Counterbled-Counterfeeding in Harmonic Grammar

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1. Introduction

The analysis of phonological patterns whose description requires reference to derivational history has presented a major challenge for parallel constraint-based models of grammar. This paper argues that such patterns can, in some cases, be readily captured within a constraint-based model, provided that the constraints are weighted as in Harmonic Grammar (HG; Legendre, Miyata & Smolensky 1990, Pater 2009b, Potts et al. 2010, Smolensky & Legendre 2006). The key patterns – which in rule-based frameworks involve interactions between counterfeeding and counterbleeding orders – are illustrated here with data from Ponapean (Rehg & Sohl 1981). The constraints required for analysis of these data in HG are simple, and no serial derivation is necessary. Such simplicity of analysis stands in contrast with rule-based frameworks and with Optimality Theory (OT; Prince & Smolensky 1993/2004), which must make recourse to some type of hidden structure or extrinsic ordering to account for the patterns in question. This paper thus follows Baković (2007) in demonstrating that certain types of opacity can be effectively captured in constraint-based frameworks, and provides further typological support for weighted-constraint models (see also Potts et al. 2010, Jesney 2012, to appear).

The paper is structured as follows. Section 2 presents the basic assimilation and nasalization processes seen in Ponapean reduplication. Section 3 focuses on the interaction of these processes, illustrating the mechanism by which blocking is achieved in HG, and contrasting this with the difficulties encountered in parallel OT. Section 4 places these patterns in the broader context of process interaction, showing how rule-based analysis of these data requires a combination of counterfeeding and counterbleeding rule orders, and, in many cases, highly-specific rules. Section 5 returns to the issue of blocking in OT vs. HG, and section 6 concludes that while HG is likely unable to model all cases of complex process interaction, the ability of constraints to interact cumulatively offers promising analytical possibilities.

* Thanks to Rachel Walker, Paul de Lacy, Bruce Hayes, Brian Hsu, Katya Pertsova, Francesc Torres-Tamarit, Matt Wolf, Kie Zuraw, and the audiences at NELS 45, the IGRA Workshop on Grammatical Building Blocks, and the UCLA-USC joint phonology meeting for helpful questions and feedback.
2. Ponapean assimilation and nasalization

2.1 Consonant inventory and phonotactics

The key data in this paper come from the interaction of assimilation and nasalization in Ponapean reduplication. All descriptions and generalizations are based on the discussion in Rehg & Sohl (1981) and Goodman (1995).

There are three voiceless coronal obstruents in Ponapean, each differing in sub-place as well as manner of articulation: \( [t] \) is a dental stop, \( [s'] \) is a palatalized alveolar fricative, and \( [t'] \) is a retroflex affricate. The palatalized alveolar coronal nasal \( [n'] \) and the retroflex nasal \( [n] \) are limited in distribution, appearing only immediately before \( [s'] \) and \( [t'] \), respectively; the dental nasal \( [n] \) appears elsewhere. The liquids are also coronal; the lateral \( [l] \) is slightly palatalized and the rhotic \( [r] \) is generally realized as an alveolar trill (Rehg & Sohl 1981: 33-34). The full consonant inventory is given in (1).

(1) Ponapean consonant inventory (based on Rehg & Sohl 1981)

<table>
<thead>
<tr>
<th></th>
<th>stop</th>
<th>fricative</th>
<th>affricate</th>
<th>nasal</th>
<th>liquid</th>
<th>glide</th>
</tr>
</thead>
<tbody>
<tr>
<td>bilabial</td>
<td>( p )</td>
<td>( m )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>velarized bilabial</td>
<td>( p^w )</td>
<td>( m^w )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dental</td>
<td>( t )</td>
<td></td>
<td>( n )</td>
<td>( r )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>palatalized alveolar</td>
<td>( s' )</td>
<td></td>
<td>( (n') )</td>
<td>( l' )</td>
<td>( j )</td>
<td></td>
</tr>
<tr>
<td>retroflex</td>
<td></td>
<td>( t' )</td>
<td></td>
<td>( (\eta) )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>velar</td>
<td>( k )</td>
<td></td>
<td></td>
<td>( \eta )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Consonant-consonant sequences are quite restricted in Ponapean. In intervocalic contexts only geminate sonorants and sequences of a nasal followed by a homorganic obstruent are generally permitted.¹

