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Too-many-solutions and Reference to Position in Serial OT

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Abstract

Any OT constraint banning a phonological entity in some position predicts that two types of languages should be attested: the ones which satisfy the constraint by changing the marked element and the ones where position of a marked element is modified. Yet for most such constraints, the languages which modify the marked element are attested but the ones modifying the position are not.

The paper proposes a way to principally solve this problem within the framework of Serial OT. The solution consists in replacing the relevant OT constraints with constraints that specify position in the output of the previous derivational step (PS-constraints). Modifying position does not improve on PS-constraints since position in the output is irrelevant to their violation profile and position in the previous step cannot be changed by Gen. Adopting PS-constraints makes phonological theory more restrictive in a way that is compatible with the attested typology in the domain of voicing neutralization and syncope-stress interaction.

The theory of PS-constraints is grounded in a precise definition of phonological position. If a constraint C mentions the elements of prosodic hierarchy both below and above the segmental level, the elements above the segmental level constitute position.

Too-many-solutions and Reference to Position in Serial OT

Peter Staroverov*

1 Introduction

The term *too-many-solutions* (TMS; another term often used as a synonym is *too-many-repairs*) refers to a set of problems whereby a given principle universally does not give rise to certain imaginable responses (see Blumenfeld, 2006; de Lacy, 2003; Steriade, 2001; van Oostendorp, 2007; Wilson, 2000 for a general discussion of TMS, as well as many others on specific TMS problems). In Optimality Theory (OT, Prince and Smolensky, 1993/2004), such problems become particularly visible — they arise as constraint rankings not attested in any language.

Any constraint banning a phonological entity in some position predicts that two types of languages should be attested: the ones which satisfy the constraint by changing the marked element and the ones where position of a marked element is modified. Yet for most such constraints, the languages which modify the marked element are attested, but the ones modifying the position are not. I will refer to such cases as *positional* TMS problems.

For example, the constraint *VCDOBS$]_{PWD}$ banning word-final voiced obstruents is often responded to by devoicing the consonant. Epenthesizing a vowel could improve on this constraint just as well, since it pushes the consonant away from the word edge. OT predicts both repairs to be attested, but only devoicing is found in natural languages (Steriade, 2001; but cf. van Oostendorp, 2007). Intuitively, the constraint at hand is "meant to" target voiced obstruents, not prosodic word boundaries. Inserting a vowel modifies the position, not the marked element.

In what follows, I offer a way of making these intuitions precise. I propose a modification to the way certain OT constraints refer to phonological position. Within the framework of Serial OT (Prince and Smolensky, 1993/2004; McCarthy, 2006, 2007, 2008a,b), where optimization proceeds in steps, constraints can make reference to position specified at the previous step in derivation. Replacing certain Classic OT constraints with the ones referring to previous step position makes the theory more restrictive by eliminating positional TMS problems.

In section 2, I introduce the proposal and exemplify positional TMS problems with the final devoicing problem. Section 3 shows that my analysis straightforwardly extends to other positional TMS problems. I consider the alternative analyses in section 4; section 5 concludes.

2 Word-final Devoicing and PS-constraints

This section introduces the proposal as applied to the final devoicing problem (Steriade, 2001). Section 2.1 states the problem. Section 2.2 gives some necessary background on Serial OT, and section 2.3 introduces my proposal, which is applied to the final devoicing problem in section 2.4.

2.1 The Final Devoicing Problem

Let us consider the problem mentioned in the introduction more carefully. In many languages voiced obstruents do not occur in word-final position[1] (Lombardi, 1999; Steriade, 1997 – see (1) adopted from van Oostendorp, 2007). This motivates the constraint *VCDOBS$]_{PWD}$ in (2).

