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Assimilation triggers metathesis in Balantak: Implications for theories of possible repair in Optimality Theory

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The basic form of the Balantak second person possessive suffix is –Vm, where V is a vowel that assimilates completely to the final vowel in the stem. This alternant appears both with vowel-final and glottal-final stems (e.g. /tama+Vm/ -> [tamaam] 'your father'; /aleʔ+Vm/ -> [aleʔem] 'your garden'). When the stem-final consonant is oral, it metathesizes with the vowel of the suffix (/sarat+Vm/ -> [saraat] 'your foot'). The suffixal consonant also deletes, since Balantak prohibits consonant clusters. Given that oral consonants often block total vowel assimilation (Aoki 1968, Steriade 1987), metathesis can be straightforwardly analyzed as serving to allow assimilation to apply unimpeded by the potential blocking consonant. However, this raises the question of why partial assimilation processes (e.g. nasal assimilation) do not dispose of potential blockers in like fashion. I propose that this is due to a fixed ranking of faithfulness constraints banning such repairs above markedness constraints driving assimilation, and argue that this gap in repair typology cannot be handled by targeted constraints (Wilson 2001). This entails that Balantak total vowel assimilation cannot be produced by the same constraints that cause partial assimilation; the analysis provided here is that it fills an underlyingly empty prosodic position.

1. Introduction

The second person singular possessive suffix in Balantak (Busenitz and Busenitz 1991) displays total vowel assimilation between adjacent vowels, and across a glottal stop:

(1)	a. /tama + Vm/	→	[tamaam]	'your father'
	b. /tambu + Vm/	→	[tambuum]	'your green beans'
	c. /aleʔ + Vm/	→	[aleʔem]	'your garden'
	d. /bakokoʔ + Vm/	→	[bakokoʔom]	'your knife'

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When an oral stop occurs stem finally, it metathesizes with the suffixal vowel, and assimilation occurs between adjacent elements. The nasal of the suffix is concomitantly lost due to a prohibition against coda clusters.

(2) a. /sarat + Vm/ → [saraat] 'your foot'
b. /popurun + Vm/ → [popuruun] 'your sago'

Given that oral consonants often block total vowel assimilation (Aoki 1968, Steriade 1987), this case of metathesis can be analyzed as serving to allow assimilation to apply unimpeded (cf. Broselow 2000). In terms of Optimality Theory, both the constraint driving assimilation and the constraint blocking assimilation across an oral consonant are satisfied, at the cost of violating faithfulness constraints against segmental metathesis and deletion. With the relevant assimilation constraint (expositorily ASSIM) and the constraint against trans-oral assimilation (BLOCK) ranked above the anti-metathesis and anti-deletion constraints (SEGFAITH), this pattern is produced. Failed candidate (3b) is an instance of trans-oral assimilation, and candidate (3c) is an instance of non-assimilation, with a default vowel surfacing (here schwa) instead of an assimilated one.

(3)

/sarat + Vm/	ASSIM	BLOCK	SEGFAITH
a. ☞ saraat			* *
b. saratam		*!	
c. saratʌm	*!		

Systems like that of Balantak are in fact expected under factorial typology. Analyses of vowel assimilation in Optimality Theory have focused on candidates like those in (3b) and (3c), showing how permuting the ranking of instantiations of 'ASSIM' and 'BLOCK' yields various patterns of assimilation and blocking (e.g. McCarthy 1994, Gafos 1996, Ní Chiosáin and Padgett 1997, Walker 1998, Gafos and Lombardi 1999, Bakovic and Wilson 2001). Implicit in these analyses is that the faithfulness constraints against rearrangement of the segmental string cannot be violated to satisfy ASSIM and BLOCK, presumably because SEGFAITH ranks above those constraints. Under standard assumptions, this ranking is a language particular choice, and we would expect to find systems in which SEGFAITH falls beneath ASSIM and BLOCK, as in Balantak.

This is a good result, but it also points to a serious problem. While we now have one attested instance of SEGFAITH being violated to allow total vowel assimilation, there are no reports of parallel phenomena involving partial vowel assimilation, such as nasal harmony, rounding harmony or ATR harmony. In all of these cases, we find patterns of blocking and assimilation that can be, and have been, analyzed in terms of rankings of instantiations of ASSIM and BLOCK. Yet despite the sustained attention that partial vowel assimilation has received since the emergence of autosegmental phonology, not one case of a potential blocking segment being deleted or moved has been reported.

The challenge this raises for a restrictive theory of phonology is to allow total vowel assimilation to trigger metathesis and deletion, but to deprive partial vowel assimilation of the ability to do the same. This challenge is part of the more general problem of limiting the set of repairs that can be used to satisfy a given markedness constraint. Here I adopt perhaps the most obvious approach within an Optimality Theoretic framework, but one that has yet to receive much attention: that some faithfulness constraints are fixed in rank above some markedness constraints. Specifically, I claim that all constraints on segmental correspondence ("SEGCOR", which is intended to denote McCarthy and Prince's 1995, 1999 MAX, DEP, LINEARITY, UNIFORMITY, and INTEGRITY, but not IDENT) universally dominate all constraints driving vowel assimilation ("ASSIM", which is intended to denote the AGREE, SPREAD or ALIGNFEAT constraints):

(4) Universal meta-ranking
SEGCOR >> ASSIM

To produce movement or deletion of blockers, ASSIM must dominate SEGCOR as in (3), in contravention of this universal meta-ranking.

