/.
4. B1 is super-optimal, for there is no better match for /otin/ or for [odin].
5. B2 is not super-optimal, for (B1) is a better match for /otin/.

We get this outcome *only* when /d/ is excluded from the input (this is critical for (11a,d)). Classic OT has no such conditions (Richness of the Base). In Stratal OT, this is true only for lexical inputs on the first stratum. (A corollary is that the shape of the lexicon is determined exclusively by the stem-level phonology, not by word-level and postlexical phonology). Because in Stratal OT the character of the input at stratum *n* is fixed by the constraint system of stratum *n–1*, the existence or absence of a given input can be checked by reference to the relevant constraint system. For example, if the stem-level phonology prohibits /d/, then stem-level inputs to word-level phonology necessarily lack /d/ On the other hand, if /d/ were included in the input and S-O were highly ranked, then the requirement to maintain distinctions would block every link of the potential chain shift.

In some dialects of Western Finnish, Consonant Gradation is accompanied by displaced compensatory lengthening. We shall see that super-optimality helps explain the displacement effect. First we need a closer look at the triggering process of Consonant Gradation, specifically at how it does or does not affect syllable structure.

Consonant Gradation across dialects. The context of Consonant Gradation is for present purposes the same in all dialects, and so is the degemination part of the process, viz. *tt,pp,kk* → *t,p,k*. The main variation occurs in the lenition of singleton stops, especially /k/. The constraint *T$\mu\mu$ can be satisfied either by lenition to a fricative or approximant, or, where these are not allowed, by deletion. On this point the dialects divide into three groups.[5]

1. In *Eastern dialects*, /k/ is deleted under gradation.[6]
2. In *Western dialects*, /k/ is gradated to an approximant, typically *v* next to rounded vowels and *j* next to unrounded front vowels. Deletion occurs before *a*, sometimes before other vowels (details below). Importantly, a deleted intervocalic consonant leaves hiatus or even a glottal stop behind in this dialect (except when the vowels are identical, in which case they optionally fuse into a single long vowel).
3. *Standard Finnish*, along with the *Southwestern* dialects around Turku, has the same three reflexes, but in a different distribution. /k/ gradates to *v* between high rounded vowels, to *j* after a liquid before *e*, and elsewhere deletes with hiatus (there is again optional fusion when the vowels are identical).

Schematically:

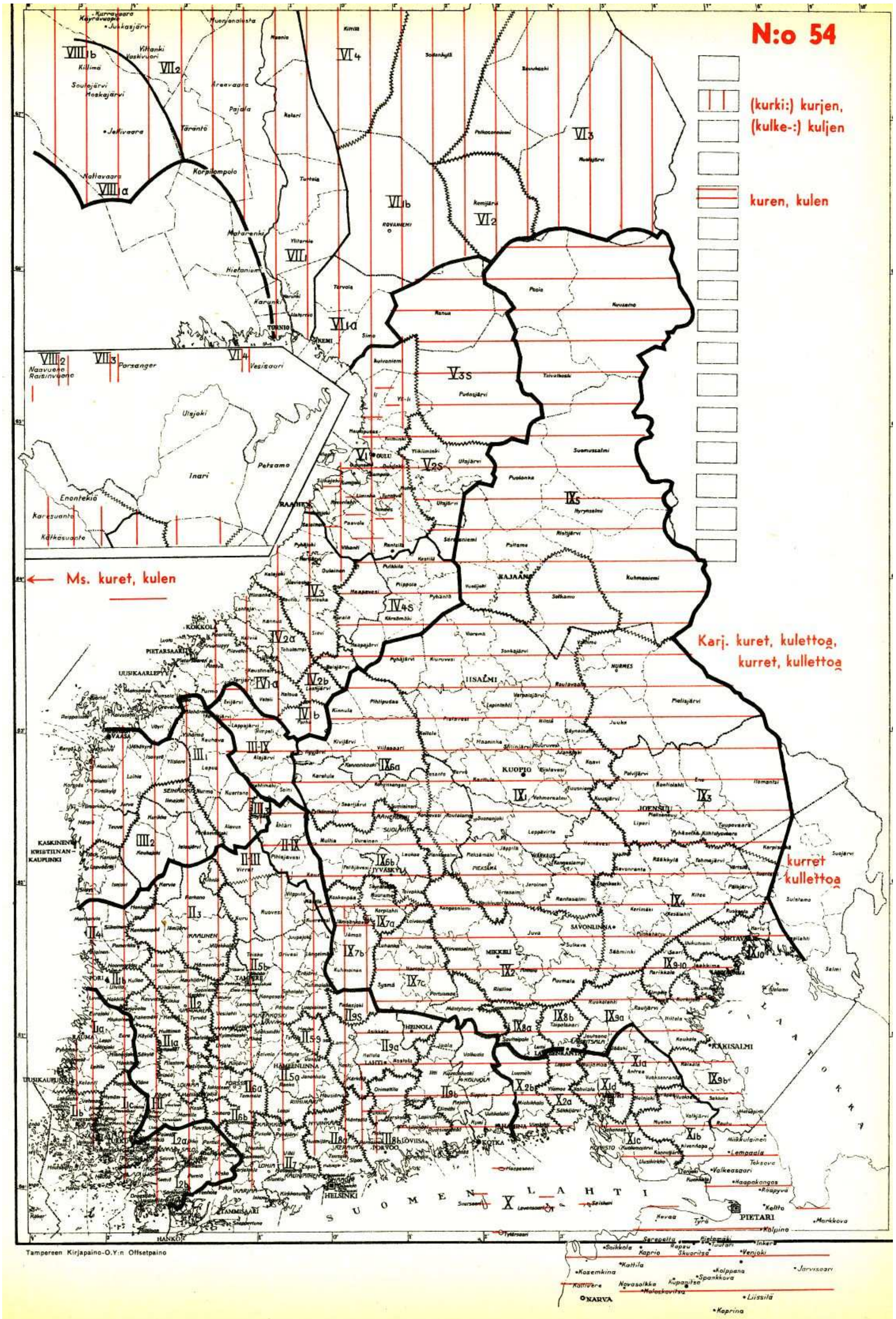
(12)			/kurke-n/	/mäke-n/	/rako-t/
	a.	Western	*kur.jen*	*mä.jen*	*ra.vot*
	b.	Southwestern, Standard	*kur.jen*	*mä.en*	*ra.ot*
	c.	Eastern	*ku.ren*	*mäen, mäin*	*raot, raut*
			'crane' (Gen.)	'hill' (Gen.)	'cracks' (Nom.)

The map (from Kettunen 1942) shows this major East/West isogloss for /kurke-n/ *kurjen : kuren* 'crane's'.

(13)

[5] Data from Kettunen 1942 (maps 40, 45, 54) and Rapola 1966: 47-89.

