Chains or Strata? The Case of Maltese

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1 Cyclicity as opacity

In previous versions of OT phonology, GEN generates a universal set of output candidates and EVAL selects the most harmonic of them in accord with the language's specific constraint ranking. In OT-CC (OT with Candidate Chains), GEN and EVAL together build CHAINS, derivations which link input to output by minimal steps (McCarthy 2007, Kimper 2008, McCarthy 2009, 2010, Hyde 2009). The initial link in the chain is the most harmonic faithful parse of the input. Every successive link in the chain must be minimally less faithful than the immediately preceding one, and less marked. That is, it must have all of its unfaithful mappings and exactly one new one (the GRADUALNESS requirement), and it must be more harmonic than the preceding with respect to the language's constraint hierarchy (the HARMONIC IMPROVEMENT requirement). The chain terminates in a link that cannot be further optimized in any such minimal step.

OT-CC also introduces a novel approach to opacity. Transderivational faithfulness constraints such as Sympathy are replaced by PREC(EDENCE) constraints, which are transderivational well-formedness conditions on the sequence of links in a chain. McCarthy defines them as follows.

(1) PREC(A, B): Let A′ and B′ stand for forms that add [minimal] violations of the faithfulness constraints A and B, respectively.

- To any chain of the form $<$ X, B′, Y $>$, if X does not contain A′, assign a violation mark, and
- to any chain of the form $<$ X, B′, Y $>$, if Y contains A′, assign a violation mark.

In effect, PREC(A, B) says that a link that violates B must be preceded by a link that violates A (this prevents counterbleeding), and cannot be followed by a link that violates A (prevents counterfeeding).

O(ptimal) I(nterleaving) (Wolf 2011) extends PREC constraints to cyclic phonology/morphology interactions. OI allows phonology and morphology to be interleaved, as in Lexical Phonology and Morphology and Stratal OT, and now also in Distributed Morphology (Embick 2010). Unlike Stratal OT, OI adopts DM's realizational view of morphology, according to which words are built by spelling out the features of an abstract morphosyntactic structure by morphological exponents, in satisfaction of Faithfulness constraints that demand the expression of those features. The novelty of OI is that PREC constraints regulate not only the sequence of phonological steps in the derivation, but the relative order of affixation and phonological processes. They do so by requiring

that when a particular morph M is inserted, a particular phonological operation P must have taken place previously in the chain, and cannot take place afterward in the chain. PREC constraints are ranked, so they should be defeasible by higher-ranked constraints.

OI is reminiscent of Inkelas' (1993) idea that the order of morphological processes and the construction of prosodic constituency can be parametrically fixed for a language. The empirical evidence that the two researchers adduce is analogous too. Wolf supports his proposal with a new analysis of cyclic stress assignment in Maltese, addressing a problem that has resisted a principled solution in standard phonological frameworks since it was discovered by Odden 1993. Inkelas, in a paper coincidentally published in the same volume as Odden's, draws her evidence from a problem involving cyclic stress assignment in Carib; I will suggest essentially the same Stratal OT solution for both cases.

In the OT context, the attraction of OI is that it promises to replace Sympathy constraints and Output/Output constraints with a single type of transderivational constraint that takes care of both opacity and cyclicity, the two major stumbling blocks to OT. OI is the only such unification of opacity and cyclicity as yet proposed in OT phonology, other than Stratal OT. Conceptually it is certainly a major step forward compared to the separate types of transderivational constraints that mainstream OT phonology has offered so far.

Wolf's article is an admirably clear exposition of OI, but his argument for dealing with cyclicity by PREC constraints is almost entirely internal to OT-CC. Output/Output constraints are not mentioned at all, and Stratal OT is mentioned only to be dismissed without argument as being committed to implausible typological predictions. Making a convincing case for a model or theory requires engaging a sufficiently representative set of actually worked-out alternatives. As a first step towards this project, this paper compares OI and Stratal OT analyses of Maltese and Carib, in the hope that proponents of other approaches, including rule-based ones, will tackle this material from their own perspective.

2 Maltese stress, syncope, and lengthening

Like the historically related North African Arabic dialects and the so-called "non-differential" dialects of Levantine Arabic (e.g. Kfar-Ṣgha͞b, Fleisch 1963), Maltese deletes unstressed short vowels in non-final open syllables irrespective of their height, as in (2b) *ħtáfna* 'we snatched', from /ħataf-na/. As in Levantine Arabic, this syncope process does not apply before object/possessive endings; see (2c).[1]

(2)	a.	*ħátaf*	'he snatched'	
	b.	*ħtáfna*	'we snatched'	(syncope before subject *-na*)
	c.	*ħatáfna*	'he snatched us'	(no syncope before object *-na*)

In the analysis first proposed by Brame 1974, the first syllable in (2c) *ħatáfna* is protected from syncope by a stress regularly assigned to the base (2a) *ħátaf*, which the inflected form cyclically inherits from it, until destressed by a later rule. In the Stratal OT implementation of Brame's

[1] Words in italics, or contained in labeled brackets marking constituency, are in Maltese spelling, with accents and length marks added where necessary. In the Maltese writing system, *j* represents a front palatal semivowel (yod), which I write /y/ in phonemic transcriptions, *q* represents a glottal stop (/ʔ/), and *x* the palatal fricative (/ʃ/). Examples not taken from Wolf 2011 are from Sutcliffe 1936, Aquilina 1959, 1990 and Borg 1997.

analysis presented below, syncope is postlexical and the protective stresses are exactly the ones that are present in the output of the word phonology, which is the input to the postlexical phonology. This is illustrated by the (condensed) derivations in (3), where α = Stem and ω = Word.

(3) a. [ħátaf]$_{\alpha}$ → [ħátaf]$_{\omega}$ → *ħátaf* 'he snatched'
b. [ħatáf-na]$_{\alpha}$ (from (a)) → [ħatáf-na]$_{\omega}$ → *ħtáfna* 'we snatched' (syncope)
c. [ħátaf]$_{\omega}$ (from (a)) → [ħàtáf-na]$_{\omega}$ → *ħatáfna* 'he snatched us' (no syncope)

The form in (2c) is derived from the prosodic word in (2a) by affixing a pronominal object ending to it at the Word level. Its initial secondary stress, inherited from the base, protects the vowel from undergoing postlexical syncope, by the faithfulness constraint MAX-V́. In contrast, the subject ending is (3b) is are assigned at the Stem level, where stress is not cyclically inherited, because of a dominant foot binarity condition (or *CLASH, on an alternative view).

Verbs whose stems end in a vowel present an interesting challenge to the cyclic understanding of Maltese stress and syncope, and to Lexical Phonology and Stratal OT in general. They drop the vowel of the first syllable *whenever* it is unstressed in the output — not only before stem-level subject endings, but before word-level object endings as well, where its retention would be expected on the analogy of (3).

(4) a. *ʔára* 'he read'
b. *ʔrájna* 'we read' (syncope)
c. *ʔrá:na* 'he read us' (*syncope!*)

Another class of -V verbs shows the same generalized syncope with another vowel pattern.

(5) a. *méla* 'he filled'
b. *mléjna* 'we filled' (syncope)
c. *mlíena* 'he filled us' (*syncope!*)

Suffixes must be preceded by a heavy syllable, so a short stem-final vowel is lengthened before them. The lengthening applies not only to verb stems, but also to affixes and pronouns; its triggers include, in addition to the object markers, also the clitic *-x* (/-ʃ/) which is appended to verbs and pronouns negated with *ma*.

(6) a. *ħtáf-tu* 'you (pl.) snatched' *ħtaf-tú:-na* 'you (pl.) snatched us'
b. *ħtáf-na* 'we snatched' *ħtaf-níe-kom* 'we snatched you (pl.)'
c. *hú:ma* 'they' *m'humíe-x* 'they are not'
d. *jíena* 'I' *ma jiníe-x, m'iníe-x* 'I am not'

We will come back to the question why final *-a* corresponds to medial *áj* and *á:* in (4), and to medial *éj* and *íe* in (5).[2]

[2]The *aj* pattern is actually productive, and has been extended to verbs borrowed from Italian and English, such as *abbanduna* 'abandon', *fada* 'trust', *illandja* 'land' (a plane) (Aquilina 1990: 1654). It has been suggested that the termination has become reanalyzed as an independent morpheme, a root extension or stem-forming suffix (Mifsud 1994, Fabri 1999, Spagnol 2011). This could impact the analysis by making an allomorphy treatment of the vowel alternations more palatable, though still not superior to the phonological one proposed in section 4, I think.