Under this view, total vowel assimilation in Balantak cannot be due to the same constraints that drive partial assimilation. In line with this, the analysis that I provide in section 2 treats Balantak vowel assimilation as filling an underlyingly empty prosodic position, rather than as satisfying constraints demanding featural identity between successive vowels. Treating Balantak total vowel assimilation as essentially a type of epenthesis receives support from the fact that truly epenthetic vowels also exhibit total assimilation. The analysis also deals with two related complications. First, blocking of trans-oral assimilation is not categorical in Balantak, since it occurs across stem-initial oral consonants (e.g. /mVŋ+bala/ → [mambala]). This is dealt with as an instance of positional faithfulness: a stem-initial LINEARITY constraint blocks metathesis across the left edge. Second, nasal-sonorant sequences, banned throughout Balantak, are resolved by deletion when the prefix has a fixed vowel (e.g. /saŋ+wuras/ → [sawuras]), but by epenthesis when the prefix has an assimilating vowel (e.g. /mVŋ+wawau/ → [maŋawawau]). The initially puzzling limitation of epenthesis to assimilating prefixes falls out directly from the analysis of prefixal trans-oral vowel copy.

Following the analysis of Balantak, I flesh out the fixed ranking analysis of the typology of possible repairs. I use this approach to deal with two instances of impossible repair: the absence of segmental movement and deletion as repairs for violations of constraints causing partial assimilation, for the absence of epenthesis as a repair for *NC̥, a constraint against nasal-voiceless obstruent sequences. I then discuss an alternative approach to the typology of possible repair in OT: targeted constraints (Wilson 2001), and show that it faces difficulties in capturing these typological gaps.

2. Balantak vowel assimilation

2.1 Analytic preliminaries

In this analysis, total vowel assimilation in Balantak results from the need to fill a prosodic position that has no underlying segmental content. I will assume that the position is a bare mora, unspecified for segmental content. Underlying representations for a suffix and a prefix with assimilating vowels are as in (5a) and (5b).

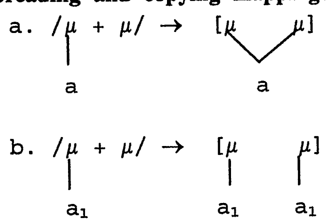
(5) a. /μm/ b. /mμŋ/

I will further assume that an unfilled mora is universally ill-formed at surface structure; for MAX-μ (6a) to be satisfied the mora must be linked to a vowel.[1] The adoption of an adjacent vowel's features, rather than default features, is forced by DEP-V (6b). These and all other faithfulness constraints are based on the correspondence theory of McCarthy and Prince (1995, 1999).

(6) a. MAX-μ Input moras must have Output correspondents
b. DEP-V Output vowels must have Input correspondents

I take the constraints in (6) to be undominated in Balantak. There are two ways that they can be satisfied, through analogues of spreading and copying (cf. Kitto and de Lacy 2000). In (7a), a "spreading" Input-Output mapping appears; here two prosodic positions share a single segmental melody. In a "copying" mapping (7b), on the other hand, the underlying segmental melody has two output correspondents.

(7) 'Spreading' and 'copying' mappings



The mapping in (7b) violates the following constraint (McCarthy and Prince 1995, 1999), and will thus be chosen over (7a) only under compulsion of higher ranked constraints:

(8) INTEGRITY: No Input element has multiple Output correspondents

[1] The mora could presumably also be attached to coda position in the Output. There appears to be no evidence for moraic codas in Balantak, so an undominated constraint could be invoked to rule out this possibility.

In the sections that follow, I will argue for an analysis of Balantak in which the melodic material is provided to the suffix through spreading, and to the prefix through copying.

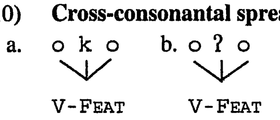
2.2 Suffixal alternations

The following is a fuller set of data to illustrate the alternations involving the suffix -*Vm*. Its basic form occurs with stems ending in vowels (9a-e) or glottals (9f-h). When the stem-final consonant has an oral place of articulation (9i-m), it metathesizes with the vowel of the suffix. The nasal is lost in these cases as well, presumably in order to avoid creating a coda cluster, which is not allowed in Balantak.

(9)	a. /tama+Vm/	→	[tamaam]	'your father'
	b. /tambue+Vm/	→	[tambueem]	'your green beans'
	c. /kopi+Vm/	→	[kopiim]	'your coffee'
	d. /tigo+Vm/	→	[tigoom]	'your tobacco'
	e. /apu+Vm/	→	[apuum]	'your fire'
	f. /aleʔ+Vm/	→	[aleʔem]	'your garden'
	g. /bakokoʔ+Vm/	→	[bakokoʔom]	'your knife'
	h. /oriiʔ+Vm/	→	[oriiʔim]	'your poles'
	i. /sarat+Vm/	→	[saraat]	'your foot'
	j. /popurun+Vm/	→	[popuruun]	'your sago'
	k. /wewer+Vm/	→	[weweer]	'your lips'
	l. /witis+Vm/	→	[witiis]	'your calf-of-leg'
	m. /suap+on+Vm/	→	[suapoon]	'burned by you'

A cross-linguistically common pattern is for total vowel assimilation to apply only across glottals, and for it to be blocked by intervening oral consonants (Aoki 1968, Steriade 1987, Gafos and Lombardi 1999). Following Gafos and Lombardi (1999) (see also McCarthy 1994, Gafos 1996, Ní Chiosáin and Padgett 1997), I derive blocking by assuming that the intervening consonant participates in V-to-V linkage, so that a featural co-occurrence constraint can be invoked to determine which consonants can intervene.

