Fed counterfeeding and positional reference: re-solving opacity

Opaque interactions have been recognised as a challenge for Optimality Theory (OT) for a long time. We show that although there has been considerable effort to bring opacity into the scope of OT, some types of process interactions are still problematic for the theory. Based on data from Tundra Nenets, we present and analyse a case of *fed counterfeeding* in which process A feeds process B, and B counterfeeds A. We argue that such interactions present a challenge to OT with Candidate Chains (OT-CC, McCarthy 2007) since the two interactions impose contradictory ranking requirements. We propose an extension of the theory that does not abandon its main assumptions and that makes fed counterfeeding analysable in OT-CC. This extension is based on the assumption that constraints can make reference to the position specified in a previous step in the derivation.

1. Introduction

Opacity in process interaction is an intensely scrutinised topic in the recent phonological literature. The reason for the attention to the issue is that classic Optimality Theory (OT) cannot handle the full variety of opacity cases. Most amendments to the theory proposed in the last decade or so can only address particular problems (see McCarthy 2007 for an overview).

McCarthy (2007) proposes a derivational extension of classic OT (Prince & Smolensky 1993/2004), OT with Candidate Chains (OT-CC), claimed to account for all known cases of opacity. In this article we investigate *fed counterfeeding*, a process interaction that is problematic for OT-CC. Fed counterfeeding refers to situations in which the same two processes are both in feeding (transparent) and counterfeeding (opaque) relations. We propose an amendment to the theory that enables it to account for fed counterfeeding, using Tundra Nenets as our primary example.

We will use a well-documented example from Lardil, an Australian Tangkic language (Hale 1973, Klokeid 1976, Ngakulmungan Kangka Leman 1997) to illustrate the nature
of the problem. Two word-final deletion processes, consonant deletion and vowel deletion, interact in Lardil. Nouns longer than two moras undergo apocope of the final vowel, as in (1)a, and non-apical consonants are deleted in word-final position, as in (1)b. (1) and (2) provide a comparison of nominatives that undergo apocope and deletion with non-future accusatives that do not undergo these processes since in the latter case the final vowel is protected by the apical suffix -n.

(1) a. Stem Nominative Gloss cf. Non-Future Acc. [H 424]  
/yiliyili/ yiliyil ‘oyster sp’ yiliyili-n [ibid.]  
/mayarra/ mayarr ‘rainbow’ mayarra-n [ibid.]  
/wiwalal/ wiwal ‘bush mango’ wiwala-n [ibid.]

b. /wangalk/ wangal ‘boomerang’ wangalk-in [H 438]  
/thurarrang/ thurarra ‘shark’ thurarrang-in [ibid.]  
/wungkunung/ wungkunu ‘queenfish’ wungkunung-in [ibid.]

The examples in (2) demonstrate that consonant deletion is triggered by apocope. However, apocope does not apply to vowels that are made final by consonant deletion (and thus, consonant deletion counterfeeds apocope).

(2) Stem Nominative Gloss cf. Non-Future Acc. [H 425]  
/bulumunidami/ bulumunda ‘female dugong’ bulumunidami-n [ibid.]  
/yukarrba/ yukarr ‘husband’ yukarrba-n [ibid.]  
/karrwakarrwa/ karrwakarr ‘tree sp, wattle’ karrwakarrwa-n [ibid.]  
/dibirdibi/ dibirdi ‘rock cod’ dibirdibi-n [ibid.]  
/mungkumungku/ mungkumu ‘wooden axe’ mungkumungku-n [K 52]

In rule terms, the derivations of the examples above can be recast as in (3).

(3) Feeding+Counterfeeding

Input wangalk yiliyili dibirdibi  
Apocope n/a yiliyil dibirdib  
C-deletion wangal n/a dibirdi  
Output wangal yiliyil dibirdi

While the rule-based analysis in (3) accounts for the pattern of fed counterfeeding, this interaction presents a problem for OT. Both the input and the output in a mapping like /dibirdibi/ → [dibirdi] end in a vowel and thus defining the constraint or constraints responsible for this alternation is not trivial. The generalisation that words do not end in a vowel is not surface-true.

Interestingly, this situation is also problematic for OT-CC, as feeding and counterfeeding impose contradictory ranking requirements. Each step in an OT-CC chain must improve harmony (see section 2). Therefore the ordering relations such as the ones

1 We adhere to the Lardil orthography introduced in Ngakulmungan Kangka Leman (1997) [NKL] dictionary even when we cite examples from other sources, such as Klokeid (1976) [K] and Hale (1973) [H].
in Lardil directly translate into rankings of markedness constraints. The rankings needed for “A feeds B” and “B counterfeeds A” contradict each other. This situation arises because in OT-CC counterfeeding is analysed as feeding with an additional blocking mechanism of a PRECEDENCE (PREC) constraint.

This paper is structured as follows. We outline the predictions of OT-CC with respect to feeding and counterfeeding in section 2. Section 3 presents the relevant Tundra Nenets data and addresses the problem of generating harmonic chains for fed counterfeeding. To solve the problem, we propose that markedness constraints can make reference to a position in the output of the previous step in the chain. Our analysis of Tundra Nenets is further developed in section 4. To account for opacity in Tundra Nenets, section 4 introduces a modification of the PREC(A, B) constraint of McCarthy (2007) so that the constraint is violated whenever there is no violation of B in the chain. Section 5 follows with the theoretical and typological implications of the proposed analysis. Section 6 addresses alternative analyses of the data and identifies a challenge that the Tundra Nenets data presents for Stratal OT (section 6.3). While OT-CC connects feeding (and counterfeeding) to a specific ranking of markedness constraints, Stratal OT connects the interaction of processes (or their ordering) to morphology. Although neither prediction is borne out, OT-CC proves to be more flexible in that it can be modified to accommodate the range of data under consideration (see also Jacobs 2008).

2. Predictions of OT-CC with respect to feeding and counterfeeding

In this section, we will highlight the features of OT-CC that predict the impossibility of fed counterfeeding. We will first briefly describe the relevant components of the theory (section 2.1) and then formulate the predictions of OT-CC with respect to the range of possible interactions between phonological processes (section 2.2).

2.1 Basic architecture of OT-CC and its analysis of opacity

In OT-CC, the output is reached from the input via a series of steps (a candidate chain). Each step constitutes a selection of possible continuations based on constrained Gen and Eval.

Each step’s Gen performs one basic operation at a time. More formally, this requirement (dubbed gradualness) is equivalent to the introduction of one violation of one basic faithfulness constraint per step, where basic faithfulness includes MAX, DEP, IDENT and probably some version of LINEARITY (see McCarthy 2007: 77-93 for further discussion).

In a version of OT-CC developed in McCarthy (2007), faithfulness constraints compare each form to the original input (see McCarthy 2006 for an exploration of another possible view – faithfulness with respect to the previous step output, i.e., the immediate input).

The first step is assumed to be the most harmonic faithful parse of the input. Every other step’s input equals the output of the previous step.
All valid steps must introduce unfaithfulness, that is, fully faithful steps are prohibited. Additionally, each step must improve harmony (harmonic improvement)\(^2\) and provide an optimal way of violating the given basic faithfulness constraint (best violation). Both of these requirements are evaluated against the same language-specific constraint hierarchy.

There is no requirement that each step’s output be the most harmonic form. Thus, if a given marked configuration can be repaired by violating either MAX or DEP, both repairs would represent valid ways of producing the next form as long as they improve harmony. Out of the candidates that violate the same basic faithfulness constraint, only one is selected.

Opaque interactions are captured in OT-CC by a special family of PRECEDENCE (PREC) constraints that essentially require that faithfulness violations in the chain come in a certain order. PREC constraints do not affect chain formation in that they do not count for the evaluation of harmonic improvement and best violation.

Thus, in addition to chain formation steps, there is one more step at which different candidate chains from the same input are evaluated against the full constraint hierarchy, including the PREC constraints. At this chain evaluation step, the output for each chain equals the output of the previous step. To be evaluated, each chain is confronted with the sequence of faithfulness violations that the forms in it incur. A single violation of one basic faithfulness constraint (a localised unfaithful mapping or LUM) represents one step. Each chain has a correspondent set of LUMs — \(\mathcal{L}\)-set — as well as an ordering of the elements in this set — LUMSeq.

The LUMSeq is further reduced to include only the crucial orderings of faithfulness violations. The orderings that can be different without any consequences for the output are eliminated (see McCarthy 2007 for a full description of this procedure).

McCarthy’s (2007) definition of a candidate in OT-CC is given in (4), and the definition of how PREC assesses a candidate is in (5).

(4) Candidate in OT-CC (McCarthy 2007: 97)
A candidate is an ordered 4-tuple \((in, out, \mathcal{L}\text{-set}, rL)\), where
\(in\) is a linguistic form, the input;
\(out\) is a linguistic form, the output;
\(\mathcal{L}\text{-set}\) is a set of LUMs on \(in \rightarrow out\);
\(rL\) is a partial order on a subset of \(\mathcal{L}\text{-set}\)

(5) PREC(A, B)(cand) (McCarthy 2007: 98)
Let \(A’\) and \(B’\) stand for LUMs that violate the faithfulness constraints \(A\) and \(B\), respectively.
Let \(cand=(in, out, \mathcal{L}, rL)\)
i. \(\forall B’ \in \mathcal{L} \text{ assign a violation mark if } \neg \exists A’ \in \mathcal{L} \text{ where } <A’, B’> \in rL\)
ii. \(\forall B’ \in \mathcal{L} \text{ assign a violation mark if } \exists A’ \in \mathcal{L} \text{ where } <B’, A’> \in rL\)

\(^2\) As Alan Prince (p. c.) points out, harmonic improvement per se is in fact a property of any OT grammar. Thus, harmonic improvement is only motivated as a separate principle by the fact that at each step the chain may have many possible continuations.
Informally, PREC(A, B) requires that all violations of B are preceded by and not followed by violations of A.

There is one more component in the OT-CC approach to opacity. The ranking metaconstraint in (6) requires the faithfulness constraint B to universally outrank PREC(A, B).

(6) Ranking Metaconstraint (McCarthy 2007: 99)
\[ B >> \text{PREC}(A, B) \]

The ranking metaconstraint is necessary to ensure that violations of PREC constraints depend on, but do not affect, whether the individual faithfulness constraints are violated. The ranking metaconstraint will be further discussed in section 4.3. We now turn to the predictions of OT-CC with respect to the range of possible process interactions.

2.2 Feeding in OT-CC: No mutual (counter)feeding

In the previous section we briefly reviewed the basic properties of the OT-CC approach to opacity. According to this theory, in opaque interactions the transparent candidate is blocked by PREC. Thus, the rankings of markedness and faithfulness constraints are the same for bleeding and counterbleeding, as well as for feeding and counterfeeding (the ranking of PREC being the only difference). This approach predicts that the range of possible opaque interactions coincides with the range of possible transparent interactions. We will argue that this prediction is too strong in one particular case.

Let us consider what feeding (and counterfeeding) would amount to in OT and OT-CC. As Wolf (2009) shows, there is no direct translation of notions like counterfeeding to OT. In what follows, we will be concerned with the (counter)feeding interactions of the triggering type, that is, interactions where the satisfaction of one markedness constraint introduces violations of another one. Opaque interactions of this kind are known as counterfeeding on environment (McCarthy 1999, Baković 2007, to appear). Other (counter)feeding interactions (i.e., counterfeeding on focus) are better translated into OT as cases where satisfying one constraint removes violations of some blocker-constraint and makes it possible to satisfy a third constraint (see Wolf 2009 for discussion). Counterfeeding on focus is generally unproblematic for OT (see Baković to appear and references therein).

We would like to focus on what may be called “triggering feeding.” We will use the term “feeding” to refer to processes that fall under the generalization in (7) where \( M_A \) and \( M_B \) represent markedness constraints whose satisfaction corresponds to processes A and B.

(7) In OT, process A feeds process B if satisfying \( M_A \) introduces violations of \( M_B \)

OT-CC imposes more requirements than classic OT. Since in the triggering feeding interaction satisfying \( M_A \) introduces violations of \( M_B \), there is only one way in which a feeding step can improve harmony. \( M_A \) should dominate \( M_B \) for a feeding interaction to go through.

(8) Feeding ranking in OT-CC: \( M_A >> M_B \)
The ranking condition in (8) follows from the basic properties of OT-CC and makes an important prediction: mutual feeding is impossible. In other words, OT-CC predicts that it is impossible for A to feed B and B to feed A in the same language, since this kind of interaction imposes contradictory requirements on the ranking of $M_A$ and $M_B$.

The fact that OT-CC excludes mutual feeding is arguably a virtue of the theory. The exclusion is responsible for OT-CC’s inability to analyse the Duke-of-York derivations or the hypothetical shrink-all-words-to-nasal languages (see McCarthy 2007: 60-99 for details).

However, this very fact coupled with the OT-CC approach to opacity yields more dangerous predictions. Specifically, counterfeeding in OT-CC is just like feeding plus the blocking mechanism of PREC. Therefore, all the predictions of OT-CC with respect to feeding can be generalised to counterfeeding as well.

In (9), the prediction of OT-CC with respect to counterfeeding is summarised.

(9) The following situation is predicted to be impossible in OT-CC:

\[ \text{A (counter)feeds B and B (counter)feeds A}^3 \]

We will argue that this prediction is too strong because situations in which B feeds A and then ceases to be active while A creates an environment in which B could apply are attested. For example, Lardil vowel deletion creates illicit codas while coda consonant deletion creates new word-final vowels, which in turn do not delete. In the following section, we turn to yet another example of fed counterfeeding that is attested in Tundra Nenets.

3. Tundra Nenets

In this section, we introduce a case of fed counterfeeding in Tundra Nenets. Section 3.1 presents the Tundra Nenets data and provides the motivation for the constraints we postulate, and section 3.2 develops the proposal of the previous step constraints. An analysis of Tundra Nenets opacity follows in section 4.

