

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

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Opaque interactions have long been recognised as a challenge for Optimality Theory. We show that although there has been considerable effort to bring opacity into the scope of Optimality Theory, 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 a process A feeds a process B, and B counterfeeds A. We argue that such interactions present a challenge to Optimality Theory 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 not to be able to handle the full variety of opacity cases. Most amendments to the theory

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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), OT with Candidate Chains (OT-CC), which is 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, Ngakulumungan 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 (1a), and non-apical consonants are deleted in word-final position, as in (1b). (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)	<i>stem</i>	<i>nom</i>		<i>non-fut acc</i>
a.	yiliyili	yiliyil	‘oyster sp’	yiliyili-n
	mayarra	mayarr	‘rainbow’	mayarra-n
	wiwala	wiwal	‘bush mango’	wiwala-n
b.	wangalk	wangal	‘boomerang’	wangalk-in
	thurarrang	thurarra	‘shark’	thurarrang-in
	wungkunung	wungkunu	‘queenfish’	wungkunung-in

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)	<i>stem</i>	<i>nom</i>		<i>non-fut acc</i>
	bulumunidami	bulumunida	‘dugong’	bulumunidami-n
	yukarrba	yukarr	‘husband’	yukarrba-n
	karrwakarrwa	karrwakarr	‘tree sp’	karrwakarrwa-n
	dibirdibi	dibirdi	‘rock cod’	dibirdibi-n
	mungkumungku	mungkumu	‘wooden axe’	mungkumungku-n

¹ We adhere to the Lardil orthography introduced in the Ngakulumungan Kangka Leman (1997) dictionary, even when we cite examples from other sources, such as Klokeid (1976) and Hale (1973). All Lardil forms are taken from these sources.

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

(3)			<i>feeding+counterfeeding</i>
input	wangalk	yiliyili	dibirdibi
apocope	<i>n/a</i>	yiliyil	dibirdib
C-deletion	wangal	<i>n/a</i>	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 defining the constraint or constraints responsible for this alternation is thus 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 §2). The ordering relations such as the ones in Lardil therefore translate directly 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 constraint.

This paper is structured as follows. We outline the predictions of OT-CC with respect to feeding and counterfeeding in §2. §3 presents the relevant Tundra Nenets data and addresses the problem of generating valid chains for fed counterfeeding. To solve this 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 §4. To account for opacity in Tundra Nenets, §4 introduces a modification of the PRECEDENCE(A, B) constraint of McCarthy (2007), so that the constraint is violated whenever there is no violation of B in the chain. §5 addresses alternative analyses of the data and identifies a challenge that the Tundra Nenets data present for Stratal OT (§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 (§2.1) and then formulate the predictions

of OT-CC with respect to the range of possible interactions between phonological processes (§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 modified Gen.

Each step's Gen performs one basic operation at a time. More formally, this requirement (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 is the same as 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, which 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; LUM)

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.

represents one step. Each chain has a correspondent set of LUMs, the \mathcal{L} -set, as well as an ordering of the elements in this set: the 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 (4a), and the definition of how PREC assesses a candidate in (4b).

(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* \rightarrow *out*;

rL is a partial order on a subset of \mathcal{L} -set.

b. $\text{PREC}(A, B)(\text{cand})$ (McCarthy 2007: 98)

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

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

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

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

Informally, $\text{PREC}(A, B)$ 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 $\text{PREC}(A, B)$.

(5) *Ranking metaconstraint* (McCarthy 2007: 99)

$B \gg \text{PREC}(A, B)$

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 §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, 2009). 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 2009 and references therein).

We therefore focus here on what we call ‘triggering feeding’. We will use the term ‘feeding’ to refer to processes that fall under the generalisation 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 satisfying M_A in the triggering feeding interaction 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*

$$M_A \gg M_B$$

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 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.

The predictions of OT-CC with respect to counterfeeding are summarised in (8).³

³ Given 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

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

We will argue that this prediction is too strong, because situations are attested in which B feeds A and then ceases to be active, while A creates an environment in which B could apply. 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, attested in Tundra Nenets.

