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Austronesian Nasal Substitution and other NÇ effects*

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Introduction

Nasal substitution occurs in Austronesian languages as far flung as Chamorro (Topping 1969, 1973), and Malagasy (Dziwirek 1989), as well as in several African languages (Rosenthal 1989: 50). However, it is most famous for its appearance in the Indonesian *məN-* prefixation paradigm (see e.g. Halle and Clements 1983: 125).¹ Nasal substitution refers to the replacement of a root-initial voiceless obstruent by a homorganic nasal (1a). If the obstruent is voiced, a homorganic cluster results instead (1b). As illustrated by the data in (1c), NÇ (nasal/voiceless obstruent) clusters are permitted root internally:

(1)	a.	/məN+pilih/ /məN+tulis/ /məN+kasih/	məmilih mənulis məŋasih	'to choose, to vote' 'to write' 'to give'
	b.	/məN+bəli/ /məN+dapat/ /məN+ganti/	məmbəli məndapat məŋganti	'to buy' 'to get, to receive' 'to change'
	c.	əmpat 'four'	untuk 'for'	muŋkin 'possible'

Though familiar to most students of phonology, Austronesian nasal substitution has not engendered much theoretical discussion. The standard analysis invokes two ordered rules to generate the single nasal from the underlying pair of segments: nasal assimilation, followed by a rule of root-initial, post-nasal, voiceless consonant deletion (e.g. Topping 1973: 49; Onn 1980:15; Herbert 1986:252;

¹Though the dialects of Malay spoken in Malaysia and Indonesia are distinct in some ways, unless noted otherwise the phenomena discussed here are common to both Bahasa Indonesia as described in Lapoliwa (1981), and Cohn and McCarthy (1994), amongst others, and the Johore dialect of Malay described in Onn (1980) and Teoh (1988). The Indonesian data cited are all from Lapoliwa (1981). Both Chamorro and Malagasy also display essentially the same pattern as that in (1), as do a number of other languages spoken in the Indonesian archipelago. The unspecified nasal in the underlying form of the /məN-/ prefix is employed only as a matter of convention, and does not imply any particular analysis of the assimilative behaviour of the prefix.

Teoh 1988:156; though cf. Lapoliwa 1981:111, Uhrbach 1987:72).

In this paper, I reanalyze nasal substitution as fusion of the nasal and voiceless obstruent, driven by a phonetically motivated constraint that disallows nasal/voiceless obstruent clusters (*NÇ). This analysis is cast in the framework of Optimality Theory, as developed in Prince and Smolensky (1993), and McCarthy and Prince (1993a,b, 1994a,b, 1995, this volume). In particular, aspects of Correspondence Theory, and the theory of morphology-phonology interaction expounded in McCarthy and Prince (1994b, 1995, this volume), play a central role.

Nasal substitution is just one of a range of processes that languages make use of to rid themselves of NÇ clusters, which also include post-nasal voicing, nasal deletion, and denasalization. Permutation of the constraint rankings posited for nasal substitution is all that is needed to provide a unified account of these NÇ effects. Nasal substitution occurs when the anti-fusion constraint LINEARITY is dominated by *NÇ and the other Faithfulness constraints. Each of the other NÇ effects is similarly generated when the Faithfulness constraint that it violates falls to the bottom of the hierarchy. Especially strong motivation for a unified treatment of the NÇ effects comes from the existence of languages in which two of the processes act in a 'conspiracy' (Kisseberth 1970) to eliminate NÇ clusters. In this paper I introduce conspiracies between nasal substitution and each of nasal deletion and post-nasal voicing (see Pater 1996 for others). Since neither the standard rule-based analyses of nasal substitution or post-nasal voicing, nor Itô, Mester, and Padgett's (1995) recent analysis of post-nasal voicing extend to the full range of these processes, they fail to yield an account of the conspiracies between them.

The analysis of nasal substitution, and the other NÇ effects, appears in §1 through §3. Section 1.1 introduces the *NÇ constraint. In §1.2, I discuss the segmental violations of Input-Output

Faithfulness that satisfy *NÇ (e.g. fusion and deletion), and provide an account of the morphological restrictions on Indonesian nasal substitution. Section 3 is concerned with the Input-Output mismatches in the featural makeup of NÇ sequences (e.g. denasalization and post-nasal voicing), and contains a modification to the formulation of McCarthy and Prince's (1995) Featural Identity, which is necessitated by the Identity violations incurred by fusion. Section 4 focuses on the Oshikwanyama conspiracy between nasal substitution and post-nasal voicing, and on Itô, Mester, and Padgett's (1995) redundant feature licensing approach to post-nasal voicing. The results are summarized in the final section, with directions for further research.

1 *NÇ

In a wide variety of languages, NÇ clusters seem to be disfavoured. That is, Input NÇ (nasal/voiced obstruent) sequences are represented faithfully in the Output, while NÇ's are somehow altered. The usual result is for the obstruent to be voiced, though there are other possibilities, as enumerated in the Introduction, and below.

The fact that these NÇ effects, in particular post-nasal voicing, occur with such frequency has long been assumed to stem from the ease of articulation of NÇ clusters relative to NÇ (see Kenstowicz and Kisseberth 1979: 37, Herbert 1986), but without a specific hypothesis about the articulatory difficulty inherent in NÇ being proposed. However, Huffman's (1993: 310) observation that the raising of the velum occurs very gradually during a voiced stop following a nasal segment, with nasal airflow only returning to a value typical of plain obstruents during the release phase, suggests an articulatory basis for a *NÇ constraint, since an NÇ cluster allows a more leisurely raising of the velum than an NÇ. Put another way, an NÇ cluster requires an unnaturally quick velar closure.

The fact that this constraint is asymmetrical (i.e. *NÇ, and not *ÇN - see the discussion in section 5), can then be understood in light of Zuckerman's (1972) finding that 'the velum can be lowered more quickly and with greater precision than it can be raised' (Herbert 1986: 195).² Ohala and Ohala (1991: 213 - cited in Ohala and Ohala 1993: 239) provide the following complementary perceptually oriented explanation for nasal deletion in the NÇ configuration:

- (2) Among the auditory cues for a voiced stop there must be a spectral and amplitude discontinuity with respect to neighbouring sonorants (if any), low amplitude voicing during its closure, and termination in a burst; these requirements are still met even with velic leakage during the first part of the stop as long as the velic valve is closed just before the release and pressure is allowed to build up behind the closure. However, voiceless stops have less tolerance for such leakage because any nasal sound - voiced or voiceless - would undercut either their stop or their voiceless character.

