When an interaction is both opaque and transparent: the paradox of fed counterfeeding[*]

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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) has been claimed to not be able to 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).

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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.[1] 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 segment 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.]
	/wiwala/	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 fed 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/	bulumunida	'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

[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].

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 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 valid 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 addresses alternative analyses of the data and identifies a challenge that the Tundra Nenets data present for Stratal OT (section 5.2). 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.

2. Feeding and counterfeeding: predictions made by OT-CC

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 OT-CC: basic architecture and the 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 the 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 overall. 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)a, and the definition of how PREC assesses a candidate is in (4)b.

(4) a. Candidate in OT-CC (McCarthy 2007: 97)

A candidate is an ordered 4-tuple (*in*, *out*, $\mathcal{L}$-set, rL), where
in is a linguistic form, the input;
out is a linguistic form, the output;
$\mathcal{L}$-set is a set of LUMs on *in* → *out*;
rL is a partial order on a subset of $\mathcal{L}$-set

[2] Harmonic improvement *per se* is in fact a property of any OT grammar (Moreton 2004). Thus, only the fact that at each step the chain may have many possible continuations motivates harmonic improvement as a separate principle in OT-CC.

b. **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' $\in\mathcal{L}$ assign a violation mark if $\neg\exists$A' $\in\mathcal{L}$ where <A',B'> $\in$rL
ii. $\forall$B' $\in\mathcal{L}$ assign a violation mark if $\exists$A' $\in\mathcal{L}$ where <B',A'> $\in$rL

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 (5) requires the faithfulness constraint B to universally outrank PREC(A, B).

(5) Ranking Metaconstraint (McCarthy 2007: 99)
B >> 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 and counterfeeding in OT-CC

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 (2010) 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 2010 for discussion). Counterfeeding on focus is generally unproblematic for OT (see Baković to appear and references therein).

Thus, 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 (6) where M_A and M_B represent markedness constraints whose satisfaction corresponds to processes A and B.

(6) 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.

(7) Feeding ranking in OT-CC: $M_A >> M_B$

The ranking condition in (7) 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 for 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 (8), the prediction of OT-CC with respect to counterfeeding is summarised.[3]

(8) The following situations are predicted to be impossible in OT-CC:
   a. A feeds B and B feeds A
   b. A counterfeeds B and B counterfeeds A
   c. A feeds B and B counterfeeds A

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.

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[3] 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 $P_1 \ldots P_n$ such that B (counter)feeds P_1 and for every i P_i (counter)feeds P_{i+1} and P_n (counter)feeds A.

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 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.

The vowel inventory of the particular dialect addressed in this study is shown in (9)a, and the consonantal inventory is presented in (9)b[4].

(9) Tundra Nenets phoneme inventory

a.
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i iˑ        u uˑ
 e          o
      ʌ
      a
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b.

	labial	dental	palatal	velar	glottal
stops	p p^j b b^j	t t^j d d^j		k g	ʔ
nasals	m m^j	n n^j		ŋ	
fricatives		s s^j z z^j		x	
affricates		ts ts^j			
liquids		r r^j l l^j			
glides	w		j		

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, as described below.

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[4] Our analysis of the TN segmental inventory differs somewhat from the assumptions of Salminen (1997 et seq.), which are now relatively standard. Salminen (1997) posits an additional mid vowel (° in his transcription) in the inventory of TN. Essentially, ° 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 vowels /æ/ and /e/ merged as [e] in the studied dialect, which is a 'Far Western' feature according to Salminen (2008). However, even though the studied dialect is spoken in the Western part of Tundra Nenets territories, its consonantal inventory is more like that of the Central dialects. The only difference between the inventory in (9)b and the one posited by Salminen (1997, 1998b) is that according to Salminen, separate /z/ and /z^j/ phonemes are not present in the inventory, 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 n°c vs. nc with automatic "phonetic" post-nasal voicing in the latter case.

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.[5] The examples in (10) illustrate the application of debuccalisation.[6]

(10) Debuccalisation: t, d, s, n and ŋ change to a ʔ word-finally

/m^{j}at/	m^{j}aʔ	'tent-NOM.SG'
cf. /m^{j}at-ta/	m^{j}ata	'tent-POSS.3SG'
/jan/	jaʔ	'soot-NOM.SG'
cf. /jan-ta/	janda	'soot-POSS.3SG'
/s^{j}in/	s^{j}iʔ	'lid-NOM.SG'
cf. /s^{j}in-ta/	s^{j}inda	'lid-POSS.3SG'
/wi·ŋ/	wi·ʔ	'tundra-NOM.SG'
cf. /wi·n-ta/	wi·nda	'tundra-POSS.3SG'
/maʌs/	maːʔ[7]	'place on chest under the outer layer of clothing-NOM.SG' [Salminen 1998a: 317]
cf. /maʌs-ʌʔ/	maːsʔ[8]	'place on chest under the outer layer of clothing-GEN.SG'

The second process of interest is apocope. As shown in (11), the vowel ʌ deletes word-finally.

(11) Word-final deletion of ʌ

/xʌrʌ/	xʌr	'knife-NOM.SG'
cf. /xʌrʌ-rʌ/	xʌrʌr	'knife-2SG.POSS'
/xʌlʌ/	xʌl	'steam-NOM.SG' [Tereshchenko 1965: 724]

5 Out of the remaining consonants, /b l m r/ occur at the right edge of the word only as the first members of a consonant plus glottal stop cluster (e.g., [warʔ] 'shore,' [nobʔ] 'one'). These clusters may or may not be underlying, but the resolution of this problem is outside of the scope of this paper. In most cases when the rest of the segments listed in (9)b surface word-finally, there is evidence that underlyingly they are followed by a vowel, which is then deleted.

6 Several examples in (10) and (12) 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.

7 The surface long vowel in [maːʔ] is a result of vowel coalescence.

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

The apocope of ʌ makes debuccalisation non-surface-true. The examples in (12) show that the process of final ʌ-deletion creates surface consonants [t], [d], [s], and [n][9] 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 /xarʌtʌ/ [xarʌd] 'house' vs. /xarʌtʌ-ta/ [xardʌda] 'house-3SG.POSS.'