(10) **Cross-consonantal spreading configurations**



In (10a), an oral consonant bears vowel features, in contravention of the following constraint (see Gafos and Lombardi 1999 for a more fine-grained approach that derives a typology of possible blockers):

(11) *C/VFEAT
Oral consonants are not specified for vocalic features

With this much in hand, the Balantak pattern of metathesis and deletion can be straightforwardly produced by having *C/VFEAT rank above the faithfulness constraints LINEARITY ("no metathesis") and MAX-C ("no deletion"). The constraints are defined in (12) and (13), and (14) provides a tableau showing the outcome of this ranking for a root ending in an oral consonant.[2]

(12) LINEARITY
The precedence relation of Input elements must be maintained in the Output

(13) MAX-C
Input consonants must have Output correspondents

(14)

	$sara_1t_2+\mu_3m_4$	*C/VFEAT	LINEARITY	MAX-C
a.	☞ $sara_1a_3t_2$		*	*
b.	$sara_1t_2a_3m_4$	*!		

When the root ends in a glottal or a vowel, *C/VFEAT is not at issue, and the lower ranked faithfulness constraints choose ordinary suffixation:

(15)

	$ale_1ʔ_2+\mu_3m_4$	*C/VFEAT	LINEARITY	MAX-C
a.	$ale_1e_3ʔ_2$		* !	* (!)
b.	☞ $ale_1ʔ_2e_3m_4$			

Violation of *C/VFEAT, as well as LINEARITY and MAX-C, would be avoided if copying, rather than spreading were employed. This would lead to the wrong outcome for roots ending in an oral consonant; the tableau in (16) shows that INTEGRITY must dominate LINEARITY and MAX-C. The subscripting '$a_{1,3}$' on the assimilating vowel in (16b) indicates that it is in correspondence with the underlying suffixal mora, and with the melodic content of the stem-final vowel. That is, it indicates copying, as in (7b).

(16)

	$sara_1t_2+\mu_3m_4$	INTEGRITY	LINEARITY	MAX-C
a.	☞ $sara_1a_3t_2$		*	*
b.	$sara_1t_2a_{1,3}m_4$	*!		

2.3 Prefixation

The verbal prefixes *mVŋ-*, *nVŋ-*, and *pVŋ-* also undergo total vowel assimilation, which in this case does regularly traverse oral consonants:

[2] Under the present ranking, a candidate in which only the root-final consonant deletes would emerge as optimal. This candidate could be ruled out by invoking a root-specific version of MAX-C.

(17) a. /mVŋ+bala/ → [mambala] 'to fence'
b. /mVŋ+keke/ → [meŋkeke] 'to dig'
c. /mVŋ+goop/ → [moŋgoop] 'to suck'
d. /nVŋ+tete/ → [nentete] 'to signal'
e. /nVŋ+tuluŋ/ → [nuntuluŋ] 'to help'

Broselow (2000) points to examples like these to argue that a ban on trans-oral spreading cannot be responsible for suffixal metathesis. In the context of Optimality Theory, in which constraint ranking leads to nonuniform constraint activity, this argument is not conclusive. There is no reason that the constraint against trans-oral spreading could not be active in driving metathesis in the context of suffixation, yet be violated in the context of prefixation. However, it does remain to be shown that the intervention of well-motivated constraints can derive the prefix/suffix difference.

Root-initial position is a psycholinguistically prominent position and hence regularly a target of positional faithfulness constraints (see e.g. Casali 1997, Beckman 1998, Smith 2002). Thus, positional faithfulness is a likely cause of the prefix/suffix asymmetry. I assume the following constraint is at work:

(18) LINEARITY(ROOT-INITIAL)
The Input precedence relation between the root initial segment and other segments must be maintained in the Output

If metathesis applied between the prefix and root, this constraint would be violated. In (19a), we have the failed candidate Input-Output mapping that undergoes root-initial metathesis to satisfy *C/VFEAT. If we examine the ordering of the numeric subscripts indicating the Input-Output correspondence relation, 1 precedes 3 in the Input, but 1 does not precede 3 in the Output. In the optimal Input-Output mapping, shown in (19b), all Input precedence relations are maintained (new ones are also added, but I take this to be irrelevant for LINEARITY)

(19) a. /$m\mu_1ŋ_2$+b_3a_4la/ → *[$m_2b_3a_1a_4la$]
b. /$m\mu_1ŋ_2$+b_3a_4la/ → [$ma_{1,4}ŋ_2b_3a_4la$]

With this constraint ranked above INTEGRITY, vowel copy is chosen for prefixes instead of metathesis and strictly local spreading:

(20)

	$m\mu_1ŋ_2$+b_3a_4la	LIN(ROOT-INI)	INTEGRITY	LINEARITY
a.	☞ $ma_{1,4}ŋ_2b_3a_4la$		*	
b.	$m_2b_3a_1a_4la$	*!		*

Spreading across the oral consonant is ruled out by *C/VFEAT being ranked above INTEGRITY:

(21)

	/mμ₁ŋ₂+b₃a₄la/	*C/VFEAT	INTEGRITY
a.	☞ $ma_{1,4}ŋ_2b_3a_4la$		*
b.	$ma_1ŋ_2b_3a_4la$	*!	

As this completes the analysis of assimilation, in (22) I combine all of the rankings motivated above into a single hierarchy:

(22) MAX-μ, DEP-V, *C/VFEAT, LINEARITY(ROOT-INITIAL) >> INTEGRITY >> MAX-C, LINEARITY

Before moving on to consider an alternative approach, I will briefly recap the analysis. Empty moras must receive an adjacent vowel's features due to undominated MAX-μ and DEP-V. Spreading generally occurs rather than copying due to the activity of INTEGRITY. Spreading across oral consonants, however, runs afoul of undominated *C/VFEAT. For suffixes, metathesis and deletion serve to allow spreading, since MAX-C and LINEARITY are dominated by the other constraints. For prefixes, the ranking of LINEARITY(ROOT-INITIAL) and *C/VFEAT above INTEGRITY leads to copying rather than spreading.