Additional evidence for the markedness of NÇ clusters comes from Smith's (1973: 53) observation that they emerged considerably later than NÇ's in his son's speech, with the nasal consonant of adult NÇ's being deleted in the child's production. This pattern has also been observed in the speech of learners of Greek (Drachman and Malikouti-Drachman 1973) and Spanish (Vogel 1976). Thus, data from typology, phonetics, and acquisition all converge on the existence of a universal, but violable, *NÇ constraint:

- (3) *NÇ
No nasal/voiceless obstruent sequences

One of the primary strengths of a constraint-based theory like Optimality Theory is that phonetically

² I am grateful to John Kingston and Donca Steriade for very helpful discussion of the phonetic facts, though I hasten to claim sole responsibility for any errors of interpretation. See also Hayes (1995) for a somewhat different hypothesis about the phonetic grounding of *NÇ.

grounded contextual markedness statements like *NÇ can be directly incorporated into the phonology (Mohanan 1993: 98, Prince and Smolensky 1993: §5, Archangeli and Pulleyblank 1995; see Flemming 1995, Hayes 1995, Jun 1995, Kirchner 1995 and Steriade 1995b for extensive development of this sort of approach within Optimality Theory). In what follows, I demonstrate how the interaction between *NÇ and constraints on Input-Output Correspondence creates grammars that generate nasal substitution, as well as the other NÇ effects.³

2 *NÇ and Segmental Correspondence

2.1 Segmental Fusion

Rather than positing discrete steps of nasal assimilation and voiceless consonant deletion, or of complete assimilation of the voiceless consonant to the nasal and degemination (Uhrbach 1987:72; cf. Herbert 1986:252), I assume that the relationship between Input *məN+pilih* and Output *məmilih* is mediated by fusion, or coalescence of segments (Lapoliwa 1981:111). Part of the motivation for this assumption is specific to the model of phonology being assumed here - a fusional analysis allows nasal substitution to be treated as a one step Input-Output mapping, without the intermediate derivational stage that assimilation + deletion requires. There are, however, two relatively theory neutral arguments for fusion: one is from typology, the other is internal to the phonology of Indonesian.

³ The discussion here abstracts from two other NÇ effects: nasal devoicing and obstruent aspiration. These processes cannot be captured by the simple statement of *NÇ in (3). It is conceivable that the articulatory or perceptual difficulties of post-nasal voicelessness could be overcome by enhancement with aspiration and/or extension of the duration of voicelessness. However, a proper treatment of these phenomena would force a long digression from the central concerns of this paper, since at least the following rather complex questions would have to be answered: What is the nature of the interaction between these processes: does devoicing result from aspiration, or vice versa (Herbert 1986, Nurse and Hinnebusch 1993)? Are voiceless nasals [-Voice], or [+Aspirated] (Lombardi 1991, Huffman 1994)? Are the voiceless nasals in fact even entirely voiceless (Maddieson and Ladefoged 1993: 262)? Related to the last question, are these processes categorical or more implementational in nature? Therefore, for present purposes I leave *NÇ in its perhaps overly simple form.

In arguing for fusion-based analyses of other processes, Stahlke (1976) makes the point that an ordered rule account predicts that each of the rules should be independently observed. While place assimilation of nasals is of course extremely common, post-nasal voiceless consonant deletion seems never to apply without the prior assimilation of the nasal. As we will see below, there are examples of other N_C effects applying without place assimilation, such as Zoque post-nasal voicing (Wonderly 1951, Kenstowicz and Kisseberth 1979:36, Padgett 1994), and denasalization in both Toba Batak (Hayes 1986) and Kaingang (Henry 1948, Piggott 1995). By using fusion rather than ordered rules, we avoid the 'false step' of voiceless consonant deletion.

There is also evidence from within the phonology of Indonesian for the fusional analysis. Lapoliwa (1981: 110) notes that reduplication copies a substituted nasal (4a), while prefixal nasals preceding a voiced obstruent (4b), or a vowel (4c), fail to be copied:

(4)	a. /məN+kata+RED+i/	məŋataŋatai	'to speak ill about someone'
	b. /məN+gerak+RED/	məŋgerakgerak	'to move something repeatedly'
	c. /məN+əlu+RED+kan/	məŋəluəlukan	'to praise'

Lapoliwa formulates the rule of nasal substitution as one of phonological and morphological coalescence, so that the substituted nasal in (4a) becomes part of the morphological stem, unlike the unassimilated nasal in (4c). Building on work by Uhrbach (1987), Cohn and McCarthy (1994) propose an entirely prosodic approach to these facts, in which the prefix final nasal in (4a) becomes initial to the prosodic word, while the one in (4c) ends up in coda position outside of the prosodic word. The differing prosodic position of these consonants is due to an ALIGNWORD constraint, which forces coincidence of the edges of the root and prosodic word. If the root-initial consonant simply deleted, this analysis would be difficult, if not impossible to maintain.

To formalize the fusional Input-Output mapping, I draw on McCarthy and Prince's (1994b, 1995, this volume) proposal that the relationship between Input and Output is directly assessed by constraints on Correspondence. This approach contrasts with the indirect method of using purely Output-based constraints, and stipulating that the phonological and morphological properties of the Input must be contained in the Output, by the principles of Containment and Consistency of Exponence (Prince and Smolensky 1993, McCarthy and Prince 1993a&b). In the Containment approach to Input-Output Faithfulness, the constraint PARSE SEGMENT forces the realization of underlying segments (unpronounced Input segments are present in the Output, but unparsed). The equivalent in Correspondence terms is a MAX constraint that demands that every segment in the Input map to a segment in the Output, in other words, that every Input segment have an Output correspondent. The replacement of PARSE SEGMENT with MAX allows an interpretation of fusion as a two-to-one mapping from Input to Output: two Input segments stand in correspondence with a single Output segment (McCarthy and Prince 1995; see also Gnanadesikan 1995 and Lamontagne and Rice 1995). This results in the satisfaction of MAX, though under a strict interpretation of Containment, PARSE SEGMENT would be violated in this situation (McCarthy and Prince 1993a:163, Myers 1994, Russell 1995). I illustrate the difference between Input and Output in (5), where subscripting is used to indicate the crucial correspondence relationship:

(5) mən₁+p₂ilih (Input) məm_{1,2}ilih (Output)

Even though fusion does not involve deletion, and so satisfies MAX, it does incur violations of other constraints. At the featural level, fusion between non-identical segments violates constraints

demanding Identity between Input and Output segments (see section 3 below for elaboration of Identity constraints, and for an example in which NC̣ fusion is overruled by a Featural Identity constraint). Because fusion incurs violations of Featural Identity, it tends to occur between segments that are identical, or nearly so (cf. McCarthy and Prince 1993a:163, where fusion is restricted to identical elements). However, even fusion between identical segments is not automatic or universal, so it must violate at least one constraint other than Featural Identity. One such constraint is LINEARITY, which is independently needed in Correspondence Theory to militate against metathesis.⁴ McCarthy and Prince's (1995) formulation of LINEARITY is as in (6), where S₁ and S₂ refer to Input and Output strings (or any other string of correspondent segments, such as Base and Reduplicant):

- (6) LINEARITY
 S₁ reflects the precedence structure of S₂, and vice versa.

In the fusional I,O relationship depicted in (5), /N/ precedes /p/ in the Input, but not in the Output, so LINEARITY is violated.⁵ To command a violation of LINEARITY, *NC̣ must be ranked above the Faithfulness constraint, as illustrated in the tableau in (7). A check mark indicates a grammatical form, and exclamation marks show where other candidates fail. Solid lines between constraints are used when the constraints are ranked, and dashed lines when there is no evidence for their ranking. Unless noted otherwise, all of the following tableaux apply to Indonesian.

