

## **Austronesian Nasal Substitution Revisited**

Joe Pater  
University of Alberta and  
University of Massachusetts, Amherst

### **Introduction**

In Indonesian,<sup>1</sup> the voicing of the root-initial obstruent determines the outcome of /mən-/ prefixation. When that consonant is voiceless, it coalesces with the prefix-final nasal to produce a nasal with the same place of articulation as the obstruent, in a process referred to as nasal substitution (e.g. /mən+paksa/ → [məmaksə] 'to force'). When the root-initial obstruent is voiced, though, simple place assimilation results (/mən+buat/ → [məmbuat] 'to make/do').

In traditional analyses of nasal substitution, the limitation to voiceless consonants is expressed as a featural restriction on the scope of the relevant rule. No attempt is made to derive this restriction from principles active elsewhere in Indonesian, or in other languages. Pater (1999) points out that Indonesian is far from alone in its avoidance of nasal-voiceless obstruent clusters, and invokes a substantive output constraint against these clusters, \*NC̥, as the formal driving force behind processes like nasal substitution, post-nasal voicing, nasal deletion, and denasalization. The Optimality Theoretic ranking between \*NC̥ and faithfulness constraints determines which of these routes a language chooses to take to eliminate nasal-voiceless obstruent clusters.

Despite the relative success of the \*NC̥ account in formally connecting nasal substitution to a cross-linguistic range of phonological processes, in this paper I will argue for a reanalysis, based on evidence from other Austronesian languages, as well as Indonesian itself. Muna nasal

substitution (van den Berg 1989) parallels Indonesian in targeting only voiceless obstruents, but differs in that it arises not from the avoidance of NC<sub>ɔ</sub> clusters, but from the avoidance of multiple labials in word. To deal with the Muna case, it is necessary to posit a constraint that specifically blocks coalescence between a nasal and a voiced obstruent, which is argued to be one that forces preservation of an obstruent-specific voice feature, Pharyngeal Expansion (IDENTPHAREXP; cf. Trigo 1991, Steriade 1995).

Adoption of this constraint pays off in the context of Indonesian by permitting a more principled account of the restriction of nasal substitution to root-initial position (e.g. [əmpat] 'four', /məŋ+pər+besar/ [məmpərbesar] 'to enlarge'). While this morphological restriction was handled only awkwardly in the \*NC<sub>ɔ</sub> analysis, here the limited scope of nasal substitution is explained by relating it to other phonological processes that treat the left edge of the root as special (Cohn and McCarthy 1994). Along with Cohn and McCarthy's (1994) ALIGN–WD constraint, crucial use is made of Itô and Mester's (1999a) related CRISP–EDGE. Through factorial typology, this reanalysis extends to other cases of Austronesian nasal substitution that are clearly out of the reach of \*NC<sub>ɔ</sub>, in which voiced obstruents are targeted along with voiceless ones.

In the first section of the paper, I review the \*NC<sub>ɔ</sub> analysis of nasal substitution, demonstrating how it succeeds in relating the asymmetric coalescence behavior of voiceless stops to other cross-linguistically common processes. Section 2 introduces the Muna data, showing why they are problematic for that approach to Austronesian nasal substitution. This will then lead to the reanalysis of Indonesian, followed by some discussion of factorial typology. In the concluding section, I will discuss whether this reanalysis of Austronesian nasal substitution, or that of Archangeli, Moll, and Ohno (1998), threatens the existence of \*NC<sub>ɔ</sub> as a constraint.

## 1. Austronesian nasal substitution as a \*N<sub>0</sub>C effect

As mentioned in the introduction, nasal substitution is only one of a number of phonological processes that serve to eliminate nasal/voiceless obstruent sequences. The table in (1) provides schematic descriptions of some others, using T and D to stand for voiceless and voiced obstruents and N for nasals, as well as a few illustrative languages (see Pater 1996, 1999 for references and further language examples).

(1)	Post-nasal voicing	NT	ND	(Japanese, Puyo Pungo Quechua)
	Nasal deletion	NT	T	(Kelanatan Malay, Swahili)
	Denasalization	NT	TT	(Toba Batak, Kaingang)

The goal of the analysis in Pater (1996, 1999) is to provide a unified account for these processes, without generating unattested ones, such as *pre*-nasal voicing. A set of conspiracies (cf. Kisseberth 1970), in which two processes cooperate to rid a language of N<sub>0</sub>C clusters, provides strong support for the need for an analysis that generalizes across these cases:

### (2) N<sub>0</sub>C conspiracies

Modern Greek:	NT	ND	MPS	PS	<i>post-nasal voicing and deletion</i>
Karpathos Greek:	NT	ND	N#T	T#T	<i>post-nasal voicing and denasalization</i>
OshiKwanyama:	NT	ND	N#T	N	<i>post-nasal voicing and nasal substitution</i>
Kihehe:	NT	N	NS	S	<i>nasal substitution and deletion</i>

In Optimality Theory, this goal can be met straightforwardly due to the theory's reliance on substantive output constraints to drive phonological phenomena. In the present instance, an output constraint against nasal/voiceless obstruent clusters (\*N<sub>0</sub>C) can be justified in terms of the articulatory difficulty of the quick velum raising needed to produce a voiceless obstruent

following a nasal (see also Hayes 1999; cf. Hyman 1998 for a skeptical view). If \*NC<sub>◌</sub> outranks a faithfulness constraint against segmental fusion, or coalescence (e.g. UNIFORMITY - McCarthy and Prince 1999), the result is nasal substitution, as shown in the tableaux in (3). Subscripted numbers are used to indicate the correspondence relation between segments (see McCarthy and Prince 1999); fusion is interpreted as a two-to-one mapping between input and output that incurs a UNIFORMITY violation.

(3) Nasal substitution: \*NC<sub>◌</sub> >> UNIFORM(ITY)

Input: məŋ <sub>1</sub> +p <sub>2</sub> aksa	*NC <sub>◌</sub>	UNIFORM
☞ məm <sub>1,2</sub> aksa		*
məm <sub>1</sub> p <sub>2</sub> aksa	* !	