Given the data we have seen thus far, there is no reason that one could not assume that all vowel assimilation in Balantak is spreading, and that root-initial LINEARITY (STEM-INI) forces a violation of *C/VFEAT in initial position, rather than of INTEGRITY. In the next section, however, I show that the copy analysis of prefixal assimilation allows for an account of facts that seem recalcitrant under such a spreading account.

2.4 Assimilation licenses epenthesis

In section 2.2, we saw that total vowel assimilation plays a role in triggering metathesis and deletion. In this section, we see that it also is involved in triggering epenthesis. Morpheme-internally, Balantak has no nasal-sonorant sequences, and when these arise at a prefix-stem boundary, nasal deletion results:

(23)	a. /miŋ+noa/	→	[minoa]	'to breath'
	b. /niŋ+ŋoap/	→	[niŋoap]	'yawned'
	c. /toŋ+yooŋ/	→	[toyooŋ]	'unintentionally shake'
	d. /saŋ+wuras/	→	[sawuras]	'one seed'
	e. /saŋ+loloon/	→	[saloloon]	'one thousand'

When an assimilating prefix is added to a sonorant-initial stem, however, epenthesis occurs instead of deletion:

(24)	a. /mVŋ+wawau/	→	[maŋawawau]	'to do'
	b. /mVŋ+memel/	→	[meŋememel]	'to cool'
	c. /mVŋ+limbaŋ/	→	[miŋilimaŋ]	'to move'
	d. /mVŋ+roŋor/	→	[moŋoroŋor]	'to hear'
	e. /mVŋ+yuŋgot/	→	[muŋuyuŋgot]	'to shake'

Here we have an instance of a conspiracy between two processes in the satisfaction of a single target constraint (Kisseberth 1970), which is usually straightforwardly handled in Optimality Theory (see e.g. McCarthy 2002: 95). It is not immediately apparent, however, why the occurrence of assimilation should license the presence of the epenthetic vowel. It is a nice outcome, therefore, that an account of the distribution of these two repairs falls out from the analysis of vowel assimilation provided above.

The prohibition against nasal-sonorant sequences is likely the result of a syllable contact restriction, which I state in terms of the relatively parochial constraint *N/SON:

(25) *N/SON
No nasal/sonorant sequences

The default preference for deletion over epenthesis is what our current hierarchy predicts. Like the assimilating vowels, epenthetic vowels will necessarily violate INTEGRITY in order to receive featural specification; default insertion is ruled out by higher ranked DEP–V, and spreading by *C/VFEAT. Since deletion violates only MAX-C, it is the chosen repair:

(26)

	$sa_1ŋ_2+w_3u_4ras$	*N/SON	INTEGRITY	MAX-C
a.	$sa_1ŋ_2u_4w_3u_4ras$		*!	
b.	$sa_1ŋ_2w_3u_4ras$	*!		
c. ☞	$sa_1w_3u_4ras$			*

In the case of assimilating prefixes, violation of INTEGRITY with respect to the root-initial vowel is already forced by higher ranked constraints (DEP-V and root-initial LINEARITY). Epenthesis incurs no extra violation of INTEGRITY since no additional underlying vowel has multiple correspondents, and it is therefore optimal:[3]

[3] It is unlikely that copying a vowel or consonant to satisfy one constraint always licenses extra copies to satisfy another constraint. This is due, presumably, to the fact that constraints other than INTEGRITY are violated by copying (e.g. *STRUCTURE). In Balantak, all such constraints rank beneath MAX-C. Cf. also Buckley (1997), who assumes that INTEGRITY is gradiently violable.

(27)

	mμ$_1$ŋ$_2$+w$_3$a$_4$wau	*N/SON	INTEGRITY	MAX-C
a.	ma$_{1,4}$w$_3$a$_4$wau		*	* !
b.	ma$_{1,4}$ŋ$_2$w$_3$a$_4$wau	*!	*	
c. ☞	ma$_{1,4}$ŋ$_2$a$_4$w$_3$a$_4$wau		*	

A similar analysis is impossible if prefixal assimilation is 'spreading', since deletion would avoid accumulating violations of *C/VFEAT. In the tableau in (28), a bomb appears beside the candidate that such an analysis would wrongly prefer.

(28)

	mμ$_1$ŋ$_2$+w$_3$a$_4$wau	*N/SON	*C/VFEAT	MAX-C
a. 💣	ma$_1$w$_3$a$_4$wau		*	*
b.	ma$_1$ŋ$_2$w$_3$a$_4$wau	*!	**	
c.	ma$_1$ŋ$_2$a$_5$w$_3$a$_4$wau		**!	

Besides supporting the specific proposal that prefixal assimilation is copying, rather than spreading, these cases of epenthesis lend credence to the general approach of treating total assimilation in Balantak as being due to the filling of a segmentally unspecified position.

3. Implications for theories of possible repair

3.1 The problem

In Balantak suffixal vowel assimilation, assimilation and blocking constraints are satisfied by changing the segmental makeup of the Input string through metathesis and deletion. This way of avoiding the violation of assimilation and blocking constraints is unattested, however, when assimilation is partial, rather than total. In this section, we look at one particular example of such an unattested repair, deletion of opaque segments in nasal harmony, and consider how it can be accounted for in Optimality Theory.