⁴ In using LINEARITY to block fusion, I am adopting a suggestion of John McCarthy's (p.c.). While McCarthy and Prince (1995, this volume) have subsequently proposed a separate UNIFORMITY constraint for such cases (see also Gnanadesikan 1995), I have retained LINEARITY because it is still not entirely clear that a separate constraint is in fact needed, and because LINEARITY has some interesting potential extensions in the featural domain, which are noted below in the text.

⁵ Here I am assuming that the Input is made up of a linearly sequenced set of morphemes. It is not crucial to the analysis that this position be maintained, since it is only LINEARITY within the root that must be obeyed, and there are other ways of ruling out trans-morphemic nasal substitution, such as through the use of DISJOINTNESS constraints (McCarthy and Prince 1995; see the following note).

(7) Nasal substitution: *NC̣>> LIN

Input: m̄N ₁ +p ₂ ilih	NC̣	LIN
a. m̄m _{1,2} ilih ✓		*
b. m̄m ₁ p ₂ ilih	* !	

With the ranking reversed, the candidate without substitution (7b) would be optimal. Such a ranking characterizes languages that tolerate NC̣ clusters.

2.2 Morphological conditions on fusion

The fact that fusion violates LINEARITY leads to a straightforward account of the lack of root-internal nasal substitution in Indonesian. McCarthy and Prince (1994b), and Urbanczyk (1996) show that a large number of disparate phonological phenomena, reduplicative and otherwise, result from stricter Faithfulness requirements within the root than elsewhere in the word, that is, from the relative markedness of roots. The greater markedness of roots is no doubt driven by the need to maintain more contrasts between roots than between affixes. McCarthy and Prince formalize this difference in markedness by proposing a general ranking schema in which root-specific versions of Faithfulness constraints are intrinsically ranked higher than the general, or affix-specific version of the constraints. If nasal substitution were to apply within the root, massive neutralization would result. A root-specific ranking of LINEARITY (ROOTLIN) above *NC̣ stops this from happening. A tableau illustrating the blocking of substitution within the root appears in (8):

(8) **Root-internal NC tolerance: ROOTLIN >> *NC**

Input: əm ₁ p ₂ at	ROOTLIN	*NC	LIN
a. əm _{1,2} at	* !		*
b. əm ₁ p ₂ at ✓		*	

ROOTLIN rules out fusion within the root because fusion destroys the precedence relationship between Input root segments /m/ and /p/ (8a). Since the nasal in /məN+pilih/ is not part of the root, nasal substitution across the morpheme boundary does not disturb the precedence structure of root elements, and ROOTLIN is obeyed.⁶

ROOTLIN is effective in blocking substitution within the root because it is a constraint on the relationship between Input and Output strings, rather than between individual Input and Output segments, or features. If we attempted to rule out root internal fusion with a root-specific constraint on Identity between Input and Output correspondents, substitution in the middle of the root, and at the beginning of it would be assessed equally, since both would turn a voiceless obstruent belonging to the root into an Output nasal. As Donca Steriade (p.c.) has pointed out, it is not at all clear how a theory with Faithfulness constraints demanding only faithful segmental and featural parsing would handle these and other segmental 'derived environment' effects (see Kiparsky 1993 for recent discussion). The main difference between Indonesian nasal substitution, and more commonly discussed cases such as the Sanskrit Ruki rule and Finnish assibilation, is that the latter involve segmental change, rather than segmental fusion. However, if linearity is generalized to sub-segmental

⁶ It should be noted that fusion is not free to occur between any two morphemes. Both the prefix+prefix and root+suffix boundaries are impermeable to nasal substitution (e.g. /məN+pər+besar/ → [məmpərbesar] 'to enlarge' and /məN+yakin+kan/ → [məyakinkan] 'to convince'). To encode this sort of morphological conditioning, constraints are needed to render particular morpheme boundaries opaque to fusion. In particular, McCarthy and Prince's (1995) DISJOINTNESS constraints, which require that the sets of correspondents (or exponents) of morphemes be non-overlapping, could be recruited for this purpose.

elements, such that it forces their underlying precedence relationship to be maintained, and if these cases can all be analyzed as involving partial segmental overlap, then root-specific rankings of sub-segmental linearity would generate non-derived environment blocking effects.⁷ Clearly, a great deal of work needs to be done to determine the empirical coverage of root-specific LINEARITY constraints, but it seems plausible that the ranking of morpheme specific Faithfulness constraints above phonotactic constraints is the source of this sort of phenomenon.

2.3 Segmental Deletion and Insertion

So far we have only considered candidates with and without NC fusion. Deletion, and epenthesis could also satisfy *NC̥, without incurring violations of LINEARITY. This means that in Indonesian, the constraints MAX, and DEP, which are violated by deletion and epenthesis respectively (McCarthy and Prince 1995), must be ranked above LINEARITY. In fact, these constraints must be placed even higher in the hierarchy, above *NC̥, since neither deletion nor epenthesis is used to resolve *NC̥ violations root-internally, where fusion is ruled out by ROOTLIN:

(9) Deletion and epenthesis blocked by MAX, DEP >> *NC̥

Input:əmpat	MAX	DEP	*NC̥
a. əmpat ✓			*
b. əpat	* !		
c. əməpat		* !	

⁷ See Itô and Mester's (1996) extension of this approach to Japanese Rendaku, in which a similar 'Neighborhood' constraint is proposed which does not require featural overlap.

If MAX, or DEP were ranked beneath *NC̥, deletion (9b), or epenthesis (9c) would be wrongly preferred over the optimal candidate (9a).

Though neither deletion nor epenthesis is resorted to in Indonesian to avoid *NC̥ violations, permutation of the rankings of these constraints (Prince and Smolensky 1993: §6) predicts the existence of other languages in which MAX and DEP are dominated by *NC̥ and the other Faithfulness constraints, producing NC̥ deletion and NC̥ epenthesis.

Examples of segmental deletion in the NC̥ configuration include the aforementioned cases of child English (Smith 1973: 53), child Greek (Drachman and Malikouti-Drachman 1973), and child Spanish (Vogel 1976). Amongst the adult languages with NC̥ deletion is the Kelantan dialect of Malay, which differs from standard Johore Malay in that it lacks nasals before voiceless obstruents, though it permits homorganic NC̥ clusters (Teoh 1988). This pattern is replicated in African languages such as Venda (Ziervogel, Wetzel, and Makuya 1972: cited in Rosenthal 1989: 47), Swahili⁸ and Maore (Nurse and Hinnebusch 1993: 168), as well as several others cited by Ohala and Ohala (1993: 239).⁹

What unites all of these examples is that the nasal, rather than the obstruent is deleted. This parallels the nasal/fricative cluster effects detailed in Padgett (1994), which sometimes involve nasal, but never fricative, deletion. The constraints posited thus far assess obstruent and nasal deletion equally, as violations of MAX. How to formalize nasal-obstruent asymmetries in deletion, as well as

⁸ Swahili nasal deletion is historically preceded by aspiration of the following voiceless consonant, which spread to the nasal, but there is no evidence for this intermediate stage in the other languages cited here (see Herbert 1986: 252, Nurse and Hinnebusch 1993: 168).