3 Tundra Nenets

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

3.1 Data and constraints

Tundra Nenets is a Uralic language spoken in Arctic Russia and Northern Siberia (Castrén 1854, Tereshchenko 1947, 1956, 1965, Lehtisalo 1956, Janhunen 1984, 1986, Salminen 1993, 1997, 1998a, b, 2008, among others). The data come from the authors' fieldwork on the Malaya Zemlya dialect of Tundra Nenets. Six female speakers, ranging in age from 44 to 65, 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 (9a), and the consonant inventory in (9b).⁴

a sequence of processes $P_1 \dots P_n$, such that B (counter)feeds P_1 and for every i P_i (counter)feeds P_{i+1} and P_n (counter)feeds A.

⁴ Our analysis of the Tundra Nenets segmental inventory differs somewhat from the assumptions of Salminen (1997, 1998a, b, 2008), which are now relatively standard. Salminen (1997) posits an additional mid vowel (° in his transcription) in the inventory of Tundra Nenets. 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 Tundra Nenets 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 dialect studied, a 'Far Western' feature according to Salminen (2008). However, even though the dialect is spoken in the Western part of the Tundra Nenets territories, its consonantal inventory is more like that of the Central dialects. The only difference between the inventory in (9) and the one posited by Salminen (1997, 1998b) is that Salminen does not have separate /z/ and /zʲ/ phonemes 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

(9) *Phoneme inventory of Tundra Nenets*

a.	i	iʳ	u	uʳ
	e		o	
		ʌ		
		a		

b.	labial	dental	palatal	velar	glottal
stops	p pʲ b bʲ	t tʲ d dʲ		k g	ʔ
nasals	m mʲ	n nʲ		ŋ	
fricatives		s sʲ z zʲ		x	
affricates		ts tsʲ			
liquids		r rʲ l lʲ			
glides	w		j		

The Tundra Nenets syllable template 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.

The two interacting processes that we are concerned with are word-final debuccalisation and apocope. The input consonants /t d s n 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 ŋ/ → [ʔ] word-finally*

/mʲat/	mʲaʔ	'tent-NOM SG'	cf. /mʲat-ta/	mʲata	(3SG POSS)
/jan/	jaʔ	'soot-NOM SG'	/jan-ta/	janda	(3SG POSS)
/sʲin/	sʲiʔ	'lid-NOM SG'	/sʲin-ta/	sʲinda	(3SG POSS)
/wiŋ/	wiʔ	'tundra-NOM SG'	/wiŋ-ta/	wiŋda	(3SG POSS)
/maʌs/	ma:ʔ ⁷	'place on chest-NOM SG' (Salminen 1998a: 317)	/maʌs-ʌʔ/	ma:sʔ ⁸	(GEN SG)

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

[nts] and [nz] are rendered as /n^oc/ vs. /nc/, with automatic 'phonetic' postnasal voicing in the latter case.

⁵ Of the remaining consonants, /b l m r/ occur at the right edge of the word only as the first members of a consonant + 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 (9b) 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 postnasal and postvocalic 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 [ma:ʔ] is a result of vowel coalescence.

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

(11) *Apocope of /ʌ/*

/xʌrʌ/	xʌr	'knife-NOM SG'	cf. /xʌrʌ-rʌ/	xʌrʌr	'2SG POSS'
/xʌʌ/	xʌʌ	'steam-NOM SG'	(Tereshchenko 1965: 724)		

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 n] that are word-final and thus expected to undergo debuccalisation, but nevertheless do not debuccalise.⁹ The presence of the word-final vowel in these examples is manifested in alternations like /xʌrʌtʌ/ [xʌrʌd] 'house' vs. /xʌrʌtʌ-tʌ/ [xʌrdʌdʌ] 'house-3SG.POSS'.

