Inversion of stress-conditioned phonology in Stratal OT[*]

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1. Introduction

The last decade or so has witnessed a number of theoretical and typological studies of the relationship between segmental phonology and stress and metrical structure, including de Lacy (2001), Smith (2002), González (2003), Gordon (2005), Blumenfeld (2006), Bye & de Lacy (2008), Vaysman (2009), and Giavazzi (2010); see Gordon (2011) for a recent overview. Examination of the surface sound patterns—static phonotactic patterns as well as alternations between morphologically-related words—of attested languages corroborates that, as a general matter, different kinds of segmental properties are characteristically favored in stressed positions versus in unstressed positions. For example, a number of languages have aspiration (or stronger aspiration) on stops preceding a stressed vowel than stops elsewhere; Giavazzi (2010: 50) cites as examples English, Māori, German, Pattani, Farsi, Silcayoapan Mixteco, and Sḵwx̱wú7mesh (Squamish). However, there are not known to be languages where stops have longer or stronger aspiration in the onsets of unstressed syllables (González 2003: 173). In Optimality-Theoretic (Prince & Smolensky 2004 [1993]) terms, we would infer from this that the universal constraint-set CON contains a constraint which calls for the presence of aspiration on a stop preceding a stressed vowel, but that there is no corresponding constraint encouraging that stops preceding unstressed vowels be aspirated. In this paper I will use the term ASYMMETRIC to such a state of affairs in the constraint set; in this case, the constraint set is asymmetric with respect to aspiration in stressed vs. unstressed contexts. Many of the works cited above develop phonetically-based proposals which aim to predict which kinds of segmental properties will be favored in stressed or unstressed position.

A crucial methodological point is that such inferences about the constraint set are based on empirical generalizations about what kinds of correlations between stress and segmental properties we do and don't find *on the surface* in the world's languages. This is entirely safe as a basis for conclusions about the constraint set in the common variant of OT where the mapping from underlying forms to surface forms happens fully in parallel, with only one pass of constraint evaluation, and no intermediate derivational stages. On such a view, it is only candidate surface forms which are subject to the evaluation of the constraints we hypothesize.

But this is not the only logically possible way things might be arranged. Much work in OT on phonological opacity and the phonology-morphology interface has been

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pursued in the framework of Stratal OT[1], which is an OT version of the theory of Lexical Phonology and Morphology (Pesetsky 1979; Kiparsky 1982a,b; Mohanan 1986). In LPM, the morphology of a language is divided into a set of LEVELS or STRATA, each of which is associated with a phonological grammar. Glossing over fine differences between specific versions of LPM, the general idea is that after a word receives morphology at some level, it then passes through the phonological grammar of that level. There are also assumed to be one or more post-lexical phonologies through which utterances pass after the syntax has joined multiple words together to form sentences. Words (and more generally utterances) thus pass through several different phonological grammars on their way to the surface. Stratal OT updates this picture with the assumption that these several phonologies are OT grammars, rather than rule-based ones.

Work in Stratal OT almost always assumes that the various stratas' phonologies have the same set of constraints, but may rank them differently. Indeed, inter-stratum ranking differences are essential to be able to model phonological opacity, wherein we need certain processes to apply at certain levels, and not at other levels. One consequence of this is that the same string may be assigned different metrical parses at successive levels. The concern of this paper is with what can happen if stress-conditioned segmental processes are applied at an intermediate level, with respect to one parse, and the parse is then changed at a later level. This will result in situations where the surface distribution stress-conditioned segmental properties (e.g. aspiration) doesn't match the distribution of surface stress. As I will show, this is not simply a matter of the familiar fact of phonological opacity, i.e. that some generalizations can be concealed by others. Rather, it means that *even given an asymmetric constraint set, Stratal OT predicts a symmetric typology of stress/segmental-phonology correlations*. That is, even if we have a constraint that encourages aspiration in stressed syllables but no constraint encouraging aspiration in unstressed syllables, we can generate languages in which *on the surface* aspiration is found on all and only the voiceless stops in the onsets of unstressed syllables. To do this, as section 2 lays out in detail, it suffices to have successive levels which assign complementary patterns of alternating stress, where every syllable which is stressed at the first level is unstressed at the next level, and vice versa. By applying aspiration at the first level, and preserving this pattern of aspiration at the second level, we produce a language which applies aspiration in all and only the surface unstressed syllables. I will refer to this kind of scenario as INVERSION, since it reverses the unidirectional relationship between stress and aspiration encoded in the hypothesized asymmetrical constraint set. The point of this demonstration is that Stratal OT typologically over-generates because it intrinsically dooms *any* effort to establish a reliable correlation between stress and segmental processes, since even given an asymmetric constraint set, Stratal OT offers us the means to model languages with the inverted pattern on the surface.

The remainder of this paper is organized as follows. Section 2.1 presents in more detail specific hypothetical inversion scenarios, and how we can generate them in

[1] A far from exhaustive list of works which argue for Stratal OT models includes Rubach (1997, 2000a,b, 2003a,b, 2004) Bermúdez-Otero (1999, 2003, to appear), Kiparsky (2000, 2002, 2003, 2008, 2010, 2011a,b), Itô & Mester (2001, 2003a), Anttila (2006), and Anttila *et al*. (2008).

Stratal OT via re-ranking of particular constraints from one stratum to the next. Section 2.2 presents a related but arguably even more implausible prediction, where there is a cross-level change in stress distribution in one phonological class of words but not in another. In the illustrative example I will present, cross-level changes in the length of final vowels result in a level-to-level change in stress in V-final but not in C-final words; as a result, stress conditioned phonology applies in the 'natural' manner in C-final words but is inverted in V-final words. This scenario is especially worrisome not only for the non-local conditioning factor that it adds to the basic inversion scenario, but also because the underlying mechanism—stress shift at the second of two strata brought on by the shortening of word-final vowels which had been stressed on the first stratum—has been argued to be necessary in Stratal OT (Kiparsky 2011b) in order to cope with the absence of cyclic stress on vowel-final verbs in Maltese (Odden 1993; Wolf to appear a).

In section 3, I consider two possible ways that Stratal OT could avoid the undesirable inversion prediction. First, if the set of languages in the factorial typology of CON did not include any pairs of stress systems which were exactly complementary (every syllable which is [α stress] in one language is [-α stress] in the other language), then perfect inversion would not be achievable. In section 3.1 I argue that language typology does in fact supply evidence for the existence of such mutually-complementrary stress systems. Second, inversion would be unachievable if moving from one stress pattern on one stratum to its exact complement on the next stratum would require too radical of a change in ranking between the successive strata. In section 3.2 I examine limitations in inter-stratum re-ranking which have been proposed in the literature to date, showing that all of them either do not bar the inversion scenario, are independently counter-exemplified, or both.

Section 4 briefly demonstrates why inversion scenarios are not predicted in the kindred theories of Harmonic Serialism (Prince & Smolensky 2004 [1993]: §5.2.3.3) and OT with Candidate Chains (McCarthy 2007). These theories are serial, like Stratal OT, but crucially differ in that serial derivation occurs relative to a single constraint ranking, rather than via the succession of multiple, differently-ranked grammars as in Stratal OT. This difference is the basis for why HS and OT-CC do not suffer from the inversion problem.

In Section 5, I examine in detail three cases of metrically-conditioned phonology which have been noted in the literature as paradoxical, and which hence might be taken to furnish evidence that inversion does in fact exist. These are consonant gradation in Nganasan, coda [h]-epenthesis in Huariapano, and optional lenition of stressed onsets in Mokša and Urubu-Kaapor. I argue that all of these can be re-analyzed, and that in some cases the hypothetical Stratal-OT-based inversion treatment of the data would be problematic for independent reasons. Section 6 summarizes the paper's argument.

2. How to produce inversion scenarios

2.1 Across-the-board inversion

Let us imagine a hypothetical language in which the last lexical stratum has the following two properties: stress is assigned to every odd-numbered syllable counting from the left, and aspiration is allophonically assigned with respect to stress: voiceless stops are unaspirated except in the onsets of stressed syllables, where they are aspirated:

(1) *First stratum: stress and aspiration assigned to odd-numbered syllables*[2]

/patakap^{h}a/	STRESS	*UNASP/ˈσ	*ASP	IDENT(asp)
a. ☞ |(ˈp^{h}a.ta)(ˌk^{h}a.pa)|			2	3
b. |(ˈp^{h}a.ta)(ˌk^{h}a.p^{h}a)|			W3	L2
c. |(ˈpa.ta)(ˌka.pa)|		W2	L	L1
d. |(pa.ˈt^{h}a)(ka.ˌp^{h}a)|	W1		2	L1

(*Notation used throughout*: '.' for syllable boundaries; '(...)' for foot boundaries; '|...|' for prosodic word boundaries)

(2) *UNASP/ˈσ: One violation-mark for every voiceless unaspirated stop immediately preceding a stressed vowel.
(3) *ASP: One violation-mark for every aspirated stop.
(4) IDENT(asp): One violation-mark for every output segment whose specification for (non-)aspiration differs from that of its input correspondent.

Here, in this initial presentation, the markedness constraints responsible for stress placement are abbreviated by a cover constraint 'STRESS' for ease of exposition. Assuming that the stress constraints are top-ranked on the first stratum, all viable candidates will have the assumed pattern of alternating stress with stress on the first and all subsequent odd-numbered syllables.

The ranking of the other constraints ensures that voiceless stops in the onset of stressed syllables, and only these, are aspirated in the output of the first stratum. The ranking of *ASP over IDENT(asp) results in the elimination of underlying aspiration outside of stressed syllables. This is illustrated by the fact that candidate (1b), which preserves the underlying aspiration of the /p^h/ in the word-final, unstressed syllable, loses to the otherwise-identical candidate (1a), which eliminates this aspiration. Meanwhile, the ranking of *UNASP/ˈσ above *ASP and IDENT(asp) ensures that aspiration is present on voiceless stops in the onsets of all stressed syllables, even at the cost of violating the general anti-aspiration *ASP, and of violating IDENT(asp) by adding aspiration to stressed syllables which lack it underlyingly. This is illustrated by the victory of candidate (1a), which aspirates the two stressed-syllable onsets, over

[2] I use comparative tableaux (Prince 2002, 2003) throughout. Numerals indicate tallies of violation-marks; in rows for losing candidates, W indicates that a constraint prefers the winning candidate over that loser, and L indicates that a constraint prefers that loser over the winner.

candidate (1c), which does not and therefore performs better on both *Asp and Ident(asp). Because *Unasp/ˈσ is higher-ranked, candidate (1a) is the winner.

Now suppose that the next, postlexical stratum[3] of our hypothetical language differs from the first in the following two ways. First, the stress constraints are re-ranked in such a manner as to cause stress to fall on each *even*-numbered syllable counting from the left. This means that every syllable which was stressed in the output of the first stratum will switch to being unstressed in the output of the second stratum. Second, Ident(asp) is promoted above *Unasp/ˈσ and *Asp, ensuring that the distribution of aspiration assigned in the first stratum is not altered in the second stratum, the shift of stress notwithstanding:

(5) *Second stratum: Stress relocated to even-numbered syllables, but promotion of faithfulness means aspiration unchanged*

|(ˈp^{h}a.ta)(ˌk^{h}a.pa)|	Stress	Ident(asp)	*Unasp/ˈσ	*Asp
a. ☞ |(p^{h}aˈta)(k^{h}aˌpa)|			2	2
b. |(paˈta)(kaˌpa)|		L2	2	L
c. |(paˈt^{h}a)(kaˌp^{h}a)|		L4	L	2
d. |(p^{h}aˈt^{h}a)(k^{h}aˌp^{h}a)|		L2	L	W4
e. |(ˈp^{h}a.ta)(ˌk^{h}a.pa)|	W1		L	2

The winning candidate (5a) stresses all of the even-numbered syllables counting from the right, but does not change the input aspiration. Candidate (5b), which moves the stress and deletes the aspiration from the now-unstressed first and third syllables, performs better on *Asp but loses to (5a) by virtue of violating higher-ranked Ident(asp). Candidate (5c), which de-aspirates the stops in unstressed syllables and aspirates the stops in the stressed syllables, does even worse on Ident(asp). Candidate (5d), which keeps the input aspiration of the now-unstressed syllables but also adds aspiration to the now-stressed syllables, also incurs violations of Ident(asp) and therefore loses to (5a), despite candidate (5d)'s doing better on *Unasp/ˈσ.

The result is a language in which all of the odd-numbered syllables get stress, and hence aspiration, on the first stratum, and then all lose their stress but keep their aspiration on the second stratum. On the surface in this language, voiceless stops are aspirated in the onsets of all and only the unstressed syllables, inverting the normal

[3] The second of the two strata needs to be a post-lexical stratum in order to ensure that all affixes in a word are already present on the first stratum. If the second stratum of the example in the text were lexical, in some words certain morphology would be added only at the second stratum. These affixes would hence not be stressed on the first stratum, and would not undergo aspiration on the first level. The generalization would then come out in the end not as "voiceless stops are aspirated in the onsets of unstressed syllables, and are otherwise unaspirated", but rather "voiceless stops are aspirated in the onsets of unstressed syllables (excluding unstressed syllables belonging to Level 2 affixes), and are otherwise unaspirated." A language conforming to that generalization would be just as typologically implausible as the one presented in the text, but because it would be more complicated, the text sticks to the scenario where the second stratum involved is postlexical. (If there are multiple postlexical strata—on which see the references in fn. 10 below—then we could alternatively assume that both of the strata in the scenario presented in the text are postlexical; the resulting generalization would be the same.)

affinity of aspiration for stressed syllables. Importantly, Stratal OT succeeds in producing such a scenario without having to add to the constraint set a constraint which favors aspiration on unstressed syllables. Even if the markedness constraints which drive metrically-conditioned segmental changes do not exist in symmetric pairs (e.g. we do not have both *UNASP/ˈσ and *UNASP/σ̆), we can still 'flip' a process's affinity for stressed vs. unstressed syllables by applying the process in the natural environment on one stratum, and then changing the location of stress on the next stratum.

