Lookahead Effect in Mbe Reduplication

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1 Introduction

The interaction of reduplication with phonology is a prime testing ground for comparison of parallel versus serial theories of phonology. In Base-Reduplicant Correspondence Theory (McCarthy & Prince 1995ab), implemented in the classic parallel version of Optimality Theory (P-OT, Prince & Smolensky 1993/2004), the mapping from the underlying representation to the surface output is direct, without intermediate stages. In P-OT, the candidate-generating function GEN can simultaneously introduce multiple changes to the input (e.g. deletion, insertion, assimilation, etc.). On the other hand, Serial Template Satisfaction (STS; McCarthy, Kimper, and Mullin 2012; henceforth MKM) is a theory of reduplication couched within Harmonic Serialism (McCarthy 2000 et seq.), a derivational version of OT with evaluation of intermediate levels of structure. In Harmonic Serialism, GEN is restricted to making no more than one change in each derivational step, a property known as *gradualness*.

Parallel and serial versions of OT depart in their predictions about the possibility of a *lookahead effect* in reduplication, where the amount of material copied depends on a potential subsequent phonological change. Due to the stepwise gradual change in Harmonic Serialism, STS predicts that lookahead effects are not possible; however, the parallel evaluation of candidates with potential for multiple changes in P-OT predicts lookahead effects. This paper shows that the reduplication in Mbe imperative paradigm instantiates a pattern that characterizes the lookahead effect. This pattern is accounted for by P-OT without difficulty, but it cannot be captured in STS without introducing further complications and unwanted theoretical implications.[1]

The paper is organized as follows. Section 2 summarizes the basic mechanism of STS and the hypothetical lookahead effect discussed in MKM. In Section 3 I show that imperative reduplication in Mbe instantiates this very effect. This reduplicative pattern is straightforwardly modeled in P-OT but seems problematic for STS in its current formulation. In section 4, I consider an alternative within STS but do not find a satisfactory solution. Section 5 concludes the paper.

2 The mechanism of STS and the lookahead effect

The STS framework has three primary components. First, instead of a RED morpheme in P-OT, reduplicative affixes are templates in the form of empty prosodic constituents (e.g. syllable, foot, or PWd). Second, one of the following two operations applied by GEN satisfies the empty template: Insert(X) inserts an empty prosodic constituent of type X and integrates it into the template; Copy(X) copies a continuous string of constituents of type X with their contents and places them within the template. The operation of Copy(X) is penalized by the constraint, *COPY(X). Third, in addition to the general well-formedness constraints on syllable or foot structure such as ONSET and FOOT-BINARITY (FT-BIN) (Prince & Smolensky 1993/2004), a family of constraints, HEADEDNESS(X) (HD(X) for short), applies to a prosodic category X and requires X to have a head of type X-1. The ranking of constraints from the HD(X) and *COPY(X) families decides whether Insert(X) or Copy(X) is applied first to satisfy the template. Consequently, the surface shape of the reduplicant is determined collectively by the shape of the underlying prosodic template and the constraint ranking.

In STS, reduplication is viewed as an operation Copy(X) in GEN along with operations that insert, delete, spread, or change phonological elements. In P-OT, the effects of all these operations are evaluated in one fell swoop. By contrast, because of the built-in property of gradualness, in STS, each step of the derivation can

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[1] See Jeff & Adler (2016) for another lookahead effect pattern in Maragoli, which is employed to argue for irreducible parallelism.

apply only one operation. Therefore, STS does not predict lookahead effects**,** where how much material is copied depends on its possible subsequent phonological manipulation. The lookahead effect is illustrated in MKM with a hypothetical case. Suppose that a language allows a coda only if it is a nasal homorganic with a following onset, as enforced by CODA-COND. Suppose further that this language exhibits a reduplicative pattern where the reduplicant takes the form CV (1a), but CVC when a nasal can be copied and place-assimilated (1b).