[6] Except after a nasal (where it either assimilates to it completely, or remains unchanged as *k*), and in a few other contexts.



The crucial generalization of interest to us is that when deletion of a gradated consonant results in a sequence of unlike vowels, the syllable boundary is retained in Western dialects and erased in Eastern dialects.

The three reflexes are historically derived from *k* via γ, which got assimilatorily palatalized to *j*, labialized to *v*, and was otherwise deleted, depending on the vowel context. On top of this, the Western dialects have a layer of dissimilatory deletions which apply to *j* and *v*, giving the reflexes of lenited /k/ in this region an extraordinary diversity. The front glide *j* tends to delete before *i* (an OCP effect). In some places it also deleted before *ä* (perhaps by analogy to the corresponding back vowel *a*, with which it alternates in vowel harmony). Only before *e* is *j* stable everywhere. A number of dialects also delete *v* before rounded vowels, perhaps also an OCP-driven deletion. There is also some variation in the realization of lenited /t/ which we can afford to ignore here.

For ease of reference, here is a summary of the basis outcomes for each place of articulation across dialects. (A few supplementary details will be added in the next section.)

(14)
1. Lenition of *t*
   a. After vowels (including diphthongs)
      - /t/ → *r* (most Southwestern dialects)
      - /t/ → *l, ð* (stigmatized older pronunciations in parts of Southwestern Finland)
      - /t/ → *d* (standard Finnish only)
      - /t/ → ∅, sometimes with transitional *j, v, h* under conditions that depend on the vocalic context and on the dialect (elsewhere).

   b. After liquids and nasals (*l, r, n*), lenited *t* undergoes complete assimilation in all dialects. (NB: Only homorganic nasals occur before stops.)
2. Lenition of *p*
   a. After vowels (including diphthongs) and liquids: /p/ → *v* in all dialects.
   b. After *m*: complete assimilation in all dialects.
3. Lenition of *k*
   a. After vowels and liquids
      - /k/ → *v*, ∅ before rounded vowels, /k/ → *j*, ∅ before front vowels, /k/ → ∅ before *a* (Southwestern dialects, with much fine-grained local variation, and Standard Finnish).
      - As above, but /k/ → ∅ invariably accompanied by compensatory lengthening of the following vowel (a subset of Southwestern dialects).
      - /k/ → ∅ across the board, without compensatory lengthening (elsewhere).

   b. After *ŋ*: complete assimilation in all dialects.

With the basic Consonant Gradation process in place, let us turn to the compensatory lengthening that accompanies it.

Western Finnish compensatory lengthening. Compensatory lengthening occurs *only* in those Western Finnish dialects where the output of Consonant Gradation is in general not resyllabified. In these dialects it applies across the board wherever the phonological conditions are present. The generalization for these dialects is that *whenever a stop is deleted in the weak grade, and the preceding coda is resyllabified as a result, the vowel of the following syllable becomes long*.

(15) Gradation of -*k*- in env. *C*___ in Western Finnish

1. *k* → ∅+$\bar{\text{V}}$ before *a*
   /jalka-t/ → *ja.laat* 'feet, legs'

2. *k* → *j* or ∅+$\overline{\mathrm{V}}$ before *i, ä*, depending on the dialect
   /nälkä-n/ → *näl.jän* ∼ *nä.lään* 'hunger' (Gen.)
   /kulke-i-t/ → *kul.jit* ∼ *ku.liit* 'you went'
   /arka-ista-a/ → *ar.jis.taa* ∼ *ariistaa* 'to be shy'
3. *k* → *v* or ∅+$\overline{\mathrm{V}}$ before *o, u, ö, y*, depending on the dialect
   /pelko-tta-n/ → *pel.vo.tan* ∼ *pe.loo.tan* 'I frighten'
   /halko-t/ → *hal.vot* ∼ *ha.loot* 'logs'
   /hylky-t/ → *hyl.vyt* ∼ *hy.lyyt* 'wrecks'
4. *k* → *j* before *e* (no deletion, no lengthening)
   /kurke-t/ → *kur.jet* 'cranes'
   /kulke-n/ → *kul.jen* 'I go'
   /lohke-ttu/ → *loh.jet.tu* 'split' (pp.)

That the vowel lengthening is truly compensatory is established by the following facts. It takes place only when deletion triggers resyllabification of a coda ($\mathrm{CVC}_i.\mathrm{C}_j\mathrm{VC} \rightarrow \mathrm{CV.C}_i\mathrm{VVC}$). Otherwise Gradation by itself never triggers lengthening. When it deletes an intervocalic consonant, no mora is lost, and therefore no lengthening occurs:

(16)	/mäke-t/ → *mä.et* (∼ *mä.jet*)	'hills'	(**mä.eet*, **mä.jeet*)
	/teko-t/ → *te.ot* (∼ *te.vot*)	'deeds'	(**te.oot*, **te.voot*)

When it results in a lenited consonant (*j, v*, or a nasal), it never triggers lengthening:

(17)	/kurke-t/ → *kur.jet*	'cranes'	(**kur.jeet*)
	/vehkeke/ → *veh.jeK*	'device'	(**veh.jeeK*)
	/heŋke-n/ → *hengen* [-ŋ.ŋ-]	'breath, life' (Gen.)	(**hen.geen*)

Underlying /j/ or /v/ (there is no underlying /γ/) do not delete, therefore trigger no lengthening.

(18) /karja/ → *kar.ja* 'cattle' (**ka.raa*, **ka.ra*)
/velje-n/ → *vel.jen* 'brother's' (**ve.leen*, **ve.len*)
/veräjä/ → *ve.rä.jä* 'gate' (**veräjää*, *verää*)
/arvo-n/ → *ar.von* 'value' (Gen.) (**a.roon*, **a.ron*)

Even where the deletion of the gradated consonant is optional, the resyllabification and compensatory lengthening attendant on it are obligatory. Lengthening takes place *always* and *only* when the preceding coda is resyllabified as an onset. So, whenever a postconsonantal consonant is optionally deleted in the compensatory lengthening dialects, there are exactly two outputs, never four.[7]

(19)	/kulke-i-n/ → *kul.jin* ∼ *ku.liin*	'I went'	(**ku.lin*, **ku.ljiin*)
	/halko-t/ → *hal.vot* ∼ *ha.loot*	'logs'	(**ha.lot*, **hal.voot*)

Finally, even though it is fed by Consonant Gradation, which is opaque and has a number of lexical and morphological exceptions, compensatory lengthening itself is purely phonologically conditioned. It applies across all morphological categories — nouns and verbs, inflectional and derivational. It is a productive, exceptionless process, not directly triggered by Consonant Gradation, but responding to such resyllabification as Consonant Gradation may cause.

[7] Standard Finnish, which has no compensatory lengthening, has *kuljin* and *halot*.