Odden (1993), who first drew attention to the significance of the syncope pattern in (4) and (5), explained the generalized initial syncope of vowel-final roots by the final stress that they receive on the lengthened syllable. In the Lexical Phonology framework that he adopted, this required a new type of allomorphy, phonologically conditioned but "precompiled" for later insertion in the derivation. A precyclic lengthening process applies at level 1 (the stem level) before the phonology proper. It generates an input allomorph for vowel-final stems (for example, /ʔara/ → [ʔara:]), which is then phonologically converted to [ʔrá:] by the regular vowel deletion and stress rules, still at level 1.[3] The resulting output allomorph [ʔrá:] is then stored, and selected at level 2 (the Word level) by the object endings, which are added at that level.

Wolf (2011) also capitalizes on the lengthening of vowel-final roots to explain the two syncope patterns, (2) versus (4) and (5), but in a different way. He derives them from different orderings of prosodic structure building and attachment of object endings. The "cyclic" derivation results from building prosodic structure on the verb *before* adding object morphology, which blocks syncope from applying to it, and the "noncyclic" derivation results from building prosodic structure on the whole word *after* object morphology. The ordering is enforced by two PREC constraints, one requiring that prosodic structure is built after vowel lengthening, the other requiring that prosodic structure is built before morphology. So ranked, and properly placed among the rest of the constraints, they ensure that V-final stems get prosodified with the morphologically triggered lengthening of the final syllable in place, and are therefore assigned root-final stress. For C-final stems, which can't undergo lengthening, the first PREC constraint has no effect one way or the other. In order to satisfy at least the second PREC constraint, they get their prosodic structure built before morphology, with the result that the root-initial vowel is stressed and retained.

A common feature of Odden's and Wolf's theoretical proposals is their hybrid character: a precompilation rule quacks like phonology but walks like allomorphy, OT-CC/OI quacks like OT but walks like old-time stipulative rule ordering. Their analyses also share some omissions in empirical coverage, especially of the diphthongs in (4b) and (5b) and the different vowel quality associated with pre-object lengthening in (4c) and (5c). For Odden's proposal these additional data mean merely that it needs four allomorphy rules instead of just one. For Wolf's phonological treatment they raise a more serious question: how will four distinct long nuclei *ay, a:, ey, ie* be derived from underlying short /-a/?

I will undertake to show that Stratal OT's off-the-shelf analytical tools of proven worth yield a better understanding of Maltese stress, length, and syncope, and with improved empirical coverage. We'll see that the neglected vowel alternations actually provides a crucial clue to understanding what is really going on. Section 3 reviews Wolf's analysis, and section 4 puts forward a Stratal OT alternative. Section 5 supports the analysis with Inkelas' interestingly parallel case of apparent non-cyclicity in Carib. I conclude in section 6 with a few more general remarks on OT-CC.

3 Maltese in OI

The OI derivation of (3b) *ħtáfna* 'we snatched' and (3c) *ħatáfna* 'he snatched us' is shown in in (7a) and (7b) (parentheses delimit feet and square brackets delimit Prosodic Words).

[3] Although Maltese does not have a length contrast on word-final vowels, its stress rule is quantity-sensitive (see below) and can be formulated without loss of generality in such a way that the lengthened vowel of the precompiled allomorph gets assigned final stress.

(7) a. ħataf → ħataf-na → [ħa(táf)na] → [(ħtáf)na] ‘we snatched’

b. ħataf → [(ħá)taf] → [(ħá)taf-na] → [(ħà)(táf)na] ‘he snatched us’

The chain (7a) derives the case where *-na* is the 1.Pl. subject agreement morpheme. In Wolf’s analysis it wins over chain (7b) on markedness grounds: with one foot less, it has two fewer violations of ALL-FOOT-RIGHT, a constraint which requires feet to be aligned with the right edge of the word. Chain (7b) must prevail over it when *-na* is the 1.Pl. object ending. It is selected over (7a) by the constraint PREC(build-PWd, insert-object), which requires that the insertion of an object is preceded by the building of a PWd, and that the insertion of an object is not followed by the building of a PWd. Accordingly the object ending *-na* is appended to a base that is already prosodified and accented. Its accent is locked in by the Free Element Condition (FEC, Prince 1985, revived for Harmonic Grammar by Pruitt 2008 and Kimper 2011) according to which foot-parsing only operates on syllables that are not already footed.[4] The FEC causes the initial syllable of the base to retain its accent in the second “cycle”, protecting it from syncope.

The OI derivation requires that the *second* syllable in (7b) *ħataf* remain unparsed in the base: otherwise the FEC will prevent it from getting stressed before the object suffix *-na*. The input has to be prosodically parsed as [(ħá)taf], with a monomoraic initial foot (ħá), a parse achieved by the ranking NONFINAL(Foot) ≫ FOOTBIN (which says that it is more important that a foot should be non-final than that it should be binary). Here the concern arises that the underparsing, and the constraint ranking that enforces it, is otherwise unmotivated, and indeed undesirable because FOOT-BIN at the moraic level is unviolated in the output of Maltese words. The minimal foot of Maltese is a moraic trochee: the language has, for example, no monomoraic words (Aquilina 1959, Borg 1997).

Wolf does posit monomoraic feet for Maltese in words like *ħatáfna* ‘he snatched us’: his constraints assign a secondary accent to their first syllable. Such a secondary accent is however not vouched for in any description of Maltese available to me.[5] In Levantine Arabic (where OI is committed to a similar analysis) there is no audible initial accent in the corresponding kinds of words either, at least for speakers I have heard. If in fact Maltese words like *ħatáfna* are pronounced with the stress pattern of underived words such as *kanásta* ‘Canasta’, then OI is in trouble. Stratal OT can postlexically delete the cyclic accent that protects the vowel from syncope (as in the Lexical Phonology analysis of Levantine Arabic, Kiparsky 2000), but in Wolf’s analysis, the output *ħatáfna* is harmonically bounded: it can’t be derived under any ranking, let alone a ranking that also derives *ħtáfna* ‘we snatched’. Moreover, the FEC (at least in the formulation reproduced in fn. 4) does not allow the cyclically assigned accent to be deleted at all. This is a crucial empirical difference between the analyses, which appears to favor Stratal OT.

The issue is not just internal to Maltese. It is a more general concern about the Free Element Condition. Prince’s formulation appears to be too strong, as noted long ago on the basis of ev-

[4] “Any foot that is built in the course of deriving stress is inherited by any member of the candidate set for subsequent iterations.” (Pruitt 2008:6). If this is an inviolable constraint, it will prevent any destressing processes; in particular, it will make it impossible to account for a language in which stress is fully predictable, since any arbitrary feet in the lexical representation would be locked in all the way to the output. (In standard OT, as in Stratal OT, these are languages in which foot building constraint dominate the faithfulness constraints that can defeat them.) This proposal seems so obviously wrong that I suspect that I have somehow misunderstood it.

[5] Aquilina (1959) explicitly says (p. 68) that a word can only bear one stress, even taking care to state as an exception that pharyngealized vowels “always bear a sort of secondary stress”, e.g. *rá ɣa*, *rà ɣáw* ‘they pastured’, *rà ɣáwlhom* ‘they pastured for them’. Borg 1997 describes this property of pharyngealized vowels as length, rather than stress. In any case it is fair to infer that if words like *ħatáfna*, which don’t have a pharyngealized vowel, had an initial secondary stress, these meticulous observers would have duly reported it.

idence from English and other languages (Kiparsky 1982). English stress is cyclically assigned (Chomsky and Halle 1968, Pater 2000). An OI treatment of cyclicity requires some prosodic category to be constructed on the base before the affixation of level 1 endings like *-ity* (and a fortiori before level 2 endings, where preservation of the base's stress is almost total). Under the Free Element Condition, the base of *livíd-ity, solíd-ity, metáll-ic* can't be prosodified with a disyllabic foot [(livi)<d>], [(soli)<d>], [(meta)<l>], as standardly assumed, with just the final consonant remaining extrametrical (prosodically unparsed), or non-moraic, depending on the analysis. To escape the FEC, the base would have to be prosodified with a one-mora foot as [(li)<vid>], [(so)<lid>], [(me)<tal>], leaving the second syllable free to be stressed when the suffix is added. Monomoraic feet in basic stress assignment would be as undesirable in English as in Maltese. English abhors monomoraic words, and a light syllable is destressed next to a stress, witness the reduction of the pretonic syllables in *lividity, solidity, metallic, exclamation, invitation*.