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[1]I will not focus on word-medial voicing neutralization in this paper, since the factors underlying it are a matter of debate. It is often assumed that coda position is relevant for devoicing. On the OT analysis of Lombardi (1999), coda neutralization results from interaction of a general constraint *VCDOBS with positional faithfulness. However, Steriade (1997) gives some examples that are hard to analyze as coda devoicing and proposes a detailed hierarchy of positions based on the cues for voicing they provide. More data may be needed to decide between these analyses (cf. Inkelas and Orgun, 1995 on Turkish). The theory advocated here extends to positional faithfulness constraints as argued in section 3.1 and by Jesney (to appear).

(1) a. Catalan
gris – grizə 'grey M. – F.'; *gos – gosə* 'dog M. – F.'
b. Dutch (Standard)
kwaa[t] – kwadə 'angry Pred. – Att.'; *laat – latə* 'late Pred. – Att.'
c. German
blin[t] – blində 'blind Pred. – Att.'; *bunt – buntə* 'colorful Pred. – Att.'
d. Russian
knik – kniga 'book Gen.Pl – Nom.Sg'; *sok – soka* 'juice Nom.Sg – Gen.Sg'

(2) *VCDOBS]$_{PWD}$: assign a violation mark for a [+voice] obstruent at the end of a PWord.

If high-ranked, this constraint may be responded to in various ways depending on which of the faithfulness constraints is lowest-ranked. However, out of all the repairs listed in (3) (adopted from Steriade, 2001), only devoicing occurs in natural languages.

(3) a. Devoicing: /tab/ → [tap]
b. Nasalization: /tab/ → [tam]
c. Lenition: /tab/ → [taj]
d. C deletion: /tab/ → [ta]
e. Feature Reversal: /tab/ → [dap]
f. Metathesis: /tab/ → [tba] or [bat]
g. Epenthesis: /tab/ → [tabi]

Thus the predictions of the theory do not match up with the attested typology of languages. There have been two essential approaches to this problem (see section 4 for discussion). First, Steriade (2001) proposes a move towards abandoning the original OT assumption that every constraint may trigger multiple repairs. Second, Lombardi (1995/2001) and van Oostendorp (2007) adopt a modified theory of faithfulness to features which allows them to account for the unavailability of repairs in 3b-d (as well as 3e-f with a more radical analysis of van Oostendorp, 2007).

The present proposal is mainly focused on the cases where the position of the voiced obstruent is modified: vowel epenthesis and metathesis (3f-g). Before the proposal is introduced, a brief introduction of the main assumptions of Serial OT is necessary.

2.2 Serial OT

The label "Serial OT" is used here for a broad family of OT grammars with iterative, step-by-step optimization. In these grammars, Gen is limited to performing a single minimal change at a step and the output of Gen is fed back to Eval and then back to Gen again until harmonic improvement is not possible any longer. Hence there is a sequence of harmonically-improving steps from input to the ultimate output. As a first step, the most harmonic fully faithful parse of the input is selected (McCarthy, 2007). Any unfaithful mappings can only occur after the most harmonic faithful parse of the input has been selected and therefore the operations which are not protected by faithfulness (such as syllabification, as argued in McCarthy, 2007) have to be applied first. At the end of the derivation, the grammar iterated on its own output does not make any changes. The derivation terminates if the output of some step equals its input.

The property of performing one change at a step is known as *gradualness* (McCarthy, 2006, 2007). A single change is assumed to be one violation of one basic faithfulness constraint in the mapping. There are different proposals as to how faithfulness constraints should be evaluated in Serial OT. For the sake of simplicity, I adopt a view under which faithfulness at every step is evaluated with respect to the input of that step (McCarthy, 2006). Alternatively, the correspondence relations may be tied to the original input directly (McCarthy, 2007; Kavitskaya and Staroverov, submitted). Thus, the assumption of reference to previous step position introduced below can be reduced to *input* position for current purposes[2].

