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Abstract:

The weight of a syllable-sized reduplicant is never dependent on the syllabification of the base — that is, no language has a reduplicative morpheme that copies a coda in [*pat*-pat.ka] but no coda in [*pa*-pa.ta]. Yet this behavior is attested in the second syllable of foot-sized reduplicants: [*pa.ta*-pa.ta.ka], [*pa.tak*-pa.tak.ta]. Why is dependence on base syllabification possible in foot-sized reduplicants, but not in syllable-sized ones?

This article provides an answer to that question in the form of a novel theory of reduplication called Serial Template Satisfaction (STS), which is situated within Harmonic Serialism (a derivational variant of Optimality Theory). In STS, a reduplicative template of type X can be filled by copying constituents of type X-1 from the base. A foot-sized reduplicant can be filled by copying syllables, but not a syllable-sized reduplicant, which must be filled by copying segments. Lacking base-reduplicant correspondence constraints, STS has no way of forcing segment copying to depend on base syllabification, so it cannot produce the unattested pattern.

This article also fleshes out STS as a general theory of reduplication that can be compared to other approaches in Optimality Theory and rule-based phonology. Phenomena discussed include reduplicant size, locality, and identity of base and reduplicant.

Keywords: Reduplication, Optimality Theory, derivation, syllable, overapplication.

Copying Prosodic Constituents

1. Introduction

According to Marantz (1982), reduplication occurs when a template consisting of empty structural positions is affixed to a base. According to the theory of Prosodic Morphology (McCarthy & Prince 1986/1996), these templates consist of prosodic constituents like the syllable or foot. The two Ilokano reduplicative morphemes exemplified in (1) are typical. One prefixes a reduplicative template consisting of an empty light syllable, and they other prefixes an empty heavy syllable. Both are satisfied by copying material from the base;.[1]

(1) Reduplication in Ilokano (Hayes & Abad 1989)

a. Light syllable reduplication

si-*bu*-bu.neŋ	'carrying a machete'
si-*pa*-pan.diliŋ	'wearing a skirt'

b. Heavy syllable reduplication

pus-pu.sa	'cats'
kal-kal.diŋ	'goats'

Although languages reduplicate by *affixing* a syllable, as in Ilokano, they never reduplicate by *copying* one (Marantz 1982, Moravcsik 1978). Specifically, we do not find any reduplicative process that follows the pattern in (2), copying the first syllable exactly regardless of whether it is CV or CVC. In other words, there are no cases of monosyllabic reduplication where the reduplicant[2] has a coda if and only if the corresponding syllable in the base also has one.

(2) Unattested syllable-copying reduplication

pa-pa.ta
pat-pat.ka

Instead, existing cases of monosyllabic reduplication work more like the examples in (1): the reduplicant may or may not have a coda, but the choice is specific to the reduplicative affix and has nothing to do with how the potential coda is syllabified in the base.

This observation is all the more interesting because the dependency in (2) actually does occur, but only in the second syllable of a disyllabic, foot-sized reduplicant. In both Yidiny (Dixon 1977, Nash 1979) and Warlpiri (Nash 1980), the stress foot includes the first two syllables, and both are copied in their entirety:

(3) Noun reduplication in Yidiny

mu.la-mu.la.ɾi	'initiated man'
kin.tal-kin.tal.pa	'lizard species'

In this case, the second syllable of the reduplicant has a coda if and only if the second syllable of the base has one.

[1] Typographic conventions: Syllable boundaries are indicated by a period/full stop. When syllable and morpheme or foot boundaries coincide, the syllable boundaries are omitted. Foot boundaries are marked by parentheses.

[2] *Reduplicant* is Spring's (1990) term for the surface exponent of the reduplicative morpheme. The segments of the reduplicant are italicized throughout this article.

Not all languages with foot-sized reduplicants work like Yidiny, however; in Waalubal, for example, the reduplicant is disyllabic and may have an internal coda but never a final one, regardless of how the base is syllabified:

(4) Verb reduplication in Waalubal (Crowley 1978)

gal.ga-gal.ga	'chop'
ba.la-ba.la:.ya-ni	'are all dead'
ba.ra-ba.ram.ga:-la	'are jumping about all over'

Why is syllable copying impossible when the template is monosyllabic but possible (though not required) when the template is a disyllabic foot? Marantz (1982: 456) raises this question but leaves it unanswered. McCarthy & Prince (1990) analyze Yidiny as a case of prosodic circumscription: circumscribe the initial foot and copy it. But they offer no explanation for why "circumscribe the initial *syllable* and copy it" never occurs. More recent work on reduplication, such as Inkelas & Zoll (2005), McCarthy & Prince (1994, 1995a, 1999), and Raimy (2000), is principally concerned with other issues and so does not address this question.

In this article, we develop an answer to the syllable-copying question within a theory of reduplicative copying called Serial Template Satisfaction (STS). STS is embedded in Harmonic Serialism (HS), a derivational version of Optimality Theory. In STS, a reduplicative template of type X can be satisfied in one of two competing ways. It can be satisfied by copying constituents of type X–1 from the base. Or it can be satisfied by populating it with empty constituents of type X–1 (which themselves must be satisfied as the derivation continues). The choice between these two ways of satisfying a template is determined by constraint ranking.

When the template is a foot, it can be satisfied by copying syllables from the base, as in Yidiny. Alternatively, it can be satisfied by filling it with empty syllables, which eventually are satisfied by copying segments, as in Waalubal. But when the template is a syllable, it cannot be satisfied by copying a syllable. Instead, the only options are to satisfy it by copying segments, as in Ilokano, or to satisfy it with epenthetic segments. In this scheme, as we will show in detail in section 3, the impossibility of (2) follows as an automatic consequence.

This article is organized as follows. Section 2 briefly explains the premises of Harmonic Serialism. Section 3 then lays out the proposal (3.1) and applies it to Yidiny (3.2) and Waalubal (3.3), concluding with a discussion of the results (3.4) and a comparison with other theories (3.5). Section 4 fills in some important details of the proposal, explaining how it determines the location (4.1) and extent (4.2) of the copied material. Finally, section 5 responds to an obvious objection to STS's derivational character: reduplication has been the source of some of the main arguments that Optimality Theory must be parallel.

2. Background: A brief introduction to Harmonic Serialism

The dominant version of Optimality Theory in Prince and Smolensky (1993/2004) can be called Parallel OT (P-OT). In P-OT, the mapping from underlying to surface representation is direct, with no intermediate stages. P-OT is "parallel" in the sense that the candidate-generating GEN component can change the underlying form in multiple ways at once.

Prince and Smolensky briefly mention, but quickly set aside, a version of OT called Harmonic Serialism (HS). The case for HS was reopened in McCarthy (2000, 2002:

159-163, 2007), where some general consequences of this theory are identified and discussed. HS differs from P-OT in two respects, *gradualness* and the existence of a *GEN→EVAL loop*.

Gradualness refers to a property of HS's GEN component: it can make only one change at a time. Since "one change" is too vague a notion to be useful for analysis, HS requires a precise definition of the operations in GEN that each constitute a single change. General techniques for drawing inferences about GEN in HS are described in McCarthy (2010). A goal of this article is to define the operations in GEN that are important in reduplication.

In P-OT, a derivation consists of a single pass through GEN and EVAL. In HS, the output of EVAL is submitted as a new input to GEN, in a GEN→EVAL loop. This loop continues until it reaches *convergence*, when EVAL chooses as winner a candidate that is identical to the most recent input. That is the final output of the grammar.

There is considerable evidence that HS is superior to P-OT in certain respects. Because HS has intermediate levels of representation, it is able to solve problems in stress-syncope (McCarthy 2008a) and stress-epenthesis (Elfner 2009) interaction, resolve a paradox in positional faithfulness (Jesney to appear), and account for how and when a process can vary in applicability within an utterance (Kimper to appear). And because HS requires the path from underlying to surface representation to proceed through a succession of optima chosen by EVAL, it makes more restrictive and accurate typological predictions than P-OT in the areas of cluster simplification (McCarthy 2008b), stress assignment (Pruitt 2008), autosegmental spreading (McCarthy 2007, to appear), and apocope and metathesis (McCarthy 2007).

To date, nothing has been said about how reduplication might be analyzed in HS. Thus, in addition to the principal goals of this article as stated in the introduction, we will develop answers to some basic questions about reduplication in HS: How is reduplicative copying in GEN limited by HS's gradualness requirement? How does copying interact with phonological processes that can affect what is copied? How are overapplication effects obtained in this theory?

3. Serial Template Satisfaction

3.1. Overview

We follow Marantz (1982) in assuming that reduplicative affixes are templates. We follow McCarthy & Prince (1986/1996, 1995b) in also assuming the basic premises of the theory of prosodic morphology: in partial reduplication, the template is a prosodic constituent syllable (σ) or foot (*ft*); and constraints on these constituents determine how templates are satisfied. To focus on our main point, we set aside the possible role of moras in reduplication.

Unlike analyses in P-OT, any analysis in HS requires an explicit hypothesis about those aspects of GEN that are relevant to the phenomenon under discussion. Two aspects are particularly relevant to reduplication: the operations that build prosodic structure and the copying operation. We describe each in turn.

Prosodic structure is built by an operation Insert(X) that inserts a prosodic constituent node of type X and integrates it into existing structure. X can be integrated into prosodic structure in two ways. It can be parsed as a dependent of a constituent of type **W** (**W**>X): $[\ ]_W \rightarrow [X]_W$, such as $[\ ]_{ft} \rightarrow [\sigma]_{ft}$. Or X can parse as its dependents one or more constituents of type Y (X>Y): $Y_1Y_2Y_3 \rightarrow [Y_1Y_2Y_3]_X$, such as *pa* → $[pa]_\sigma$. We will refer to these two modes of applying Insert(X) as top-down and bottom-up, respectively.