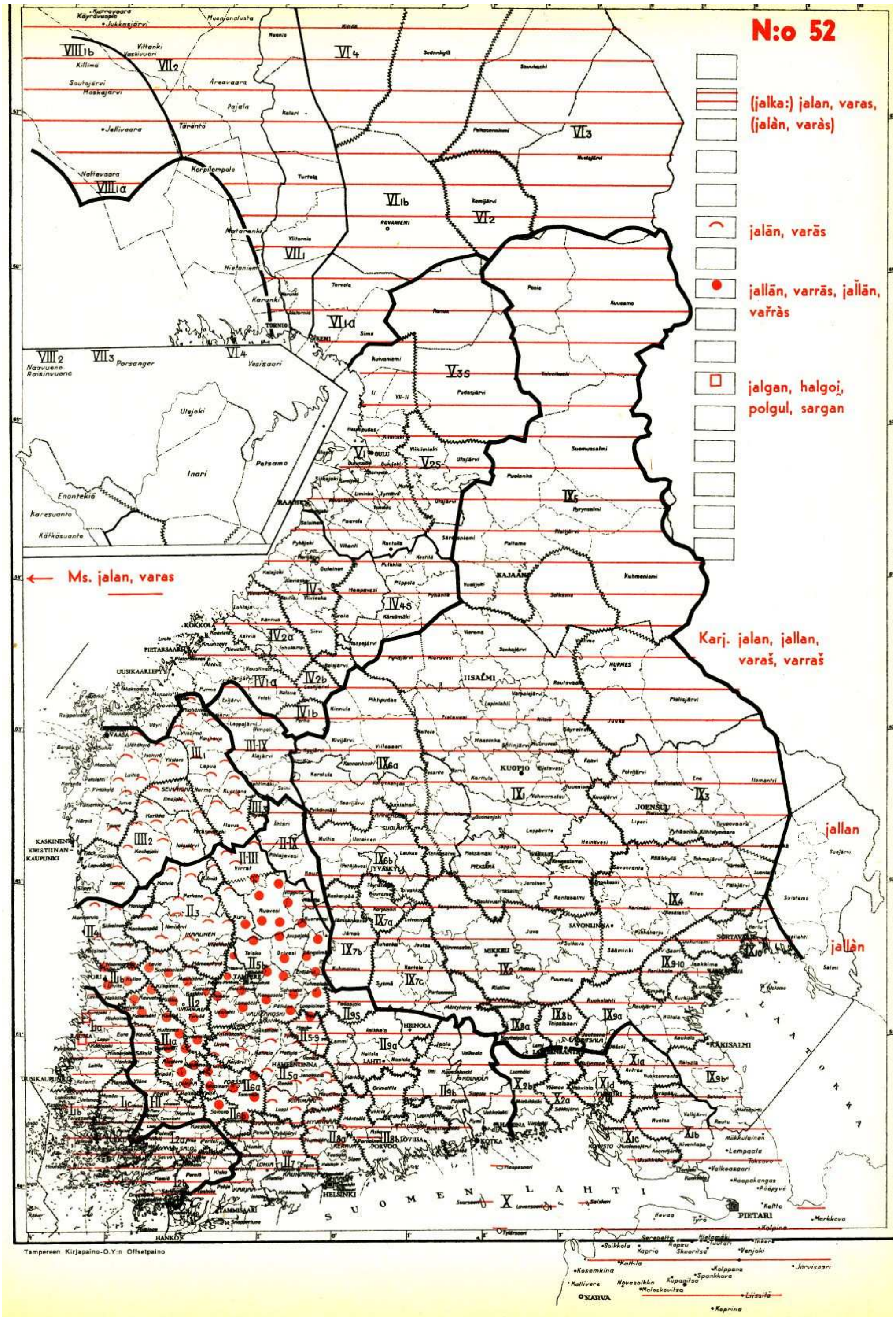
Interaction with other quantitative constraints. Diphthongs don't undergo compensatory lengthening. That is due to a general restriction against long nuclei in Finnish word-level phonology, where Consonant Gradation takes effect.

(20) /nahka-i-ksi/ > *nahkoiksi* ∼ *nahoiksi* (**nahooiksi*) 'skins' (Translative).

The relevant contraint is justified in full in Kiparsky 2003.

In a wedge-like area that intrudes from Eastern Finland into the West (polka-dotted in Kettunen's map reproduced in (21) below), consonants are automatically lengthened between a stressed short vowel (in particular, a word-initial short vowel) and a long vowel, e.g. /kala-an/ → *kallaan* (Iness.) 'into the fish'. This lengthening is prosodically motivated by the moraic trochee foot structure of Finnish. *CV́.CVV(C)* is too long to be one moraic trochee, and two short to be two moraic trochees. Lengthening allows such a sequence to be parsed into two normal moraic trochees $(C\acute{V}C)_\phi(CVV)_\phi$. In the dialects where the consonant lengthening applies, it applies across the board, both before original long vowels, and before those long vowels that come from the compensatory lengthening process discussed above. As the map shows, the distribution of *jallaan* 'foot' (Gen.) from /jalka-n/ in the wedge area exactly matches that of *kallaan* from /kala-an/ 'fish' (Iness.). The former is derived by Consonant Gradation and deletion with compensatory vowel lengthening followed by consonant lengthening (/jalka-n/ > *jal.γan* > *ja.laan* > *jal.laan*), the latter directly from the underlying form by consonant lengthening (/kala-an/ > *kal.laan*).

(21)



Together with the regional variation in the scope of *j*- and *v*-deletion described above, this yields three outputs in forms with postconsonantal /k/:

(22) 1. /nälkä-n/ → *näl.jän*, *nä.lään*, *näl.lään* ‘hunger’ (Gen.)

2. /kulj-i-n/ → *kul.jin*, *ku.liin*, *kul.liin* ‘I went’

3. /pelko-n/ → *pel.von*, *pe.loon*, *pel.loon* 'fear' (Gen.)
4. /alku-n/ → *al.vun*, *a.luun*, *al.luun* 'beginning' (Gen.)
5. /hylky-n/ → *hyl.jyn*, *hy.lyyn*, *hyl.lyyn* 'wreck' (Gen.)
6. /tahko-n/ → *tah.von, ta.hoon*, *tah.hoon* 'whetstone' (Gen.)
7. /poika-n/ → *poi.jan, po.jaan*, *poi.jaan* 'boy' (Gen.)

To repeat, the gemination in compensatorily lengthened forms such as (22a) *kul.liin* is phonologically conditioned and has the same distribution as gemination in basic *CV.CVV* sequences.