3.1 Data and constraints

Tundra Nenets (TN) is a Uralic language spoken in Arctic Russia and Northern Siberia (Castrén 1854; Janhunen 1984, 1986, 1993; Lehtisalo 1956; Salminen 1993, 1997, 1998a, 1998b, 2008; Tereshchenko 1947, 1956, 1965; among others). The data come from the authors’ fieldwork on the Malaya Zemlya dialect of Western TN. Six female speakers ranging in age from forty-four to sixty-five participated in the study. All speakers were born and raised in the same area (the Nenets district of Russia) and lived in the village of Nelmin Nos at the time of the recording. Five out of the six speakers did not speak any Russian until they went to school at the age of seven.

\[ \text{Given the ranking transitivity, this statement can be further generalised. OT-CC predicts the following set of situations to be impossible: A (counter)feeds B and there is a sequence of processes } P_1 \ldots P_n \text{ such that B (counter)feeds } P_1 \text{ and for every } i \ P_i \text{ (counter)feeds } P_{i+1} \text{ and } P_n \text{ (counter)feeds A.} \]
The vowel inventory of the particular dialect addressed in this study is shown in (10), and the consonantal inventory is presented in (11) (see section 6.1 for a comparison with previous descriptions).

(10) **Tundra Nenets vowel inventory**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>i</td>
<td>i'</td>
</tr>
<tr>
<td>u</td>
<td>u'</td>
</tr>
<tr>
<td>e</td>
<td></td>
</tr>
<tr>
<td>o</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td></td>
</tr>
</tbody>
</table>

(11) **Tundra Nenets consonantal inventory**

<table>
<thead>
<tr>
<th></th>
<th>labial</th>
<th>dental</th>
<th>palatal</th>
<th>velar</th>
<th>glottal</th>
</tr>
</thead>
<tbody>
<tr>
<td>stops</td>
<td>p p¹ b b¹</td>
<td>t t¹ d d¹</td>
<td>k q</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>nasals</td>
<td>m m¹</td>
<td>n n¹</td>
<td></td>
<td>η</td>
<td></td>
</tr>
<tr>
<td>fricatives</td>
<td>s s¹ z z¹</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>affricates</td>
<td>ts ts¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>liquids</td>
<td>r r¹ l l¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>glides</td>
<td>w w¹</td>
<td></td>
<td>j</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The syllable template in TN is of the form CV(CC), with one consonant in the onset and up to two consonants in the coda. The segmental composition of word-medial codas is governed by the Sonority Sequencing Principle: only codas of falling sonority are allowed. Word-finally, a richer set of codas is created by vowel deletion described below.

The two interacting processes that we are concerned with are word-final debuccalisation and apocope. The input consonants /t/, /d/, /s/, /n/ and /ŋ/ debuccalise in word-final position, yielding a surface glottal stop. The examples in (12) illustrate the application of debuccalisation.4

(12) **Debuccalisation:** t, d, s, n and η change to a ? word-finally

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>/m'at/</td>
<td>m'ata</td>
<td>‘tent-NOM.SG’</td>
<td></td>
</tr>
<tr>
<td>cf. /m'at-ta/</td>
<td></td>
<td>‘tent-POSS.3SG’</td>
<td></td>
</tr>
<tr>
<td>/jan/</td>
<td>jaʔ</td>
<td>‘soot-NOM.SG’</td>
<td></td>
</tr>
<tr>
<td>cf. /jan-ta/</td>
<td>janda</td>
<td>‘soot-POSS.3SG’</td>
<td></td>
</tr>
<tr>
<td>/s'in/</td>
<td>s'iʔ</td>
<td>‘lid-NOM.SG’</td>
<td></td>
</tr>
<tr>
<td>cf. /s'in-ta/</td>
<td>s'inda</td>
<td>‘lid-POSS.3SG’</td>
<td></td>
</tr>
<tr>
<td>/wiŋ/</td>
<td>wiʔ</td>
<td>‘tundra-NOM.SG’</td>
<td></td>
</tr>
<tr>
<td>cf. /wi'n-ta/</td>
<td>wi'nda</td>
<td>‘tundra-POSS.3SG’</td>
<td></td>
</tr>
</tbody>
</table>

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4 Several examples in (12) and (14) show the effects of post-nasal and post-vocalic voicing of labial and dental stops, for instance, ‘soot-POSS.3SG’ and ‘house-NOM.SG.’ Note also that nasals assimilate in place to the following stops.
| /ma₃s/       | ma₃?⁵ | ‘place on chest under the outer layer of clothing-NOM.SG’  
|            |     | [Salminen 1998a: 317] |
| cf. /ma₃s−A₃?/ | ma₃s?⁶ | ‘place on chest under the outer layer of clothing-GEN.SG’ |

The second process of interest is apocope. As shown in (13), the vowel Λ deletes word-finally.

(13) **Word-final deletion of Λ**

<table>
<thead>
<tr>
<th>Word</th>
<th>/xl̂a/</th>
<th>x̂la</th>
<th>‘steam-NOM.SG’</th>
</tr>
</thead>
<tbody>
<tr>
<td>/talma/</td>
<td>t̂alm</td>
<td>‘cloudiness-NOM.SG’</td>
<td></td>
</tr>
</tbody>
</table>

The apocope of Λ makes debuccalisation non-surface-true. The examples in (14) show that the process of final Λ-deletion creates surface consonants [t], [d], [s], and [n]⁷ that are word-final and thus expected to undergo debuccalisation, but nevertheless do not debuccalise. The presence of the word-final vowel in these examples is manifested in alternations like /x̂a₅̂ₐₐ/ [xₐ̂ₐd] ‘house’ vs. /xₐ₅ₐₐₐₐ/ [xₐₐₐₐₐₐ] ‘house-3SG.POSS.’

(14) **Apocope counterfeeds debuccalisation**

<table>
<thead>
<tr>
<th>Word</th>
<th>/n̂₃₎₃ₐₜₐ/</th>
<th>n̂₃₅₃ₐₜ₉</th>
<th>*n̂₃₅₃ₐₚ</th>
<th>‘otter-NOM.SG’</th>
</tr>
</thead>
<tbody>
<tr>
<td>/xₐ₅ₐₐ/</td>
<td>xₐ₅ₐₐ</td>
<td>*xₐ₅ₐₙ</td>
<td>‘house-NOM.SG’</td>
<td></td>
</tr>
<tr>
<td>/xₐₚₐ/</td>
<td>xₐₚₐ</td>
<td>*xₐₚ</td>
<td>‘snowstorm-NOM.SG’</td>
<td></td>
</tr>
<tr>
<td>/ₚₙ₉ₐ/</td>
<td>n̂ₚₚₐ</td>
<td>*ₚₚₚ</td>
<td>‘long sledge with wooden top’</td>
<td></td>
</tr>
<tr>
<td>/ₚₚₐ/</td>
<td>t̂ₚₚₐ</td>
<td>*ₚₚ</td>
<td>‘whole’</td>
<td></td>
</tr>
<tr>
<td>/ₚₐₐₐ/</td>
<td>xₚₐ</td>
<td>*ₚₐₚ</td>
<td>‘sledge-NOM.SG’</td>
<td></td>
</tr>
</tbody>
</table>

The examples in (15) present an additional environment for Λ-deletion. The vowel also deletes before the word-final glottal stop. Deletion applies only if Λ is separated from the right edge of the word by one consonant: the vowel does not delete in words that end in a cluster of a consonant followed by a glottal stop, as in [Jonₐₕ?] ‘thousand.’

(15) **Apocope and debuccalisation: Λ is deleted before word-final ?**

<table>
<thead>
<tr>
<th>Word</th>
<th>/t̂ₚₐim⁻jₐ⁻ₙₐ⁻s/</th>
<th>t̂ₚₐim$j$_</th>
<th>‘it rotted’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>rot-REFL-3SG.REFL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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⁵ The surface long vowel in [ma₃?] is a result of vowel coalescence.

⁶ The deletion of /Λ/ before a word-final glottal stop will be discussed below.

⁷ The example with the word-final [ŋ] is missing since /ŋ/ does not seem to occur before the underlying word-final /Λ/. We consider this an accidental gap.
The generalisation that unifies the deletion processes in the examples in (14) and (15) is that vowel deletes at the right edge of the prosodic word with an optional glottal stop intervening. After Clements (1985), Steriade (1987), Lloret (1995), Broselow (2001), McCarthy (2008b), and many others, we assume that the glottal stop lacks place features (see Gafos & Lombardi 1999 for an alternative view). Additionally, we assume that vowel place and consonant place are on the same tier (Gafos & Lombardi 1999). When a vowel is immediately followed by a word-final glottal, the vowel’s place is still at the prosodic word edge (unlike situations when the word-final consonant is anything other than a glottal). Therefore, the vowel deletion process can be generally termed apocope because it applies at the right edge of the word.

The examples in (15) demonstrate that debuccalisation feeds apocope. Compare, for instance, the reflexive and reflexive preterite forms of the verb ‘appear suddenly’ in (15)b. In the first form, the word-final /-s/ of the 3rd singular reflexive suffix debuccalises, and the vowel before it deletes. In the second form, the consonant is not word-final: the final vowel deletes, the /s-sj/ cluster surfaces as [ts j], and the vowel preceding it does not delete.

Thus, when a word-final consonant debuccalises, the preceding λ deletes (debuccalisation feeds apocope), but when a word-final vowel is deleted, the consonant that precedes it does not debuccalise, nor is the preceding vowel deleted (apocope...
counterfeeds debuccalisation). This example of fed counterfeeding is analogous to the Lardil example discussed in section 1 and is predicted to be nonexistent by OT-CC. In (16), we suggest what the derivation of the relevant examples would be in rule terms. Crucially, according to the rule-based analysis, debuccalisation would be ordered before apocope and would condition it while apocope would counterfeed debuccalisation at the same time.

(16) Tundra Nenets debuccalisation and apocope in rule terms

<table>
<thead>
<tr>
<th></th>
<th>Feeding</th>
<th>Counterfeeding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
<td>前沿</td>
<td>xadλ</td>
</tr>
<tr>
<td><strong>Debuccalisation</strong></td>
<td>前沿λ?</td>
<td>---</td>
</tr>
<tr>
<td><strong>Apocope</strong></td>
<td>前沿и?</td>
<td>xad</td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td>前沿и?</td>
<td>xad</td>
</tr>
</tbody>
</table>

Let us now consider what constraints motivate apocope and debuccalisation. We propose that the word-final debuccalisation of consonants stems from a constraint (17), holding that the presence of consonantal place features at a prosodic word boundary incurs a violation (cf. McCarthy 2008b on debuccalisation in serial OT).

(17) *C-Pl[PrWd]: No C-Place features at the right P-Word boundary.

To account for the deletion of word-final λ,8 we need to take into consideration the fact that λ is the least sonorous vowel of TN (cf. Kavitskaya under revision on the duration and other phonetic properties of λ). The deletion of low-sonority vowels appears to be a well-attested phenomenon: there are plenty of languages that allow for the deletion of only the least sonorous vowel in the inventory, e.g., the high front vowel in Palestinian Arabic (Brame 1974) or the schwa in English.

Interestingly, de Lacy (2002, 2006) and Gouskova (2003) argue that minimally prominent vowels are unmarked in non-prominent positions, and thus it is expected that the least sonorous λ should be unmarked word-finally. Nevertheless, this vowel is specifically targeted by word-final deletion.

There are two possible analyses of the TN pattern of vowel deletion. First, according to a stringent theory of faithfulness constraints (de Lacy 2002, 2006), we might assume that all vowels are penalised word-finally, but high-sonority vowels are specifically preserved while λ is not protected by high-ranked faithfulness (cf. Gouskova 2003: 240–245 on differentiated faithfulness constraints).

Second, we can hypothesise that the right edge of the word does not necessarily pattern with word-medial metrically weak positions,9 and that markedness constraints work differently with respect to the word-final position as opposed to weak branches of

---

8 Another process of vowel deletion exists in TN: metrical vowel deletion. Just like apocope, metrical vowel deletion affects only the vowel λ. However, the conditions for this deletion are quite different and require a separate set of constraints. An analysis of metrical vowel deletion in TN is outside of the scope of this paper.

9 Kavitskaya & Staroverov (2008) present preliminary evidence that word-final syllables are extrametrical in TN. See also McCarthy (2008a: 27–29) for a discussion of a typology of syncope that distinguishes between vowels in weak branches of feet and extrametrical vowels.
feet. Furthermore, more prominent vowels can arguably satisfy the goal of marking word boundaries better than less prominent ones. Therefore, it is not surprising that low-sonority vowels are avoided in this context in TN.

Either of the analytical options will work for our purposes. For expository reasons we will adopt the constraint *LOWSON-PL]PRWD in (18), which targets the least sonorous vowel at the PWord boundary.

(18) *LOWSON-PL]PRWD: No low sonority V-Place features at the right P-Word boundary.

The faithfulness constraints we use are as follows: MAXCor (McCarthy 2008b) prohibits the deletion of coronal place (MAXVelar, which prohibits the deletion of dorsal place, is necessary for the debuccalisation of /ŋ/), and MAXV prohibits vowel deletion. In TN, MAX is violated in response to the constraints driving apocope and debuccalisation, and hence we assume that all the faithfulness constraints responsible for the alternative repairs are ranked higher than MAX. We will not list these faithfulness constraints in the tableaux below.

In the original OT-CC, it is impossible to rank the constraints in (17) and (18). Satisfying *LOWSON-PL]PRWD in TN introduces violations of *C-PL]PRWD and vice versa. If we assume that *LOWSON-PL]PRWD dominates *C-PL]PRWD, only the counterfeeding interaction would be predicted. The opposite ranking predicts only feeding. This is illustrated by the tableaux in (19) and (20).