GEN also includes an operation Copy(X) that creates a copy of a string of constituents of type X (with their contents) and places that copy anywhere. From the requirement that a string be copied, it follows that the constituents copied in any single application of GEN must be contiguous and of the same type. For example, syllable copying applied to [pat.ka] gives candidates like [*pat*-pat.ka] and [*pat.ka*-pat.ka], copying one or two entire syllables. Syllable copying will not yield [*pa*-pat.ka], which can only be obtained by segment copying.

In HS, violations of faithfulness constraints are associated with the application of operations in GEN. Each application of Copy(X) incurs a violation of the constraint *COPY(X). (Applications of Insert(X) may also incur faithfulness violations, but that will not be important in our proposal.) Because Copy(X) is defined to copy strings of elements of type X, a single application of Copy(X) brings a single violation of *COPY(X), no matter how many Xs are copied at the same time. Thus, *COPY(σ) is violated equally by [*pat*-pat.ka] and [*pat.ka*-pat.ka].

Although our focus here is on cases where the X of Copy(X) is a segment or syllable, total reduplication of roots, stems, or morphosyntactic words suggests that X can be a grammatical constituent as well. Ghomeshi et al. (2004) and Kimper (2008) provide evidence that reduplication above the level of the word depends on syntactic, rather than prosodic, constituency (cf. Fitzpatrick-Cole 1996). Alternatively, total reduplication could be analyzed as a type of compounding, as in Morphological Doubling Theory (Inkelas 2005, Inkelas & Zoll 2005).

STS does not include base-reduplicant (BR) correspondence (McCarthy & Prince 1995a, 1999). Copy(X) must copy some whole number of *X*s exactly. Differences between base and reduplicant are the result of copying fewer *X*s than the base contains (e.g., because of a template) or processes applying after copying. Some other recent theories of reduplication, such as Inkelas and Zoll (2005) or Raimy (2000), reject BR correspondence as well, but they differ from STS in other respects. Explicit comparison of STS with BR correspondence is on the agenda in sections 3.5, 4, and 5.

The contents of a template are determined by markedness constraints. These constraints may include FOOT-BINARITY, for the *ft* template, or ONSET, for the σ template. There is also a family of HEADEDNESS constraints, which are applicable to any prosodic category:

(5) HEADEDNESS(X) (HD(ft), HD(σ)) (Selkirk 1995)
Assign a violation mark for every constituent of type X that does not contain a constituent of type X–1 as its head.

Templates enter the derivation as empty constituents. Thus, a template of type X violates HEADEDNESS(X) and possibly some category-specific constraints on X. As the highly schematized derivation in (6) shows, applying Insert(X–1) in the top-down mode removes the HEADEDNESS(X) violation, but at the expense of introducing a violation of HEADEDNESS(X–1). Insert(X–2) can fix that (third column in (6)), but introduces a HEADEDNESS(X–2) violation. This top-down, template-satisfying derivation can be terminated at any point X–n by applying Copy(X–n–1). When the bottom of the prosodic hierarchy is reached, it can also be terminated by segmental epenthesis. Satisfying a template means reaching the bottom of the hierarchy by one means or another.

(6) Role of HEADEDNESS

X	→	$[X{-}1]_X$	→	$[[X{-}2]_{X-1}]_X$
*HD(X)		✓HD(X)		✓HD(X)
		*HD(X–1)		✓HD(X–1)
				*HD(X–2)

e.g.,

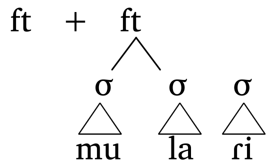
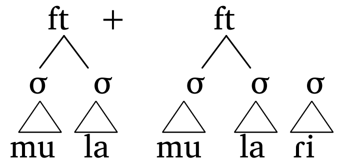
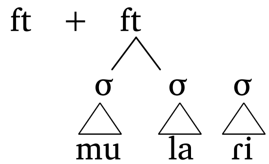
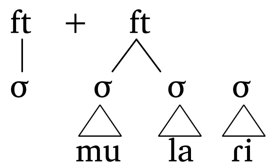
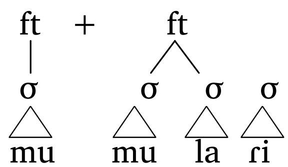
ft	→	$[\sigma]_{ft}$	→	$[[\text{ə}]_{\sigma}]_{ft}$
*HD(ft)		✓HD(ft)		✓HD(ft)
		*HD(σ)		✓HD(σ)

As subsequent sections show in detail, the relatively simple STS model sketched above provides all of the resources needed to address the problem described in section 1. One aspect of this problem is the observation that the foot-sized reduplicative template *ft* can be satisfied in two ways, by copying syllables (Yidiny) or by copying segments (Waalubal). The *ft* template starts out empty, violating HEADEDNESS(ft) and FOOT-BINARITY. GEN offers two ways of eliminating these violations: fill *ft* by copying σ constituents from the base, or fill *ft* by inserting empty σ nodes. These two options have different costs: copying violates *COPY(σ), but inserting empty σ nodes violates HEADEDNESS(σ). The ranking of these two constraints therefore determines the choice between these options. If HEADEDNESS(σ) is ranked higher, we get syllable copying into a foot-sized template, as in Yidiny (3). If *COPY(σ) is ranked higher, we eventually get segment copying into a foot-sized template, as in Waalubal (4). We will now work through these two examples in detail. After that, we will explain the impossibility of syllable copying with a syllable-sized template.

3.2. Syllable-copying reduplication: Yidiny

We assume that the base in Yidiny has already been parsed prosodically before the *ft* template is satisfied. Thus, the input to Step 1 of template satisfaction consists of this template prefixed to a prosodified base, as in the upper left cell of tableau (7). Various candidates are included in this tableau. Two of them are the result of applying the operation Copy(σ) to fill the *ft* template by copying a string of one (7)d or two (7)a syllables from the base. Candidate (7)c is the result of applying Insert(σ) in top-down fashion from the *ft* template. The remaining candidate, (7)b, is identical to the input. The ranking in tableau (7) selects the desired result by placing FOOT-BINARITY above *COPY(σ). This is sufficient to rule out all of the losing candidates, which leave the *ft* template empty or fill it with only a single syllable. In addition, (7)b violates HEADEDNESS(ft), and (7)c violates HEADEDNESS(σ).

(7) Step 1 in Yidiny [*mula*-mulaɾi][3]

		Ft-Bin	*Copy(σ)
			
a. →			1
b.		1 **W**	**L**
c.		1 **W**	**L**
d.		1 **W**	1

The winning candidate (7)a is submitted as the input to another round of Gen and Eval. Since (7)a wins again, the grammar converges on [(*mu.la*)-(mu.la)ɾi] as its final output. When the input is [*ft*-(kin.tal)pa], then copying the first two syllables yields [(*kin.tal*)-(kin.tal)pa] at Step 1, with convergence at Step 2.

Tableau (7) omits some obvious competitors. The validity of the analysis depends on showing that they are less harmonic than (7)a. One of them is *[(*mu.la*)*ɾi*-(mu.la)ɾi], which more than fills the template by copying [ɾi]. This candidate introduces a gratuitious violation of Parse-Syllable because [ɾi] is unfooted in the reduplicant. Parse-Syllable will rule out this candidate no matter where it is ranked relative to the constraints in (7). (This is an example of emergence of the unmarked in the sense of McCarthy and Prince (1994).)

Another candidate omitted from (7) is *[(*la.ɾi*)-(mu.la)ɾi], where the reduplicant and the material it copies are non-adjacent. Candidates like this are discussed in section 4.1. The form *[(*mu.ɾi*)-(mu.la)ɾi], it should be noted, is not among (7)a's competitors because by hypothesis the Copy(X) operation can only copy a string of Xs; copying the (plural) strings [mu] and [ɾi] requires multiple applications of Copy(X) over multiple

[3] Tableaux are in the comparative format introduced by Prince (2002). The number of violations is indicated by an integer. In loser rows, a cell may contain **W**, **L**, or neither depending on whether the constraint favors the winner, the loser, or neither. Because every loser-favoring constraint must be dominated by some winner-favoring constraint, in a properly ranked tableau every **L** is preceded in the same row by a **W** across a solid line.

derivational steps. The apparent effect of discontinuous copying must be obtained by other means, as 4.1 also explains.

There are also some not-so-obvious competitors. In HS, unlike P-OT, it is possible to conduct an exhaustive examination of the losing candidates, because gradualness limits GEN to one operation at a time. To illustrate this feature of HS, we will take a moment to check whether any other candidates obtained by applying the GEN operations specified in 3.1 pose a threat to (7)a's optimality.

Insert(ft) could insert a *ft* node over the syllable [ɾi], parsing it in bottom-up fashion: [*ft*-(mu.la)(ɾi)]. This candidate merely adds another violation of FOOT-BINARITY. The same goes for candidates that insert a *ft* node but give it no contents.

Insert(σ) has no intelligence about where to insert σ, so it will in addition to (7)c produce candidates where σ appears at various other locations. These other candidates are harmonically bounded because they introduce violations of HEADEDNESS(σ) with no concomitant improvement in performance on any other constraint.

The operation Copy(ft) could copy the foot [(mu.la)] and place it anywhere, such as *[*ft*-(mu.la)ɾi-(*mu.la*)]. All such candidates are harmonically bounded because they violate *COPY(ft) without greater satisfaction of any other constraint. Because the template is of type *ft*, copying a constituent of type *ft* does not advance the goal of template satisfaction. To fill a template of type X, type X–1 constituents are needed (see (6)).

The operation Copy(σ) also has no intelligence about where to put the copy, so it creates candidates with strings of one or more copied syllables anywhere in the word, such as *[*ft*-(mu.la)ɾi-*la*]. These candidates are harmonically bounded because they violate *COPY(σ) without addressing the FOOT-BINARITY violation.