2.2 Coping with compensatory lengthening

Problem 1: Compensatory lengthening self-destructively feeds consonant lengthening. Feeding order's reputation of being problem-free for parallel OT is not quite deserved. In the preceding section I justified the following synchronic derivations for the lengthening dialects:

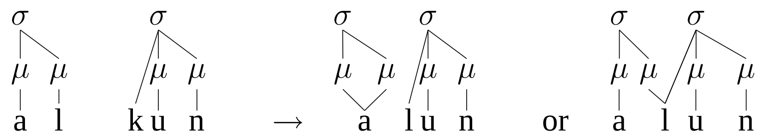
(23)			
	Input	/alku-n/	/talo-on/
	Gradation with C.L.	aluun	—
	Gemination	alluun	talloon

This is an instance of "self-destructive feeding" (Bakovic 2007). A theory that is committed to a one-step derivation, such as parallel OT, must telescope compensatory vowel lengthening and the prosodically driven consonant gemination into a single mapping, /alku-n/ → *alluun*. This loses sight of the motivation of both lengthening processes. The vowel lengthening becomes gratuitous. It can no longer be understood as compensatory. Since the geminated consonant in *alluun* already preserves the mora, what is the point of lengthening the vowel of the second syllable? The wrong mapping /alku-n/ → **allun* should beat /alku-n/ → *alluun* on moraic faithfulness. The wrong mapping can also not be motivated prosodically, for **allun* is at least as good as *alluun*. In short, it seems that the actual output is not optimal on any constraint ranking that can be justified for Finnish phonology. I.e. it is harmonically bounded.

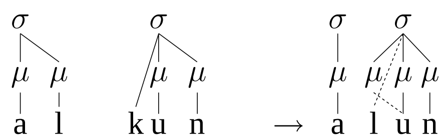
Nor is it clear that OT-CC (McCarthy 2007) can do any better. This theory reconstructs derivations in a parallel guise, as chains leading by successive gradual harmonic improvements to an optimal output. Each link in such a chain must improve on the previous one *within a single constraint system*. The two-step derivation in (25) does not satisfy this requirement. The compensatory lengthening of the second syllable's vowel serves weight conservation but makes the foot structure *worse*, while the consonant gemination improves foot structure but scores worse on weight conservation (because it adds a mora). This is synchronically a kind of "Duke of York" derivation, a type questioned by McCarthy (2003) but actually cross-linguistically very well motivated.[8]

Problem 2: Line-crossing. Quite apart from this interaction with consonant lengthening, Western Finnish compensatory lengthening represents one of the few types of cases that Hayes' (1989) theory can't handle, even descriptively. Simple delinking and reaffiliation predicts the wrong forms **aalun* or **allun*, just as in the Greek example (1).

[8]The grand old Duke of York,
He had ten thousand men;
He marched them up to the top of the hill,
And he marched them down again.

(24) 

Operations such as “double flop” and “parasitic delinking” (Hayes 1989) won’t get the desired derivation /alku-n/ → *aluun*, for *l* and the mora to which it is affiliated must cross paths to reach their new affiliations, in violation of the line-crossing prohibition.

(25) 

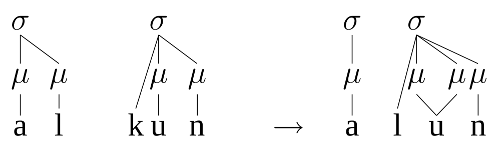
In OT (classic or OT-CC) the line-crossing violation is not necessarily a problem anymore, because the constraint that forbids it can be assumed to be violable like any other constraint. A would-be OT solution still has the onus of identifying the constraint that forces the line-crossing violation and of motivating its high ranking. I will put forward a constraint with that effect in the next section, and show that it only works in Stratal OT.

Problem 3: Faithfulness to positional weight. A major hurdle for the treatment of compensatory lengthening in classic OT and OT-CC is that it requires *faithfulness to positional weight*. Unlike quantity and syllabicity, positional weight is apparently never distinctive. This implies that is is not subject to Faithfulness, an idea articulated in different ways in Bermúdez-Otero 2001, Campos-Astorkiza 2004, and McCarthy 2007. In other words, although vowel lengthening, consonant gemination, glide formation, and vowel contraction are all subject to Faithfulness constraints, there are no MAX-μ constraints and no DEP-μ constraints. But it is precisely the moraic status of coda consonants that really needs to be subject to Faithfulness constraints for Finnish compensatory lengthening to happen. And in any case, even if the moraic status of coda consonants *were* subject to MAX-μ and DEP-μ constraints, Richness of the Base entails that predictably moraic codas cannot be guaranteed to be underlyingly specified as moraic; therefore their loss or resyllabification does not necessarily affect syllable weight. So we are left with the question why resyllabification of codas leads obligatorily to compensatory lengthening in these dialects.

In OT-CC there are even deeper reasons why moras can’t be protected by Faithfulness (McCarthy 2007: 72-77). McCarthy proposes that “IDENT$_{\mathrm{ONS}}$ and other syllable-sensitive positional faithfulness constraints can never *affect* syllabification” (2007: 75) and that “moras can be freely added or removed at no cost in Faithfulness, but changes in quantity and syllabicity violate IDENT constraints” (2007: 77).[9]

Problem 4: The missing link. Western Finnish compensatory lengthening is difficult for OT-CC for another reason as well. An OT-CC derivation (a CANDIDATE CHAIN) monotonically accumulates unfaithful mappings by minimal steps (localized unfaithful mappings). It is not clear how such a chain could be formed between the input /alku-n/ and the output *aluun*.

[9]The distinction between merely adding/deleting moras and changing quantity is actually tricky to draw formally, since quantity is represented precisely by moras, but let us assume for the sake of the discussion that it is achieved somehow. Shaw 2008 tackles compensatory lengthening in OT-CC, although I believe his approach does not generalize to the Finnish case.

(26) 

Even if there were moraic/syllabic Faithfulness, and the presence of underlying moras were ensured, the Western Finnish compensatory lengthening would still be impossible under the OT-CC regime. The two available options are: a chain that has an intermediate link that does not exist in the language, such as *hal.γon* (there is no *γ in Finnish), and a chain that has an intermediate link that is well-formed in the language, such as *ha.lon*. The former chain is ruled out because any such link introduces a new infraction of an undominated markedness constraint (such as *γ) that dominates MAX-C, and therefore cannot be the best violation, as required. The latter chain is ruled out because any intermediate link that is well-formed in the language will "collide" with *actual* forms derived from inputs of the same shape, which do *not* undergo deletion and compensatory lengthening. For example, if /halko-t/ → *hal.vot* → *ha.loot* 'logs', then why not also /arvo-t/ → *ar.vot* → **a.root* 'values'? And if /halko-t/ → *ha.lot* → *ha.loot*, then why not also /talo-t/ → *ta.lot* → **ta.loot* 'houses'?