The tableau in (19) illustrates one step in an OT-CC derivation: the debuccalisation of the final consonant in the derivation of \[\text{t}imj\̄\] ‘it rotted’ (the step \[\text{t}imj\̄s, t\imja?\] in the chain \[\text{t}imj\̄s, t\imja?, t\imj?\]). The tableau demonstrates that *C-PL]PRWD should dominate *LOWSON-PL]PRWD for the feeding step to improve harmony. The output of the previous step (or the most harmonic faithful parse of the input) and forms that violate the same basic faithfulness constraint (in our case, MAXCor) are under consideration. The opacity constraint is irrelevant in (19), since Prec constraints do not participate in the evaluation until the chains are formed.

(19) Feeding requires *C-PL]PRWD >> *LOWSON-PL]PRWD

Input: /t\imj\̄s/

<table>
<thead>
<tr>
<th>Prev. output:</th>
<th>t\imj\̄s</th>
<th>step</th>
<th>*C-PL]PRWD</th>
<th>*LOWSON-PL]PRWD</th>
<th>MaxV</th>
<th>MaxCor</th>
</tr>
</thead>
<tbody>
<tr>
<td>t\imj\̄s?</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>t\imj\̄s</td>
<td>W_1</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10 In the rest of the paper, we use comparative tableaux (Prince 2002). The winning candidate appears to the right of the arrow (the format used in McCarthy 2007), and the losing candidates are in the other rows. The number of violations incurred by a candidate is denoted by subscripted integers. In the losing rows, W indicates that the constraint in question favors the winner, and L indicates that it favors the loser.
The tableau in (20) illustrates the next step: apocope in the derivation of ‘it rotted’ (the step $t'\text{imja}\text{?}$, $t'\text{imj}\text{?}$) in the chain $t'\text{imja}\text{?,} t'\text{imja}\text{?,} t'\text{imj}\text{?}$). In this case, the output of the previous step and forms that violate the same basic faithfulness constraint MAXV are considered. In order for the first candidate to win, *LOWSON-PL\[PRWD should dominate *C-PL\[PRWD and MAXV.

(20) Counterfeeding requires *LOWSON-PL\[PRWD >> *C-PL\[PRWD

\begin{tabular}{|c|c|c|c|}
\hline
Prev. step output: & $t'\text{imj}\text{?}$ & MAXV & $t'\text{imj}\text{?}$
\hline
$t'\text{imj}\text{?}$ & *LOWSON-PL\[PRWD & 1 & L
\hline
$t'\text{imja}\text{?}$ & MAXV & L & L
\hline
\end{tabular}

For the chain leading to the actual output to be harmonically improving, both of the rankings suggested in (19) and (20) must hold. However, the two ranking requirements are contradictory, and therefore the chain $t'\text{imja}\text{?,} t'\text{imja}\text{?,} t'\text{imj}\text{?}$ cannot be formed.

A question that arises is how to make such a chain harmonically improving. In response to this problem, we argue that the markedness constraints that are responsible for the problematic interaction refer to a position specified in the output of the previous step in the derivation.

### 3.2 Reference to a position in the previous step

This section justifies the assumption that markedness constraints can refer to a position in a previous step in the chain. The original motivation for this assumption comes from the too-many-solutions problems of various kinds (Blumenfeld 2006; McCarthy 2008a, 2008b; de Lacy 2003; Steriade 2001; van Oostendorp 2007). Jesney (to appear) and Staroverov (to appear) present evidence that many of the too-many-solutions problems arise when a markedness or faithfulness constraint enforces a modification of the position where a given marked element is situated, but not the element itself. No such prediction is made if constraints can make reference to a position in the output of the previous step in the derivation.

For example, the positional faithfulness constraint IDENTONS-VOICE and the markedness constraint *VOICEDOBS are often used to analyse voicing neutralisation in the coda. However, if both of these constraints dominate the general IDENT-VOICE and ONSET, an unattested pattern is predicted in which an input like /pada/ surfaces with the medial consonant devoiced and syllabified in the coda, as in [pat.a] (after Beckman 1998: 36 fn. 27, citing a personal communication from Rolf Noyer; McCarthy 2007: 73 dubs this situation the Beckman-Noyer problem). This prediction disappears if the constraint IDENTONS-VOICE is assumed to protect segments that are in the onset of the output of the previous step. Indeed, syllabifying /d/ as a coda at any given step would no longer satisfy this previous-step-referring version of IDENTONS-VOICE and hence would not be a solution (see Jesney to appear and Staroverov to appear for details).

Thus there is an independently motivated class of position-referring markedness constraints that specify a particular position in the output of the previous step (in the
previous step for short) and penalise a marked element if its correspondent is in that position. We argue that TN constraints are exactly of this kind.

We will refer to the constraints specifying position in the previous step as PS-constraints (for ‘previous step’). The symbol “∅” is appended to constraint names to indicate reference to the previous step. We assume that instead of an apocope constraint *LOWSON-PL]PRWD that penalises vowels of low sonority at the end of a prosodic word, there is a constraint ∅*LOWSON-PL]PRWD, which is defined as in (21). The ∅*C-PL]PRWD constraint replacing the *C-PL]PRWD used in the previous section is defined in (22).11

(21) ∅*LOWSON-PL]PRWD: Given a chain c, let x be a segment in the first form (=input), x’ be its correspondent in the form under evaluation (=output if c is valid), and x’’ be its correspondent in the penultimate form of c. If the V-place features of x’’ are at the right PWord boundary, assign a violation mark if x’ is of low sonority and has V-Place features.

(22) ∅*C-PL]PRWD: Given a chain c, let x be a segment in the first form (=input), x’ be its correspondent in the form under evaluation (=output if c is valid), and x’’ be its correspondent in the penultimate form of c. If the C-Place features of x’’ are at the right PWord boundary, assign a violation mark if x’ has C-Place features.

Before we proceed to our analysis of TN, a few additional properties of PS-constraints must be spelled out.

First, PS-constraints act as regular markedness constraints at the last step of chain evaluation (i.e., at the step when PREC constraints are assessed). Indeed, the candidate output of that step equals the output of the previous step for each chain in the comparison. Furthermore, each OT-CC derivation necessarily has a step of chain comparison. Therefore, all derivations are subject to PS-constraints.

Second, we assume that at the chain initiation where the most harmonic faithful parse of the input is selected, all PS-constraints are vacuously satisfied because there is no previous step. However, once the initial form of the chain is selected, PS-constraints become active.

As the newly defined constraints refer to a position in the previous step, modifying the position of a segment does not immediately introduce a violation of the PS-constraints. This is why satisfying another markedness constraint is allowed until the next step, where the violation pops up.

Tableau (23) illustrates the debuccalisation step in the derivation of [t’imjʔ]. The PS-constraint ∅*LOWSON-PL]PRWD checks if the segment that was prosodic-word-final in the previous step is a low sonority vowel in the current candidate output. For the constraint to be violated, the prosodic structure must be already assigned, and we assume this to be the case. Thus, the previous step’s output in (23) has the prosodic structure that the input might lack. Crucially, the winner in (23) does not violate ∅*LOWSON-PL]PRWD since in the previous step the vowel is separated from the right edge of the prosodic word by a consonant other than the glottal stop (the bracketed violation indicates a violation that

11 The issue of whether PS-constraints should co-exist with their traditional counterparts is irrelevant to our analysis of fed counterfeeding. See section 5.1 for discussion.
will emerge in the next step). In tableau (23) the violation of $\exists^*\text{LOWSON-PL}\text{PRWD}$ does not occur when the harmonic improvement decisions are made. Comparing the winner with the faithful candidate demonstrates that $\exists^*\text{C-PL}\text{PRWD}$ must dominate $\text{MAXCOR}$.

(23) Tundra Nenets: debuccalisation is allowed to feed apocope

<table>
<thead>
<tr>
<th>Prev. step output</th>
<th>$\exists^*\text{LOWSON-PL}\text{PRWD}$</th>
<th>$\exists^*\text{C-PL}\text{PRWD}$</th>
<th>$\text{MAXV}$</th>
<th>$\text{MAXCOR}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t^\text{i}\text{m}\text{j}\text{a}$?</td>
<td>(1)</td>
<td></td>
<td>$W_1$</td>
<td>$L$</td>
</tr>
<tr>
<td>$t^\text{i}\text{m}\text{j}\text{a}$</td>
<td>$t^\text{i}\text{m}\text{j}\text{i}$</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

In the next step, illustrated in (24), there is a vowel whose position satisfies the definition of $\exists^*\text{LOWSON-PL}\text{PRWD}$ (because this vowel has place features, and its place features are word-final in the previous step’s output $t^\text{i}\text{m}\text{j}\text{a}$?) and therefore apocope is harmonically improving. Crucially, $\exists^*\text{LOWSON-PL}\text{PRWD}$ dominates the faithfulness constraint $\text{MAXV}$. The parenthesised violation indicates that a violation of $\exists^*\text{C-PL}\text{PRWD}$ will emerge in the next step.

(24) Tundra Nenets: apocope applies in the next step

<table>
<thead>
<tr>
<th>Prev. step output</th>
<th>$\exists^*\text{LOWSON-PL}\text{PRWD}$</th>
<th>$\exists^*\text{C-PL}\text{PRWD}$</th>
<th>$\text{MAXV}$</th>
<th>$\text{MAX-COR}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t^\text{i}\text{m}\text{j}\text{a}$?</td>
<td>$t^\text{i}\text{m}\text{j}\text{a}$</td>
<td></td>
<td>$W_1$</td>
<td>$L$</td>
</tr>
<tr>
<td>$t^\text{i}\text{m}\text{j}\text{a}$</td>
<td>$t^\text{i}\text{m}\text{j}\text{i}$</td>
<td></td>
<td>(1)</td>
<td>$1$</td>
</tr>
</tbody>
</table>

Thus, the chain $<t^\text{i}\text{m}\text{j}\text{a}, t^\text{i}\text{m}\text{j}\text{a}, t^\text{i}\text{m}\text{j}\text{i}>$ is now harmonically improving. However, we will see shortly that our account makes some additional non-optimal chains harmonically improving as well. The next question is: how is the correct chain selected as the winner? This question is addressed in section 4.

### 3.3 Summary of section 3

Every chain in OT-CC has to be harmonically improving with respect to the constraint hierarchy of a given language. Opacity is analysed as an interaction in which transparent chains are blocked. On such an account, both transparent and opaque derivations impose ranking conditions on the chains.

TN presents a case where transparent and opaque derivations impose contradictory requirements. The contradiction arises because for the right chains to be formed, some feeding relationships have to be reversible. In other words, among the valid chains of the language we find both chains where A feeds B (transparently) and B feeds A (opaquely). Since opacity is invisible when chains are formed, this results in a ranking paradox.

PS-constraints offer a way of resolving this paradox and making the correct chains harmonically improving. According to our account, the fact that both processes are word-final is not accidental. In fact, the two interacting processes must compete for the same
position if fed counterfeeding interactions are derived via PS-constraints. See section 5 for further discussion of the predictions of PS-constraints.

4. Opacity: from PREC to EPREC

In the previous section we showed how PS-constraints allow for chains with fed counterfeeding to be accommodated into the grammar. The next question that arises is how the correct chains are selected. In this section, we argue that the OT-CC mechanism for dealing with opacity needs to be revised to account for fed counterfeeding. However, we do not depart from key theoretical assumptions of OT-CC. In section 4.1, we propose a modified version of PREC constraints, EPREC, and in section 4.2, we show how it resolves the problem of fed counterfeeding in TN. Section 4.3 argues for a revised ranking metaconstraint. A summary follows in section 4.4.

4.1 Existential PREC

Tundra Nenets presents a challenging piece of data where the requirements that drive word-final vowel deletion are not surface-true. In mappings like /tîimjás/ → [tîimjʔ] both the input and the output fare equally poorly against the constraint ∆*C-PL]PrWD that requires that words do not end in consonants with place features. This follows from an assumption that the glottal stop is placeless, and thus the features of [j] in [tîimjʔ] are at the right edge of the PWord. Because the faithful chain is available for any input in OT-CC, the PREC-evaluation step has to compare the faithful [tîimjás] to the actual output [tîimjʔ]. From the constraints we have considered so far, it is not at all clear why the actual output wins in this comparison.

We would like to suggest that this peculiar behavior of debuccalisation is connected to opacity. In this section, we develop a way of capturing in OT-CC the generalisation that debuccalisation is inactive after vowel deletion has applied. To ensure that a process can be inactive after the application of another process, we propose an amendment to PREC. The new constraint in (25), stated formally after McCarthy (2007), is called EPREC for “existential PREC” and is violated whenever there is no B violation in the chain.

(25) EPREC(A, B)

Let A’ and B’ stand for LUMs that violate the faithfulness constraints A and B, respectively.

Let cand=(in, out, ε, rL)

i. ∀B’εε if ¬∃A’εε where <A’,B’> ∈ rL assign a violation mark
ii. ∀B’εε if ∃A’εε where <B’,A’> ∈ rL assign a violation mark
iii. Assign a violation mark if there is no B’ (∼∃B’) in ε

Informally, EPREC states that “B should be violated, and the violations of A should precede and not follow violations of B (if there are any violations of B).” This opacity constraint effectively incorporates an anti-faithfulness requirement (Alderete 2001). However, this requirement actually has an effect only in a very limited number of situations. In these situations (TN being one of the examples), anti-faithfulness is connected to opacity.
As stated in McCarthy (2007), PREC constraints do not participate in chain formation. We take the same to be true for EPREC. By adhering to McCarthy’s schema where opacity constraints only evaluate chains that are already formed, we preclude EPREC(A, B) from being able to induce a B violation. EPREC may favor a chain where B is violated over the faithful chain, but the violation of B has to be due to some markedness constraint: otherwise, there would be no such harmonically improving chain. For the inputs to which the process yielding B violations is inapplicable, all the candidates will tie on EPREC since no chain will contain B violations.

So, in which situations does the new constraint make a difference? In such cases, a markedness constraint will dominate some faithfulness constraint, but later on in the derivation, that markedness constraint will be violated. This is exactly what happens in TN: word-final consonants are debuccalised even though later derivational steps may lead to the C-place features of some other consonant being at the PWord boundary.