It is important to emphasize that the argument is not in any way specific to aspiration: we could construct analogous scenarios involving segmental property which can be allophonically conditioned by stress. Further, it is not specific to processes which are conditioned by stressedness as opposed to unstressedness. To illustrate using a hypothetical scenario analogous to the one presented above, suppose again that on the first stratum, all of the odd-numbered syllables counting from the left get stress, and suppose additionally that all unstressed vowels are reduced to schwa (I assume here that schwa is featureless):

(6) *First stratum: Stress assigned to odd-numbered syllables; unstressed vowels reduce to schwa*

/pitekapu/	STRESS	*VPL/WK	MAX(VPl)
a. ☞ |(ˈpi.tə)(ˌka.pə)|			2
b. |(ˈpi.te)(ˌka.pu)|		W2	L
c. |(pəˈte)(kəˌpu)|	W1		2

(7) *VPL/WK: One violation-mark for every vowel which carries V-place features and is in the weak branch of a foot. (Kenstowicz 1996; McCarthy 2008)

(8) MAX(VPl): One violation-mark for every V-place feature in the input which lacks an output correspondent.

Now suppose that, as in our first hypothetical language, the stress constraints are re-ranked on the second stratum such that all of the even-numbered syllables are assigned stress. Assume further that any markedness constraints against stressed schwa are outranked both by the stress constraints (9) was well as by faithfulness constraints which disfavor turning schwa into a full vowel (10). Finally, assume that MAX(VPl) is promoted above *VPL/WK on the second stratum, such that reduction does not apply to the syllables which become unstressed here (11):

(9) *Second stratum: Even-numbered syllables get stress, despite having schwa as their nuclei*

|(ˈpi.tə)(ˌka.pə)|	STRESS	*ˈə
a. ☞ |(piˈtə)(kaˌpə)|		2
b. |(ˈpi.tə)(ˌka.pə)|	W1	L

(10) *Second stratum: Schwas that become stressed on second stratum remain schwa*

|(ˈpi.tə)(ˌka.pə)|	DEP(VPl)	*ˈə
a. ☞ |(piˈtə)(kaˌpə)|		2
b. |(piˈti)(kaˌpi)|	W2	

(11) *Second stratum: Odd-numbered syllables lose stress but don't reduce to schwa*

|(ˈpi.tə)(ˌka.pə)|	STRESS	MAX(VPl)	*VPL/WK
a. ☞ |(piˈtə)(kaˌpə)|			2
b. |(pəˈtə)(kəˌpə)|		W2	L

(12) *ˈə: One violation-mark for every stressed schwa. (Kenstowicz 1996)

(13) DEP(VPl): One violation-mark for every V-place feature in the output which lacks an input correspondent.

The result here is a language where, on the surface, all of the *stressed* vowels are reduced to schwa, while the unstressed syllables support as large a range of vowel-place contrasts as we care to imagine. As with the aspiration example, the existence of such a language not attested, and would be decidedly implausible.

As a general manner, for *any* phonological process *P* which CON gives us the means to make occur only in stressed (or only in unstressed) syllables, Stratal OT gives us the means to set up languages where the distribution of *P* is reversed, occurring in all and only those syllables which are unstressed (or stressed) on the surface. To accomplish this all we need to do is (1) on one stratum, assign a particular alternating stress parse, and have *P* apply with reference to this parse; (2) on the next stratum, assign a new alternating parse in which every syllable which was stressed on the first stratum switches to being stressed on the second stratum, and vice versa; and (3) promote faithfulness on the later stratum relative to the earlier stratum, ensuring that the results of applying *P* on the earlier stratum are left intact, regardless of the change in the location of stress.

2.2 Non-local inversion in specific classes of words

In the scenario laid out in section 2.1, all words of the hypothetical language have different stresses on the successive levels. Stratal OT also predicts the possibility of languages in which the level-to-level mismatch in stress distribution, and consequently the inversion of stress-conditioned phonology, occurs in some words but not in others. To illustrate, consider a hypothetical language where the Level 1 phonology has the following properties:

•Word-final consonants are non-moraic (as in Estonian [Prince 1980: 531], Levantine Arabic [Broselow, Chen & Huffman 1997: 57], Ponapean [Kennedy 2002], or Maltese [Wolf to appear a; Kiparsky 2011b]), and complex codas are banned (meaning any C-final word ends in a *single* consonant)

•Word-final vowels are all long, due to the systematic application of final lengthening.

•Quantity-sensitive trochaic main stress is assigned at the right edge, falling on the ultima if it's heavy, otherwise on the penult. Given the above, this means that C-final words get penult main stress, whereas V-final words get final main stress.[4]

•Secondary stress is assigned to alternating syllables preceding the main stress. This is ensured by having secondary stress, unlike main stress, be quantity-insensitive (as in Huariapano [Parker 1994, 1998] and other languages discussed by McGarrity [2003: §5.2.3]; see also Bye & de Lacy [2008], Topintzi [2010: 89-92])[5]

•Aspiration is assigned to voiceless stops in the onsets of stressed syllables at Level 1.

In such a language, consonant-final words will get stress (and aspiration) on even-numbered syllables counting from the right, while vowel-final words will get stress and aspiration on odd-numbered syllables counting from the right:

(14) *Vowel-final words at Level 1: Final main stress, onsets of odd-numbered syllables counting from the right are aspirated*

/patakapa:/	MAIN-TO-WT	MAX (μ)	*V:#	*UNASP/ˈσ	IDENT (asp)	IDENT (stress)	*ASP
a. ☞ |pa.(ˌtʰa.ka)(ˈpʰa:)|			1		2	2	2
b. |(ˌpʰa.ta)(ˈkʰa.pa:)|	W1		1		2	2	2
c. |(ˌpʰa.ta)(ˈkʰa.pa)|	W1	W1	L		2	2	2
d. |pa.(ˌta.ka)(ˈpa:)|			1	W2	L	2	L
e. |(ˌpa.ta)(ˈka.pa:)|	W1		1	W2	L	2	L
f. |(ˌpa.ta)(ˈka.pa)|	W1	W1	L	W2	L	2	L

(15) MAIN-TO-WEIGHT: One violation-mark for every main-stressed syllable which is light. (Bye & de Lacy 2008)

(16) MAX(μ): One violation-mark for every input mora lacking an output correspondent.

(17) *V:#: One violation-mark for every word-final long vowel.

(18) IDENT(stress): One violation-mark for every output segment differing in stressedness from its input correspondent.

[4] Attraction of stress to final CV:(C) syllables, but not to final CVC(C) syllables is attested in Chickasaw and Klamath: see Gordon (2000) and references therein. In Maltese, final CV:(C) (as well as CVCC) syllables attract stress, but final CVC syllables do not; see Wolf (to appear a) for references.

[5] Alternatively, we could ensure that all word-initial and -medial syllables are light by (a) banning long vowels except word-finally, where their presence is compelled by the constraint favoring final lengthening, and (b) assuming that CVC syllables, if they exist in non-final syllables, count as light, as in Khalkha Mongolian and 34 other languages in Gordon's (1999) typological survey.

(19) *Consonant-final word at Level 1: Penult main stress, onsets of even-numbered syllables counting from the right are aspirated*

/patakapan/	*C$^\mu$#	Main-to-Wt	*Unasp/ˈσ	Id (asp)	Id (str)	*Asp
a. ☞ |(ˌp^{h}a.ta)(ˈk^{h}a.pan)|		1		2	2	2
b. |pa.(ˌt^{h}a.ka)(ˈp^{h}an)|		1		2	2	2
c. |(ˌp^{h}a.ta)(ˈk^{h}a.pan$^\mu$)|	W1	1		2	2	2
d. |pa.(ˌt^{h}a.ka)(ˈp^{h}an$^\mu$)|	W1	L		2	2	2
e. |(ˌpa.ta)(ˈka.pan)|		1	W2	L	2	L
f. |pa.(ˌta.ka)(ˈpan)|		1	W2	L	2	L

(20) *C$^\mu$#: One violation-mark for every word-final consonant which projects a mora.

Now suppose that at Level 2, the constraint against word-final long vowels is promoted, compelling final vowels to shorten. If the final vowel is shortened but the final monosyllabic foot is left in place, this will result in a violation of FtBin, as in candidate (21b) below. If FtBin dominates Ident(stress), shortening will thus induce re-assignment of binary feet in order to accommodate the now-light status of the final syllable. Further, suppose that Ident(asp) is promoted above both *Unasp/ˈσ and *Asp, which will have the effect of freezing in place the distribution of aspiration which had been assigned relative to the distribution of stress at Level 1. This is shown in tableau (21) below; the two constraints *V:# and Ident(asp) which are promoted at Level 2 are depicted as being promoted all the way to the top of the hierarchy for the sake of showing that the inversion scenario can be modeled in Stratal OT even if inter-stratum re-ranking is limited to constraints being promoted to undominated status (a point to be discussed in the next section).

(21) *Vowel-final word at Level 2*

|pa.(ˌt^{h}a.ka)(ˈp^{h}a:)|	*V:#	Id (asp)	Main-to-Wt	Max (μ)	FtBin	*Unasp/ˈσ	Id (str)	*Asp
a. |(ˌp^{h}a.t^{h}a)(ˈk^{h}a.p^{h}a)|		W2	1	1		L	4	4
b. |pa.(ˌt^{h}a.ka)(ˈp^{h}a)|			1	1	W1	L	L	2
c. |pa.(ˌt^{h}a.ka)(ˈp^{h}a:)|	W1		L	L		L	L	2
d. |(ˌp^{h}a.t^{h}a)(ˈk^{h}a.p^{h}a:)|	W1	W2	1	L		L	4	4
e. ☞ | (ˌpa.t^{h}a)(ˈka.p^{h}a)|			1	1		2	4	2
f. |(ˌp^{h}a.ta)(ˈk^{h}a.pa)|		W4	1	1		L	4	2

(22) FtBin: Feet are binary at some level of analysis (moraic or syllabic). (Prince & Smolensky 2004 [1993]: 56)

C-final words meanwhile are unchanged at Level 2:

(23) *C-final word at Level 2*

<table>
<tr><th>|(ˌp^ha.ta)(ˈk^ha.pan)|</th><th>*V:#</th><th>Id (asp)</th><th>Main-to-Wt</th><th>Ft Bin</th><th>*Unasp/ˈσ</th><th>Id (str)</th><th>*Asp</th></tr>
<tr><td>a. ☞ |(ˌp^ha.ta)(ˈk^ha.pan)|</td><td></td><td></td><td>1</td><td></td><td></td><td></td><td>2</td></tr>
<tr><td>b. |pa.(ˌt^ha.ka)(ˈp^han)|</td><td></td><td>W4</td><td>1</td><td></td><td></td><td>W4</td><td>2</td></tr>
<tr><td>c. |(ˌpa.ta)(ˈka.pan)|</td><td></td><td>W2</td><td>1</td><td></td><td>W2</td><td></td><td>L</td></tr>
<tr><td>d. |pa.(ˌta.ka)(ˈpan)|</td><td></td><td>W2</td><td>1</td><td>W1</td><td>W2</td><td>W4</td><td>L</td></tr>
</table>

The result of this is a language where, on the surface, C-final words have aspiration in the onsets of stressed syllables, whereas V-final words have aspiration in the onsets of unstressed syllables. This scenario is all the more implausible than the ones presented in the previous subsection, not only because of it features inversion of the normal stress-aspiration relationship, but because this inversion is triggered (from the descriptive perspective of the surface pattern) in a highly non-local way, by the open or closed status of the word-final syllable. Moreover, this type of scenario, where two kinds of words have the same stress distribution on the surface but only one kind features inversion, is quite strongly specific to Stratal OT. We could not model this hypothetical language in parallel, single-grammar OT *even if there were a constraint favoring aspiration in unstressed syllables*. This is because, assuming C-final and V-final words are assigned the same stress pattern on the surface, there is no consistent ranking of constraints which will favor aspiration in stressed syllables for one set of words but in unstressed syllables for the other, as is illustrated by the following pair of ERCs (Prince 2002, 2003):[6]

(24)

<table>
<tr><th>W~L</th><th>*Asp</th><th>*Unasp/ˈσ</th><th>*Unasp/σ̆</th></tr>
<tr><td>|(ˌp^ha.ta)(ˈk^ha.pan)| ~ |(ˌpa.t^ha)(ˈka.p^han)|</td><td>e</td><td>W</td><td>L</td></tr>
<tr><td>|(ˌpa.t^ha)(ˈka.p^ha)| ~ |(ˌp^ha.ta)(ˈk^ha.pa)|</td><td>e</td><td>L</td><td>W</td></tr>
</table>

This particular hypothetical language, in which vowel-final words systematically end in *long* vowels, and get final stress, at one level, and then undergo final shortening and concomitant re-assignment of stress at the next level, is also particularly worrisome in that essentially the same cross-level change in stress and final length must be posited in Stratal OT in order to be able to cope with the absence of cyclic stress on vowel-final verb stems in Maltese (Kiparsky 2011b). Perfective verbs

[6] An Elementary Ranking Condition (ERC) is a proposition about the ranking relationships which must hold in order for some desired winning candidate to beat some losing competitor. This proposition is expressed as a vector of *W*s, *L*s and *e*s for each constraint. With respect to a given winner~loser pair, the *W*s and *L*s have the same function as in a comparative tableau: they indicate whether a constraint prefers the winner or the loser. An *e* indicates that a constraint is indifferent between the winner and loser. The ERCs in (24) are inconsistent because there is no way to rank the constraints such that every L is dominated by a W.

with object markers in Maltese show cyclic stress, as evidenced by the underapplication of syncope (Sutcliffe 1936: 15, 155; Odden 1993: 1939-140; Borg 1997: 279; Kiparsky 2011b; Wolf to appear). In paradigms like the one below, we see the vowel of the unstressed, stem-initial open syllable syncopating in the subject suffixed form the verb (25b), but not in the segmentally-identical object-marked form (25c):

(25)	(a) /ħataf-$Ø_{3masc.sg.subj}$/	[ˈħa.taf]	'he snatched'
	(b)/ħataf-$na_{1pl.subj}$/	[ˈħtaf.na]	'we snatched'
	(c) /ħataf-$Ø_{3masc.sg.subj}$-$na_{1pl.subj}$ /	[ħa.ˈtaf.na]	'he snatched us'

The cyclic analysis of this asymmetry—following Brame's (1974) analysis of the corresponding generalization in Palestinian Arabic—assumes that the stem plus subject markers, if any, but not the object markers, forms a cyclic stress domain. Thus in (25c), there will be an inner cycle of stress on /ħataf-$Ø_{3masc.sg.subj}$/, and just as when this is a freestanding word (25a), it will get initial main stress. After the object marker /-na/ is added at the next level, stress will be re-assigned to the penult, but the stress assigned to the initial syllable on the previous cycle persists as a secondary stress, protecting the first vowel from syncope. When /-na/ is instead a subject marker as in (25b), it is part of the same cyclic domain as the stem, so stress is assigned to the second syllable to begin with, and the first vowel is left exposed to syncope.