(1) Assimilation-dependent copying (MKM: 213)
a. pa.ta pa-pa.ta
b. pa.na pam-pa.na

As shown in MKM, this hypothetical case is predicted to be possible by P-OT. Tableau (2) illustrates that reduplication and place assimilation proceed in parallel.

(2) Assimilation-dependent copying in P-OT (adapted from MKM: 213)

	CODA-COND	MAX-BR	IDENT-BR(Place)
→ a. pa-pa.ta		2	
b. pat-pa.ta	1W	1L	
→ a. pam-pa.na		1	1
b. pa-pa.na		2W	L

On the other hand, the pattern in (2) presents a derivational paradox for STS: the nasal cannot be copied unless it is assimilated, but it cannot assimilate until it has been copied; copying and assimilation cannot apply in the same derivational step. I illustrate the mechanics of this paradox in the next section. Selective copy of a nasal coda but not other consonants requires lookahead to see whether the copied coda consonant can subsequently undergo assimilation. STS thus predicts lookahead effects to be impossible, and the discussion in MKM makes note that their existence would present a serious challenge to STS theory.

3 The lookahead effect in Mbe reduplicative imperative affixation

Mbe is a Benue-Congo language of Nigeria. Mbe presents a syllable-size reduplication pattern in which a nasal in the stem triggers the occurrence of a nasal coda in the reduplicant with its place features linked to the following onset. This section illustrates that this pattern exemplifies the lookahead nasal assimilation described in section 2. The data and description are drawn from Bamgboṣe (1966, 1967a, b, c, 1971) and the account is informed by the analysis of Walker (2000).

The verbs in Mbe are categorized into two classes (Class 1 and Class 2), and the imperative affixation has two realizations: either reduplicated or simple (non-reduplicated). Depending on the segmental content of the stem, the pattern of reduplication for Class 2 imperative singular verbs produces a prefix with the form of either an open syllable or a closed syllable with a nasal coda. When the stem contains only oral consonant(s), the reduplicant is of CV shape without copying the onset of the second syllable into the coda position (3a-d). The presence of a post-vocalic nasal in the stem triggers the occurrence of a nasal coda in the reduplicant homorganic to the following onset (3e-h).

(3) Class 2: reduplicative imperative singular

a. rû	rû-rû	'pull'	f. gbé.nò	gbə̂ŋm-gbé.nò	'collide'
b. jú.bò	jû-jú.bò	'go out'	g. pûɔ.nì	pûm-pûɔ.nì	'mix'
c. só.rò	sə̂-só.rò	'descend'	h. dzûɔŋ	dzûn-dzûɔŋ	'be higher'
d. tá.rò	tə̂-tá.rò	'throw'	i. lúo.nî	lûn-lûo.nì	'repair'
e. tâŋ	tə̂n-tâŋ	'teach'	j. jíɔ.nî	jîɲ-jîɔ.nì	'forget'

Class 2 imperative singular reduplication is accompanied by two vocalic simplifications. The vowel in the reduplicant is an identical copy of a high stem vowel (3a-b), but it is [ə] when the stem vowel is non-high (3c-f). When the stem contains a diphthong, only the first vowel is copied (3g-j).

Similar to the hypothetical case introduced in section 2, Mbe has strict constraints on coda consonants in general. Oral codas are prohibited in Mbe and nasal codas are place-assimilated with a following consonant (except root finally). I assume that CODA-COND proscribes consonants that are not homorganic with a following onset (Itô 1989). I attribute the prohibition on oral coda consonants to a cover constraint $*C_{oral}]_{\sigma}$.[2] Following this set of assumptions about the relevant constraints, $*C_{oral}]_{\sigma}$ would also be high-ranked in the hypothetical case, because for the reduplicated form of (1a) [pa.ta], the reduplicative form [pap-pa.ta] is supposed to be unattested. I conclude that the assimilation-dependent nasal copy in Mbe exemplifies the lookahead effect predicted to be impossible by STS.