For EPREC(A, B) to actively favor chains containing a violation of B, one more condition should hold: EPREC(A, B) should dominate B (indeed, were this not to hold, any chain violating B would not be preferred to a chain violating EPREC but satisfying B). However, this contradicts the ranking metaconstraint (6) of McCarthy (2007). In section 4.3, we will show why the ranking metaconstraint was needed and propose a modified ranking metaconstraint that will effectively serve the same goal but will allow for the EPREC(A, B) >> B ranking (cf. Wolf 2008). Before addressing this problem, though, we will illustrate how the proposed constraint works for TN.

4.2 Analysis of TN interactions

In section 3.2, we demonstrated how the use of PS-constraints makes the correct chains possible in TN. This section shows how the correct chains are selected over their competitors.

First, we consider a derivation in which counterfeeding plays a crucial role. For the input /xadΔ/ ‘snowstorm,’ our constraints generate three harmonically-improving chains. Those are given in (26) together with the sets of LUMs and rLUMSeqs.

(26) a. <… xadΔ> Ø, Ø (faithful)
   b. <… xadΔ, xad, xa?> {MAXV, MAXCOR}, {<MAXV, MAXCOR>} (transparent)
   c. <… xadΔ, xad> {MAXV}, Ø (opaque)

The transparent candidate in (26)b performs two operations: the vowel is deleted and then the consonant debuccalises. This candidate is not optimal in TN because debuccalisation precedes deletion. Thus, the transparent candidate is blocked by the EPREC(MAXCOR, MAXV) constraint defined in (27). This constraint requires that debuccalising precedes, rather than follows, vowel deletion.

(27) EPREC(MAXCOR, MAXV): assign a violation mark
   (i) For every MAXV violation that is not preceded by a MAXCOR violation in rLUMSeq of the candidate chain
   (ii) For every MAXV violation that is followed by a MAXCOR violation in rLUMSeq of the candidate chain
(iii) For each chain that does not have a MAXV violation

The tableau in (28) illustrates our analysis. This tableau represents a chain evaluation step, and the candidates are listed together with their sets of LUMs and rLUMSeqs. Chains are enclosed in <> brackets. The initial form in the chain is omitted as well as the prosodification steps that ensure the presence of the PWord (this is signified by “…” at the beginning of each chain).

The first set after the chain contains a list of all of the LUMs on in → out. The LUMs are numbered according to the position in the input where the unfaithful mapping occurred (as in McCarthy 2007, e.g., the winner in (28) has a violation of MAX at the fourth position; cf. \(x_1a_2d_3A_4\)). The second set represents the rLUMseq; it contains the ordered pairs of LUMs representing the crucial orderings of operations.

(28) Tundra Nenets: counterfeeding with EPREC

<table>
<thead>
<tr>
<th>/xada/</th>
<th>(\mathcal{L}^{\text{Low SON-PL}}_{\text{PRWD}})</th>
<th>MAX V</th>
<th>EPREC(MAXCOR, MAXV)</th>
<th>(\mathcal{L}^{\text{C-PL}}_{\text{PRWD}})</th>
<th>MAX COR</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\rightarrow) a. (&lt;\ldots xada, xad&gt;) {MAXV@4}, Ø</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>b. (&lt;\ldots xad, xa&gt;) {MAXV@4, MAX-COR@3} {&lt;MAXV@4, MAX-COR@3&gt;}</td>
<td>1</td>
<td>W₂</td>
<td>L</td>
<td>W₁</td>
<td></td>
</tr>
<tr>
<td>c. (&lt;\ldots xada&gt;) Ø, Ø</td>
<td>W₁</td>
<td>L</td>
<td>1</td>
<td>L</td>
<td></td>
</tr>
</tbody>
</table>

Only two markedness constraints are at play in the relevant part of TN grammar. Therefore, any candidate that satisfies both of them allows no more harmonic improvement. Hence, the chains listed in (28) are the only harmonically improving chains from the input /xada/. The constraint that enforces the surface-true generalisation, \(\mathcal{L}^{\text{Low SON-PL}}_{\text{PRWD}}\), has to dominate the other markedness constraint, \(\mathcal{L}^{\text{C-PLACE}}_{\text{PRWD}}\), whose effects are opaque. The opacity constraint is ranked high enough to block chains in which debuccalisation (driven by \(\mathcal{L}^{\text{C-PL}}_{\text{PRWD}}\)) follows apocope, as in (28)b.

Candidate (28)c violates the highly ranked PS-constraint because it contains a low sonority vowel, which is final in the previous step. Candidate (28)b loses because it has two violations of EPREC (the violation of MAXV precedes the violation of MAXCOR, and there is an unpreceded violation of MAXV), while (28)a has only one violation (for an unpreceded violation of MAXV).

Thus, tableau (28) establishes the rankings \(\mathcal{L}^{\text{Low SON-PL}}_{\text{PRWD}} >> \text{MAXV}, \mathcal{L}^{\text{Low SON-PL}}_{\text{PRWD}} >> \mathcal{L}^{\text{C-PL}}_{\text{PRWD}}\) and \(\text{EPREC(MAXCOR, MAXV)} >> \mathcal{L}^{\text{C-PL}}_{\text{PRWD}}\). The ranking of \(\mathcal{L}^{\text{C-PL}}_{\text{PRWD}}\) over MAXCOR is also necessary because we know that TN has word-final consonant debuccalisation.

We now turn to an example that illustrates both a transparent interaction between vowel deletion and consonant deletion and the effects of the anti-faithfulness requirement of EPREC. The input /t̥imjɑs/ ‘it rotted’ undergoes both debuccalisation and apocope. Crucially, both the input and the output in this example violate \(\mathcal{L}^{\text{C-PL}}_{\text{PRWD}}\), but
debuccalisation still applies. In (29), all harmonically improving chains from the input /t̩imjas/ are listed together with their rLUMSeqs and sets of LUMs.

(29) Possible harmonically-improving chains from the input /t̩imjas/

a. <... t̩imjas>, Ø, Ø
b. <... t̩imjas, t̩imja?>, {MaxCor}, Ø
c. <... t̩imjas, t̩imja?, t̩imj?>, {MaxCor, MaxV}, {<MaxCor, MaxV>}
d. <... t̩imjas, t̩imja?, t̩imj?, t̩imj?>
   {MaxCor, MaxV, MaxCor}, {<MaxCor, MaxV, MaxCor>}

The selection of the winner is illustrated in tableau (30). The transparent chain (30)c shows the effects of vowel deletion when it has been made active only in the course of derivation. The winner, (30)c, violates MaxV, but the faithful candidate (30)a seemingly has no violation of a constraint that is ranked higher than MaxV. In other words, a violation of \( \not{\Sigma}^{*\text{LOWSON-PL}}[\text{PrWd}] \) arises in the course of derivation but is “invisible” in the fully faithful chain. Here the triggering power of \( \text{EPREC} \) becomes crucial. \( \text{EPREC}(\text{MaxCor, MaxV}) \) disfavors the faithful chain and selects the derivation where both processes occur. Finally, candidate (30)d also loses by virtue of \( \text{EPREC} \), since it has a MaxV violation that is followed by a MaxCor violation.

(30) Tundra Nenets: feeding correctly allowed

<table>
<thead>
<tr>
<th>/t̩imjas/</th>
<th>( \not{\Sigma}^{*\text{LOWSON-PL}}[\text{PrWd}] )</th>
<th>( \text{EPREC(\text{MaxCor, MaxV})} )</th>
<th>MaxV</th>
<th>( \not{\Sigma}^{*\text{C-PL}}[\text{PrWd}] )</th>
<th>MaxCor</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. &lt;... t̩imjas&gt;, Ø, Ø</td>
<td></td>
<td>W₁</td>
<td>L</td>
<td>1</td>
<td>L</td>
</tr>
<tr>
<td>b. &lt;... t̩imja?&gt;, {MaxCor@6}, Ø</td>
<td>W₁</td>
<td>W₁</td>
<td>L</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>→ c. &lt;... t̩imj?&gt;, {MaxCor@6, MaxV@5}, {&lt;MaxCor@6, MaxV@5&gt;}</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. &lt;... t̩im?&gt;?, {MaxCor@6, MaxV@5, MaxCor@4}, {&lt;MaxCor@6, MaxV@5, MaxCor@4&gt;}</td>
<td>W₁</td>
<td>1</td>
<td>1</td>
<td>W₂</td>
<td></td>
</tr>
</tbody>
</table>

The constraint \( \not{\Sigma}^{*\text{LOWSON-PL}}[\text{PrWd}] \) is the highest ranked in this tableau (it outranks \( \text{EPREC} \) by the revised ranking metaconstraint (36), see section 4.3), and its effects are surface-true in TN. In general, according to our theory of opacity, the markedness...
constraint that is satisfied last in the course of the derivation will be surface-true and also
the highest ranked.

We have shown that reference to position in the previous step allows for the attested
feeding relations. Our approach makes more chains harmonically improving, and the
opacity constraint EPREC correctly selects the winner chains in TN. We will consider the
typological predictions of our approach to opacity in section 5.4.

Importantly, EPREC(A, B) must outrank B for our analysis to yield the correct result.
This condition runs contrary to the ranking metaconstraint (6) of McCarthy (2007). In the
next section we show what motivated the ranking metaconstraint and propose a revision
to it.

4.3 The revised ranking metaconstraint

To illustrate the need for the ranking metaconstraint, we will use an example from
McCarthy (2007). In Bedouin Arabic, syncope and palatalisation are in a counterbleeding
interaction. As the examples in (31)a show, the velars /k/ and /ɡ/ are palatalised when
adjacent to the front vowel /i/. However, even if /i/ undergoes syncope, as illustrated in
(31)b and (31)c, the consonants still surface as palatalised, as shown in (31)c. The fact
that the environment of palatalisation is not surface-apparent renders the alternation
opaque. Were deletion to apply first, it would bleed palatalisation: the rule order is thus
counterbleeding.


ruːɡ ‘be calm’  rawwiːɡ ‘do not make noise!’
guːl ‘say!’  ɡ;iːl ‘it was said’
mamluːk ‘owned’  jmallik ‘he makes someone own’
jaskut ‘he becomes silent’  jsaklikt ‘he silences someone’

b. Bedouin Arabic syncope

/ti-ɾsil-ːn/  tirslun ‘you (m.sg) send’
/jarib-ːt/  jarbat ‘he drank’

c. Syncope counterbleeds palatalisation

/hakim-iːm/  hakim ‘ruling (m.pl.)’
/kitib-t/  kitibt ‘you (m.sg.) were written’

McCarthy (2007) assumes that the following two markedness constraints are
responsible for palatalisation and deletion: *iCV bans i in open syllables, while *ki bans
non-palatalised dorsals adjacent to high vowels. Repairing on these markedness
constraints is done by violating MAX and ID(back). PREC(ID(back), MAX) requires all
ID(BACK)-violating LUMs to precede all MAX-violating LUMs.

The tableau in (32) illustrates an OT-CC analysis of Bedouin Arabic.

12 See McCarthy (2007: 90-93) for why an alternative analysis in terms of coalescence is not possible in
OT-CC.
(32) OT-CC analysis of counterbleeding in Bedouin Arabic (McCarthy 2007: 101)

<table>
<thead>
<tr>
<th>/haːkim-im/</th>
<th>*iCV</th>
<th>#ki</th>
<th>MAX</th>
<th>PREC(Id(back), MAX)</th>
<th>Id(back)</th>
</tr>
</thead>
<tbody>
<tr>
<td>→ a. &lt;haːkim-im, hakjim-im, hakjm-im&gt;</td>
<td>*iCV</td>
<td>#ki</td>
<td>MAX</td>
<td>PREC(Id(back), MAX)</td>
<td>Id(back)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>b. &lt;haːkim-im&gt; Ø, Ø</td>
<td>W₁</td>
<td>W₁</td>
<td>L</td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>c. &lt;haːkim-im, hakjim-im&gt;</td>
<td>W₁</td>
<td>L</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. &lt;haːkim-im, hakjm-im&gt;</td>
<td></td>
<td></td>
<td>W₁</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Crucially, the transparent bleeding candidate (32)d with syncope and no palatalisation is blocked by the PREC constraint. If PREC were ranked below Id(back), the transparent candidate would win.

If PREC(Id(back), MAX) were ranked above *iCV, it would block syncope only in cases where there is no palatalisation. McCarthy (2007) uses the example in (33) to illustrate this point. In Bedouin Arabic, /ʕarib-at/ ‘he drank’ surfaces as [ʕarbat], with syncope and no palatalisation. Since r is not a velar, there is no harmonically improving chain with palatalisation from the input /ʕarib-at/. The only two competing chains are the one with syncope and the one without it. Crucially, PREC(Id(back), MAX) is violated when a chain violates MAX only (since there is no preceding Id(BACK) violation). Therefore, ranking PREC(Id(back), MAX) above *iCV blocks syncope in this case, as shown in (33).¹³ In this tableau, syncope is blocked because palatalisation is not possible.

(33) Unwanted effect of ranking PREC(Id(back), MAX) >> *iCV (McCarthy 2007: 202)

<table>
<thead>
<tr>
<th>/ʕarib-at/</th>
<th>PREC(Id(back), MAX)</th>
<th>*ki</th>
<th>*iCV</th>
<th>MAX</th>
<th>Id(back)</th>
</tr>
</thead>
<tbody>
<tr>
<td>→ &lt;ʕaribat&gt; Ø, Ø</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>⊗ &lt;ʕarbat&gt;</td>
<td>W₁</td>
<td></td>
<td>L</td>
<td>W₁</td>
<td></td>
</tr>
</tbody>
</table>

EPREC does not yield this result because both candidates in (33) violate it. However, with two or more iCV sequences in the input, the problematic interaction still arises. Consider, for example, the hypothetical input /ʕirabita/.