Like total vowel assimilation, nasal harmony is also often blocked by a subset of intervening consonants. Walker (1998) analyzes the blocking patterns in terms of the interaction of a 'Spread' constraint, whose formulation is paraphrased in (29), with the fixed ranking of co-occurrence constraints in (30):

(29) SPREAD([+NASAL])
For any segment linked to a feature [+nasal], all other segments in the domain must be linked to that same instance of [+nasal] (violated by every unassociated segment)

(30) *NASOBSSTOP >> *NASFRICATIVE >> *NASLIQUID >> *NASGLIDE >> *NASVOWEL >> *NASSONSTOP

The tableau in (31) shows how the ranking of one of the blocking constraints, *NASGLIDE, above the assimilation constraint SPREAD([+NASAL]) stops assimilation from proceeding through a glide (as in Sundanese; Robins 1957):

(31)

/mawa	*NASGLIDE	SPREAD(NAS)
a. mãw̃ã	*!	
b. ☞ mãwa		**

The reverse ranking would yield a language in which glides participate in harmony, as in Malay (Onn 1976). However, both of these constraints could be satisfied by deleting the intervening consonant.[4] This is the predicted outcome if MAX-C ranked beneath them:

(32)

/mawa	*NASGLIDE	SPREAD(NAS)	MAX-C
a. mãw̃ã	*!		
b. mãwa		**!	
c. ☞ mãã			*

Despite the considerable attention that the typology of nasal harmony has received in the phonological literature (e.g. Schourup 1973, Cohn 1987, Piggott 1992, Walker 1998), not a single case of this type has emerged. Similarly, other types of partial vowel harmony, such as ATR harmony and rounding harmony, never seem to dispose of blocking consonants or vowels through metathesis or deletion.

To capture this asymmetry between total and partial vowel assimilation, the markedness constraint(s) driving total assimilation must be differentiated from those causing partial assimilation in that only the former can be satisfied when segmental movement or deletion occurs. The first step towards this goal has already been taken by providing an analysis of Balantak total vowel assimilation that relies on constraints demanding that a prosodic position be segmentally filled, rather than on the constraints demanding feature sharing or agreement that are responsible for other types of vowel assimilation. The second step is to deprive the feature sharing or agreement constraints of the ability to force deletion, as one of them does in (32), as well of the ability to force any other change to the number of segments or their order. In this section I will consider two approaches to this problem: imposition of a universally fixed ranking amongst constraints (cf. Prince and Smolensky 1993), and reformulation of the markedness constraints within the targeted constraint framework of Wilson (2001a,b).

3.2 Fixed ranking of markedness and faithfulness constraints

When factorial typology overgenerates, one way to rein it in is through the imposition of universally fixed rankings, first introduced by Prince and Smolensky (1993) in their account of Berber syllabification. Most of the proposed fixed rankings, like Prince and

[4] See also Piggott (2002) on debucallization and nasal substitution as unattested repairs for intervening oral stops.

Smolensky's Peak/Margin sonority hierarchies, and Walker's (1998) nasal co-occurrence hierarchy in (30), involve rankings between markedness constraints, though Steriade (2001a,b) has also invoked universally ranked faithfulness constraints to constrain typology. For the case at hand, however, it is the ranking between a markedness constraint and a faithfulness constraint that must not be allowed to vary cross-linguistically (see Pater 1999; see also Piggott 2002 in a parametric framework). Taking our example of nasal harmony, (33) provides the full factorial typology produced by the free ranking of representative assimilation, blocking, and segmental faithfulness constraints, along with the Output they would select for underlying /mawa/:

(33)

	Ranking	/I: mawa	*Attested?*
a.	MAX-C >> *NASGLIDE >> SPREAD([+NASAL])	O: mãwa	Yes
b.	MAX-C >> SPREAD([+NASAL]) >> *NASGLIDE	O: mãw̃ã	Yes
c.	SPREAD([+NASAL]) >> MAX-C >> *NASGLIDE	O: mãw̃ã	Yes
d.	*NASGLIDE >> MAX-C >> SPREAD([+NASAL])	O: mãwa	Yes
e.	SPREAD([+NASAL]) >> *NASGLIDE >> MAX-C	O: mãã	No
f.	*NASGLIDE >> SPREAD([+NASAL]) >> MAX-C	O: mãã	No

Rankings (33a-d) produce the attested patterns in which glides either block or participate in harmony, while the rankings producing unattested results are those in (33e) and (33f). What these have in common is that MAX-C falls to the bottom of the hierarchy. To rule them out, MAX-C must universally dominate either SPREAD(+NASAL) or *NAS-GLIDE.[5] Fixed ranking of the markedness constraints will not help, since they are in opposite orders in (33e) and (33f). A fixed ranking of faithfulness constraints, as in Steriade (2001), is also of no avail. Even with MAX-C fixed in rank above IDENT(+NAS), if they both fell beneath the markedness constraints, deletion would still result:

(34)

/mawa	*NASGLIDE	SPREAD(NAS)	MAX-C	IDENT(NAS)
a. mãw̃ã	*!			***
b. mãwa		**!		*
c. ☞ mãã			*	**

Thus, it seems that a fixed faithfulness over markedness ranking, such as the one between SPREAD(+NASAL) and MAX-C in (35), is required:

(35) Fixed ranking: MAX-C >> SPREAD(+NASAL)

Since it appears that no partial vowel assimilation process ever leads to a disruption of the segmental (as opposed to featural) makeup of the Input string, this universal ranking should be generalized.

[5] One advantage of having the assimilation constraint SPREAD(+NASAL), rather than the co-occurrence constraint *NAS-GLIDE, universally dominated by MAX-C, is that the latter would not rule out deletion of the triggering nasal (e.g. /mawa/ → [awa]).