(12) Apocope counterfeeds debuccalisation

/nʲenzʌtʌ/	nʲenzʌd	*nʲenzʌʔ	'otter-NOM.SG'
/xarʌtʌ/	xarʌd	*xarʌʔ	'house-NOM.SG'
/xatʌ/	xad	*xaʔ	'snowstorm-NOM.SG'
/nortʌ/	nort	*norʔ	'long sledge with wooden top-NOM.SG'
/tasʌ/	tas	*taʔ	'whole'
/xʌnʌ/	xʌn	*xʌʔ	'sledge-NOM.SG'

The examples in (13) present an additional environment for ʌ-deletion. The vowel also deletes before the word-final glottal stop. Deletion applies only if ʌ 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 [jonʌrʔ] 'thousand.'

(13) Apocope and debuccalisation: ʌ is deleted before word-final ʔ

/tʲim-jʌ-s/ rot-REFL-3SG.REFL	tʲimjʔ	'it rotted'
/muŋkʌm-jʌ-s/ appear-REFL-3SG.REFL	muŋgʌmjʔ	'it rushed out by itself'
cf. /muŋkʌm-jʌ-s-sʲʌ/ appear-REFL-3SG.REFL-PRET	muŋgʌmjʌtsʲ	'it appeared suddenly'
/mʲelʌd/	mʲelʔ	'master'
cf. /mʲelʌd-ʌʔ/	mʲelʌdʔ	'master-GEN.SG'
/wabtʌd/	wabtʔ	'slope'
cf. /wabtʌd-ʌʔ/	wabtʌdʔ	'slope-GEN.SG'
/ŋebtobertsʲʌn/	ŋebtobertsʲʔ	'scissors'
cf. /ŋebtobertsʲʌn-ta/	ŋebtobertsʲʌnda	'scissors-POSS.3SG'
/sʲadobertsʲʌn/	sʲadobertsʲʔ	'mirror'
cf. /sʲadobertsʲʌn-ta/	sʲadobertsʲʌnda	'mirror-POSS.3SG'

[9] The example with the word-final [ŋ] is missing since /ŋ/ does not seem to occur before the underlying word-final /ʌ/. We consider this an accidental gap.

/p^{j}i·nʌbts^{j}ʌn/	p^{j}i·nʌbts^{j}ʔ	'fear'; 'reason of fear'
cf. /p^{j}i·nʌbts^{j}ʌn-ta/	p^{j}i·nʌbts^{j}ʌnda	'his fear-POSS.3SG'
/s^{j}alʌn/	s^{j}alʔ	'underarm'
cf. /s^{j}alʌn-kʌnta/	s^{j}alʌŋgʌnda	'underarm-POSS.3SG.DAT'

The generalisation that unifies the deletion processes in the examples in (12) and (13) 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 (13) demonstrate that debuccalisation feeds apocope. Compare, for instance, the reflexive and reflexive preterite forms of the verb 'appear suddenly.' 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-s^{j}/ cluster surfaces as [ts^{j}], and the vowel preceding it does not delete.

Thus, when a word-final consonant debuccalises, the preceding ʌ 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 (14), 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.

(14) Tundra Nenets debuccalisation and apocope in rule terms

	Feeding	*Counterfeeding*
Input	t^{j}imjʌs	xadʌ
Debuccalisation	t^{j}imjʌʔ	---
Apocope	t^{j}imjʔ	xad
Output	t^{j}imjʔ	xad

Let us now consider what constraints motivate apocope and debuccalisation. We propose that the word-final debuccalisation of consonants stems from a constraint (15), holding that the presence of consonantal place features at a prosodic word boundary incurs a violation (cf. McCarthy 2008b on debuccalisation in serial OT).[10]

(15) *C-PL]$_{PRWD}$: No C-Place features at the right P-Word boundary.

To account for the deletion of word-final ʌ,[11] we need to take into consideration the fact that ʌ is the least sonorous vowel of TN (cf. Kavitskaya *under revision* on the duration and other phonetic properties of ʌ). 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 ʌ should be *un*marked 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 ʌ 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,[12] and that markedness constraints work differently with respect to the word-final position as opposed to weak branches of 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 (16), which targets the least sonorous vowel at the PWord boundary.

(16) *LOWSON-PL]$_{PRWD}$: No low sonority V-Place features at the right P-Word boundary.

Note also that it is irrelevant for the purposes of the current analysis whether ʌ-deletion is a single process or two separate processes (however this is to be formalised), since in both cases the violation of the same faithfulness constraint is involved. Because

[10] The result of the debuccalisation of /s/ would be [h], and the loss of place for the nasals /n/ and /ŋ/ would yield the placeless nasal. However, these segments are generally unavailable in TN and thus are ruled out by additional constraints. We are grateful to a reviewer for bringing this issue to our attention.

[11] Another process of vowel deletion exists in TN: metrical vowel deletion. Just like apocope, metrical vowel deletion affects only the vowel ʌ. 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.

[12] Kavitskaya & Staroverov (2008) present preliminary evidence that word-final syllables are extrametrical in TN. See also McCarthy (2008a: 524–525) for a discussion of a typology of syncope that distinguishes between vowels in weak branches of feet and extrametrical vowels.

of that, even if we dealt with the two processes here, these processes would necessarily be ordered at the same derivational stage by PREC constraints (see also footnote 22).

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.[13] We will not list these faithfulness constraints in the tableaux below.

In the original OT-CC, it is impossible to rank the constraints in (15) and (16). Satisfying *LOWSON-PL]$_{\text{PrWd}}$ in TN introduces violations of *C-PL]$_{\text{PrWd}}$ and vice versa. If we assume that *LOWSON-PL]$_{\text{PrWd}}$ dominates *C-PL]$_{\text{PrWd}}$, only the counterfeeding interaction would be predicted. The opposite ranking predicts only feeding. This is illustrated by the tableaux in (17) and (18).

The tableau in (17) illustrates one step in an OT-CC derivation: the debuccalisation of the final consonant in the derivation of [tʲimjʔ] 'it rotted' (the step <tʲimjʌs, tʲimjʌʔ> in the chain <tʲimjʌs, tʲimjʌʔ, tʲimjʔ>).[14] The tableau demonstrates that *C-PL]$_{\text{PrWd}}$ should dominate *LOWSON-PL]$_{\text{PrWd}}$ 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 (17), since PREC constraints do not participate in the evaluation until the chains are formed.