For these and other reasons I proposed in the cited article that the Free Element Condition is not a separate condition on the construction of prosodic words, and that the effects attributed to it are actually a special case of blocking in non-derived environments. The generalization is that structure-changing operations take effect only if the input satisfies them in virtue of an earlier phonological or morphological process. For example, in the derivation [(sóli)<d>] → [so[lídi]ty], prosodification *does* reach into the already prosodified base and combines its second syllable with newly inserted material from the affix, precisely because the affixation of *-ity* provides a derived environment for reprosodification to apply in.

Putting this problem aside, let's return to the apparently non-cyclic behavior of vowel-final verbs. Wolf's analysis gets it by adding a second PREC constraint that outranks PREC(build-PWd, insert-object), namely PREC(IDENT(long), build-PWd), which says that a lengthening or shortening process must precede the building of a Prosodic Word, and may not follow the building of a Prosodic Word. Chains involving vowel-final verbs satisfy PREC(IDENT(long), build-PWd) only if the building of a Prosodic Word (which subsumes stress assignment) takes effect *after* lengthening, and therefore after the morphology that conditions the lengthening. Consonant-final stems cannot lengthen their final syllables, and so the constraint will be equally violated by all their forms. Since it does not differentiate between the output candidates, the decision between them devolves on the remaining constraints, which apply as just described.

This example raises another major concern about OI, the specter of globality. In OI, the constraints, and PREC constraints in particular, evaluate entire derivational chains. This formalism is capable of subverting locality in a pernicious way. Letting chains to have morphology and phonology interleaved in OI style aggravates the problem, especially under parallel OT's and Distributed Morphology's commitment to a single combinatoric system from morphemes to sentences (or phases). In Maltese, the timing of prosodic constituency formation could theoretically depend on the presence of an IDENT(long) violation arbitrarily far away in the derivation, resulting in pathological predictions such as that 'he snatched us' will be pronounced as *ħatáfna* if the phase contains somewhere a word with a shortened or lengthened vowel (say *Keli:nu* 'Michael', from *Kíeli* 'id.'), and otherwise as *ħtáfna*.

The globality would be mitigated if we assume a quasi-stratal, non-DM version of OI where words and sentences are generated as separate phases, or by separate constraint systems. Though admittedly not in the spirit of parallel OT, this would be consistent with Wolf's practice, and would leave his analysis of Maltese intact. From what I can see, OI really doesn't need all of DM, it just needs some kind of realizational approach, where input features are "spelled out" by morphemes, in order to have faithfulness constraints drive affixation. The rest of DM could then be dropped in

favor of lexicalism. But even such a modularized OI would still predict weird global long-distance effects *within* words, as well as *within* sentences. This is illustrated by the following example. In order to protect the initial vowel from syncope in the derivation of *qasam-hú:-lu* 'he broke it for him' (Sutcliffe 1936: 158), the base *qasam* must be prosodified before an object ending is added, according to the OI story. Later in the chain, the second object ending *-lu* lengthens the first, an IDENT(long) violation. So the chain would have to look something like this:[6]

(8) qasam → [(qá)sam] → [(qá)samhu] → [(qà)(sám)hu] → [(qà)(sám)hu:lu] → [(qà)(sàm)(hú:)lu]
'he broke it for him'

But this chain has prosodification before lengthening, and will be ruled out by the dominant constraint PREC(IDENT(long), build-PWd). The system wrongly rejects it in favor of the chain (9), where prosodification is deferred until after lengthening:

(9) qasam → qasamhu → qasamhu:lu → [qasam(hú:)lu] → *[qsam(hú:)lu] (or *[qasm(hú:)lu])

A theory which allows the cyclicity of a stem depend on whether some lengthening process is going to take effect five morphemes away (let alone five words away) is not credible. One of the virtues of a model in which words are interpreted incrementally as they are built up, such as Stratal OT, is that it makes morphology and phonology intrinsically cyclic and local, restricting their interaction to the empirically justifiable limits.

Another worry about OI is familiar from earlier discussions of Sympathy (e.g. Kiparsky 2000), and applies equally to other transderivational versions of OT. It is that faithfulness constraints do not necessarily group phonological processes into the relevant classes. Violations of, say, IDENT(long) can arise at more than one stratum, and in such cases they will be subject to different PREC constraints. For example, phonetic lengthenings/shortenings might have to apply later than phonological ones, with other processes taking effect between them. On the other hand, the processes of one stratum, though interacting transparently with each other, may involve a range of different faithfulness violations, so that they couldn't be subsumed under the same PREC constraints. Consider PREC(IDENT(long), build-PWd) again. It is devised to make lengthening before endings apply before prosodification. But what the formulation actually says is that *all* lengthening and shortening must precede prosodification. But that isn't true, and there is no reason why it should be. The negation *-x* lengthens the vowel directly before it, but unlike object suffixes, causes cyclic prosodification of the base, so that the first stem vowel gets stressed and escapes syncope (Wolf 2011, citing data from Mifsud 1995: 119):

(10) a. *bena* 'he built' *ma beníex* 'he did not build'
b. *dara* 'he got used' *ma dara:x* 'he did not get used'
c. *nesa* 'he forgot' *ma nesíex* 'he did not forget'

What does this mean for the OI analysis? When lengthening is triggered by the negation *-x*, the constraint PREC(IDENT(long), build-PWd) must be dominated by some other constraint that requires building a PWd before the negative suffix is added. Wolf suggests that PREC(IDENT(long),

[6]The 3.Sg. object suffix has a final vocalic allomorph *-u*, e.g. *qásmu* 'he broke it'. So perhaps the bound allomorph *-hu-* is bundled with the indirect object *-lu* together into a package. This would do nothing for the conundrum raised in the text, though. The point is that not any random lengthening in the word or phase causes deferred prosodification, as the OI analysis would have it.

build-PWd) is dominated by an alignment constraint that requires building a PWd before the negative suffix is added — quite literally a restatement of the problem rather than a solution. (In the Stratal OT analysis developed below, the difference between object endings and the negation *-x* follows from the assumption that *-x* is a clitic added postlexically, whereas the object endings are added at the word level.)

The true generalization about cyclic effects has nothing to do with type of faithfulness violation that an operation incurs. The phonological and morphological operations at a given level are mutually transparent, they see the output of the preceding levels, and they do not see the operation of any operations at the next level. Again the problem is not particular to this analysis, nor even to OT-CC in particular. Any form of transderivational OT that individuates processes or groups them into functional classes by the faithfulness violations they introduce will fall prey to it.

A basic objection to the OI analysis of Maltese is that it does not connect the special behavior of object endings to their external position in the word structure, or to any of their other morphological and phonological properties. As far as Wolf's analysis is concerned, it could just as well be the inner, subject endings that must go on prosodified bases (by high-ranking PREC(build-PWd, insert-subject)). And the cyclicity could as well involve not PWd building but some other arbitrary phonological process. What Stratal OT claims is that all opacity results from masking of the regularities of a stratum by those of a later one.

Finally, *why* do subject agreement endings stand closer to the verb than object endings? This is not strictly a question that OI itself needs to answer, but the answer does bear on the choice between lexical and distributed morphology. The puzzle is that the morphological constituency of the word is the reverse of the syntactic constituency, where objects are internal arguments and subjects are external arguments — an apparent mirror principle violation, recalcitrant to DM. From a lexical perspective the ordering might be understood as follows. Agreement (like anaphora) targets the most prominent available argument — the subject if available, otherwise the most prominent object. (An argument may be unavailable to agreement if it bears a lexical "quirky" case or is governed by a preposition, and it certainly is unavailable if it is demoted, as the logical subject of passives is.) Assume a constraint to that effect, and assume further the Stratal OT view that affixation is done incrementally and interpreted cyclically. Then it follows that the first agreement morpheme that is added is the innermost one and marks agreement with the subject if available (presumably registered in the verb's thematic structure by coindexation with the subject argument). If another agreement morpheme is added, it agrees with the next most prominent available argument, and so on. An additional prediction that follows directly is that (subject to availability as above) object agreement implies subject agreement.