⁹ In discussing these African languages I follow, for ease of exposition, Herbert (1986) and Padgett (1994) in treating derived prenasalized stops as segmental sequences (cf. Piggott 1992, and Steriade 1993 for other views on prenasalization). It should be emphasized, though, that 'segment' in Correspondence theory might well be understood as the equivalent to what in feature geometric terms is the root node and everything it dominates (i.e. a melodic element). Two root node theories of prenasalized stops have been proposed by Piggott (1988), Rosenthal (1989), Trigo (1993), and to some extent, Steriade (1993), and Piggott (1995).

in assimilation, remains unaddressed in Optimality Theory (and more generally, in phonology: see Mohanan 1993). One possibility is to introduce intrinsic rankings of the Faithfulness constraints. For example, the fact that nasals tend to assimilate in place to obstruents, rather than the other way around, could be captured by a fixed ranking of OBSPLACEIDENT >> NASPLACEIDENT (i.e. the identity requirement between an obstruent and its underlying correspondent is intrinsically higher ranked than that between a nasal and its correspondent; see Jun 1995 for development of this type of approach). For deletion, a ranking of an obstruent specific MAX constraint (OBSMAX) above the nasal specific NASMAX achieves the desired result. Establishing the phonetic basis, and typological correctness of this presumed fixed ranking is beyond the purview of this study, but it can be noted that its universionality is supported by the observation that a few languages lack nasals, but none are without oral segments (Maddieson 1984, cited in McCarthy and Prince 1994a, who provide a different explanation for this generalization).

The tableau in (10) demonstrates how an /NT/ cluster would be treated in a language such as Kelantan Malay, in which *NC̥ dominates MAX (note that all other Faithfulness constraints, including LINEARITY, are also ranked above MAX):

(10) **Tableau for Kelantan-like languages**

Input: N_1T_2	*NC̣	OBSMAX	NASMAX
N_1T_2	* !		
N_1		* !	
T_2 ✓			*

In future tableaux, I will merge the two MAX constraints, and show only the candidate with the deleted nasal.

For some reason, languages seem not to make use of epenthesis to resolve *NC̣ violations. One might stipulate that DEP universally dominates *NC̣, but without any independent motivation for this fixed ranking, such a formalization would remain in the realm of description, rather than explanation.¹⁰ With this potential gap in the typology of NC̣ effects duly noted, I will now turn to the featural changes that can be used to satisfy *NC̣, and propose constraints to rule them out in Indonesian. In these instances, we will see the predicted factorial typology is indeed fulfilled.

3 *NC̣ and Featural Faithfulness

3.1 Denasalization

Instead of completely deleting the nasal, another way to meet the *NC̣ requirement is to change the underlying nasal into an obstruent. There are at least three languages that take this route: Toba

¹⁰ One path to explanation may lie in the fact that NC̣ sequences tend to be place assimilated, and thus resist epenthesis due to some version of geminate integrity. However, this explanation is difficult, if not impossible to formalize in Optimality Theory (why should place assimilation have precedence over *NC̣?), and faces the empirical challenge that NC̣ effects do occur in the absence of place assimilation in several languages.

Batak¹¹ (Hayes 1986), Kaingang (Henry 1948; cf. Piggott 1995), and Mandar (Mills 1975). Mandar, a language spoken in South Sulawesi, is particularly interesting because it has a prefixation paradigm that differs minimally from that of Indonesian. A homorganic nasal appears before voiced obstruents (11a), but instead of nasal substitution with the voiceless ones, there is gemination (11b) (in Toba Batak and Kaingang, the resulting obstruent retains its place specification, and can be heterorganic with the following consonant).

(11) **Mandar maN- prefixation**

- | | | | |
|----|-------------|----------|------------|
| a. | /maN+dundu/ | mandundu | 'to drink' |
| b. | /maN+tunu/ | mattunu | 'to burn' |

In Mandar, unlike Indonesian, the prohibition against NC̥ extends throughout the language:

- (12) Nowhere in my material nor in Pelenkahu's extensive lists of minimal pairs is there a single instance of nasal plus voiceless stop.¹² Where such a cluster would be expected, because of cognate items or at certain morpheme boundaries, there is invariably a geminate voiceless stop. In this respect, [Mandar] is far more consistent than [Buginese]; perhaps it reflects greater freedom from outside influence (Mills 1975: 82).

There are number of potential constraints, or sets of constraints that could rule out denasalization in Indonesian, as well as in languages like Kelantan Malay that have nasal deletion. Before turning to them, a short discussion of featural Faithfulness within Correspondence theory is in order.

¹¹ In Toba Batak, the obstruents produced by denasalization fail to undergo the debuccalization that affects other obstruents in the same position. Hayes (1986) attributes this to a type of geminate inalterability, with the double linking of a [-Voice] feature spread from the following voiceless consonant inhibiting debuccalization. More plausibly, this a case of avoidance of neutralization. That is, underlying nasals fail to go all the way to glottals so as to avoid neutralizing the distinction between them and underlying obstruents. See Flemming (1995) for discussion of the formal issues involved in setting up contrast-maintaining constraints; see also McCarthy (1993) and Kirchner (1995) for other approaches to chain shifts in Optimality Theory.

¹² Mills does not comment on nasal-/s/ clusters, but as far as I can tell from Pelenkahu et al. (1983), the same restriction holds as for the stops, since there are many examples of /-ss-/, but none of /-ns-/.

To replace the containment-based PARSE FEATURE (see e.g. Itô, Mester, and Padgett 1995) in Correspondence Theory, McCarthy and Prince (1994a, 1995) outline two approaches. One is to extend Correspondence into the featural domain, and require mappings between instances of features such as [voice] in the Input and Output. A less elaborate theory, and the one that McCarthy and Prince adopt, invokes a set of identity requirements between segmental correspondents. A general formulation for such constraints is given in (13):

- (13) Featural Identity - IDENT-(F)
Correspondents are identical in their specification for F

Formulated in this way, featural Faithfulness is not violated if a segment is deleted, since if an Input segment has no Output correspondent, Identity constraints do not come into force. On the other hand, if there were a whole set of Correspondence constraints that examined features, then every time an underlying segment failed to be realized in the Output, all of the applicable Featural Correspondence constraints would be violated. This would force all of the Featural Correspondence constraints to be dominated by whatever constraint favoured deletion. Whether this is a fatal flaw, or a happy result,¹³ can only be assessed through careful study of the relationship between segmental deletion and feature changing processes, but it is evident that Featural Identity has the advantage of analytic convenience, especially when considering reduplication, which often involves long strings of Correspondence violations.¹⁴

¹³ Since this was first written, Lombardi (1995) has found a 'happy result' in one domain, while Alderete et al.(1996) find a 'fatal flaw' in another. Needless to say, the issue is far from settled.