Input: məŋ <sub>1</sub> +b <sub>2</sub> uat	*NC <sub>◌</sub>	UNIFORM
məm <sub>1,2</sub> uat		* !
☞ məm <sub>1</sub> b <sub>2</sub> uat		

To account for the blocking of nasal substitution within roots, Pater (1999) appeals to a root specific instantiation of an anti-fusion constraint that blocks coalescence between pairs of root segments (see also McCarthy and Prince 1994, Urbanczyk 1996, and Beckman 1997 on root specific faithfulness). With this constraint ranked above \*NC<sub>◌</sub>, nasal substitution continues to apply at the prefix-root boundary, but not within roots:

(4) UNIFORM(ITY)<sup>RT</sup> >> \*NC<sub>◌</sub> >> UNIFORM(ITY)

Input: ə <sub>1</sub> m <sub>1</sub> p <sub>2</sub> at	UNI-FORM <sup>RT</sup>	*NC <sub>◌</sub>	UNI-FORM
ə <sub>1</sub> m <sub>12</sub> at	* !		
☞ ə <sub>1</sub> m <sub>1</sub> p <sub>2</sub> at		* !	*

Input: məŋ <sub>1</sub> +p <sub>2</sub> aksa	UNI-FORM <sup>RT</sup>	*NC <sub>◌</sub>	UNI-FORM
☞ məm <sub>1,2</sub> aksa			*
məm <sub>1</sub> p <sub>2</sub> aksa		* !	

Constraint reranking generates the other NC<sub>o</sub> effects. For instance, if a constraint demanding a match between input and output voice specification (IDENT[VOICE]: ‘correspondent segments are identical in voice’)<sup>2</sup> falls beneath \*NC<sub>o</sub>, the result is postnasal voicing:

(5) Postnasal voicing: \*NC<sub>o</sub> >> IDENT[VOICE]

Input: NT	*NC <sub>o</sub>	IDENT [VOICE]
☞ ND		*
NT	* !	

A conspiracy obtains if two of the relevant faithfulness constraints fall beneath \*NC<sub>o</sub>. While the ranking between these two constraints will generally determine the outcome, violation of the higher ranked one can be forced if violation of the lower ranked one is disallowed in a particular morphological or phonological environment. The makings of such a situation are present in (4), where nasal substitution is blocked root internally. If IDENT[VOICE] falls between \*NC<sub>o</sub> and UNIFORMITY, then the OshiKwanyama conspiracy between nasal substitution and postnasal voicing is produced. The following tableau shows the root-medial situation; root-initially, nasal substitution continues to apply as in (4), due to the ranking of IDENT[VOICE] above UNIFORMITY.

(6) UNIFORM(ITY)<sup>RT</sup>, \*NC<sub>o</sub> >> IDENT[VOICE] >> UNIFORM(ITY)

Input: N <sub>1</sub> T <sub>2</sub>	UNIFORM <sup>RT</sup>	*NC <sub>o</sub>	IDENT [VOICE]	UNIFORM
☞ N <sub>1</sub> D <sub>2</sub>			*	
N <sub>1</sub> T <sub>2</sub>		* !		
N <sub>1,2</sub>	* !			*

## 2. Muna morphophonemics

Data from Muna, a Western Austronesian language spoken on an island off the south-east coast of Indonesia (van den Berg 1989), present what seems to be an insurmountable challenge for the \*NC analysis of nasal substitution. Austronesian nasal substitution is most commonly associated with prefixation of an affix similar to Indonesian *məŋ-* (e.g. *man-* both in Chamorro; Topping 1973 and in Malagasy; Dziwirek 1989). In Muna, however, it occurs in the context of *-um-* affixation, which marks the irrealis form of verbs. Before proceeding to nasal substitution, and the challenge it poses, there are a relatively large number of preliminaries to be dealt with. Section 2.1 presents the basic pattern of infixation and prefixation displayed by *-um-*, with section 2.2 focusing on the special behaviour of labials in *-um-* affixation, and related root internal phonotactics. Finally, in 2.3 we return to the main issue at hand: nasal substitution.

### 2.1 ONSET-driven infixation

The data in (7) display two of the realizations of *-um-*:

- |     |               |           |              |
|-----|---------------|-----------|--------------|
| (7) | a. /um+dadi/  | [dumadi]  | 'live'       |
|     | b. /um+gaa/   | [gumaa]   | 'marry'      |
|     | c. /um+rende/ | [rumende] | 'alight'     |
|     | d. /um+solo/  | [sumolo]  | 'flow'       |
|     | e. /um+ala/   | [mala]    | 'take'       |
|     | f. /um+ere/   | [mere]    | 'stand up'   |
|     | g. /um+uta/   | [muta]    | 'pick fruit' |

As illustrated by (7a-d), *-um-* appears as an infix with consonant-initial roots. When the root is vowel-initial, as in (7e-g), the vowel of *-um-* deletes. Both infixation, and vowel deletion, can be understood as ways of satisfying a constraint against onsetless syllables, ONSET. Infixation

occurs at the cost of a violation of ALIGNLEFT, which demands that *-um-* occur at the left edge of the output word (see McCarthy and Prince's 1993 analysis of Tagalog infixation).

(8) ONSET >> ALIGNLEFT

Input: um+dadi	ONSET	ALIGN LEFT
☞ dumadi		*
umdadi	* !	

Deletion violates MAX.<sup>3</sup>

(9) ONSET >> MAX

Input: um+ala	ONSET	MAX
☞ mala		*
umala	* !	

Making the simplifying assumption that MAX applies to both consonants and vowels (cf. McCarthy and Prince 1999: 294), it would need to dominate ALIGNLEFT to block the alternative of deletion of the entire affix (as long as this vacuously satisfies ALIGNLEFT):

(10) ONSET >> MAX >> ALIGNLEFT

Input: um+dadi	ONSET	MAX	ALIGN LEFT
☞ dumadi			*
dadi		**!	
umdadi	* !		

## 2.2 Labial-initial roots

Roots beginning with labials form a set of systematic exceptions to the pattern of infixation with consonant-initial roots<sup>4</sup>. As the following examples show, both the vowel and the nasal are deleted when the root begins with a voiced (11a) or implosive (11b) labial. When the root-initial

labial is voiceless, we find deletion of the vowel, accompanied by nasal substitution (11c,d). Finally, roots beginning with a bilabial approximant can induce either nasal substitution (11e) or deletion (11f), with a majority in the latter category.