4 Maltese in Stratal OT

I proceed to my own proposal, which is in keeping with the Stratal OT understanding of how morphology and phonology interact. The key point is that verbs like (4) end in an underlying *heavy* syllable, which receives stress at the stem level. Presuffixally, the stem-final stress is retained, and the unstressed syllable before it syncopates. If no suffix is added, the final vowel is shortened, with concomitant stress retraction, preventing syncope. We'll see that the final stress, as well as syncope, shortening, and retraction, all follow from general constraints of Maltese phonology, and operate transparently in their respective strata.

The reason the final syllable is heavy is that the last vowel has an underlying /y/ after it, originally the third element in the Arabic root melody. It is expected in roots that pattern morphologically with the Semitic stratum of the Maltese vocabulary, to which even loans such as *fada* 'trust' have assimilated. The final /-y/ surfaces as such before stem-level consonantal endings in all verbs of this class.[7]

(11) a. *qrájtu* 'you (pl.) read'
b. *qrájna* 'we read'
c. *qrájt* 'I read', 'you (Sg.) read'

The *-j* also appears in derivatives next to vowels, as in singulative event nominalizations such as *ħámja* ' a heating', *qárja* 'a reading', and in agent nouns, such as *qarráj* 'a reader' (or *qarréj*, Aquilina 1959: 53), *ħarráj* 'a shitter'.[8] It may also explain the lack of open syllable lengthening before /-y/ in process nominalizations, e.g. *qári* 'reading', *ħámi* 'heating', from /ʔary/, /ħamy/, if vocalization takes effect at a level after stem lengthening.

Before 3.P. *-w*, stem-final *-j* is deleted, e.g. *qráw*, in deference to an absolute ban on final **-yw* clusters in Maltese. The vowel of 3.Sg.F. *-et* undergoes contraction with the stem-final vowel.

(12)

	Singular	Plural	Singular	Plural	Singular	Plural
3M.	*qásam*	*qásm-u*	*qára*	*qrá-w*	*béda*	*bdé-w*
3F.	*qásm-et*		*qrá:-t*		*bdíe-t*	
2.	*qsám*-t	*qsám-tu*	*qráj-t*	*qráj-tu*	*bdéj-t*	*bdéj-na*
1.	*qsám-t*	*qsám-na*	*qráj-t*	*qráj-na*	*bdéj-t*	*bdéj-na*

(From Sutcliffe 75, 118-9)

Let's return to the height alternations and diphthongizations in the root-final syllable. Why does the final short unstressed *-a* of *qára* alternate with long stressed *a:* in *qrá:t* (see (12)) and in (3b) *qrá:na* 'he read us', whereas the final short unstressed *-a* in *béda* and *ħtáf-na* alternates with stressed *íe* before the object ending in *bdíe-t* (see (12)) and in (6b) *ħtafníe-kom*? And why does this correlate with the variation between preconsonantal *-ej* and *-aj*? The obvious hypothesis is that the verbs stems end respectively in /-ey/ and /-ay/.

The distribution of /-ey/ and /-ay/ seems to be partly predictable. Verbs that have *-ej* before -C subject endings and *-ie* before object endings and 3.Sg.Fem. /-et/ have *e* as the first root vowel, and verbs that have *-aj* and *-a:* before these respective ensings have *a* as the first root vowel:

(13) a. *-íe*/*-ej* verbs: *béda* 'begin', *méla* 'fill', *séwa* 'cost', *kéra* 'hire', *féda* 'redeem', *méxa* 'walk'

b. *-a:*/*-aj* verbs: *qára* 'read', *ħára* 'shit', *fáda* 'trust', *dára* 'get used to'

Apparently the nucleus of the second syllable in /-y/ verbs harmonizes with the nucleus of the first syllable. If there is such a harmony constraint, it must be enforced at the stem level.

[7]Including even those verbs whose Arabic cognates have *w*, Aquilina 1959:280.

[8]The final stress and lack of syncope appears to be regular for a word of this shape, but something needs to be said about the failure of *-j* to contract in these nouns. My guess is that /-y/ is part of the nucleus in the basic verb and a coda in nouns.

The stem level will also assign accent of the standard Arabic type, similar to the Latin stress rule, except that superheavy final syllables are stressed. Undominated FINAL-C requires a word-final consonant to be weightless (nonmoraic), see (14a). The second member of a final diphthong (*-y, -w*) is part of the syllable nucleus and is moraic, (14b).

(14) a. *ħábbat* 'he knocked', *ħabbá:t* 'person who knocks', *ħabbát-t* 'I knocked' (Aquilina 1959: 70)

b. *darráw* 'they accustomed to', *kawkáw* 'cocoa', *dewwéw* 'they cured', *gadráj* 'bumboat-man' (but also given as *gádraj* on p. 51), *Muléj* 'my Lord', *jbintéj* 'two cheesecakes', *servéw* 'they served', *babáw* 'bogey' (Aquilina 1959: 44, 49, 53, 69-70)

Together with undominated FOOT-BIN, FINAL-C ensures that final CVC syllables cannot form a foot. Consequently, final syllables of the form -CV(C) are not stressable, lexical monosyllables of the form CVC are excluded, and words ending in -CVC normally have the same stress pattern as words ending in -CV.

(15) a. FINAL-C: A word-final consonant is non-moraic.

b. TROCHEE: A foot is left-headed.

c. FT-MAX: A foot is maximally bimoraic.

d. FT-MIN: A foot is minimally bimoraic.

e. WDCON: A morphosyntactic word must be wholly parsed into a prosodic word [their edges must coincide] (Wolf 2011: 7, from Selkirk 1995).

f. RIGHTMOST: The rightmost foot bears the most prominent stress.

(16)

Stem level	FINAL-C	TROCHEE	FT-MAX	FT-MIN	WDCON	RIGHTMOST	MAX(stress)
Input: ħataf, ħátaf, ħatáf, ħátáf…							
1a. ☞ [(ħátaf)]							
1b. [(ħatáf)]		*		*			
1c. [ħataf]					*		
1d. [(ħátáf)]				*			
1e. [(ħá)taf]				*	*		
1f. [(ħà)(táf$_\mu$)]	*			*			
1g. [ħa(táf$_\mu$)]	*				*		
Input: ħátaf-na (from (1a) ħátaf)							
2a. [(ħátafna)]			*				
2b. [(ħatáfna)]		*	*				*
2c. [ħa(táfna)]			*		*		*
2d. ☞ [ħa(táf)na)]					**		*
2e. [(ħátaf)na]			*		*		
2f. [(ħà)(táfna)]			*	*			
2g. [(ħà)(táf)na]				*	*		

Promotion of MAX(stress) at the Word Level forces cyclic retention of secondary stresses, so that (2g) [(ħà)(táf)na] beats (2d) when *-na* is the object ending. Postlexically, FT-MIN is dominant, and it appears that a word can only have a single stress ("Conflation").

The data in (3)-(4) can now be understood as follows. Since *qaraj* has a moraic final /-y/, underlying /ʔaray/, it gets stem-final stress by (16). When an ending is added at the stem level, *-áj* surfaces, and the unstressed vowel in the initial light syllable is deleted, as in (4): *qaraj* → *qaráj* → *qaráj-na*. When no ending is added at the stem level, *-j* is deleted at the word level with compensatory lengthening: *qaráj* → *qará:*. When an object ending is added to *qará:* at the word level, *-á:-* surfaces. If neither a subject ending is added at the stem level nor an object ending is added at the word level, *-a:* shortens postlexically to *-a*, because word-final long vowels are prohibited in the output. Since feet must be binary in the output, the stress is retracted from the shortened final vowel to the penult, and syncope is blocked: *qaray* → *qaráj* → *qará:* → *qára* (both **aqrá* and **qrá* would violate FT-BIN). Final *-e* is also categorically prohibited in Maltese, hence *-e:* shortens to *-a*. Medially *-e:-* obligatorily raises to *-ie-*, again by a general constraint in Maltese (Aquilina 1959: 25). The crucial assumption is that the accent in the input to the postlexical phonology (inherited from the output of the Word level) protects the vovel from postlexical syncope, by MAX-V́, but the accent itself is deleted in virtue of FOOT-MIN, unviolated at that stratum.