¹⁴ One could even imagine a hybrid theory. Features that display clear independence from segments, most prominently tones, might be subject to Correspondence requirements, while those that do not would be targeted by Identity.

In cases of fusion, however, the simple statement of Featural Identity given in (13) does lead to some complications. Consider the Input-Output mappings in (14):¹⁵

(14)	Input	a. n t	b. n t
		\ /	
	Output	n	t t

Nasal substitution is represented in (14a), and denasalization in (14b). One consequence of the symmetrical nature of Identity is that IDENT[NAS] is violated to the same degree in (14a) and (14b), since in both instances a nasal and a voiceless obstruent stand in correspondence with one another. Nasal substitution also violates LINEARITY, so in terms of the constraints considered thus far, it is impossible for a language to prefer (14a) over (14b), since the Faithfulness violations incurred by (14b) are a subset of those for (14a).

One might consider ruling out (14b) with constraints against coda obstruents, and/or gemination. By using a syllable structure constraint to rule out denasalization, however, the resulting prediction should be that languages that display nasal substitution have tight restrictions on possible codas. To some extent, this is borne out. However, Chamorro, which has nasal substitution in *man-* and *fan-* prefixation, also has geminates and coda obstruents (Topping 1973: 36-49), even in prefixes, such as *hat-*, *chat-*, and *tak-* (Topping 1973: 66). Thus, nasal substitution does not appear to be driven by a desire to avoid coda obstruents, or gemination.

¹⁵ There is no theoretical stance implicit in the representation of the geminated /t/ as a pair of segments. This representation is used because denasalization sometimes produces a non-assimilated segment (Kaingang and Toba Batak), and because the results in terms of Correspondence and Identity are the same if a single /t/ is used for a geminate. Different results in terms of LINEARITY might obtain depending on whether geminates were considered a single segment with a mora, or two segments with linked features. It should also be noted that these diagrams do not represent autosegmental mappings; rather, they illustrate the set-theoretic relationship between the Input and Output sets of segments.

Another response to this problem is to elaborate Identity somewhat, so that we have a way of stating that in nasal substitution an Input nasal maps to an Output one, while in denasalization an Input nasal maps to an obstruent. With this shift away from symmetry the theory of featural Faithfulness begins to look more like segmental Correspondence, which has separate MAX and DEP constraints. However, I will preserve the analytic advantage of Identity noted above by stating the constraint in such a way that featural Faithfulness is not violated in cases of deletion:

- (15) IDENTI→O[F]
 Any correspondent of an Input segment specified as F must be F

Nasal substitution does not violate IDENTI→O[NAS], while denasalization does. [NAS] here would refer to the feature [Nasal] in monovalent feature theory, or [+Nasal] if bivalent features were assumed. The choice is not crucial, but since the feature [-Nasal] seems not to be active in any phonological process, I will assume there is but a single monovalent feature [Nasal] (Piggott 1993, Rice 1993, Steriade 1993, Trigo 1993, cf. Cohn 1993). Note that if bivalent features were used, and Featural Identity were stated without any reference to the value of the feature (i.e. 'any correspondent of Input segment X must be identical to X in its specification for F'), then the effects of this constraint would remain symmetrical, and the problem of differentiating I→O and O→I Identity would remain.

For a language like Mandar, IDENTI→O[NAS] is ranked beneath *NÇ and the rest of the Faithfulness constraints. In Indonesian, IDENTI→O[NAS] is ranked above LINEARITY, so that fusion is preferred over denasalization. A tableau for Mandar is given in (16):

(16) **Mandar denasalization: *NC̥ >> IDENTI→O[NAS]**

Input: maN ₁ +t ₂ unu	DEP	MAX	LINEARITY	*NC̥	IDENTI→O [NAS]
a. man _{1,2} unu			* !		
b. man ₁ t ₂ unu				* !	
c. mat ₁ t ₂ unu✓					*
d. mat ₂ unu		* !			
e. maŋ ₁ at ₂ unu	* !				

Some further motivation for the recognition of separate IDENTI→O[NAS] and IDENTO→I[NAS] constraints comes from the fact that there is at least one language in which a geminate nasal is created to avoid a *NC̥ violation (the South Sulawesi language Konjo - Friberg and Friberg 1991: 88). To distinguish Konjo from its near neighbour Mandarin, IDENTO→I[NAS] can be ranked beneath IDENTI→O[NAS], so that having an Output nasal in correspondence with an Input obstruent (i.e. NT → NN) is a better resolution of *NC̥ than having an Input nasal in correspondence with an Output obstruent (i.e. NT → TT). In Mandarin, of course, the ranking between these constraints would be reversed.¹⁶

3.2 Post-nasal voicing

The most common, and most widely discussed NC̥ effect is post-nasal voicing. A particularly relevant, and perhaps less familiar example is that of the Puyo Pungo dialect of Quechua (Orr 1962,

¹⁶This leaves a not insignificant problem unresolved. How do we distinguish between nasalization of the voiceless stop, and nasal substitution? In terms of the constraints considered thus far, nasal substitution incurs all the violations that nasalization does, plus a LINEARITY violation that is avoided by nasalization. One possibly key difference is that in fusion, one of the underlying correspondents of the Output nasal is a nasal, while in nasalization the second member of the cluster has as its sole correspondent a voiceless obstruent. I should also note here that Konjo nasalization is subject to considerable morphological conditioning. In fact, the prefix that causes nasalization has a homophonous counterpart that differs only in that it fails to nasalize the following voiceless obstruent.

Rice 1993). As shown in (17), post-nasal voicing only affects affixal consonants. Root-internally, post-nasal consonants can remain voiceless.

(17) **Puyo Pungo Quechua**

a. **Root-internal NC̣:**

šɪŋki 'soot' čuntina 'to stir the fire' pampal'ina 'skirt'

b. **Suffixal alternations:**

sinik-pa	'porcupine's'	kam-ba	'yours'
sača-pi	'in the jungle'	hatum-bi	'the big one'
wasi-ta	'the house'	wakin-da	'the others'

Obviously, post-nasal voicing satisfies *NC̣. Again, the question of what it violates is not as straightforward as it might at first seem. Compare the I,O correspondences for nasal substitution and post-nasal voicing:

(18)	Input	a.	n	t	b.	n	t
			∖	/			
	Output		n		n	ɖ	

If we assume full specification of the traditional set of features (i.e. those of Chomsky and Halle 1968), IDENT[VOICE] is the only constraint violated in (18b), yet it is also violated in (18a) since Input /t/ corresponds to Output /n/. Nasal substitution violates LINEARITY, while post-nasal voicing does not, so again, there is some difficulty in establishing how Indonesian could prefer (18a) over (18b).