2.3 Phonological Position and PS-constraints

The main idea of my account is that certain OT constraints can specify position *in the output of the previous step in derivation*. Modifying position does not improve on such constraints since position in the output is irrelevant to their definition. Only the position in the input (i.e. previous step output) is mentioned, but that cannot be modified by Gen. I will call the constraints that single out phonological position in this way *previous step constraints* (PS-constraints). To signify previous step reference, the symbol "⮌" is appended to constraint names. A general definition of a PS-constraint is given in (4). To achieve a more restrictive theory, certain Classic OT constraints should be reformulated according to this schema.

(4) a. Let X be an input entity at some step
    b. Let X' be its correspondent in the candidate under evaluation
    c. Assign a violation if X is in position P and X' meets certain conditions

Any constraint formulated as in (4) specifies the position in the input (or equivalently in the output of the previous step) – in X. However, Gen can only modify X', and therefore any candidates that modify the position of the marked element do not improve on such a constraint, since the position of the marked element in X does not change.

Before I proceed to resolving the final devoicing problem, a few assumptions about PS-constraints need to be spelled out. First, the intuitive notion of position needs to be made precise. Every Classic OT constraint that needs to be replaced with a PS-constraint has to mention two things – a phonological element and its position. I further assume that both are specified as units of prosodic hierarchy. The part of the constraint definition that refers to position is then determined by the principle (5).

(5) If a constraint C mentions the elements of prosodic hierarchy both below and above the segmental level, the elements above the segmental level constitute position.

Thus in the case of *VCDOBS]$_{PWD}$ prosodic word boundary counts as position, whereas the segmental features defining voiced obstruents constitute the elements targeted by the constraint.

At the first step of every Serial OT derivation, the most harmonic faithful parse of the input is selected. At that step PS-constraints play no role: they all are vacuously satisfied since there is no previous step. At the final step of every derivation, the grammar makes no changes to its input. PS-constraints act just as Classic OT constraints at that step.

2.4 Excluding the Positional Solutions to the Final Devoicing Problem

Replacing the classic constraints with PS-constraints within Serial OT makes the theory more restrictive in the realm of final devoicing. The constraint *VCDOBS]$_{PWD}$ is exactly of the kind that we expect to be a PS-constraint: it targets voiced obstruents *in word-final position*. To formalize this intuition I reformulate the constraint as in (6).

(6) ⮌*VCDOBS]$_{PWD}$:
    a. Let X be an input segment
    b. Let X' be its correspondent in the candidate under evaluation
    c. Assign a violation mark if X is PWord-final and X' is a voiced obstruent

Unlike the original constraint (2), the new PS-constraint cannot be responded to by epenthesizing a vowel. This is shown in Tableau 1, which illustrates the selection of possible continua-

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[2]However, Kavitskaya and Staroverov (submitted) demonstrate that Serial OT with PS-constraints actually has to assume that faithfulness is evaluated with respect to the original input to avoid unwelcome computational consequences. The results in this paper are valid on both theories of faithfulness.

tions in a Serial OT derivation. This competition can occur at any step except the first step, where the most harmonic faithful parse is selected. For a candidate to become next step, it must be more harmonic than the faithful candidate. However, the epenthetic candidate in Tableau 1 cannot be better than the faithful candidate. In fact, candidate b is harmonically bounded by candidate a, and hence it can never win. Thus epenthesis is principally excluded by our grammar as a response to ⮌*VCDOBS]$_{PWD}$ and for a good reason: it modifies the position of the voiced obstruent, not the segment itself. A very similar story will apply to metathesis – another unattested positional repair.

Input: /tab/ Prev. step output: [tab]	⮌*VCDOBS]$_{PWD}$	DEP
☞ a. tab	1	
b. ta.bi	1	W_1

Tableau 1: Epenthesis excluded as a response to ⮌*VCDOBS]$_{PWD}$.

3 Other Positional TMS Problems

The final devoicing problem described above is not the only positional TMS problem, not even the only one related to voicing. This section gives more examples and shows that my theory is quite general in solving these problems.