The Mbe pattern is straightforwardly captured in P-OT, as demonstrated in Walker 2000. In that account, the one-syllable size of the reduplicant is obtained through The Emergence of the Unmarked (TETU; McCarthy & Prince 1994a) ranking. Similarly, the two vocalic changes in the reduplicant—diphthong reduction and mapping of non-high vowels to [ə]—are also attributed by Walker to TETU rankings. Because these TETU rankings do not bear directly on the lookahead effect in P-OT, I refer readers to Walker 2000 for details and exemplification.

Turn to the lookahead effect. The P-OT analysis in (2) for the hypothetical case obtains the Mbe data. The following two tableaux show that the lookahead effect is made possible by the parallel evaluation of MAX-BR and CODA-COND. Tableau (4) illustrates the evaluation for an input without a nasal consonant. Copying the oral onset of the second syllable into the coda position of the reduplicant violates CODA-COND, which dominates MAX-BR, so the reduplicant is realized as the CV shape.

(4) [tárò] 'throw'

RED + tárò	CODA-COND	MAX-BR	IDENT-BR(PLACE)
→ a. tə̂-tá.rò		2	
b. tə̂r-tá.rò	1W	1L	

Tableau (5) shows the evaluation of a stem that contains a nasal segment. Because MAX-BR dominates IDENT-BR(PLACE), the nasal is copied at the expense of violating place-feature identity, and the reduplicant surfaces with a CVC shape.

(5) [pûɔnì] 'mix'

RED + pûɔnì	CODA-COND	MAX-BR	IDENT-BR(PLACE)
→ a. pûm-pûɔ.nì		2	1
b. pû-pûɔ.nì		3W	L
c. pûn-pûɔ.nì	1W	2	L

STS theory faces difficulty with the nasal copying in Mbe. Because the surface shape of the reduplicative prefix is either CV or CVC, it is reasonable to assume a σ template for the reduplicative affix. When there is no nasal in the stem, STS has no problem deriving the output in two steps. The first step copies segments from the stem to satisfy undominated HD(σ), as in (6a). Candidate (6b) copies the onset of the second syllable in the stem, which fatally violates CODA-COND. (6c) makes no change, and thus obeys *COPY(seg) but violates the higher ranked HD(σ).

(6) Step 1 of [jû-jú.bò]

σ + σ σ jú.bò	HD(σ)	CODA-COND	*COPY(seg)
→ a. σ + σ σ jû jú.bò			1
b. σ + σ σ jûb jú.bò		1W	1
c. σ + σ σ jú.bò	1W		L

However, under this ranking, the STS grammar would generate the wrong output for a stem containing a nasal. Take the stem [gbé.nò] 'collide' as an example. In the first step, illustrated in (7), segment copying

[2] See Padgett (1995) for a proposal on specifics of this manner-based restriction.

provides the empty syllable template with a head, satisfying HD(σ). Copying the nasal in (7a) fatally violates CODA-COND. An intermediate output [gbéŋm-gbé.nò], which simultaneously copies the nasal and changes its place to obey CODA-COND, is not a possible candidate. This is because gradualness prevents copy of the stem nasal /n/ and change of its features in a single derivational step. Thus, (7b) [gbé-gbé.nò] will be the most harmonic intermediate output in step 1.

(7) Step 1 of [gbə̂ŋm-gbé.nò]

σ + σ σ gbé.nò	HD(σ)	CODA-COND	IDENT [col]$_{root}$	*NONHIFULLV	*COPY (seg)	IDENT [col]$_{affix}$
a. σ + σ σ gbén gbé.nò		1W		2	1	
☹ b. σ + σ σ gbé gbé.nò				2	1	
c. σ + σ σ gbé.nò	1W			1L	L	

The faithful candidate (7c) is ruled out by the top-ranked HD(σ). In step 2, the non-high vowel in the intermediate output (7b) is reduced to schwa. The TETU ranking in the P-OT analysis is converted to "IDENT[col]$_{root}$ >> *NONHIFULLV >> IDENT[col]$_{affix}$" to trigger the diphthong reduction.[3] With this ranking, the wrong output *[gbə̂-gbé.nò] is generated.