(2) Ponapean intervocalic consonant sequences (based on Rehg & Sohl 1981)

\[
\begin{align*}
[mm] & & [l'l'] & & [mp] & & [n's'] \\
[m^m'm^w'] & & [rr] & & [m^*p^*r] & & [n'l'] \\
[nn] & & [n't] & & [\eta k] \\
[\eta\eta] & & & & & & \\
\end{align*}
\]

Complex codas are allowed only word finally, where they are restricted to glide + consonant and homorganic nasal + obstruent sequences – e.g., [emp] ‘coconut crab’ (Rehg & Sohl 1981: 52). In word-initial position homorganic nasal + obstruent sequences are also permitted, but the segments are syllabified separately, either through prothesis or through realization of the nasal as syllabic – e.g., [in.ta] ~ [n.ta] ‘blood’ (Rehg & Sohl 1981: 55). Sonorant geminates are found in both word-final and word-initial position – e.g., [ku\( l' \)] ‘roach’, [mmet\( r' \)] ‘full’ (Rehg & Sohl 1981: 36).

¹ Intervocalic geminate obstruents are limited to exclamations and loanwords – e.g., [nappa] ‘Chinese cabbage’. Coronal geminate obstruents also optionally appear across root-suffix boundaries – e.g., [lus\( s \)] ‘to jump’ vs. [lus\( s \eta \)] ‘to jump from’ (Rehg & Sohl 1981: 37).
2.2 Assimilation

Ponapean has a productive pattern of coronal nasal place assimilation that applies regressively within words and between words in rapid speech to ensure that the phonotactic restrictions on intervocalic consonant sequences are respected. This assimilation process leads to changes between coronal sub-places (3a), as well as changes from coronal to labial or velar place (3b).

(3) a. Assimilation within the coronal place (Rehg & Sohl 1981: 57-60; Goodman 1995:160)
/naŋ-sʰɛt]/ [naŋʰisɛt] ‘in the ocean’
/ʈʊn-ʈʰune]/ [ʈʊɲʰuɲe] ‘tie together’

b. Assimilation to labial and velar place
/naŋ-pʰuŋara]/ [namʰpuŋara] ‘between them’
/naŋ-maṭ'au]/ [nammaṭ'aw] ‘ocean, beyond the reef’

Labial and velar nasals resist assimilation; epenthesis is triggered when concatenation would otherwise give rise to an illicit intervocalic consonant sequence (4).²

(4) Resistance to assimilation by input labials/velars (Goodman 1995: 166-168)
/lim-ṭip]/ [limaṭip] ‘slices, chips’
/lim-sʰou]/ [limisou] ‘heaps, piles’
/lim-kap]/ [limakap] ‘sheaves’

When faithful mapping of the input sequence respects the phonotactic requirements of the language, no repair applies – e.g., /ṭeŋ-ṭenek]/ [ṭeŋṭeŋek] ‘hung up’, /lim-pak]/ [limæk] ‘times’.

These data can be modeled straightforwardly within HG using the constraints in (5).
The basic approach here closely follows de Lacy’s (2002) Optimality-Theoretic analysis.

(5) AGREEPLACE: Assign a violation mark to any sequence of two consonants that disagree in Place
IDENTPLACE: Assign a violation mark to any input segment that differs in Place relative to its output correspondent
IDENTPLACE-KP: Assign a violation mark to any input velar or labial segment that differs in Place relative to output correspondent
DEP-V: Assign a violation mark to any output vowel that lacks an input correspondent

In order for coronal nasals to assimilate in place to a following consonant, two weighting conditions must hold. The weight of AGREEPLACE must be greater than the weight of

² The quality of the epenthetic vowel is determined by properties of the surrounding segments, and, in the case of reduplication, the quality of the input base vowels. I abstract away from these distinctions here.
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IDENTPLACE, ensuring that assimilation is preferred to place disagreement, and the weight of DEP-V must be greater than the weight of IDENTPLACE, ensuring that assimilation is preferred to epenthesis. The tableau in (6) illustrates this interaction using representative constraint weights; any set of weights that meet these conditions would yield the Ponapean pattern. (For more on weighting conditions, see esp. Pater to appear.)