The constraint interaction is thus transparent at each level; opacity results only from masking of the constraint systems of earlier strata by those of later strata.

Achieving derivations like this in OT-CC and OI seems to founder on a "you can't get there from here" problem due to the gradualness requirement. The stress typology clearly requires something like the constraint decomposition that we assumed for Maltese in (15), which in standard OT can drive a derivation such as *qará:* → *qára*, with shortening of the final vowel and concomitant retraction. This step involves two new faithfulness violations, one incurred by shortening, the other by accent shift. OT-CC's gradualness requirement would require breaking it down into two steps, either [ʔa(rá:)] → [(ʔára:)] → [(ʔára)], or [ʔa(rá:)] → [ʔa(rá)] → [(ʔára)]. In either case, the final stage is a harmonic improvement, but the intermediate stage is not. It *adds* a FT-BIN violation, so the derivation should stop at *qará:*. Even if we reject this derivation for Maltese it can't be excluded for languages in general.

With these additions, the Stratal OT account for Arabic generalizes to the parallel Maltese data; see the derivations in (17).

(17)	*Underlying*	/ħataf/	/ħataf/	/ħataf/
	Stem level	[ħátaf]$_{\alpha}$	[ħátaf]$_{\alpha}$	[ħátaf]$_{\alpha}$
	Stem level	———	[ħatáfna]$_{\alpha}$	———
	Word level	[ħátaf]$_{\omega}$	[ħatáfna]$_{\omega}$	[ħátaf]$_{\omega}$
	Word level	———	———	[ħàtáfna]$_{\omega}$
	Postlexical	[ħátaf]$_{\omega}$	[ħtáfna]$_{\omega}$	[ħatáfna]$_{\omega}$
		'he snatched'	'we snatched'	'he snatched us'

(18)	*Underlying*	/ʔaray/	/ʔaray/	/ʔaray/
	Stem level	[qaráj]$_{\alpha}$	[qaráj]$_{\alpha}$	[qaráj]$_{\alpha}$
	Stem level	———	[qarájna]$_{\alpha}$	———
	Word level	[qará:]$_{\omega}$	[qarájna]$_{\omega}$	[qará:]$_{\omega}$
	Word level	———	———	[qará:na]$_{\omega}$
	Postlexical	[qára]$_{\omega}$	[qrájna]$_{\omega}$	[qrá:na]$_{\omega}$
		'he read'	'we read'	'he read us'

(19)	*Underlying*	/meley/	/meley/	/meley/
	Stem level	[meléj]$_{\alpha}$	[meléj]$_{\alpha}$	[meléj]$_{\alpha}$
	Stem level	———	[meléjna]$_{\alpha}$	———
	Word level	[melé:]$_{\omega}$	[meléjna]$_{\omega}$	[melé:]$_{\omega}$
	Word level	———	———	[melé:na]$_{\omega}$
	Postlexical	[méla]$_{\omega}$	[mléjna]$_{\omega}$	[mlíe:na]$_{\omega}$
		‘he filled’	‘we filled’	‘he filled us’

A tricky point is that [a:] derived by loss of /-j/ with compensatory lengthening is retained as a low vowel, while presuffixally lengthened /a/ is raised to [e:] and surfaces as [ɪə] or as [ɪ:] (written *íe*), and as *i* when pretonically shortened. I assume that raising and lengthening are triggered by a constraint which applies in the context before word level endings and clitics. A faithfulness constraint which requires the height of long vowels to be retained, if active at this level, will have the desired effect of preserving the [+low] feature of an *a:* which is already long, while allowing raising of a lengthened short *a*. A nice illustration is the form *(ma) sraqnihilhíex* ‘we did not steal it from her’ (Borg 1997: 272), with a subject ending, two object endings, plus the negation clitic at the end.

(20)	seraq	-na	-ha	-lha	-x	‘we did not steal it from her’
	steal	we	it	from her	Neg	

Here final *-a* is cyclically raised and lengthened before the endings and the clitic to *é:*, which is reduced to *i* in pretonic position, and under stress surfaces as *íe* (rendered as [ɪ:] in Borg’s transcription followed by Wolf).

(21)	*Underlying*	/sera?/
	Stem level	[(seráq)]$_{\alpha}$
		[se(ráq)na]$_{\alpha}$
	Word level	[se(ráq)na]$_{\omega}$
		[se(ráq)ne:-ha]$_{\omega}$
		[se(ràq)(né:)-ha]$_{\omega}$
		[se(ràq)(nè:)(hé:)-lha]$_{\omega}$
		[se(ràq)(nè:)(hè:)(lhé:)-x]$_{\omega}$
	Postlexical	[sraqnihilhíex]$_{\omega}$

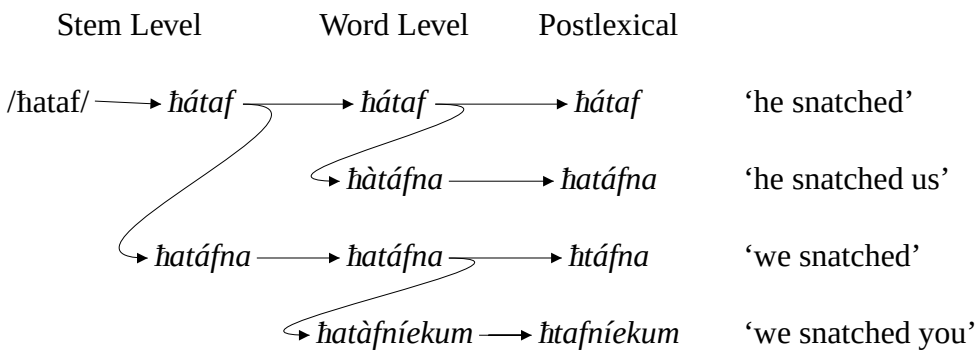
Stratal OT directly solves a problem with syncope noted by Wolf. Why is the output *ħatáfna* and not **ħátfna*? On his assumption that they are respectively parsed as [(ħà)(táf$_{\mu}$)na] and [(ħát$_{\mu}$)fna], the latter candidate should win because it is more harmonic with respect to ALL-FOOT-RIGHT, and cannot be ruled out by syllable structure either because -CCC- clusters are good in Maltese. So he proposes a constraint MAX-V(heavy) (“vowels cannot be deleted in heavy syllables”), which blocks deletion of the second vowel (provided it outranks Weight-to-Stress). It remains to be seen whether MAX-V(heavy) is ever independently needed. Of course vowels in closed syllables often resist deletion, but usually the deletion is blocked by syllable structure constraints. In any case, the Stratal OT analysis needs no such constraint to block **ħátfna*. As can be seen in (17), there is no vowel deletion at the Stem level or at the Word level; postlexically **ħátfna* loses out to the winners *ħtáfna* (subject) and *ħatáfna* (object) by high-ranking MAX-V́.

The imperfective plural, for which OI requires yet another PREC constraint, (PREC(build-PWd, insert-imperf-pl), Wolf 2011: 23) falls out directly.

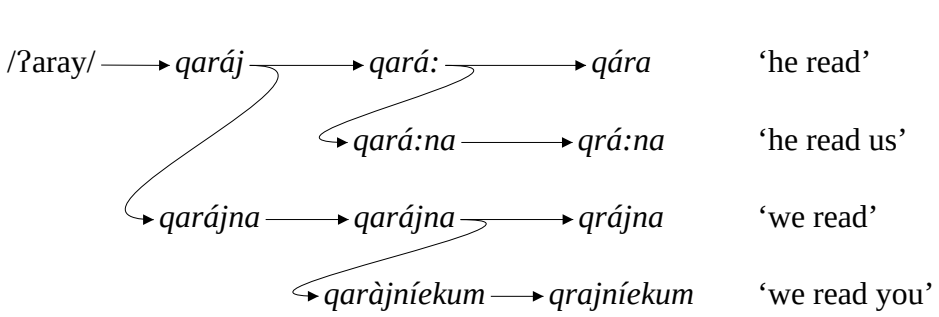
(22)	*Underlying*	/ʔaray/	/ʔaray/
	Stem level	[qa(ráj)]$_{\alpha}$	[qa(ráj)]$_{\alpha}$
		[(jàqa)(ráj)]$_{\alpha}$	[(jàqa)(ráj)]$_{\alpha}$
	Word level	[(jàqa)(rá:)]$_{\omega}$	[(jàqa)(rá:)]$_{\omega}$
		———	[(jàqa)(rá:-w)]$_{\omega}$
	Postlexical	[(jáq)ra]$_{\omega}$	[jaq(ráw)]$_{\omega}$
		‘he was reading’	‘they were reading’

The flowchart in (23) summarizes the derivation of the perfective paradigm:

(23)



(24)



5 Carib

In what was probably the first study to address cyclic stress effects in OT, Kenstowicz 1996 put forward Carib as evidence for O/O constraints. Inkelas 1993 had already presented some remarkable additional data from this language. I will now show that they support Stratal OT over any kind of transderivational OT, whether O/O or OI.