Constraints motivating vowel assimilation have been proposed to either require feature sharing between segments, as in Walker's (1998) SPREAD(+NASAL) constraint, or for adjacent segments to have the same value, as in Bakovic's (2000) AGREE formulation.[6] A choice between these is tangential to the present undertaking, so I will use "ASSIM" to stand for either one.[7]

For the faithfulness constraints, what is required is a rubric that includes the constraints on segmental correspondence in McCarthy and Prince's (1995, 1999) theory of faithfulness. I take SEGCOR to denote MAX, DEP, LINEARITY, UNIFORMITY, and INTEGRITY. Crucially, IDENT constraints, which require that segments in correspondence have identical featural values, fall outside the scope of this denotation.

(36) Generalized fixed ranking: SEGCOR >> ASSIM

With this ranking schema limiting factorial typology, only featural changes, and not segmental ones, can be commanded by the constraints driving partial assimilation processes.

There seems to be a relationship between the representational level at which the assimilation process is taking place, and the type of change it can affect to the Input string. Total vowel assimilation, which copies an entire segment, can use segmental deletion and metathesis to remove a potential blocker, as we have seen in Balantak. Partial vowel assimilation, which involves changes at the featural level, does not compel wholesale segmental alterations to deal with opaque segments. This provides some initial plausibility for a theory in which the repairs that are used to satisfy a given markedness constraint are somehow restricted to the level of representation that the markedness constraint targets.

However, the typology of possible repairs for a given constraint often crosscuts the segmental/featural divide. *NC̥, which militates against nasal/voiceless obstruent clusters, can be satisfied through deletion of the nasal or voicing of the obstruent, as well several other ways (Pater 1996, 1999, Hayes 1999). The chief gap in the typology of NC̥ repairs is the lack of epenthesis, a repair that is otherwise well-attested in breaking up ill-formed clusters, including nasal-sonorant clusters, as we have seen in Balantak (see

[6] The literature on vowel assimilation in Optimality Theory is quite large; Walker (1998) and Bakovic (2000) have extensive citations of earlier invocations of these types of constraint.

[7] Constraints requiring homorganicity between adjacent consonants do seem to induce segmental deletion, as well as assimilation, as de Lacy (2002) emphasizes. This could entail that such constraints are of a different formal family than the vowel assimilation constraints; it is also possible that a coda condition is at work (Ito 1989).

further Myers 2002).[8] As suggested in Pater (1999), this constraint must be universally dominated by just one of the segmental correspondence constraints, DEP-V:

(37) Fixed ranking: DEP-V >> *NC̥

The typology of repairs for *NC̥ thus suggests that allowing markedness constraints to affect change only on a given representational level will be inadequate as a general account of possible repair.

In relying on fixed rankings, we can construct an account of repair typology that makes use of only the formal elements provided by standard Optimality Theory. One might wonder, however, about the functional grounding of these rankings. McCarthy (2002: 21) suggests that all universal hierarchies might be derived from natural scales of relative prominence, like sonority. To limit repairs through fixed ranking, however, it is necessary to fix the rank between Faithfulness and Markedness constraints, which seem to stand in no inherent relationship, and certainly not one of prominence. A different sort of grounding for these fixed rankings, however, may be derived from the considerations of perceptual distance that Steriade (2001a,b) and Wilson (2001) invoke as components of their approaches to repair typology. In these approaches, a particular repair is preferred because it is closest perceptually to the unchanged input string. Instead of stating what is close enough perceptually, the fixed F >> M ranking could be taken to define what is *too far* perceptually to be considered as an alternative to violation of a given constraint.

It might also be objected that this approach makes no predictions beyond the facts at hand. However, when it is extended to a wider range of processes, relatively subtle but testable predictions will emerge about the shape of individual phonological systems. For example, given two fixed rankings F1 >> M1 and F2 >> M2, if M1 >> M2, then F1 must dominate M2; similarly, if M2 >> M1, then F2 must dominate M1.[9]

3.3 Targeted constraints

Targeted constraints (Wilson 2001, see also Bakovic and Wilson 2000) have been proposed as a general solution to the "too many repairs" problem. As such, they would appear to offer an alternative to fixed rankings as account of the typological gaps addressed here.

[8] The further unattested repairs Myers cites are metathesis and changing the voiceless obstruent to a sonorant. While these do remain to be dealt with, they seem somewhat less worrisome than the epenthesis gap. First, it is possible that these repairs are a sort of "overkill" (McCarthy 2002:113); metathesis may be harmonically bound by fusion, and sonorantization by post-nasal voicing. Second, these repairs are themselves rare, so their absence from the NC̥ typology is less unexpected than that of epenthesis. And finally, allomorphic NC̥ metathesis is documented in Steriade (2001b).

[9] Thanks to Ania Lubowicz for discussion of this point.

Standard markedness constraints in Optimality Theory penalize a particular structure, and are satisfied by all candidates lacking that structure. Targeted constraints also penalize marked structures. However, they do so by placing a harmonic ordering between a candidate bearing that structure, and one specified candidate that lacks that structure (hypothesized to be the one that is the most perceptually similar to the dispreferred candidate). Returning to our example of nasal harmony, what we want is a constraint that compares only candidates in which the segmental string has been preserved intact. The constraint in (38) has that property.

(38) →NASASSIM
Candidate x' is preferred over x (x' > x) iff x' is exactly like x except that a segment adjacent to and to the right of a nasal segment has been changed from [-nasal] to [+nasal]

For an input like /mawa/, this constraint will place the harmonic orderings in (39a) on output candidates displaying varying degrees of assimilation. When combined, these yield harmonic ordering in (39b):

(39) a. maəwəaə > maəwəa, maəwəa > maəwa, maəwa > mawa
b. maəwəaə > maəwəa > maəwa > mawa

As desired, NASASSIM is silent on the candidate [maəaə], which was problematic because it satisfied the SPREAD[+NASAL] constraint.

