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*NC

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0. Preliminaries

Two views of post-nasal voicing (henceforth PNV) have emerged in the recent Optimality Theoretic literature. Itô, Mester, and Padgett (1995) claim that PNV results from the licensing of the nasal's redundant [voice] feature through the obstruent, while Pater (1995), as well as Hayes (1995), suggest that PNV is instead simply a response to **NC*, a phonotactic constraint against nasal/voiceless obstruent sequences. The present paper compares these analyses by testing them against the cross-linguistic facts surrounding PNV, and finds that the evidence clearly implicates *NC as the motive force behind this process.

In first two sections of this paper, we see that the directional asymmetry of nasal-obstruent voicing, and the existence of conspiracies between PNV and other processes that eliminate NC clusters, are captured by a *NC constraint, but not by redundant feature licensing. Section 3 demonstrates that the apparent ordering paradox between PNV and Lyman's Law in Yamato Japanese (Itô, Mester, and Padgett 1995) is purely the product of a view of PNV as autosegmental feature propagation; the paradox disappears when PNV is understood to be driven by an output constraint like *NC. In the conclusion, I point out that the data examined here support not only the *NC analysis of PNV, but also more broadly a theory of segmental phonology based on substantive output constraints.

1. Redundant feature licensing

I will start by outlining the redundant feature licensing analysis, and showing that it generates both pre- and post- nasal voicing, though only the latter is attested. The basic premise of this analysis is that because the feature [voice] is redundant in sonorants, it cannot be licensed by sonorants. If only obstruents can license [voice], a constraint stating that [voice] must licensed (LICENSE[VOICE]), and one that forces sonorants to be specified as

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voiced(SONVOI), will prefer a candidate in which [voice] is linked to both members of a nasal/obstruent cluster, as in (1c). When these two constraints are ranked above a Faithfulness constraint demanding identity between the voicing specification of Input and Output obstruents (for the moment simply FAITH), an Input NT cluster (nasal/voiceless obstruent) surfaces as ND (nasal/voiced obstruent). In this and following tableaux, ranked constraints are separated by solid lines, and the optimal (i.e. grammatical) form is indicated by a checkmark:

(1) **Post-nasal voicing as redundant feature licensing**

<table>
<tr><th>Input: <i>NT</i></th><th>LICENSE[VOICE]</th><th>SONVOI</th><th>FAITH</th></tr>
<tr><td>a. NT
|
[VOICE]</td><td>* !</td><td></td><td></td></tr>
<tr><td>b. NT</td><td></td><td>* !</td><td></td></tr>
<tr><td>c. ND
|/
[VOICE] ✓</td><td></td><td></td><td>*</td></tr>
</table>

To single out nasals as the only sonorant triggers of [voice] spread, Itô, Mester, and Padgett (1995) introduce a set of 'NOLINK' constraints, which have the effect of prohibiting linkage between obstruents and segments that are more sonorous than nasals. However, neither this solution, nor the alternative of changing SONVOI to NASVOI (Itô, Mester, and Padgett 1993) stops this grammar from overgenerating in another direction – leftward:

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

<table>
<tr><th>Input: <i>TN</i></th><th>LICENSE[VOICE]</th><th>SONVOI</th><th>FAITH</th></tr>
<tr><td>a. TN
|
[VOICE]</td><td>* !</td><td></td><td></td></tr>
<tr><td>b. TN</td><td></td><td>* !</td><td></td></tr>
<tr><td>c. DN
\|
[VOICE] ✓</td><td></td><td></td><td>*</td></tr>
</table>

Post-nasal voicing is extremely common, and is exhibited by typologically unrelated languages such as Greek (Newton 1972), Zoque (Wonderly 1951), Kikuyu (Armstrong 1967), and Yamato Japanese (IMP). Pre-nasal voicing, that is, voicing of obstruents before nasals only, is unattested. Given the prevalence of post-nasal voicing, it is unlikely that the complete absence of pre-nasal voicing is an accidental gap. Redundant feature licensing ignores this fundamental directional asymmetry. The lack of pre-nasal voicing further suggests that PNV is motivated by a force other than [voice] agreement, since voicing assimilation tends to be leftward (Anderson 1979). We now turn to an alternative to redundant feature licensing, and to the usual [voice] spreading analyses of PNV.

2. *NC

*NC, which penalizes nasal/voiceless obstruent sequences, is a contextual markedness[1] constraint that has a variety of effects, depending on its ranking *vis-à-vis* the Faithfulness constraints. In an account based on this constraint, PNV is grouped with other resolutions of the ill-formed NC configuration, such as nasal deletion, denasalization, and nasal substitution (Pater 1995). The next three sub-sections introduce unequivocal evidence for a unified treatment of PNV and the rest of these NC effects: that they participate in conspiracies (Kisseberth 1970) to rid languages of NC clusters. These conspiracies fall out naturally from the *NC analysis, but are completely unexpected if PNV is driven by redundant feature licensing.