The theoretical thrust of Inkelas’ article was that there is a typological distinction between languages that have a stem cycle and languages that do not have a stem cycle. As is natural in the processual approach that she was adopting in that article, she analyzed this distinction in terms of the the timing of prosodic word construction in the derivation. She takes cyclicity to be the default, and proposes a way to defeat it on a language-specific basis by delaying the construction of prosodic constituency on stems until after the first affix is added to it. For Wolf, it is non-cyclic application that is expected, and PREC constraints *achieve* cyclicity by forcing early construction of prosodic constituency. The difference follows from the respective background assumptions of these researchers. Lexical Phonology and Morphology’s interactionist view that morphology is

interpreted as soon as it is introduced requires a mechanism to block cyclic effects if they don't appear. The opposite is true for OI, which contrary predicts noncyclic phonology in so far as it minimizes opacity. (Syllabification is intrinsically cyclic even in OI, however, since it is assumed that syllable structure is not protected by faithfulness constraints and combines with other operations into a single derivational step, McCarthy 2010). Another difference is that whereas Inkelas restricts her proposal to prosodic constituency construction, and claims that its order with respect to stem-level phonology is parametrically specified for the language as a whole, OI would let any type of phonological operation to be ordered with respect to any morphological operation.

Inkelas' starting point, then, is the LPM and Stratal OT assumption that every constituent must meet the phonological constraints applicable to the type it belongs to. She goes on to claim that stems in Carib are not cyclic domains, and that Carib belongs to a whole class of languages in which the first round of affixation *precedes* Prosodic Constituency Formation (PCF).

(25)

(a) with stem cycle:		*(b) without stem cycle:*	
Underlying:	stem	Underlying:	stem
PCF:	$[\text{stem}]_{\alpha}$	Affixation:	$[\text{stem-suffix}]_{\alpha}$
Affixation:	$[\text{stem-suffix}]_{\alpha}$	PCF:	—

Could the reason the stems in question are not cyclic domains just be that they are bound roots? Unlikely, for they seem to be genuine nominal stems, which meet all prosodic minimality requirements, can appear on their own as free forms, and should therefore be domains of constraint evaluation. This second type of language would present a complication for Stratal OT because it excludes a stipulative ordering account for the putatative typological difference. Some other way would have to be devised to accomplish the equivalent of (25). OI, on the other hand, could in principle replicate Inkelas' analysis with Maltese-type PREC constraints.

Inkelas' argument consists of two parts: first, that stress is cyclically assigned, second, that bare stems are not cyclic domains. We'll take them in turn.

Nonderived stems in Carib have stress on alternating syllables, except that word-final syllables are never stressed. The vowels in the first two stressed syllables are lengthened if they are open, and the second one has high pitch (not marked here). Most stems have the alternating stress on every *even* syllable. A smaller, unpredictable class of stems has it on every *odd* syllable.

(26) a. Stems with stress on even-numbered non-final syllables:

aká:mi	'trumpeter bird'
ará:mari	'mythical snake'
asá:pará:pi	'species of fish'

b. Stems with stress on odd-numbered non-final syllables:

wo	'to beat'
é:ro	'this'
é:maka	'to comb a parting'
árawá:ta	'howling monkey'
aúwanó:pono	'causing laughter'

Iambic footing assigns stress to even-numbered syllables, generating the unmarked pattern in (26a) directly (Kenstowicz 1996). Marked stems like those in (26b) can be assumed to have an inherent

accent on the first syllable, protected by a positional faithfulness constraint that privileges the stress of a initial syllable. Alternatively they could begin with an catalectic syllable that forms an iamb with the syllable after it. For present purposes we don't need to choose between these alternatives.[9]

In morphologically complex words, stress is assigned cyclically. Stresses assigned to stems according to the pattern in (26) are preserved, and in addition, sequences of unstressed syllables created by affixation are grouped into binary feet, whose strong branch is lengthened. If it sits in the first or second foot of the complex word, it also gets stressed, as seen in (27a,b).

(27)	a.	*kó:roka*	'scrub'	*kó:roká:no*	'he scrubbed'
	b.	*kurú:wese*	'palm shell'	*kurú:wesé-mbo*	'old palm sheath'
	c.	*etámboka*	'untie'	*kïn-é:támboka:-no*	'she unties it'

The metrical reparsing shows an asymmetry between prefixes and suffixes. As (28) illustrates, metrical reparsing of stem+suffix combinations never creates stress clashes, but clashes do arise when prefixes are added, as in (27c) *kïn-é:támboka:-no* and (28b) *ay-á:wó:mï-i*.

(28)	a.	*koró:mo*	'recent'	*koró:mo-no (*koró:mó:-no)*	'a recent thing'
	b.	*awó:mï*	'to get up'	*ay-á:wó:mï-i (*ay-a:wó:mï-i)*	'you must not get up'

On the iambic analysis, the asymmetry follows from the generalization — already illustrated by the data in (26) — that a word-final syllable cannot be accented, let us assume because of inviolable NON-FINAL. Then an iambic foot can be constructed on initial *ay-a-* in (28b), but not on final *-mo-no* in (28a).

(29) Cyclic refooting

a.	/awomï/	→	*(awó:)mï*	→	*(awó:)(mï-i)*	→	*(ay-á:)(wó:)(mï-i)*
b.	/koromo/	→	*(koró:)mo*	→	*(koró:)(mo-no)*		

We are now ready for Inkelas' two arguments that Carib has no stem cycle. The first argument is based on the fact that the distinction between the even-syllable stress pattern in (26a) and the odd-syllable pattern in (26b) is neutralized in unaffixed isolation forms:

(30) a. Disyllables with even-syllable stress:

á:pi	'red, ripe'	*apí:-ro*	'cause to ripen'
é:ta	'hear'	*etá:-topo*	'means of hearing'
ká:rai	'blackness'	*karái-ma*	'blacken'

b. Disyllables with odd-syllable stress:

é:ro	'this'	*é:ro-me*	'now'
ká:mi	'flame'	*ká:mi-ro*	'cause to become pale red'

The neutralization follows from the generalization — already motivated by the data in (26) — that a word-final syllable cannot be accented (NON-FINAL). Suppose now that NON-FINAL were enforced cyclically on the stems in (30). Then *both* classes of disyllabic stems would receive

[9] Inkelas opts for trochaic footing with initial extrametricality. I adopt the iambic analysis here, for the lengthening of strong syllables is characteristic of iambic systems, for as Kenstowicz and Inkelas (fn. 17) note (see Hayes 1995). It also helps explain the prefix/suffix asymmetry described below.

initial stress on the first cycle, and the emergence of the different stress pattern in their suffixed forms could not be explained.

NON-FINAL must apply to word-final syllables, but there is no reason to believe it is applicable to *stem-final* syllables. If it only applies at the word level (or postlexically), then disyllabic stems of the even-syllable type (30a) are free to receive iambic feet at the stem level. Consequently, alternating iambic stress will be correctly assigned to the suffixed forms built from them on subsequent cycles, e.g. *apí* → *apí:ro*. The result is the pattern of derived words shown in (30a). Later NON-FINAL forces stress retraction from the second syllable to the first in disyllabic words, e.g. *apí* → *á:pi*. In sum, the neutralization of the odd-syllable and even-syllable stress patterns in the isolation forms of disyllabic stems is due to post-stem level constraints. This analysis is consistent with the cyclic status of the stem constituent in Carib.

The final stress of polysyllabic words is not retracted but simply deleted: contrast (31a) and (31b).