An exception to this pattern, first pointed out in the theoretical phonology literature by Odden (1993) is that this evidence for the cycle disappears in 3rd weak radical verb stems, which historically had a glide as the third root consonant. In isolation these verbs end in a short vowel; the final vowel however lengthens pre-suffixally and thereby attracts stress. The first stem vowel freely syncopates in object-marked forms of such verbs, implying the absence of an inner cycle on the stem:[7]

(26)

/mela/	[ˈme.la]	'he filled'			
/mela-Ø-ni/	[ˈmlɪːni]	1sg.obj	/mela-Ø-na/	[ˈmlɪːna]	1pl.obj
/mela-Ø-k/	[ˈmlɪːk]	2sg.obj	/mela-Ø-kom/	[ˈmlɪːkom]	2pl.obj.
/mela-Ø-h/	[ˈmlɪːh]	3.masc.sg.obj	/mela-Ø-hom/	[ˈmlɪːhom]	3pl.obj.
/mela-Ø-ha/	[ˈmlɪːha]	3.fem.sg. obj			

(Paradigm from Sutcliffe [1936: 157])

The challenge for a Stratal OT account of Maltese cyclicity, and the exception to it, is then to ensure that the third-weak-radical verbs do not get initial stress in the stem-level phonology. Kiparsky (2011) achieves this by assuming that stems like the one in (26) have the final glide still present underlyingly, i.e. that they end in a diphthong: /melaj/. Consistent with the normal behavior of Maltese words ending a diphthong, the stem would get final stress at Level 1: [me.ˈlaj]. If object markers are added at Level 2, stress remains on the second syllable of the stem, the stressed diphthong undergoes re-adjustment to [ɪː], and the first vowel is syncopated. However,

[7] The data in (26) display a tangential alternation in which stressed long /aː/ raises to [ɪː] (orthographically <ie>); see amongst others Borg (1997: 271-273) for more details.

if no object marker is added, the final glide is deleted, causing stress to retract to the initial syllable, giving [ˈme.la]. The means by which this analysis allows 3rd weak radical verbs to bypass what would otherwise be stem-level stress on their first syllable thus involves just the sort of scenario underlying our hypothetical split-inversion language earlier, where V-final stems get final stress at one level, and then retract that stress at the next level after undergoing shortening. The analysis which the Maltese data force on us in Stratal OT thus opens the door to a whole range of unattested 'split-inversion' languages like the hypothetical one presented earlier in this section. This undesirable prediction is not shared by the analysis of Maltese in Wolf (to appear a), to which Kiparsky (2011b) is a rebuttal. This analysis is cast within an extension of OT with Candidate Chains (McCarthy 2007), which is unable to produce inversion scenarios for the reasons discussed below in section 4.

Is there a way for Stratal OT to avoid the inversion scenarios described in this section? There are two possible ways to do so. The first would be if the factorial typology of constraints on stress could not actually generate precisely inverse parses, where every syllable that was stressed in the first parse was unstressed in the second, and vice versa. The second would be if there are metaconstraints which limit how different the rankings on successive strata can be. Conceivably, the rankings required to generate the distinct parses on the first versus the second stratum in our hypothetical languages might differ to a degree which would be excluded by some universal limitation on inter-stratum re-ranking. These possibilities are scrutinized in the next section. Subsection 3.1 looks at whether language typology gives us justification to think that perfectly-complementary pairs of alternating stress patterns can exist, and concludes that they do. Subsection 3.2. examines proposals in the Stratal OT literature for meta-constraints limiting inter-stratum re-ranking. There, I conclude that all of these proposed meta-constraints are empirically falsified, fail to exclude the hypothetical languages presented above, or both.

3. Stratal OT allows reversal of stressedness between strata

3.1 Typological scenarios for complementary stress patterns

It is essential to the argument against stratal OT being presented here that the set of stress patterns which can be produced under various rankings of the universal constraint-set Con includes pairs of patterns S_1, S_2, where every syllable which is stressed in S_1 is unstressed in S_2, and where every syllable which is unstressed in S_1 is stressed in S_2. If no such pairs of patterns are to be found in attested language typology, then obviously the grammars of successive strata in Stratal OT could not have such a pair of stress patterns, no matter how much we permuted the constraint ranking from one level to another.

Gordon's (2002) survey of quantity-insensitive stress systems finds (§3) that in the reported typology of systems with binary, alternating stress on every other syllable, there are in fact pairs of languages whose stress systems are complementary to one another in the way our argument requires. In his survey results, the values of the two descriptive parameters of 'stress every {even/odd}-numbered syllable counting from the {left/right} edge' are observed to combine freely. The following table lists the languages from his sample instantiating each pattern (excluding those where there are morphological restrictions on the domain within which each stress–assignment pattern applies):

(27)

a.	Odd, L→R	σ́σσ̀σ, σ́σσ̀σσ̀	Bagandji, Burum, Czech, Hanty, Hungarian, Icelandic, Livonian, Mansi, Maranungku, Murinbata, Ningil, Ono, Panamint, Northern Sámi, Selepet, Sinaugoro, Timucua, Votic
b.	Even, L→R	σσ́σσ̀, σσ́σσ̀σ	Araucanian, Hatam, Sirenik Yup'ik
c.	Odd, L←R	σσ̀σσ́, σ̀σσ̀σσ́	Asmat, Chulupi, Kamayurá, Suruwahá, Urubú Kaapor, Weri
d.	Even, L←R	σ̀σσ́σ, σσ̀σσ́σ	Anejom, Berbice, Cavineña, Djingili, Ese Ejja, Malakmalak, Muna, Nengone, Orokolo, Tawala, To'abaita, Tukang Besi, Ura, Warao

It is easy to see that every syllable which gets stress in a type (27a) system is unstressed in type (27b), and vice versa; likewise, patterns (27c) and (27d) assign stressedness and unstressedness to exactly complementary sets of syllables. The type of implausible prediction which I wish to argue results from Stratal OT can then arise in a hypothetical language where, for instance, the ranking at Level 1 produces a type (27a) parse and the ranking at Level 2 produces a type (27b) parse.

Obviously, for a grammar to be able to produce perfectly rhythmic stress for all words, we must be able to ensure that quantity distinctions among syllables do not disrupt the alternating pattern by, e.g. in a language of type (27a), drawing stress onto even-numbered syllables if they happen to be heavy. That is, perfect alternation is guaranteed only in quantity-insensitive systems. There is therefore a potential worry about how plausible is the existence of stress systems of types (27b) and (27c). In terms of a foot-based theory of stress, these languages have iambic rhythm (with feet built left to right and right to left, respectively). The worry is that quantity-insensitive iambic feet have been claimed not to exist (Hayes 1987, 1995). Now, one possible response to this is to conclude that patterns (27b-c) simply falsify that hypothesis, showing that quantity-insensitive iambic-type parsing does exist (this is what Gordon [2002] concludes, though his OT analysis is couched within a purely grid-based rather than foot-based framework). On the other hand, doubts have been raised about how well the languages in Gordon's (2002) survey do in fact make the case that we have to countenance QI iambs (Altshuler 2009: 367).[8]

[8] Additionally, for at least some of the better-studied languages listed in (27), it has been disputed whether they can be accurately described as having alternating secondary stresses; see for instance Blaho & Szeredi (2011a,b) on Hungarian.

There are several reasons why this is not as much of a worry for this paper's line of argumentation as it may seem. First, detailed arguments for the existence of QI iambs have been given from data in Suruwaha (Everett 1996), Paumari (Everett 2003), and Osage (Altshuler 2009), all of which have long vowels and/or diphthongs; the lack of vowel-length contrasts in many of the languages in (27) is one of the reasons Altshuler cites for being skeptical that Gordon's [2002] typological survey does establish the need for QI iambic feet. Second, as Altshuler (2009: 367, fn. 3) notes (citing personal communication from Brett Hyde) the parses corresponding to our (27b) and (27c) *are* found in quantity-sensitive languages in words where all of the syllables happen to be underlyingly light. Therefore, even if the QI iambic feet (HˈL) and (HˈH) are universally excluded, there is no reason to think that the parses in (27b-c) could not be found across the board in languages which were vacuously quantity-insensitive because they totally forbade both codas and long vowels, resulting in all syllables being light.

Third, pattern (27c)—stress on all odd-numbered syllables from the right—is, under suitable ancillary assumptions, obtainable using trochaic feet only, along the lines of what we assumed to happen to V-final words at Level 1 of the hypothetical language in section 2.2. Kager (1989) and van de Vijver (1998) propose that apparent right-to-left iambic systems such as that of Tübatulabal (Voegelin 1935) be re-analyzed as trochaic via the assumption that a fixed stress (parsed as a monosyllabic foot) is placed on the final syllable of every word, and then trochees are built over the remainder of the word from right to left. In the absence of quantity-sensitivity (or the absence of any heavy syllables in a QS language like Tübatulabal), the result is a parse of …(ˌσσ)(ˌσσ)(ˌσσ)(ˈσ), with stress on every odd-numbered syllable from the right, but without any iambic feet.

The only tricky part of such an analysis is what ensures that every word has a stress on the final syllable. It could be that there is simply a constraint which directly demands that the final syllable bear stress. Van de Vijver (1998) assumes that all words in Tübatulabal have a lexically-listed word-final stress, for historical reasons, though as Hyde (2011) notes, this is not the most satisfactory approach: it converts part of the language's stress generalizations into a lexical accident, which in OT-internal terms runs afoul of Richness of the Base (Prince & Smolensky 2004 [1993]: 225-231).

Another possibility—the one used for V-final words of the hypothetical language in section 2.2—would be that final syllables always get stress because they're always heavy. Adopting this line, we could obtain pattern (27c) using trochees only in a language which built moraic trochees from right to left, and in which all and only word final syllables counted as heavy. All words of this language would then be footed as …(ˌσσ)(ˌσσ)(ˌσσ)(ˈH), with stresses falling on every odd-numbered syllable from the right.

Something very close to this state of affairs is found in Émérillon (Tupi-Guaraní, French Guiana), which is the subject of an instrumental study and phonological analysis by Gordon & Rose (2006). Syllables in this language are generally (C)V, with (C)VC possible word-finally and "in very rare instances" word-internally as the last syllable of a morpheme. (Vowel length is not contrastive; speaker intuitions as well as reduplication provide evidence that vowel sequences are parsed heterosyllabically, as seen in e.g. (29d) below.) Gordon & Rose argue that the stress system is based on right-to-left moraic trochees (with the phonological phrase being the domain of stress assignment). If the final syllable in the stress domain is closed, stress is final, with stress falling on odd-numbered syllables from the right:

(28) *a.* |(ˌke.dʒu)(ˌka.si)(ˈwaɾ)| 'apron' *b.* |(ˌku.ɾa)(ˌta.ɾa)(ˈpɨdʒ)| 'manioc house'
c. |(ˌe.ɾe)(ˈzoɾ)| 'you come'

If the final syllable is open, then main stress is on the penult, and on even-numbered syllables before this:[9]

(29) *a.* |(ˌma.na)(ˈni.to)| 'how' *b.* |(ˌte.pe)(ˌdʒa.pɨ)(ˌa.ka)(ˈõ.wã)| 'you all must think a little'
c. |(ˌku.dʒa)(ˈbu.ɾu)| 'siren' *d.* |(ˌda.e)(ˈpɨ.dʒi)| 'it's not expensive'

The only thing we would have to add to the real stress system of Émérillion to produce pattern (27c) would be for the language to require *every* word to end in a consonant (or alternatively, for every word to end in a long vowel, or in one or the other). Such a restriction is indeed attested, for instance in Yapese, where all native words end in a consonant on the surface, as a result of a productive process of apocope (Jensen 1977: 49, 56-61; Piggott 1991); Yapese also allows word-final long vowels in loanwords, but lacks final short vowels (Jensen 1977: 48-49). Moreover, it would not even be necessary for a language to ban codas or long vowels word-internally in order to achieve the parse in (27c). This is because of the evidence from languages like Huariapano (Parker 1994, 1998a,b; McGarrity 2003: §5.2.3) that it is possible in the same language for main stress to be quantity sensitive but secondary stress to be quantity insensitive. In that case, our language would have stress on every alternate syllable preceding the main stress, regardless of those syllables' composition.