- |      |               |         |          |
|------|---------------|---------|----------|
| (11) | a. /um+baru/  | [baru]  | 'happy'  |
|      | b. /um+ɓala/  | [ɓala]  | 'big'    |
|      | c. /um+pili/  | [mili]  | 'choose' |
|      | d. /um+futaa/ | [mutaa] | 'laugh'  |
|      | e. /um+waa/   | [maa]   | 'give'   |
|      | f. /um+wanu/  | [wanu]  | 'get up' |

The question to be addressed in this subsection is what is responsible for the blocking of the infixation pattern with this set of roots. The answer appears to lie in the general phonotactics of the language.

Following Uhlenbeck's (1949) study of root constraints in Javanese, van den Berg (1989) examined the co-occurrence patterns between consonants in the 1,100 CVCV roots in his database. In terms of restrictions between homorganic consonants, van den Berg (1989: 30-31) makes the observations in (12):

- (12) “Obstruents and prenasalized consonants do not co-occur with homorganic nasals“  
 “Initial plosives do not co-occur with contra-voiced homorganic plosives”

One might wonder whether these co-occurrence constraints are symptomatic of a wider ban on homorganic consonants, of the type found in Javanese (Uhlenbeck 1949), or Semitic (Greenberg 1950).

The data in (13) support this conjecture. Root types are organized according to the initial consonant, which is listed in the first row under "C1". The pairs of consonants in the following



columns refer to the initial and medial consonants of the CVCV roots. Whether or not a particular root type occurs is indicated by whether it falls into the "Occurring", "Non-occurring" or "Marginal" column, the categories that van den Berg (1989) uses. Unfortunately van den Berg (1989) does not provide the raw data (i.e. the number of instances of "occurring" root types) that would be required for a proper statistical treatment. However, to give some impression of the relative robustness of the co-occurrence patterns for each initial consonant, the total number of roots starting with that consonant in the database is given in the final row.

(13) Muna homorganic consonant co-occurrence patterns

C1	Occurring (n =2)	Non-occurring (n=0)	Marginal (n=1)	Total <sup>5</sup>
p-	p-p	p-b, p-ḃ, p-f, p-w, p-m		84
b-	b-b	b-p, b-ḃ, b-f, b-w, b-m		50
ḃ-	ḃ-ḃ, <b>ḃ-w</b>	ḃ-p, ḃ-b, ḃ-f, ḃ-m		73
f-	f-f, <b>f-p</b>	f-b, f-ḃ, f-w, f-m		17
w-	w-w	w-p, w-b, w-f, w-m	w-ḃ	59
m-	m-m	m-p, m-b, m-ḃ	m-f, m-w	44
k-		k-k, k-g, k-ɣ, k-ŋ		86
g-	g-g	g-k, g-ɣ, g-ŋ		46
ɣ-	ɣ-ɣ	ɣ-k, ɣ-g, ɣ-ŋ		62
ŋ-		ŋ-ŋ, ŋ-k, ŋ-ɣ, ŋ-g		5
t-	<b>t-t, t-d, t-s, t-l, t-r, t-n</b>			127
d-	<b>d-d, d-t, d-l, d-n</b>		d-s, d-r	50
s-	<b>s-s, s-d, s-l, s-r</b>	s-t, s-n		89
l-	<b>l-l, l-t, l-d, l-s, l-n</b>		l-r	97
r-	<b>r-r, r-t, r-d, r-s, r-n</b>	r-l		72
n-	<b>n-t, n-d, n-l</b>		n-s, n-n, n-r	20

For the labial and dorsal initial roots, we find much the same pattern as in Javanese and Semitic:

non-identical homorganic consonants are not permitted to co-occur. Exceptions to this

generalization are highlighted in bold face in the table, and there are very few of them amongst the labials and dorsals. However, unlike the root constraints first documented in Uhlenbeck (1949) and Greenberg (1950), in Muna we find that coronals co-occur freely (see McCarthy 1988, Frisch, Broe and Pierrhumbert 1997 on the more limited co-occurrence allowed between coronals in Arabic).

It seems likely that the blocking of *-um-* infixation with initial labials is a morphophonemic response to the same phonotactic constraint that bans multiple labials in a root. A number of proposals have surfaced in the recent literature for how to formalize such dissimilatory constraints, which following McCarthy (1986, 1988) are usually assumed to be the result of the OCP (Leben 1973): these include Alderete 1997, Itô and Mester 1996, Frisch, Broe and Pierrehumbert 1997, MacEachern 1997, and Suzuki 1998. Here I will follow Alderete's (1997) suggestion that dissimilation results from local self-conjunction (cf. Smolensky 1995) of markedness constraints (see also Itô and Mester 1996).

Of particular relevance is Alderete's analysis of a morphophonemic pattern in Tashlhiyt Berber, which like the Muna root restriction eliminates multiple labials, but tolerates multiple coronals. To account for this, he suggests that the constraints in Prince and Smolensky's (1993) place markedness hierarchy be self-conjoined, preserving the fixed rankings in the original hierarchy. As illustrated in (14), Prince and Smolensky's hierarchy fixes the rank of constraints against labial and dorsal place of articulation above that against Coronal, yielding the general unmarkedness of coronal place:

(14) \*PL/LAB, \*PL/DORS >> \*PL/COR

Local self-conjunction of a constraint results in a new constraint that penalizes forms that contain two violations of the original constraint, within a particular domain. The self-conjoined place markedness hierarchy appears in (15).

(15) \*PL/LAB<sup>2</sup>, \*PL/DORS<sup>2</sup> >> \*PL/COR<sup>2</sup>

With an appropriate faithfulness constraint intervening between the non-coronal and the coronal markedness constraints, multiple instances of homorganic non-coronals, but not coronals, will be eliminated, just as the Muna root constraints require.