(31) a. *etámboka* (**etámboká:*, **etámbó:ka*) 'untie'
b. *á:pi* (**apí:*, **api*) 'ripe'

Why is final stress eliminated by retraction in disyllables, and by destressing in longer words? Destressing in disyllabic words would leave them entirely unaccented, violating the requirement that a word must contain at least a foot (Strict Layering). Destressing is possible in longer words such as (31a), where prosodic minimality constraints do not come into play. In that case, it is actually *favored* over stress shift if final syllables are extrametrical (unfooted) and binary feet are preferred. With this alternative analysis on the table, Inkelas' first argument that Carib has no stem cycle is at least inconclusive.

Inkelas' second argument that Carib has no stem cycle is based on derived words containing a class of "strong" suffixes. Strong suffixes have the property that they cause stems with even-syllable stress to switch to the odd-syllable stress pattern, but *only when the first syllable begins with a consonant*. The effect of the strong suffix *-rï, -ru* is illustrated in (32).

(32) a. Shift from even to odd in words beginning with CV-:

kurí:yara	*kú:riyá:ra-rï*	'canoe'
yamá:tu	*yá:matú:-ru*	'basket'

b. Retention of even-syllable stress in words beginning with V-:

akí:nu	*akí:nu-ru*	'laziness'
iné:ku	*iné:ku-ru*	'wasp'

c. No effect on odd-syllable stress:

sú:rabaŋ	*sú:rabá:-nï*	'beam of roof'
ká:rawá:si	*ká:rawá:si-rï*	'rattle'

Inkelas assumes trochaic feet and decomposes initial extrametricality (invisibility) into consonant and vowel extrametricality. Extrametricality of the initial syllable is then the joint result of both, and will fail when either one fails. She attributes to strong suffixes the property that they prevent the imposition of initial consonant extrametricality by blocking Prosodic Constituency Formation. If there is no initial consonant extrametricality, only initial V- syllables will be extrametrical, for the C- of initial CV- syllables remains visible, and with it the whole syllable. Therefore stems must

not become prosodified until after the strong suffixes are added. This would a second, independent piece of support for the claim that stems in Carib are not cyclic domains of rule application.

The weak point of this argument is the premise of cumulative extrametricality coupled with trochaic feet. It is simpler to assume iambic feet and have strong suffixes assign initial accent to their stems, subject to the constraint that initial onsetless syllables remain unstressed. Extrametricality (invisibility) of initial onsetless syllables is widely attested, see Downing 1998 and Breen & Pensalfini 1999 ("In Arrernte, stress is assigned within a word to the first nucleus that is preceded by a consonant"). On this alternative, the conclusion does not follow.

The main point here is that in Carib, as in Maltese, inputs to cyclic stem-level morphology and phonology do not surface as isolation forms because of some later phonology they undergo if they remain unsuffixed. The crucial phonological properties that are cyclically transferred from the stem are masked in the output form of the stem by later processes. In both languages this involves the retraction of an originally final stress. In Maltese, the form *qrá:na* 'he read us', with the object ending, is built on the stem-level representation [ʔaráy], its stress computed on the input form rather than on the output form *qára* that results from retraction. In Carib, the stress is computed from the stem-level representation, where the odd-numbered and even-numbered stems remain distinct (e.g. *apí* vs. *éro*), not from the word-level output, where NONFINAL neutralizes them into *á:pi* and *é:ro*. Such cases are problematic for O/O theory because it holds that the Base must be a free form in its output shape, and for OI theory because it holds that the chain must monotonically converge on a maximally harmonic output within a single constraint ranking. Stratal OT accounts for both systems by distinct constraint rankings at the stem, word, and phrase levels, consistent with the morphology which drives the cyclic derivation. Since each of these levels is a fully parallel constraint system, the grammar is formally well-behaved and computationally tractable. No global PREC constraints are required.

6 Further remarks on OT-CC

I summarize the six main criticisms of OI (and of OT-CC in general) made above in sections and 4, elaborating a little on the last and adding two others, on the basis of Finnish data.

(1) *The Free Element Condition is untenable.* In order to guarantee cyclic stress, construction of prosodic constituency is subjected to the FEC. The FEC prohibits reparsing of previously assigned foot structure. Apparent stress shifts must therefore be "prepared" by judicious prosodic underparsing earlier in the derivation. In Maltese and English, such underparsing was shown to require monomoraic feet, forbidden in both languages. Moreover, the version of the FEC quoted in fn. 4, taken at face value, implies that no language can have fixed stress.

(2) PREC *constraints lead to unwanted globality.* OI's method of determining the relative order of morphological and phonological operations makes it possible for the order of prosodic constituency building (and hence the cyclicity or noncyclicity of an operation), or the order of any other minimal operation for that matter, to depend on the presence of an arbitrarily designated faithfulness violation anywhere the chain. This is a type of globality which no other version of OT or any other phonological theory allows, and for which there is no empirical evidence.

(3) *There is no general definition of an "elementary operation".* The concept of a minimimal unfaithful operation has become increasingly stipulative as OT-CC has engaged stress and syllabification, compromising the crucial GRADUALNESS requirement on links in a chain. The

introduction of OI exacerbates the problem by introducing minimal steps such as the addition of a morpheme, which are faithful operations rather than minimimal unfaithful ones. Syllabification is not such an unfaithful operation, for it must happen for free at each step of the derivation, for reasons nicely laid out by McCarthy 2010. Also "moras can be freely added or removed at no cost in Faithfulness" (McCarthy 2007: 77). These operations must therefore be cyclic in OI. But "changes in quantity and syllabicity violate IDENT constraints" (McCarthy 2007: 77).[10] The docking of a floating mora, crucially counts as a minimal IDENT violation in Wolf's analysis, as does the building of a higher-level prosodic unit, such as a prosodic word with a head foot. Whether deletion of a segment is a single minimal operation is a single operation is under dispute in the literature. But deletion of a sequence of segments is certainly not a single operation: a cluster of consonants cannot be deleted in a single operation, even if the consonants are adjacent and in the same syllabic slot and violate the same constraint, such as *CODA; for example, in OT-CC Greek /galakt/ → *gala* 'milk' must go through intermediate **galak*. The worry is that there may be no general characterization of the relation that must hold between links in a chain, and that might be left with a laundry list of elementary operations without any unifying principle behind it.

(4) *Faithfulness does not properly individuate phonological operations.* Questions about faithfulness also impact the formulation and interpretation of PREC constraints. These constraints have to pick out particular operations (particular kinds of relations between successive links in a chain). Since operations that incur the same faithfulness violations may be "ordered" differently, and operations that incur different faithfulness violations may be "ordered" the same way, phonological operations cannot be grouped into ordering classes on the basis of the faithfulness violations they incur. But there is no known alternative way to pick out particular "operations" in OT — indeed the whole point of OT is that operations are epiphenomenal.

(5) *OI's phonology/morphology interface is arbitrary.* OI (and OT-CC in general) fails to relate cyclicity to morphological organization in a principled way. Specifically, it makes no intrinsic connection between the order and constituency of affixes and the way the affixes interact with the phonology.

(6) *The leapfrogging problem.* Derivations that require links involving two faithfulness violations, one forcing the other, are intractable in OT-CC. Our example was the shortening and concomitant accent retraction in *qará:* → *qára*. This is not a minor technical issue. It endangers at a stroke a large class of analyses that were part of the original attraction of OT. Since leapfrogging is avoided in Wolf's analysis of these data, and is not required for the Carib case, I illustrate it with Finnish compensatory lengthening, where I believe it is unavoidable, and for which I have proposed a stratal OT analysis (Kiparsky 2011).

In Western Finnish dialects,[11] consonant gradation (deletion of a stop the onset of a -VC rhyme) is accompanied by compensatory lengthening of the following vowel, and this feeds a consonant lengthening process that applies between a light syllable (L) and a heavy syllable (H), ensuring a moraic trochee parse. The derivation looks like this:

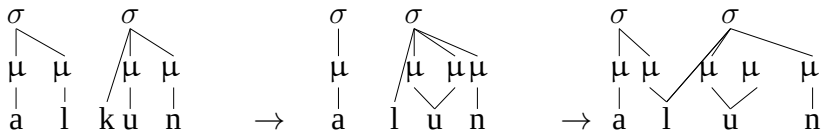
(33)	Input	/alku-n/	/talo-on/
	Gradation + C.L.	aluun	—
	Gemination	alluun	talloon

[10] I find the distinction between "adding and removing moras" and "changing quantity" elusive, since quantity is represented precisely by moras. Also, the distinction between syllabification ("free") and changes in syllabicity (IDENT-violating) is not entirely clear to me. Is it the distinction between structure-building and structure-changing operations?