¹³ In this tableau the ⊗ sign indicates the intended winner, whereas the arrow shows the actual winner.
EPREC makes wrong predictions if $\text{EPREC}(\text{ID(back)}, \text{MAX}) \gg *\text{iCV}$

<table>
<thead>
<tr>
<th>/řarbita/ (hypothetical)</th>
<th>EPREC(\text{ID(back)}, \text{MAX})</th>
<th>*\text{ki}</th>
<th>*\text{iCV}</th>
<th>\text{MAX}</th>
<th>\text{ID(back)}</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. &lt;řarbita&gt; Ø, Ø</td>
<td>1</td>
<td></td>
<td></td>
<td>W₂</td>
<td>L</td>
</tr>
<tr>
<td>b. &lt;řarbita&gt;</td>
<td>W₂</td>
<td></td>
<td></td>
<td>L</td>
<td>W₂</td>
</tr>
<tr>
<td>{MAX@2, MAX@6}, Ø</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>c. &lt;řarbita&gt;</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>{MAX@2}, Ø</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

EPREC(\text{ID(back)}, \text{MAX}) assigns a violation for every violation of MAX that is not preceded by a violation of ID(back). Therefore, the constraint favors chains with one unpreceded MAX violation, as in (34)c-d, over ones with two such violations, as in (34)b. The undesired blocking effect is still present, but it affects all MAX-violations after the first one. Thus, the pattern predicted by the ranking in which EPREC(A, B) is ranked highly looks even more bizarre than the one in which PREC(A, B) is ranked highly: multiple violations of B are blocked in chains that do not violate A.

In what follows, we will formulate the ranking metaconstraint with EPREC, although all of our claims also hold for the original PREC.

The undesired ranking is made impossible because of the ranking metaconstraint in (6), repeated here in (35) with EPREC. Indeed, if B always has to dominate EPREC(A, B) then it cannot block violations of B (and act as a more highly ranked markedness constraint, as it does in (33)).

(35) Ranking Metaconstraint with EPREC

B >> EPREC(A, B)

The metaconstraint achieves its goal somewhat indirectly. In fact, to ensure that EPREC never affects whether B is violated, it suffices for EPREC to be outranked by all other constraints that dominate B. However, since these constraints are not known in advance, McCarthy (2007) chooses to formulate the metaconstraint in terms of faithfulness.

We suggest that what matters is not that B dominates EPREC(A, B), but rather that every constraint dominating B also dominates EPREC(A, B).14

(36) Revised Ranking Metaconstraint

For every constraint C if C >> B, then C >> EPREC(A, B)

For our pseudo-Bedouin example, (36) would amount to a requirement that *iCV dominate EPREC(\text{ID(back)}, \text{MAX}). As expected, the undesired prediction disappears with this ranking, as shown in (37): since EPREC(A, B) is outranked by all markedness

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14 See also Wolf (2008) who argues that the Ranking Metaconstraint as formulated in McCarthy (2007) needs to be disposed of in order to model non-derived environment blocking.
constraints above B, its violation will never be worse than a violation of these markedness constraints. The chains (37)c and (37)d are correctly ruled out and the right chain wins under this ranking.

(37) \(*iCV > EPREC(Id(back), MAX)\) makes no harmful predictions

<table>
<thead>
<tr>
<th>/ʃirabita/ (hypothetical)</th>
<th>*ki</th>
<th>*iCV</th>
<th>EPREC(Id(back), MAX)</th>
<th>MAX</th>
<th>Id(back)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ʃirabita Ø, Ø</td>
<td></td>
<td>W₂</td>
<td>L₁</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>→ b. ʃrabta</td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>{MAX@2, MAX@6}, Ø</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. ʃirabta</td>
<td></td>
<td>W₁</td>
<td>L₁</td>
<td>L₁</td>
<td></td>
</tr>
<tr>
<td>{MAX@6}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. ʃrabta</td>
<td></td>
<td>W₁</td>
<td>L₁</td>
<td>L₁</td>
<td></td>
</tr>
<tr>
<td>{MAX@2}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thus, the revised ranking metaconstraint prevents EPREC from having blocking effects. However, it allows for EPREC to have triggering effects, which is precisely what explains the TN generalisation that consonant debuccalisation applies opaquely before vowel deletion but fails to apply after it (see section 5.4 for a demonstration of the fact that EPREC does not have any other effects beyond triggering).

To sum up, our treatment of fed counterfeeding relies on two key assumptions: (i) reference to a position in the previous step, and (ii) the triggering formulation of EPREC. The next section considers the broader implications of our theory.

4.4 Summary of section 4

In this section we have examined the relevant TN data in detail, and we have modified the opacity constraint of McCarthy (2007) to handle these data. EPREC(A, B) differs from the original PREC(A, B) in that it incorporates a requirement that B be violated. We have also argued for a modified ranking metaconstraint that allows EPREC(A, B) to be ranked just above B.

These two modifications of the OT-CC theory of opacity allow us to account for the TN examples in which the chain that represents the input faithfully loses to the one debuccalising the final consonant and deleting the final vowel even though both outputs have a consonant with word-final place features.

5. Consequences of the Proposal

We have demonstrated that the original OT-CC of McCarthy (2007) cannot deal with fed counterfeeding interactions. In order to bring these interactions within the scope of the theory, we have proposed two modifications: first, some OT constraints must be PS-constraints; and second, the theory of opacity must be modified.

In this section, we consider the typological and theoretical implications that result from our proposed extension of OT-CC. First, we will address a number of questions related to the introduction of PS-constraints. A property of PS-constraints that we have
not discussed extensively thus far is that they restrict the range of available repairs. Indeed, if a PS-constraint mentions the position P in the output of the previous step and the element A in the candidate under evaluation, it can only be responded to by changing A. Changing the candidate in order to affect P will not alter the violation profile. The consequences of this are discussed in section 5.1, as well as the predictions for the range of fed counterfeeding interactions that follow from this property of PS-constraints. Section 5.2 follows with a discussion of whether PS-constraints should replace the “regular” constraints.\footnote{We are grateful to an anonymous reviewer for valuable comments on the issues discussed in sections 5.1 and 5.2.}

PS-constraints also increase the extent of possible derivational paths. We offered a way of exploiting this property of PS-constraints in OT-CC, where different derivations are compared. In section 5.3, we will consider other derivations made possible in our theory and argue that the Duke-of-York patterns are still excluded due to independently needed assumptions of OT-CC.

Finally, in section 5.4, we discuss the consequences of the approach to opacity advocated in this paper.

### 5.1 PS-constraints, typology of repairs, and the extent of fed counterfeeding

PS-constraints can only be responded to by modifying or removing material that is mentioned in the candidates. Jesney (to appear) and Staroverov (to appear) make use of this property to address the too-many-solution problems, where OT predicts that a positional constraint can be responded to by changing both the position of an element and the element itself, while only the repairs modifying the element are attested. For example, Steriade (2001) notes that even though word-final voiced segments are presumably penalised by some constraint, they seem to never be made word-medial (e.g., by epenthesis) because of this pressure (cf. Van Oostendorp 2007 and see Staroverov to appear for discussion). This can easily be accounted for if we assume that the constraint responsible for devoicing is a PS-constraint – call it $^{*}\text{VCDOBS}\mid_{\text{PRWD}}$. This constraint penalises a voiced obstruent when it corresponds to a word-final segment in the previous step output (Staroverov to appear).

\begin{align}
\text{(38)} & \quad ^{*}\text{VCDOBS}\mid_{\text{PRWD}}: \text{ Given a chain } c, \text{ let } x \text{ be a segment in the first form (}=\text{input}), x' \text{ be its correspondent in the form under evaluation (}=\text{output if } c \text{ is valid}), \text{ and } x'' \text{ be its correspondent in the penultimate form of } c. \text{ If } x'' \text{ is at the right PWord boundary, assign a violation mark if } x' \text{ is a voiced obstruent.}
\end{align}

Changing the word-final status of the segment in question does not improve on such a constraint, since the segment is still word-final in the previous step. Thus, as illustrated in (39), epenthesisising a vowel after a word-final voiced consonant does not improve on $^{*}\text{VCDOBS}\mid_{\text{PWD}}$. Epenthesis is an impossible step since it does not improve harmony. The epenthetic candidate is harmonically bounded by the faithful one: both violate $^{*}\text{VCDOBS}\mid_{\text{PWD}}$ since in both of them the final segment of the previous step is voiced.
No epenthesis in response to a PS-constraint $\sim \text{VC DOBS}_\text{PWD}$.

<table>
<thead>
<tr>
<th>Input: /tab/</th>
<th>$\sim \text{VC DOBS}_\text{PWD}$</th>
<th>DEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prev. step output: [tab]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>→ a. tab 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. ta.bi 1</td>
<td>W₁</td>
<td></td>
</tr>
</tbody>
</table>

On the other hand, devoicing of the word-final voiced consonant is a valid response if $\sim \text{VC DOBS}_\text{PWD}$ dominates IDENT. Indeed, the voiced status of the consonant is checked in the candidates, and hence the devoicing candidate is able to win over the faithful one, as illustrated in (40).

Devoicing is a valid response to a PS-constraint $\sim \text{VC DOBS}_\text{PWD}$.

<table>
<thead>
<tr>
<th>Input: /tab/</th>
<th>$\sim \text{VC DOBS}_\text{PWD}$</th>
<th>IDENT-VOICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prev. step output: [tab]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. tab W₁</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>→ b. tap 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In general, positional repairs are never a response to PS-constraints because the position is mentioned in the previous step. Metathesis and many cases of epenthesis are positional in this sense because they are used to improve a segment’s position, but not the segment itself.

Let us now consider the predictions of this property of PS-constraints for the typology of fed counterfeeding. Our approach leads us to expect that not all kinds of processes can be related by a fed counterfeeding relationship. In particular, in our treatment of fed counterfeeding, it is crucial that at least one of the interacting processes be motivated by a PS-constraint (otherwise, the interaction will cause a ranking paradox, see 2.2). As we have just seen, PS-constraints can motivate only processes that target a given element (in other words, deletion and featural changes), but not those that target position (in other words, epenthesis and metathesis). If our analysis is to be generalised to all cases of fed counterfeeding, it predicts that one of the interacting processes must involve deletion or featural change.

In addition to the cases that are schematically similar to TN, we thus predict the existence of fed counterfeeding patterns where only one of the interacting processes is motivated by a PS-constraint. Let us say that the two interacting processes in such cases are motivated by a non-PS constraint $C_1$ and a PS-constraint $\sim C_2$. On our theory, $C_1$ cannot be ranked higher than $\sim C_2$. Indeed, if $C_1$ dominates $\sim C_2$, satisfying $\sim C_2$ will not be allowed at the cost of violating $C_1$. On the other hand, if the ranking is $\sim C_2 >> C_1$, fed counterfeeding is possible since satisfying $C_1$ can lead to violations of $\sim C_2$, which will only arise at the next step, and satisfying $\sim C_2$ at a cost of violating $C_1$ is permitted by ranking.

We have previously demonstrated that the constraint that enforces the surface-true generalisation has to be the highest ranked in our treatment of fed counterfeeding. Taking this into account, the prediction of our theory can be formulated as follows: in fed counterfeeding interactions, the process whose effects are surface-true has to be motivated by a PS-constraint (and hence be either deletion or featural change).
Building a typology of fed counterfeeding interactions is hampered not only by the relative rarity of the interaction, but also by the fact that a very thorough description is needed to prove that the relevant processes really interact in the way suggested. The examples that we are aware of satisfy the prediction outlined above, but a wider typological survey has to be left for further research.

One famous example\textsuperscript{16} parallel to the TN case comes from Lardil and has been briefly discussed in the introduction (see Hale 1973, Klokeid 1976, Ngakulmungan Kangka Leman 1997 for the data and Bye 2006, McCarthy 2003a, Prince & Smolensky 2004, and Wilkinson 1988, among many others, for analyses). As was shown in section 1, in Lardil both word-final nonapical consonants and word-final vowels are avoided via deletion. Consonants made final by vowel deletion in turn delete, whereas vowels made final by consonant deletion do not. In other words, C-deletion counterfeeds V-deletion while V-deletion feeds C-deletion.\textsuperscript{17} With our approach, the reverse of Lardil, with two interacting epenthesis processes, is predicted not to occur.

In effect, the theory advocated here makes rather restrictive predictions about fed counterfeeding. One of the interacting processes, namely the one whose effects are surface-true, must be either deletion or featural change. Furthermore, as we will shortly see in section 5.3.2, our theory is unable to produce Duke-of-York patterns, which leaves even less room for the predicted range of fed counterfeeding. It remains to be shown whether our theory is too restrictive, but no clear counterexamples are known to us as of yet.

5.2 PS constraints and regular OT constraints

In this section, we will address the relationship between regular OT constraints and PS-constraints. Not all OT constraints can be reasonably formulated as PS-constraints. We thus face two questions: (i) how the class of possible PS-constraints is defined, and (ii) whether the PS-constraints replace their non-PS counterparts. At an intuitive level, all PS-constraints have to penalise something in a position. Staroverov (to appear) proposes to formalise this intuition based on the elements of the prosodic hierarchy that the constraints mention. On his theory, at least the prosodic structure constraints (e.g., FT-BIN, ONSET) and feature co-occurrence constraints are not PS-constraints. A full investigation of the range of possible PS-constraints is left for future research.

Let us now move to the question of whether PS-constraints should replace their regular counterparts. The application of PS-constraints to too-many-solutions requires that they replace the relevant markedness and faithfulness constraints, not coexist with them. Indeed, any too-many-solutions problem can be solved only if nothing in the grammar can produce the pathological pattern.

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\textsuperscript{16} Odden (2008) mentions another example of fed counterfeeding in the Bantu language Zinza. In the first process, a high tone is deleted from a tone-bearing verb if it has an object. The second process inserts an H on a word-final syllable of a verb if the following word is toneless. If the description is correct, examples with underlying word-final H undergo a Duke-of-York derivation where H is first deleted and then inserted again. Such a derivation is impossible in OT-CC and in OT-CC with PS-constraints (see section 5.3.2 for discussion).