"Grandfathering" effects à la Comparative Markedness (McCarthy 2003) provide a solution within transderivational OT, at least at the technical level. The idea is that "old" (underived) sequences of the form "*v* + short vowel" would be frozen by Faithfulness, whereas "new" instances of such sequences with *v* from /k/ *would* undergo lengthening. After lengthening, the triggering consonant would be deleted, wiping out the context of the lengthening.

Even if Comparative Markedness can get the compensatory lengthening itself, it does not have the resources to account for its opacity in the gemination dialects, so transderivational OT would still require OT-CC. But OT-CC's gradualness requirement is at odds with the leapfrogging derivations that Comparative Markedness provides. So OT-CC has displaced Comparative Markedness for what appear to be good reasons, and it cannot simply be added back in. This is not to say that no combination of OT-CC and Comparative Markedness would be coherent, but it remains to be seen whether one can be found.

2.3 A Stratal OT solution

Why positional weight counts. Stratal OT dictates that syllabification takes place at the first pass through the constraint system. At the word level, moras assigned at the stem-level are indistinguishable from underlying moras (if there are any). Word-level Faithfulness effects apply to both alike. This is why compensatory lengthening can translate predictable weight into distinctive length through prosodic Faithfulness.

Let us first see how Consonant Gradation triggers resyllabification by ONSET, and consequent compensatory lengthening by MAX-μ. We show the word-level derivation, whose input in this case is just the syllabified underlying form.

(27)

Western Finnish	*T$\mu\mu$	MAX-μ	ONSET	MAX-C
Input (from stem level): /hal.kon/				
1a. hal.kon	*			
1b. ha.lon		*		*
1c. hal.on			*	*
1d. ha.loon				*

Super-optimality again. Tableau (27) shows why an output with compensatory lengthening is preferred to an output without compensatory lengthening, but it does not show why compensatory lengthening is realized on the vowel of the second syllable rather than somewhere else, i.e. why the output is *haloon* rather than **haalon* or **hallon*. This is what we referred to as the realization problem. From the perspective of locality, the outcome in Finnish is especially surprising. Why should the length of the first syllable's resyllabified coda migrate to the *second* syllable of the word?

The obvious answer is that any lengthening in the first syllable would produce wholesale mergers of important quantitative distinctions of Finnish. Lengthening of an unstressed syllable does not produce any merger, since there are no unstressed long nuclei, and in particular no unstressed long vowels, at this level of representation (Kiparsky 2003).

We already have the technology to formalize this idea. Super-optimality, if highly ranked, correctly predicts the locus of compensatory lengthening in Finnish. The derivations which take /hal.kon/ to **haa.lon, *hal.lon, *hal.kon* and **ha.lon* are not super-optimal because each of these output has a better input match, respectively /haa.lon/, /hal.lon/, /halk.kon/, ha.lon/. These outputs are therefore ruled out. The derivations /hal.kon/ → *hal.kon* and /hal.kon/ → *ha.lon* also fail to qualify for another reason, namely that the input has a better output match. This latter reason also rules out /hal.kon/ → **hal.γon*, whose output violates *γ. But /hal.kon/ → *ha.loon* is super-optimal because *ha.loon* has no better input match, /ha.loon/ not being a possible stem-level output (for, as already stated, the stem level has no unstressed long vowels) and /hal.kon/ has no better output match. The following tableau represents these considerations explicitly.

(28)

Western Finnish		S-OPT	*T$\mu\mu$	*γ	MAX-μ	ONSET	MAX-C
Input (from stem level): /hal.kon/							
1a.	hal.kon	*	*				
1b.	ha.lon	*			*		*
1c.	hal.on	*				*	*
1d.	haa.lon	*					*
1e.	hal.lon	*					
1f. ☞	ha.loon						*
1g.	hal.von	*					
1h.	hal.γon	*		*			

Two further points are of interest here. First, the lengthening of the first syllable is blocked globally, not just when it would result in a merger of actual lexical items. For example, **haalon* and **hallon* are not actual words of Finnish (as far as I know), but compensatory lengthening in /hal.kon/ → *haloon* is still displaced to the second syllable. This confirms the choice of SUPER-OPTIMALITY (or some other anti-neutralization constraint defined over classes of representations), over a constraint which which penalizes homonymy between individual lexical items.

Secondly, unlike compensatory lengthening, the gemination process in (22) neutralizes length contrasts with impunity. For example, /olka-n/ → *olaan* → *ollaan* 'shoulder' (Gen.) merges with *ollaan* 'be' (3.P.Passive). This indicates that it operates at a level where it outranks SUPER-OPTIMALITY. This is presumably the postlexical phonology. By providing independent evidence that the shortening of the first syllable by Consonant Gradation with compensatory lengthening and the subsequent relengthening of the first syllable are separate processes, it confirms the Duke of York character of the derivation.

Eastern Finnish. The remaining question is why there is no compensatory lengthening in Eastern Finnish. Since compensatory lengthening is the result of high-ranking prosodic faithfulness, its absence would be expected in dialects that rank prosodic faithfulness low. That Eastern Finnish dialects do rank prosodic faithfulness low is suggested by the fact that these dialects regularly contract any hiatus created by consonant gradation, e.g. /teko-t/ → *teot, teut*, or *te.vot* 'deeds', /raaka-t/ → *raat, roat*, rather than *te.ot, raa.at* as found in various places in Southwestern Finland. The Western dialects optimize syllable structure even at the price of losing of a mora or a syllable, while the Eastern dialects preserve syllables and moras even at the expense of hiatus. Compensatory lengthening introduces a type of syllable otherwise absent at this level of representation, namely unstressed long vowels. The absence of compensatory lengthening in Eastern dialects fits well with the other evidence for their more aggressive syllable structure constraints.

Conclusion. a Stratal OT constraint system imposes syllable structure on inputs at the stem level. At the word level, moras assigned at the stem-level have the same status as underlying moras with respect to Faithfulness constraints. In this way, predictable weight can be manifested as distinctive length. Seen in this light, compensatory lengthening is an instance of the much more widespread phenomenon of DERIVED CONTRAST, and, in diachronic phonology, SECONDARY SPLIT.

3 Samothraki Greek

3.1 An unusual case of compensatory lengthening

Loss of onsets as the trigger. The Greek dialect spoken on the island of Samothraki off the coast of Trace regularly deletes prevocalic *r* in onsets (Heisenberg 1934, Newton 1972a, 1972b, Katsanis 1996). Intervocalic *r* is simply lost, and a resulting sequence of identical vowels is contracted into a long vowel (here transcribed as a geminate vowel, in accord with the cited sources).[10]

(29)	/ɣáðaros/	[ɣáðaus]	'donkey'
	/ɣaðaro-ráxi/	[ɣaðáax́]	'Donkey Ridge'
	/píre/	[píi]	'took'
	/saradapodarúsa/	[saadapudaúsa]	'millipede'
	/éɣðera/	[éɣðaa]	'flayed (1.Sg.)'