(17) Feeding requires *C-PL]$_{\text{PrWd}}$ >> *LOWSON-PL]$_{\text{PrWd}}$
Input: /tʲimjʌs/

Prev. step output: tʲimjʌs	*C-PL]$_{\text{PrWd}}$	*LOWSON-PL]$_{\text{PrWd}}$	MAXV	MAXCOR
→ tʲimjʌʔ		$_1$		$_1$
tʲimjʌs	W$_1$	L		L

The tableau in (18) illustrates the next step: apocope in the derivation of 'it rotted' (the step <tʲimjʌʔ, tʲimjʔ> in the chain <tʲimjʌs, tʲimjʌʔ, tʲimjʔ>). In this case, the output of the previous step and forms that violate the same basic faithfulness constraint MAXV

[13] As far as we know, this assumption does not significantly complicate the analysis of other processes in TN. For example, for postvocalic voicing (discussed in footnote 6 and section 5), the ranking of IDENT(VOICE) over MAX seems to predict that voiceless consonants would delete instead of surfacing as voiced, as suggested by a reviewer. However, this is only an apparent contradiction since in fact only the *onset* consonants undergo voicing, hence we may assume that a constraint prohibiting deletion of onset consonants is high-ranked.

[14] 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.

are considered. In order for the first candidate to win, *LowSon-Pl]$_{PrWd}$ should dominate *C-Pl]$_{PrWd}$ and MaxV.

(18) Counterfeeding requires *LowSon-Pl]$_{PrWd}$ >> *C-Pl]$_{PrWd}$
Input: /tʲimjʌs/

Prev. step output: tʲimjʌʔ	*LowSon-Pl]$_{PrWd}$	MaxV	*C-Pl]$_{PrWd}$	MaxCor
→ tʲimjʔ		1	1	
tʲimjʌʔ	W$_1$	L	L	

For the chain leading to the actual output to be harmonically improving, both of the rankings suggested in (17) and (18) must hold. However, the two ranking requirements are contradictory, and therefore the chain <tʲimjʌs, tʲimjʌʔ, tʲimjʔ> 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 2009; van Oostendorp 2007). Jesney (to appear) and Staroverov (2010) 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 Ident$_{ONS}$-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 Ident$_{ONS}$-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 Ident$_{ONS}$-voice and hence would not be a solution (see Jesney to appear and Staroverov 2010 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, a constraint ⮌*LOWSON-PL]$_{PRWD}$, which is defined as in (19)a, is active. The appropriate version of *C-PL]$_{PRWD}$ used in the previous section is defined in (19)b.[15]

(19) a. ⮌*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.

b. ⮌*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.

Finally, 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.[16]

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[15] Our proposal raises the question of whether PS-constraints replace their regular counterparts or coexist with them. The application of PS-constraints to too-many-solutions requires that they replace the relevant markedness and faithfulness constraints. Indeed, any too-many-solutions problem can be solved only if nothing in the grammar can produce the pathological pattern. 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. We leave the exploration of this issue for future research.

[16] Note also that PS-constraints can only be responded to by certain changes. 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. As a result, PS-constraints can motivate only processes that target a given element

Tableau (20) illustrates the debuccalisation step in the derivation of [tʲimjʔ]. 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 (20) has the prosodic structure that the input might lack. Crucially, the winner in (20) 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 parenthesised violation indicates that a violation of ⮌*LowSon-Pl]$_{PrWd}$ will emerge in the next step, but in tableau (20) the violation of this constraint does not occur when the harmonic improvement decisions are made. Comparing the winner with the faithful candidate demonstrates that ⮌*C-pl]$_{PrWd}$ must dominate MaxCor.

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

Input: /tʲimjʌs/

Prev. step output tʲimjʌs	⮌*LowSon-Pl]$_{PrWd}$	⮌*C-pl]$_{PrWd}$	MaxV	MaxCor
→ tʲimjʌʔ	(1)			1
tʲimjʌs		W$_1$		L

In the next step, illustrated in (21), there is a vowel whose position satisfies the definition of ⮌*LowSon-Pl]$_{PrWd}$ (because this vowel's place features are word-final in the previous step's output *tʲimjʌʔ*) and therefore apocope is harmonically improving. Crucially, ⮌*LowSon-Pl]$_{PrWd}$ dominates the faithfulness constraint MaxV. The parenthesised violation indicates that a violation of ⮌*C-pl]$_{PrWd}$ will emerge in the next step.

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

Input: /tʲimjʌs/

Prev. step output tʲimjʌʔ	⮌*LowSon-Pl]$_{PrWd}$	⮌*C-pl]$_{PrWd}$	MaxV	Max-cor
tʲimjʌʔ	W$_1$		L	1
→ tʲimjʔ		(1)	1	1

Thus, the chain <tʲimjʌs, tʲimjʌʔ, tʲimjʔ> 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

(in other words, deletion and featural changes), but not those that target position (in other words, epenthesis and metathesis).

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 the chain formation process is blind to whether the resulting chains ultimately involve transparent or opaque interactions, 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.

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.[17] 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 word-final debuccalisation does not lead to a surface-true generalisation. In mappings like /t^jimjʌs/ → [t^jimjʔ] 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 [t^jimjʔ] 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 [t^jimjʌs] to the actual output [t^jimjʔ]. 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

[17] Another important question is related to the general typology of chains admitted by PS-constraints. As stated, PS-constraints appear to allow for circular chain shifts where harmonic improvement will never terminate. Such non-terminating Duke-of-York chains are ruled out by an independent requirement of OT-CC that all steps introduce unfaithfulness with respect to the original input. It is thus crucial to the success of our theory that faithfulness is evaluated with respect to the original input rather than with respect to the current step input.

PREC. The new constraint in (22), stated formally after McCarthy (2007), is called *EPREC* for "existential PREC" and is violated whenever there is no B violation in the chain.