In sum, then, it seems clear that the space of possible stress systems includes systems of alternating stress which are exactly complementary to one another. Since any given stress system (and more generally, any whole phonology) corresponds simply to some ranking of CON, then under Stratal OT we could have successive strata whose rankings correspond to two of these mutually-complementary patterns. Now, in principle, the co-existence of e.g. stress patterns (27a) and (27b) on successive strata of the same language might be ruled out by a meta-constraint which limited re-ranking of constraints across strata. The next subsection accordingly considers whether any proposed restrictions on inter-stratum re-ranking would have this effect.

[9] A tangential complication in real Émérillon is that when main stress is on the second syllable from the left, there is an optional secondary stress on the first syllable.

3.2 Proposed limitations on inter-stratum re-ranking

If any of the patterns in (27) holds strictly for some language as a whole, with the location of all stresses being fully predictable, it follows from OT's Richness of the Base principle that faithfulness to input stress must be low-ranked; the placement of stress is entirely a matter of the ranking of markedness constraints on stress placement. From that it follows in turn that the differences amongst patterns (27a-d) are strictly a matter of differences in the ranking of markedness constraints.

Assigment of different predictable stress patterns on successive strata would thus be excluded is if the ranking of markedness constraints were completely fixed across all strata, with only the position of the faithfulness constraints being subject to adjustment, as proposed by Kiparsky (1997). However, this hypothesis is easy to set aside as being far too strong: as McCarthy (2007: §2.3.4.2) notes, the Stratal OT literature is replete with analyses in which markedness constraints are re-ranked across strata.

At least two weaker limits on inter-stratum re-ranking have been proposed. First, Itô & Mester (2003a) tentatively suggest that ranking differences between the (last) lexical level and the postlexical level are limited to two kinds:

(30) (a) Faithfulness constraints may be promoted in the post-lexical level relative to the lexical level.
(b) Contextual markedness constraints may be promoted in the post-lexical level relative to the lexical level.

Of these, only (30b) is relevant to the question of how different the stress patterns assigned on successive strata can be, for the reasons mentioned above. However, it is worth noting in passing that our undesired hypothetical languages require promotion on the second stratum of faithfulness to the segmental property assigned with reference to stress on the first stratum, and (30a) permits just this.

In the Japanese facts which Itô & Mester (2003a) are discussing, the 'contextual' constraint in question is *VgV, which is promoted postlexically above a general markedness constraint *ŋ. This results in intervocalic lenition of /g/ to [ŋ] occurring only post-lexically. With respect to an example like this, it is easy to see what is 'general'—a constraint against a particular type of segment, regardless of the surrounding environment—and what is 'contextual'—a constraint against a particular type of segment in some surrounding environment.

While it is not entirely obvious how this classification of constraints on segmental structure would apply to constraints on metrical structure, an intuitive case could be made for constraints on stress being 'contextual', and hence re-rankable. While there is a variety of theories of stress in OT which vary in their assumptions about representations and about the exact set of constraints which evaluate them, the constraints involved almost always involve requiring or forbidding the temporal coincidence of two structures: for example, constraints requiring all feet to be aligned with the right or left edge of the PWd, or the head of a foot to be aligned with the foot's right or left edge (McCarthy & Prince 1993), forbidding the head foot and/or stressed syllable to fall at the right edge of the PWd (Prince & Smolensky 2004 [1993]: 62), or forbidding adjacent syllables which are both stressed (*CLASH) or both unstressed (*LAPSE; on these see among many others Prince 1983; Selkirk 1984; Kager 1994; Green & Kenstowicz 1996; Alber 1997, 2005; Elenbaas 1999; Elenbaas & Kager 1999; Gordon 2002). It seems intuitively reasonable that these constraints would all count as 'contextual', since they penalize certain structures for appearing (or failing to appear) in proximity to some other structure. If so, then proposal (30b) would seem to allow languages to freely re-arrange the relative rankings of these constraints from stratum to stratum. In any case, absent a more explicit definition of the notions 'general' and 'contextual', it is hard to see what limitations, if any, (30b) gives us regarding the inter-stratum re-rankability of constraints on stress placement.

At the same time, even if we restrict our attention only to segmental phonology, it is not clear that (30) exhaustively characterizes the set of possible re-rankings. As Itô & Mester (2003a) note, one effect which post-lexical promotion of general markedness could produce is a situation where absolute neutralization occurred only postlexically; that is, a segment whose existence can be inferred in the lexical phonology is eliminated across the board post-lexically. In this regard, it is worth noting that two of the best-known cases of absolute neutralization argued for in the abstractness debate of the 1970s both involve consonants which cannot be deleted until the some point in the postlexical phonology. First, the consonant /ʕ/, which Brame (1972) argues to remain synchronically underlying in Maltese despite its absence on the surface, conditions among other effects insertion of a prothetic vowel when it occurs in a word-initial cluster (Brame 1972: 49); however, this rule of prothesis would have to be postlexical, since it does not apply if the preceding word ends in a vowel (see e.g. Sutcliffe 1936: 16). This indicates that the /ʕ/ must still be present at the point in the post-lexical phonology where prothesis applies.

Similarly, the *h aspiré* of French, which Selkirk & Vergnaud (1973) argue is best analyzed as an underlying abstract consonant, must still be present in (early stages of) the post-lexical phonology because its effects include the blocking of *liaison* across word boundaries (31a), triggering of VN coalescence in a preceding word (31b), and forcing selection of the pre-consonantal allomorph of certain preceding adjectives (31c):

(31) *Examples of French* h-aspiré *blocking or triggering post-lexical processes*

	C-initial noun	V-initial noun	*h-aspiré*-initial noun (pattern as if C-initial)
(a)	*de mauvais sujets* 'some bad subjects' [də.mo.vɛ.sy.ʒɛ]	*de mauvais objets* 'some bad objects' [də.mo.vɛ.zɔb.ʒɛ]	*de mauvais haubans* 'some bad cable-stays' [də.mo.vɛ.o.bã], *[də.mo.vɛ.zo.bã]

(b) *le prochain conflit*	*le prochain accord*	*le prochain hors d'oeuvre*
'the next conflict'	'the next agreement'	'the next hors d'oeuvre'
[lə.pʁɔ.ʃ ɛ̃.kɔ̃.fli]	[lə.pʁɔ.ʃɛ.na.kɔʁ]	[lə.pʁɔ.ʃ ɛ̃.ɔʁ.dœvʁ], *[lə.pʁɔ.ʃɛ.nɔʁ.dœvʁ]
(c) *un vieux garçon*	*un vieil ami*	*un vieux hongrois*
'an old boy'	'an old friend'	'an old Hungarian'
[œ̃.vjø.gaʁ.sɔ̃]	[œ̃.vjɛ.ja.mi]	[œ̃.vjø.ɔ̃g.ʁwa], *[œ̃.vjɛ.jɔ̃g.ʁwa]

If the arguments for absolute neutralization in cases such as these go through, it would seem that we must allow post-lexical promotion of 'general' segmental markedness constraints like *ʕ or *h, contrary to (30).[10]

The third and final extant proposal about limits on inter-stratum re-ranking is known as the Constraint Promotion Hypothesis (hereafter CPH), and is introduced by Koontz-Garboden (2001), who attributes it to personal communication from Paul Kiparsky. This proposal is that all between-stratum re-rankings involve promoting constraints to undominated status. That is, any two successive strata are identical except that one or more non-top-ranked constraints of the first stratum may be promoted to undominated status in the second stratum.

In order to show that the CPH does not bar inversion, it would suffice to give an analysis of an inversion scenario in which the cross-stratum ranking adjustment was limited to promotion to undominated status. We have in fact already done so; in the hypothetical split-inversion language presented in §2.2 above, as we noted, the Level 1 and Level 2 rankings are identical except that *V:# and IDENT(asp) are moved up to the top of the constraint hierarchy at Level 2. Making them undominated at Level 2 amounts to saying that at Level 2 the language shortens absolutely all word-final vowels, and that the distribution of aspiration in the Level 1 output is always absolutely faithfully preserved in the output of Level 2. Since the absolute nature of these generalizations are essentially core premises of the hypothetical language, it is hopefully intuitive why the CPH provides no bar to the sort of inversion scenario which this language instantiates. (Also, it worth noting that the CPH allows across-the-board inversion as well as 'split inversion' of the kind presented in section 2.2. The hypothetical split-inversion language has inversion in V-final but not C-final words, so to modify it into an across-the-board inversion language, all we would need to change

[10] If these examples of absolute neutralization are accepted, then they involve an opaque interaction *within* the postlexical phonology, since deletion of Maltese /ʕ/ or French /h/ must be ordered after the phonological processes which the segment's presence blocks or triggers. To implement such interactions within Stratal OT would require that there be more than one postlexical stratum, with absolute neutralization in these examples assigned to the second postlexical level. The idea that there are two post-lexical strata was explored in rule-based Lexical Phonology (due originally to Kaisse [1985]) and has also been suggested in Stratal OT (Koontz-Garboden 2001; Thompson 2011). For discussion of (post-lexical) within-stratum opacity as a potential problem for Stratal OT, see McCarthy (2007: §2.3.4.2), Wolf (2008: §5.4.2), and Kavitskaya & Staroverov (2010: §5.2).

would be for the language to require all words to be V-final—either by banning codas across the board, or just in word-final syllables [Broselow 2003; Flack 2007: 62-63].)

Additionally, even if the CPH *did* bar the assignment of complementary parses on successive levels, an independent argument can be given against incorporating the CPH into Stratal OT: to do so would strip the theory of its ability to model many attested cases of phonological opacity. Stratal OT hypothesizes that the opaque interactions which rule-based phonology handles via rule ordering are to be handled by assigning the interacting processes to different serially-ordered strata, with the order of the strata corresponding to the order of the rules. In any opaque interaction modeled in this way, whichever process is ordered second must occur on some later stratum, but must not occur on the earlier stratum where the first process occurs, lest this result in the two processes interacting transparently. 'Activation' of the second-ordered process on the later stratum means that, in the later stratum, the markedness constraint *M* which motivates it must be promoted relative to its rank in the earlier stratum. If the CPH is correct, this means that *M* must become undominated on the later stratum. That means, in turn, that the *M*-driven process must apply absolutely across the board, extirpating from the language all *M*-violating structures whatsoever (at least, those which exist at this stage of the derivation), since no constraint can outrank *M* to limit its activity.

Empirically, what that means is that in any opaque interaction between two processes P_1, P_2 where P_2 applies later, P_2's application cannot be subject to any limitations at all. It cannot be blocked in situations where it would create phonotactically ill-formed sequences, or in strong positions protected by positional faithfulness constraints (Beckman 1998); nor can it have lexical exceptions or be blocked from applying in non-derived environments (Kiparsky 1973). The existence of any of these kinds of blocking conditions on P_2 would require that some constraint enforcing the condition outrank the *M* which motivates P_2. Similar considerations would arise with respect to processes which we could infer became active only on later strata due to the morophosyntactic domains in which they applied. For example, if it were the case that some process applied only on the (final) post-lexical stratum, it would necessarily be the case that the markedness constraint motivating it had been promoted to undominated status on the postlexical stratum, implying that the post-lexical process could not be subject to blocking effects of any kind.

Counterexamples to these predictions are undoubtedly numerous,[11] but I will give just one illustrative case here. The well-known process of intervocalic velar-deletion in Turkish stands in an opaque feeding relationship (Baković 2007) to the process of vowel epenthesis which breaks up illicit clusters. When a consonant-initial suffix is added to a /k/-final word, a vowel is epenthesized into the resulting consonant cluster; this renders the /k/ intervocalic and causes it to delete. While /k/-deletion is fed by epenthesis, its application renders epenthesis opaque, because the C_C# environment responsible for conditioning the epenthesis is no longer present:

[11] McCarthy (2007: §2.3.4.2) notes that the Stratal OT literature features many analyses in which constraints promoted from one stratum to the next cannot be promoted to undominated status.

(32) UR /bebek-m/ baby-1SG.POSS
Epenthesis bebekim
Velar deletion bebeim
SR [bebeim]

To analyze this pattern in Stratal OT, we must assume that epenthesis occurs on one stratum and velar deletion on some subsequent stratum. The following tableau shows how we get epenthesis but not deletion to occur on the first stratum:

(33) *Opaque feeding in Stratal OT: Epenthesis only on first stratum*

/bebek-m/	*COMPLEX	MAX-C	DEP-V	*VkV
a. be.bekm	W1		L	L
b. ☞ be.be.kim			1	1
c. be.be.im		W1	1	L
d. be.bem		W1	L	L

(34) *COMPLEX: One violation-mark for every complex syllable margin. (Prince & Smolensky 2004 [1993]: 108)
(35) MAX-C: One violation-mark for every input consonant without an output correspondent.
(36) DEP-V: One violation-mark for every output vowel without an input correspondent.
(37) *VkV: One violation-mark for every intervocalic velar stop.

Notice here that *VkV has to rank below MAX-C. Placing *VkV above MAX-C but below *COMPLEX would result in candidate (33d), [bebem], being the winner; from here it is hard to see how we could motivate vowel-epenthesis into the environment /e_m/ on any subsequent stratum. Ranking *VkV above both MAX-C and *COMPLEX would be pointless, since this would block epenthesis, making the fully faithful candidate (33a) [bebekm] the winner. This statum would then have done no work towards bringing us any closer to the attested output [bebeim]. Therefore, on the earlier of the two strata involved, *VkV must rank below both *COMPLEX and MAX-C, as shown, making candidate (33b), [bebekim], the winner on the first stratum. The need to distribute the processes over two successive strata is also indicated by the fact that the direct mapping /bebek-m/ → [bebeim], which is candidate (33c), is harmonically bounded by candidate (33d) with respect to this set of constraints.