Elsewhere, the deletion of onset *r* results in compensatory lengthening of the nucleus.

(30)	/róɣos/	[óoɣus]	'spider *sp.*'
	/ráxi/	[áax́]	'ridge'
	/iɣrí/	[ɣɨ́ɨ]	'wet' (Pl.)
	/brostá/	[buustá]	'in front of'
	/vródo/	[vóodu]	'thunder'
	/epítropo/	[pítuupu]	'bishop's representative'

Before a consonant and word-finally, *r* is retained.

[10]In Samothraki examples, *y* denotes a front glide/approximant. In the Finnish examples cited above, it denotes a front rounded vowel, and *j* a front glide/approximant, in accord with the orthography.

(31)	/samári/	[samár]	‘packsaddle’
	/babúri/	[babúr]	‘bee-fly’ (Bombylius *sp.*)
	/ɣrjá/	[ɣɨrɣ́á]	‘old woman’
	/kryás/	[kɨrɣ́ás]	‘meat’
	/aɣrjá/	[aɣɨrɣ́á]	‘wild’ (plant *sp.*)
	/ávrjo/	[ávɨrɣ́ü]	‘tomorrow’

Compensatory lengthening is synchronically active. Samothraki fully participates in the Northern Greek chain shift of nonlow unstressed vowels.

(32)
1. Unstressed *i,u* are deleted (subject to syllabic constraints)
2. Unstressed *e,o* are raised to *i,u*

(33)	/mérmig-as/	[mérmigas]	/mermíg-i/	[mirmíǵ]	ant
	/kórak-as/	[kóok-as]	/korák-i/	[kuáḱ]	raven
	/vun-ós/	[vnós]	/vun-já/	[vuńá]	‘mountain(s)’
	/míl-i/	[miĺ]	/-mil-os/	[-mlus] (in *Palió-mlus*)	‘mill’
	/pétr-a/	[pétaa]	/-petres/	[-pitiis] (in *Tsakmakó-pitiis*)	‘rocks’

The deletion of unstressed high vowels is blocked by some syllable structure constraints, but it nevertheless expands the repertoire of consonant clusters to some extent. Among initial clusters that arise only by vowel deletion are those with falling sonority, and initial geminates:

(34)	/mikr-ó/	[mkóo]	‘little’
	/mikr-í/	[mkíi]	‘little’ (Pl.)
	/kukí/	[kḱí]	‘fava bean’
	/ðiká su/	[θkás]	‘your own’

The vowel shift bleeds *r*-deletion,

(35)	/rizári/	[rzár]	‘plant *sp.*’ (*Rubia tinctorum*)
	/riáki/	[rɣáḱ]	‘spring’

and results in productive synchronic *r/∅* alternations.

(36)	/mér-os/	*méus*	/mér-ia/	*mérɣ́a*	‘place(s)’
	/bábur-as/	*bábuas*	/babúr-i/	*babúr*	‘bee-fly’
	/ɣliɣór-is/	*ɣliɣórs*	/ɣliɣor-úðis/	*ɣliɣuúðs*	(names)
	/liutér-is/	*liutérs*	/liuter-úðis/	*liutiúðs*	(names)
	/láskar-is/	*láskars*	/laskar-úðias/	*laskaúð́as*	(names)
	/sotér-is/	*sutírs*	/soter-élias/	*sutiélɣ́as*	(names)

Another piece of evidence that *r*-deletion is synchronically alive is that *r* is restored when the prevocalic context is lost through other changes. This can be seen in a comparison of Heisenberg’s data from the 1920s with the modern dialect recorded in Katsanis 1996. It seems that prevocalic *i* as seen in the older form of the dialect underwent glide formation to *y*, eliminating the context for deletion of *r* and causing it to reappear.

(37)	a.	/ávrio/	*áviü*	‘tomorrow’	(older)
		/ávrjo/	*ávɨrɣ́u*	‘tomorrow’	(more recent)
	b.	/θirío/	*θiíu*	‘beast’	(older)
		/θirjó/	*θirɣ́ó*	‘beast’	(more recent)
	c.	/rufó/	*iifó*	‘belch’	(older)
		/rfó/	*rfó*	‘belch’	(more recent)

Previous proposals. In a brief section on Samothraki compensatory lengthening, Hayes 1989 suggested that the process actually was insertion of a prothetic vowel followed by loss of intervocalic *r*, viz. *rV* → *VrV* → *VV*. Hayes’ epenthesis analysis however predicts that *CrV́* should merge with original *CVrV́*, which is not the case. In fact, there is an accentual contrast between them:

(38)
1. *rV́* → *V́V* (never *VV́*)
   e.g. *θrími* → *θíim* → *θíiða*
2. but *VrV́* usually → *VV́*
   e.g. *xará* → *xaá*

This results in a new accentual contrast V́V : VV́, similar to the ancient Greek acute:circumflex opposition, though obviously quite unrelated to it historically. The same accentual contrast can result when *r*-deletion is fed by *i-*,*u-* deletion:

(39)
1. /ɣurúni/ → **ɣrúń* → *ɣúuń* ‘pig’
   /ɣorúni/ → **ɣurúń* → *ɣuúń* ‘bee-fly’
2. /kirízo/ → *kríizu* → *kíizu*
   /kerízo/ → *kirízu* → *kiízu*

Exceptions to the accent generalization do occur, but in one direction only, and seem to be due to a lexical diffusion process *VV́* > *V́V*, often manifested in coexisting variant forms.

(40) *katsará* → *katsaá* ∼ *katsáa* ‘curly’
karávi → *kaáv* ∼ *káav* ‘boat’
katurúsan → *katuúsan* ∼ *katúusan* ‘they pissed’

One might suppose that *rV* sequences underwent metathesis, followed by loss of the coda *r*: *rV* → *Vr* → *VV*. The difficulty then is how to keep the metathesized *Vr* from /rV/ distinct from original *Vr*, which is retained. Modern Samothraki freely allows coda -*r*.

(41)
1. *tsafĺárs* (place name)
2. *fanárɣ́a* ‘beacons’ (place name)
3. *samár* ‘packsaddle’

Kavitskaya 2002: 99 suggests that *r* was reinterpreted as vowel length due to its acoustic similarity to vowels. This is probably not quite right because the deletion of *r* (at least as far as it is phonologically active) applies just to *onsets*, while it is coda *r* that would normally be more similar to a vowel than onset *r*. Moreover, Kavitskaya's proposal for Samothraki is in a sense too easy. It involves giving up either the well-supported generalization that compensatory lengthening is weight-preserving, or the equally well-supported generalization that onsets are weightless.