(12) *Apocope counterfeeds debuccalisation*

/nʲenzʌtʌ/	nʲenzʌd	*nʲenzʌʔ	'otter-NOM SG'
/xʌrʌtʌ/	xʌrʌd	*xʌrʌʔ	'house-NOM SG'
/xʌtʌ/	xʌd	*xʌʔ	'snowstorm-NOM SG'
/nortʌ/	nort	*norʔ	'long sledge-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/	tʲimjʔ	'it rotted'
/munʒkʌm-jʌ-s/	munʒʌmjʔ	'it rushed out by itself'
cf. /munʒkʌm-jʌ-s-sʲʌ/	munʒʌmjʌtsʲ	'it appeared suddenly'
/mʲelʌd/	mʲelʔ	'master'
/mʲelʌd-ʌt/	mʲelʌdʔ	(GEN SG)
/wabtʌd/	wabtʔ	'slope'
/wabtʌd-ʌt/	wabtʌdʔ	(GEN SG)
/nɛbtobertsʲʌn/	nɛbtobertsʲʔ	'scissors'
/nɛbtobertsʲʌn-tʌ/	nɛbtobertsʲʌndʌ	(3SG POSS)
/sʲadobertsʲʌn/	sʲadobertsʲʔ	'mirror'
/sʲadobertsʲʌn-tʌ/	sʲadobertsʲʌndʌ	(3SG POSS)
/pʲi'nʌbtsʲʌn/	pʲi'nʌbtsʲʔ	'fear'
/pʲi'nʌbtsʲʌn-tʌ/	pʲi'nʌbtsʲʌndʌ	(3SG POSS)
/sʲʌʌn/	sʲʌʌʔ	'underarm'
/sʲʌʌn-kʌntʌ/	sʲʌʌŋʒʌndʌ	(3SG DAT POSS)

The generalisation that unifies the deletion processes in the examples in (12) and (13) is that the vowel deletes at the right edge of the prosodic

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

word with an optional glottal stop intervening between the deleting vowel and the right edge of the prosodic word. Along with 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-sʲ/ cluster surfaces as [tsʲ], 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 §1 and is predicted to be non-existent 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*

	<i>feeding</i>	<i>counterfeeding</i>
input	tʲimjΛs	xadΛ
debuccalisation	tʲimjΛʔ	—
apocope	tʲimjʔ	xad
output	tʲimjʔ	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 prosodic word boundary.

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

To account for the deletion of word-final / Λ /,¹¹ we need to take into consideration the fact that / Λ / is the least sonorous vowel of Tundra Nenets (cf. Kavitskaya 2010 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 Tundra Nenets 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,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 Tundra Nenets.

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 prosodic word boundary.

(16) ***LOWSON-PL**]_{PrWd}

No low-sonority V-Place features at the right prosodic word boundary.

Note also that it is irrelevant for the purposes of the current analysis whether / Λ -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 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 note 22).

¹¹ Another process of vowel deletion exists in Tundra Nenets: 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 Tundra Nenets is outside of the scope of this paper.

¹² Kavitskaya & Staroverov (2008) present preliminary evidence that word-final syllables are extrametrical in Tundra Nenets. 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.

The faithfulness constraints we use are as follows: MAX[cor] (McCarthy 2008b) prohibits the deletion of coronal place (MAX[velar], which prohibits the deletion of dorsal place, is necessary for the debuccalisation of /ŋ/), and MAXV prohibits vowel deletion. In Tundra Nenets, 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]_{PrWd} in Tundra Nenets 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 (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 [ʈimjʔ] ‘it rotted’ (the step <ʈimj_{AS}, ʈimj_{AP}> in the chain <ʈimj_{AS}, ʈimj_{AP}, ʈimjʔ>).¹⁴ 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, MAX[cor]) are under consideration here. 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]_{PrWd} ≫ *LOWSON-PL]_{PrWd}

input: /ʈimj _{AS} / previous step output: ʈimj _{AS}	*C-PL] _{PrWd}	*LOWSON-PL] _{PrWd}	MAXV	MAX[cor]
☞ a. ʈimj _{AP}		1		1
b. ʈimj _{AS}	W ₁	L		L

The tableau in (18) illustrates the next step: apocope in the derivation of ‘it rotted’ (the step <ʈimj_{AP}, ʈimjʔ> in the chain <ʈimj_{AS}, ʈimj_{AP}, ʈimjʔ>). In this case, it is the output of the previous step and forms that violate the same basic faithfulness constraint MAXV that are being

¹³ As far as we know, this assumption does not significantly complicate the analysis of other processes in Tundra Nenets. For example, for postvocalic voicing (discussed in note 6 and §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 *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 number of violations incurred by a candidate is denoted by subscripted integers. In the losing rows, W indicates that the constraint in question favours the winner, and L indicates that it favours the loser.