To reach the attested output, the earlier-stratum output [bebekim] will be submitted to a later stratum where *VkV has been promoted above MAX-C, resulting in intervocalic velar deletion now applying:

(38) *Opaque feeding in Stratal OT: Epenthesis only on first stratum; Promotion of markedness causes velar deletion to become active on second stratum*

/bebekim/	*VkV	MAX-C
a. be.be.kim	W1	L
b. ☞ be.be.im		1

However, *VkV most definitely cannot have been promoted to *undominated* status on this second stratum, since velar deletion is subject to a whole battery of blocking conditions which are reviewed by Inkelas (2009). Velar deletion is generally blocked when the root is monosyllabic, e.g. the 1sg possessive form of [ok] 'arrow' is [o.kɯm] and not *[o.ɯm]. Deletion is blocked when the vowel preceding the velar is long, e.g. [meraːk-a] 'curiousity-DATIVE', *[meraːa]. Deletion is famously blocked in underived morpheme-internal environments, as seen in /sokak-m/ 'street-1SG.POSS' surfacing as [sokaɯm] and not *[soaɯm]. Moreover, deletion only applies in epenthesis-derived environments when the epenthesis is traceable back to suffixation. When a root ends in an underlying kC# cluster, a vowel is epenthesisized into the cluster if a vowel-initial suffix does not follow, but this does not trigger deletion of the velar, e.g. /aks/ 'reflection' surfaces as [a.kis] and not *[a.is]. Deletion does not apply at all in verbs or to suffix-initial velars. Finally, there are a number of /Vk/-final noun roots (mainly borrowings) which are lexical exceptions to deletion. Their final /k/ persists even when followed by a vowel-intial suffix, e.g. /orak-I/ → [orakɯ] 'sickle-ACCUSATIVE', *[o.ra.ɯ].

The existence of these limitations shows that *VkV cannot be undominated on the stratum where it first becomes sufficiently high-ranked to induce deletion. Instead, it must be dominated by any number of other constraints, such as a markedness constraint against pre-vocalic long vowels, or indexed (Pater 2009) versions of MAX-C associated with lexically-exceptional roots. In short, the opaque interaction of epenthesis and velar deletion in Turkish cannot be analyzed in Stratal OT if the CPH is assumed. Arguments of the same kind can be given for *any* opaque interaction where the second-ordered process is subject to any type of blocking effects whatsoever.

Accordingly, we cannot rule out the inversion prediction by pointing to any as-yet-proposed limitation on inter-stratum re-ranking in Stratal OT. All such proposed restrictions either do not bar the prediction, are empirically counterexemplified, or both.

4. Why Harmonic Serialism cannot produce the inversion scenarios

Having established that Stratal OT gives rise to the inversion problem owing to its ability to assign different metrical parses on successive levels, I will in this section demonstrate why the same problem does not arise in a different serial variant of OT, namely Harmonic Serialism (HS: Prince & Smolensky 2004 [1993]: §5.2.3.3).

In the standard parallel implementation of OT, each candidate is a direct mapping from the input form to a potential output form, which may in principle differ from the input to an arbitrarily great extent. (Work in Stratal OT, with its sequence of serially-linked OT grammars, almost always assumes that each of these grammars is internally fully parallel.) HS is different in that there is some hypothesized set of basic changes which can be made to the input, and GEN is limited to producing candidates which differ from the input by a single basic change. After each round of optimization, the winning candidate is re-submitted as an input to GEN, with this loop continuing until at some step a candidate identical to the input is chosen as the winner. Once this point of convergence is reached, it is not possible to make any further changes, and this form becomes the output of the grammar. In HS, the path from the ultimate input to the ultimate output thus may trace a derivational path with multiple intermediate stages.

What is crucial for our purposes is that each of these stages will of necessity be more harmonic than the previous one with respect to a *single* constraint ranking.[12] To understand why this prevents inversion from arising, let's first consider the simplest stratagem for creating inversion: first we assign trochaic feet, then we perform aspiration (or whatever) with respect to these feet, and then we switch the feet to being iambic, leaving the aspiration in the now-stressless syllables. (This assumes that building a single foot [Pruitt 2010] and changing a single feature-value of a single segment [McCarthy 2007] are amongst the set of basic operations.) For a two-syllable word, such a derivation would look like this:

(39) /pa.ta/ $\rightarrow_1$ |(ˈpa.ta)| $\rightarrow_2$ |(ˈp^{h}a.ta)| $\rightarrow_3$ |(p^{h}a.ˈta)|

For the stress-shifting move at step 3 to happen, the iambic parse |(p^{h}a.ˈta)| must be more harmonic than the trochaic parse |(ˈp^{h}a.ta)|, implying a ranking of IAMB >> TROCHEE. The problem is that the opposite ranking would be required in order for trochaic |(ˈpa.ta)| rather than iambic |(pa.ˈta)| to win the optimization at step 1:

(40)

/pa.ta/	TROCHEE	IAMB
a. ☞ |(ˈpa.ta)|		1
b. |(pa.ˈta)|	W1	L

(41) TROCHEE: One violation-mark for every foot whose head is not at the foot's left edge.

[12] For this reason, the arguments given in this section will also apply to OT with Candiate Chains (OT-CC), which is a more elaborate relative of HS in which multiple gradual derivations are constructed, which then compete as candidates. All of these derivations must improve harmony relative to the same ranking, so any derivational steps requiring inconsistent rankings cannot co-exist in the same language. Hypothetically, at a step like (40), laying down either an iambic or a trochaic parse could both improve harmony, but in OT-CC different ways of doing the same operation are assumed to have to compete locally, just as in HS, meaning that only one can feature in the set of derivations being constructed. This requirement is called LOCAL OPTIMALITY; see Wolf (2008: 160-185; to appear) for discussion of this aspect of OT-CC and the empirical motivations for it.

(42) IAMB: One violation-mark for every foot whose head is not at the foot's right edge. (both of these traceable to RHTYPE constraints in Prince & Smolensky [2004/1993: 63-66)

Putting it less formally, if the grammar really judges iambic parses to be better than trochaic ones—which it has to do at step 3 of (39)—then it would have assigned an iambic parse to begin with at step 1.

The argument is slightly more complicated for a derivation like the one in section 2.2, where final shortening triggers a re-assignment of feet. This is more involved than the scenario in (39) because to proceed gradually we would have to tear down the previously-assigned feet in order to make room for the new feet (here, we add 'remove one foot' to the set of basic operations already assumed):

(43) /pa.ta.ka:/ $\rightarrow_1$ |pa.ta('ka:)| $\rightarrow_2$ |(ˌpa.ta)('ka:)| $\rightarrow_3$ |(ˌpa.ta)('k^{h}a:)| $\rightarrow_4$ |(ˌp^{h}a.ta)('k^{h}a:)| $\rightarrow_5$ |(ˌp^{h}a.ta)('k^{h}a)| $\rightarrow_6$ |('p^{h}a.ta).k^{h}a| $\rightarrow_7$ |p^{h}a.ta.k^{h}a| $\rightarrow_8$ |p^{h}a.('ta.k^{h}a)|

Here the problem is consistency between the ranking requirements for steps 2 and 7 to each be harmonically-improving with respect to the steps which respectively precede them. For step 2, the construction of a foot on the two non-final syllables, to be harmonically-improving, it is necessary for a constraint favoring footing to outrank any and all constraints which disfavor the presence of a foot in this position, for instance the alignment constraint ALL-FOOT-RIGHT, which is violated by any foot that is not at exactly the right edge of the PWd:

(44) *Ranking for harmonic improvement of foot-building at step 2*

	|pa.ta('ka:)|	EXH(wd)	ALL-FT-R
build foot	*a.* ☞ |(ˌpa.ta)('ka:)|		1
fully-faithful candidate	*b.* |pa.ta('ka:)|	W2	L

(45) EXHAUSTIVITY(word) (Itô & Mester 2003 [1992]; Selkirk 1995): One violation-mark for every syllable which is a direct dependent of the prosodic word.

(46) ALL-FOOT-RIGHT (Prince & Smolensky [2004/1993: 46]; McCarthy & Prince [1993b])
The right edge of every foot is aligned with the right edge of the PWd. (Violations assessed gradiently by syllables.)

The problem then is that the removal of this foot at step 7 will require the opposite ranking: at least one of the constraints disfavoring a foot in this position must outrank the pro-footing constraint EXH(wd) in order to make this move harmonically improving:

(47) *Removal of foot at step 7 requires opposite ranking*

	|(ˈpʰa.ta).kʰa|	ALL-FT-R	EXH(wd)
fully-faithful candidate	*a.* |(ˈpʰa.ta).kʰa|	W1	L1
remove foot	*b.* ☞ |pʰa.ta.kʰa|		3

Now, admittedly, the contexts surrounding the non-final foot in the output of step 2 and the input to step 7 are not the same: the final syllable is footed in the former but not the latter. Therefore, in principle the two steps could be compatible with the same ranking if foot-deletion at step 7 were motivated by a constraint which was satisfied at step 2. This constraint would have to say something like "one violation mark for every foot which is not at the right edge of the PWd, unless it is followed by another foot"; or effectively "the rightmost foot in the PWd must be exactly at the right edge", which I abbreviate as RM-AT-R (for RIGHTMOST-AT-R) in the tableaux below:

(48) *Hypothetical RIGHTMOST-AT-RIGHT makes both steps harmonically-improving*

Step 2

|pa.ta(ˈka:)|	RM-AT-R	EXH (wd)	AFR
a. ☞ |(ˌpa.ta)(ˈka:)|			1
b. |pa.ta(ˈka:)|		W1	L

Step 7

|(ˈpʰa.ta).kʰa|	RM-AT-R	EXH (wd)	ALL-FT-R
a. |(ˈpʰa.ta).kʰa|	W1	L	W1
b. ☞ |pʰa.ta.kʰa|		1	

I am not aware that such a constraint as RIGHTMOST-AT-R has ever been proposed. (When categorical foot-alignment constraints [McCarthy 2003] compare candidates with identical degrees of footing, they only differentiate between candidates according to whether the {right/left}-most foot is at the {right/left} edge; this is because every non-edgemost foot will produce one violation of the constraint, no matter where the foot is positioned; see Hyde [2008: 9-10, 18] for discussion. The violations incurred by non-edgemost feet are nevertheless still there, and can be decisive when comparing candidates with different degrees of footing. Pertinently, categorical ALIGN(Ft, R, PWd, R) will, like gradient ALL-FOOT-R, prefer (b) over (a) in step 2 of (48). Categorical alignment constraints thus do not have the same favoring relations as hypothetical RIGHTMOST-AT-R.) In the absence of any reason to believe that RIGHTMOST-AT-R exists, we can conclude that steps 2 and 7 of the derivation in (43) cannot improve harmony with respect to a single constraint ranking.

5. Possible examples of SCP inversion

We have established thusfar that Stratal OT predicts a symmetric surface typology of stress-conditioned segmental phonology: for any process which can be induced to apply just in [α stressed] syllables, Stratal OT predicts that we should also find languages where the process applies just in [-α stressed] syllables. In this section, I consider several cases of metrically-conditioned processes which at least appear to instantiate this prediction: in these cases, we see a process which is more typical of one type of metrical position (strong as opposed to weak; foot-initial as opposed to foot-medial) appearing to apply in the opposite type of position. I will argue that all of these apparent examples will yield to an analysis which is more typologically conservative than the extreme alternative of adopting Stratal OT and its prediction of a completely symmetric typology for all metrically-conditioned segmental processes. Additionally, we will see that for at least one of these examples, a Stratal-OT based inversion analysis is arguably non-viable for independent reasons.

5.1 Nganasan consonant gradation

5.1.1 Apparent divergence in foot-initial sonority preferences

Nganasan is a Uralic language spoken on the Taymyr Peninsula in Siberia, at the very northernmost extreme of mainland Asia. It has a system of rhythmic consonant gradation involving two grades traditionally termed 'strong' and 'weak' (Helimsky 1998: 487-495; González 2003: 81-83, 183-186; Vaysman 2009: 40-60; Gordon 2011: §5.1):

(49)

strong	h	t	k	s	ç	c	^{ŋ}h	^{n}t	^{ŋ}k	^{n}s	^{ɲ}ç	^{n}c
weak	b	ð	g	ɟ	ɟ	ɟ	h	t	k	s	ç	c

Notice that we have here two alternation patterns, which interact opaquely: voiceless, non-prenasalized consonants count as weak when they alternate with prenasals, but count as strong when they alternate with voiced consonants. This fact will be important to the analysis I will suggest.

The distributional generalization concerning the two grades is that a consonant appears in its 'weak' form in the onset of odd-numbered non-initial syllables, and in its strong form in the onset of even-numbered non-initial syllables. Further, the even/odd syllable count is reset following any syllable containing a long vowel. Both of these generalizations can be seen in the following examples, in which we observe the alternation of the 3rd person singular possessive suffix between strong-grade /-tu/ and weak-grade /-ðu/, as well as the distribution of grades within roots:

(50)
(a) |(ɟa.ma)(ða-tu)| animal-3SG.POSS.
(b) |(ŋo.ru)(mu-tu)| copper-3SG.POSS.
(c) |(suː)(ðəː)-(ðu)| lung-3SG.POSS.
(d) |(ŋu.hu)-(ðu)| mitten-3SG.POSS.