Topintzi 2006 draws attention to the incompatibility of Samothraki compensatory lengthening with OT, and argues that it requires resurrecting segment-based theories of compensatory lengthening. She suggests that *r* is placeless, hence disallowed as an onset. To drive compensatory lengthening she proposes a constraint POSCORR which requires that an input segment must have an output correspondent either segmentally, by means of a *root node*, or prosodically by means of moras. This would be an unfortunate move because segment-based theories predict a range of unattested types of compensatory lengthening, and leave no room for the standard explanation of the type of compensatory lengthening that is triggered by desyllabification, as in the Pali example in (2), the Luganda example in (3), and the Kihehe and Kimatuumbi cases of *iV-* → *yVV-* well-known from Odden 1996.

Nevertheless I think that Kavitskaya's and Topintzi's proposals each contain an insight which I will adopt. Kavitskaya's idea that *r* is in some sense vowel-like, and Topintzi's idea that it is disallowed as an onset can be combined in a natural way in the moraic theory of syllable structure.

3.2 A Stratal OT account

The preference for low-sonority onsets. I propose to base the explanation of Samothraki compensatory lengthening on the well-established fact that high-sonority segments do not make good onsets. There are quite a few languages which have /r/ but exclude it from word-initial position, sometimes even syllable-initial positions (de Lacy 2000, Smith 2003, Flack 2007). The Korean native vocabulary has no syllable-initial liquids. Languages with no initial liquids include Sestu Campidanian Sardinian (Bolognesi 1998), Basque (Hualde and de Urbina 2003: 29), Piro (Matteson 1965), Mbabaram (Dixon 1991), Golin (Bunn & Bunn 1970), Guugu Yimidhirr (Haviland 1979), Pitta-Pitta (Blake & Breen 1971), Kuman (Blevins 1994), Telefol (Healey & Healey 1977), Chalcatongo Mixtec (Macaulay 1996), West Greenlandic (Fortescue 1984), Nganasan and Selkup (Helimski 1998: 482), Taimyr Pidgin Russian. Northern Bangla (Kamrupa, Bhattacharya), and Japanese (Old Japanese, and modern Japanese Yamato and mimetic stems, Itô & Mester 1993). Most languages of the Dravidian, Tungus, Turkic (Kornfilt 1997: 492), and Yeniseyan families belong. Even some older Indo-European languages lack initial *r-* (Hittite and Classical Greek[11]).

The ban on sonorous onsets often starts from the top of the sonority hierarchy, so that it also encompasses the still more sonorous glides. Languages that lack initial liquids often lack initial glides. There are however languages which ban onset *r-* in positions that ostensibly allow glides. Smith (2003) argues that in languages that allow syllable-initial glides but not liquids, the glides are part of the nucleus, i.e. moraic rather than true onsets. There is indeed independent evidence for nuclear/moraic onglides in at least some of these languages, including Campidanian (van de Veer 2004), Toda (Emeneau 1984), Korean (Sohn 1987). Nuclear/moraic onglides are also found in Spanish (Harris 1983, Harris & Kaisse 1999), French (Kaye & Lowenstamm 1984), Slovak (Rubach 1998), English (Davis & Hammond 1995) and Mizo (Vijayakrishnan MS.). For example,

[11] The initial *r-* of Greek is voiceless/aspirated, which is why it is written with the rough breathing, and transliterated as *rh-*.

in Spanish and Mizo, sequences of the form *iV* always count as heavy syllables for the purpose of stress assignment and phonotactics.

For concreteness, let us assume the definition of sonority in terms of major class features along the lines of Zec 1994 and Clements 1990:

(42)

	Obstruents	Nasals	Liquids	Rhotics	Vowels
non-consonantal	–	–	–	–	+
approximant	–	–	–	+	+
vocalic	–	–	+	+	+
sonorant	–	+	+	+	+

Prince and Smolensky (1993) work out a theory of syllabification which accesses the sonority hierarchy from both ends — from the top through a constraint family which prohibits segments from syllable margins, and from the bottom by a constraint family which prohibits segments from peaks. The former applies in the core cases to the most sonorous segments and in more general versions to successively less sonorous segments, and the latter applies in the core case to the least sonorous segments and in more general versions to successively more sonorous cases.

I will adopt a slightly different approach here. In addition to the familiar minimum sonority licensing constraints on syllables and moras proposed by Zec and others,

(43) Minimum sonority licensing constraints:

a. $\mu/\sigma \supset$ [–cons,+low] — a mora/syll. must be licensed by *a*
b. $\mu/\sigma \supset$ [–cons] — . . . by *a, i, u*
c. $\mu/\sigma \supset$ [+son,+approx] — . . . by *a, i, u, r*
d. $\mu/\sigma \supset$ [+son,–nasal] — . . . by *a, i, u, r, l*
e. $\mu/\sigma \supset$ [+son] — . . . by *a, i, u, r, l,* nasals
f. . . .

Let us assume a complementary set of maximum sonority licensing constraints on sonorous segments.

(44) Maximum sonority licensing constraints:

a. [-cons,+low] $\supset \mu/\sigma$ — *a* must be licensed by a mora/syll.
b. [–cons] $\supset \mu/\sigma$ — *a, i, u* . . .
c. [+son,+approx] $\supset \mu/\sigma$ — *a, i, u, r* . . .
d. [+son,–nasal] $\supset \mu/\sigma$ — *a, i, u, r, l* . . .
e. [+son] $\supset \mu/\sigma$ — *a, i, u, r, l,* nasals . . .
f. . . .

We can now get the syllable typology by interspersing the standard syllable structure constraints with the sonority constraints in the constraint hierarchy. A simple example: in Spanish, *ye* is a complex nucleus, and in English it is a CV sequence. In terms of our proposal, this means that the Spanish ranking is (44b) ≫ ONSET, while the English ranking is ONSET ≫ (44b):

(45)

			(44b)	ONSET
1a	☞	ia		*
1b		ya	*	

			ONSET	(44b)
2a		ia	*	
2b	☞	ya		*

A prediction made by this approach (but not by the classic OT syllable theory) is that, although there are languages where every segment wants to be moraic/syllabic (Berber, famously), there are no languages where every segment wants to be non-moraic/non-syllabic. E.g. no language syllabifies /pit/ as [pyVt], with an epenthetic vowel to get the segments into the margin.

How is the prohibition of onset *r* enforced? Just as satisfaction of the constraints in (43) is achieved by many different processes, including sonorization of coda segments, vocalic epenthesis, and resyllabification, so the constraints in (44) are are also implemented by many different processes:

(46) How to avoid sonorous onsets

1. Vocalization/prothesis: *ya* → *iya*
2. Deletion: *ya* → *a*
   Proto-Nyulnyulan **wamba* ‘man’ (Nyikina, Yawuru, Warrwa *wamba*) > Bardi *amba*.[12]
3. Fortition: *ya* → *ja*
   Indic **y*- > *j*-.
4. Anti-gemination: *aya* ↛ *ayya* even when otherwise VCV → VCCV
   Germanic **iyya* > *iddja*, **uwwa* > *uggwa*
5. Incorporation into nucleus: diphthongal *ia*
   Italian, Spanish

The same processes are in principle available for *r*, and indeed all are attested.