[11] For additional data and justification of the Stratal OT analysis, consult Kiparsky 2011.

At step 1, the context that triggers consonant gradation is wiped out by the concomitant compensatory lengthening of the second vowel, and the consonant lengthening at the second step adds another layer of opacity.

The example raises several problems for non-Stratal OT and for OT-CC in particular. It calls into question the possibility of imposing gradualness on OT-CC derivations. A candidate chain monotonically accumulates unfaithful mappings by minimal steps (localized unfaithful mappings). But it is not clear how such a chain could be formed between the input /alku-n/ and the output *aluun*.

(34) 

The intermediate link in the chain must either be ill-formed in the language, such as *al.γun* (there is no *γ in Finnish), or well-formed in the language, such as *a.lun*. The former chain is ruled out because any such link brings in 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'?

The example also illustrates that feeding order is not always trouble-free for parallel OT (Bakovic 2007). What Bakovic calls "self-destructive feeding" — when one process feeds another, which in turn obliterates the trigger of the first — is intractable in parallel OT. The whole thing has to be telescoped into a single mapping, in this case /alku-n/ → *alluun*, which seems impossible. The wrong mapping /alku-n/ → **allun* should beat /alku-n/ → *alluun* because the latter's vowel lengthening adds an extra faithfulness violation. The desired mapping can also not be motivated prosodically, for **allun* is at least as good as *alluun* with respect to syllable and foot structure (better, actually). In short, the actual output is harmonically bounded — it is not optimal on any constraint ranking that can be justified for Finnish phonology.

Here OT-CC at first looks more promising than straight parallel OT because it operates with serial derivations of a sort. However, it turns out that OT-CC doesn't allow the self-destructive feeding derivation in (33) either, because its derivation requires different, conflicting optimalities. (The other possible chain *alkun* → *alkuun* → *alluun* is even more hopeless). The compensatory lengthening of the second syllable's vowel is motivated by weight conservation (Faithfulness) but makes the foot structure *worse* (Markedness). Conversely, consonant gemination improves foot structure (Markedness) but scores worse on weight conservation, because it changes a light syllable into a heavy one (Faithfulness). But in OT-CC, each link in a derivational chain must improve on the previous one according to a *single* constraint ranking, which remains invariant across all iterations of the "GEN → EVAL → GEN…" loop. And it seems that no single ranking of constraints can drive this derivation. Here Stratal OT makes a solution possible in virtue of allowing a language to successively enforce distinct rankings at different levels, as shown in the cited reference.

Western Finnish compensatory lengthening is difficult for OT-CC for yet another reason. It challenges the core assumption that that there is no Faithfulness to positional weight. Unlike

quantity and syllabicity, positional weight is apparently never distinctive; in OT terms, this means that it is not subject to Faithfulness (Bermúdez-Otero 2001, Campos-Astorkiza 2004, McCarthy 2007), and consequently that there are no MAX-μ constraints and no DEP-μ constraints. But it is precisely the moraic status of coda consonants (such as the *-k-* of /alku-n/ in (33)) that really needs to be subject to Faithfulness constraints in order for Finnish compensatory lengthening to happen. Moreover, 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 why does resyllabification of codas lead *obligatorily* to compensatory lengthening in these Finnish dialects?

Turning briefly from issues of undergeneration to issues of overgeneration, the availability of an arbitrary number of PREC constraints raises the concern of derivations with an arbitrary depth of opacity. While long chains of *transparent* phonological processes are amply documented, especially of the feeding type, there are no credible examples of long opaque chains in the literature. The maximum securely attested depth is two (three processes, the second and third each rendering the previous one opaque), as for example in English, Yokuts, and Arabic. Since Stratal OT deals with opacity as inter-level constraint masking, that is the maximum permitted opacity, under current assumptions about morphology and syntax. Should an additional stratum or strata turn up, perhaps in morphologically complex languages,[12] the predicted maximum depth of opacity would increase, but the theory and typology of morphology tells us that it will remain small, and could not possibly come anywhere near what PREC constraints allow.

As an example of what does *not* occur, here is a hypothetical language with stacked opacity of much greater depth, constructed from real Yowlumne Yokuts by piling on additional processes in consistently counterbleeding order. As in real Yokuts, we assume lowering of long vowels *u:*, *i:* → *o:*, *e:*, rounding harmony between vowels of the same height, and shortening of vowels in closed syllables, applying in bleeding order. For example, in /ċu:m-hin/ → [ċomhun] ‘devour’, the underlying /u:/ is lowered even though it is shortened, and the suffix harmonizes with it even though it is lowered. On top of that, let our constructed language have epenthesis of a high vowel after coda consonants, except in word-final position. The quality of the epenthetic vowel is to comply with rounding harmony. For some action on the consonantal side, let there also be long-distance place assimilation between nasals in adjacent syllables *m*...*n* → *m*...*m* à la Luganda (Katamba & Hyman 1991), place assimilation of coda nasals to following obstruents, neutralization of nasals to a weakly velar (really placeless) nasal *ŋ* before placeless consonants such as *h* (cf. Spanish dialects, Sanskrit), and palatalization/fortition of *h* to the fricative *ç* before *i*, as in Japanese. Let all these processes interact opaquely: in rule ordering terms, the phonological derivations of this invented language are relentlessly counterbleeding. Each process destroys the context that triggered the previous one.

[12] It is worth noting that in one of the few comprehensive OT phonologies to date, Jaker (2011) finds three levels in Dogrib, a language of the legendarily complex Athapascan family.

(35)	/ċu:m-hin/	Underlying
	ċu:mhim	Labial assimilation
	ċu:ŋhim	Coda neutralization (counterbleeds labial assimilation)
	ċu:ŋçim	*h*-fortition (counterbleeds coda neutralization)
	ċu:ŋçum	Rounding harmony (counterbleeds *h*-fortition)
	ċo:ŋçum	Lowering (counterbleeds rounding harmony)
	ċoŋçum	Shortening (counterbleeds lowering)
	[ċoŋiçum]	Epenthesis (counterbleeds shortening)

The final *-m* is assimilated to the medial *m*, which however becomes *ŋ* before the placeless consonant *h*, which however becomes a palatal *ç* by assimilation to the following *i*, which however becomes *u* by harmony to the root vowel *u:*, which however is lowered because it is a long vowel, which however shortens because it is in a closed syllable, which however becomes open by epenthesis.

No systems with this degree of opacity have ever been found. That is, for no language has it ever been argued that the best analysis, or the simplest analysis, requires a depth of counterbleeding like (35), or an equivalent depth of counterfeeding. For Stratal OT, the existence of such phonologies would be devastating: since opacity results only from interlevel constraint masking, the depth of opacity is limited by the number of levels in the hierarchy. On our working assumption that phonology operates on stems, words, and sentences, three layers of opacity is the maximum, and systems like (35) are way beyond the pale.

For classical ordering theory, the opaque derivation (35) is formally indistinguishable from the unremarkable derivation in (36), where the same processes apply in reverse (bleeding) order, with even less opacity than what is seen in actual Yowlumne Yokuts.

(36)	/ċu:m-hin/	Underlying
	ċu:muhin	Epenthesis (bleeds shortening)
	—	Shortening (bleeds lowering)
	ċo:muhin	Lowering (bleeds rounding harmony)
	ċo:muhun	Rounding harmony (bleeds *h*-fortition)
	—	*h*-fortition (bleeds coda neutralization)
	—	Coda neutralization (bleeds labial assimilation)
	—	Labial assimilation
	[ċo:muhun]	Output

Rule ordering theory's failure to capture the asymmetry between opaque and transparent rule interaction, with the massive typological overgeneration that results from it, is shared by all transderivational OT accounts of opacity. Not only do they fail to exclude (35) as a possible phonology, they make it look just as simple as (36). For OT-CC (including OI) they just differ in the ranking of the relevant PREC constraints. The failure of OT-CC, Sympathy, and rule ordering to privilege transparency is as damaging at the explanatory level as non-transderivational parallel OT's failure to countenance opacity is at the descriptive level. Stratal OT is unique in providing a treatment of rule interaction that both allows opacity and formally accounts for its restricted depth and marked character in phonological systems.

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