As depicted above, and as Vaysman (2009) argues, this distribution is easily accounted for if we assume that the language builds feet from left to right, with long-vowelled syllables forming monosyllabic feet, and degenerate feet containing only a single light syllable permitted only word-finally. (It is relevant to the argument of this paper that this foot structure is not what one would infer from the language's stress pattern alone; the issue of claimed stress/footing mismatches in Nganasan and other languages is discussed in §5.1.2 below.)

If we posit this footing pattern in Nganasan, then the distribution of grades is straightforward: weak grades occur foot-initially (except word-initially), and strong grades occur foot-medially. As González (2003: 184-186) notes, the replacement of strong-grade voiceless consonants with weak-grade voiced ones foot-initially runs counter to what is otherwise a typologically robust pattern: the beginnings of prosodic constituents favor not lenition but fortition (Pierrehumbert & Talkin 1992; Byrd 1994; Dilley *et al.* 1996; Cho & Keating 2001; Smith 2002; Keating *et al.* 2003; Kavitskaya 2005; Flack 2007; Gordon 2011: §4.1).[13] Generalizing this tendency to *foot*-initial position is potentially tricky, because in a trochaic foot it is ambiguous whether restrictions on the onset of the foot-initial syllable hold because it is at the beginning of a foot or because it is at the beginning of a stressed syllable. However, foot-initial fortition processes are attested in Alutiik and Norton Sound Yup'ik (Leer 1985; González 2003: 179-180, 64-67; Kavitskaya 2005; Gordon 2011: §4.1), which are iambic.[14]

Nganasan therefore appears to present a genuine inversion of a typological tendency: voiced consonants seem to be favored over their lower-sonority voiceless counterparts in foot-initial position. Building on a suggestion by González (2003: 186), I will suggest that the paradox is resolvable if, for both of the alternations in the grade system, we consider which value is underlying and which is derived:

(51)

For the voiced/voiceless alternation, are we seeing:	*For the prenasalized/voiceless alternation, are we seeing:*
Underlying voiceless consonants become voiced foot-initially, *or*	Prenasalized consonants become plain voiceless consonants foot-initially, *or*
Underlying voiced consonants become voiceless foot-medially?	Plain voiceless consonants become prenasalized foot-medially?

Considered individually, pinning down which grade is underlying and which derived in the two alternation patterns may be impossible, given Richness of the Base. However, the coexistence of both, together with the inversion paradox we want to resolve, suggests an answer. González (2003: 186) proposes that in the voiced/voiceless alternation, the consonants are voiced (weak grade) underlyingly. If so, then there is no foot-initial voicing (lenition) going on; instead we have de-voicing in the non-initial position of a foot, which González suggests can be understood as an instance of laryngeal neutralization in a non-prominent position.

In positional faithfulness theory (Beckman 1998), this effect could be attributed to a constraint IDENT(voice)-($_{\varphi}$σ, which would protect the underlying voicing specifications of segments in the foot-initial syllable. Assuming, as alluded to earlier, a

[13] See also Uffmann (2007) for related conclusions about the quality of epenthetic consonants.
[14] An additional argument (Flack 2007: 32-33) for parallelism between the effects of foot-boundaries and the edges of other prosodic domains concerns restrictions on the distribution of [ŋ]. Wiese (1996) argues that the distribution of [ŋ] in English and German is correctly characterized by saying that the segment is banned in foot-initial onsets; this parallels numerous languages cited by Flack (2007: 25-27) in which [ŋ] is banned from *word*-initial onsets, but permitted in word-medial onsets.

general parallelism between levels of the prosodic hierarchy with respect to the kinds of constraints which may refer to their edges, such a constraint would be analogous to positional faithfulness constraints to laryngeal features in *word*-initial syllables, for which there is good evidence. Becker, Nevins & Levine (to appear) argue that initial-syllable faithfulness furnishes the best available account of patterns where monosyllabic words resist alternations, cases of which involving laryngeal features are attested in English and Turkish. Buckley (1998) presents a case which combines aspects of word-initial and foot-initial licensing, arguing that laryngeal increments in Kashaya are permitted only as the first segment of a word's first foot.

Adopting González's proposal that the voiced ~ voiceless alternators in Nganasan are underlyingly voiced obliges us to ask what would happen to underlyingly voiceless consonants, since Richness of the Base prevents us from banning their presence in the input. An answer is readily at hand given the other alternation pattern in the Nganasan gradation system: we may assume that underlyingly voiceless consonants (and underlyingly pre-nasalized ones) participate not in the voiced/voiceless alternation but instead in the pre-nasalized/voiceless alterantion. These consonants surface as pre-nasalized foot-medially and as plain voiceless consonants foot-initially. This alternation pattern is typologically unproblematic, since it features foot-initial fortition of underlying prenasals, and foot-medial lenition of underlying voiceless stops (on the entirely reasonable assumption that voiceless prenasals are more sonorous than plain voiceless stops). While fortition of pre-nasals in foot-initial position is not otherwise known that I am aware of, there are numerous languages in which pre-nasals are found *word*-medially but not word-initially. In Northern Tohoku Japanese, for instance, voiced stops are prenasalized word-medially but oral word-initially (Kanai 1982; Nasukawa 2005). Sinhala (Feinstein 1979) has a contrast between prenasalized and oral voiced stops medially, but lacks prenasals word initially; almost the same is true in Nzɛbi (Guthrie 1968), where initial pre-nasals are not allowed except when they arise via attaching a nasal prefix to stop-initial words.[15]

Thus, in Nganasan, there is no need to posit foot-initial voicing because there are in fact voiceless stops which surface as voiceless foot-initially—those that participate in the prenasality alternation rather than in the voicing alternation. If there were a language like Nganasan which had only the voicing alternation, and in which this was perfectly allophonic, with exclusively voiced consonants foot-initially and exclusively voiceless consonants foot-medially, this might qualify as evidence for inversion. Real Nganasan, however, does not.

One might protest that such an analysis, featuring foot-medial devoicing, is tantamount to positing inversion anyway, since foot-medial position is classically recognized as a lenition-favoring context, as in the cases of flapping in various dialects of English (Kahn 1976; Kiparsky 1979; Bye & de Lacy 2008), consonant gradation in Estonian (Prince 1980), and stop lenition in Ibibio (Harris & Urua 2001), and since moreover the proposed analysis must assume that an underlying voiceless consonant

[15] Additional examples of contrasts between prenasalized and oral voiced stops being neutralized word-initially are discussed in Milner (1965) and Herbert (1986).

in foot-medial position lenites to a prenasalized consonant. This appearance is, however, only superficial. It seems reasonable to assume—generally following Bye & de Lacy (2008)—that no markedness or faithfulness constraint refers to foot-medial position as such. With faithfulness to foot-initial position, we can in principle make just about any general phonological process apply foot-medially only, by blocking it foot-initially. But to make a process apply only foot-initially, we would need recourse to markedness constraints specific to foot-initial position, and this sub-set of constraints we can take to be not fully symmetric in some substantive way, such as that there are constraints calling for low sonority foot-initially but not ones calling for high sonority in that position.

5.1.2 The question of stress-footing independence

One complication posed by the Nganasan data—which is Vaysman's (2009) major theoretical point—concerns the independence of stress and foot structure (see also Gordon 2011: §5). While the rhythmic distribution of consonant grades is easily explicable in terms of foot structure, this foot structure is inferred solely from consonant gradation itself, and does not perfectly correlate with the distribution of stress. Generally, main stress in Nganasan falls on the ultima if it is heavy, and otherwise on the penult; this is complicated by a variety of patterns wherein the stress shifts off of the penult when it is one of the low-sonority vowels /ə, ɨ/ (see also de Lacy [2004]).

As a result of these restrictions, it is possible for a word-final foot whose presence is implied by the foot-based account of consonant gradation to lack any stress:

(52)	(a)	|(ŋu.ˈhu)-(ðu)|	mitten-3SG.POSS	(Vaysman 2009: 24)
	(b)(i)	|(ɟy.ˈby)-(tə.ni)|	sledge-LOCATIVE	(Vaysman 2009: 28)
	cf. (ii)	|(ˌɲo.ru)(ˈmu-^{n}tə)(nu)|	copper-LOCATIVE	(Vaysman 2009: 28)

In a word like (52a) which consists of an odd number of light syllables, we expect there to be a unary foot formed on the final syllable which is left over by binary left-to-right parsing, and the presence of this foot is corroborated by the initial consonant of this syllable appearing as weak-grade [ð]. This final foot is not, however, stressed; the ultima is light and the penultimate vowel is not /ə/ or /ɨ/, so main stress is on the penult, and the final foot apparently corresponds to no stress. The same outcome is observed for different reasons in a word like (52b.i): the ultima is light, so we would expect stress on the penult, but because the penult is /ə/, it forfeits main stress to the antepenult. This leaves the binary foot formed on the final two syllables (the locative suffix) with no stress; nevertheless we can infer that the foot is there from the fact that the suffix-initial vowel appears in its foot-initial, weak-grade plain voiceless form, rather than in its foot-medial prenasalized form, as found in such words as (52b.ii).

Now, allowing for a degree of independence between feet and stress is precedented outside of the matter of metrically-conditioned segmental phonology. Most notable is the case of Cairene Arabic, in which iterative footing is needed to correctly determine the location of the main-stressed foot, but where audible secondary stress is not reported. Halle & Vergnaud (1987) handle such cases in derivational terms by deleting the secondary-stressed feet after they are no longer needed; Crowhurst (1996) proposes a parallel OT alternative in which the requirement that feet have a head is a violable constraint.[16] What is possibly worrisome about the Nganasan data is thus not the independence of stress and footing in and of itself, but rather whether this independence offers a back door to permitting inversion of metrically-conditioned phonology. The critique of Stratal OT which I have given in this paper involves the way in which this theory allows two distinct metrical patterns to coexist *at different stages of the same derivation*: the earlier one with respect to which stress-conditioned phonology is applied, and the later one which represents the audible surface stress pattern. If stress and foot structure are in principle independent, this might be seen as coming close to claiming that two different metrical patterns coexist *in the same level of representation.*

In reality, this will not be a worry to the extent that stress marks and foot-edges, being distinct phonological objects, are expected to differ in the kinds of segmental processes can be favored there. In some cases these might overlap; for example, as mentioned above, there is reason to think that there are constraints favoring lower sonority in foot-initial segments, and the same is true of onsets of stressed syllables (see discussion in §5.3 below). However, in other cases they clearly would not. As González (2003: 177) notes, phonological processes which are grounded in the greater intensity or duration of stressed vowels, for example, are expected to be conditioned only directly by stress, rather than by foot boundaries. These two phonetic characteristics of stressed syllables are central to the proposal made in Giavazzi (2010) about what kinds of processes we do and don't expect to find occurring in stressed positions. Aspiration of pre-tonic consonants, for example, is claimed to be a consequence of the increased subglottal pressure involved in stressed vowels. If this phonetic basis is in some way incorporated into the phonology, we naturally expect it to be possible for languages to have systematic aspiration in stressed onsets, but not systematic aspiration at foot edges. (Further, we expect that aspiration in stressed onsets is limited to languages in which greater intensity is an acoustic correlate of stress [Giavazzi 2010: 89]).[17, 18]

[16] The possibility of stressless and/or headless feet is also argued for by van de Vijver (1998), Hyde (2002), González (2003: 267, 287-303), and Buckley (2009), among others.

[17] A related consideration about what sort of segmental processes foot-edges should and shouldn't be able to condition is that, as discussed earlier, there is some evidence to think that processes which are conditioned by the edges of feet should mirror those which are observed to be conditioned by constituents at other levels of the prosodic hierarchy.

[18] An additional layer would be added to all this if we make a distinction between stress marks and foot heads. While Crowhurst's (1996) analysis of Cairene Arabic treats stressless feet as lacking a head, Buckley (2009: 412) argues, based on the distribution of (iambic) lengthening in Kashaya, that we must be able to distinguish between the head and non-head syllables of feet which nevertheless don't receive an overt stress. Similarly, González's (2003: 287-303) analysis of rhythmic /ʔ/-deletion in Capanahua relies on positing feet which are stressless but nevertheless trochaic, with the weak branch of the foot being targeted by deletion. Taking the latter line, our theory of metrically-conditioned segmental phonology would need to differentiate between effects which are conditioned by stress as such, those which are conditioned by a segment's being in the strong or weak branch of a foot, and those which are

Moreover, even in a theory where stress and foot structure are necessarily tied together, obtaining an asymmetrical typology (there are languages where process *P* applies only in stressed syllables, but none where *P* applies only in unstressed syllables) already implicitly requires the assumption that the kinds of positional markedness constraints referring to stressed position differ from those referring to foot edges. Consider, for instance, a language with iambic stress. In such a language, all unstressed syllables will be foot-initial. Such a language could then systematically feature aspiration in all unstressed onsets—e.g. [(pʰa.ˌta)(kʰa.ˈpa)]—*if* there were a constraint demanding that foot-initial stops be aspirated. Even if stress were taken to be intrinsically tied to foot structure, we would have to assume that there is no such constraint in order to correctly predict the non-existence of any language with aspiration in all and only its unstressed syllables.

In sum, then, making an allowance for a degree of independence between stress and foot structure, as Nganasan seems to call for, does not fundamentally menace the asymmetric behavior of stressed as opposed to unstressed syllables with regards to the kinds of segmental phonology they can condition. In the next section I consider a case which is more worrisome to the extent that it has been claimed to require not just stress-footing independence, but actual co-existence of distinct metrical parses.