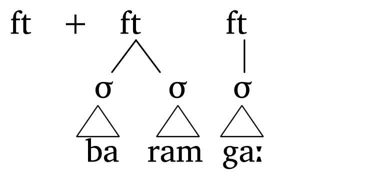
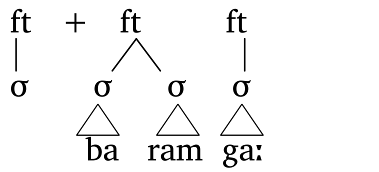
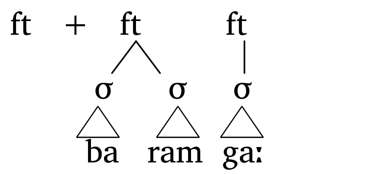
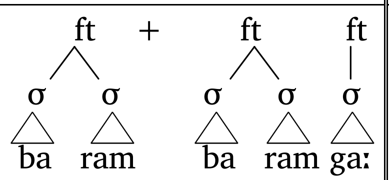
The operation Copy(seg) copies a string of segments of any length and places it anywhere in the input. Direct copying of segments will not contribute to satisfying the *ft* template because there are no σ nodes to intervene between the segments and the *ft* node. Given our assumptions about GEN, HS will not allow Copy(seg) and Insert(σ) to apply in the same step of the derivation.

It is clear, then, that the full range of candidates produced by the Copy and Insert operations are dealt with correctly by the hierarchy in (7).

3.3. Segment-copying reduplication: Waalubal

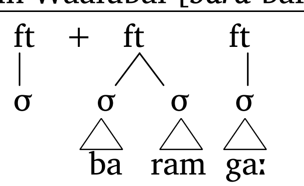
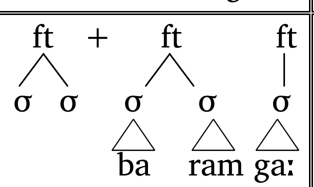
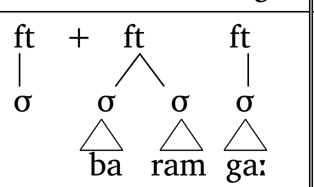
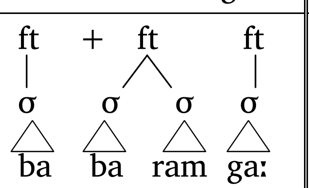
The starting point is the same as in Yidiny, but the grammar is different. At the first step, the alternatives besides doing nothing are to supply the *ft* template with an empty syllable as its head, as in (8)a, or to fill it fully by copying two syllables from the base, as in (8)c. Because *COPY(σ) dominates FOOT-BINARITY and HEADEDNESS(σ), (8)a is chosen as winner.

(8) Step 1 in Waalubal [*bara*-baramga:(-la)]

	*COPY(σ)	FT-BIN	HD(σ)	*COPY (seg)
a. → 		1	1	
b. 		1	**L**	
c. 	1 **W**	**L**	**L**	

At the next step, one option is to apply Insert(σ) again, as in (9)a, and another is to apply Copy(seg) in order to fill the empty syllable with segmental material, as in (9)c. To force the template to expand to two syllables, as it must, FOOT-BINARITY has to dominate HEADEDNESS(σ).

(9) Step 2 in Waalubal [*bara*-baramga:(-la)]

	*COPY(σ)	FT-BIN	HD(σ)	*COPY (seg)
a. → 			2	
b. 		1 **W**	1 **L**	
c. 		1 **W**	**L**	1 **W**

Segment copying occurs at Step 3, shown in tableau (10). The two empty syllables in the template have to be supplied with heads (i.e., nuclei) and onsets, and that is accomplished by copying segments from the base. This means that HEADEDNESS(σ) dominates *COPY(seg). The role of NO-CODA will be explained shortly.

(10) Step 3 in Waalubal [*bara*-baramga:(-la)]

ft + ft ft σ σ σ σ σ ba ram ga:	*COPY (σ)	FT-BIN	HD(σ)	*COPY (seg)	NO-CODA
a. → ft + ft ft σ σ σ σ σ ba ra ba ram ga:				1	1
b. ft + ft ft σ σ σ σ σ ba ram ga:			**2 W**	**L**	1
c. ft + ft ft σ σ σ σ σ ba ba ram ga:			**1 W**	1	
d. ft + ft ft σ σ σ σ σ ba ram ba ram ga:				1	**2 W**

The derivationa then converges at Step 4.

Since tableau (10) shows how the final form of the Waalubal reduplicant is determined, it bears close examination. The reason why (10)b and (10)c lose is clear: they violate HEADEDNESS(σ), which ranks higher than the winner's worst violation, *COPY(seg). HEADEDNESS(σ) also explains why Waalubal does not reduplicate the same segments twice: *[*baba*-baramga:-la]. To reduplicate [ba] twice, two derivational steps are required, and the winner required at the first step would violate HEADEDNESS(σ).

The form in (10)d is ruled out by NO-CODA. The NO-CODA column has been separated from the rest of the tableau because its ranking with respect to the other constraints is not relevant to this competition. Its role is to break the tie between (10)a and (10)d, and tie-breaking constraints are unrankable with respect to the constraints that yield the tie. This is another instance of emergence of the unmarked, since Waalubal clearly violates NO-CODA under other circumstances. The question of why the reduplicant can violate NO-CODA in its first syllable (e.g., [*galga*-galga]) will be addressed in section 4.1.

The essential feature of this analysis of Waalubal is that high-ranking *COPY(σ) leaves insertion of empty syllable nodes as the only viable way of satisfying the

HEADEDNESS(ft) and FOOT-BINARITY requirements of the *ft* template. These empty nodes are then filled by copying segments from the base.

3.4. Discussion

The difference between Yidiny and Waalubal is now clear. The template is the same but, as promised, the grammars differ in the ranking of HEADEDNESS(σ) and FOOT-BINARITY with respect to *COPY(σ). If *COPY(σ) is ranked higher, then the *ft* template expands to two syllables that are filled with a string of copied segments. In this case, the reduplicative prefix never ends in a coda because NO-CODA emerges uncontradicted to prevent that. If *COPY(σ) is ranked lower, then the *ft* template is filled immediately with a string of copied syllables. In this case, the reduplicative prefix ends in a coda if and only if the second syllable of the base has a coda to copy.

This grammar-determined choice between syllable copying and segment copying only exists when the template is of type *ft*. When the template is of type σ, the only choice is between satisfying the template with copied segments, which violates *COPY(seg), or satisfying it with epenthetic segments, which violate DEP (or some equivalent in STS's operational model of GEN). Satisfaction of a reduplicative template with epenthetic material is occasionally observed (Alderete et al. 1999), but here we have focused on the more common satisfaction-by-copying pattern.

As we have previously noted, a template of type X cannot satisfy HEADEDNESS(X) with a copy of a constituent of type X; what is needed is a copy of type X–1, because that is the type of X's head. Therefore, a template of type σ can only be satisfied reduplicatively with copied segments (recall that we have set aside moras), as shown in tableau (11). The segmental string [pa] is copied to provide the σ with a head (and an onset), as required by HEADEDNESS(σ). Copying a syllable, as in (11)c, leaves the template empty and pointlessly violates *COPY(σ). That is why this candidate is harmonically bounded by the candidate that has done nothing at all, (11)b.

(11) Step 1 in Ilokano [(si-)*pa*-pan.diliŋ]

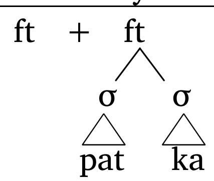
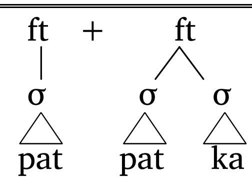
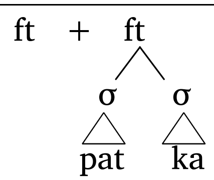
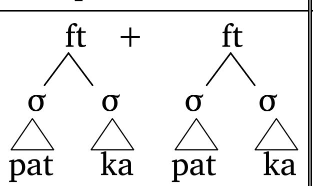
σ + σ σ σ pan di liŋ	HD(σ)	*COPY(seg)	*COPY(σ)	NO-CODA
a. → σ + σ σ σ pa pan di liŋ		1		2
b. σ + σ σ σ pan di liŋ	1 **W**	**L**		2
c. σ σ + σ σ σ pan pan di liŋ	1 **W**	**L**	1 **W**	3 **W**
d. σ + σ σ σ pan pan di liŋ		1		3 **W**

Candidate (11)d has been included to show that NO-CODA rules out copying the segmental string [pan], much as it ruled out copying [baram] in tableau (10). In general, when NO-CODA and other constraints against heavy syllables are active in determining how to fill the template's empty σ node, we consistently see a light syllable as the reduplicant, as in (1)a. On the heavy syllable template, see 5.2.

We now return to the problem laid out in section 1. One aspect of the problem is that disyllabic reduplicants can, but need not, be sensitive to the syllabification of the base. The analyses of Yidiny and Waalubal show how STS obtains that result. The other aspect of the problem is that monosyllabic reduplicants can never be sensitive to the syllabification of the base. The analysis of Ilokano shows why. The only way in this theory for satisfaction of a template to be sensitive to the base's syllabification is by copying a syllable from the base and using that syllable to fill the template. But when the template is itself a syllable, filling it with a syllable is simply impossible. Therefore, syllable-copying is not a possible pattern of reduplication in STS.

In OT, typological results depend as much on what constraints do *not* exist as on what constraints do exist. Our result here — the impossibility of syllable-copying reduplication in STS — depends on the nonexistence of a markedness constraint with the power to force *ft* to be monosyllabic under all conditions. This hypothetical constraint, denoted by *???* in (12), has to favor candidates like (12)a (such as [(*pat*)-(pat.ka)], [(*pa*)-(pa.ta)], etc.) over candidates like (12)c (such as [(*pat.ka*)-(pat.ka)], [(*pa.ta*)-(pa.ta)], etc.).