However, for [maəaə] to be ruled out universally as a response to NASASSIM, it must be the case that no constraint orders it above [maəwəaə] (or above any of the other candidates displaying assimilation, if the ones higher in the ordering in (38b) are dispreferred by some other constraint). To see this, consider a putative constraint X, that does prefer [maəaə] over [maəwəaə]. Combining the ordering imposed by constraint X and the one in (39b) will result in that of (40):

(40) maəaə > maəwəaə > maəwəa > maəwa > mawa

The co-occurrence constraint *NASGLIDE would have exactly this effect, unless it is targeted as well (cf. Bakovic and Wilson 2000 on a targeted (+HI, -ATR) co-occurrence constraint):

(41) →*NASGLIDE
Candidate x' is preferred over x (x' > x) iff x' is exactly like x except that a glide is changed from [+nas] to [-nas]

This constraint will impose the following orderings:

(42) maəwaə > maəwəaə, maəwa > maəwəa

Here we have introduced another candidate [maəwaə], which is the one preferred over the fully assimilated [maəwəaə] by a targeted *NASGLIDE constraint.
The orderings imposed by *NASGLIDE and NASASSIM conflict. *NASGLIDE prefers [maəwaə] over [maəwəaə], while NASASSIM will place the candidates in the reverse order; the same applies to [maəwa] and [maəwəa]. As in standard Optimality Theory, ranking resolves conflict between constraints. A harmonic ordering is placed on the candidate set starting with the highest ranked constraint. Each subsequent constraint in the hierarchy also places its ordering on the candidate set, insofar as it does not conflict with orderings already imposed by higher ranked constraints. If →NASASSIM dominates →*NASGLIDE a fully assimilated candidate is chosen as optimal (e.g. maəwəaə). As shown in (43), →NASASSIM first imposes its ordering on the candidate set, and →*NASGLIDE is blocked from imposing its own:

(43) →NASASSIM >> →*NASGLIDE

1. →NASASSIM:	maəwəaə > maəwəa > maəwa > mawa
	maəwəaə > maəwaə
2. →*NASGLIDE:	–
Cumulative ordering:	maəwəaə > maəwəa > maəwa > mawa
	maəwəaə > maəwaə

With the reverse ranking, [maəwaə] and [maəwa] are at the top of their respective orderings, but nothing chooses between them:

(44) →*NASGLIDE >> →NASASSIM

1. →*NASGLIDE:	maəwaə > maəwəaə, maəwa > maəwəa
2. →NASASSIM:	maəwəaə > maəwəa, maəwa > mawa
Cumulative ordering:	maəwaə > maəwəaə > maəwəa
	maəwa > maəwəa, maəwa > mawa

To produce the blocking pattern (e.g. [maəwa]), we need a constraint that will choose blocking over "transparency" (e.g. [maəwaə]). To do so, something like the following "doubly conditioned assimilation" constraint seems to be needed (see Bakovic and Wilson 2000 for a similar approach to blocking of ATR harmony):

(45) *NASORNAS
No Nasal-Oral-Nasal sequences

This constraint will prefer everything, including [maəwa], over [maəwaə]. To get blocking to beat full assimilation, →*NASGLIDE must dominate *NASORNAS and →*NASASSIM, so that [maəwaə] is ordered above [maəwəaə] (either of the other constraints would prefer the reverse). *NASORNAS can then place the blocking candidate [maəwa] above [maəwaə], which results in the blocking candidate being transitively ordered above [maəwəaə]. The ranking between →NASASSIM and *NASORNAS appears to be indeterminate, but I have placed the constraints in a total order in (46) to illustrate one of the rankings that chooses the correct outcome:

(46) →*NASGLIDE >> →*NASASSIM >> *NASORNAS

1. →*NASGLIDE:	maəwaə > maəwəaə, maəwa > maəwəa
2. →NASASSIM:	maəwəaə > maəwəa, maəwa > mawa
3. *NASORNAS	maəwa > maəwaə
Cumulative ordering:	maəwa > maəwaə > maəwəaə > maəwəa
	maəwa > mawa

By creating targeted versions of *NASASSIM and *NASGLIDE, and by adding the *NASORNAS constraint, we have an account of nasal assimilation and blocking that does not produce the unattested deletion candidate through ranking permutation. There are some outstanding issues, however.

First, this approach makes the prediction that every assimilation process that has a set of opaque segments should have a related doubly conditioned assimilation process. Whether this is the case can only be substantiated through further research. Bakovic and Wilson (2000) do list a set of doubly conditioned assimilation processes, but conspicuously absent from that list is the one that would be produced by their constraint. Furthermore, the relationship between transparency and blocking is potentially problematic. In Bakovic and Wilson's account, an untargeted assimilation constraint prefers full assimilation over blocking, and transparency is then ordered above full assimilation by the targeted co-occurence constraint. However, transparency cannot be produced in this way if the assimilation constraint is targeted as in (37). This is a desirable result for glides in nasal harmony, since while glides and liquids can block or undergo nasal harmony, they are never transparent to it (Walker 1998: 21 ff.). However, if segmental deletion is to be ruled out as a response to ATR harmony, then that constraint should be targeted too, and we could lose the account of the attested transparency cases for that type of assimilation.