Returning to *-um-* affixation, a ranking of \*PL/LAB<sup>2</sup> above MAX will produce deletion of the affix's nasal when it is added to labial initial roots (recall that ONSET forces deletion of the vowel):<sup>6</sup>

(16) \*PL/LAB<sup>2</sup> >> MAX

Input: um <sub>1</sub> +b <sub>2</sub> aru	*PL/LAB <sup>2</sup>	MAX
a. b <sub>2</sub> um <sub>1</sub> aru	* !	
☞ b <sub>2</sub> aru		**

### 2.3 Nasal substitution

We are now finally in a position to deal with the Muna nasal substitution pattern. Under the assumption that nasal substitution results from fusion of the nasal and the root-initial consonant, it produces no violation of MAX. MAX requires that Input segments have Output correspondents; in fusion, both segments share a single Output correspondent. As fusion does violate UNIFORMITY, MAX must rank above that constraint to produce fusion rather than simple deletion:

(17) \*PL/LAB<sup>2</sup> >> MAX >> UNIFORM(ITY)

Input: um <sub>1</sub> +p <sub>2</sub> ili	*PL/LAB <sup>2</sup>	MAX	UNIFORM
p <sub>2</sub> um <sub>1</sub> ili	* !		
p <sub>2</sub> ili		* !	
☞ m <sub>1,2</sub> ili			*

Here we see a classic case of a conspiracy: \*PL/LAB<sup>2</sup> is satisfied by either deletion or fusion, depending on the voicing of the initial consonant. To complete our account of it, we must explain why fusion is blocked in the case of the voiced consonants, but not voiceless ones. More specifically, there must be some constraint that militates against satisfaction of \*PL/LAB<sup>2</sup> by fusion between a nasal and voiced obstruent, and this constraint must be ranked above MAX, as shown in (18):

(18) \*PL/LAB<sup>2</sup>, CON(X) >> MAX >> UNIFORM(ITY)

Input: um <sub>1</sub> +b <sub>2</sub> aru	*PL/LAB <sup>2</sup>	CON (X)	MAX	UNIFORM
b <sub>2</sub> um <sub>1</sub> aru	* !			
☞ b <sub>2</sub> aru			*	
m <sub>1,2</sub> aru		* !		*

Fusion is often blocked by featural incompatibility between participants. For example, Pater (1999) points out that in the nasal substitution patterns observed in many African languages, fricatives fail to undergo fusion, with the nasal deleting instead. Since incompatibility between nasality and frication is phonetically and phonologically well documented (Cohn 1993a, Padgett 1994) such a pattern is to be expected, assuming an imperative to preserve underlying continuancy. However, expectations in the present case are not so clear. In fact, voicing would seem to make a consonant more amenable to fusion with a nasal, since this results in no perturbation of underlying [voice] specification. Figure (19) schematizes fusional relationships between nasals and obstruents specified underlyingly as voiced and voiceless, showing that only the latter violates IDENT[VOICE]:

(19) a. N <sub>1</sub> D <sub>2</sub> [+nas, +vce][-nas, +vce]	N <sub>1,2</sub> [+nas, +vce]	✓ IDENT[VOICE]
b. N <sub>1</sub> T <sub>2</sub> [+nas, +vce][-nas, -vce]	N <sub>1,2</sub> [+nas, +vce]	* IDENT[VOICE]

For Faithfulness to block fusion between voiced obstruents and nasals, voiced obstruents must bear a feature that is shared by neither nasals nor voiceless obstruents.

Trigo (1991) provides evidence for exactly such a feature. She points out that in Madurese (Stevens 1968), vowel height is conditioned by the preceding consonant. Following



The spreading and blocking pattern in Madurese provides an especially strong argument for adding a feature separating voiced obstruents from nasals and voiceless obstruents to the traditional feature set. Steriade (1995) also points out that the adoption of an obstruent-specific voicing feature allows one to analyze cases of voice assimilation and dissimilation in which only voicing of obstruents assimilates (e.g. Russian) or dissimilates (Japanese), without the need to invoke underspecification. For cases in which sonorants and obstruents do interact, the traditional [voice] feature (relabelled Vibrating Vocal cords by Steriade) is retained.

As (22) demonstrates, preservation of such a Pharyngeal Expansion feature ([PharExp]) can be invoked to account for the blocking of fusion between nasals and voiced obstruents:

(22) a. N <sub>1</sub> T <sub>2</sub>	N <sub>1,2</sub>	✓ IDENT[PHAREXP]
[+nas, -PE][-nas, -PE]	[+nas, -PE]	
b. N <sub>1</sub> D <sub>2</sub>	N <sub>1,2</sub>	* IDENT[PHAREXP]
[+nas, +vce][-nas, +PE]	[+nas, -PE]	

With IDENT[PHAREXP] taking the place of 'CONX', we now have an account of the conspiracy between nasal substitution and deletion in \*PL/LAB<sup>2</sup> satisfaction.

(23) \*PL/LAB<sup>2</sup>, IDENT[PHAREXP] >> MAX >> UNIFORM(ITY)

Input: um <sub>1</sub> +b <sub>2</sub> aru	*PL/LAB <sup>2</sup>	IDENT [PHAREXP]	MAX	UNIFORM
b <sub>2</sub> um <sub>1</sub> aru	* !			
☞ b <sub>2</sub> aru			*	
m <sub>1,2</sub> aru		* !		*

As implosives are also produced with an articulatory gesture of pharyngeal expansion (forceful larynx lowering), they would pattern with the voiced stops in this analysis, as the data do require (e.g. /um+ɓala/ → [ɓala] 'big'). Since neither nasals nor voiceless stops are pharyngeally

expanded, IDENT(PHAREXP) is satisfied when they are coalesced, so that the MAX violation that would be incurred by deletion becomes fatal:

(24) \*PL/LAB<sup>2</sup>, IDENT(PHAREXP) >> MAX >> UNIFORM(ITY)

Input: um <sub>1</sub> +p <sub>2</sub> ili	*PL/LAB <sup>2</sup>	IDENT (PHAREXP)	MAX	UNIFORM
p <sub>2</sub> um <sub>1</sub> ili	* !			
p <sub>2</sub> ili			* !	
m <sub>1,2</sub> ili				*

This account would also predict nasal substitution with /w/, as does in fact occur in some cases (e.g. /um+waa/ [maa] 'give'). For the blocking pattern observed with other roots (e.g. /um+wanu/ [wanu] 'get up'), it would seem to be necessary to invoke a lexically specific faithfulness constraint forcing preservation of approximant features in that subset of the lexicon (cf. Pater 1995, Itô and Mester 1999b).

In Muna, then, we have a case of Austronesian nasal substitution which like Indonesian, targets voiceless, but not voiced obstruents. Unlike Indonesian, however, \*NC̥ cannot be invoked as either the driving constraint behind fusion, or the motivation for the voiced/voiceless asymmetry, since clusters are not produced at all in *-um-* affixation. I have suggested that fusion in Muna *-um-* affixation is a response to a general constraint in the language against multiple labials, and that it is blocked in voiced obstruents by a constraint forcing the preservation of a Pharyngeal Expansion feature. In the following section, I will argue that this account of voiced/voiceless asymmetry can be usefully generalized to the Indonesian case, suggesting that Indonesian nasal substitution is in fact not an effect of \*NC̥ either.