(12) Hypothetical syllable copying reduplication with *ft* template

	HD(ft)	???	FT-BIN	*COPY(σ)
a. → 			1	1
b. 	1 **W**		1	**L**
c. 		1 **W**	**L**	1

Our result rests on the claim that there is no constraint that will do the work of *???* in (12). There is no danger from the constraint *COPY(σ), since it is violated once when a string of syllables of any length is copied. A segmental markedness constraint like *DORSAL might have this effect in specific words, but no such constraint would yield the general pattern of single-syllable copying, and the pattern is what is at issue. A general constraint against syllables — that is, *σ — could perhaps do the work of *???* and thereby put our result in peril, but Gouskova (2003) has argued convincingly that such constraints do not and must not exist. We therefore conclude that STS has successfully accounted for the nonexistence of syllable-copying reduplication.[4]

Could the same result have been obtained in P-OT? In the next section, we show why the standard P-OT approach to reduplication, BR correspondence, is not adequate. In the remainder of the current section, we explain which aspects of our explanation come from the fact that STS is a *serial* theory of template satisfaction.

The discussion of tableau (11) explained why a σ template can never produce syllable-copying reduplication in the sense of (2): a copy of a σ node and its contents cannot be used to fill the empty σ node of the template. Taken by itself, this explanation in no way relies on the fact that STS is embedded in a derivational version of OT, HS. Rather, the role of derivations is to provide a principled, grammar-based account of the difference between Yidiny and Waalubal.

Yidiny and Waalubal have the same *ft* template, but the difference in their grammars determines when in the course of the derivation a candidate with copying beats a candidate with insertion of empty prosodic nodes, and that difference determines whether the template is satisfied by copying syllables or segments. Without serial derivations, it would be necessary to specify the difference between Yidiny and Waalubal in the form of the template: *ft* in Yidiny and σσ in Waalubal. The fact that the reduplicant in Waalubal (and many other Australian and Austronesian languages — see 4.1) has the form of an optimal, disyllabic foot would be entirely accidental. Stipulating a σσ template abandons the goals of the theory of prosodic morphology, which requires that properties of template form be explained in terms of principles of prosodic well-formedness and not merely stipulated (McCarthy & Prince 1986/1996).

3.5. Comparison with other approaches

The aim of this section is to compare STS's explanation for the nonexistence of (2) with two other approaches, a constraint-based parallel theory and a rule-based derivational theory. We argue that STS's constraint-based derivational account is superior.

The more or less standard approach to reduplication in P-OT is correspondence theory (McCarthy & Prince 1995a, 1999). Identity between the reduplicant and the base to which it is attached is enforced by base-reduplicant (BR) correspondence constraints. MAX_{BR} requires every segment in the base to have a correspondent in the reduplicant, IDENT_{BR}(F) requires corresponding segments in the base and reduplicant to have identical values for the feature [F], and so on.

The BR correspondence constraint that would be required in a P-OT analysis of Yidiny is STROLE, defined as follows:

[4] A further consequence of STS is that the number of syllables in the *ft* template cannot depend on properties of the copy in segment-copying reduplication, since the syllables in the template have already been determined (as in (9)) before copying occurs. This dependence is possible in syllable-copying reduplication, however. An example is Manam (Buckley 1997, Lichtenberk 1983, McCarthy & Prince 1986/1996): [salaga-*laga*] 'long (sg.)'; [malabom-*bóŋ*] 'flying fox sp.'

(13) $\text{S}{\small\text{T}}\text{R}{\small\text{OLE}}_{BR}$ (McCarthy & Prince 1994)
Corresponding segments in base and reduplicant must have identical syllabic roles.

By dominating $\text{M}{\small\text{AX}}_{BR}$, $\text{S}{\small\text{T}}\text{R}{\small\text{OLE}}_{BR}$ prevents an onset from being copied as a coda in [*mu.la*-mu.la.ɾi], while allowing a coda to be copied as a coda in [*kin.tal*-kin.tal.pa], as shown in (14).

(14) Yidiny in P-OT with correspondence

	STROLE_{BR}	MAX_{BR}
a. → *mu.la*-mu.la.ɾi		2
b. *mu.laɾ*-mu.la.ɾi	1 **W**	1 **L**
c. → *kin.tal*-kin.tal.pa		2
d. *kin.ta*-kin.tal.pa		3 **W**

The problem with STROLE_{BR} is that it predicts the existence of the unattested pattern syllable-copying reduplication in (2), as tableau (15) demonstrates.

(15) Syllable-copying reduplication in P-OT with correspondence

	STROLE_{BR}	MAX_{BR}
a. → *pa*-pa.ta		2
b. *pat*-pa.ta	1 **W**	1 **L**
c. → *pat*-pat.ka		2
d. *pa*-pat.ka		3 **W**

There does not seem to be any way of avoiding this unwanted prediction, since attested (14) and unattested (15) are identical except for the size of the reduplicant. Correspondence theory in P-OT has no explanation for why syllable-copying reduplication is always associated with a *ft* template.

Rule-based theories of reduplication in the manner of Marantz (1982) also have difficulty in distinguishing between the attested and unattested patterns of syllable reduplication. To deal with Yidiny, Marantz assumes a disyllabic template that is satisfied by copying the C and V skeletal slots as well as their contents, with the proviso that "the Cs and Vs of the stem in syllabic reduplication are copied clustered in the syllabic units that they form in the stem" (p. 455). But this predicts the existence of (2) as well: a monosyllabic template satisfied by copying Cs and Vs with the same syllabic clustering. Working within the same general framework, Steriade (1988: 111) posits a principle to the effect that "The copy of a segment syllabified as onset in the base cannot occur as a component of the rhyme in the reduplicated affix." This principle is equivalent in its effects to STROLE and therefore makes the same unwanted prediction about syllable-copying reduplication.

Indeed, the contrast between Yidiny and unattested (2) has proved so vexing to previous approaches that it has elicited claims that (2) actually occurs. We know of two such cases. Yaqui is reported by Haugen (2008) to have syllable-copying reduplication similar to (2), but Harley and Florez (2009: 247) conclude that Yaqui is actually reduplicating CVC roots, not syllables. Ballantyne (1999) says that Yapese has syllable-copying reduplication. Only two crucial examples are cited, and data inconsistent with syllable copying can be found in another source, Jensen (1977: 111).[5] With no convincing counterexamples, the typological claim persists, and so does the problem it presents for theories of reduplication. Of those theories, only STS offers a solution.

4. Further properties of STS

For STS to have any claim to being a general theory of reduplication, it needs to provide answers to two basic questions that have not yet been addressed: What is copied? How much is copied? This section discusses these questions, contrasting STS's answers with those given by BR correspondence theory in P-OT.

4.1. What is copied?

In Yidiny, the first two syllables of the base are copied: [(*mu.la*)-(mu.la)ɾi], not *[(*la.ɾi*)-(mu.la)ɾi]. This is a reflection of the following generalizations, which are due to Marantz (1982):

Edge-in. The base is copied from left to right in reduplicative prefixes and from right to left in suffixes

Phoneme-driven. Copying does not skip over segments.

In P-OT with BR correspondence, these generalizations are attributed to two violable constraints. One, $\text{A}\textsc{nchor}_{BR}$, requires the first (with prefixes) or last (with suffixes) segment in the base to have a correspondent that is first/last in the reduplicant. The other, $\text{C}\textsc{ontiguity}_{BR}$, is violated by any segment in the base that is preceded and followed by segments with correspondents but has no correspondent itself. The effects of these constraints can be seen in tableau (16). For explicitness, corresponding segments in reduplicant and base have been coindexed.

(16) $\text{A}\textsc{nchor}_{BR}$ and $\text{C}\textsc{ontiguity}_{BR}$ at work

	$\text{A}\textsc{nchor}_{BR}$	$\text{C}\textsc{ontig}_{BR}$
a. → b_1u_2-$b_1u_2n_3e_4ŋ_5$		
b. b_1e_4-$b_1u_2n_3e_4ŋ_5$		2 W
c. n_3e_4-$b_1u_2n_3e_4ŋ_5$	2 W	

$\text{A}\textsc{nchor}_{BR}$ is problematic and controversial, even within correspondence theory, and more recent work in that framework has rejected $\text{A}\textsc{nchor}_{BR}$ in favor of locality constraints requiring the original and its copy to be adjacent (Lunden 2006, Nelson 2003, 2005, Riggle 2004). Any constraint with this effect will correctly favor (16)a over (16)c and render $\text{A}\textsc{nchor}_{BR}$ largely superfluous.

Correspondence is not essential to defining this sort of adjacency constraint. Its effects can also be obtained within STS's operational approach. Recall from 3.1 that HS ties faithfulness violations to the application of operations. An operation that copies a string and places the copy adjacent to the original is more faithful than one that places the copy further away. Just as an application of the operation Copy(X) automatically

[5] Efforts to contact Ballantyne and obtain further information have proven unsuccessful.

produces a violation of *COPY(X), so too it may produce a violation of the following constraint:

(17) COPY-LOCALLY (COPY-LOC)
To a candidate produced by Copy(X), assign as many violations as there are *X*s intervening between the original X string and its copy.

Some of the details of this definition are speculative and may be modified with further research, but it will suffice for now.

COPY-LOCALLY does exactly what is required with candidates (16)a and (16)c. When Copy(seg) produces [*bu*-buneŋ], the original segmental string and copy are adjacent. When it produces [*ne*-buneŋ], the original and its copy are separated by two segments, so COPY-LOCALLY is violated twice.