(6) Assimilation is preferred in the case of input coronal nasals

<table>
<thead>
<tr>
<th>/ŋan-par/</th>
<th>AGRPLACE w = 4</th>
<th>DEP-V w = 3</th>
<th>IDPLACE w = 2</th>
<th>IDPLACE-KP w = 2</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ŋanpar</td>
<td></td>
<td></td>
<td></td>
<td>-1</td>
<td>-4</td>
</tr>
<tr>
<td>ŋampar</td>
<td>-1</td>
<td></td>
<td>-1</td>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>ŋamapar</td>
<td>-1</td>
<td></td>
<td>-1</td>
<td>-3</td>
<td></td>
</tr>
</tbody>
</table>

Blocking of assimilation and triggering of epenthesis with non-coronal nasals then requires only that the summed weight of IDENTPLACE-KP and IDENTPLACE exceeds the weight of DEP-V (cf. de Lacy 2002: 318-320).

(7) Epenthesis is preferred in the case of non-coronal nasals

<table>
<thead>
<tr>
<th>/l̃im-ṭip/</th>
<th>AGRPLACE w = 4</th>
<th>DEP-V w = 3</th>
<th>IDPLACE w = 2</th>
<th>IDPLACE-KP w = 2</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>̃limṭip</td>
<td></td>
<td></td>
<td>-1</td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>̃lintip</td>
<td>-1</td>
<td></td>
<td>-1</td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>̃limatip</td>
<td>-1</td>
<td></td>
<td>-1</td>
<td>-3</td>
<td></td>
</tr>
</tbody>
</table>

Direction of assimilation can be modeled by adding a positional IDENTPLACE constraint (Beckman 1998) that penalizes changes to input place among segments syllabified as onsets. This constraint must outweigh IDENTPLACE-KP to ensure that assimilation is regressive even in forms like /ŋan-par/ → [ŋampar], *[ŋanṭar]

Importantly, the constraints here are all very general in nature. AGREEPLACE only references consonant place; it is not specific to nasals or to coronals. Similarly, IDENTPLACE and IDENTPLACE-KP apply to all consonant manners of articulation. The HG analysis is driven by interaction of these very basic building blocks.

2.3 Obstruent nasalization

In addition to assimilation, Ponapean also employs nasalization (what Rehg & Sohl 1981 call “nasal substitution”) in avoiding illicit intervocalic consonant sequences. This paper focuses on the use of nasalization in reduplicative contexts. Examples are given in (8).

(8) Nasalization in obstruent-obstruent contexts (Rehg & Sohl 1981: 59)

/pap-pap/  [pampap]  ‘swim’
/kak-kak/  [kaŋkak]  ‘able’
/sas-sas/  [s’an’s’an]  ‘stagger’
/ṭat-ṭat/  [ṭaŋṭaŋ]  ‘writhe’
/tit-tit/  [t’iŋt’iŋ]  ‘build a wall’
I attribute this nasalization pattern to a preference for falling sonority sequences across syllable boundaries (e.g., Murray & Venneman 1983, Gouskova 2004), and cast the preference as a scalar constraint – cf. Prince & Smolensky (1993/2004), Pater (2010).

(9) **SYLLABLECONTACT**: For any sequence of two intervocalic consonants:
- assign 2 violation marks if sonority rises from coda to onset
- assign 1 violation mark if sonority is level from coda to onset
- assign 0 violation marks if sonority falls from coda to onset

Sequences like those in (8) undergo nasalization if the weight of **SYLLABLECONTACT** is greater than the weight of **IDENTNASAL**, so that nasalization is preferred to violating the syllable contact constraint, and the weight of **DEP-V** is greater than the weight of **IDENTNASAL**, so that resolving syllable contact violations via nasalization is preferred to resolving them via epenthesis. The tableau in (10) illustrates the basic interaction. Again, the constraints here are all very general in nature.

(10) Nasalization applies across syllable boundaries

| /ṭāṭ-ṭāṭ/ | SYLLCONTACT  
| w = 4 | DEP-V  
| w = 3 | IDENTNASAL  
| w = 2 | H |
| --- | --- | --- | --- | --- |
| ṭāṭṭāṭ | −1 | | | −4 |
| ṭaṭṭaṭ | | −1 | | −2 |
| ṭaṭaṭāṭ | | −1 | | −3 |

3. **Blocking through cumulative constraint interaction**

While nasalization is a regular means of avoiding phonotactically-illicit consonant sequences in Ponapean, it does not apply as broadly as one might expect. This section addresses two conditions under which nasalization is blocked, and shows how they can be straightforwardly modeled using the constraints and weighting conditions already defined. Attempts to analyze these patterns in OT using the same general constraints yield ranking paradoxes.