### 3. A reanalysis of Indonesian nasal substitution

In section 1, we noted that NC̥ clusters are permitted root internally, a fact that Pater (1999) attributes to the activity of a root specific faithfulness constraint. However, these clusters are also found between morphemes, even when the same *məŋ-* prefix that triggers nasal substitution at the prefix–root boundary appears before the prefix *pər-* (Lapoliwa 1981: 49, 51, 106):

- (25) /məŋ+pər+besar/                      məmpərbesar                      ‘to enlarge’  
      /məŋ+pər+tun̥d uk+kaŋ/              məmpərtun̥d ukan 'to show'  
      /məŋ+pər+timbaŋ+kan+ŋa/        məmpərtimbaŋkanŋa 'to consider it'

In (25c.), there are in fact three NC̥ clusters: between the prefixes, root-internally, and at the root-suffix boundary. While Pater (1999: fn. 7) suggests that fusion might be blocked between morphemes by DISJOINTNESS constraints (McCarthy and Prince 1995), the need to invoke this device along with root faithfulness just to limit nasal substitution to the prefix-root boundary is surely a deficit of this analysis. Ideally, an account of Indonesian nasal substitution would instead derive the morphological restriction on nasal substitution from constraints observably active elsewhere in the language. It is this goal that the following account aims to meet.

#### 3.1 *Crisp-Edge in Indonesian*

Cohn (1989) and Cohn and McCarthy (1994) discuss a number of phenomena related to stress and syllabification in Indonesian that require reference to the left edge of the root. One of these is the choice between glide formation and glottal stop epenthesis in the resolution of hiatus. Glide formation occurs both root internally and at the root–suffix boundary. A glide agreeing in

backness with the preceding vowel is inserted between a high vowel and a following non-identical vowel. Here we have examples of glide insertion following high front vowels:

- |      |              |           |         |
|------|--------------|-----------|---------|
| (26) | a. /diam/    | [dijam]   | 'quiet' |
|      | b. /siap/    | [sijap]   | 'ready' |
|      | c. /hari+an/ | [harijan] | 'daily' |
|      | d. /ud i+an/ | [ud ijan] | 'exam'  |

Root-initially, however, glide formation is blocked, and instead a glottal stop is inserted, even when the phonological environment is identical (i\_a):

- |      |                |             |          |
|------|----------------|-------------|----------|
| (27) | a. /di+ambil/  | [diʔambil]  | 'taken'  |
|      | b. /di+ad ari/ | [diʔad ari] | 'taught' |

Cohn and McCarthy's (1994) account of this relies on the ALIGNWORD constraint in (28):

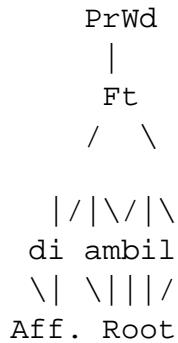
- (28) ALIGN-WD  
 Align(Root, Left; PrWd, Left)  
 'The left edge of each root coincides with the left edge of some PrWd'

Cohn and McCarthy initially invoke this constraint to deal with stress facts: that prefixes lie outside the domain of stress assignment, and that root compounds and reduplicated roots are parsed into two separate prosodic words. They argue, however, that Root-to-Prosodic Word alignment also has consequences further down the prosodic hierarchy. One of these consequences is the blocking of glide formation at the left edge of the root.

Figure (29) (Cohn and McCarthy's fig. (92)) provides an illustration of how glide formation would violate ALIGNWORD. Glide formation is formalized as the spreading of the vowel's features into onset position, thereby creating an approximant (see Rosenthal 1994).

ALIGNWORD is violated because the left edge of the root does not match up with the left edge of the Prosodic Word.

(29) De-alignment by glide formation



In their account, ranking of ALIGN-WD above ONSET renders the above structure ill-formed.

Satisfaction of ONSET yields glide formation in a form like [harijan] (from /hari+an/), but when the higher ranked ALIGN-WD is at stake, ONSET must be violated:

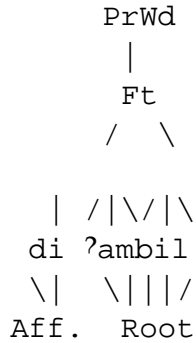
(30) ALIGN-WD >> ONSET

Input: hari+an	ALIGN-WD	ONSET
☞ harijan		
harian		* !

Input: di+ambil	ALIGN-WD	ONSET
dijambil	* !	
☞ diambil		*

A significant complication arises because the optimal candidate [diambil] does not correspond to the actual surface form [diʔambil], which has an intervocalic epenthetic glottal stop. As (31) illustrates, the glottal stop also interferes with alignment:

(31) De-alignment by epenthesis



Cohn and McCarthy's solution to this problem is to place glottal stop insertion into the post-lexical phonology. The output of the lexical phonology permits onsetless syllables initially in the Prosodic Word, which are then repaired post-lexically, where ALIGN-WD is demoted beneath ONSET (and presumably, faithfulness constraints deciding between glide formation and glottal insertion are reranked).

An alternative solution that does not require serialism can be achieved by appealing to what Itô and Mester (1999a) refer to as edge 'crispness'. One difference between the structures created by glottal stop insertion and glide formation is that only the latter has segmental content shared across the left edge of the prosodic word; that is, glottal stop insertion yields a crisp edge. The relevant constraint can be stated as in (32) (see Itô and Mester (1999a: 208) for a more careful formulation).

- (32) CRISP-EDGE[PRWD]  
 No element belonging to a Prosodic Word may be linked to a prosodic category external to that Prosodic Word

Since suffixes, unlike prefixes are incorporated into the Prosodic Word, there is no need to relativize this constraint to a particular edge. For present purposes, I will label the constraint that

leads to a general preference for glide formation over glottal insertion as '\*?'. The tableaux in (33) show how the ranking of CRISP-EDGE[PRWD] above this constraint yields glottal insertion in Prosodic Word-initial position.

(33) CRISP-EDGE[PRWD] >> \*?

Input: hari+an	CRISP-EDGE [PRWD]	*?
☞ harijan		
hariʔan		* !