3.1 Voicing, Syllabification, and Positional Faithfulness

Positional faithfulness constraints systematically give rise to positional TMS problems, as first noted by Beckman (1998:36 fn 27). I will illustrate this with voicing and syllabification data, but the pattern extends to other positional faithfulness phenomena. The unwelcome predictions disappear if the positional faithfulness constraints are PS-constraints (see also Jesney, to appear).

Assuming that syllabification is responsible for devoicing patterns (cf. fn 1), coda devoicing is often analyzed as resulting from interaction of the general constraint *VCDOBS banning voiced obstruents and a positional faithfulness constraint ID_{ONS}(VOICE) requiring faithfulness to onset voicing (Lombardi, 1999). However, if both of these constraints dominate both ONSET and the general ID(VOICE), a pathological pattern is predicted where underlying voicing is mapped to surface syllabification. This prediction, illustrated in Tableau 2, is dubbed the *Beckman-Noyer problem* in McCarthy (2007).

	ID_{ONS}(VOICE)	*VCD-OBS	ONSET	ID(VOICE)
/pada/				
☞ pat.a			1	1
pa.da		W_1	L	L
pa.ta	W_1		L	1
/pata/				
☞pa.ta				
pat.a			W_1	

Tableau 2: Beckman-Noyer Problem

In a hypothetical language illustrated in this tableau, /pada/ is mapped to [pat.a] while /pata/ gets syllabified [pa.ta]; hence, we get contrastive syllabification. Similar problems arise with other positional faithfulness constraints targeting segmental features (Jesney, to appear). Reformulating positional faithfulness constraints as PS-constraints makes such pathological patterns principally impossible. For instance, the new constraint ⮌ID_{ONS}(VOICE) is formulated in (7).

(7) ⮌ID_{ONS}(VOICE)
 a. let X be an input segment at some step
 b. X' be its correspondent in the candidate under evaluation
 c. If X is in the onset, assign a violation mark if X and X' have different values of the feature [voice]

Like all PS-constraints, this constraint does not participate in the selection of the most harmonic faithful parse of the input at the first step. Thus at that step /pada/ will be mapped to [pa.da] in conformity with the basic syllable theory of Prince and Smolensky (1993/2004). Crucially, with the new constraint at no step can an input like *pa.da* be mapped to *pat.a* as illustrated in tableau 3.

Prev. step output: [pa.da]	⮌ID$_{ONS}$(VOICE)	*VCD-OBS	ONSET	ID(VOICE)
a. pa.da		*		
b. pa.ta	*			*
c. pat.a	*		*	*

Tableau 3: Beckman-Noyer problem disappears with PS-constraints

In this tableau, I switch to the star-notation from the comparative format of Prince (2002). The tableau is not intended to demonstrate that some candidate is the winner. Depending on the ranking, either candidate a or candidate b can win. Crucially, however, candidate c can never win, because its violation marks form a superset of those of candidate b. Thus the theory of PS-constraints, unlike Classic OT with positional faithfulness, does not predict languages where input voicing is mapped to surface syllabification.

A related point is raised by Blumenfeld (2006). Blumenfeld observes that voiced obstruents in consonant clusters never require being syllabified as onsets. In other words, there are no languages where VDCV syllabifies V.DCV but VTCV is partitioned VT.CV because voiced codas are dispreferred. This observation is automatically captured if we admit that positional faithfulness constraints are PS-constraints. The pattern described by Blumenfeld arises for VCCV inputs on the ranking analogous to that in Tableau 2 with one difference: the syllable structure constraint violated is *COMPLEX, not ONSET. Crucially, the result illustrated in Tableau 3 holds in this case as well.

3.2 Syncope-Stress Interaction

Another famous positional TMS problem has to do with syncope-stress interaction. Metrical syncope is conditioned by stress and foot structure, but the constraints responsible for syncope never affect which vowels are stressed (Blumenfeld, 2006; McCarthy, 2008a). In other words, the vowel that is to be stressed is never deleted, even though in some cases this could lead to a better overall structure.