3.1 **Blocking under non-identity**

The first condition under which nasalization is blocked arises when the input intervocalic obstruents have non-identical place specifications. This non-identity can arise between a non-coronal segment and a coronal segment, as in the first example in (11), or between a two coronal segments, as in the second two examples. In each of these cases, nasalization and assimilation are blocked, and epenthesis is triggered. While both nasalization and assimilation are independently preferred to epenthesis (see 8 and 3), their joint application is not tolerated.

(11) Nasalization blocked when place is not identical (Rehg & Sohl 1981: 61, 75)

/ṭeptep/  
/[ṭeptep]  
*[ṭeptep]  
‘to kick’

/petpet'/  
/[petpet']  
*[pempet']  
‘to be squeezed’

/sēṭ-sēṭik/  
/[sēṭisēṭik]  
*[s'en'sēṭik]  
‘quick in performing action’
This blocking effect is modeled in HG through the cumulative interaction of IDENTNASAL and IDENTPLACE. In order for an input sequence like /tʃp/ to map to an output sequence like [mp], both the nasality and the place of the first obstruent would need to be altered. If the summed weight of IDENTNASAL and IDENTPLACE is greater than the weight of DEP-V, however, the attested repair of epenthesis is preferred.

(12) Nasalization is blocked when input obstruent place is not identical

<table>
<thead>
<tr>
<th></th>
<th>AGRPLACE</th>
<th>SYLLCON</th>
<th>DEP-V</th>
<th>IDPLACE</th>
<th>IDNASAL</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>/peʃ'-peʃ'/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pet'petš'</td>
<td>-1</td>
<td>-1</td>
<td></td>
<td></td>
<td></td>
<td>-8</td>
</tr>
<tr>
<td>pempeš'</td>
<td></td>
<td></td>
<td></td>
<td>-1</td>
<td>-1</td>
<td>-4</td>
</tr>
<tr>
<td>peʃ'ipetš'</td>
<td></td>
<td></td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>-3</td>
</tr>
</tbody>
</table>

The analysis here relies on a comparison of mappings. Homorganic nasal + obstruent sequences, as in the suboptimal candidate [pempeʃ'], are perfectly licit in Ponapean, and both assimilation and nasalization are a well-attested repairs. When both assimilation and nasalization must apply to yield a licit sequence, however, epenthesis is deemed less costly. This is a cumulative faithfulness effect, with a single repair being selected when two distinct repairs would otherwise need to apply (Farris-Trimble 2008).

These same basic constraints cannot capture this pattern in OT. There, in order for assimilation to be preferred for forms like /n̞an-par/ → [n̞anpar], DEP-V must dominate IDENTPLACE. Likewise, in order for nasalization to be preferred for forms like /pap-pap/ → [pampap], DEP-V must dominate IDENTNASAL. If these two conditions hold, however, the combination of nasalization and assimilation is expected to be (wrongly) preferred even in forms like /pet' -pet'/, where input place is not identical.

(13) Ranking paradox in OT with simple constraints

<table>
<thead>
<tr>
<th></th>
<th>DEP-V</th>
<th>IDENTPLACE</th>
<th>IDENTNASAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>n̞anpar ~  n̞anpar</td>
<td>W</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>pam pap ~  pampap</td>
<td>W</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>peʃ'ipetš' ~ pempeš'</td>
<td>L</td>
<td>W</td>
<td>W</td>
</tr>
</tbody>
</table>

3.2 Blocking under non-optimal syllable contact conditions

The second condition under which nasalization is blocked emerges when the sonority profile of the input consonant sequence is rising – i.e., from an obstruent coda to a sonorant onset. Again, epenthesis is employed as a repair in this situation. This second blocking condition is independent of place; as the examples in (14) show, epenthesis in rising sonority sequences applies even when the intervocalic consonants have the same input place specification.

(14) Nasalization blocked given rising input sonority profile (Rehg & Sohl 1981: 61)

/net-net/  [netenet]  ‘smell’
/lus'-lus'/  [lu's'ulus']  ‘jump’
/roṭ-roṭ/  [roto'rot]  ‘dark’
Blocking is again modeled through cumulative interaction – this time between the faithfulness constraint IDENTNASAL and the markedness constraint SYLLABLECONTACT.