(22) **EPREC**(A, B)

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

Let *cand=(in, out,* $\mathcal{L}$*, rL)*

i. $\forall B' \in \mathcal{L}$ if $\neg\exists A' \in \mathcal{L}$ where $\langle A',B'\rangle \in rL$ assign a violation mark

ii. $\forall B' \in \mathcal{L}$ if $\exists A' \in \mathcal{L}$ where $\langle B',A'\rangle \in rL$ assign a violation mark

iii. Assign a violation mark if there is no B' ($\neg\exists B'$) in $\mathcal{L}$

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. Since unfaithful mappings have to be introduced during chain formation and opacity constraints only evaluate chains that are already formed, for every B-violating chain there must be a markedness constraint that induced the violation. EPREC may favor a chain where B is violated over the faithful chain (at the chain evaluation step), 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 dominates some faithfulness constraint, but later on in the derivation, that markedness constraint is 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 (5) 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 /xadʌ/ ‘snowstorm,’ our constraints generate three harmonically-improving chains. Those are given in (23) together with the sets of LUMs and rLUMSeqs.

(23) a. <… xadʌ> Ø, Ø (faithful)
b. <… xadʌ, xad, xaʔ> {MAXV, MAXCOR}, {<MAXV, MAXCOR>} (transparent)
c. <… xadʌ, xad> {MAXV}, Ø (opaque)

The transparent candidate in (23)b, where vowel deletion precedes consonant debuccalisation, is to be blocked by an opacity constraint. The relevant constraint, EPREC(MaxCor, MaxV), is defined in (24). It requires debuccalisation to precede vowel deletion, blocking the reverse order.

(24) 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 (25) 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 (25) has a violation of MAX at the fourth position; cf. x$_1$a$_2$d$_3$ʌ$_4$). The second set represents the rLUMseq; it contains the ordered pairs of LUMs representing the crucial orderings of operations.

(25) Tundra Nenets: counterfeeding with EPREC

/xadʌ/	⮌*LOW SON-PL]$_{PRWD}$	MAX V	EPREC(MAXCOR, MAXV)	⮌*C-PL]$_{PRWD}$	MAX COR
→ a. <… xadʌ, xad> {MAXV@4}, Ø		1	1	1	
b. <… xad, xaʔ> {MAXV@4, MAX-COR@3} {<MAXV@4, MAX-COR@3>}		1	W$_2$	L	W$_1$
c. <… xadʌ> Ø, Ø	W$_1$	L	1	L	

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 (25) are the only harmonically improving chains from the input /xadʌ/. The constraint that enforces the surface-true generalisation, ⮌*LowSon-Pl]$_{\text{PrWd}}$, has to dominate the other markedness constraint, ⮌*C-Place]$_{\text{PrWd}}$, whose effects are opaque. The opacity constraint is ranked high enough to block chains in which debuccalisation (driven by ⮌*C-Pl]$_{\text{PrWd}}$) follows apocope, as in (25)b.

Candidate (25)c violates the highly ranked PS-constraint because it contains a low sonority vowel, which is final in the previous step (at the chain evaluation step previous step output equals the current step output). Candidate (25)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 (25)a has only one violation (for an unpreceded violation of MaxV).

Thus, tableau (25) establishes the rankings ⮌*LowSon-Pl]$_{\text{PrWd}}$ >> MaxV, ⮌*LowSon-Pl]$_{\text{PrWd}}$ >> ⮌*C-Pl]$_{\text{PrWd}}$, and EPrec(MaxCor, MaxV) >> ⮌*C-Pl]$_{\text{PrWd}}$. The ranking of ⮌*C-Pl]$_{\text{PrWd}}$ over MaxCor is also necessary because we know that TN has word-final consonant debuccalisation (see section 3.2).

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 /t^{j}imjʌs/ 'it rotted' undergoes both debuccalisation and apocope. Crucially, both the input and the output in this example violate ⮌*C-Pl]$_{\text{PrWd}}$, but debuccalisation still applies. In (26), all harmonically improving chains from the input /t^{j}imjʌs/ are listed together with their rLUMSeqs and sets of LUMs.

(26) Possible harmonically-improving chains from the input /t^{j}imjʌs/

a. <… t^{j}imjʌs> Ø, Ø

b. <… t^{j}imjʌs, t^{j}imjʌʔ> {MaxCor}, Ø

c. <… t^{j}imjʌs, t^{j}imjʌʔ, t^{j}imjʔ> {MaxCor, MaxV}, {<MaxCor, MaxV>}

d. <… t^{j}imjʌs, t^{j}imjʌʔ, t^{j}imjʔ, t^{j}imʔʔ>
{MaxCor, MaxV, MaxCor}, {<MaxCor, MaxV, MaxCor>}

The selection of the winner is illustrated in tableau (27). The winning chain (27)c deletes the vowel whose place features are only exposed to final position in the course of the derivation. This chain thus violates MaxV, but the faithful candidate (27)a seemingly has no violation of a constraint that is ranked higher than MaxV. In other words, a crucial violation of ⮌*LowSon-Pl]$_{\text{PrWd}}$ arises in the course of the derivation but is absent in the fully faithful chain. Here the triggering power of EPrec becomes crucial. EPrec(MaxCor, MaxV) disfavors the faithful chain and selects the derivation where both processes occur. Finally, candidate (27)d also loses by virtue of EPrec, since it has a MaxV violation that is followed by a MaxCor violation.

(27) Tundra Nenets: feeding correctly allowed

/tʲimjʌs/	⮌*LowSon-Pl]$_{PrWd}$	EPrec(MaxCor, MaxV)	MaxV	⮌*C-Pl]$_{PrWd}$	Max Cor
a. <… tʲimjʌs>, Ø, Ø		W_1	L	1	L
b. <… tʲimjʌʔ> {MaxCor@6}, Ø	W_1	W_1	L		1
→ c. <… tʲimjʔ> {MaxCor@6, MaxV@5}, {<MaxCor@6, MaxV@5>}			1	1	1
d. <... tʲimʔʔ> {MaxCor@6, MaxV@5, MaxCor@4}, {<MaxCor@6, MaxV@5, MaxCor@4>}		W_1	1	1	W_2

The constraint ⮌*LowSon-Pl]$_{PrWd}$ is the highest ranked in this tableau (it outranks EPrec by the revised ranking metaconstraint (33), 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.[18]

Importantly, EPrec(A, B) must outrank B for our analysis to yield the correct result. This condition runs contrary to the ranking metaconstraint (5) 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 (28)a show, the velars /k/ and /g/ are palatalised when adjacent to the front vowel /i/. However, even if /i/ undergoes syncope, as illustrated in

[18] 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). 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. Building a typology of fed counterfeeding interactions on the basis of this observation has to be left for future research.