\textsuperscript{17} A number of approaches to Lardil challenge this generalization by trying to assume that apocope is a morphological process essentially marking nominative in nouns (Bye 2006, Horwood 2001, Kurisu 2001). This analysis, however, is untenable: see Klokeid (1976) for a reanalysis and NKL (24-26) for counterexamples.
On the other hand, fed counterfeeding patterns can be accounted for even if PS-constraints coexist with their regular counterparts. What is relevant in the analysis of fed counterfeeding is that PS-constraints are active in a given language and their non-PS counterparts are inactive. In principle, it may not be the case that the question of whether PS-constraints replace their non-PS counterparts is answered uniformly for all constraints. It might be that for some constraints, only the PS-versions are present in the grammar (thus accounting for too-many-solutions) while for others, both PS-versions and regular versions are available.

Of course, the strongest hypothesis to aim for is that all PS-constraints replace their regular counterparts. However, the case of Lardil might provide evidence that this hypothesis is too strong. The significance of Lardil depends on the exact generalisation about the possible NC clusters in this language. Most theoretical approaches assume that CODACOND (Itô 1986) is surface-true in Lardil and that non-apical consonants are not allowed in the coda unless they are also linked to the following onset. On this approach, nasals sharing place of articulation with the following obstruent are allowed by virtue of being doubly linked. However, (41) shows that nonhomorganic NC clusters are allowed word-medially.18 The status of these examples needs to be clarified in order to understand whether CODACOND is indeed the constraint responsible for prohibition on word-final nonapicals in Lardil. In the following discussion we will tentatively assume that it is in order to illustrate the problem.

(41)  mirnkemirnke ‘to sit on’ [NKL 212]
      wanka ‘arm, wing’ [NKL 269]
      manba ‘having bad luck (in hunting or fishing)’ [NKL 195]

For the analysis of Lardil fed counterfeeding, we need to treat CODACOND as a PS-constraint that stipulates that there is one violation mark per every non-apical corresponding to a segment exclusively linked to a coda node in the previous step output. However, not all CODACOND constraints can be safely replaced with PS-constraints: there seem to be multiple examples of epenthesis driven by CODACOND, i.e., of cases where the constraint is responded to by moving the consonant out of a coda rather than by changing its quality or deleting it. For instance, in Ponapean, syllables can be closed by a consonant that is either part of a geminate or part of a homorganic NC cluster. Non-homorganic clusters are resolved by epenthesis, as in /kitik-men/ → kitikimen ‘rat’ (see Itô (1986) and Rehg & Sohl (1981) for a full description of cluster resolution patterns). Other relevant cases include Axininca Campa (Itô 1986, McCarthy & Prince 1993a), Japanese (Itô 1986), and Tiberian Hebrew (Itô & Mester 1994, McCarthy & Prince 1993b, Prince 1975).

Thus, if CODACOND is the constraint active in Lardil, it appears that some instances of the general CODACOND schema behave like PS-constraints in that they participate in fed counterfeeding interactions, while some other instances behave like regular OT constraints in that they trigger epenthesis. This constitutes a potential problem for the hypothesis that PS-constraints should always replace their regular counterparts.

For this problem to be real, the examples like the ones in (41) need to be analysed to show that CODACOND is active at some level. If such analysis proves to be possible, the

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18 We are grateful to an anonymous reviewer for drawing our attention to such examples.
theoretical problem can be resolved in two ways. First, we may admit that for some constraints the PS-version and the regular version are both present in the grammar (the PS-versions of these constraints would then be solely motivated by fed counterfeeding). The surface forms in Lardil would be achieved by rendering the PS-version of CODACOND active and the regular version inactive by ranking.

Second, it is possible that the range of phenomena known as coda condition effects is not homogenous, insofar as some relevant constraints are PS-constraints and some are not. This latter view would maintain that every constraint is present in the grammar either as a PS-constraint or as a regular one. However, supporting such a view would necessarily imply a substantial reanalysis of CODACOND effects.

5.3 Computational power of the amended OT-CC

This section addresses the question of how the adoption of PS-constraints enlarges the predictive power of OT-CC. We show that stipulations that are independently needed in the framework of OT-CC guarantee that most of the patterns that cannot be generated with classic OT (Moreton 2004) are still excluded. However, some of the patterns that were not possible in the original OT-CC become possible in OT-CC with PS-constraints and EPREC.

In section 5.3.1, we discuss one such pattern that exhibits deletion of a word-final portion of the word until a particular condition is met. Section 5.3.2 addresses the issue of circular chain shifts (a.k.a. Duke-of-York derivations).

5.3.1 Truncation of large portions

Consider what would happen if the two processes in TN (or Lardil, for that matter) interacted transparently rather than opaquely. This would mean that both processes feed each other and an arbitrary portion of a word gets truncated until some blocking condition is met. To illustrate, let us construct a hypothetical language that is like TN but differs in two important respects. First, apocope and debuccalisation interact transparently in that language. Second, biconsonantal clusters are allowed, but triconsonantal ones are disallowed. Such a hypothetical language looks quite similar to the one discussed by McCarthy (2007: 84-86): whenever a full vowel can be reached by deleting up to two \( \lambda \)'s and debuccalising the consonants, this will be done. Otherwise, only the final vowel is deleted. Such a language would arise if EPREC were ranked low enough and \( \mathfrak{C}-\text{PtL}_{[\text{PrWd}]} \) were promoted above MAXV. In the tableaux below, we omit the unordered sets of LUMs, since all LUMs are crucially ordered. Words that contain a full vowel are shrunk in order to make this vowel’s place features word-final, as in (42)a, whereas all other words delete just the final \( \lambda \), as in (42)b.

---

19 McCarthy’s original example could illustrate the point just as well since it is based on the Lardil interaction. We constructed our own example here since our discussion is mainly based on the TN data.
(42) Hypothetical pseudo-TN: shrinking words up to two glottals in a row

a. A word that has a full vowel two syllables away from right edge

<table>
<thead>
<tr>
<th>Word</th>
<th>LwSON-PrWd</th>
<th>LwC-PrWd</th>
<th>MaxV</th>
<th>MaxCor</th>
<th>EPREC</th>
</tr>
</thead>
<tbody>
<tr>
<td>/patasa/</td>
<td>W1</td>
<td>L</td>
<td>L</td>
<td>L1</td>
<td></td>
</tr>
</tbody>
</table>

b. A word with no full vowel

<table>
<thead>
<tr>
<th>Word</th>
<th>LwSON-PrWd</th>
<th>LwC-PrWd</th>
<th>MaxV</th>
<th>MaxCor</th>
<th>EPREC</th>
</tr>
</thead>
<tbody>
<tr>
<td>/patasa/</td>
<td>W1</td>
<td>L</td>
<td>L</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

As McCarthy (2007) points out, such a pattern is also predicted by classic OT. Thus, even though we do reduce the predictive power of the original OT-CC, we do not go far beyond the limits of classic OT with this example.
5.3.2 **Circular chain shifts**

There is a more general worry, however. Since PS-reference decouples feeding and harmonic improvement in positional constraints, our system might give rise to circular chain shifts, that is, to the Duke-of-York pattern where A is mapped to B and B is mapped to A by the grammar. Moreton (2004) demonstrates that classic OT with only markedness and faithfulness constraints does not predict such a pattern if the input and the output are constructed of the same material (*homogeneous* in terms of Moreton 2004).

According to McCarthy (2007), this prediction is also valid for OT-CC. In our system, however, such patterns are seemingly possible. Imagine, for instance, a language where codas are repaired by epenthesis (i.e., NoCoda, Max >> DepV) and word-final low sonority vowels apocope, just as in TN. An input like /pat/ would be amenable to both epenthesis and deletion. In (43), we hypothesise that the previous step was already prosodified (as indicated by dots symbolizing syllable boundaries) and show how the two steps would result in a Duke-of-York derivation.

(43) Chain shifts seemingly possible with PS-constraints

a. Epenthesis at the first step

<table>
<thead>
<tr>
<th>Input: /pat/</th>
<th>Prev. step output</th>
<th>[\text{\textbf{*LOWSON-PL}}]_{PRWD}</th>
<th>NoCoda</th>
<th>Max</th>
<th>DepV</th>
</tr>
</thead>
<tbody>
<tr>
<td>.pat.</td>
<td>[\text{\textbf{W}}]_{1}</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>→ .pati.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. Epenthetic vowel deleted at the next step

<table>
<thead>
<tr>
<th>Input: /pat/</th>
<th>Prev. step output</th>
<th>[\text{\textbf{*LOWSON-PL}}]_{PRWD}</th>
<th>NoCoda</th>
<th>Max</th>
<th>DepV</th>
</tr>
</thead>
<tbody>
<tr>
<td>.pati.</td>
<td>[\text{\textbf{W}}]_{1}</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>→ .pat.</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Derivations like the one in (43) threaten one of the fundamental components of the theory: if A is mapped to B and B is mapped to A, the system would yield no output for either /A/ or /B/ – harmonic improvement in this case has no endpoint. Luckily, OT-CC requires an independent stipulation that rules out circular chain shifts. One of the requirements for chain validity (McCarthy 2007: 60-64) is that the chains monotonically increase unfaithfulness relative to the original input. Any mapping of the form A → B → A is thus prohibited because the output of the second step is faithful to the input. The requirement that each step introduces unfaithfulness is crucial, for instance, in prohibiting steps that only involve resyllabification. Nothing in the present theory is meant to abandon this requirement. Therefore, even if our constraints could potentially make the A → B → A chain harmonically improving, it would still be illicit.

---

20 A strict mathematical proof is not given, however. It might be necessary, since the treatment of opacity in OT-CC violates homogeneity: the outputs contain derivational information that is not present in the input.

21 McCarthy (2006, 2007) argues that there is no faithfulness to syllabification.
To summarise, the PS-constraints enlarge the predictive power of OT-CC. This allows the theory to achieve a better match with the attested typology. However, by making fed counterfeeding interactions amenable to an OT-CC analysis, our theory also approaches classic OT in its predictive power: for instance, it predicts languages that truncate large portions of the word to reach some goal. Furthermore, because of the independently needed assumptions of OT-CC, we do not predict circular chain shifts.

5.4 Why EPREC embedding antifaithfulness is harmless

In this section, we consider the predictions of the approach to opacity advocated in this paper. In section 3.2, we proposed two crucial modifications to OT-CC’s original opacity mechanism. First, the newly defined EPREC(A, B) requires B to be violated. Second, the ranking metaconstraint is modified. These modifications allowed us to account for the pattern of fed counterfeeding in TN. This section demonstrates that the proposed modifications do not predict any unattested patterns.

The overall system of opacity constraints is characterised in (44) and (45) below.

(44) EPREC
Let A’ and B’ stand for LUMs that violate the faithfulness constraints A and B, respectively.
Let cand=(in, out, L, rL)

i. ∀B' ∈ L if ¬∃A' ∈ L where <A',B'> ∈ rL assign a violation mark
ii. ∀B' ∈ L if ∃A' ∈ L where <B',A'> ∈ rL assign a violation mark
iii. Assign a violation mark if there is no B' (∼∃B') in L

(45) Ranking metaconstraint
For every constraint C if C >> B, then C >> EPREC(A, B)

The most fruitful way to analyse the predictions of our system is to compare our new constraint EPREC with the original PREC of McCarthy (2007).

In (46), the violations assigned by the new constraint are compared to those assigned by PREC. Crucially, the presence of violations of faithfulness constraints other than A or B is irrelevant to the constraints in question, and thus we can focus only on violations of A and B. Hereafter, we will call the candidates that do not contain violations of either A or B crucially faithful chains (CFC). The crucial orderings present in the rLUMSeq of the candidate are shown in the first column. If two elements are not crucially ordered, as in the row (46)d, they are separated by a comma. No other candidates are relevant, as the behavior of any other chain can be computed as a sum of violations on the simpler candidates in (46). For instance, a chain that has two A’s and two B’s, of which only one pair is crucially ordered (e.g. L={A'₁,A'₂,B'₁,B'₂}, rL={<A'₂,B'₁>}), would incur a sum of violations of candidates d and e below.
Violations of EPREC compared to those of the original PREC

<table>
<thead>
<tr>
<th>A’s and B’s in the rLUMSeq of the candidate</th>
<th>PREC(A, B)</th>
<th>EPREC(A, B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. CFC</td>
<td>none</td>
<td>1</td>
</tr>
<tr>
<td>b. A’</td>
<td>none</td>
<td>1</td>
</tr>
<tr>
<td>c. B’</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>d. A’,B’</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>e. &lt;A’,B’&gt;</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>f. &lt;B’,A’&gt;</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>g. &lt;B’₁,B’₂&gt;</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

As the table in (46) shows, the new EPREC(A, B) is only different from PREC(A,B) for the crucially faithful chains and for those violating just A. The table in (47) illustrates how this plays out in actual candidate comparisons. Only comparisons involving crucially faithful chains or chains violating just A are relevant.

Differences between PREC and EPREC in candidate comparison

<table>
<thead>
<tr>
<th>Candidate rLUMSeqs compared</th>
<th>PREC(A, B)</th>
<th>EPREC(A, B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. CFC~A’</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>b. CFC~B’</td>
<td>favors CFC</td>
<td>-</td>
</tr>
<tr>
<td>c. CFC~&lt;A’₁,B’₂&gt;</td>
<td>-</td>
<td>favors &lt;A’,B’&gt;</td>
</tr>
<tr>
<td>d. CFC~&lt;B’,A’&gt;</td>
<td>favors CFC</td>
<td>favors CFC</td>
</tr>
<tr>
<td>e. CFC~&lt;B’,B’&gt;</td>
<td>favors CFC</td>
<td>favors CFC</td>
</tr>
<tr>
<td>f. A’~B’</td>
<td>favors A’</td>
<td>-</td>
</tr>
<tr>
<td>g. A’~&lt;A’,B’&gt;</td>
<td>-</td>
<td>favors &lt;A’,B’&gt;</td>
</tr>
<tr>
<td>h. A’~&lt;B’,A’&gt;</td>
<td>favors A’</td>
<td>favors A’</td>
</tr>
<tr>
<td>i. A’~&lt;B’₁,B’₂&gt;</td>
<td>favors A’</td>
<td>favors A’</td>
</tr>
</tbody>
</table>

There are four differences between the effects of PREC and EPREC on candidate comparisons, as illustrated in lines b, c, f and g. We will consider them one after the other.