2.1 Post-nasal voicing and nasal deletion

Post-nasal voicing violates a constraint demanding Input-Output identity of [voice] specification (IDENT[VCE] in McCarthy and Prince 1995[2]). If this constraint ranks beneath *NC, post-nasal voicing (3b), rather than [voice] faithfulness (3a), is chosen as optimal:

(3) **Post-nasal voicing as *NC satisfaction**

Input: *NT*	*NC	IDENT[VCE]
a. NT	*!	
b. ND ✓		*

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[1] The markedness of NC clusters stems from the arbitrary phonetic fact that velum raising in the transition from nasal to obstruent creates conditions favorable to voicing, and disfavorable to voicelessness (see especially Hayes 1995 for a careful investigation of the exact nature of these conditions, as well as the slightly different account in Pater 1995).

[2] The focus here is on the formulation of the phonotactic constraint(s) driving post-nasal voicing, rather than on that of the faithfulness constraints, so some expository simplifications are made in the latter. For relevant discussion, see Pater [illegible]

In and of itself, this is an admittedly uninteresting analysis of post-nasal voicing. Its appeal is increased, though, upon considering additional constraints. When a Faithfulness constraint other than IDENT[VCE] falls beneath *NC, an NT Input is mapped to an Output other than ND. For example, if *NC dominates a constraint forcing every segment in the Input to correspond to a segment in the Output (MAX in McCarthy and Prince 1995), then deletion results. Importantly, nasal deletion in the NC configuration (i.e. NT → T) is cross-linguistically attested (e.g. Kelantan Malay as described in Teoh 1988 and Maore in Nurse and Hinnebusch 1993: 168; see further Pater 1995).[3]

A more intriguing situation arises when *NC dominates more than one Faithfulness constraint. In the usual case, because strict domination (Prince and Smolensky 1993) forces a ranking between the faithfulness constraints, such a hierarchy produces but a single result. For instance, with IDENT[VCE] ranked the lowest, PNV continues to be optimal, even if MAX is also dominated by *NC:

(4) *NC >> MAX >> IDENT[VCE]

Input: *NT*	*NC	MAX	IDENT[VCE]
a. NT	*!		
b. _T		*	
c. ND ✓			*

However, with some elaboration, this ranking will generate both deletion and PNV. If another, higher ranked, constraint militates against obstruent voicing in a particular environment, deletion occurs in just that context. This scenario is fulfilled by Modern Greek (Newton 1972).[4] PNV (5a&c) applies except when the post-nasal obstruent is itself followed by a voiceless obstruent (a fricative). In this situation, nasal deletion applies instead (5b&d):

(5)	a. /pemp+o/	[pembo]	'I send'
	b. /e+pemp+s+a/	[epepsa]	-aorist
	c. /ton+topo/	[tondopo]	'the place'
	d. /ton#psefti/	[topsefti]	'the liar' (Cypriot)[5]

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[3] One might well ask why nasals, rather than obstruents, are deleted. Pater (1995) suggests that this is due to an inherent ranking of a obstruent-specific Max constraint over a nasal-specific one, but there are other possibilities. See Pater (1995) for arguments that nasal substitution of the Indonesian/Malay variety involves fusion, rather than deletion.

[4] Thanks to Adamantios Gafos for bringing Newton (1972) to my attention.

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

Here we have a transparent case of conflict: between PNV, and a robust pattern of regressive obstruent voicing assimilation. As a proper analysis of voice assimilation lies beyond the reach of this paper, I will simply posit a constraint VOICEASSIM that baldly demands regressive voicing assimilation between obstruents. This constraint is violated not only by MBS, but also by MBZ, which is in fact the Output for MPS in some dialects.

A ranking of VOICEASSIM and *NC above MAX and IDENTVCE produces the Greek conspiracy between PNV and deletion. VOICEASSIM has nothing to say about an Input that contains a single post-nasal obstruent, so ND continues to be prefered as the Output for an NT cluster, as depicted in (5). However, when the Input is MPS (TS clusters are independently illicit), deletion becomes optimal:

(6) The Greek Conspiracy: VOICEASSIM, *NC >> MAX >> IDENT[VCE]

Input: *MPS*	VOICEASSIM	*NC	MAX	IDENT[VCE]
a. MPS		* !		
b. _PS ✓			*	
c. MBS	* !			*

To produce the deletion pattern for MPS, the only crucial ranking is for both VOICEASSIM and *NC to dominate MAX. The ranking between VOICEASSIM and *NC is inconsequential, as both are fully satisfied. The general ranking schema for conspiracies is thus as in (7):

(7) Blocking Constraint, Phonotactic Constraint >> Faith X >> Faith Y

In contrast to the straightforward account that *NC affords, it appears that redundant feature licensing cannot capture the conspiracy between PNV and nasal deletion. This is due to its inability to generate nasal deletion, as illustrated in the following tableau, which places MAX beneath LICENSE[VOICE] and SONVOI.