(28)b and (28)c, the consonants still surface as palatalised, as shown in (28)c.[19] 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.

(28) a. Bedouin Arabic palatalisation (cited after McCarthy 2007: 99-109, 177-210)

ru:g	'be calm'	rawwig^j	'do not make noise!'
gu:l	'say!'	g^{j}i:l	'it was said'
mamlu:k	'owned'	jmallik^j	'he makes someone own'
jaskut	'he becomes silent'	jsak^{j}k^{j}it	'he silences someone'

b. Bedouin Arabic syncope

/ti-rsil-u:n/ tirslu:n 'you (m.sg) send'
/ʃarib-at/ ʃarbat 'he drank'

c. Syncope counterbleeds palatalisation

/ha:kim-i:n/ ha:k^{j}mi:n 'ruling (m.pl.) cf. ha:k^{j}im 'ruling (m.sg.)'
/kitib-t/ k^{j}tibt 'you (m.sg.) were written' cf. k^{j}itbaw 'they (m.) 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 (29) illustrates an OT-CC analysis of Bedouin Arabic.

(29) OT-CC analysis of counterbleeding in Bedouin Arabic (McCarthy 2007: 101)

	/ha:kim-i:n/	*iCV	*ki	MAX	PREC(ID(back), MAX)	ID(back)
→	a. <ha:kimi:n, ha:k^{j}imi:n, ha:k^{j}mi:n> {ID(back)@3, MAX@4} {<ID(back)@3, MAX@4>}			1		1
	b. <ha:kimi:n> Ø, Ø	W$_1$	W$_1$	L		L
	c. <ha:kimi:n, ha:k^{j}imi:n> {ID(back)@3}, Ø	W$_1$		L		1
	d. <ha:kimi:n, ha:kmi:n> {MAX@4}, Ø			1	W$_1$	L

[19] See McCarthy (2007: 90-93) for why an alternative analysis in terms of coalescence is not possible in OT-CC.

Crucially, the transparent bleeding candidate (29)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 (30) to illustrate this point. In Bedouin Arabic, /ʃarib-at/ 'he drank' surfaces as [ʃarbat], with syncope and no palatalisation. Since *r* is not a velar, there is no harmonically improving chain with palatalisation from the input /ʃarib-at/. The only two competing chains are the one with syncope and the one without it. 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 (30).[20] In this tableau, syncope is blocked because palatalisation is not possible.

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

/ʃarib-at/	PREC(ID(back), MAX)	*ki	*iCV	MAX	ID(back)
→ <ʃaribat> Ø, Ø			1		
☹ <ʃarbat> {MAX@4}, Ø	W_1		L	W_1	

EPREC does not yield this result because both candidates in (30) violate it. However, with two or more *iCV* sequences in the input, the problematic interaction still arises. Consider, for example, the hypothetical input /ʃirabita/.

(31) EPrec makes wrong predictions if EPREC(ID(back),MAX) >> *iCV

	/ʃirabita/ (hypothetical)	EPREC(ID(back), MAX)	*ki	*iCV	MAX	ID(back)
	a. <ʃirabita> Ø, Ø	1		W_2	L	
☹	b. <ʃrabta> {MAX@2, MAX@6}, Ø	W_2		L	W_2	
→	c. <ʃirabta> {MAX@6}, Ø	1		1	1	
→	d. <ʃrabita> {MAX@2}, Ø	1		1	1	

EPREC(ID(back), 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 (31)c-d, over ones with two such violations, as in (31)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.

[20] In this tableau the ☹ sign indicates the intended winner, whereas the arrow shows the actual winner.

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 (5), repeated here in (32) 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 (30)).

(32) 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).[21]

(33) Revised Ranking Metaconstraint
For every constraint C if C >> B, then C >> EPREC(A, B)

For our pseudo-Bedouin example, (33) would amount to a requirement that *iCV dominate EPREC(ID(back), MAX). As expected, the undesired prediction disappears with this ranking, as shown in (34): since EPREC(A, B) is outranked by all markedness constraints above B, its violation will never be worse than a violation of these markedness constraints. The chains (34)c and (34)d are correctly ruled out and the right chain wins under this ranking.

(34) *iCV >> EPREC(ID(back), MAX) makes no harmful predictions

	/ʃirabita/ (hypothetical)	*ki	*iCV	EPREC(ID(back), MAX)	MAX	ID(back)
	a. <ʃirabita> Ø, Ø		W_2	L_1	L	
→	b. <ʃrabta> {MAX@2, MAX@6}, Ø			2	2	
	c. <ʃirabta> {MAX@6}		W_1	L_1	L_1	
	d. <ʃrabita> {MAX@2}		W_1	L_1	L_1	

Thus, the revised ranking metaconstraint prevents EPREC from having blocking effects. However, it allows for EPREC to have *triggering* effects, which is precisely what

[21] 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.

explains the TN generalisation that consonant debuccalisation applies opaquely before vowel deletion but fails to apply after it.

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 analytical alternatives.

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. Analytical alternatives

In what follows, we address alternative analyses of TN fed counterfeeding. Section 5.1 presents evidence that the two processes in TN cannot be reanalysed as unrelated by a feeding relationship. Section 5.2 considers the Stratal OT alternative to the present analysis.

5.1 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 ʌ in fact deletes before any consonant (as suggested by Stephen Anderson *p.c.*)? On this view, then, the fact that we see apocope only before ʔ would be an accidental consequence of word-final debuccalisation, and the interaction between apocope and debuccalisation would not be that of fed counterfeeding. In what follows we will show that this reanalysis faces multiple problems.