First, EPREC(A, B) has nothing to say about the crucially faithful chains as compared to those violating just B, while PREC(A, B) favors the crucially faithful chains, as shown in (47)b. In fact, the ability of PREC(A, B) to favor faithful chains over those violating just B (and hence block B-violations) was what initially motivated the ranking metaconstraint of McCarthy (2007). As discussed in section 4.3, taking the metaconstraint into account, neither PREC(A, B) nor EPREC(A, B) can favor crucially faithful chains over those containing a B-violation. Thus, the difference in (47)b never shows up due to the ranking metaconstraint.

Second, our system also favors the chains that violate A and B in the right order over the crucially faithful ones, as shown in (47)c. Comparing crucially faithful chains to those

---

22 The new EPREC(A, B) constraint favors the CFCs over the <B’, A’> sequence by 1 violation whereas the original PREC does so by 2 violations. As far as we know, this does not make any difference. When comparing <B’> and <B’, A’> (as in the analysis of counterfeeding in McCarthy 2007), both PREC and EPREC behave in exactly the same way.
violating A and B in the right order is a key feature of our account – it is this property of the analysis that allows us to capture the TN alternations.

Third, \( \text{PREC}(A, B) \) favors chains violating just A over those violating just B, while \( \text{EPREC}(A, B) \) has nothing to say with regards to this comparison, as shown in (47)f. For instance, if a markedness constraint can be satisfied by violating either A or B, we do not expect an opacity constraint to be able to select which repair will be made. Thus, \( \text{EPREC} \) appears to make better predictions in such a situation.23

Fourth, our system favors chains that violate A and B in the right order over those that violate just A, as in (47)g. However, this comparison will never lead to the selection of a winning chain. By assumption, the two candidate chains at hand (which can be symbolically represented as \( \ldots A' \ldots \) and \( \ldots <A', B'> \ldots \)) differ on B. Now, because there is a harmonically improving chain that contains a violation of B, there must be a markedness constraint \( M_B \) that dominates B.

Let us demonstrate that the chain \( \ldots A' \ldots \) violates \( M_B \). The fact that there is a chain \( \ldots <A', B'> \ldots \) suggests that the two violations are crucially ordered. This can only hold if violating A introduces violations of \( M_B \) or removes violations of some blocker-constraint making it possible to satisfy B. In other words, the process that incurs A-violations on our input feeds the process that incurs B-violations. Were the processes not connected, they would not be crucially ordered24 and the rLUMSeq would not contain the pair \( <A', B'> \).

The process that introduces violations of A also applies to the chain \( \ldots A' \ldots \). We have just proved that this process either introduces violations of \( M_B \) or makes it possible to repair on the violations of \( M_B \) already present, and hence that the chain \( \ldots A' \ldots \) violates \( M_B \).

Crucially, then, \( M_B \) is the highest ranked constraint that differentiates the two chains since \( M_B \) outranks both B and \( \text{EPREC} \) by the ranking metaconstraint (and A does not differentiate the two candidate chains). This constraint selects the \( <A', B'> \) chain, and hence the effects of opacity constraints are vacuous (i.e., identical to those of \( M_B \) but never showing up because of the ranking).

Thus, our theory of opacity does not overgenerate.

6. Analytical alternatives

In what follows, we present alternative approaches to the TN data in general and alternative analyses of TN fed counterfeeding in particular. In section 6.1, we discuss the

---

23 In fact, based on the analysis of McCarthy (2007), \( \text{PREC} \) cannot select a repair because of the ranking metaconstraint. Indeed, for the effect of \( \text{PREC} \) to show up, the ranking should be \( \text{PREC}(A, B) >> A >> B \) – only in this case would the normal repair strategy be to violate B, although the one dictated by \( \text{PREC} \) is to violate A. Such a ranking contradicts McCarthy’s original ranking metaconstraint (as well as our revised version).

24 In OT-CC, the crucial orderings are detected by the fact that they are irreversible, i.e., the same output would not be reached if the violations of given faithfulness constraints occurred in reverse order. The LUMSeqs of chains having the same output and input are intersected to yield the crucial ordering (rLUMSeq). The candidate is thus not just a chain, but a class of chains with the same crucial orderings of LUMs. In order to be able to intersect two LUMSeqs of different chains, it is necessary to detect the identical LUMs in different chains somehow. More work is needed to establish exactly how the notion of cross-chain identity of LUMs is defined. We leave this issue for future research, and we will try to make our reasoning as precise as possible in spite of this caveat. We are grateful to Bruce Tesar for discussing this with us.
differences between the standard analysis of the TN vowel and consonant inventories and the analysis assumed in this paper. Section 6.2 presents evidence that the two processes in TN cannot be reanalysed as unrelated by a feeding relationship. Finally, section 6.3 considers the Stratal OT alternative to the present analysis.

### 6.1 Previous descriptions of TN

In this section, we compare our assumptions about TN to the ones found in the literature, most notably to the assumptions of Salminen (1997 et seq.), which are now relatively standard. The discussion will focus on the inventories of TN segments, but it will also touch on some analytical issues. The vowel inventory of TN presented in section 3.1 is repeated in (48). The inventory in (49) is given on the basis of Salminen (2008).

(48) Tundra Nenets vowel inventory

```
i i’        u u’
e           o
A
a
```

(49) Tundra Nenets vowel inventory (Salminen 2008)

```
i í        u ú
e           o
α ø
a
```

(48) is different from (49) in two ways. First, there are notational differences: we render the “stretched” high vowels transcribed as í and ú in Salminen (1997) as [i’] and [u’].\(^{25}\) The central mid vowel [A] is transcribed as [ø] in Salminen (1997) and as [α] in his most current work.

The second difference is analytical: Salminen (1997) posits an additional mid vowel (º in his transcription) in the inventory of TN. Essentially, º is a null vowel that does not have an independent phonetic realisation in most cases and is posited to account for the effects of metrical syncope. The issue of how TN metrical syncope should be analysed is beyond the scope of this paper. Our account is compatible with both the “null vowel” analysis of Salminen (1997, 1998b) and the deletion approach of Staroverov (2006) and Kavitskaya & Staroverov (2008).

The consonant inventory of TN is repeated in (50).

---

\(^{25}\) While the duration of these high vowels is greater than the duration of their short counterparts, they are not bimoraic and do not act as phonologically long.
(50) Tundra Nenets consonantal inventory

<table>
<thead>
<tr>
<th></th>
<th>labial</th>
<th>dental</th>
<th>palatal</th>
<th>velar</th>
<th>glottal</th>
</tr>
</thead>
<tbody>
<tr>
<td>stops</td>
<td>p</td>
<td>$p^l$</td>
<td>t</td>
<td>$t^l$</td>
<td>d</td>
</tr>
<tr>
<td>nasals</td>
<td>m</td>
<td>$m^l$</td>
<td>n</td>
<td>$n^l$</td>
<td>η</td>
</tr>
<tr>
<td>fricatives</td>
<td>s</td>
<td>$s^l$</td>
<td>z</td>
<td>$z^l$</td>
<td>x</td>
</tr>
<tr>
<td>affricates</td>
<td>ts</td>
<td>$ts^l$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>liquids</td>
<td>r</td>
<td>$r^l$</td>
<td>l</td>
<td>$l^l$</td>
<td></td>
</tr>
<tr>
<td>glides</td>
<td>w</td>
<td>$w^l$</td>
<td></td>
<td></td>
<td>j</td>
</tr>
</tbody>
</table>

As with vowels, there are both transcriptional and analytical differences between the traditional system, in particular, Salminen (1998b), and the inventory in (50). The transcriptional differences are as follows: $C' = Cy$ (for palatalisation), η = ng, $ts = c$, $j = y$ or $y$ after vowels, $?$ = q/h. The dialect under consideration did not undergo denazalisation (*nt > d) and lacks the affricate dʒ (rendered as $j$ by Salminen).

Some of the phonemic contrasts in (50) are not present in the inventory according to Salminen (1997, 1998b). For example, separate /z/ and /z j/ phonemes are not recognised, and the surface voicing distinction is analysed as a result of the presence or absence of the null vowel in a cluster; thus, the sequences [nts] and [nz] are rendered as nɔc vs. nc with automatic “phonetic” post-nasal voicing in the latter case.

Another analytical difference concerns the number of glottal stops in the inventory. The fact that many citation forms exhibit a glottal stop that seemingly unpredictably alternates either with obstruents (t, s, and d from underlying /t/) or with nasals (n, η, and m, the latter arising due to nasal place assimilation) led researchers to postulate two or even three different glottal stop entities (variants in Salminen 1997, phonemes in Tereschenko 1956,26 morphophonemes in Janhunen 1986). However, Janhunen (1986) argues convincingly that there is no difference in the phonetic realisation of the two alleged glottal stop entities. In this paper, we assume that there is only one glottal phoneme in TN.

6.2 Analysing apocope and debuccalisation as unrelated phenomena

It is crucial to our analysis of TN that the application of apocope be conditioned by debuccalisation. Descriptively, the vowels delete only before a glottal stop, but could it be that $A$ in fact deletes before any consonant (as suggested by Stephen Anderson p.c., Eric Baković p.c.)? On this view, then, the fact that we see apocope only before $?$ would be an accidental consequence of word-final debuccalisation. Indeed, the data presented so far appears to be amenable to such a reanalysis. However, we will show that this reanalysis faces multiple problems.

26 The fact that Tereschenko, who devised the writing system currently used for TN, postulated two different glottal phonemes has interesting sociolinguistic consequences. Nenets children are taught at school that there are two different glottal phonemes. As a result, well-educated Nenets people (especially teachers of Nenets) consistently distinguish between the two. However, most of our less educated consultants have significant difficulties in differentiating between the two alleged phonemes. Interestingly, the art of distinguishing the two glottals has become a prototype of scholarly wisdom in the eyes of many Nenets.
A rule-based version of the alternative analysis is outlined in (51), where Apocope' is the rule deleting \( \lambda \) before an optional word-final consonant. With this approach, the interaction between apocope and debuccalisation is quite different from the one proposed above. Apocope' still counterfees debuccalisation in vowel-final forms, as the example [xar\( \lambda \)d] ‘house’ in (51)a demonstrates. However, the ordering of the rules is irrelevant in consonant-final forms, such as [t\( \lambda \)imj?] ‘it rotted,’ since the vowel is assumed to delete regardless of the presence or absence of debuccalisation of the final consonant, as shown in (51)b. Under this analysis, TN does not exhibit fed counterfeeding since the two rules in question are not in a feeding relation.

(51) Tundra Nenets apocope and debuccalisation: an alternative rule-based analysis

a. **Counterfeeding**

<table>
<thead>
<tr>
<th>Input</th>
<th>CTIP( \lambda )d( \lambda )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debuccalisation</td>
<td>---</td>
</tr>
<tr>
<td>Apocope'</td>
<td>xar( \lambda )d</td>
</tr>
<tr>
<td>Output</td>
<td>xar( \lambda )d</td>
</tr>
</tbody>
</table>

b. **Ordering 1**  **Ordering 2**

<table>
<thead>
<tr>
<th>Input</th>
<th>t( \lambda )imj( \lambda )s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debuccalisation</td>
<td>t( \lambda )imj?</td>
</tr>
<tr>
<td>Apocope'</td>
<td>t( \lambda )imj?</td>
</tr>
<tr>
<td>Output</td>
<td>t( \lambda )imj?</td>
</tr>
</tbody>
</table>

In OT terms, the alternative analysis requires a constraint *VC# that penalises vowels separated from the right edge of the word by one consonant but not by a cluster because, as was mentioned before, \( \lambda \) does not delete in words like [jon\( \lambda \)r?] ‘thousand.’

However, the analysis that uses *VC# faces both theoretical and empirical problems. On the theoretical side, further motivation for *VC# is necessary. First of all, it is unclear whether a similar deletion pattern is firmly established in any language. If such patterns existed, one could probably appeal to extrametricality of just one final consonant, but extrametricality resists a straightforward translation into OT (cf. Prince & Smolensky 2004, who derive extrametricality effects by a complex set of constraint interactions). It is also unlikely that extrametricality, stipulated for the word-final vowel deletion, would match up with an analysis of TN metrical syncope. Indeed, as argued by Kavitskaya & Staroverov (2008), a plausible account of metrical deletion requires the whole final syllable, not just the final consonant, to be extrametrical.