As (15) shows, provided that the summed weight of these two constraints is greater than the weight of DEP-V, epenthesis is preferred for input forms like /net-net/.

(15) Nasalization is blocked given a rising input sonority profile

<table>
<thead>
<tr>
<th>/net-net/</th>
<th>SYLLCON</th>
<th>DEP-V</th>
<th>IDENTNASAL</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>net-net</td>
<td>w = 4</td>
<td>w = 3</td>
<td>w = 2</td>
<td></td>
</tr>
<tr>
<td>net-net</td>
<td>-2</td>
<td>-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nen-net</td>
<td>-1</td>
<td>-1</td>
<td>-6</td>
<td></td>
</tr>
<tr>
<td>net-eten</td>
<td>-1</td>
<td>-3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Once more, blocking of nasalization relies on a comparison of mappings. The non-optimality of the candidate [nen-net] in (15) cannot be attributed to simple phonotactics, because intervocalic geminate nasals are admitted in Ponapean, including in reduplicative contexts – e.g., /mem-mem/ → [memmem] ‘sweet’. Likewise, the failure of nasalization cannot be attributed to a general dispreference for this process, given that it is well attested in cases where the input contains a sonority plateau (see 8). Epenthesis is preferred to nasalization just when the result of nasalization would be a non-ideal syllable contact sequence.

This blocking pattern cannot be captured using these simple constraints in OT, even if SYLLABLECONTACT is redefined using the two stringently-related constraints rather than a single scalar constraint (de Lacy 2002). The reasoning here parallels that seen in the previous section. In order for repair to be triggered, the version of SYLLCON that is violated by rising sonority sequences must dominate DEP-V. DEP-V must, in turn, dominate IDENTNASAL for nasalization to be preferred in forms like /pap-pap/ → [pampap] (see also 13), and also the version of SYLLCON that is violated by sonority rises and plateaux so that sonorant geminates are admitted in forms like /mem-mem/ → [memmem]. If these rankings hold, however, nasalization is expected to be (wrongly) preferred even for input forms like /net-net/.

(16) Ranking paradox in OT with these constraints

<table>
<thead>
<tr>
<th>W ~ L</th>
<th>SYLLCON</th>
<th>DEP-V</th>
<th>SYLLCON</th>
<th>IDENTNASAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>netnet ~ netnet</td>
<td>W</td>
<td>L</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>pam-pap ~ pam-pap</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>memmem ~ memmem</td>
<td>W</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>netnet ~ nen-net</td>
<td>L</td>
<td>W</td>
<td>W</td>
<td></td>
</tr>
</tbody>
</table>

3.3 Previous ranked constraint alternatives

In common with analyses of other phenomena where derivational history plays a role in statement of the relevant generalizations, previous OT treatments of the Ponapean interactions have depended in some way on hidden structure and/or reference to related output candidates. Goodman’s (1995) analysis, for instance, relies on a distinction between input morae and morae introduced through weight-by-position, while Davis’s
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(2000) analysis relies on faithfulness to the moraic structure of related output candidates within the framework of Sympathy Theory (McCarthy 1999). Additional OT analyses have addressed some aspect of the Ponapean pattern, but have not focused on the interaction of nasalization with assimilation and syllable contact (e.g., de Lacy 2002, Kennedy 2003, Spaelti 1997, Wilson 2001).

The HG approach captures the attested data and avoids the need for reference to hidden structure by directly admitting the possibility of cumulative constraint interaction. The result is a simple analysis that relies only on the interaction of basic markedness and faithfulness constraints and that does not require the learner to posit abstract structure for which there is no direct evidence.

4. Complexity in ordered-rule approaches

Part of the success of the constraint-based HG analysis of Ponapean lies in the fact that nasalization, assimilation and epenthesis conspire to ensure that the phonotactics of the language are respected – a fact that has been recognized in much earlier work (e.g., McCarthy & Prince 1986, Itô 1986, 1989, Kennedy 2003). This conspiracy, as well as the mutual exclusivity of the nasalization and assimilation processes, is evident Rehg & Sohl’s original expression of the rules.