5.2 Stress/epenthesis mismatches in Huariapano

Besides Nganasan, the second case which González (2003: 182-183) identifies as involving paradoxical metrical tendencies is that of coda /h/-epenthesis in Huariapano (Parker 1994, 1998a,b), a Panoan language of Peru which became extinct with the death of the last fluent speaker in 1991. As referred to earlier, main stress in this language is quantity sensitive, falling on the ultima if it is heavy, and otherwise on the penult:

(53)	[ja.ˈwiʃ]	'opossum'	[ʂa.ˈβin]	'bee'
	[ˈhi.wi]	'branch, stick'	[ram.bo.ˈʂo.βo]	'knees'

Secondary stress is quantity insensitive, parsing the material before the main stress into syllabic trochees (Parker 1998; González 2003: 304-330; McGarrity 2003: 206-215):

(54) |(ˌjo.mɯ)(ˌra.no)(ˈʂi.ki)| 'he is going to hunt'

In an example like this one, with an even number of syllables preceding the head foot, we get no evidence about the directionality of parsing for secondary stress. Amongst words with an odd number of syllables preceding the main stress, we find lexical inconsistency: about two thirds (González [2003: 308], citing Parker [1998: 9]) of

conditioned by foot boundaries. While this does make things a bit more complex, the situation remains conceptually the same: we are dealing with different prosodic objects whose potential segmental effects, while sometimes overlapping, will not be completely identical.

such words show left-to-right parsing as in (55a), with the remaining third showing right-to-left parsing as in (55b):

(55) (a) |(ˌku.βjaj).βa(ˈʂi.ki)| 'I cooked'
(b) |βis.(ˌma.noh)(ˌko.no)(ˈʂi.ki)| 'I forgot'

The paradox is that no such inconsistency exists with respect to /h/-epenthesis. A fricative, which following Parker and González I will depict phonemically as /h/[19], is epenthesized in the codas of odd-numbered syllables counting left-to-right, provided the onset of the following syllable is voiceless. (Syllables which already have a coda, and syllables which are both main-stressed and word-initial,[20] also do not undergo epenthesis.) In words with an even number of syllables before the main stress, this corresponds to epenthesis in all of the (eligible) stressed syllables (/h/es in the position of epenthesis are italicized):

(56) [(ˌjo.mɯ)(ˌra*h*.ka)(ˈti*h*.kæ̃j)] '(they) hunted'

But when an odd number of syllables precedes the main stress, this correlation is broken. This is most dramatically the case in words where we also have right-to-left footing, since here, all of the odd-numbered syllables (counting from the right) are stressless, and yet it is they which (if eligible on other grounds) get the epenthetic /h/:

(57) |a(ˌri.βa*h*)(ˈkaŋ.ki)| 'they repeated'

We thus have an apparent case of inversion: /h/ epenthesis targets stressed syllables on one class of words but unstressed syllables in another.

We also see epenthesis into unstressed syllables in words with left-to-right footing and an odd syllable count before the main stress. Specifically, in such words the syllable immediately preceding the main stress will be unfooted (and perforce unstressed), but it is eligible for epenthesis:[21]

(58) |(ˌja.na)pa*h*(ˈkw̃iŋ)| 'I will help'

Such words also feature a dissociation of stress from epenthesis in that the main-stressed syllable, being in even-numbered position counting from the left, will *not* undergo epenthesis:

[19] This segment's allophonic realization depends on the quality of the preceding vowel (Parker 1994: 115). It is [h] after /a/, [ç] after /i/, [x] after /ɯ/, and [w̥] after [o].

[20] However, word-initial syllables which are not main-stressed, and main-stressed syllables which are not word-initial, *do* get epenthetic /h/ (provided again that they are odd-numbered and followed by a voiceless consonant). Parker (1998a) analyzes this by locally conjoining (Smolensky 1995) a constraint against the feature [spread glottis] in main-stressed syllables with a constraint against against the same feature in initial syllables. The desired result could presumably also be achieved via the use of weighted constraints; see Jesney (to appear) for discussion of weighted constraints and positional licensing.

[21] The same goes for words with only a single syllable before the main stress, e.g. [kɯh(ˈpɯn)] 'I open'.

(59) |(ˌkæj.βa)kãn.(ˈʂ̬i.ki)| '(they) went'

Based on these facts, Parker (1998) argues that /h/-epenthesis requires the co-existence of two separate, disjoint metrical parses: one for stress, and one which groups syllables into binary rhythmic units from left to right, with epenthesis applying to the initial syllable of each unit. It is not hard to see how this analysis, with the co-existence of two different parses at the same level of representation, could be translated into a Stratal OT analysis, with the different parses assigned at successive levels of representation. Specifically, we could (for the pertinent class of words) assign the left-to-right binary parse at one level, and apply /h/-epenthesis with respect to this parse; and then at the next level, a new parse would be assigned, corresponding to the observed surface stress pattern.

The danger in either type of analysis, of course, is that it risks opening the floodgates to full-scale inversion of any type of stress-conditioned phonology, since the two parses could be arbitrarily different from one another. While the defender of Stratal OT may counter that the contrast between [(ˌjo.mɯ)(ˌra*h*.ka)(ˈti*h*.kæ̃j)] versus [a(ˌri.βa*h*)(ˈkaŋ.ki)] represents a *prima facie* case of inversion (epenthesis can target either stressed or unstressed syllables), it behooves us (as González [2003: 318] also concludes) to inquire whether or not a typologically more restrictive analysis of Huariapano, not reliant on positing distinct parses for the same words, could be found.

Given that the words with right-to-left parsing represent a minority of the lexicon, it may be independently necessary to set these aside as listed exceptional forms—they diverge from the norm in the placement of stress itself, not just in the distributional relationship between stress and /h/-epenthesis. (González [2003: 318, 323-325] relies on a similar assumption, that these forms have their stresses lexically specified, but still get binary right-to-left footing. From there it is but a short step to assuming that these words are fossilized exceptions in their entirety, with the /h/es also present underlyingly.) Assuming that this move is justified, this means that stressed syllables and epenthesis sites fail to match up in two types of remaining cases, both of which we find in words where there are an odd number of syllables to the left of the main stress.

First, we need to account for why the solitary left-over syllable immediately preceding the main stress gets epenthetic /h/. In Parker (1994), there are numerous examples where this occurs in the first syllable of the word, such as (60a); it also occurs, under appropriate conditions, when the third syllable, as in (60b), or the fifth syllable, as in (60c-d), are immediately pre-tonic:

(60) *Epenthesis in odd-numbered syllable immediately preceding main stress*

(a) |poh(ˈʂ̬oj)|	'(I) fall down'	(Parker 1994: 100)
(b)|(ˌkɯ.na)mah(ˈkaŋ.ki)|	'when they called (for me)'	(Parker 1994: 117)
(c)|(ˌbɯ.na)(ˌka.no)ʂ̬ih(ˈkæ̃j)|	'(they) will look for'	(Parker 1994: 101)
(d) |(ˌjo.mɯ)(ˌra.no)ʂ̬ih(ˈkæ̃j)|	'(they) will hunt'	(Parker 1994: 101)

A reasonable analysis of such cases in fact has already been proposed (Parker [1994: 104-107]; see also González [2003: 320-321]), specifically that /h/-epenthesis serves to provide the spare syllable with a second mora, allowing it to be parsed as a foot.[22] Now, it might be objected that hypothesizing a foot to be formed on the left-over syllable seems to be in tension with the lack of any reported stress on such syllables. We may need here to assume that the structural status of the pre-tonic syllable as the head of a foot is not phonetically realized in any form which is recognizable as 'stress'. Since stress in Huariapano is otherwise alternating and lacking in clashes, it is not totally implausible to assume that the pre-tonic secondary stress would not be audibly realized.

Since we have discussed Harmonic Serialism in this paper, it is worth addressing the possible argument that such an analysis is incompatible with serial optimization. The intuition that /h/-epenthesis is performed in order to 'allow' the leftover syllable to be footed seems to require that epenthesis and footing happen in parallel. While arguments of this form have appeared many times in the OT literature, McCarthy, Pater & Pruitt (to appear) show that they do not in fact go through, owing to the fact that, in HS, constraints which a language never violates on the surface may nevertheless be violated at intermediate stages of a harmonically-improving derivation. In the present case, what we would need to assume is that the grammar of Huariapano initially builds a unary foot on the leftover syllable, creating a temporary violation of FTBIN (seen at Step 3 of the schematic derivation below), a violation which is resolved by [h]-epenthesis at step 4:

(61) *Schematic HS derivation for Huariapano word with /h/-epenthesis in odd-numbered pretonic syllable*

(a) *Step 1: Build PWd with head foot at right edge*

/CVCVCVCVCV/	WDCON	HEADFT-R	EXH(wd)	ALL-FT-L	FTBIN	DEP-C
a. ☞ |CV.CV.CV.('CV.CV)|			3	3		
b. |('CV.CV).CV.CV.CV|		W3	3	L		
c. CV.CV.CV.CV.CV	W1	L	L	L		

(b) *Step 2: Parsing of secondary stress feet begins from left edge*

|CV.CV.CV.('CV.CV)|	WDCON	HEADFT-R	EXH(wd)	ALL-FT-L	FTBIN	DEP-C
a. ☞ |(ˌCV.CV).CV.('CV.CV)|			1	3		
b. |CV.(ˌCV.CV)('CV.CV)|			1	W4		
c. |CV.CV.CV.('CV.CV)|			W3	3		

[22] Parker (1998b) argues, based on durational data, that coda /h/ is in fact moraic.

(c) *Step 3: Leftover odd-numbered syllable parsed as unary foot*

|(ˌCV.CV).CV.(ˈCV.CV)|	WdCon	HeadFt-R	Exh(wd)	All-Ft-L	FtBin	Dep-C
a. ☞ |(ˌCV.CV)(ˌCV)(ˈCV.CV)|				5	1	
b. |(ˌCV.CV).CV.(ˈCV.CV)|			W1	L3	L	

(d) *Step 4: /h/ epenthesized to make unary foot bimoraic*

|(ˌCV.CV)(ˌCV)(ˈCV.CV)|	WdCon	HeadFt-R	Exh(wd)	All-Ft-L	FtBin	Dep-C
a. ☞ |(ˌCV.CV)(ˌCVh)(ˈCV.CV)|				5		1
b. |(ˌCV.CV)(ˌCV)(ˈCV.CV)|				5	W1	L

(62) WordCon (Selkirk 1995; cf. Prince & Smolensky's [2004 (1993): 51] Lex≈Pr)
≈ One violation-mark for every morphosyntactic word which is not parsed into a prosodic word.

(63) Exhaustivity(word) (Itô & Mester 2003 [1992]; Selkirk 1995): One violation-mark for every syllable which is a direct dependent of the prosodic word.

(64) HeadFt-R: The head foot must be aligned with the right edge of the word. (violations assessed gradiently by syllables) (cf. Edgemost constraints on head foot position in Prince & Smolensky [2004/1993: 34-38])

(65) All-Ft-Left: The left edge of every foot is aligned with the left edge of the PWd. (violations assessed gradiently by syllables) (McCarthy & Prince 1993)

In relation to the issue of harmonic serialism vs. parallelism, this analysis of Huariapano has two notable features. First, it involves positing bidirectional stress assignment (right-edge main stress with left-to-right secondary stress) together with parsing of leftover syllables as a unary foot. Using standard alignment constraints, this type of bidirectional exhaustive parsing is predicted possible in HS but not in parallel OT, as shown by Hyde (2009: §2.2). Hyde notes that such patterns are not reported, making this an argument against HS and for parallel OT; therefore, it is a significant point in favor of serialism if the Huariapano facts are best understood as instantiating such a parsing pattern.

Second, this HS analysis relies on the assumption that epenthesis of a coda consonant immediately brings a (CV) foot up to bimoraic size—that is, the inserted /h/ must immediately, upon insertion, acquire a mora and be incorporated into the CV syllable. Otherwise, epenthesis would not immediately remove the violation of FtBin, and would not be harmonically improving—epenthesis of [h] would bring no payoff in improved performance on FtBin to compensate for the added violation of Dep-C. All this is consistent with standard assumptions in the HS/OT-CC literature that moraification of codas (McCarthy 2007: §3.2.4.1) and syllabification (McCarthy 2010) happen 'for free' at each step. In this regard, Huariapano makes an interesting complement to the typological generalization (Blumenfeld 2006; Moore-Cantwell 2011) that epenthesis of *vowels* for foot binarity is unattested. This difference between C-epenthesis and V-epenthesis is that when we epenthesize a coda consonant for foot-binarity, the coda immediately is incorporated into an already footed syllable and can contribute to the foot's mora count at once. When we epenthesize a vowel, however, it becomes the head of a *new* syllable. If the incorporation of syllables into feet is necessarily a step of its own in HS, and not something that can happen for free together with epenthesis—the assumption at the crux of Moore-Cantwell's (2011) Harmonic-Serialist account of this typological gap—then adding an epenthetic vowel cannot contribute immediately to the mora-count of any foot, since the epenthetic vowel will initially be the head of a new, unfooted syllable. Hence vowel-epenthesis is predicted in HS not to be a possible 'repair' for FTBIN violations.

Now back to the possible arguments for inversion to be found in the Huariapano data. There is one remaining stress/epenthesis-site mismatch for us to deal with, which concerns the main-stressed syllable. When an odd number of syllables precede the main stress, the main-stress itself will be in an even-numbered syllable, and is therefore predicted to be ineligible for epenthesis. In Parker (1994) and González (2003) I was able to find only one form[23] which bears on this prediction (in that it has left-to-right parsing of secondary stress, an odd number of syllables preceding the main stress, and a voiceless consonant immediately following the main-stressed vowel):

(66) |(ˌku.βjaj)(ˌβa)(ˈʂ̬i.ki)| 'I cooked' (González 2003: 308)

This one datum is consistent with the prediction that the main-stressed syllable in these words will be ineligible for /h/-epenthesis, though interestingly this word seems to be exceptional in that the third syllable also fails to receive epenthetic /h/, despite being followed by a voiceless consonant.