In this case, it is pointless to consider constraints that would rule out the NC̣ configuration itself, since this does occur in Indonesian as the Output of an underlying NC̣ sequence. Nor does the problem lie in the symmetry of Identity, since in both cases a voiceless Input segment stands in

correspondence with a voiced Output segment. Rather, it is due to the mistaken assumption that [voice] on a sonorant, and on an obstruent, are equivalent (see Chomsky and Halle 1968: 300, Lombardi 1991, Rice and Avery 1989, Piggott 1992, Rice 1993, and Steriade 1995a for discussion from a variety of perspectives). Because the exact method adopted for capturing the non-equivalency of sonorant and obstruent [voice] is of no particular consequence in the present context, I will simply invoke an Identity constraint that specifically targets obstruent [voice]. There is no need to specify the constraint as applying from I-to-O or O-to-I:

(19) Obstruent Voice Identity - IDENT[OBSVCE]

Correspondent obstruents are identical in their specification for [voice]

As it applies only to obstruents in correspondence, this constraint is not violated by nasal substitution, in which an obstruent is in correspondence with a nasal. For Indonesian, we can thus block post-nasal voicing by ranking IDENT[OBSVCE] above *NC̥. In Puyo Pungo Quechua, a root specific version of IDENT[OBSVCE] ranks above *NC̥, and the general IDENT[OBSVCE] ranks below it, thus producing affixal post-nasal voicing only.

As this completes the analysis of nasal substitution, it is appropriate to provide an illustrative tableau:

(20) Final tableau for nasal substitution

Input: /məN ₁ +p ₂ ilih/	DEP	IDENT I→O [NAS]	MAX	ROOT LIN	IDENT [OBSVCE]	*NÇ	LIN
a. məm _{1,2} ilih ✓							*
b. məm ₁ p ₂ ilih						* !	
c. məp ₁ p ₂ ilih		* !					
d. məm ₁ b ₂ ilih					* !		
e. məp ₂ ilih			* !				
f. məŋ ₁ əp ₂ ilih	* !						

Noteworthy in this tableau is the fact that all of the non-optimal candidates, with the exception of the epenthetic (20f), do turn up as optimal in other languages, and that each of these cases can be generated simply by having one of the constraints fall beneath all the others. Candidate (20b) is generated if *NÇ ranks beneath the Faithfulness constraints, as in languages that permit NÇ clusters. With IDENTI→O[NAS] at the bottom of this hierarchy, candidate (20c) is made optimal, as in we have seen in Mandarin. Candidate (20d) is preferred when IDENT[OBSVCE] is lowest ranked, as in Puyo Pungo Quechua. Finally, candidate (20e) wins with MAX dominated by the others, as in Kelantan Malay.

With the introduction of constraints such as ROOTLIN that disallow one of the NÇ effects in a particular environment, we would also expect to see cases where an alternate process takes place in the environment in which the usual one is ruled out. Such conspiracies between NÇ effects can be modeled simply by having both of the relevant Faithfulness constraints ranked beneath *NÇ. It

is a powerful argument for this approach that this expectation is indeed fulfilled.

3.3 *NÇ fusion overruled by Featural Identity*

In this section, I show how a high ranking Featural Identity constraint can disallow fusion between particular segments. This discussion also serves to introduce evidence of a conspiracy between nasal substitution and nasal deletion. The data to be accounted for involve a parametric difference between Austronesian and African nasal substitution. In all the Austronesian examples of which I am aware, the fricative /s/ undergoes substitution:¹⁷

- (21) /mən+sapu/ [mɛŋapu] 'to sweep' (Indonesian)
/man+saga/ [maŋaga] 'stay' (Chamorro: Topping 1973: 50)
/N+sambuŋ/ [ŋambuŋ] 'to connect' (Javanese: Poedjosoedarmo 1982:51)

African languages with nasal substitution demonstrate a split in behaviour between stops and fricatives, as in the following examples cited by Rosenthal (1989: 49) (see also Odden and Odden 1985 on Kíhehe):

- (22) a. /N+tuma/ [numa] 'I send'
/N+seva/ [seva] 'I cook' (Umbundu: Schadeberg 1982)
- b. /N+tabi/ [nabi] 'prince'
/N+supa/ [supa] 'soup' (Si-Luyana: Givón 1970)

To stem any suspicion that deletion before the fricatives is motivated solely by the markedness of

¹⁷ These examples also demonstrate the well-known complication that /s/ becomes a palatal nasal under substitution. The apparent oddness of this alternation is somewhat tempered by the independent evidence from a Javanese morpheme structure constraint that Austronesian /s/ is in fact itself phonologically palatal (Mester 1986). A related complication is that nasal substitution often fails to occur with a /c/ initial root (/c/ is variously described as a palatal stop or an alveo-palatal affricate); see Onn (1980: 62) for discussion.

nasal/fricative clusters (see Padgett 1994), note that voiced fricatives undergo post-nasal hardening in Kíhehe (Odden and Odden 1985: 598). This shows that *NÇ is needed for deletion in a nasal/voiceless fricative sequence, since one would otherwise predict that /ns/ should surface as [nt].

As in Indonesian, fusion with the voiceless stops can be attributed to the ranking of LINEARITY beneath *NÇ and the rest of the Faithfulness constraints, including MAX. However, unlike Indonesian, deletion occurs with root-initial voiceless fricatives instead of fusion. This indicates that preservation of Input continuancy is more highly valued than preservation of the Input nasal segment in these languages, in other words, that IDENTI-O[CONT] dominates MAX. The fact that deletion does occur rather than a *NÇ violation places *NÇ above MAX. Combining these rankings, we get *NÇ, IDENTI-O[CONT] >> MAX >> LINEARITY. The following tableaux show how this hierarchy generates the different responses to *NÇ violations in fricative-initial and stop-initial roots:

(23) **Fusion with stops**

Input: N ₁ +t ₂ abi	*NÇ	IDENTI-O [CONT]	MAX	LIN
a. n ₁ t ₂ abi	* !			
b. n _{1,2} abi ✓				*
c. t ₂ abi			* !	

With a stop-initial root, IDENT[CONT] is satisfied in fusion, so MAX is free to choose fusion (23b) over deletion (23c) as the best alternative to a *NÇ violation (23a).

When the root begins with fricative, as in (24), fusion creates a violation of IDENTI-O[CONT],

since an Input fricative has a stop as an Output correspondent (assuming an undominated constraint against nasal fricatives in all these languages - see Cohn 1993, Padgett 1994). With IDENTI→O[CONT] >> MAX, the candidate with deletion (24c) becomes optimal in this instance:

(24) Deletion with fricatives

Input: N ₁ +s ₂ upa	*NÇ	IDENTI→O [CONT]	MAX	LIN
a. n ₁ s ₂ upa	* !			
b. n _{1,2} upa		* !		*
c. s ₂ upa ✓			*	

Austronesian nasal substitution evinces the opposite ranking MAX >> IDENT[CONT], since loss of Input continuancy, as in (24b), is preferred to deletion.

As Kisseberth (1970) originally pointed out, cases like this in which two processes conspire to avoid a single configuration provide strong motivation for the formal recognition of output constraints. Under a purely rule-based analysis of nasal substitution, such as the standard one of nasal assimilation followed by voiceless consonant deletion, the functional connection between nasal substitution and nasal deletion would have to be stated independently of the rules themselves; their shared property of eliminating NÇ clusters is only obliquely retrievable from the rule formulation. This contrasts with the present Optimality Theoretic analysis of African nasal substitution and nasal deletion, in which the functional motivation for these processes is directly incorporated into the formal explanation, thus allowing for a perspicuous account of the conspiracy between them.