The analyses of metrical syncope often assume a constraint that penalizes vowel place in weak positions (weak in foot or extrametrical). I will refer to this constraint as *V-PL$_{WEAK}$ (see McCarthy, 2008b and references cited there). However, if this constraint freely interacts with other constraints, such interaction can give rise to unattested patterns. For instance, in the hypothetical language illustrated below, the syncope pattern in odd-parity words is either iambic or trochaic depending on what kind of codas it results in. The constraint CODASON demands codas to be sonorous. FT-FORM abbreviates the constraints responsible for foot form. I assume that the default stress is trochaic and that weight-to-stress principle is active.

4.1 /patakasafa/	CODASON	*V-PL$_{WEAK}$	FT-FORM
☞ a. (pat)(kas)fa	2	1	
b. (patak)(saf)	2	1	W$_1$
4.2 /patanasala/			
☞ a. (patan)(sal)		1	1
b. (pat)(nas)la	W$_2$	1	L

Tableau 4. Syncope is either iambic or trochaic depending on which codas it creates

In the absence of sonorant consonants in the input (as in 4.1), the candidate with trochaic syncope (4.1a) wins, since the competitor (4.1b) violates either WSP by stressing *pa* or TROCHEE by stressing *tak*. For an input that contains sonorants, however, an iambic syncope pattern can win (4.2). For the input 4.2, the candidate with iambic syncope emerges as optimal, since it better satisfies CODASON.

In this hypothetical language, either even or odd-numbered vowels delete in odd-parity words depending on which codas result. No language exhibits a pattern like that in tableau 4. This example is a little more complicated than the ones given before, but the nature of the problem is very similar. The syncope constraint *V-PL_{WEAK} globally interacts with other constraints, and this makes the considerations of syncope (or what happens "after syncope", i.e. what kind of codas arise) relevant to metrical structure assignment.

The generalization, however, is that syncope can only affect what has earlier been specified as weak, not determine what is going to be weak or strong. In derivational terms, syncope always seems to apply after the prosodic structure is formed.

This can be straightforwardly captured by assuming that syncope constraints are PS-constraints. Metrically weak position, which is defined in prosodic terms, is then presupposed to be specified in the previous step output. The new constraint ⮌*V-PL_{WEAK} is formulated in (8) below.

(8) ⮌*V-PL_{WEAK}
   a. let X be an input segment at some step
   b. let X' be its correspondent in the candidate under evaluation
   c. If X is in the weak position (weak in foot or extrametrical), assign a violation mark if X' has vowel place features

The constraint in (8) cannot be responded to by modifying metrical structure: what is weak and what is strong is already predetermined at the previous step. Before the stress assignment and at the stress-assigning step, PS-constraints referring to metrical position will be vacuously satisfied. This is exactly what we find in metrical syncope systems: metrical structure is always assigned before syncope applies. After stress assignment, syncope can only apply to vowels in weak positions.

For example, both inputs from tableau 4 will be parsed into default trochaic feet at the stress assigning step: *(pata)(kasa)fa* and *(pata)(nasa)la*. At that step, CODASON is satisfied since there are no codas, and ⮌*V-PL_{WEAK} is satisfied since there are no weak positions in the input. Crucially, at any later step ⮌*V-PL_{WEAK} can only target the vowels in weak positions, and therefore there is no harmonically improving derivation that would lead to output *(patan)(sal)* – to derive it, a vowel in a strong position (i.e. a previously stressed vowel) would have to be deleted. The ultimate output for input /patanasala/ would either exhibit trochaic syncope or no syncope at all, depending on the ranking of CODASON and ⮌*V-PL_{WEAK}.

4 Alternative Analyses

4.1 The Empirical Basis of TMS Generalizations

Van Oostendorp (2007) argues that the containment theory of faithfulness can be used to make OT more restrictive. Such a drastic move would necessarily have to be motivated not only by the fact that it increases restrictiveness, but also by demonstrating how the containment approach can handle the cases that originally motivated the correspondence theory of McCarthy and Prince (1995). Additionally, McCarthy (2008b, 2009) demonstrates that switching to containment theory may not be necessary to achieve similar results in Serial OT: gradualness of the derivations may be invoked instead.