(8) 'Nasal deletion' as redundant feature licensing

Input: *NVNT*	License[Voice]	SonVoi	Max
a. NVNT | | [VCE] [VCE]	* * !		
b.NV_T | [VCE]	* !		*
c. NVNT		* * !	
d. NV_T		* !	*
e. _V_T ✓			**

This ranking does in fact lead to a preference for nasal deletion over the violation of either License[Voice] or SonVoi. However, the optimal outcome is for all nasals to be deleted (10e), not just those adjacent to voiceless obstruents (10b or d). If, as this result suggests, redundant feature licensing cannot generate NC nasal deletion, then it of course fails to express the Greek conspiracy.

2.2 Post-nasal voicing and denasalization

Another way to avoid a *NC violation, besides simply deleting the nasal, is to change it into an obstruent. Densalization results from a ranking of *NC above Ident[Nas] (*correspondent segments must be identical in [nasal] specification*), and occurs in Toba Batak (Hayes 1986), Mandar (Mills 1975), and Kaingang (cf. Piggott 1995).

Conspiratorial evidence also exists for a unified analysis of PNV and denasalization. In the Greek dialect spoken on Karpathos (Newton 1972), PNV applies except when the obstruent is word-initial, in which case denasalization occurs instead, as in (9):

(9)	/tin+porta/	[tipporta]	'the door'
	/tin+kori/	[tikkori]	'the girl'

There are at least two possible interpretations of initial blocking. One is to invoke Positional Faithfulness (Selkirk 1994; Beckman 1995; cf. Steriade 1993), so that a constraint on [voice] identity in initial position blocks PNV. The other would be to pursue the following suggestion of Newton (1972:98), and provide an account in terms of paradigm uniformity:

> ...it is tempting to suppose that what we have is rather a failure of the stop to voice through analogical pressure of positions other than the postnasal one, followed by some process of gemination.

In McCarthy and Prince's (1995) Correspondence Theory, paradigm uniformity can be formalized in terms of a Faithfulness constraint that demands Identity in [voice] specification between correspondent Output segments (Benua 1995, McCarthy 1995, see also Burzio 1994, Kenstowicz 1995, Steriade 1994).

As the choice between these approaches is of no immediate consequence, I will simply call the constraint that blocks initial voicing SPECIALFAITH. Following the schema for conspiracies in (7), the ranking of SPECIALFAITH and *NC above IDENT[NAS] and IDENT[VCE] captures the Karpathian conspiracy. As (10) shows, this ranking generates PNV medially.

(10) **SPECIALFAITH, *NC >> IDENT[NAS] >> IDENT[VCE]**

Input: *NT*	SPECIALFAITH	*NC	IDENT[NAS]	IDENT[VCE]
a. NT		*!		
b. TT			*!	
c. ND ✓				*

However, denasalization is favored at the word boundary:

(11) **SPECIALFAITH, *NC >> IDENT[NAS] >> IDENT[VCE]**

Input: *N#T*	SPECIALFAITH	*NC	IDENT[NAS]	IDENT[VCE]
a. N#T		*!		
b. T#T ✓			*	
c. N#D	*!			*

Any attempt to deal with this conspiracy in terms of redundant feature licensing would face the same problem as such an account of the PNV/deletion conspiracy. When IDENT[NAS] is ranked beneath LICENSE[VOICE] and SONVOI, all nasals are deleted, not just those that abut voiceless obstruents:

(12) **'Denasalization' as redundant feature licensing**

Input: *NVNT*	LICENSE[VOICE]	SONVOI	IDENT[NAS]
a. NVNT | | [VCE] [VCE]	* * !		
b. NVTT | [VCE]	* !		*
c. NVNT		* * !	
d. NVTT		* !	*
e. TVTT ✓			**

2.3 Post-nasal voicing and nasal substitution

Yet another well-attested NC effect is nasal substitution (NT → N), which Pater (1995) argues to result from the fusion of the nasal and the voiceless obstruent. In this case, the violated constraint in McCarthy and Prince (1995) would be UNIFORMITY, stated as 'Input segments may not share an Cutput correspondent'.