4 *NÇ vs. redundant feature licensing

It is of course not the case that simply being framed within Optimality Theory automatically endows an analysis of one of the NÇ effects with the power to extend to the whole set. A case in point is Itô, Mester, and Padgett's (1995) account of post-nasal voicing, which ingeniously reduces the phenomenon to what appear to be more basic and general constraints, but fails to cope with nasal substitution, and also straightforwardly generates an unattested pattern of nasal-obstruent voicing. The existence of a conspiracy between post-nasal voicing and nasal substitution in the Bantu language Oshikwanyama, as well as the non-existence of pre-nasal voicing, argue for the use of a relatively parochial, locally motivated constraint like *NÇ, which by hugging the phonetic ground, stays closer to the attested facts.

4.1 Post-nasal voicing

The basic premise of Itô, Mester, and Padgett's analysis is that because [voice] is redundant in sonorants, it cannot be licensed by sonorants. With this restriction, a nasal specified for [voice] violates the constraint LICENSE[VOICE], as in the first candidate in the tableau in (25):

(25) Post-nasal voicing as redundant feature licensing

Input: NT	LICENSE[VOICE]	SONVOI	FAITH
a. NT [VOICE]	* !		
b. NT		* !	
c. ND / [VOICE] ✓			*

As can be seen in (25b), the alternative of leaving the nasal unspecified for [voice] runs afoul of the implicational constraint SONVOI, which demands that sonorants must be specified for [voice]. The final candidate manages to satisfy both LICENSE[VOICE] and SONVOI by having a single [voice] feature linked to both the nasal and the obstruent, the latter of which is able to license it. This candidate is optimal when the Faithfulness constraint that is violated by non-identity between the voicing specification on Input and Output obstruents is ranked beneath LICENSE[VOICE] and SONVOI. I have labelled this Faithfulness constraint 'FAITH' so as to abstract from irrelevant differences in formulation between Itô, Mester, and Padgett (1995) and the present analysis.

4.2 Nasal substitution?

To understand why redundant feature licensing cannot deal with nasal substitution, consider the table in (26):

(26) Nasal substitution and redundant feature licensing

Input: NT	LICENSE [VOICE]	SONVOI	LINEARITY
a. N [VOICE]	*		*
b. N		*	*
c. NT [VOICE]	*		
d. NT		*	

In a language with nasal substitution, either (26a) or (26b) must be optimal. However, the violations incurred by each of those candidates are a superset of those of one of the faithful ones, (26c) and (26d) respectively. Therefore, fusion could not be the result of any ranking of this set of constraints.

Intuitively, one might think that nasal substitution and post-nasal voicing are in some way related, since both act to get rid of NC sequences. This intuition is borne out by the facts of OshiKwanyama, a western Bantu language discussed by Steinbergs (1985), which demonstrates a conspiracy between nasal substitution and post-nasal voicing. While there are no alternations, root-internal postnasal voicing is evidenced by the complementary distribution of [k] and [g] - [k] appears word-initially and intervocalically, while [g] occurs after nasals. Furthermore, loanwords are modified by voicing the postnasal obstruent. The following are borrowings from English:

(27) Postnasal voicing in OshiKwanyama loanwords

[sitamba]	‘stamp’
[pelenda]	‘print’
[oinga]	‘ink’

Root-initially, nasal substitution, rather than postnasal voicing, occurs to resolve underlying NC sequences (nasal/voiced obstruent clusters remain intact, though Steinbergs provides no examples):

(28) Root-initial nasal substitution in OshiKwanyama

/e:N+pati/	[e:mati]	‘ribs’
/oN+pote/	[omote]	‘good-for-nothing’
/oN+tana/	[onana]	‘calf’

A straightforward analysis of OshiKwanyama is obtained under the assumptions of the present study. As in Indonesian, root-internal nasal substitution can be ruled out by a Root-specific ranking of LINEARITY above *NC̣, while root-initial substitution is permitted because the general LINEARITY constraint is dominated by *NC̣. However, unlike Indonesian, IDENT[OBSVCE] is also ranked beneath *NC̣, so that post-nasal voicing occurs root-internally. Also crucial here is the ranking of IDENT[OBSVCE] >> LIN, since the reverse ranking would result in post-nasal voicing everywhere, as can be verified in the following tableau by comparing the violations incurred by candidates (29b) and (29c):

(29) Root-initial nasal substitution

Input:N ₁ #T ₂	ROOT-LIN	*NC̣	IDENT [OBSVCE]	LIN
a. N ₁ #T ₂		* !		
b. N ₁ #D ₂			* !	
c. #N _{1,2} ✓				*

(30) **Root-internal post-nasal voicing**

Input: N ₁ T ₂	ROOT-LIN	*NC̣	IDENT [OBSVCE]	LIN
a. N ₁ T ₂		* !		
b. N ₁ D ₂ ✓			*	
c. N _{1,2}	* !			*

Since redundant feature licensing cannot generate nasal substitution, it cannot express the OshiKwanyama conspiracy. This must be counted as serious inadequacy, especially within Optimality Theory, in which output constraints play such a central role. For further evidence of conspiracies between NC̣ effects, drawn from Newton's (1972) study of Greek dialects, which pose similar problems for redundant feature licensing, see Pater (1996).

4.3 Pre-nasal voicing

At least as problematic as the inability of redundant feature licensing to generate nasal substitution is its ability to generate pre-nasal voicing. The result of supplying an Input /TN/ cluster to exactly the same hierarchy that produces post-nasal voicing is illustrated in (31):

(31) **Pre-nasal voicing as redundant feature licensing**

Input: TN	LICENSE[VOICE]	SONVOI	FAITH
a. TN [VOICE]	* !		
b. TN		* !	
c. DN \\ [VOICE] ✓			*

With just the three constraints discussed thus far, all sonorants would be [voice]-linked to adjacent obstruents. Itô, Mester, and Padgett single out nasals as the only sonorant triggers of [voice] spread by introducing a set of constraints that have the effect of prohibiting linkage between obstruents and segments that are more sonorous than nasals (the NOLINK constraints). However, both this solution, and the alternative of changing SONVOI to NASVOI (see Itô, Mester, and Padgett 1993, and the discussion in Itô, Mester, and Padgett 1995) would equally limit pre-sonorant voicing to nasals. Though post-nasal voicing is extremely widespread, there are no reported cases of regressive voicing triggered by nasals only. The progressive nature of nasal-obstruent voicing is particularly striking since more general forms of voicing assimilation tend to be regressive (Anderson 1979, Lombardi 1991, Mohanan 1993). This directional asymmetry, which is a fundamental property of post-nasal voicing (hence the name), completely escapes the redundant feature licensing analysis.¹⁸

It is worth noting that the asymmetry of nasal-obstruent voicing also militates against a view of post-nasal voicing as autosegmental spreading of [voice] (or copying of Sonorant Voice; see Rice

¹⁸ See however Kawasaki (1995), in which redundant feature licensing is supplemented by a principle of government that produces the required asymmetry in nasal-obstruent voicing.