A rule-based version of the alternative analysis is outlined in (35), where Apocope' is the rule deleting ʌ before an optional word-final consonant.[22] On this approach, Apocope' still counterfeeds debuccalisation in vowel-final forms, as the example [labʌs] 'plate, slice' in (35)a demonstrates. This example also shows that Apocope' needs to apply non-iteratively: the vowel before the last consonant is not deleted. The rules of Apocope' and Debuccalisation are not in a feeding relation, and the form [tʲimjʔ] 'it rotted' can be derived on both orderings of the rules, as shown in (35)b. Under this

[22] Recall from section 3.1 that it is not important for an OT-CC analysis whether ʌ-deletion in the absolute word-final position and before a word-final consonant are formulated as a single process or as two separate processes (the latter suggested by Eric Baković *p.c.* and an anonymous reviewer). Even in the latter case, both processes would still violate the same basic faithfulness constraint and thus would have to be ordered together by OT-CC. For simplicity, we postulate a single rule of Apocope'.

analysis, TN does not exhibit fed counterfeeding since Debuccalisation does not feed Apocope'.

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

a.	*Counterfeeding*	
Input	labʌsʌ	[Tereshchenko 1965: 160]
Debuccalisation	---	
Apocope'	labʌs	
Output	labʌs	

b.	*Ordering 1*		*Ordering 2*
Input	t^{j}imjʌs	Input	t^{j}imjʌs
Debuccalisation	t^{j}imjʌʔ	Apocope'	t^{j}imjs
Apocope'	t^{j}imjʔ	Debuccalisation	t^{j}imjʔ
Output	t^{j}imjʔ	Output	t^{j}imjʔ

In OT-CC terms, the alternative analysis would most straightforwardly be translated into two constraints: *ʌC# penalizing [ʌ] separated from the right edge of the word by one consonant and *ʌ# penalizing word-final [ʌ]. However, such an analysis could not easily implement the non-iterativity of the application of Apocope' (cf. Kaplan 2008 on non-iterativity as a dubious concept in general).

The constraint *ʌC# needs to dominate MAX since it leads to the deletion of a vowel in the mapping /t^{j}imjʌs/ → [t^{j}imjʔ]. However, ranking this constraint above faithfulness would incorrectly predict the deletion of *two* vowels in the input /labʌsʌ/, i.e. /labʌsʌ/ → *[labs]. If *ʌC# is adopted, one has to provide an explanation of why just one vowel is deleted in this case. The problem is that no good explanation seems to be available here. In what follows, we will briefly consider the factors that could plausibly block the second ʌ-deletion and show that no such factor can apply in TN.

First, clusters like *bs* are allowed word-finally in TN (cf. /p^{j}i·nʌbts^{j}ʌ/ [p^{j}i·nʌbts^{j}] 'fear', /mebtsʌ/ [mebts] 'habit', /ŋaʌbtsʌ/ [ŋa:bts] 'in general'). Therefore consonant phonotactics cannot be responsible for the blocking of the deletion of the second vowel. Second, appealing to the opacity mechanism of OT-CC is also not possible in this case since OT-CC cannot impose orderings on processes violating the same basic faithfulness constraint. Note that the form [labʌs] does not undergo any process other than vowel deletion and therefore the absence of deletion of ʌ in the final syllable cannot be attributed to an interaction with some other process (as suggested for other forms by an anonymous reviewer).

Third, a way to prevent Apocope' from applying "for the second time" 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 ʌ-deletion is categorical in TN. As was mentioned in footnote 4, labial and dental stops voice after vowels (and nasals), as shown in (36)a. Examples in (36)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 (36)c.

(36) a. /xarʌtʌ/ xarʌd ‘house’

b. /n^{j}arma pasʌkojʌ/ [n^{j}arma baskoj]
red-ADJ beautiful
‘(that) red-cheeked (one) is beautiful’

/nʌkr^{j}o taraʌ/ [nʌkr^{j}o daraː][23]
prepare need.3SG
‘it is necessary to get ready’

c. /wabtas^{j}ʌ taraʌ/ [wabtas^j taraː] *daraː
overturn need.3SG
‘it is necessary to overturn’

/pasʌkojʌ pedara/ [paskoj pedara] *bedara
‘beautiful forest’

Were the nucleus of the last syllable preserved on the surface, the first consonant of the second word in the phrases in (36)c could undergo voicing, just as it does in (36)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.

To sum up, if one assumes that [ʌ] in TN deletes before any word-final consonant, one faces the problem of non-iterativity. Unlike in the rule-based approaches, non-iterativity cannot simply be stipulated in an OT grammar and, as we have shown, there is no good reason why “deleting for the second time” would always be blocked. Therefore the OT version of the Apocope' approach is hardly tenable.

Additionally, the constraint *VC#, which is crucial to the alternative account discussed here, needs further motivation. It is unclear whether deletion of a vowel before just one final consonant is attested elsewhere. 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.

We can thus conclude that although the rule-based reanalysis presented in (35) accounts for the data, an alternative OT reanalysis of TN fed counterfeeding in terms of *VC# is not tenable because the non-iterativity of rule-application has no correspondent in OT and the apocope of the final vowel is categorical.

[23] The long final vowel in [taraː] ‘it is necessary’ is a result of vowel coalescence (also exemplified in (10)). In such a case, the word-final ʌ 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 ʌ.

5.2 Stratal OT

Our 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; Bermúdez-Otero forthcoming).[24]

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 couterfeeding is presented in Kiparsky (forthcoming) for Lardil.[25] 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 $*C\text{-PLACE}]_{PrWd}$ 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[26], several words may become a single prosodic unit (for simplicity, we will be assuming that this unit is the prosodic word).[27] 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 ʌ-deletion

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[24] 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).

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

[26] We impressionistically define fast speech as speech at a normal conversational speed, as opposed to slow speech or careful pronunciation, obtained when the speakers speak slowly and clearly.

[27] 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.

within the prosodic unit, 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 (37) and compared with the actual data, both slow speech and fast speech.