Whatever the limits of the available data, let's assume at least for the sake of argument that main-stressed syllables in words like (66) are systematically ineligible for epenthesis. What might be the motivation for this? Assuming we are correct that the syllable immediately preceding the main stress forms a unary foot, the main-stressed syllable and the preceding syllable will form a stress clash. A somewhat speculative hypothesis is that epenthesizing /h/ to the main-stressed syllable is blocked because it creates a 'worse' clash: a clash like *(ˌβa)(ˈʂ̬ih) where the second syllable involved is both main-stressed *and* heavy is just too much prominence crammed together. While I am not aware of any instantiation of this precise pattern in other languages, two near parallels can be cited. First, Pater (2000) and Plag (1999) propose that clash involving the main stress is uniquely marked—that is, in addition to general *CLASH, there is a constraint *CLASH-HEAD which specifically penalizes σ̀σ́ and σ́σ̀, but not σ̀σ̀.

[23] Parker (1994: 117) states that the examples given in his article, including the appendix, "constitute an exhaustive list of all the Huariapano forms in my data which illustrate the predictable occurrence of syllable-final [h]."

Second, Kennedy's (2002) analysis of Ponapean durative reduplication makes use of a constraint against adjacent heavy syllables. Stems consisting of an odd number of moras form the durative by prefixing a heavy-syllable reduplicant: /RED-pa/ → [(pàa).(pá)] 'weave'. He attributes the lengthened vowel in the reduplicant to the need to avoid clash at the moraic level (there is however clash at the syllabic level), combined with the need for both the base and reduplicant to host at least one stress. However, for a stem like /duup/ 'dive', the reduplicant is only monomoraic: |(dù)(duúp)|.[24] Kennedy accounts for this by proposing that *|(duù)(duúp)| (which equally well avoids mora-level clash, and has more complete reduplicative copying) is ruled out by a constraint against adjacent heavy syllables. Again, we can note here that examples like this one do feature clash at the syllabic level, so it is conceivable that the operative constraint is something like '*CLASH between two heavies'.[25] Given this and the arguments for *CLASH-MAIN, it is not hard to imagine that there could also be a constraint '*CLASH involving both a heavy syllable and a main-stressed syllable' (or, perhaps, the effect of such a prohibition arising from additive interaction of constraints against clash involving the main-stressed syllable and clash involving at least one heavy syllable.)

In sum, then, if we take left-to-right footing to be the default in Huariapano, the amount of stress/epenthesis-site mismatching that demands an explanation is rather limited, and two cases which we do have to account for can be given quite reasonable, if in one case somewhat tentative, explanations. Accordingly it would be premature to reason that the Huariapano data justify embracing Stratal OT and the full range of inversion scenarios which it can give rise to.

5.3 Lenition of stressed onsets

A number of lines of evidence have been presented suggesting that higher-sonority onsets are more marked in unstressed syllables. First, several languages are reported to have processes which eliminate high-sonority onsets in stressed syllables. Glides in stressed onsets are fortited in West Tarangan (w, j → g, dʒ: Nivens 1992; González 2003: 71-72) and Guayabero (w → β: Keels 1985; González 2003: 67-70). A different strategy is found in loan adaptation in Niuafo'ou (Tsukamoto 1988; de Lacy 2001; Smith 2002: 106-108, 2008). This language lacks glide onsets in the native vocabulary, but does allow them in loans (67a); an exception is that when the glide would form the onset of a stressed syllable, it is vocalized, forming a separate syllable (67b):

(67)	(a)	[ju.ˈni.ti]	'unit'	[wa.ˈi.ne]	'wine'
	(b)	[i.ˈa.te]	'yard'	[u.ˈa.fu]	'wharf'

[24] This stem has an even number of moras, since word-final consonants in Ponapean are non-moraic.

[25] However, for additional arguments for a constraint against consecutive heavy syllables (without reference to their being stressed), see Anttila (1997) and Kiparsky (2003: 131-132) on various phenomena in Finnish.

In addition to processes like these which serve to eliminate high-sonority onsets, there are also cases reported in which onset voicing contributes to determining the location of stress; in these cases, all else being equal, stress prefers to go on a syllable with a voiceless obstruent onset. Versions of this kind of pattern are reported in Pirahã (Everett & Everett 1984; Everett 1988; Smith 2003: 108-113; Gordon 2005; Topintzi 2010: 75-83), Arabela (Topintzi 2010: 83-97) and Karo (Gabas [1998]; cf. Blumenfeld [2006: 23-29], and in turn cf. Topintzi [2010: 39-57]). Preference for low-sonority onsets has been proposed to have a perceptual basis (Smith 2002: 50-52; Gordon 2005): because the sensitivity of the auditory system decreases with continued exposure to a stimulus (e.g. a vowel sound), inserting a period of lower acoustic intensity (e.g., a low-sonority consonant) provides a chance to recover from this adaptation, enhancing the perceived loudness of a following higher-intensity sound (in this case, the vowel). That is, having a low-sonority onset serves to bolster the perceptual prominence of a stressed vowel.[26]

As Gordon (2011) notes, however, the preference seen in many languages against high-sonority stressed onsets is in tension with attested cases of lenition in the onsets of stressed syllables. Probably the most striking example of this is found in the Uralic language Mokša (Vaysman 2009: 142-146). In this language, a range of variable lenition processes affect stressed onsets. Voiceless stops (68a), affricates (68b), fricatives (68c) and sonorants (68d) become voiced; voiced stops spirantize (68e); /m/ becomes [w] (68f); and /n/ deletes (68g):

(68) *Optional lenition of stressed onsets in Mokša*

(a) [sʲər.ˈpe] ~ [sʲər.ˈbe]	‘heart’	(e) [rʲi.ˈbʲeʒ] ~ [rʲi.ˈβʲeʒ] ‘fox’
(b) [kir̥.ˈtʃen] ~ [kir̥.ˈdʒen]	‘swamp’	(f) [pʲi.ˈma] ~ [pʲi.ˈwa] ‘large cup, mug’
(c) [kərʲ.ˈsʲæ] ~ [kərʲ.ˈzʲæ]	‘bread’	(g) [kə.ˈnak] ~ [kə.ˈak] ‘guest’
(d) [pəjə.ˈl̥ʲ-oze] ~ [pəjə.ˈlʲ-oze] ‘my knife’		

Mokša is not alone in exhibiting voicing in stressed onsets. In Urubu-Kaapor (Kakumasu 1986: 399; González 2003: 94-95), /p, t/ are optionally voiced in the onsets of secondary-stressed syllables (in the onset of the main-stressed syllable, there is instead lengthening).[27]

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[26] If we accept this explanation of the functional basis for constraints against high-sonority stressed onsets, then the Niuafo’ou example presents an interesting case of an OT constraint, as a participant in a formal system, producing effects which are abstracted away from the constraint’s phonetic motivation: while turning glide onsets into vowels saves the stressed syllable from having a high sonority onset, it doesn’t create an interval of lower intensity preceding the stressed vowel, and hence does not allow for perceptual recovery. See Smith (2008) for discussion of this point.

[27] González (2003) also cites the Wasco-Wishram dialect of Upper Chinook (Sapir 1925) as having voicing in stressed onsets. However, the description of Wishram in Dyk (1933) suggests a different analysis. While some stops in Wishram are fixedly voiced or voiceless, a “majority” (p. 9) are variable between voiced and voiceless (or sonant and surd, in the terminology he uses). Dyk states that variable stops are realized as sonants before vowels or /m, n, l, w/, and that “[c]ommonly, though with no great uniformity, they tend to become surds if, when followed by a vowel, or by m, n, l, w, they represent the initial phonemes of last syllables, or if the stress should come upon the immediately following syllable.” What this suggests is that, rather than voicing being preferred specifically in stressed onsets, stops are assimilatorially voiced before any sonorant (including vowels), a generalization which is sometimes

What should we make of this? González (2003: 162-163) suggests that voicing in stressed syllables has an aerodynamic basis, specifically arising from the higher airflow in stressed syllables. If we were to translate this proposed physical process into a functionally-grounded OT constraint, this would come close to positing constraints favoring greater sonority in stressed onsets, assuming that intensity of airflow is the physical dimension upon which the sonority hierarchy is based (Parker 2002). In essence, this would amount to saying that the set of markedness constraints is at least approximately symmetric with respect to the onsets of stressed syllables: there are constraints encouraging such consonants to be of low sonority (perhaps grounded in facts of perception, along the lines proposed by Smith and Gordon), and other constraints encouraging such consonants to be of high sonority (perhaps grounded in facts of production, as suggested by González). The alternative, of course, would be to keep the constraint set asymmetric and instead invoke Stratal OT's power of inversion: if all of the surface-stressed syllables in Mokša or Urubu Kaapor could be made unstressed at some earlier level, we could have their onsets lenite at that earlier level, and then shift stress into its surface position at the next level.

There are several reasons why adopting a symmetric constraint set would be a much more attractive option for these cases than the Stratal OT-based inversion analysis. First, surface word-stress in Mokša is attracted to high-sonority vowels (Kenstowicz 1996: 181-183; de Lacy 2002: 59, fn. 25; Vaysman 2009: 135-141). In order for all of the surface-stressed vowels to be unstressed in the output of the earlier, hypothetical lenition stratum, we would need this earlier stratum to preferentially stress lower-sonority vowels. Thus, to preserve an asymmetric set of constraints on the sonority of stressed-syllable onsets, we would have to pay the price of setting up a symmetric set of constraints on nucleus sonority. This is not only conceptually undesirable, but also would predict the existence of unattested languages which preferentially stress lower-sonority vowels on the surface.[28] Second, speakers of Mokša reportedly have a "preference to use the lenited version when word stress is also phrasal stress" (Vaysman 2009: 144, fn. 19). If lenition applied variably to unstressed syllables at one stratum, and then stress was then re-assigned to these erstwhile unstressed syllables at a later stratum, there would be no way for the location of the phrase-level stress to have influenced the frequency of lenition to have applied, or speakers' judgments as to whether lenition should have applied. If, on the other hand, lenition is conditioned by stress in one and the same grammar at which stress is

over-ridden by a variable process of devoicing in certain metrically weak positions. (I would like to thank the staff of the Manuscripts and Archives department of the Yale University Libraries for help tracking down a copy of Dyk [1933].)

[28] A recently-claimed counterexample (Durvasula & Rodrigues 2012) involves truncated words in Brazilian Portuguese: if the final vowel of the truncatum is high, it always stressed. As a constraint on the output of truncation, however, this may reflect some kind of morphological template, rather than involving phonological markedness *per se*. Beyond natural-language typology, additional evidence that CON is asymmetric in this domain is reported by Carpenter (2006, 2010). She found that subjects were more successful in learning the stress pattern of an artificial language in which stress was preferentially placed on low (high-sonority) vowels than in learning one which preferentially stressed high (low-sonority) vowels.

applied, it makes perfect sense that phrase-level stresses, being stronger, should encourage lenition more greatly.

If we are to entertain the existence of constraints preferring higher-sonority onsets in stressed syllables, it is fair to ask why we see languages like Pirahã which attract stress to lower-sonority onsets, but no languages where stress is attracted to higher-sonority onsets. (A morphologically-restricted case of this has been reported in second-conjugation verbs in Italian [Davis, Manganaro & Napoli 1987; Davis 1988; Davis & Napoli 1994], however cf. Gordon [1999: 231] on some reasons why the data are not conclusive.) While a legitimate concern, this is not a problem specifically for such constraints because the same typological gap is associated with most markedness constraints on consonants in stressed syllables; for instance, there are languages like English which aspirate voiceless stops in stressed onsets, but there are no known languages where stress is attracted to syllables whose onsets have aspiration. For proposed formal solutions to this problem, see Blumenfeld (2006), Pizzo (2010), and Staroverov (2010), the latter two of which are cast within Harmonic Serialism. In terms of Staroverov's proposal, one possible line of explanation for the lack of stress-attraction to syllables with high-sonority onsets would be to say that the constraints responsible for lenition in Mokša refer directly to voicing and continuancy, rather than to sonority levels; under his proposal, constraints referring both to prosodic position and to segmental features other than sonority necessarily make reference to a segment's prosodic position at the previous (input) step of an HS derivation, so they cannot be satisfied by modifying the prosodic structure (e.g. shifting of stress).

6. Conclusion

This paper has presented a particular type of consequence that follows from Stratal OT's claim that, on their way to the surface, utterances pass through a succession of different grammars with potentially different constraint rankings. Such an arrangement allows for different, up to and including exactly-complementary, distributions of stress to be assigned at successive levels. That in turn means that Stratal OT permits languages to perform metrically-conditioned phonological processes such as aspiration or vowel reduction with reference to a stress pattern which is the precise inverse of the one found on the surface. The result is that Stratal OT fundamentally undermines any attempt to find universal typological correlations between metrically-conditioned phonological processes and stressed vs. unstressed position: if there is a language which applies process *P* only in stressed syllables, then Stratal OT predicts the existence of languages which apply *P* only unstressed syllables. Furthermore, we have seen that Stratal OT permits the inversion of normal stress-segmental phonology relationships to take place in only one phonological subclass of words (e.g. vowel-final as opposed to consonant-final words), since it is possible to force only one such subclass to undergo metrical re-adjustment at a later level. All of this places Stratal OT at a substantial typological disadvantage relative to variants of OT which employ only one grammar with one ranking (including classic parallel OT as well as certain serial approaches like Harmonic Serialism and OT with Candidate Chains).

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