(47) How to avoid initial *r*-

1. Prothesis: *ra* → *ara*
   Latin *rana* ‘frog’ > Campidanian *ará:na*, similarly Basque
2. Deletion: *ra* > *a*
   North Bangla (Kamrup) *ram* → *am*

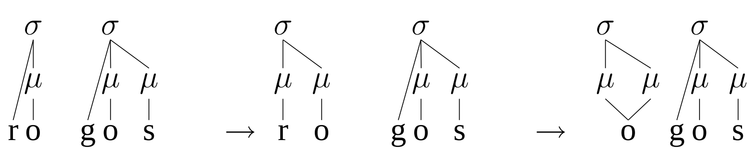
[12] “Most vowel initial words in Bardi result from a fairly recent phonological change whereby word initial glides w and v were deleted.” (McGregor 2004).

3. Fortition: *ra* → *na* (Korean)
4. Anti-gemination

   In Sanskrit, *r* is the only consonant which does not occur geminated. In sandhi, *rr* is degeminated with compensatory lengthening: *VrrV* → *V̄rV*.[13]
5. Incorporation into nucleus: diphthongal *ra*

Since glides can be incorporated into the syllabic nucleus as moraic elements, as in Spanish and Mizo, we expect that the same could happen to *r*-. The result would be a nucleus of the form *ra*, technically a rising diphthong. My proposal is that this rather surprising development is just what happened in Samothraki.

Samothraki. According to the proposed scenario, then, the fate of Samothraki *r* was as follows. At some point, glides were lost in the language.[14] In Samothraki, the constraint on onsets was then further tightened by one notch: not only *i*, *u*, but also *r* had to be moraic. Formally, (44c) comes to be ranked high, prohibiting onset glides and onset *r*. To conform to this sonority constraint, initial preconsonantal *r*- (as in *rzári*) became moraic, either syllabic or semisyllabic.[15] The semisyllabic structure was needed anyway for initial geminates, as in /kukí/ [kḱí], since there is really no other way of characterizing geminates than to make them moraic. In prevocalic position, there are no syllabic or semisyllabic segments, so this parse is not available. Consequently the only remaining option for prevocalic /r/ is to incorporate it into the nucleus. At a subsequent stage it is then deleted with compensatory lengthening.

(48) 

As a synchronic account, this requires two distinct syllabifications of the same input, as in Luganda. Therefore it cannot be implemented in classic or transderivational parallel OT.

As a historical account, this analysis can be supported by a parallel development in ancient Greek involving the vocalization of laryngeals. The reflexes of -*R̥h*- as Greek *RV̄*, with *V̄* having the vowel color of the original laryngeal, are well known, but phonologically rather puzzling. (Here *R* stands for *r* and *l*).

(49) Greek -*R̥h*- > *RV̄* via vocalization of laryngeals.

1. **R̥*h_3 > *Rō*: **str̥*h_3*-tó-* > *strōtós* ‘spread’
2. **R̥*h_2 > *Rā*: **kr̥*h_2*-tó-* > *krātós* ‘mixed’ ‘bearable’
3. **R̥*h_1 > *Rē*: *pl̥*h_3*-t*^{h}*ú-* > *plēt*^{h}*ús* ‘fullness’

[13] Likewise, in Germanic *r* is the only C which does not undergo West Germanic C-gemination: /sitjan/ → [sit.tan], but /nerjan/ = [ner.jan] (↛ *[ner.ran]).

[14] Modern [ʝ], phonetically an approximant, patterns phonologically as a fricative, functioning as the front counterpart to the velar spirant [ɣ], with which it alternates regularly.

[15] On the analysis in Kiparsky 2002, semisyllables are moras adjoined to a syllable. The details are not important for now; what matters is only that they should be moraic.

In the original syllabification (reconstructed, but uncontroversial), -*R̥h*- is a heavy syllable. The idea is that when the laryngeals became syllabic, the weight was retained. The mora associated with the formerly syllabic liquid is reassociated with the melody of former laryngeal, now a vowel.

Returning to modern Greek: even if this is what happened historically, is there reason to think that it is a synchronic live system? I believe the answer is yes. One piece of evidence is the parallel evolution of /l/, the next element on the sonority scale, in older Samothraki. The data in (50) (recorded around WW I and published in Heisenberg 1934) show that at that time onset /l/was subject to exactly the same deletion process as /r/,

(50)	/fustanéla/	[fustanéa]	‘(man’s) skirt’
	/katálave/	[katáavi]	‘noticed (3.Sg.)’
	/petrovolúse/	[pituuvuúsi]	‘threw rocks (3.Sg.)’
	/xalási/	[xaás]	‘destroyed (Perf.Inf.)’

and with compensatory lengthening under the same conditions as /r/.

(51)	/klépsi/	[kéeps]	‘steal (subj.)’
	/san kléftis/	[sa géefts]	‘like a thief’
	/eklisía/	[akiišá]	‘church’
	/alla aft’os/	[aaftós]	‘but he’
	/ɣlítose/	[ɣíitusi]	‘escaped (3.Sg.)’

Remarkably enough, *l* has been restored in the modern Samothraki dialect (Katsanis 1996).

(52)		Heisenberg 1934	Katsanis 1996	
	/xalási/	[xaás]	[xalás]	‘destroyed’
	/vrikólakas/	[viikóakas]	[viikólakas]	(place name)
	/nikólas/	[ńkóas]	[ńkólas]	(personal name)

Such restoration would hardly be possible if the speakers did not identify their long vowels with the liquid-glide sequences, known to them partly from alternations internal to the dialect (such as those cited in (36)) and partly no doubt from the corresponding words in the standard language.

If the cross-stratal resyllabification required by the autosegmental approach to compensatory lengthening is indeed independently motivated, then Luganda supports Stratal OT over parallel OT.[16]

4 Conclusion

The Finnish and Samothraki Greek instances of compensatory lengthening examined here appear to be intractable in both classic parallel OT and in transderivational OT, as well as in older rule-based autosegmental approaches. I have argued that Stratal OT deals with them in a way that rescues the essential idea behind the autosegmental theory of compensatory lengthening. The theoretical issues addressed concern the ACTUATION of compensatory lengthening, its REALIZATION and specifically the locality relation between the target of lengthening and its trigger, the DISTINCTIVENESS of the resulting weight, and the possibility of apparent NON-MORAIC TRIGGERS.

[16]Specifically, classic parallel OT cannot derive Luganda compensatory lengthening at all, and OT-CC (nominally parallel but with quasi-derivations) can derive it only in a stipulative way (Shaw 2007).

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