Numerous examples of this process can be found in Western Austronesian, and in Bantu languages. It is a language of the latter family that provides us with a conspiracy. OshiKwanyama (Steinbergs 1985) has root-internal PNV. While there are no alternations, PNV is evidenced by the complementary distribution of [k] and [g]: [k] appears word-initially and intervocalically, and [g] occurs only after nasals. Furthermore, loanwords are modified by voicing the postnasal obstruent. The following are borrowings from English:

(13) **Postnasal voicing in OshiKwanyama loanwords**

[sitamba]	'stamp'
[pelenda]	'print'
[oiŋga]	'ink'

Root-initially, nasal substitution, rather than PNV, occurs to resolve underlying NC sequences (nasal/voiced obstruent clusters are reported to remain intact, though no examples are given in Steinbergs 1985):

(14) Root-initial nasal substitution in OshiKwanyama

/eːN+pati/	[eːmati]	'ribs'
/oN+pote/	[omote]	'good-for-nothing'
/oN+tana/	[onana]	'calf'

Root-internal nasal substitution can be blocked by a root specific Uniformity constraint demanding that root segments remain distinct (as in the analysis of Indonesian in Pater 1995, see also Buckley 1995a&b on root specific constraints). With the ranking Uniform-Root, *NC >> Ident[Vce] >> Uniform, nasal subsitution is preferred root-initially:

15) Uniform-Root, *NC >> Ident[Vce] >> Uniform

Input: *N+T*	Uniform-Root	*NC	Ident[Vce]	Uniform
a. NT		* !		
b. ND			* !	
c. N ✓				*

But root-internally, PNV occurs instead:

16) Uniform-Root, *NC >> Ident[Vce] >> Uniform

Input: *NT*	Uniform-Root	*NC	Ident[Vce]	Uniform
a. NT		* !		
b. ND ✓			* !	
c. N	* !			*

The prognosis for a treatment of the OshiKwanyama conspiracy in terms of redundant feature licensing is even worse than the cases discussed above. As Pater (1995) demonstrates, no matter how License [Voice], SonVoi, and Uniformity are ranked, a non-coalesced candidate is chosen over a fused one. This is because, as illustrated in (17), the violations incurred by the fused candidates (17a&b) are a superset of those of the faithful ones (17c&d).

(17) **Redundant feature licensing and NC Fusion**

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

3. Post-nasal voicing and underspecification

While redundant feature licensing fails to generalize from PNV to the rest of the NC effects, 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 PNV first noted by Itô and Mester (1986). In this section I will show that while a *NC-based analysis of PNV does not produce or require underspecification, it does avoid any conflict with Lyman's Law.

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

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

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

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

*NC, in contrast, is silent about the presence or absence of [voice] on sonorants. However, 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 NC configuration, since *NC would continue to demand a post-nasal voiced obstruent, even if the nasal itself lacked [voice]. When PNV is attributed to *NC, rather than to autosegmental feature propagation, the ordering paradox thus quietly vanishes.

It is important to note, though, that because the *NC analysis of PNV is completely independent of sonorant [voice] specification, we are free to contemplate alternatives to the traditional analysis 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, then the traditional analysis would be secure. However, as Steriade (1995) notes, no other cases besides that of sonorant [voice] appear to exist. It is thus well worth seeking alternative solutions that generalize to other phenomena, and avoid the proliferation of derivational stages temporary underspecification requires (see Rice 1993, Pater 1995, Steriade 1995 for some suggestions). In the end, the disentanglement of PNV from sonorant [voice] underspecification that *NC allows may well prove to be advantageous.

4. Conclusion

The redundant feature licensing and *NC analyses of PNV generalize to different phenomena: sonorant [voice] underspecification, and the NC effects respectively. The conspiracies discussed in §2 require a unified treatment of PNV and the other NC effects. This is easily achieved when PNV is driven by *NC, but is elusive when PNV is attributed redundant feature licensing. On the other hand, a unified analysis of PNV and sonorant [voice] underspecification was shown in §3 to be unnecessary. The cross-linguistic evidence thus weighs heavily in favor of *NC as the basis for a general account of PNV.

There are also some broader conclusions to be drawn from these data. The asymmetry of nasal-obstruent voicing discussed in §1 shows the futility of attempting to construct a restrictive theory of segmental phonology on the basis of a restrictive set of features freely combined with operational parameters (or constraint-based reformulations thereof). If nasal [voice] can spread right, then why could it not spread left? At least this apparent case of spreading must be attributed to a substantive constraint. Furthermore, the NC conspiracies can be added to the evidence for a theory of phonology based on output constraints (starting with Kisseberth 1970: see §1 of Prince and Smolensky 1993). Since substantive output constraints (along with Faithfulness constraints) are the building blocks of Optimality Theoretic grammars, it should not be surprising that Optimality Theory handles these facts in an elegant fashion.

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