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: /tʰimjʌs/ previous step output: tʰimjʌʔ	* <small>LOWSON-PL</small> _{PrWd}	* <small>C-PL</small> _{PrWd}	<small>MAXV</small>	<small>MAX</small> [cor]
☞ a. tʰimjʔ		1	1	
b. tʰimjʌʔ	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 <tʰimjʌs, tʰimjʌʔ, tʰimjʔ> 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 (de Lacy 2003, Blumenfeld 2006, van Oostendorp 2007, McCarthy 2008a, b, Steriade 2009). 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, n. 27, citing 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 Tundra Nenets constraints are exactly of this kind.

We will refer to the constraints specifying position in the previous step as PS CONSTRAINTS (for ‘previous step constraints’). The symbol ‘ \Leftarrow ’ is appended to constraint names to indicate reference to the previous step. We assume that instead of an apocope constraint $*\text{LOWSON-PL}]_{\text{P}r\text{W}d}$ that penalises vowels of low sonority at the end of a prosodic word, a constraint $\Leftarrow*\text{LOWSON-PL}]_{\text{P}r\text{W}d}$, which is defined in (19a), is active. The appropriate version of $*\text{C-PL}]_{\text{P}r\text{W}d}$ used in the previous section is defined in (19b).¹⁵

(19) a. $\Leftarrow*\text{LOWSON-PL}]_{\text{P}r\text{W}d}$

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. $\Leftarrow*\text{C-PL}]_{\text{P}r\text{W}d}$

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 Tundra Nenets, 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.

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.

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 occurs.¹⁶

Tableau (20) illustrates the debuccalisation step in the derivation of [tʰimjʔ]. The PS-constraint $\Leftarrow^* \text{LOWSON-PL}]_{\text{PrWd}}$ checks whether 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 $\Leftarrow^* \text{LOWSON-PL}]_{\text{PrWd}}$, 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 $\Leftarrow^* \text{LOWSON-PL}]_{\text{PrWd}}$ 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 $\Leftarrow^* \text{C-PL}]_{\text{PrWd}}$ must dominate $\text{MAX}[\text{cor}]$.

(20) *Debuccalisation is allowed to feed apocope*

input: /tʰimj _{AS} / previous step output: tʰimj _{AS}	$\Leftarrow^* \text{LOWSON-PL}]_{\text{PrWd}}$	$\Leftarrow^* \text{C-PL}]_{\text{PrWd}}$	MAXV	$\text{MAX}[\text{cor}]$
☞ a. tʰimj _Δ ʔ	(1)			1
b. tʰimj _{AS}		W ₁		L

In the next step, illustrated in (21), there is a vowel whose position satisfies the definition of $\Leftarrow^* \text{LOWSON-PL}]_{\text{PrWd}}$ (because this vowel's place features are word-final in the previous step's output [tʰimj_Δʔ]) and therefore apocope is harmonically improving. Crucially, $\Leftarrow^* \text{LOWSON-PL}]_{\text{PrWd}}$ dominates the faithfulness constraint MAXV . The parenthesised violation indicates that a violation of $\Leftarrow^* \text{C-PL}]_{\text{PrWd}}$ will emerge in the next step.

(21) *Apocope applies in the next step*

input: /tʰimj _{AS} / previous step output: tʰimj _Δ ʔ	$\Leftarrow^* \text{LOWSON-PL}]_{\text{PrWd}}$	$\Leftarrow^* \text{C-PL}]_{\text{PrWd}}$	MAXV	$\text{MAX}[\text{cor}]$
☞ a. tʰimjʔ		(1)	1	1
b. tʰimj _Δ ʔ	W ₁		L	1

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

Thus, the chain <ʈimjʌs, ʈimjʌʔ, ʈimjʔ> 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 §4.

3.3 Summary

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.

Tundra Nenets 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 in 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 the key theoretical assumptions of OT-CC. In §4.1, we propose a modified version of PREC constraints, EPREC, and in §4.2, we show how it resolves the problem of fed counterfeeding in Tundra Nenets. §4.3 argues for a revised ranking metaconstraint. A summary follows in §4.4.