(37) Predictions of Stratal OT

Input		Stratal OT	Slow speech	Fast speech[28]
/n^{j}enets^{j}ʌn	sawa/	[n^{j}enets^{j}ʌʔ sawa]	[n^{j}enets^{j}ʔ sawa]	[n^{j}enets^{j}ʌn zawa]
man	good			
‘The man is good.’				
/padʌr-ʌn	t^{j}axana/	[padarʌʔ t^{j}axana]	[padarʔ t^{j}axana]	[padarʌn d^{j}axana]
paper-GEN.SG	behind			
‘behind paper’				

As it happens, the predictions of Stratal OT are not borne out by TN. The data in (37) show that in fast speech, debuccalisation and apocope (both present in slow speech) are blocked if the consonant and the vowel in question are not prosodic-word-final.[29] 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 neither of them applies within a prosodic word formed out of two morphological words. The data in (38) present additional evidence that debuccalisation, just like apocope, is postlexical in TN. The examples in (38) 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 (38)a, while in (38)b, the underlying nasal does not debuccalise, but rather assimilates in place to the following velar.

(38)		Input	Output	
	a.	/n^{j}e-ʔ xʌnʌ/	[n^{j}e kʌn]	‘a women’s sledge’
		woman-GEN.PL sledge		
	b.	/n^{j}e-n xʌnʌ/	[n^{j}eŋ gʌn]	‘a woman’s sledge’
		woman-GEN.SG sledge		

If debuccalisation belonged exclusively to a stratum earlier than the postlexical stratum, the input /n^{j}en/ in (38)b would be mapped to /n^{j}eʔ/ at that level. At the postlexical level, then, the nasal would not be recoverable, and the contrast in (38) could not exist. Thus, debuccalisation has to be active postlexically.

[28] In far Western TN dialects, which are spoken by two of our consultants, the phrases in (37) are pronounced without either the final consonant or the preceding vowel of the first word, as in [n^{j}enets^{j} sawa] ‘The man is good,’ [padar t^{j}axana] ‘behind paper.’ These dialects appear to have lost the word-final glottal stop and the preceding vowel ʌ.

[29] 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 a reviewer points out, the absence of debuccalisation in fast speech units, such as the ones in (37) and (38), 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 (39), 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 (37), (38), and (39) is transparent, which also points to the fact that no lexicalisation has taken place.[30]

(39)	Input	Slow speech	Fast speech[31]
a.	/nilʌn taraʌ/	[nilʔ taraː]	[niln daraː]
	rest need.3SG		
	'Rest is needed.'		
b.	/jilʌn pasʌkojʌ/	[jilʔ 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 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

[30] A 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.

[31] Note that in (39), the /ʌ/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: non-final /ʌ/ regularly deletes in even syllables, which is also evidenced by the deletion of /ʌ/ in the second syllable of the word /pasʌkojʌ/ 'beautiful' (see Kavitskaya & Staroverov 2008 for an analysis).

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.

6. 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 a position specified in the output of the previous step in the chain. Second, we have proposed a modified constraint EPREC(A, B) that differs from the 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 a requirement that B has to dominate PREC(A, B), we formulate the metaconstraint more precisely, stating that every constraint that dominates B also needs to dominate the new 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 2010). 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

Alderete, John (2001). Dominance effects as transderivational anti-faithfulness. *Phonology* **18**. 201–253.

Baković, Eric (2007). A revised typology of opaque generalisations. *Phonology* **24**. 217–259.

Baković, Eric (to appear). Opacity deconstructed. In Marc van Oostendorp, Colin Ewen, Elisabeth Hume & Keren Rice (eds.) *The Blackwell Companion to Phonology*.

Beckman, Jill (1998). Positional Faithfulness. PhD dissertation. UMass, Amherst.

Bermúdez-Otero, Ricardo (forthcoming). *Stratal optimality theory*. Oxford: OUP.

Blumenfeld, Lev (2006). *Constraints on Phonological Interactions*. PhD dissertation, Stanford University.

Brame, Michael (1974). The cycle in phonology: Stress in Palestinian, Maltese and Spanish. *LI* **20**. 51–70.

Broselow, Ellen (2001). Uh-oh: Glottal Stops and Syllable Organization in Sulawesi. In Elisabeth Hume, Norval Smith & Jeroen van de Weijer (eds.) *Surface Syllable Structure and Segment Sequencing*. HIL Occasional Papers 4. Holland Institute of Generative Linguistics, Leiden**.**

Castrén, Matias A. (1854). *Grammatik der samojedischen Sprachen*. Nordische Reisen und Forschungen 5, herausgegeben von A. Schiefner. St. Petersburg.

Clements, George N. (1985). The geometry of phonological features. *Phonology Yearbook 2*: 225–252.

de Lacy, Paul (2002). The formal expression of markedness. PhD dissertation, UMass. Available as ROA-542 from the Rutgers Optimality Archive.

de Lacy, Paul (2003). Fixed ranking and the 'Too Many Solutions' problem. CASTL Kick-off conference handout.

de Lacy, Paul (2006). *Markedness: Reduction and Preservation in Phonology*, Cambridge: CUP.

Gafos, Adamantios and Linda Lombardi (1999). Consonant transparency and vowel echo. In P. Tamanji, M. Hirotani & N. Hall (eds.) *NELS 29.* GLSA, University of Massachusetts, Amherst, MA. 81–96.

Gouskova, Maria (2003). Deriving Economy: Syncope in Optimality Theory. PhD dissertation. UMass.

Hale, Kenneth (1973). Deep-surface canonical disparities in relation to analysis and change: An Australian example. In Thomas Sebeok (ed.) *Current Trends in Linguistics.* The Hague: Mouton. 401–458.

Jacobs, Haike (2004). Rhythmic vowel deletion in OT: Syncope in Latin. *PROBUS: An international journal of Latin and Romance Linguistics* **16**. 63–89.

Jacobs, Haike (2008). Sympathy, Comparative Markedness, OT-CC and Latin syncope. *PROBUS: An international journal of Latin and Romance Linguistics* **20**. 235–255.

Janhunen, Juha (1984). Problems of Nenets phonology. *Studien zur phonologischen Beschreibung uralischer Sprachen.* Herausgegeben von Péter Hajdú und László Honti. Bibliotheca Uralica 7; Budapest: Akadémiai Kiadó. 19–28.

Janhunen, Juha (1986). *Glottal stop in Nenets*. Mémoires de la Société Finno-Ougrienne 196. Helsinki.