CONTIGUITY$_{BR}$ is also unnecessary in STS, which derives contiguity effects from the nature of the copying operation. Copy(X) copies strings of *X*s, so non-contiguous copying requires two derivational steps. This assumption by itself is sufficient to rule out skipping under most circumstances, because the necessary intermediate step fails to satisfy the template:

(18) Step 1 of [*bu*-buneŋ]

σ + σ σ (bu neŋ)	ONSET	HD(σ)
a. → σ + σ σ (bu) (bu neŋ)		
b. σ + σ σ (b) (bu neŋ)		1 **W**
c. σ + σ σ (e) (bu neŋ)	1 **W**	

The form [be-buneŋ] is not a candidate at Step 1 of tableau (18) because Copy(segment) cannot copy the discontinuous strings [b] and [e] in a single pass. But copying only one of them violates syllable markedness constraints that are satisfied by the non-skipping candidate [*bu*-buneŋ]. This interaction produces the principal effect of CONTIGUITY$_{BR}$ without correspondence.

In fact, there is one respect in which STS's account of contiguity effects bests P-OT's. Imagine a language Waalubal′ that is just like real Waalubal except that it simplifies the medial cluster in the reduplicant: [*ba.li*-bal.dim.gu] or [*ba.di*-bal.dim.gu]. It is a straightforward matter to analyze this pattern in BR correspondence theory by ranking NO-CODA above CONTIGUITY$_{BR}$:

(19) Codaless disyllabic reduplicant with correspondence

	ft-baldimgu	NO-CODA	CONTIG$_{BR}$	MAX$_{BR}$
a. →	*ba.li*-bal.dim.gu *ba.di*-bal.dim.gu	2	1	6
b.	*bal.di*-bal.dim.gu	3 **W**	**L**	5 **L**
c.	*bal.dim*-bal.dim.gu	4 **W**	**L**	4 **L**
d.	*ba.dim*-bal.dim.gu	3 **W**	1	5 **L**

This is not a good prediction. In 4.2 below, we describe a survey of disyllabic reduplication patterns. This survey turned up no languages that eliminate *all* codas, even medial ones, from the reduplicant. BR correspondence theory generates the wrong typology.[6]

STS is different. For a language to allow codas generally, HEADEDNESS(σ) has to dominate NO-CODA. If the ranking were the other way around, the language would have no codas at all because any potential coda would instead be parsed as the onset of a headless syllable: *[ba.lΔ.di.mΔ.gu]. But the ranking of HEADEDNESS(σ) over NO-CODA also has consequences for how a *ft* template will be satisfied. Suppose that the derivation has progressed to the point in (9), where the *ft* template has been filled with two empty syllables. The highest ranking constraint awaiting satisfaction is HEADEDNESS(σ). As tableau (20) shows, there are several ways to improve performance on this constraint by copying. The winner (20)a fills both empty syllables by copying the string [baldi]. One of the losers, (20)c, also fills both empty syllables, but by also copying [m] it introduces a NO-CODA violation that the winner avoids. The other loser, (20)b, avoids two additional NO-CODA violations by copying only [ba], but this leaves a fatal violation of higher ranking HEADEDNESS(σ).

[6] [name suppressed] (pers. comm.) first drew our attention to the importance of this typological gap.

(20) Step 3 in Waalubal′

[ft + ft] σ σ σ σ σ — bal dim gu	HD(σ)	NO-CODA
a. → [ft + ft] σ σ σ σ σ — bal di bal dim gu		3
b. [ft + ft] σ σ σ σ σ — ba bal dim gu	1 **W**	2 **L**
c. [ft + ft] σ σ σ σ σ — bal dim bal dim gu		4 **W**

Crucially, [*badi*-baldimgu] is not a candidate at this step of the derivation, because it has copied a non-string. Discontinuous copying requires two derivational steps, and when copying is called on to satisfy a high-ranking constraint like HEADEDNESS(σ), two steps is one step too slow.

Generally, STS discountenances discontinuous copying for the reason just given, but it offers another way of achieving similar effects in some circumstances: deletion processes that affect the reduplicant later in the derivation. An example is reduplication in the Austronesian language Seediq, which at first blush looks like the supposedly unattested [*badi*-baldimgu] pattern. fFor example, the [w] of [ˈdawras] is missing in the reduplicant [dərə]:

(21) Reduplication in Seediq (Tsukida 2005)

ˈrudan	*rədə*-ˈrudan	‘old man/pl.’
ˈdawras	*dərə*-ˈdawras	‘cliff/pl.’
ˈsəʔdiq	*sədə*-ˈsəʔdiq	‘person/pl.’

In fact, this is not reduplicative skipping but general phonological reduction of pretonic syllables. Seediq has penult stress, and syllables that precede the penult are always Cə, like the syllables of the reduplicant. The changes seen in the reduplicant — reduction to [ə] and loss codas — are also observed in the ordinary phonology: /baytaq-an/ → [bəˈtaqan] ‘to spear (goal voice 2)’.

Because STS is embedded in HS, a derivational version of OT, it is entirely possible for reduction processes to affect the reduplicant after copying. That is the situation in Seediq. A disyllabic root is first copied exactly:[7] [*dawras*-ˈdawras]. At subsequent steps of the derivation, markedness constraints on pretonic syllables cause deletion of the codas and replacement of the peripheral vowels with [ə]: [*dawras*-ˈdawras] → [*dawra*-ˈdawras] → [*dara*-ˈdawras] →[*darə*-ˈdawras] → [*dərə*-ˈdawras]. This analysis is not only

[7] Longer roots have a σ template: [*bə*-bəˈrigan] ‘stores’

feasible, but it is arguably superior to one that uses reduplicative skipping in the manner of (19). The skipping analysis has no explanation for why the first consonant in the medial cluster is always the one that is skipped — why is it [*dərə*-ˈdawras] and [*sədə*-ˈsəʔdiq], not *[*dəwə*-ˈdawras] and *[*səʔə*-ˈsəʔdiq]? The usual edge-in bias would, if anything, predict skipping of the second consonant in the cluster, since this is prefixing reduplication. In comparison, the STS analysis just sketched has a ready explanation: the first consonant deletes because, cross-linguistically, tautomorphemic cluster simplification always targets the erstwhile coda (McCarthy 2008b, Steriade 2008, Wilson 2000, 2001).

Can other cases of reduplicative skipping be reanalyzed as post-copying deletion processes? Sanskrit, for example, has five different reduplicative morphemes, and all of them simplify complex onsets. Moreover, they do so in exactly the same way, by deleting the more sonorous segment: [*pa*-prach], [*sa*-snā], [*ta*-sthā]. A post-copying deletion process explains why all five morphemes behave alike in this respect.[8] It also relates cluster simplification in reduplicants to the fact that no affixes of Sanskrit have onset clusters. And it makes a connection with onset cluster simplification by deletion of the more sonorous consonant in child phonology (Gnanadesikan 1995/2004, 1996, Pater & Barlow 2003). Obviously, more needs to be said, but this is enough to show that STS offers a plausible approach to skipping effects in reduplication.

For discussion of another type of post-copying phonological process, see section 5.2.

4.2. How much is copied?

BR correspondence theory includes a constraint MAX_{BR} that has no equivalent in STS. As a result, BR correspondence theory and STS differ in how they satisfy a template. MAX_{BR} favors satisfying a template maximally: as many segments are copied as the template will hold. In STS, there is no imperative to maximize the amount copied, so the template is satisfied in whatever way is less marked — often by copying less than the maximum that the template will hold.

This difference between BR correspondence and STS is easiest to see when the template is σ, with no weight requirement. Tableau (22) shows that the ranking of MAX_{BR} with respect to NO-CODA determines whether the reduplicant is CVC or CV:

(22) σ template with BR correspondence

	MAX_{BR}	NO-CODA
/σ-pata/		
a. → *pat*-pa.ta	1	1
b. *pa*-pa.ta	2 **W**	**L**

In STS, on the other hand, NO-CODA favors the CV reduplicant no matter how it is ranked. This was shown in tableau (11) and is schematized in (23). In general, STS satisfies the σ template in the least marked way consistent with the requirements discussed in 4.1: a single application of GEN is limited to copying contiguous segments, and the reduplicant and original are normally adjacent. The least marked way of satisfying a σ template is often with a copy of CV, as in (23), but there are

[8] Steriade (1988) also analyzes onset simplification in Sanskrit with a post-copying deletion process.

circumstances (e.g., when STRESS-TO-WEIGHT is active) when copying more that that is optimal.

(23) σ template in STS

	HD(σ)	*COPY(seg)	NO-CODA
/σ-pata/			
a. → *pa*-pa.ta		1	
b. *pat*-pa.ta		1	1 **W**
c. σ-pata	1 **W**	**L**	

There are significant empirical consequences of this difference between BR correspondence and STS. Because of $\textsc{Max}_{BR}$, correspondence theory predicts the existence of two reduplicative patterns that do not seem to occur, the simple syllable reduplicant and the σCVC reduplicant.

The reduplicative pattern illustrated with the hypothetical example in (24) is referred to as the "simple syllable" by McCarthy and Prince (1986/1996). It is simple because the template is just σ, with no weight requirement. The reduplicant is a light CV syllable unless the base begins with a CVC sequence, in which case the reduplicant is a heavy CVC syllable.

(24) The simple syllable reduplicative pattern

a. Light with #CV# or #CVV…# base

pa	*pa*-pa
pu.a	*pu*-pu.a

b. Heavy with #CVC…# base

pa.ta	*pat*-pa.ta
pat.ka	*pat*-pat.ka

McCarthy and Prince's example of the simple syllable reduplicative pattern was Ilokano, but it was based on a source that failed to indicate vowel length. In real Ilokano (Hayes & Abad 1989), words like those in (24)a lengthen the vowel of the reduplicant so it is consistently heavy: [*pu:*-pu.a]. No better examples of the simple syllable reduplicative pattern have emerged subsequently. Evidently, it does not exist.