More importantly, some of the alternations mentioned by van Oostendorp (2007) seem to contradict the distribution of repairs that was assumed for (3). According to van Oostendorp Buggenhout Dutch (BD) exhibits epenthesis driven by *VCDOBS$]_{\text{PWD}}$. The examples in (9) that come from the Goeman/Taeldeman/Van Reenen Database[3] of Dutch dialects indeed seem to confirm that word-final obstruent plosives are limited to voiceless ones, whereas in a number of stems ending in voiced obstruents in Standard Dutch (SD – see 8b), a schwa appears after the obstruent's reflex at the end of the word. SD forms are given in italics below whereas the dialectal forms are

[3]The database is available at http://www.meertens.knaw.nl/mand/database/ (accessed 6/5/2009). I follow Van Oostendorp (2007) in simplifying the BD transcriptions.

transcribed[4]. The alternations confirming that the voiced plosive is underlying in SD are not shown.

(9) a. *een baard* [nənbɔːt] 'a beard' – pl. *baarden* [bɔːtn̩]
een schaap [ənsxɔːp] 'a sheep' – pl. *schapen* [sxɔːpən]
een vat [ənvɑt] 'a barrel' – pl. *vaten* [vɔtn̩]
b. *'n bed* [əmberə] 'a bed' – pl. *bedden* [berəs]
'n rib [əmrebə] 'a rib' – pl. *ribben* [rɛbərn̩]

The data, however, are far from being conclusive for two reasons. First, the Database contains only 1875 records for BD. Thus, for example, *rib* turns out to be the only word that ends in a *b* in SD orthography and has a correspondent in BD. The distribution of voicing contrasts in this small sample might inadequately reflect the picture for the whole dialect.

Second, even in this small sample there are a number of cases that seem to exhibit regular word-final devoicing (10).

(10) *'n kind* [ənkint] 'a child' – pl. *kinderen* [kindərən]
'n lid [ənlit] 'a limb/a member' – pl. *leden* [ledn̩]
breed [briet] 'broad' – compar. *breder* [briedər/bredər]
kwaad [kwat] 'evil, angry' – compar. *kwader* [kwɔdər]
oud [aːt] 'old' – compar. *ouder* [aːder]

Patterns like those in (10) appear more frequently in the Database than the ones similar to those in (9). Thus it appears that epenthesis after a word-final voiced obstruent is not a fully general phonological pattern, while devoicing is the "standard" repair in BD.

To sum up, BD does not present a clear case of epenthesis as a response to *VCDOBS]$_{PWD}$. More data is needed to fully clarify the issue. In general, Western Germanic dialects present an interesting test ground for the theory of PS-constraints, since it seems that diachronically a process of apocope in those dialects was not as extensive after voiced obstruents as after voiceless ones (van Oostendorp, 2007, citing Ito and Mester, 2003).

Additionally, van Oostendorp (2007) suggests that the generalization formulated in Blumenfeld (2006), that coda devoicing does not affect syllabification of VCCV sequences, may not be correct. For example, in German, according to Vennemann (1990), word-medial sequences like *dl* syllabify as onsets while *tl* is split into two syllables, hence e. g. *Atlas* 'atlas' [ɑt.lɑs] but *Adler* 'eagle' [a.dlər]. However, Steriade (1997:38–43) shows that German syllabification judgments are not uniform across different speakers and in different descriptions while devoicing patterns are. On her account, syllabifications like those reported by Vennemann (1990) arise because of phonetic vowel lengthening before voiced obstruents. The constraint responsible for such syllabifications would then be the one prohibiting long vowels in closed syllables, not a constraint related to coda devoicing. It is possible that the constraint that is operative in German is not a PS-constraint.