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.

4.1 Existential PREC

Tundra Nenets presents a challenging piece of data, where word-final debuccalisation does not lead to a surface-true generalisation. In mappings like $/tʃimjʌs/ \rightarrow [tʃimjʃ]$, the input and the output fare equally poorly on the constraint $\leftarrow^*C\text{-PL}_{PrWd}$, which requires that words do not end in consonants with place features. This follows from the assumption that the glottal stop is placeless, and thus the features of [j] in $[tʃimjʃ]$ are at the right edge of the prosodic word. Because the faithful chain is available for any input in OT-CC, the PREC-evaluation step has to compare the faithful $[tʃimjʌs]$ to the actual output $[tʃimjʃ]$. 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 behaviour 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 (22), stated formally after McCarthy (2007), is called EPREC ('existential PREC') and is violated whenever there is no violation of B 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. $\forall B' \in \mathcal{L}$ assign a violation mark if $\neg \exists A' \in \mathcal{L}$ where $\langle A', B' \rangle \in rL$.
- ii. $\forall B' \in \mathcal{L}$ assign a violation mark if $\exists A' \in \mathcal{L}$ where $\langle B', A' \rangle \in rL$.
- 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 (Tundra Nenets 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 induces the violation. EPREC may favour 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 violations of B is inapplicable, all the candidates will tie on EPREC, since no chain will contain violations of B.

of LUMs and rLUMSeqs. The initial form in the chain is omitted, as well as the prosodification steps that ensure the presence of the prosodic word (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. $x_1a_2d_3\Lambda_4$). The second set represents the rLUMseq; it contains the ordered pairs of LUMs representing the crucial orderings of operations.

(25) Counterfeeding with EPREC

/xadΛ/	$\Leftarrow^* \text{LOWSON-PL}]_{PrWd}$	MAXV	EPREC(MAXV, MAX[cor])	$\Leftarrow^* \text{C-PL}]_{PrWd}$	MAX[cor]
a. <...xadΛ, xad> {MAXV@4}, 0		1	1	1	
b. <...xad, xad?> {MAXV@4, MAX[cor]@3}, {<MAXV@4, MAX[cor]@3>}		1	W ₂	L	W ₁
c. <...xadΛ> 0, 0	W ₁	L	1	L	

Only two markedness constraints are involved in the relevant part of Tundra Nenets 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 /xadΛ/. The constraint that enforces the surface-true generalisation, $\Leftarrow^* \text{LOWSON-PL}]_{PrWd}$, has to dominate the other markedness constraint, $\Leftarrow^* \text{C-PL}]_{PrWd}$, whose effects are opaque. The opacity constraint is ranked high enough to block chains in which debuccalisation (driven by $\Leftarrow^* \text{C-PL}]_{PrWd}$) follows apocope, as in (25b).

Candidate (25c) 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, the previous step output is the same as the current step output). Candidate (25b) loses because it has two violations of EPREC (the violation of MAXV precedes the violation of MAX[cor], and there is an unprecedented violation of MAXV), while (25a) has only one violation (for an unprecedented violation of MAXV).

Thus, tableau (25) establishes the rankings $\Leftarrow^* \text{LOWSON-PL}]_{PrWd} \gg \text{MAXV}, \Leftarrow^* \text{LOWSON-PL}]_{PrWd} \gg \Leftarrow^* \text{C-PL}]_{PrWd}$ and $\text{EPREC}(\text{MAX}[\text{cor}], \text{MAXV}) \gg \Leftarrow^* \text{C-PL}]_{PrWd}$. The ranking of $\Leftarrow^* \text{C-PL}]_{PrWd}$ over MAX[cor] is also necessary, because we know that Tundra Nenets has word-final consonant debuccalisation (see §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 /tʲimjAs/ undergoes both debuccalisation and apocope. Crucially, both the input and the output in this example violate $\Leftarrow^* \text{C-PL}]_{PrWd}$, but debuccalisation still applies.

In (26), all harmonically improving chains from the input /tʲimjas/ are listed, together with their rLUMSeqs and sets of LUMs.