(17) Assimilation: “When $n$ and a following consonant come together in speech, $n$ may become a nasal that agrees in position of articulation with the following consonant.” (Rehg & Sohl 1981: 56)

Nasalization: “When two identical voiceless consonants come together as a consequence of reduplication, the first will become a nasal that agrees in position of articulation with the second” (Rehg & Sohl 1981: 58)

The extent to which the rules in (17) overlap becomes apparent when they are translated into the rewrite formalism in (18).

(18) Assimilation: [+nasal, +coronal] → [αPlace] / __ [αPlace]

Nasalization: [–voice, αPlace] → [+nasal] / __ [–voice, αPlace]

Expressed in this fashion, it is clear that assimilation applies only to nasals, while nasalization applies only to sequences of segments that are already identical in place of articulation. These highly-specific definitions are necessary to ensure that the rules’ contexts are non-overlapping and that only one of these rules ever has the possibility of applying within a derivation. Any segment that becomes nasalized will necessarily already share a place of articulation with the following obstruent, obviating the need for any further process to apply. Likewise, any segment that assimilates due to the rule in (18) will necessarily already be nasal, again obviating the need for any further process to apply. Epenthesis, for its part, must be ordered after the assimilation and nasalization rules in the derivation, applying as a repair to ensure satisfaction of the language’s phonotactic restrictions. Epenthesis counterbleeds both assimilation and nasalization in this analysis.
The potential for interaction between nasalization and assimilation processes becomes clear when either of the rules in (18) is expressed in more general terms. To illustrate we can consider a revised version of nasalization rule (19), which demands simply that consonants be [+nasal] in coda position – cf. SYLLABLECONTACT.

(19) **General Nasalization:** \( C \rightarrow [+\text{nasal}] / \_ \_ \_ \sigma \)

If this general nasalization rule is ordered before the assimilation rule defined in (18), it (wrongly) creates contexts for the application of assimilation.

(20) **General Nasalization feeds Assimilation**

<table>
<thead>
<tr>
<th>/tk/</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Nasalization: ( C \rightarrow [+\text{nasal}] / _ _ _ \sigma )</td>
</tr>
<tr>
<td>Assimilation: [+nasal, +coronal] ( \rightarrow [\alpha \text{Place}] / _ _ [\alpha \text{Place}] )</td>
</tr>
<tr>
<td>*[\eta k]</td>
</tr>
</tbody>
</table>

The result of this feeding relationship is not phonotactically illicit in Ponapean – cf., /kak-kak/ \( \rightarrow [\text{kanj}kak] \) – but it is also not the attested result for input sequences like /tk/, where epenthesis is instead expected to apply.

Reversing the order of application of these rules, so that the relationship is one of counterfeeding, offers a partial solution to this problem. If Assimilation precedes General Nasalization, application of Assimilation will be blocked for forms like /tk/ because there is no coronal nasal present at the relevant point in the derivation. At the same time, however, simply requiring Assimilation to apply before General Nasalization is not a full solution. General Nasalization must also be blocked from applying to inputs like /tk/, yielding an illicit derivation like /tk/ \( \rightarrow *[\eta k] \), or, with subsequent epenthesis, /tk/ \( \rightarrow \eta k \rightarrow *[\eta Vk] \). For the attested result, a specific epenthesis rule must intervene between Assimilation and General Nasalization, as in (21) below.

(21) **General Nasalization counterfeeds Assimilation; Epenthesis intervenes**

| /tt/  | /\eta k/ | /tk/ |
|----------------|
| Assimilation (applies to coronal nasals) | -- | \( \eta k \) | -- |
| Epenthesis: \( \emptyset \rightarrow V / [\alpha \text{Place}] \_ [\alpha \text{Place}] \) | -- | -- | \( \Upsilon Vk \) |
| General Nasalization (applies to all C\( \sigma \)) | \( \eta t \) | -- | -- |
| \( [\eta t] \_ [\eta k] \_ [\Upsilon Vk] \) |

Epenthesis in the case of place disagreement must bleed the second of the two rules in a counterfeeding relationship, and counterbleed the first. Assimilation and nasalization are never permitted to jointly apply, or to apply independently when application of the other rule would also be needed in order for the phonotactic restrictions of the language to be met. Epenthesis must intervene. The product of the counterfeeding relationship between Assimilation and General Nasalization is counterbled by Epenthesis.