Input: di+ambil	CRISP-EDGE [PRWD]	*?
dijambil	* !	
☞ diʔambil		*

It should be clear that ALIGN-WD retains a key role in this analysis, as it places the left edge of the Prosodic Word in the correct position for CRISP-EDGE to have the desired effect. To do this, ALIGN-WD must be given a gradient, rather than a categorical interpretation (see McCarthy and Prince 1993: 133), so as to prefer the minimal misalignment caused by epenthesis over the more drastic divergence of category boundaries that would be caused by incorporating the prefix into the Prosodic Word. Assuming that each segment intervening between the root and Prosodic Word edges causes a violation of ALIGN-WD, the tableau in (34) shows that the correct placement of the left edge of the Prosodic Word is achieved ('|' marks root edges, with square brackets showing Prosodic Word edges):<sup>7</sup>

(34) Gradient ALIGN-WD

Input: di+ambil	ALIGN-WD
[dij ambil]	*** !
☞ di[ʔ ambil]	*



(37) NASASSIM >> CRISPEGE[PRWD]

Input: Məŋ+bəli	NAS ASSIM	CRISPEGE [PRWD]
☞ məmbəli		*
məŋbəli	* !	

We now have a motivation for nasal substitution in Prosodic Word initial position: it satisfies both NASASSIM and CRISPEGE[PRWD]. With these constraints dominating UNIFORMITY, nasal substitution emerges as optimal:

(38) NASASSIM >> CRISPEGE[PRWD] >> UNIFORM(ITY)

Input: /məŋ <sub>1</sub> +p <sub>2</sub> ilih/	NAS ASSIM	CRISPEGE [PRWD]	UNIFORM
☞ məm <sub>1,2</sub> ilih			*
məmp <sub>2</sub> ilih		* !	
məŋ <sub>1</sub> p <sub>2</sub> ilih	* !		

As it stands, there is nothing to stop voiced obstruents from undergoing nasal substitution as well. To do so, we can make use of the same constraint that served this purpose in the analysis of Muna: IDENT[PHAREXP]. As the tableaux in (39) show, ranking this constraint above CRISPEGE[PRWD] limits nasal substitution to voiceless obstruents:

(39) IDENT[PHAREXP] >> CRISPEGE[PRWD]

Input: Məŋ <sub>1</sub> +b <sub>2</sub> əli	IDENT [PHAREXP]	CRISPEGE [PRWD]
☞ məm <sub>1</sub> b <sub>2</sub> əli		*
Mə <sub>1,2</sub> əli	* !	

Input: məŋ <sub>1</sub> +p <sub>2</sub> ilih	IDENT [PHAREXP]	CRISPEGE [PRWD]
☞ məm <sub>1,2</sub> ilih		
məmp <sub>2</sub> ilih		* !

One advantage of using IDENT[PHAREXP] rather than \*NÇ to explain the voiced/voiceless asymmetry is that simple reranking of these two constraints produces a pattern of nasal substitution in which both voiced and voiceless obstruents are subject to fusion:

(40) CRISPEDGE[PRWD] >> IDENT[PHAREXP]

Input: N <sub>1</sub> +B <sub>2</sub>	CRISPEDGE [PRWD]	IDENT [PHAREXP]
↗ M <sub>1,2</sub>		*
M <sub>1</sub> B <sub>2</sub>	* !	

Input: N <sub>1</sub> +P <sub>2</sub>	CRISPEDGE [PRWD]	IDENT [PHAREXP]
↗ M <sub>1,2</sub>		
M <sub>1</sub> P <sub>2</sub>	* !	

Newman (1984: fig. 22) provides the following typology of productive nasal substitution in Austronesian:

(41)	Consonants replaced by nasals					
	p	t,s	k	b	d	g
Malay type	+	+	+	-	-	-
Sama Badjao (Sulu Archipelago, northern Borneo) type	+	+	+	+	-	-
Cebuano	+	+	+	+	+	-
Kalinga (northern Luzon)	+	+	+	+	+	+

Languages like Kalinga instantiate the ranking in (40).<sup>9</sup> The intermediate cases, in which replacement of voiced obstruents is limited to labials, or labials and coronals, might also be accounted for in this way, given an appropriate constraint to block velars (and coronals) from undergoing the process (see Zuraw to appear, where a similar place effect is observed in frequency distributions in Tagalog).



Clearly, these instances of nasal substitution are beyond the reach of \*NÇ. The other benefit of this analysis is that the problem of picking out the prefix-root boundary as the locus for this process is resolved by relying on CRISPEGE[PRWD]. Between prefixes (and root-internally) CRISPEGE[PRWD] is vacuously satisfied and NASASSIM is fulfilled by simple assimilation. Since assimilation results in a change of the underlying place specification of the nasal, a faithfulness constraint on place identity is violated, and must be ranked beneath constraints favouring other outcomes:

(42) NASASSIM >> CRISPEGE[PRWD] >> UNIFORM(ITY) >> IDENT[PLACE]

Input: /mən <sub>1</sub> +p <sub>2</sub> ər+besar/	NAS ASSIM	CRISPEGE [PRWD]	UNIFORM (ITY)	IDENT [PLACE]
məm <sub>1,2</sub> ərbesar			* !	
☞ məm <sub>1</sub> p <sub>2</sub> ərbesar				*
mən <sub>1</sub> p <sub>2</sub> ərbesar	* !			

To sum up then, in this analysis nasal substitution is driven by the need to satisfy two constraints, CRISPEGE[PRWD] and NASASSIM, both independently motivated in the phonology of Indonesian, while the limitation to voiceless obstruents is explained by the activity of IDENT[PHAREXP], a constraint postulated for a similar limitation in Muna.

#### 4. Conclusions

The \*NÇ analysis of Indonesian nasal substitution took as its explanatory burden the asymmetry between voiced and voiceless consonants, and attempted to bear this burden by drawing a formal connection between nasal substitution and other processes affecting NÇ clusters. The evidence from Muna *-um-* affixation discussed in section 2, however, shows that \*NÇ fails in this

capacity, since even though nasal obstruent clusters are not at issue, we see the same voicing asymmetry. In section 3 another deficiency of the \*NC̥ approach was highlighted: the difficulty of limiting it to the correct root-initial morphological environment. This led to a reanalysis of the voicing asymmetry in terms of a constraint on faithfulness to obstruent voicing, IDENT(PHAREXP), which in turn opened the door to a reinterpretation of Indonesian nasal substitution as being driven by constraints on morphological and prosodic structure, thus explaining its morphologically restricted nature.