(26) *Possible harmonically improving chains from input /tʲimjas/*

- a. <... tʲimjas>
∅, ∅
- b. <... tʲimjas, tʲimjaʔ>
{MAX[cor]}, ∅
- c. <... tʲimjas, tʲimjaʔ, tʲimjʔ>
{MAX[cor], MAXV}, {<MAX[cor], MAXV>}
- d. <... tʲimjas, tʲimjaʔ, tʲimjʔ, tʲimjʔʔ>
{MAX[cor], MAXV, MAX[cor]}, {<MAX[cor], MAXV, MAX[cor]>}

The selection of the winner is illustrated in tableau (27). The winning chain, (27c), 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 (27a) seemingly has no violation of a constraint that is ranked higher than MAXV. In other words, a crucial violation of \Leftarrow^* LOWSON-PL]_{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(MAX[cor], MAXV) disfavors the faithful chain and selects the derivation where both processes occur. Finally, candidate (27d) also loses, by virtue of EPREC, since it has a MAXV violation that is followed by a MAX[cor] violation.

(27) *Feeding correctly allowed*

/tʲimjas/	\Leftarrow^* LOWSON-PL] _{PrWd}	EPREC(MAX[cor], MAXV)	MAX V	\Leftarrow^* C-PL] _{PrWd}	MAX[cor]
a. <... tʲimjas> ∅, ∅		W ₁	L	1	L
b. <... tʲimjaʔ> {MAX[cor]@6}, ∅	W ₁	W ₁	L		1
☞ c. <... tʲimjʔ> {MAX[cor]@6, MAXV@5}, {<MAX[cor]@6, MAXV@5>}			1	1	1
d. <... tʲimjʔʔ> {MAX[cor]@6, MAXV@5, MAX[cor]@4}, {<MAX[cor]@6, MAXV@5, MAX[cor]@4>}		W ₁	1	1	W ₂

The constraint \Leftarrow^* LOWSON-PL]_{PrWd} is the highest-ranked in this tableau (it outranks EPREC by the revised ranking metaconstraint (33); see §4.3), and its effects are surface-true in Tundra Nenets. 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 Tundra Nenets.¹⁸

Importantly, EPREC(A, B) must outrank B for our analysis to yield the correct result. This condition runs contrary to the ranking metaconstraint in (5). 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 (28a) show, the velars /k/ and /g/ are palatalised when adjacent to the front vowel /i/. However, even if /i/ undergoes syncope, as illustrated in (28b) and (c), the consonants still surface as palatalised, as shown in (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) *Bedouin Arabic* (McCarthy 2007: 99–109, 177–210)

a. *Palatalisation*

ru:g	‘be calm’	rawwigj	‘do not make noise!’
gu:l	‘say!’	gʲi:l	‘it was said’
mamlu:k	‘owned’	ʝmallikj	‘he makes someone own’
jaskut	‘he becomes silent’	ʝsakʲkʲit	‘he silences someone’

b. *Syncope*

/ti-rsil-um/	tirslu:n	‘you (MASC SG) send’
/ʃarib-at/	ʃarbat	‘he drank’

c. *Syncope counterbleeds palatalisation*

/ha:kim-in/	ha:kʲmi:n	‘ruling (MASC PL)’
	cf. ha:kʲim	‘ruling (MASC SG)’
/kitib-t/	kʲitibt	‘you (MASC SG) were written’
	cf. kʲitbaw	‘they (MASC) 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 violations of these markedness constraints is achieved by

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.

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

violating MAX and IDENT[back]. PREC(IDENT[back], MAX) requires all IDENT[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-in/	*iCV	*ki	MAX	PREC(ID[bk],MAX)	ID[bk]
a. <ha:kimi:n> 0,0	W ₁	W ₁	L		L
b. <ha:kimi:n, ha:k'iimi:n> {ID[bk]@3},0	W ₁		L		1
c. <ha:kimi:n, ha:kmi:n> {MAX@4},0			1	W ₁	L
☞ d. <ha:kimi:n, ha:k'iimi:n, ha:k'mi:n> {ID[bk]@3,MAX@4}, {<ID[bk]@3,MAX@4>}			1		1

Crucially, the transparent bleeding candidate (29d), with syncope and no palatalisation, is blocked by the PREC constraint. If PREC were ranked below IDENT[back], the transparent candidate would win.