Another alleged example of resyllabification due to dispreference for voiced obstruent codas comes from Fery's (2003) analysis of French phrase-final lengthening. In the dialects Fery considers, the vowels lengthen before phrase-final voiced fricatives: *chose* 'thing' [ʃoːz]; *nage* 'swims' [naːʒ]. The lengthening, in her analysis, occurs in open phrase-final syllables while voiced fricatives are impossible codas and form an onset of a semisyllable (i. e. syllable without a nucleus). In the framework presented here, the French facts can be reanalyzed as resulting from opaque vowel deletion (cf. Kavitskaya and Staroverov submitted for an analysis of a similar situation in Tundra Nenets within the current theory). Such an approach would maintain that the generalization expressed by CODACOND – a constraint prohibiting voiced fricatives in coda – is rendered

[4]I am grateful to Huib Kranendonk for his help in checking the Dutch examples.

non-surface-true by the deletion of word-final vowel. Full development of such an account goes beyond the scope of the present paper, but it is well worth pursuing. The semisyllable approach has to explain why semisyllables do not occur word-medially in French – a generalization that is readily captured if we treat French word-final consonant phonotactics as a result of opaque vowel deletion.

4.2 Iterative Footing and Syncope-Stress Interaction

McCarthy (2008a) advocates an analysis of syncope-stress interaction in Serial OT based on the assumption that footing and stress assignment proceed gradually — that is, building one foot is one step in the derivation (*iterative footing* – see also Pruitt, 2008). My proposal is compatible with this analysis, but it requires a precise characterization of the intermediate stages (which is also necessary for the reasons independent of PS-constraints).

After the first foot is formed, the rest of the word lacks metrical structure. Thus, assuming iterative footing creates a class of phonological objects which did not exist in Classic OT metrical theory – the not-yet-footed material. The not-yet-footed elements can be thought of as either organized in extrametrical syllables or lacking any metrical structure altogether.

On the first view, the not-yet-footed segments are organized in syllables that are directly dominated by PWord. In other words, the not-yet-footed syllables are extrametrical. This is implicitly assumed in McCarthy (2008a). However, on this assumption, the not-yet-footed vowels are penalized by *V-PL$_{\text{WEAK}}$ as formulated in (8). Therefore, depending on the ranking of faithfulness constraints, it may prove optimal to randomly delete the not-yet-footed vowels before they gain metrical structure. This is an unwelcome result, since such deletion will not be tied to metrical structure. Before the metrical structure has been assigned, the non-metrical constraints may favor deleting the vowel that was to be stressed, contradicting the initial generalization of Blumenfeld (2006) and McCarthy (2008a).

Another possible view of not-yet-footed material is that it lacks any prosodic structure. The segments that are not yet parsed may be assumed to not be organized in syllables or to form stray syllables that are not dominated by any higher-level prosodic constituent. The problem described above would disappear, since such unparsed segments or stray syllables would not violate *V-PL$_{\text{WEAK}}$. Indeed, the vowels would not be in weak branches of feet or in syllables directly dominated by PWord level. On this analysis, the not-yet-footed material gains a special status which is not identical to the status of any surface phonological object. The question then is which constraints are responsible for turning not-yet-footed elements into surface prosodic structures. The constraints that propel metrical parsing would need to be formulated differently on this view, and fully working out an iterative theory of metrical parsing goes beyond the scope of the present paper.

In any case, the present proposal relates to the analysis in McCarthy (2008a) as a general solution to a more specific one. The theory of PS-constraints principally eliminates all positional TMS problems and is motivated even if some of those problems allow for alternative interpretation.