A more general, and serious, issue is the one raised for targeted constraint theory by McCarthy (to appear), and alluded to above. If [maəaə] is never to be rendered optimal as an output for /mawa/ by →NASASSIM, then there must be no constraint in the universal constraint set that prefers [maəaə] to [maəwəaə]. If there is, then →NASASSIM can be used to order [maəwəaə] over the more faithful [mawa], and this other constraint can place [maəaə] at the top of the ordering. For the small set of constraints under consideration, we eluded this difficulty by targeting the *NASGLIDE constraint, so that it did not prefer [maəaə] over [maəwəaə]. Another obvious worry is IDENT[NASAL] (McCarthy and Prince 1995, 1999), which is violated three times in [maəwəəaə], but only twice in [maəaə]. If IDENT[NASAL] outranks MAX, [maəaə] will be harmonically ordered above [maəwəəaə]:

(47) →NASASSIM >> IDENT[NASAL] >> MAX

1. NASASSIM:	maəwəaə > maəwəa > maəwa > mawa
	maəwəaə > maəwaə
2. IDENT[NASAL]	maəaə > maəwəəaə
3. MAX	–
Cumulative ordering:	maəaə > maəwəəaə > maəwəa > maəwa > mawa
	maəaə > maəwəəaə > maəwaə

It is perhaps conceivable that IDENT[NASAL] and other constraints could be formulated so that that they do not prefer the unattested outcome for this case, as well as for cluster reduction as discussed by Wilson (2001) and McCarthy (to appear). However, attempting to deal with the *NC˧ repair typology in this way points up a serious difficulty in pursuing this line of attack.[10]

Recall that *NC˧ is satisfied by postnasal voicing and by nasal deletion, but not by epenthesis. That postnasal voicing and nasal deletion are caused by the same constraint is highlighted by the fact that they can conspire to rid a language of NC˧ clusters. In Modern Greek (Newton 1972), post-nasal voicing (48a,c) applies except when the post-nasal obstruent is itself followed by a voiceless obstruent (a fricative). In this situation, nasal deletion applies instead (48b,d), thus avoiding voicing disagreement between obstruents, which is generally prohibited in Greek:[11]

(48)

a. /pemp+o/	[pembo]	'I send'
b. /e+pemp+s+a/	[epepsa]	-aorist
c. /ton+topo/	[tondopo]	'the place'
d. /ton#psefti/	[topsefti]	'the liar' (Cypriot)

The challenge, then, is to allow *NC˧ to participate in driving postnasal voicing and nasal deletion, but not epenthesis. Let us assume that postnasal voicing is the repair picked out by the targeted constraint (cf. Steriade 2001b):

(49) →*NC˧

Candidate x' is preferred over x (x' > x) iff x' is exactly like x except that a segment following a nasal is changed from [-voice] to [+voice]

[10] This section owes much to discussion with John McCarthy, as well as Paul de Lacy.

[11] In all dialects, the nasal is deleted within the word (5b), and in most dialects, including Cypriot, it is deleted in an article preceding a noun, except in 'slow, deliberate speech' (5d).

Given an Input /ampa/, this constraint places the following ordering on a candidate set that includes deletion, epenthesis, and postnasal voicing as repairs:

(50) amba > ampa
amʌpa, apa

Only [amba] and [ampa] are ordered with respect to each other; neither is ordered with respect to [amʌpa] or [apa], and these last two are also unordered with respect to each other.

To get deletion as an outcome, we can invoke IDENT[VOICE] (McCarthy and Prince 1995, 1999):

(51) IDENT[VOICE]
Segments in correspondence are identical in [voice] specification

This constraint will order all other candidates over [amba]:

(52) amʌpa, apa, ampa > amba

For →*NC̥ to have any effect, it must rank above IDENT[VOICE], since IDENT[VOICE] asserts the opposite ordering [ampa] > [amba]. IDENT[VOICE], however, does have an effect when ranked below →*NC̥, since it imposes orderings other than the one inconsistent with →*NC̥. In particular, it will order the deletion candidate and the epenthesis candidate above the postnasal voicing candidate:

(53) →*NC̥ >> IDENT[VOICE]

1. →*NC̥:	amba > ampa
2. IDENT[VOICE]	amʌpa, apa > amba
Cumulative ordering:	amʌpa, apa > amba > ampa

For the deletion candidate [apa] to emerge as optimal, the anti-epenthesis constraint DEP must dominate the anti-deletion constraint MAX. In addition, MAX must rank beneath IDENT[VOICE], in order to maintain the preference for deletion over postnasal voicing.

While we now have an account of deletion as a response to →*NC̥, the problem is that simple reranking of MAX and DEP will produce the unattested epenthetic outcome. Here, it is very difficult to see how one could reformulate the constraint so that it does not prefer the unattested repair: why should IDENT[VOICE] apply when the preceding consonant is deleted (so as to prefer [apa] over [amba]) but not when a preceding vowel is inserted (so as not to prefer [amʌpa] over [amba])?

Crucially, the problem of other constraints preferring the unattested repair does not arise for the fixed ranking analysis. If a constraint violated by the unattested repair is fixed in rank above the relevant markedness constraint, then it is impossible in standard Optimality Theory with strict domination for the lower ranked constraint to participate in driving a violation of the higher ranked one.

4. Conclusions

Balantak provides a unique case in which assimilation and blocking constraints are satisfied by rearrangment of the segmental string. This can be captured straightforwardly by ranking segmental correspondence constraints beneath the assimilation and blocking constraints. The challenge this raises is to limit such repairs to total vowel assimilation, since partial vowel assimilation does not seem to be capable of driving a change to the segmental makeup of the string. Here I have considered two approaches to the problem: imposing a universal ranking of the segmental correspondence constraints above the constraints driving partial assimilation, and creating targeted versions of the assimilation constraints, and have argued that only the fixed ranking account seems to be adequate. However, regardless of whether one adopts fixed rankings, targeted constraints, or some other approach to repair typology, total vowel assimilation in Balantak must be formally distinguished from partial assimilation. This was accomplished in the analysis of Balantak by treating it as a means of providing a vocalic melody to an underlyingly unfilled prosodic slot.

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