BR correspondence theory predicts the existence of the simple syllable pattern under the ranking in (22). If the base is just CV, then it will be copied in its entirety, fully satisfying $\textsc{Max}_{BR}$: [*pa*-pa]. If the base begins with a CVC sequence, then that sequence will be copied, since copying only CV would mean worse performance on $\textsc{Max}_{BR}$: [*pat*-pa.ta], [*pat*-pat.ka]. If the base begins with vowel sequence that cannot be parsed in a single syllable, then the reduplicant will also be CV, since copying more is incompatible with the monosyllabic template: [*pu*-pu.a].

The situation in STS is different. Because STS has no constraint like $\textsc{Max}_{BR}$, the template σ with no weight requirements, will be realized as the least marked syllable, CV, regardless of the form of the base. This was shown in tableau (23). The only way to get a CVC reduplicant in STS is to require the reduplicant to be a heavy syllable (see 5.2 for a proposal), as in Ilokano or Mokilese (Blevins 1996, Harrison 1976). But then we expect to see a heavy syllable reduplicant in examples like (24)a as well. As was just noted, Ilokano makes the reduplicant heavy by lengthening the vowel ([*pa:*-pa]), while Mokilese does it by gemination ([*pap*-pa]). The thus far unattested simple syllable pattern in (24) is not within STS's grasp.

A similar issue arises at the right edge of the prefixed *ft* reduplicant. In Waalubal, the shape of the reduplicant is σCV, with a codaless second syllable, rather than σCVC: [*bara*-baramga:-la] rather than *[*baram*-baramga:-la]. If $\textsc{Max}_{BR}$ were active, we would expect to get *[*baram*-baramga:-la].

Is Waalubal typical? We conducted a survey to answer this question. Because the *ft* reduplicant is particularly common in Australian and Austronesian languages, we examined all of the languages in two sources about these language groups. For Australia, we consulted the original sources for the languages reported to have disyllabic reduplication in Fabricius's (1998) survey. For Austronesian, we looked at the descriptions in Adelaar & Himmelmann (eds.) (2005).

Besides Waalubal, other Australian languages reported to have the σCV reduplicant include Diyari (Austin 1981), Djapu (Morphy 1983), Dyirbal (Dixon 1972), Mara (Heath 1981), and Ngiyambaa (Donaldson 1980).[9] For Diyari, there is an independent explanation for why σCVC is ruled out — the reduplicant is a separate prosodic word from the base, and all prosodic words of Diyari end in a vowel (McCarthy & Prince 1986/1996, 1994, Poser 1989) — but this explanation does not extend to the other examples.

The Austronesian situation is similar. The languages for which σCV reduplication has been reported include Balangao (Shetler 1976), Buol (Zobel 2005), Ilokano (Rubino 2005), Kambera (Klamer 2005), Tetun (Klinken 1999, Van Engelenhoven & Williams-van Klinken 2005), and Tomini-Tolitoli (Himmelmann 2001). In fact, speaking of Austronesian disyllabic reduplication in general, Himmelmann (2005: 123) writes, "The second syllable is usually open, regardless of the shape of the second syllable of the base."

Our survey uncovered no examples of the pattern predicted by ranking $\textsc{Max}_{BR}$ above NO-CODA: a language with σCVC reduplication in the sense of (25).

(25) Hypothetical case of σCVC reduplication

mele	*mele*-mele
kalan	*kalan*-kalan
patiru	*patir*-patiru
mikartu	*mikar*-mikartu
nampalu	*nampal*-nampalu

To be perfectly clear, a language with σCVC reduplication must follow a *pattern* of reduplication that can be unambiguously identified as that in (25). Of course, languages may occasionally reduplicate σCVC — e.g., in total reduplication of a σCVC word — without following this pattern.

One well-known but only apparent counterexample to this claim can be quickly dismissed. Based on examples like those in (26)a, Lardil has been described as having the otherwise unattested σCVC reduplication pattern (McCarthy & Prince 1986/1996, 1990, Wilkinson 1986, 1988). This description overlooks examples like (26)b, with a trisyllabic reduplicant.

[9] Some variations on the theme: in Dyirbal, the σCV reduplicant becomes σCVC only if this allows a disyllabic root to be copied exactly; in Djapu, the σCV reduplicant has an optional [ʔ] at the end; reduplicant-final [ʔ] is obligatory with the σCV reduplicant in Mangarayi (Harvey 1991, Merlan 1982) and Ritharngu (Heath 1980).

(26) Lardil reduplication
a. *paɾel*-paɾeli 'to gather'
maɽbaɾ-maɽbaɾa 'be cramped'
b. *wuɽuwal*-wuɽuwala 'go around'

All of the data in (26) can be accounted for if Lardil is analyzed as follows. It is well known that final vowels are apocopated in Lardil nouns that contain at least three moras (Hale 1973, Klokeid 1976, Prince & Smolensky 1993/2004, Wilkinson 1986, 1988): /majaɾa/ → [majaɾ] 'rainbow'. It has also been argued that verb stems are protected from apocope by an underlying suffix /-t̪/ (Klokeid 1976: 84-85): /waɾnawu-t̪/ → [waɾnawu] 'cook (uninflected non-future)'; cf. [waɾnawu-t̪-uɽ] 'cook (future)'. And there is solid evidence that compounds in Lardil consist of two prosodic words (Klokeid 1976: 66-68). Combining these three observations, we can analyze Lardil as a case of root reduplication where the reduplicant and base are in separate prosodic words. The reduplicant is consonant-final because of apocope, not because of the template:

(27) Lardil as root reduplication

$[\text{pareli}]_{\text{PWd}}$ $[\text{pareli-t̪}]_{\text{PWd}}$	Total reduplication (PWd compound)
$[\text{parel}]_{\text{PWd}}$ $[\text{pareli-t̪}]_{\text{PWd}}$	Apocope of PWd-final vowels
$[\text{parel}]_{\text{PWd}}$ $[\text{pareli}]_{\text{PWd}}$	Deletion of non-apical codas

With Lardil out of the way, we have a novel typological observation: no language follows the pattern in (25), systematically satisfying a *ft* template by copying CV(C)CVC whenever possible. BR correspondence theory predicts that this pattern should be the norm, since it is favored by MAX-BR. But STS has no constraint with the force of MAX-BR, so if disfavors the pattern in (25). This pattern could be obtained in STS only in a language where the reduplicant is required to be a separate prosodic word[10] and all prosodic words are required to end in a consonant. Languages that meet the latter criterion are unknown, or certainly rare, so the nonexistence of (25) is an expected consequence of STS.

5. Parallelism in reduplication

In P-OT with BR correspondence, the effects of reduplication and all phonological processes are evaluated together, in parallel. This property of the theory has been invoked as evidence in support of P-OT — and implicitly against the serial version of OT called HS. Since STS is just an application of HS to reduplication, we need to discuss this evidence and show that it is wrong or can be accommodated in STS. Two main arguments for parallelism in reduplication are found in the literature: overapplication of phonological processes in reduplicated forms and lookahead in copying. We consider each in turn.

5.1. Overapplication

This argument for parallelism is developed in McCarthy and Prince (1995a, 1999), with connections to earlier work by Wilbur (1974). A phonological process is said to

[10] A foot-sized reduplicant that is also a separate prosodic word can be obtained by positing a *pwd* template. The *pwd* template must be satsifed with at least one foot because of HEADEDNESS(pwd), which requires every prosodic word to have a head foot. This template must contain no more than one foot because HEADEDNESS(foot) and other constraints (for which see McCarthy & Prince 1994) will allow no more than one foot to be inserted or copied.

overapply if its effects on one member of the reduplicant/base pair are duplicated in the other member. For example, in Chumash (28), prefixal [k] fuses with an initial laryngeal; fusion overapplies because both reduplicant and base show the effects of this process. In Javanese (29), intervocalic [h] deletes. This process overapplies in [*bəɖa*-bəɖae] because the first [h] is deleted even thought it is preconsonantal.

(28) C + laryngeal coalescence in Chumash (Applegate 1976, McCarthy & Prince 1995a: 313ff., Mester 1986)

ʔaniš	*kˀan*-kˀaniš	'my paternal uncles'
hawaʔ	*kʰaw*-kʰawaʔ	'my maternal aunts'

(29) [h] deletion in Javanese (Dudas 1976, Horne 1990, McCarthy & Prince 1995a: 285ff.)

bəɖah	bəɖae	*bəɖah*-bəɖah	*bəɖa*-bəɖae	'broken'
ɖajɔh	ɖajɔe	*ɖajɔh*-ɖajɔh	*ɖajɔ*-ɖajɔe	'guest'

In P-OT, overapplication is attributed to BR correspondence constraints, such as IDENT_{BR}(Place) in Chumash or DEP_{BR} in Javanese. In the first Chumash example, for instance, the [kˀ]s in the reduplicant and the base are BR correspondents. Because they are both velar, they satisfy IDENT_{BR}(Place). So-called normal application of coalescence violates this constraint: /k-σ-ʔaniš/ → *[*kˀan*-ʔaniš]. In this way, the effects of coalescence and copying are evaluated together, in parallel.

In STS without BR correspondence, the analysis of Chumash has to evaluate the effects of coalescence and copying serially. In this respect, it is in agreement with a long tradition of analyzing overapplication by ordering the phonological process — here, coalescence — before copying (Anderson 1975, Inkelas & Zoll 2005, Kiparsky 1986, 2010, Mester 1986, Munro & Benson 1973, Odden & Odden 1985, Wilbur 1973, 1974: and many others). In STS, as in HS generally, order of application can be controlled by the ranking of markedness constraints. If the markedness constraint favoring some phonological process is ranked higher than any constraint demanding template satisfaction, then that process will occur before copying.