Adding further to the complexity of the rule-based analysis, a second epenthesis rule must be formulated to apply in cases of rising sonority consonant sequences. This rule
must apply before General Nasalization to yield derivations like /\texttt{net-\texttt{net}]/ \rightarrow [\texttt{net\texttt{e}net}], *

Epenthesis in the case of syllable contact violations must bleed nasalization.

\begin{tabular}{|c|c|c|}
\hline
 & /\texttt{t}/ & /\texttt{k}/ & /\texttt{n}/ \\
\hline
Epenthesis: $\emptyset \rightarrow \text{V} / [-\text{son}] \ __ [+\text{son}]$ & -- & -- & $\text{tVn}$ \\
Assimilation (applies to coronal nasals) & -- & $\text{nk}$ & -- \\
General Nasalization (applies to all C\textsubscript{\textit{c}}) & $\text{nt}$ & -- & -- \\
\hline
$[\text{nt}]$ & $[\text{nk}]$ & $[\text{tVn}]$ \\
\hline
\end{tabular}

The full set of rule interactions is given in (23).

\begin{enumerate}
\item[(22)] Epenthesis bleeds General Nasalization
\item[(23)] Rule interactions given General Nasalization
\end{enumerate}

In sum, while a consistent ordered-rule analysis of the Ponapean patterns is possible, it comes at the expense of simplicity. The ordered-rule analysis requires a set of highly-specific rules, and a very precise ordering of these, in order for the correct patterns to be derived. The HG analysis avoids these complications and layers of hidden structure, allowing the attested patterns to be modeled through the cumulative interaction of general constraints.

5. Blocking revisited

The bulk of the interactions in (23) are instances of mutual bleeding. This is true for the interaction between Assimilation and place-based Epenthesis, as well as for the interaction between General Nasalization and sonority-based Epenthesis. Given that bleeding interactions, and blocking more generally, can be readily modeled in OT (see esp. Baković 2013), and that the counterfeeding interaction between Assimilation and General Nasalization in (23) is essentially counterfactual, it is worth further considering why this particular system proves so challenging for a ranked-constraint model.

The answer here lies in the fact that the blocking pattern seen in Ponapean is dependent not on a single factor but on the co-occurrence of two factors. In rule-based frameworks, bleeding takes the form in (24a), where applying the rule $\text{AB} \rightarrow \text{BB}$ is blocked by the earlier occurrence of the rule $\text{AB} \rightarrow \text{CB}$, which destroys the opportunity for application of $\text{AB} \rightarrow \text{BB}$. In OT, the same interaction (24b) is modeled by having the
constraint violated through application of the “first” rule (here, *CB) be dominated by the constraint violated through application of the “second” rule (here *BB).

(24)  a. Bleeding in rule-based analysis

<table>
<thead>
<tr>
<th></th>
<th>/AB/</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB → CB</td>
<td>CB</td>
</tr>
<tr>
<td>AB → BB</td>
<td>blocked</td>
</tr>
</tbody>
</table>

b. Bleeding in OT

<table>
<thead>
<tr>
<th></th>
<th>/AB/</th>
<th>*AB</th>
<th>*BB</th>
<th>*CB</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td>(blocked by *AB &gt;&gt; *CB)</td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB</td>
<td>(blocked by *BB &gt;&gt; *CB)</td>
<td>!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>CB</td>
<td>(optimum)</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

In the Ponapean case, the rules AB → CB and AB → BB in (24a) can be understood as the Epenthesis and General Nasalization, respectively, with the ordering ensuring that Epenthesis and not General Nasalization applies. In the OT case (24b), the constraints *BB and *CB can be understood as IDENTNASAL and DEP-V, with their ranking ensuring that epenthesis is preferred to nasalization.

The problem here is that nasalization is not absolutely blocked in Ponapean. In the rule-based analysis in (23), this “non-absolute” aspect of the ordering is cashed out in two ways. First, both epenthesis rules are defined in a way that severely limits their application – to cases of an obstruent followed by a sonorant in the one instance, and to cases of place-disagreeing segments in the other. Second, the opportunity for the place-based epenthesis rule to apply is limited by the fact that it is bled by the earlier Assimilation rule. This combination of strategies is key.

Capturing the “non-absolute” aspect of the interaction using only ranked constraints is more complicated. In effect, DEP-V must be dominated not by simple IDENTNASAL, but by constraints with violation profiles like those in (25).