Though it may be obvious, it is worth emphasizing that the analysis of nasal substitution posited here will not contribute further to the recasting of NC̥ effects; it has nothing to say about post-nasal voicing, or nasal deletion or denasalization before voiceless consonants. Archangeli, Moll, and Ohno (1998) provide an analysis of Indonesian nasal substitution that does aim to supplant the \*NC̥ approach to all of these phenomena. It derives fusion of NC sequences from the interaction of a general constraint against clusters (\*CC) with a constraint forcing the preservation of nasality (MAXNASAL). However, as it stands, it does not provide an explanation for the voicing asymmetry that \*NC̥ was designed to cope with. Furthermore, it is far from obvious whether it will be capable of meeting the goals of generality *and* restrictiveness that the NC̥ account sets. Therefore, although the \*NC̥ analysis of Austronesian nasal substitution may be fatally flawed, the use of this constraint to account for the broader range of NC̥ effects in Hayes (1999) and Pater (1996, 1999) seems to remain well-motivated.

## Notes

---

<sup>1</sup> This paper was presented at the Utrecht Workshop on Typology and Acquisition, at the University of Calgary, and at the University of Massachusetts, Amherst. I would like to thank the members of those audiences for discussion, especially John Archibald, Michael Dobrovolsky, Bruce Hayes, René Kager, John Kingston, Lisa Selkirk, and Wim Zonneveld, as well as Donca Steriade and Cheryl Zoll for their comments on a handout, and David Mead for correspondence on the phonology of languages of Sulawesi. This work was supported by SSHRCC research grant 410-98-1595, as well as a grant from the NWO, which supported a stay at Universiteit Utrecht in the fall of 1999 when this paper was written.

<sup>2</sup> More properly, this constraint must be specific to obstruent voicing, so that it does not rule out fusion, in which a voiceless obstruent stands in correspondence with a nasal (see Pater 1999: 324).

<sup>3</sup> To capture the fact that onsetless roots, and other vowel-initial prefixes survive intact, one could either relativize MAX to *-um-*, or adopt an allomorphic approach, in which the choice between underlying /-um-/ and /m-/ is determined by output constraints (see e.g. Kager 1996, Mester 1994).

<sup>4</sup> The other exceptions are roots beginning with nasals and prenasalized stops, which also trigger deletion. I will not deal with those cases here, except to note that while this is also perhaps driven by a dissimilatory constraint, root internally nasals are allowed to co-occur with non-homorganic nasals and prenasalized stops. Therefore, one would have to treat the activity of this constraint as an instance of the emergence of the unmarked.

<sup>5</sup> Van den Berg provides a percentage representing the relative occurrence in initial position of each consonant. The totals were arrived at by multiplying that percentage by 1100 (the corpus includes “just over” 1100 roots).

<sup>6</sup> That \*PL/LAB<sup>2</sup> has effects in affixation requires that its domain be larger than the root itself. Definition of this domain, though, is far from straightforward. Affixes other than *-um-* contain labials, and hence seem immune to the effects of the constraint. Simply placing them outside its domain, however, is rendered problematic by the fact that *-um-* can be affixed to certain prefix-root combinations, with the normal rules of allomorphy applying (e.g. [no-fo-ada-e] 'he borrows it (realis)' [no-mo-ada-e] 'he borrows it (irrealis)').

<sup>7</sup> While adopting a gradient ALIGN-WD constraint does depart from Cohn and McCarthy (1994:48), it should be noted that the empirical evidence supporting the categorical interpretation comes from right edge alignment, and that even there, questions of the robustness of the data remain (Cohn and McCarthy 1994: fn. 31). There remains an interesting question about how the violation of ALIGN-WD in the optimal candidate in (34) is to be compelled. In the dialect that Cohn (1989) and Cohn and McCarthy (1994) discuss (cf. Cohn and McCarthy 1994: fn. 29), glottal stops appear only in hiatus; the onsetless syllables that arise because of a lack of resyllabification across the left edge of the Prosodic word are tolerated. Therefore, it would

---

appear that the ONSET constraint forcing the appearance of glottal stop would have to be specific to the V\_V environment (see Cohn 1989: 192).

<sup>8</sup> At the root-suffix juncture, heterorganic NC clusters do occur, perhaps due to positional faithfulness or paradigm uniformity.

<sup>9</sup> There is some evidence of a similar typological reranking in *-um-* nasal substitution, resulting in both voiced and voiceless obstruents participating in coalescence. David Mead (p.c.) points to the following observation of Wolff (1973: 83-84):

There was a rule in the protolanguage [Proto-Austronesian - JP] that when *\*-um-* was added to a base beginning *\*p* or a *\*b* [sic], the *\*p* or *\*b* was changed to an *m* and no other changes were made. Mongondow, a language of the Celebes, retains this rule intact.

## References

- Alderete, John. 1997. Dissimilation as Local Conjunction. In K. Kusumoto (ed.), *Proceedings of the North East Linguistics Society* 27: 17-32. Amherst, MA, GLSA.
- Archangeli, Diana, Laura Moll, and Kazutoshi Ohno. 1998. Why not *\*NC*. *Proceedings from the Main Session of the Chicago Linguistics Society's Thirty-fourth Meeting*. 1-26.
- Beckman, Jill. 1997. Positional faithfulness, Ph.D. dissertation, University of Massachusetts, Amherst, MA.
- Berg, René van den. 1989. *A grammar of the Muna language*, Dordrecht: Foris.
- Boersma, Paul. 1998. Typology and acquisition in functional and arbitrary phonology. Ms., University of Amsterdam.
- Cohn, Abigail C. 1989. Stress in Indonesian and bracketing paradoxes, *Natural Language and Linguistic Theory* 7: 167-216.
- Cohn, Abigail C. 1993a. The status of nasalized continuants, in M. Huffman and R. Krakow (eds.). *Phonetics and Phonology 5: Nasals, Nasalization, and the Velum*, San Diego, CA: Academic Press.
- Cohn, Abigail C. 1993b. Voicing and vowel height in Madurese: A preliminary report, in J.E. Edmonson and K.J. Gregerson (eds.), *Tonality in Austronesian Languages: Oceanic Linguistics Special Publications* 24.
- Cohn, Abigail C. and John J. McCarthy. 1994. Alignment and parallelism in Indonesian phonology, ms. Cornell University, Ithaca, NY, and University of Massachusetts, Amherst.
- Dziwirek, Katarzyna. 1989. Malagasy phonology and morphology, *Linguistics Notes from La Jolla* 15: 1-30.
- Frisch, Stefan, Michael Broe, and Janet Pierrehumbert. 1997. Similarity and phonotactics in Arabic, ms. Indiana University.
- Greenberg, Joseph. 1950. The Patterning of Root Morphemes in Semitic. *Word* 6: 162-181.