Chumash will serve to illustrate. The underlying representation is /k-σ-ʔaniš/ ('my' + plural + 'paternal uncle'), where σ is a heavy syllable (actually a foot — see 5.2). At the first step (30), the choices are to coalesce the segmentally adjacent /k/ and /ʔ/, or to copy /ʔan/ into the template. By ranking the markedness constraint that compels coalescence, *Cʔ, above the constraint that compels template satisfaction, HEADEDNESS(σ), we get coalescence to happen first.

(30) Step 1 of Chumash [*kˀan*-kˀaniš]

σ + σ σ k+ ʔa niš	*Cʔ	HD(σ)	NO-COALESCENCE	*COPY(seg)
a. → σ + σ σ kˀa niš		1	1	
b. σ + σ σ k+ ʔa niš	1 **W**	1	**L**	
c. σ + σ σ k+ʔan ʔa niš	1 **W**	**L**	**L**	1 **L**

At step 2 (31), *Cʔ has already been satisfied, so lower-ranking HEADEDNESS(σ) comes into play, and [kˀan] is copied into the template. The derivation converges at the next step. Coalescence of /k/ and /ʔ/ has "overapplied" because it applied prior to copying.

(31) Step 2 of Chumash [*kˀan*-kˀaniš]

σ + σ σ kˀa niš	*Cʔ	HD(σ)	NO-COALESCENCE	*COPY(seg)
a. → σ + σ σ kˀan kˀa niš				1
b. σ + σ σ kˀa niš		1 **W**		**L**

In the literature on reduplication, the principal argument against the ordering theory of overapplication comes from a variety of Malay reported by Onn (1980: 114) and discussed also by Kenstowicz (1981) and McCarthy & Prince (1995a, 1999). Since this is a case of total reduplication, we will arbitrarily assume that the reduplicant is prefixed. According to Onn, rightward spreading of nasality from the end of the reduplicant onto the beginning of the base is replicated at the beginning of the reduplicant:

(32) Overapplication of nasal harmony in Malay

/haməə/	hamə̃	*h̃ãmə̃*-h̃ãmə̃
/waŋi/	waŋĩ	*w̃ãŋĩ*-w̃ãŋĩ

As McCarthy and Prince show, no ordering theory of overapplication could account for nasalization in the underlined segments in (32). The problem is that the reduplicant both conditions and copies nasalization in these segments, and that is an impossibility in the ordering theory.

The Malay example is not very secure, however. It is not introduced until the penultimate page of Onn (1980), other sources on Malay do not mention this behavior (Inkelas & Zoll 2005: 221n.), and Kiparsky (2010) could not verify it with four native speakers of the appropriate dialect. A more far-reaching and hence more easily testable consequence of STS without BR correspondence is that it disallows overapplication of allophonic processes. We illustrate with a hypothetical example, Madurese′. In Madurese′, like real Madurese (Stevens 1968), nasality spreads rightward from nasal consonants, affecting vowels and glides. Unlike real Madurese, however, Madurese′ categorically prohibits nasalized vocoids in other contexts, so nasalization is truly an allophonic process.

In OT, and no less in HS, the simplest analysis of an allophonic alternation between A and B requires three constraints in the following ranking: a markedness constraint preferring A to B in some context; a markedness constraint preferring B to A in all contexts; and a faithfulness constraint preserving the A/B distinction. Thus, in Madurese′, a constraint requiring vocoids to be nasalized after a nasal segment (*NV_{oral} in McCarthy & Prince's (1995a, 1999) analysis) dominates a constraint against nasalized vocoids (*V_{nasal}), which dominates IDENT(nasal).

Suppose that nasalization overapplies in Madurese′ reduplicated forms. Like real Madurese, it prefixes a copy of the final syllable:

(33) Overapplication of nasal harmony in (hypothetical) Madurese′
/mao/ mã.õ *õ*-mã.õ

At the first step of the derivation, there is a choice of whether to nasalize /a/ or copy /o/. (We will ignore the question of why copying is non-local, but see Riggle (2004) for discussion.) Ranking *NV_{oral} above HEADEDNESS(σ) ensures that nasal harmony has priority:

(34) Step 1 of Madurese′

σ + σ σ ma o	*NV_{oral}	HD(σ)	*V_{nasal}	ID(nas)	*COPY(seg)
a. → σ + σ σ mã o		1	1	1	
b. σ + σ σ ma o	1 **W**	1	**L**	**L**	
c. σ + σ σ o ma o	1 **W**	**L**	**L**	**L**	1 **W**

At Step 2, the same ranking prevails and nasality spreads onto the next vocoid. At the next step, nasality has spread as far as it can, so satisfaction of HEADEDNESS(σ) is the top priority:

(35) Step 3 of Madurese′

σ + σ σ △ △ mã õ	$*NV_{oral}$	HD(σ)	$*V_{nasal}$	ID(nas)	*COPY(seg)
a. → σ + σ σ | △ △ õ mã õ			3		1
b. σ + σ σ △ △ mã õ		1 **W**	2 **L**		**L**

The derivation has not yet converged, however. At Step 4, the initial [õ] of [*õ*-mã.õ] denasalizes to satisfy $*V_{nasal}$. After that, the derivation does converge. The final result is [*o*-mã.õ], without overapplication.

(36) Step 4 of Madurese′

σ + σ σ | △ △ õ mã õ	$*NV_{oral}$	HD(σ)	$*V_{nasal}$	ID(nas)	*COPY(seg)
a. → σ + σ σ | △ △ o mã õ			2	1	
b. σ + σ σ | △ △ õ mã õ			3 **W**	**L**	

In general, STS predicts that allophonic processes will not overapply, even when the allophonic process precedes copying, as it does in (34)–(36). As we just saw, this prediction follows from the basic theory of allophony in OT and the fact that STS has no BR correspondence mechanism for enforcing base-reduplicant identity after copying has occurred. In a truly allophonic system like Madurese′, there has to be a ranking that eliminates the marked allophone in all contexts, except in those specific contexts where a higher-ranking constraint demands it. That is why $*V_{nasal}$ dominates IDENT(nasal) in (35), and that is why the derivation converges on [*o*-mã.õ] and not sooner.

With BR correspondence, allophony is analyzed in the same way, but there is a way of enforcing base-reduplicant identity. Ranking IDENT_{BR}(nasal) above $*V_{nasal}$ will guarantee that [*õ*-mã.õ] is optimal in Madurese′:

(37) Madurese′ with BR correspondence

σ + mao	$*NV_{oral}$	IDENT_{BR}(nasal)	$*V_{nasal}$	IDENT_{IO}(nas)
a. → *õ*-mã.õ			3	2
b. *o*-mã.õ		1 **W**	2 **L**	2
c. *o*-mã.o	1 **W**		1 **L**	1 **L**

Madurese′ is hypothetical. The reality is that nasal harmony is not allophonic in real Madurese because nasalized vowels do occasionally occur in non-nasal contexts: [ĩãs]

~ [ias] ‘to decorate oneself’; [ĩsa] ‘evening prayer’. The other examples of overapplying processes identified as “allophonic” by McCarthy & Prince (1995a: 373) may also not be truly allophonic either, though clearly further research is needed.[11]

5.2. Lookahead in copying

Imagine a language that allows a coda only if it is a nasal followed by a homorganic consonant. (This common pattern is usually attributed to the constraint CODA-COND (Goldsmith 1990, Ito 1989).) Could this language have a reduplicative affix that looks like (38), where the reduplicant is CV unless CVC is possible by copying a nasal and assimilating it? The conundrum is that the nasal obviously cannot assimilate until it has been copied, but it cannot be copied until it has assimilated.

(38) Assimilation-dependent copying

pa.ta	*pa*-pa.ta
pa.na	*pam*-pa.na

This hypothetical language presents no conundrum for P-OT. In P-OT with BR correspondence, the effects of assimilation and copying are evaluated together, in parallel. Copying can depend on assimilation and assimilation can depend on copying. Tableau (39) illustrates.

(39) Assimilation-dependent copying in P-OT

	CODA-COND	MAX_{BR}	IDENT_{BR}(Place)
a. → *pa*-pa.ta		2	
b. *pat*-pa.ta	1 **W**	1 **L**	
c. → *pam*-pa.na		1	1
d. *pan*-pa.na	1 **W**	1	**L**
e. *pa*-pa.na		2 **W**	**L**

Assimilation-dependent copying in the sense of (38), if it exists, would present a serious problem for serial evaluation; at the time of copying, the derivation cannot look ahead to see if the the segment copied into coda position will be able to subsequently assimilate. There is, then, no way to distinguish segments that can copy as codas from segments that cannot.

McCarthy (2002: 144-145) bases an argument for P-OT on a supposed real-life instance of (38), Southern Paiute (Sapir 1930). The contrast between with CV reduplication like [*ma*-ma.qa] ‘to give’ and examples with CVC reduplication and an assimilated nasal like [*pim*-pin.ti] ‘to hang onto’ looks like (38). We will show that these examples are misleading, however. In reality, Southern Paiute does not have a CODA-COND-conditioned alternation between CVC and CV reduplication, as in (39). Rather, it has two distinct reduplicative affix allomorphs, CVC and CV. (Later, we will propose that they are *ft* and σ templates, respectively.) The CVC allomorph, we will

[11] Overapplication of an allophonic process could be analyzed as a kind of opacity, pursuing a connection made by Inkelas and Zoll (2005). Madurese′ would be possible if copying and denasalization were in a counterfeeding relationship.

argue, is derived by first copying CVC and then making subsequent changes to the coda to satisfy markedness requirements.

The choice between the CVC and CV allomorphs is entirely unpredictable, but within each allomorph the realization is fully predictable from the phonology. There are three realizations of CVC. In the geminating pattern (40)a, the coda of the reduplicant surfaces as a fully assimilated obstruent, resulting in a geminate. This occurs when the potential coda is not a nasal and the initial consonant is not a glide. In the nasalizing pattern (40)b, the coda of the reduplicant surfaces as a nasal that shares place with a following obstruent. This occurs when the potential coda is a nasal and the base does not begin with a glide. Finally, in the debuccalizing pattern (40)c, the reduplicant coda surfaces as a glottal stop before a base-initial glide.