(25)  a. *[–son, –αPlace][–son, αPlace] → [+son, αPlace][–son, αPlace]
– i.e., Assign a violation mark to an input sequence of non-identical obstruents, where the first undergoes both place assimilation and nasalization.

b. *[–son][+son] → [+son][+son]
– i.e., Assign a violation mark to an input obstruent + sonorant sequence, where the first undergoes nasalization and the result is a sonority plateau.

Among the various OT constraint types discussed in the literature, P-Map constraints (Steriade 2001) probably come closest to the definitions in (25). We might understand (25b), for instance, to be a constraint like IDENT[–son]/[+son], which penalizes changes from [–sonorant] to [+sonorant] immediately before another [+sonorant] segment – a change that presumably reduces the perceptual contrast between the two segments. Targeted Constraints (Wilson 2001) and *MAP constraints (Zuraw 2007) offer similarly direct translations of the definitions in (25).

Alternatively, the effect of the constraints in (25) can be replicated through local constraint conjunction (Smolensky 1993, et seq.). This approach is arguably closest to that of HG from a formal perspective (but cf. Pater 2009a). In the Ponapean case, two locally conjoined constraints would be needed; these are given in (26).
(26)  a.  [IDENTPLACE &Segment IDENTNASAL]
Assign a violation mark to any input segment that differs from its output correspondent in specification for both in place of articulation and nasality.

b.  [IDENTNASAL &cc SYLLABLECONTACT]
Assign a violation mark to any sequence of two consonants where one of the input segments differs from its output correspondent in specification for nasality and the output sequence shows non-optimal syllable contact.

As the comparative tableau in (27) shows, both of these constraints must dominate Dep-V in order to achieve the desired blocking relationship, while Dep-V must dominate the general SyllableContact, IdentNasal and IdentPlace constraints.

(27)  Ranked constraints can model Ponapean blocking given complex constraints

<table>
<thead>
<tr>
<th></th>
<th>W ~ L</th>
<th>[IDENTPLACE &amp; Segment IDENTNASAL]</th>
<th>[IDENTNASAL &amp; cc SYLLABLECONTACT]</th>
<th>AgreePlace</th>
<th>Dep-V</th>
<th>SyllContact</th>
<th>IdentPlace</th>
<th>IdentNasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>nampar ~ nanpar</td>
<td>W</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nampar ~ nanapar</td>
<td>W</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pampap ~ pappap</td>
<td>W</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pampap ~ papapap</td>
<td>W</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>memmem ~ mememem</td>
<td>W</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>petʰpetʰ ~ pempetʰ</td>
<td>W</td>
<td>L</td>
<td></td>
<td>W</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>netenet ~ nenet</td>
<td>W</td>
<td>L</td>
<td>W</td>
<td>W</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There are a number of reasons to disfavour this approach relative to the HG analysis proposed in this paper. First, the constraints employed in the ranked-constraint analysis are notably more complex than those required when constraints are weighted. Whether the constraints in (25) are formalized through local constraint conjunction or through some other means, they necessarily make reference to the context of the potential violations. Second, it is necessary to overtly define the locus of violation for the complex constraints in the OT analysis. While this can sometimes be straightforwardly defined as the segment, as when two Ident constraints are conjoined in (26a), this is not always the case. The conjunction of IdentNasal and SyllableContact in (26b), for instance, requires that the domain be defined as a sequence of coda + onset consonants. This particular definition is somewhat dubious, made more so by the fact that violation of IdentNasal actually improves performance on SyllableContact in this case (cf. Łübowicz 2005). In HG, on the other hand, the domain in which constraints are able to interact need not be extrinsically defined. Rather, where, and how, cumulativity is possible is determined simply by the definitions of the constraints and the way in which they conflict. The result is a considerably more restrictive theory that allows precise predictions to be made about the typology of possible of complex process interactions.
6. Conclusion

This paper has argued that the blocking of nasalization in Ponapean is best analyzed through cumulative constraint interaction. The constraints required for analysis in HG are simple, and no serial derivation or reference to hidden structure is necessary. While it is not clear that all types of complex process interaction can be effectively modeled in this way, the current study shows that cumulativity allows for new analytical approaches to phonological patterns. This, in turn, offers possibilities for simpler learning procedures and clearer predictions about the expected range of blocking phenomena. The case presented here thus adds to the growing literature providing typological support for the adoption of weighted-constraint models, and suggests ways in which weighted constraints might facilitate our understanding of quasi-opaque phenomena.

References

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