Janhunen, Juha (1993). *Options for Tundra Nenets vowel analysis*. In Bakró-Nagy Marianne & Szíj Enikõ (eds.) *Hajdú Péter 70 Éves*. Linguistica, Series A, Studia et Dissertationes 15. Budapest: MTA Nyelvtudományi Intézet. 143–147.

Jesney, Karen (to appear). Positional Faithfulness, non-locality, and the Harmonic Serialism solution. In Suzi Lima, Kevin Mullin & Brian Smith (eds.), *NELS 39*. Amherst, MA: GLSA.

Kager, René (1997). Rhythmic vowel deletion in Optimality Theory. In Iggy Roca (ed.), *Derivations and Constraints in Phonology*, 463-499. Oxford: OUP.

Kaplan, Aaron (2008). Noniterativity is an emergent property of grammar. PhD dissertation, University of California, Santa Cruz.

Kavitskaya, Darya 2010. Acoustic correlates of Tundra Nenets stress. Ms, Yale University

Kavitskaya, Darya & Peter Staroverov (2008). Opacity in Tundra Nenets. In Natasha Abner & Jason Bishop (eds.) *WCCFL 27*. Somerville, MA: Cascadilla Proceedings Project. 274–282

Kiparsky, Paul (2000). Opacity and cyclicity. *The linguistic review* **17**. 351–367.

Kiparsky, Paul (forthcoming). *Paradigm effects and opacity*. Stanford: CSLI Publications.

Klokeid, Terry (1976). *Topics in Lardil Grammar*. PhD dissertation, Cambridge, MA: MIT.

Lehtisalo, Toivo (1956). *Juraksamojedisches Wörterbuch*. Lexica Societatis Fenno-Ugricae 13; Helsinki.

Lloret, Maria-Rosa (1995). The representation of glottals in Oromo. *Phonology* **12**. 257–280.

McCarthy, John (1999). Sympathy and Phonological Opacity. *Phonology* **16**. 331–399.

McCarthy, John (2003). Comparative markedness. *Theoretical Linguistics* **29**. 1–51.

McCarthy, John (2006). Restraint of analysis. In *Wondering at the Natural Fecundity of Things: Essays in Honor of Alan Prince*, 213 -239. Santa Cruz, CA: Linguistics Research Center.

McCarthy, John (2007). *Hidden Generalizations. Phonological Opacity in Optimality Theory*. London. Equinox.

McCarthy, John (2008a). The serial interaction of stress and syncope. *NLLT* **26**. 499–546.

McCarthy, John (2008b). The gradual path to cluster simplification. *Phonology* **25**. 271–319.

Moreton, Elliott (2004). Non-computable functions in Optimality Theory. In: John J. McCarthy (ed.) *Optimality Theory in Phonology: a reader*. Malden: Mass.: Blackwell. 141–163.

Ngakulmungan Kangka Leman (Anna Ash, Ken Hale, Kenneth Jacobs (Kulthangarr), David Nash, Norvin Richards, Lindsay Roughsey (Burrurr), Jane Simpson, *et al.*) (1997). *Lardil Dictionary*. Gununa, Queensland, Australia: Mornington Shire Council.

Prince, Alan (2002). Arguing optimality. In A. Carpenter, Andries Coetzee & Paul de Lacy (eds.) *University of Massachusetts occasional papers in linguistics 26: Papers in Optimality Theory II*. Amherst, MA: GLSA. 269–304. Available as ROA-562 on Rutgers Optimality Archive.

Prince, Alan & Paul Smolensky (1993/2004). *Optimality Theory: constraint interaction in generative grammar*. Blackwell: Malden, MA; Oxford, UK; Carlton, Aus.

Salminen, Tapani (1993). On identifying basic vowel distinctions in Tundra Nenets. *Finnisch-Ugrische Forschungen* **51**. 177–187.

Salminen, Tapani (1997). *Tundra Nenets inflection*. Mémoires de la Société Finno-Ougrienne 227. Helsinki.

Salminen, Tapani (1998a). *A Morphological Dictionary of Tundra Nenets.* Lexica Societatis Fenno-Ugricae 26. Helsinki.

Salminen, Tapani (1998b). Nenets. In Daniel Abondolo (ed.) *The Uralic languages.* London: Routledge. 516–547.

Salminen, Tapani (2008). Tundra Nenets grammatical sketch. Available at http://www.helsinki.fi/~tasalmin/sketch.html.

Staroverov, Peter (2006). Vowel deletion and stress in Tundra Nenets. In Beáta Gyuris, ed., *Proceedings of the First Central European Student Conference in Linguistics*, http://www.nytud.hu/cescl/ 24-26 May, 2006. Budapest.

Staroverov, Peter (2010). Too-many-solutions and reference to position in Serial OT. In Jon Stevens (ed.), *University of Pennsylvania Working Papers in Linguistics: Proceedings of the 33rd Penn Linguistics Colloquium* **16**:1, article 23

Steriade, Donca (1987). Locality conditions and feature geometry. In Joyce McDonough & B. Plunkett (eds.) *NELS 17*. Somerville, MA, Cascadilla. 595–617.

Steriade, Donca (2009). The phonology of perceptibility effects: the P-map and its consequences for constraint organization. In Kristin Hanson and Sharon Inkelas (eds.) *The nature of the word: essays in honor of Paul Kiparsky*. Cambridge, Mass: MIT Press, 151-179.

Tereshchenko, Natal'ya M. (1947). *Ocherk grammatiki nenetskogo (iurako-samoedskogo) iazyka.* Leningrad: Uchpedgiz.

Tereshchenko, Natal'ya M. (1956). *Materialy i issledovaniya po yazyku nentsev*. Moskva & Leningrad. Izdatel'stvo AN SSSR.

Tereshchenko, Natal'ya M. (1965). *Nenetsko-russkii slovar'*. Leningrad: Prosveschenie.

van Oostendorp, Marc (2007). Restricting repairs. Ms. Meertens Institute.

Wolf, Matthew (2008). Optimal interleaving: Serial phonology-morphology interaction in a constraint-based model. PhD dissertation, University of Massachusetts, Amherst.

Wolf, Matthew (2010). Limits on global rules in OT-CC: Mutual counterfeeding, self-counterfeeding, and mutual counterbleeding. Ms., Yale University.