(40) CVC Reduplication[12]

a. Geminating			
	patsi	*pap*-patsi	‘older sister’
	qati	*qaq*-qati	‘to sit’
b. Nasalizing			
	pannaqa	*pam*-pannaqa	‘several returned’
	pinti	*pim*-pinti	‘to hang onto’
c. Debuccalizing			
	yaqqa	*yaʔ*-yaqqa	‘to cry’
	waʔani	*waʔ*-waʔani	‘to yell’

With the CV allomorph, a base-initial obstruent stop is spirantized:

(41) CV Reduplication

a. Spirantizing			
	pai	pavai	‘to call’
	pinwa	pivinwa	‘wife’
b. Non-Spirantizing			
	maqa	mamaqa	‘to give’
	wanwi	wawanwi	‘to stand’

The predictable phonological behavior of reduplicants represents a set of phonological generalizations that hold true for the language as a whole — the only permissible codas in Southern Paiute are geminates, assimilated nasals, and glottal stop, and intervocalic spirantization occurs with obstruent stops. McDonough (1987) points out a set of mutations triggered by non-reduplicative prefixes which parallel many of the above patterns. This suggests that the phonological processes at work apply generally in the language and are not reduplicant-specific.

It is not, however, predictable whether a given root will reduplicate as CVC or CV. This is no less true when the conditions for nasalizing reduplication are met, as shown by the near minimal pair in (42). In (42)a, we see a spirantizing CV reduplicant, and in (42)b we see a nasalizing CVC reduplicant. In both examples, the second consonant of the base is a nasal and the base-initial consonant is an obstruent that the nasal could assimilate to. If CV reduplicants were the result of failure to assimilate, we would expect (42)a to be *[*pim*-pinwa].

12 These data and most of the classification of them come from McDonough (1987), which includes a collection of all reduplicated forms in Sapir (1931).

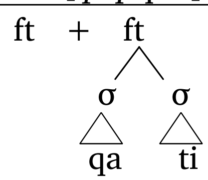
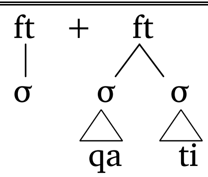
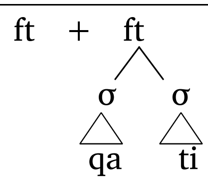
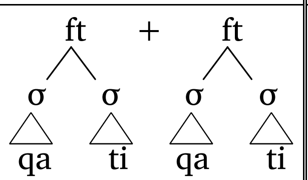
(42) Unpredictability of CVC vs. CV reduplication

a. pinwa	*pi*-vinwa	'wife'
b. pinti	*pim*-pinti	'to hang onto'

This evidence is sufficient to show that Southern Paiute is not actually an instance of the hypothetical pattern in (38) that requires the P-OT analysis in (39). The point of (39) is that CODA-COND can cause both assimilation of a coda in (39)c and non-copying of a coda in (39)a because the effects of assimilation and copying are evaluated together, in parallel. The reality of Southern Paiute is that copying or non-copying of a coda has nothing to do with CODA-COND. There are two lexically determined allomorphs of the reduplicative affix. One has a σ template, and it is satisfied by copying CV in accordance with the result shown in (11). The other allomorph has a *ft* template. It is always CVC, for reasons that we will now explain.

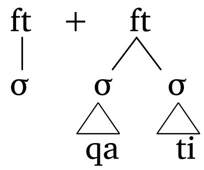
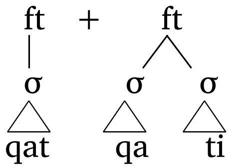
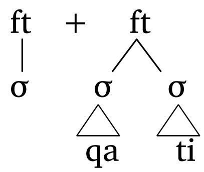
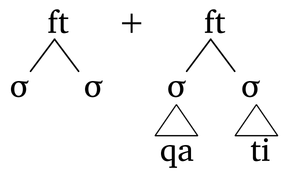
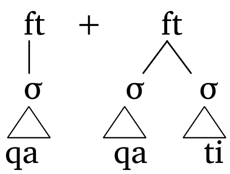
When the template is of type *ft*, the ranking in (43) and (44) will cause it to expand into a single syllable before copying a heavy syllable's worth of segments. Observe that the winning candidate at Step 2, [*qat*-qa.ti], violates CODA-COND to satisfy FOOT-BINARITY, which rules out *[*qa*-qa.ti].[13]

(43) Step 1 of [*qaq*-qati]

	*COPY(σ)	HD(ft)	HD(σ)	FT-BIN	CODA-COND	*COPY(seg)
a. → 			1	1		
b. 		1 **W**	**L**	1		
c. 	1 **W**		**L**	**L**		1 **W**

[13] Here we assume the definition of FOOT-BINARITY in McCarthy and Prince (1986/1996): feet are binary under syllabic or moraic analysis. It is therefore satisfied by any foot consisting of at least two syllables or one heavy syllable.

(44) Step 2 of [*qaq*-qati]

	*COPY(σ)	HD(ft)	HD(σ)	FT-BIN	CODA-COND	*COPY(seg)
a. → 					1	1
b. 			1 **W**	1 **W**	**L**	**L**
c. 			2 **W**		**L**	**L**
d. 				1 **W**	**L**	1

At this point, the high-ranking prosodic constraints have been satisfied, and low-ranking CODA-COND can begin to have effects on the course of the derivation. We assume McCarthy's (2008b) analysis of CODA-COND effects in HS, which has connections with earlier work in rule-based phonology (Cho 1990, Kiparsky 1993, Mascaró 1987, Poser 1982). CODA-COND first causes debuccalization, which violates the faithfulness constraint *DELETE(Place) and the markedness constraint HAVE-PLACE. Satisfaction of HAVE-PLACE is then achieved by spreading a place feature from the following onset.[14] The following tableaux illustrate the last two steps of the derivation before convergence (Irrelevant constraints and structure have been omitted to keep the size of the tableaux manageable.)

(45) Step 3 of [*qaq*-qati]

qat.qa.ti	CODA-COND	*DELETE(Place)	HAVE-PLACE	*SPREAD(Place)
a. → qaʔ.qa.ti		1	1	
b. qat.qa.ti	1 **W**	**L**	**L**	

[14] CODA-COND says that syllable coda position does not license place of articulation specifications (Goldsmith 1990, Ito 1989). A place feature that has spread from onset to coda is licensed by its association with the onset, so it does not violate this constraint.

(46) Step 4 of [*qaq*-qati]

qaʔ.qa.ti	CODA-COND	*DELETE(Place)	HAVE-PLACE	*SPREAD(Place)
a. → qaq.qa.ti				1
b. qaʔ.qa.ti			1 **W**	**L**

The derivation of [*pim*-pinti] is identical except that the output of step 3 has the placeless nasal [N] rather than [ʔ]: [*piN*-pinti]. The debuccalizing type of reduplicant is the result of a constaint against geminate glides that dominates HAVE-PLACE: [*yaʔ*-yaqqa], *[*yay*-yaqqa].

The same general process — CVC copying, debuccalization, and (attempted) assimilation — occurs for all three of the heavy-syllable reduplicant types. Crucially, the phonological processes that occur subsequent to copying have no impact on the size of the reduplicant. A pattern like that in (38), where the amount of phonological material copied in reduplication depends crucially on the ability of the copied material to undergo some subsequent phonological change, would pose a serious problem for a theory of phonology like HS, in which derivational look-ahead is impossible. In this section, however, we have shown that this prediction of HS/STS is in fact correct — the language claimed to exhibit the pattern in (38), Southern Paiute, in fact has a different sort of alternation. In Southern Paiute, the alternation between CVC and CV reduplicants is lexically idiosyncratic: the phonologically predictable alternations do not alter the weight of the reduplicant. The amount of material copied is determined by the interaction of the prosodic template of the reduplicant and emergent markedness constraints, and can be evaluated entirely on the basis of phonological properties that are accessible at the time of copying. There is no need for derivational look-ahead or parallel evaluation.

6. Conclusion

This article has presented STS, a theory of reduplicative template satisfaction embedded in a derivational version of Optimality Theory. The main premise of STS is that copying and insertion of structure are two competing ways of satisfying a template. Constraint ranking determines when copying occurs, and it thereby determines whether a template will be satisfied by copying entire prosodic constituents or individual segments.

The evidence for STS came from several sources. One is a well-known typological generalization: syllable-sized templates are not satisfied by copying syllables, but foot-sized templates can be. The explanation: a copy of a syllable will not satisfy a syllable-sized template, but a copy of a syllable can satisfy a foot-sized template. Whether foot-sized templates are satisfied by copying syllables or segments is determined by the ranking, as explained in the previous paragraph.

Another source of evidence is a novel typological generalization about foot-sized templates: they never include a gratuitous final consonant. The explanation: STS has no constraint with the force of MAX-BR. Since no constraint miliates in favor of copying more, markedness constraints alone determine how much copied material will be needed to satisfy a template.

Yet another source of evidence is a different typological generalization about foot-sized reduplicants: they do not skip internal codas. The explanation: copying with skipping is not a primitive operation in STS, which limits the copying operation to strings. The apparent effects of copying with skipping can only be obtained derivationally: by copying in two steps, or by copying and then deleting some of the copied material.

Needless to say, a single article can not do justice to a topic as broad as reduplication, nor is it possible to do much more than touch on some salient points from the extensive literature on this topic. Nonetheless, the results achieved so far in STS and the ways in which it surpasses previous work suggest that it and the HS framework in which it is embedded may be on the right track.

Acknowledgements
[suppressed]

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