On the empirical side, the alternative analysis suggested would have to explain why surface violations of *VC# are tolerated in TN. For instance, the form [xar\( \lambda \)d] ‘house’ (input /xar\( \lambda \)\( \lambda \)\( \lambda \)\( \lambda \)/) surfaces with \( \lambda \) separated from the right edge of the word by a single consonant (i.e., apocope does not apply iteratively, yielding *xard). Clusters like rd are allowed word-finally in TN (cf. /xir\( \lambda \)b\( \lambda \)ax\( \lambda \)r\( \lambda \)t\( \lambda \)/ /xir\( \lambda \)b\( \lambda \)ax\( \lambda \)r\( \lambda \)t\( \lambda \)/ ‘nobody’, /nort\( \lambda \)/ /nort/ ‘long sledge with wooden top’), and therefore, the absence of vowel deletion in [xar\( \lambda \)d] is problematic. The only way to prevent apocope from applying for the second time in such examples would be to propose that apocope is not categorical, and that a null vowel persists on the surface (see Kager 1997; Jacobs 2004, 2008 for discussions of gradual vs. categorical vowel deletion in OT and OT-CC).
However, as evidenced by the interaction between apocope and consonant voicing, word-final \( \lambda \)-deletion is categorical in TN. As was mentioned in footnote 4, labial and dental stops voice after vowels (and nasals), as shown in (52)a. Examples in (52)b show that in fast speech the consonant is voiced after a vowel across the word boundary. However, voicing does not apply if the last vowel of the preceding word has been deleted, as in (52)c.

\[
(52)\quad \text{a. } /\text{xar} \lambda \text{t} \lambda/ \quad \text{xar} \lambda \text{d} \quad \text{‘house’}
\]

\[
\text{b. } /n'\text{arma} \quad \text{pas} \lambda \text{koj} \lambda/ \quad [n'\text{arma baskoj}]
\]
\[
\quad \text{red-ADJ} \quad \text{beautiful}
\]
\[
\quad \text{‘(that) red-cheeked (one) is beautiful’}
\]

\[
\quad /n'\text{kr} \lambda \text{o} \quad \text{tara} \lambda/ \quad [n'\text{kr} \lambda \text{o dara:}]^{27}
\]
\[
\quad \text{prepare} \quad \text{need.3SG}
\]
\[
\quad \text{‘it is necessary to get ready’}
\]

\[
\text{c. } /\text{wabtas} \lambda \lambda \quad \text{tara} \lambda/ \quad [\text{wabtas} \lambda \text{tara:}] \ast \text{dara:}
\]
\[
\quad \text{overturn} \quad \text{need.3SG}
\]
\[
\quad \text{‘it is necessary to overturn’}
\]

\[
\quad /\text{pas} \lambda \text{koj} \lambda \quad \text{pedara}/ \quad [\text{paskoj pedara}] \ast \text{bedara}
\]
\[
\quad \text{‘beautiful forest’}
\]

Were the nucleus of the last syllable preserved on the surface, the first consonant of the second word in the phrases in (52)c would undergo voicing, just as it does in (52)b. The absence of such voicing indicates that the vowel has been fully deleted, and apocope in TN does not preserve any aspects of the structure.

We can thus conclude that although the rule-based reanalysis presented in (51) accounts for the data, an alternative OT reanalysis of TN fed counterfeeding in terms of \( \ast \text{VC#} \) is not tenable. We have shown that apocope in TN is categorical and thus represents a case of non-iterativity: the last vowel is deleted, but the preceding one surfaces, violating the active \( \ast \text{VC#} \) (see Kaplan (2008) for a discussion of non-iterativity in OT). Non-iterativity in vowel deletion constitutes a case of self-counterfeeding opacity that presents a problem for OT accounts. Kavitskaya & Staroverov (2008) show that neither Stratal OT nor OT-CC can single-handedly resolve this problem. To sum up, an alternative OT analysis that postulates vowel deletion before any word-final consonant (not just the glottal) faces both empirical and theoretical problems.

---

27 The long final vowel in [tara:] ‘it is necessary’ is a result of vowel coalescence (also exemplified in (12)). In such a case, the word-final \( \lambda \) does not delete. A complete analysis of this phenomenon would lead us too far astray. We hypothesise preliminarily that coalescence is only applicable when the full vowel is immediately adjacent to \( \lambda \).
6.3 Stratal OT

The discussion of fed counterfeeding would not be complete without considering how (and whether) alternative theories of opacity would account for this process interaction. Probably the most prominent (and certainly the most general) alternative theory of opacity is Stratal OT (Kiparsky 2000, forthcoming; Bermudez-Otero forthcoming).28

The key idea of Stratal OT is that the phonological grammar can be different at different levels, or *strata*. The strata are conceived of as tied to morphological structure. The most commonly accepted levels are the stem level, the lexical level, and the postlexical level. Thus, a Stratal OT grammar consists of three rankings, each applying at a corresponding level. The stem passes through all of the rankings, whereas the morphemes attached at the later levels are only subject to the later rankings.

Fed counterfeeding is in general unproblematic for Stratal OT, as long as the interacting processes involved in fed counterfeeding can be shown to belong to different strata and thus be subject to different constraint rankings. One example of the Stratal OT treatment of fed counterfeeding is presented in Kiparsky (forthcoming: 38-42) for Lardil.29 According to this analysis, vowel deletion applies only at the lexical level, whereas consonant deletion becomes active postlexically. More technically, Kiparsky postulates a lexical ranking *V]*PrWd >> MAX-V, which is then reversed postlexically. Kiparsky also hints at some possible additional evidence for the level affiliation of the processes in question.

Instead of reviewing the details of Kiparsky’s proposal, we will attempt to account for the TN data in Stratal OT. In order to do this, we would need to show that the two processes involved in TN fed counterfeeding – debuccalisation and apocope – operate at different levels. To account for counterfeeding, we need to assume that debuccalisation is active only at the strata that precede the ones where apocope is active (additionally, apocope is inactive at the strata where debuccalisation is active). In this account, surface violations of *C-PLACE]*PrWd would be allowed since the constraint is ranked below faithfulness at the relevant level.

An analysis within the framework of Stratal OT would make the following predictions. If apocope and debuccalisation belong to different strata with debuccalisation preceding apocope, then debuccalisation should apply to all units at some level, while apocope may be blocked by a process that applies at a later level.

TN offers a test for the predictions of Stratal OT. In fast speech, several words may become a single prosodic unit (for simplicity, we will be assuming that this unit is the prosodic word).30 In such a case, Stratal OT predicts that the debuccalisation of a word-final consonant should still apply within the prosodic unit, since it should have applied to words before they combine with other words. On the other hand, we expect no *-deletion within the prosodic unit, e.g., in non-prosodic-word-final lexical items in the examples in

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28 Another instantiation of OT that can capture the effects in question is Comparative Markedness (CM, McCarthy 2003), one of the predecessors to OT-CC and an inspiration for the current analysis. However, CM cannot handle all relevant cases of vowel deletion in TN (see Kavitskaya & Staroverov 2008 for a discussion).

29 We are grateful to Paul Kiparsky for sharing the relevant part of the manuscript with us.

30 Postulating a unit of a higher order does not affect our argument: in this case, we would need to appeal to the phonology of the stratum where this unit is formed.
(53), since apocope, being postlexical, applies only to the final vowel of the whole unit formed by two words.

The predictions of the Stratal OT analysis are outlined in (53) and compared with the actual data, both slow speech and fast speech.

(53) Predictions of Stratal OT

<table>
<thead>
<tr>
<th>Input</th>
<th>Stratal OT</th>
<th>Slow speech</th>
<th>Fast speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>/n'enets/ sawa/</td>
<td>[n'eenets? sawa]</td>
<td>[n'eenets? sawa]</td>
<td>[n'enets an zawa]</td>
</tr>
<tr>
<td>nenets, man good</td>
<td>‘The man is good.’</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| /padar- an | t'axana/ | [padar? t'axana] | [padar an d'axana] |
| paper-GEN.SG behind | ‘behind paper’ |

As it happens, the predictions of Stratal OT are not borne out by TN. The data in (53) show that in fast speech, de buccalisation and apocope (both present in slow speech) are blocked if the consonant and the vowel in question are not prosodic-word-final. The fact that debuccalisation is blocked is unexpected if we assume that it belongs exclusively to the lexical level.

Thus, it appears that the processes involved in fed counterfeeding do not belong to different levels since both of them do not apply within a prosodic word formed out of two morphological words. The data in (54) present additional evidence that debuccalisation, just like apocope, is postlexical in TN. The examples in (54) illustrate the underlying contrast between obstruents and nasals. In fast speech, the underlying glottal stop is deleted before the following obstruent, after causing the hardening of a fricative to a stop, as in (54)a, while in (54)b, the underlying nasal does not debuccalise, but rather assimilates in place to the following velar.

(54) Input | Output
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. /n'e-? xana/</td>
<td>[n'e kAna] ‘a women’s sledge’</td>
</tr>
<tr>
<td>woman-GEN.PL sledge</td>
<td></td>
</tr>
<tr>
<td>b. /n'e-n xana/</td>
<td>[n'e-gAna] ‘a woman’s sledge’</td>
</tr>
<tr>
<td>woman-GEN.SG sledge</td>
<td></td>
</tr>
</tbody>
</table>

Were debuccalisation to belong exclusively to a stratum earlier than the postlexical stratum, the input /n'en/ in (54)b would be mapped to /n'e?/ at that level. At the postlexical level, then, the nasal would not be recoverable, and the contrast in (54) could not exist. Thus, debuccalisation has to be active postlexically.

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31 In far Western TN dialects, which are spoken by two of our consultants, the phrases in (53) are pronounced without either the final consonant or the preceding vowel of the first word, as in [n'enets sawa] ‘The man is good,’ [padar t'axana] ‘behind paper.’ These dialects appear to have lost the word-final glottal stop and the preceding vowel.

32 The fact that the final nasal of the first word in the prosodic unit causes the following obstruent to be voiced follows from the absence of prosodic-word-medial debuccalisation of nasals.
We have shown that, in order for Stratal OT to account for TN fed counterfeeding, debuccalisation and apocope have to apply at different strata, with debuccalisation preceding apocope. We have also shown, however, that both processes belong to the same level, which constitutes a problem for the Stratal OT analysis. One the one hand, debuccalisation must apply before postlexical apocope; on the other hand, debuccalisation is itself postlexical, thus applying within the same stratum as apocope. In such a case, an account of a counterfeeding relationship becomes impossible under the Stratal OT assumptions since we are dealing with a within-stratum interaction.

In general, within-stratum interactions like the one discussed above are not problematic for OT-CC. The prosodic word, regardless of its morphological structure, constitutes a candidate, and both debuccalisation and apocope are taken to apply at the right boundary of the prosodic word.

As an anonymous reviewer points out, the absence of debuccalisation in fast speech units, such as the ones in (53) and (54), would not constitute evidence to its postlexical status if these units were lexicalised. Under the lexicalisation hypothesis, the fast speech units in question would be processed by the word level phonology (the word stratum), which then could be followed by the postlexical phonology (the postlexical stratum). However, the lexicalisation analysis is not plausible in the TN case for the following reasons. First, the different elements of the prosodic unit can each belong to a separate syntactic unit. Specifically, in the examples in (55), the first element of the prosodic unit constitutes the subject of the clause, and the second element is the predicate; the lexicalisation of such a construction seems implausible. Second, the meaning of the examples in (53), (54), and (55) is transparent, which also points to the fact that no lexicalisation has taken place.33

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(55) Input Slow speech Fast speech34
a. /nilan tara/ [nil? tara:] [niln dara:]
   rest need.3SG ‘Rest is needed.’

b. /jilan pasakoja/ [jil? paskoj] [jiln baskoj]
   life beautiful ‘Life is beautiful.’

We have established the level affiliation of the processes involved in TN fed counterfeeding that is required in order for the Stratal OT analysis to go through: debuccalisation must apply before apocope. However, we have also established that

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33 An anonymous reviewer also points out that a possible alternative solution would be to analyse fast speech as having a different register with its own particular phonology. However, in TN the phonological processes that apply within a fast speech unit, as, for instance, nasal assimilation, are completely general elsewhere in the language. The size of the prosodic unit is the only difference between the slow and fast speech, and this alone does not constitute evidence for a separate grammar associated with a difference in register.

34 Note that in (55), the /s/ in the first words of the input delete in fast speech. This is due to an entirely different process of vowel deletion in TN: the non-final /s/ regularly deletes in even syllables, which is also evidenced by the deletion of /s/ in the second syllable of the word /pasakoja/ ‘beautiful’ (see Kavitskaya & Staroverov 2008 for an analysis).
debuccalisation and apocope in TN must apply at the same level (evidence from opaque interactions and independent evidence with respect to postlexical processes show that debuccalisation and apocope are both postlexical). These two requirements cannot be simultaneously satisfied. Thus, TN counterfeeding presents a challenge to Stratal OT, although not simply because it is fed counterfeeding.

7. Conclusion

In this article, we have shown that fed counterfeeding interactions present a serious challenge to the contemporary theory of opacity. Specifically, we have argued that OT-CC cannot account for cases where the same two processes are in both a transparent feeding relation and a counterfeeding opaque relation. We have proposed an extension of OT-CC that alleviates the problem without abandoning the main tenets of the theory and demonstrated that our analysis of fed counterfeeding in TN is superior to possible alternative analyses (see also Jacobs 2008 for a similar point about Latin syncope).

There are three essential theoretical points in the proposed analysis. First, we have made an assumption that constraints can refer to position specified in a previous step in the chain. Second, we have proposed a modified constraint \( \text{Eprec}(A, B) \) that differs from the \( \text{prec}(A, B) \) constraint of McCarthy (2007) in that it is violated whenever there is no violation of \( B \) in the chain. Third, we have argued that the ranking metaconstraint proposed by McCarthy (2007) needs revision. While there is originally the requirement that \( B \) has to dominate \( \text{prec}(A, B) \), we formulate the metaconstraint more precisely, stating that every constraint that dominates \( B \) also needs to dominate the new \( \text{Eprec}(A, B) \).

We hope to have contributed to documenting an important example of an opaque interaction that any phonological theory needs to be able to account for. The theory of opacity developed in this paper is fairly complex, and therefore we expect that the model we propose will not be the last word in the OT-CC analysis of opacity. However, a bigger theoretical move would have to be based on an extensive survey of the nature of opaque interactions.

Finally, fed counterfeeding has important consequences for serial OT grammars, of which OT-CC is one instantiation. A central premise of such grammars is that the ordering of operations has to match the ranking of markedness constraints responsible for these operations. However, we hope to have demonstrated that this assumption is too strong. We have offered a way of loosening this claim by invoking constraints referring to position in the previous step. Additionally, we have alluded to the fact that reference to position in the previous step can also be used to restrict the range of available repairs in certain cases, thus addressing the too-many-solutions problem (see Jesney to appear, Staroverov to appear). Our account provides indirect support for the theory of PS-constraints because it shows that these constraints not only correctly restrict the predictive power of the theory in one domain, but also correctly expand the predictive power of the theory in another domain. Even though the precise and general theory of opacity may need further development, the theory of positional reference advocated here is supported by our findings.
REFERENCES


Kavitskaya, Darya (under revision). Acoustic correlates of Tundra Nenets stress.