- 
- Hardjadibrata, R. 1978. Consonant Clusters in Indonesian, in S.A. Wurm and L. Carrington (eds.), *Proceedings of the Second International Conference on Austronesian Linguistics*. Canberra, Pacific Linguistics.
- Hayes, Bruce. 1999. Phonetically-Driven Phonology: The Role of Optimality Theory and Inductive Grounding, in M. Darnell, E. Moravcsik, M. Noonan, F. Newmeyer, and K. Wheatly, (eds.), *Functionalism and Formalism in Linguistics, Volume I: General Papers*, Amsterdam: John Benjamins, 243-285.
- Hyman, Larry. 1998. The Limits of Phonetic Determinism in Phonology: \*NC Revisited, ms., University of California, Berkeley.
- Itô, Junko and Armin Mester. 1996. Rendaku I: Constraint Conjunction and the OCP, handout of a lecture delivered at the Kobe Phonology Forum
- 1999a. Realignment, in R. Kager, H. v.d. Hulst and W. Zonneveld (eds.), 188-217.
- 1999b. The Phonological Lexicon, in N. Tsujimura (ed.), *The Handbook of Japanese Linguistics*. Oxford: Basil Blackwell, 62-100.
- Jun, Jongho, 1995. Place assimilation as the result of conflicting perceptual and articulatory constraints, in *Proceeding of the West Coast Conference on Formal Linguistics*. Stanford: Linguistics Department, Stanford University.
- Kager, René. 1996. On affix allomorphy and syllable counting, in U. Kleinhenz (ed.), *Interfaces in Phonology. Studia Grammatica 41*, Berlin: Akademie Verlag, 155-171.
- Kager, René, Harry van der Hulst, and Wim Zonneveld, (eds.). 1999. *The Prosody Morphology Interface*, Cambridge: Cambridge University Press.
- Kisseberth, Charles. 1970. On the functional unity of phonological rules, *Linguistic Inquiry* 1: 291-306.
- Lapoliwa, Hans. 1981. *A generative approach to the phonology of Bahasa Indonesia*. Canberra: Pacific Linguistics D 34.
- Leben, William. 1973. *Suprasegmental phonology*, Ph.D. dissertation, MIT, Cambridge, MA:
- MacEachern, Margaret. 1997. *Laryngeal cooccurrence constraints*. PhD dissertation, University of California, Los Angeles.
- McCarthy, John J. 1986. OCP effects: gemination and antigemination *Linguistic Inquiry* 17, 207-263.
1988. Feature geometry and dependency: a review. *Phonetica* 43, 84-108.
- McCarthy, John J. and Alan S. Prince. 1993. Generalized Alignment, in G.E. Booij and J. van der Marle (eds.), *Yearbook of Morphology 1993*, Dordrecht: Kluwer, 79-153.
1994. Prosodic Morphology: an overview, papers presented at the Workshop on Prosodic Morphology, University of Utrecht, June 1994.
1995. Faithfulness and reduplicative identity, in J. Beckman, L. Walsh Dickey, and S. Urbanczyk (eds.), *University of Massachusetts Occasional Papers 18: Papers in Optimality Theory*. Amherst, MA: Graduate Linguistics Student Association, University of Massachusetts, Amherst, MA. 249-384.
1999. Faithfulness and identity in Prosodic Morphology, in R. Kager, H. v.d. Hulst and W. Zonneveld (eds.), 218-309.
- Mester, Armin. 1994. The quantitative trochee in Latin. *Natural Language and Linguistic Theory* 12, 1-61.
- Newman, John. 1984. Nasal Replacement in Western Austronesian: An Overview. *Philippine Journal of Linguistics* 15, 1-17.

- 
- Padgett, Jaye. 1994. Stricture and Nasal Place Assimilation. *Natural Language and Linguistic Theory* 12, 465-513.
- Padgett, Jaye. 1995. Partial Class Behavior and Nasal Place Assimilation. *Proceedings of the Arizona Phonology Conference: Workshop on Features in Optimality Theory. Coyote Working Papers*. Tuscon: University of Arizona Department of Linguistics.
- Pater, Joe. 1995. On the nonuniformity of weight-to-stress and stress preservation effects in English, ms., McGill University.
1996. \*NC̥, *Proceedings of the North East Linguistics Society* 26. 227-239.
1999. Austronesian nasal substitution and other NC̥ effects, in R. Kager, H. v.d. Hulst and W. Zonneveld (eds.), 310-343.
- Rosenthal, Samuel. 1994. Vowel/glide alternations in a theory of constraint interaction. Ph.D. dissertation, University of Massachusetts, Amherst.
- Smolensky, Paul. 1995. On the internal structure of the constraint component Con of UG. Handout of a talk presented at UCLA.
- Steriade, Donca. 1995. Underspecification and Markedness, in J. Goldsmith (ed.), *A Handbook of Phonological Theory*. Cambridge, MA: Basil Blackwell, 114-74.
- Stevens, Alan M. 1968. Madurese phonology and morphology, American Oriental Series 52, New Haven, CT: American Oriental Series.
- Suzuki, Keichiro. 1998. A Typological Investigation of Dissimilation. Ph.D. dissertation, University of Arizona, Tuscon, AZ.
- Topping, Donald M. 1973. *Chamorro Reference Grammar*, Honolulu, HI: University of Hawaii Press.
- Trigo, Loren. 1991. On pharynx-larynx interactions, *Phonology* 8, 113-136.
- Uhlenbeck, E.M. 1949. *De structuur van het Javaanse morpheem*. Bandung: Nix.
- Urbanczyk, Suzanne. 1996. *Patterns of reduplication in Lushootseed*, Ph.D.dissertation, University of Massachusetts, Amherst.
- Wolff, ohn U. 1973. Verbal inflection in Proto-Austronesian. *Parangal kay Cecilio Lopez: essays in honor of Cecilio Lopez on his seventy-fifth birthday [Philippine Journal of Linguistics special monograph issue 4]*, A. B. Gonzalez (ed.), 71-94.