In the constraint ranking shown in (7), the copy operation is triggered by HD(σ), requiring the syllable template to be headed. This constraint is not in conflict with CODA-COND because HD(σ) can be satisfied by copying a CV segment string, without a coda that potentially infringes upon CODA-COND. Furthermore, since there is no pressure for faithful mapping between the base and the reduplicant (given that BR-correspondence does not exist in STS), the CV shaped reduplicant would always be more harmonious than a CVC one. In order to ensure that the nasal segment is copied in the step of applying Copy(X), there must be some other high-ranked constraint which can only be satisfied by copying the nasal or the segment string that contains the nasal. I consider an alternative of this kind in the next section with the reduplicative template being a foot.

To summarize, the Mbe reduplicative imperative affixation exhibits in the essentials a case of the very kind identified in MKM that demonstrates the lookahead effect. STS makes the strong prediction that lookahead effects are impossible.

4 Alternative account in STS

In this section, I consider an alternative analysis of the Mbe pattern within the STS framework that involves a *Copy + Deletion* path (MKM 2012), assuming a *ft* template for the reduplicative prefix. I show that the alternative is theoretically inadequate due to inconsistent stipulations required about the evaluation of the two crucial constraints.

This alternative employs a uniform *ft* template for the imperative affix. The challenge in the Mbe data is the disyllabic verbs in which the target nasal is in the onset of the second syllable, as in forms like (3f-g), repeated in (8).

(8) a. gbé.nò gbə̂ŋm-gbé.nò 'collide'
b. pûɔ.nì pûm-pûɔ.nì 'mix'

In order for the nasal to be copied, the second syllable must be copied in the first step. Although an alternative requiring the template to be a heavy syllable might work for (8a), as the nasal would be copied into the coda position, this approach would not be successful for (8b), because the first syllable with a diphthong is bimoraic.[4]

[3] However, see Zukoff 2017 on implications of the TETU-like ranking for STS.

[4] According to Bamgboṣe (1967a:176, footnote 6), in Mbe imperative I plural verbs, the tone on the first syllable is rising or high with free variation. When it is high, an initial open syllable with a monophthong is lengthened: [tá:lì] 'touch', but a diphthong does not show any lengthening [líali] 'eat', nor does a closed syllable [tábli] 'follow'. The lengthening of monophthongs in an open syllable in contrast to diphthongs and closed syllables suggests a weight contrast that places diphthongs and closed syllables together as heavy.

I illustrate the derivation with a *ft* template with (8b). Here I assume *COPY(σ) is dominated and adopt the Copy(σ) operation to populate the template.[5] To allow syllable copying into the *ft* template, *COPY(σ) needs to be dominated by the constraints that trigger copying: FT-BIN(σ). Similar to the analysis of Balangao in MKM, it is necessary to employ a version of FT-BIN that enforces bisyllabicity. A traditional version of FT-BIN, where binarity may be satisfied at the syllabic or moraic level (McCarthy and Prince 1986/1996, Prince & Smolensky 1993/2004), would fail to trigger copying of the second stem syllable, because copying the first syllable of [pûɔ.nì] into the *ft* template obeys FT-BIN on the moraic level.

The ranking in tableau (9) is similar to the syllable copying case of Manam except that HD(σ) is not top-ranked. It will be shown that in step 3 of the derivation, the nucleus of the second syllable will be deleted, leaving a headless σ. Thus, HD(σ) is violable in this analysis. Furthermore, taking HD(σ) out of the top-ranked constraints does not affect the candidate selection in step 1 because HD(σ) does not independently exclude any candidate.