1993). If nasal [voice] can spread right, then why could it not spread left? One answer might involve claiming that rules only apply to repair an ill-formed configuration, and that *NC̣, but not *C̣N, defines a representation in need of repair. However, if spreading is itself not the motive force, but is only a response to an independent constraint, this essentially concedes the point that the locus of typological explanation here lies in the constraint system, rather than in the rule formalism.

4.4 Lyman's Law and redundant feature licensing

While redundant feature licensing fails to generalize to nasal substitution (or the other NC̣ effects; see Pater 1996), it does generate the sonorant [voice] underspecification required for an OCP account of Lyman's Law in Yamato Japanese, and overcomes the ordering paradox between Lyman's Law and post-nasal voicing first noted by Itô and Mester (1986). Here I will briefly discuss whether the Lyman's Law facts bear at all on an understanding of post-nasal voicing.

Lyman's Law is a co-occurrence constraint that allows only one voiced obstruent per root. It can be analyzed in terms of a OCP-based restriction against adjacent [voice] features, provided that sonorants are unspecified for [voice] when this restriction applies. If post-nasal voicing is viewed as the transmission of the nasal's [voice] feature to the obstruent, then Lyman's Law must derivationally precede post-nasal voicing. The ordering paradox arises because the post-nasal voiced obstruent is a target for Lyman's Law, which would lead one to believe that post-nasal voicing occurs before, rather than after, Lyman's Law.

Redundant feature licensing resolves this paradox by supplying a [voice] feature to sonorants only in the NC̣ context. This is done by ranking LICENSE[VOICE] above SONVOI, so that when there is no adjacent obstruent licenser that would allow the satisfaction of both constraints, the satisfaction

of LICENSE[VOICE] takes precedence:

(32) **Underspecification of non-NC sonorants**

Input: NV	LICENSE[VOICE]	SONVOI
a. NV [VOICE]	* !	
b. NV ✓		*

Without the adjacent obstruent as host for the parasitic licensing of [voice], the nasal without [voice] is optimal.

A *NC̥-based analysis of post-nasal voicing, in contrast, is silent about the presence or absence of [voice] on sonorants. One result of this is that the OCP + underspecification account of Lyman's Law could be maintained by underspecifying all sonorants for [voice], including nasals in the NC̥ configuration, since *NC̥ would continue to demand a post-nasal voiced obstruent, even if the nasal itself lacked [voice]. When post-nasal voicing is attributed to a substantive output constraint like *NC̥, rather than to autosegmental feature propagation, the ordering paradox thus quietly vanishes.

On the other hand, because the *NC̥ analysis of post-nasal voicing is completely independent of sonorant [voice] underspecification, we are free to contemplate alternative accounts of Lyman's Law. If temporary underspecification of non-contrastive features like sonorant [voice] were a typologically productive way of dealing with co-occurrence conditions and other phonological regularities, then the standard analysis would be secure. However, as Steriade (1995a) notes, no

cases besides that of sonorant [voice] appear to exist. It is thus well worth considering alternatives that generalize to other phenomena, and avoid the proliferation of derivational stages that temporary underspecification requires. Extant accounts of Lyman's Law which make no appeal to temporary underspecification can be found in Rice (1993), Lombardi (1995), Steriade (1995a), and Itô and Mester (1996); discussion of their relative generalizability would unfortunately take us far too afield. The crucial point here is that their very existence shows that dealing with each of Lyman's Law and post-nasal voicing can, and probably should, be a separate undertaking.

In sum, the redundant feature licensing and *NÇ analyses of post-nasal voicing extend to different phenomena: sonorant [voice] underspecification, and the NÇ effects respectively. While the conspiracies examined here and in Pater (1996) firmly establish the need for a unified treatment of the NÇ effects, neither empirical nor theoretical exigencies force an analytic consolidation of Lyman's Law and post-nasal voicing.

5 Conclusions

I have argued that nasal substitution is best analyzed as fusion of a nasal and voiceless obstruent, driven by a phonotactic constraint against this sequence, *NÇ, which can also be satisfied by nasal deletion, denasalization, and post-nasal voicing. The traditional analysis of nasal substitution, and the recent analysis of post-nasal voicing in Itô, Mester, and Padgett (1995), were shown to capture both too much, and too little, when cross-linguistic possibilities are taken into consideration. In contrast, the factorial typology predicted by the permutation of the ranking of *NÇ and the Faithfulness constraints is nearly completely fulfilled.

The fact that languages exercise a range of options in dealing with *NÇ violations, along with

the existence of conspiracies between these NC effects, provides strong support for the Optimality Theoretic program of decoupling phonotactic constraints from Faithfulness constraints, and allowing them to be freely ranked with respect to one another. However, the apparent lack of NC epenthesis raises an intriguing question for future research: Is it the case that every phonotactic constraint is satisfied in all of the ways predicted by the permutation of the rankings between it and the Faithfulness constraints? Gaps in factorial typologies often serve as indications that constraints must be reformulated, but persistent links between marked configurations and the processes used to repair them would seem to force a more fundamental shift in theoretical assumptions. Either that, or we could settle for a theory of grammar that is in some respects only 'exegetically adequate', as opposed to 'explanatorily adequate', that is, we could rest content with having 'made some progress in understanding the facts as they are, though not in the sense of showing that they could not be otherwise' (Anderson 1979: 18). Such resignation would be disappointing though, in light of the strides that Optimality Theory has made toward predictive explanatory adequacy in many areas of phonology.

Finally, I would like to conclude by commenting on an issue that bears more directly on the main concern of this volume, that is, the nature of the interaction between phonology and morphology. The primary role of morpheme-specific Faithfulness in McCarthy and Prince (1994b), and Urbanczyk (1996) is to explain prosodic influences on morphology that were formerly attributed to templates. In the present paper, a root-specific constraint is used to account for an influence in the opposite direction: a morphological restriction on the phonotactically motivated process of nasal substitution. By keeping the phonotactic constraint general, and employing morphologically conditioned Faithfulness constraints, we are able to straightforwardly capture the OshiKwanyama

conspiracy, in which the way that *NC̥ is satisfied depends on the morphological context. This is counter to the usual approach to the morphological sensitivity of OCP effects, in which the morphological domain of the phonotactic constraint itself is stipulated (McCarthy 1986, Myers 1994). Significantly, cases like OshiKwanyama, in which there are different responses to a phonotactic constraint depending on the morphological environment, cannot be dealt with in Optimality Theory by proliferating domain specific phonotactic constraints. Whatever the ranking of such specific phonotactic constraints might be, the lowest ranked Faithfulness constraint will always be the one that is violated. It is to be expected that continued examination of the differences in empirical scope between these, as well as other approaches to morphological influences on phonology, should yield a clearer understanding of the principles underlying morphophonological processes.

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