4.3 P-map, Targeted Constraints and Implicational Constraints

This section examines other existing proposals for dealing with TMS problems. Steriade (2001) proposes that the possible responses to a given constraint are restricted by the scales of perceptual difference encoded in the so-called P-map. The modifications of the input structure that are minimally different are always preferred to those that constitute more noticeable changes. For instance, experimental studies (Fleischhakker 1999 among others) confirm that the difference between [d] and [t] is perceptually smaller than that between [d] and [j] or [n] or ∅. Therefore, only devoicing is available as a response to the constraint *VCDOBS]$_{\text{PWD}}$. However, generalizing the P-map account to the cases where a given constraint gives rise to multiple responses proves difficult, as argued by van Oostendorp (2007), Zuraw and Lu (2009) and Blumenfeld (2006).

It is interesting to compare the current proposal with that of Blumenfeld (2006), since both theories are aimed at capturing essentially the same class of TMS problems – positional TMS. Blumenfeld argues that the constraints mentioning prosodic and segmental units should be reformulated as *implicational constraints*. Such constraints are of the form "if X then Y". By a special provision, an implicational constraint can only be responded to by changing Y, whereas changing X would not remove violations of such a constraint. For example, the implicational version of *VCDOBS]$_{PWD}$ would be "If PWord-final, then not a voiced obstruent". As in the case of PS-constraints, the PWord-final position gains special status – it is in the premise of the implicational constraint, and therefore modifying the position does not solve the problem.

Postulating implicational constraints does not capture one important generalization: *position* is always the antecedent and marked elements are always in the consequent of implicational constraints (see also van Oostendorp, 2007). In other words, a constraint that would say something like "If a voiced obstruent, then not PWord-final" is just as good an implicational constraint as the implicational version of *VCDOBS]$_{PWD}$ formulated above. However, this latter constraint would favor just the unattested repairs: it would be satisfied if the voiced status of the obstruent is preserved while its PWord-final status is modified. In other words, epenthesis, metathesis, and resyllabification would be possible responses to this new constraint. The theory of PS-constraints is grounded in a precise formulation of what position is, and therefore it avoids this arbitrariness problem.

In addition, the implicational constraints are hard to formulate if the intended repair is deletion (i.e. if the consequent is "nothing"). In formulating the constraint responsible for metrical syncope, this leads Blumenfeld (2006) to postulate empty nuclei whenever syncope applies. The implicational syncope constraint is formulated as "If unstressed, then an empty nucleus". The representational assumptions that this theory leads to are not borne out by syncope typology (McCarthy, 2008a). In general, it is not clear how implicational constraints may cause full deletion. The deletion problem does not arise for PS-constraints since they are not limited to positively specifying the structure that satisfies them.

Finally, a way of specifying a designated repair within the constraint is known as the theory of *targeted constraints* (Wilson, 2000). For the reasons of space, I will not consider this theory in detail, referring the reader to the critique in McCarthy (2003).

5 Conclusion

I have argued that there is a special class of TMS problems which I have dubbed *positional TMS*. These are the cases where the interaction of OT constraints predicts that modifying both position and the phonological substance in that position should be possible while only repairs that modify the substance are attested.

I have proposed a way to principally solve all such problems within the framework of Serial OT. The solution consists in replacing the relevant OT constraints with PS-constraints that specify position in the output of the previous derivational step. Adopting PS-constraints makes phonological theory more restrictive in a way that is compatible with the attested typology in the domain of devoicing and syncope-stress interaction.

My approach to the positional TMS problems does not just consist in mechanical reformulation of constraints. Rather, I put forward a hypothesis that there is a special relationship between different levels of prosodic structure and how they can be mentioned in Serial OT constraints. In a nutshell, for a constraint mentioning the elements of prosodic structure both above and below the level of segments, the position will be defined as the higher prosodic elements.

This gives a partial answer to the question of which constraints can and cannot be PS-constraints. The strongest possible hypothesis would state that *whenever* a constraint mentions the elements of prosodic hierarchy both above and below the segmental level, it *has to* be a PS-constraint. The current paper presents motivation for this hypothesis from voicing typology and syncope stress interaction. As a matter of future research, the consequences of this hypothesis in other domains are to be investigated.

Finally, I have demonstrated that Serial OT offers promising ways of making phonological theory more restrictive.

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