(9) Step 1 of [pûm-pûɔ.nì]

	ft + ft △ σ σ pûɔ.nì	FT-BIN(σ)	*COPY(σ)
a.	→ ft + ft △ △ σ σ σ σ pûɔ.nì pûɔ.nì		1
b.	ft + ft | △ σ σ σ pûɔ pûɔ.nì	1W	1
c.	ft + ft △ σ σ pûɔ.nì	1W	L

After the string of syllables with the nasal is copied, (9a) becomes the input in step 2. Additional segments, including the second vowel in the diphthong and the vowel in the second syllable, need to be deleted. I assume that the diphthong reduction takes place in step 2 in (10), triggered by NODIPH.

(10) Step 2: diphthong reduction; crucial ranking: MAX$_{root}$ >> NODIPH >> MAX$_{affix}$

Input:	Output:
ft + ft △ △ σ σ σ σ pûɔ.nì pûɔ.nì	ft + ft △ △ σ σ σ σ pû.nì pûɔ.nì

After diphthong reduction, the vowel [i] in the second syllable of the reduplicative prefix needs to be deleted. This operation could be triggered by a generalized templatic constraint, AFFIX≤σ, defined in (11) (McCarthy & Prince 1994b).[6]

(11) AFFIX≤σ: Assign one violation mark to any affix whose phonological exponent is larger than a syllable.

To reduce the prefix size from two syllables to one, a syllable nucleus must be deleted. I assume that concomitant (re)syllabification within this derivational step is consistent with gradualness, because it does

[5] The template could also be satisfied by applying Insert(σ) and segment copying. Because whether Copy(X) or Insert(X) is applied to satisfy the *ft* template in the step of "Copy" does not seem to affect the subsequent steps of "Deletion," we do not discuss the further implications of the two approaches and assume that the Copy(X) operation is applicable in the first step.

[6] A conceivable alternative would be to rank an atemplatic constraint that assigns a violation to each syllable, such as *STRUC-σ or ALL-σ-R (Spaelti 1997), between MAX$_{root}$ and MAX$_{affix}$. However, this option would not alter the implications we discuss for STS theory.

not qualify as a distinctive operation (McCarthy 2008). Deleting the first prefix vowel in [pû.nì-pûɔ.nì] would lead to a syllable with a complex onset, which is not observed in Mbe (Bamgboṣe 1967c). Deleting the second prefix vowel, as in [pûn-pûɔ.nì], is preferred, because the nasal would be resyllabified as the coda of the first syllable. Since [pûn-pûɔ.nì] violates Coda-Cond and Max$_{affix}$, and leaves a headless syllable node (violating Hd(σ)), Affix≤σ must dominate these constraints.

The question now is whether the prosodic structure shown for the output in (12) satisfies Affix≤σ. The output has two syllable nodes, but only one has realization at the segmental level. Therefore, in order to have the output satisfy Affix≤σ, the constraint must be assessed on the basis of segmental material and affiliated prosodic structure but ignore prosodic constituents without segmental realization.

(12) Step 3: affix size reduction; crucial ranking: Affix≤σ >> Max$_{affix}$, Coda-Cond, Hd(σ)

Input:	Output:
ft + ft △ △ σ σ σ σ pû.nì pûɔ.nì	ft + ft △ △ σ σ σ σ pûn pûɔ.nì

Affix≤σ must be dominated at step 1. Specifically, Affix≤σ must be ranked below Ft-Bin(σ); otherwise copying of two syllables would not transpire at the first derivational step. Yet this leads to a potential ranking paradox. If constraints involving prosodic constituency are evaluated on the basis of categories with realization at the segmental level, as is necessary for Affix≤σ in this account, then it is expected that Ft-Bin(σ) will be violated by the output in (12). However, since Ft-Bin(σ) must dominate Affix≤σ to drive copy of two syllables, then Ft-Bin(σ) is expected to block derivation of the structure in (12) at step 3.

To make the Copy + Deletion account succeed, we could suppose that Ft-Bin(σ) is instead evaluated on the basis of prosodic structure without reference to its segmental realization. However, a principled basis for this interpretation eludes us. Adopting this second interpretation of Ft-Bin(σ), the workings of the constraint ranking are illustrated in tableau (13). Non-crucial constraints from the previous step are omitted here to save space. Hd(σ) is ranked below Affix≤σ here because the selected output has a headless syllable, driven by the affixal size-restrictor. The prefix in (13b) meets the size requirements but violates the top-ranked *ComplexOnset. The faithful candidate, (13c), fatally violates the affixal size restriction. Candidate (13d) satisfies Affix≤σ by deleting a syllable node together with its segment content (incurring what we interpret to be a single violation of Max$_{affix}$, for deletion of the syllable), but it violates Ft-Bin(σ).

(13) Step 3 of [pûm-pûɔ.nì]

ft + ft △ △ σ σ σ σ pû.nì pûɔ.nì	*Complex Onset	Ft-Bin(σ)	Affix≤σ	Hd(σ)	Coda-Cond	Max$_{aff}$
a. → ft + ft △ △ σ σ σ σ pûn pûɔ.nì				1	1	1
b. ft + ft △ △ σ σ σ σ pnì pûɔ.nì	1W			1	L	1
c. ft + ft △ △ σ σ σ σ pû.nì pûɔ.nì			1W	L	L	L
d. ft + ft │ △ σ σ σ pû pûɔ.nì		1W		L	L	1

To summarize, assuming a *ft* template, STS can derive the Mbe imperative reduplication pattern as a seeming but not genuine lookahead effect, via the Copy + Deletion path. To fulfill foot bisyllabicity, two syllables in the stem are copied, or a monosyllabic stem is copied twice into the *ft* template; then post-copying deletion reduces the segmental size of the reduplicant to CV/CVC. The key constraint that drives the two-syllable size of copy is FT-BIN(σ) and the size-restricting constraint that triggers deletion of the second nucleus is AFFIX≤σ. To make the alternative approach work, however, these two size-related constraints must be assessed distinctly, with FT-BIN(σ) inspecting only the prosodic structure without reference to its segmental realization, while AFFIX≤σ is obeyed on the basis of segments and their affiliated prosodic structure. This treatment seems to be stipulative. Framed differently, it seems inconsistent to us to interpret the prefix's *ft* template as at once satisfying foot bisyllabicity and also AFFIX≤σ. However, without this apparent inconsistency, the Copy + Deletion path did not succeed for the Mbe Class 2 imperative reduplication pattern.

5 Conclusion

In this paper, I have examined the lookahead effect in Mbe imperative affixation, conditioned by CODA-COND and $*C_{oral}]_{\sigma}$: a consonant is copied into the coda position of the prefix only when it is a nasal that undergoes place-assimilation with the following onset. This type of pattern is predicted to be impossible under STS, a theory of reduplication based on the serial version of OT. The STS theory faces a derivational paradox originating from the built-in pressure of gradualness, as the copy operation and place-assimilation cannot apply in the same step. I have considered a Copy + Deletion alternative that is similar to the approach adopted by MKM in account for the skipping effect of complex onsets in Sanskrit reduplication (e.g. [du-druv] /*[dru-druv], 'run'). Although this approach could derive the desired outputs, the derivation requires inconsistent evaluation of two size-related constraints that seems to be unprincipled. On the other hand, the BR correspondence theory of P-OT predicts the possibility of the lookahead effect. The lookahead effect is captured by the parallel evaluation of MAX-BR and phonotactic constraints. Thus, the P-OT analysis does not require inconsistent treatments of the size-related constraints. Overall, the attested lookahead effect seems to challenge the viability of STS and the associated limitations that gradualness imposes, while it provides support for the P-OT based theory of reduplication.

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