If PREC(IDENT[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, /farib-at/ ‘he drank’ surfaces as [farbat], with syncope and no palatalisation. Since [r] is not a velar, there is no harmonically improving chain with palatalisation from the input /farib-at/. The only two competing chains are the one with syncope and the one without it. PREC(IDENT[back], MAX) is violated when a chain violates MAX only (since there is no preceding IDENT[back] violation). Therefore, ranking PREC(IDENT[back], MAX) above *iCV blocks syncope in this case, as shown in (30). In this tableau, syncope is blocked because palatalisation is not possible.²⁰

(30) Unwanted effect of the ranking PREC(IDENT[back], MAX) ≫ *iCV
(McCarthy 2007: 202)

/farib-at/	PREC(ID[bk],MAX)	*ki	*iCV	MAX	ID[bk]
☞ a. <faribat> 0,0			1		
☞ b. <farbat> {MAX@4},0	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 /firabita/.

²⁰ In this tableau, ☞ indicates the intended winner, and ☞ the actual winner.

(31) *EPREC makes wrong predictions if* $EPREC(IDENT[back], MAX) \gg *iCV$

/firabita/	$EPREC(ID[bk],MAX); *ki$	$*iCV$	MAX	$ID[bk]$
a. <firabita> 0,0	1	L_2	L	
☞ b. <rabta> { $MAX@2,MAX@6$ },0	W_2	L	W_2	
☞ c. <firabta> { $MAX@6$ },0	1	1	1	
☞ d. <rabita> { $MAX@2$ },0	1	1	1	

$EPREC(IDENT[back], MAX)$ assigns a violation for every violation of MAX that is not preceded by a violation of $IDENT[back]$. Therefore, the constraint favours chains with one unpreceded MAX violation, as in (31c, d), over ones with two such violations, as in (31b). 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 high-ranked looks even more bizarre than the one in which $PREC(A, B)$ is high-ranked: 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 (5), repeated here as (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* $EPREC$

$$B \gg EPREC(A, B)$$

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*

$$\text{For every constraint } C, \text{ if } C \gg B, \text{ then } C \gg EPREC(A, B).$$

For our pseudo-Bedouin example, (33) would amount to a requirement that $*iCV$ dominate $EPREC(IDENT[back], MAX)$. As expected, the

²¹ See also Wolf (2008), who argues that the ranking metaconstraint as formulated in McCarthy (2007) needs to be abandoned in order to model non-derived environment blocking.

undesired prediction disappears with this ranking, as shown in (34): since $\text{EPREC}(A, B)$ is outranked by all markedness constraints above B , its violation will never be worse than a violation of these markedness constraints. The chains (34c) and (d) are correctly ruled out, and the right chain wins under this ranking.

(34) $*iCV \gg \text{EPREC}(\text{ID}[\text{back}], \text{MAX})$ makes no harmful predictions

/firabita/	$*ki' *iCV$	$\text{EPREC}(\text{ID}[\text{bk}], \text{MAX})$	MAX	ID[bk]
a. <firabita> 0,0	W ₂	L ₁	L	
☞ b. <rabta> {MAX@2, MAX@6}, 0		2	2	
c. <firabta> {MAX@6}, 0	W ₁	L ₁	L ₁	
d. <firabita> {MAX@2}, 0	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 explains the Tundra Nenets 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

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

These two modifications of the OT-CC theory of opacity allow us to account for the Tundra Nenets 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 Alternative analyses

In what follows, we address alternative analyses of Tundra Nenets fed counterfeeding. §5.1 presents evidence that the two processes in Tundra Nenets cannot be reanalysed as unrelated by a feeding relationship. §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 Tundra Nenets that the application of apocope be conditioned by debuccalisation. Descriptively, the vowels delete only before a glottal stop, but could it be that $/\Delta/$ in fact deletes before any consonant (as suggested by Stephen Anderson, personal communication)? On this view, then, the fact that we see apocope only before $[\text{ʔ}]$ 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 $/\Delta/$ before an optional word-final consonant.²² On this approach, Apocope' still counterfeeds debuccalisation in vowel-final forms, as the example $[\text{lab}\Delta\text{S}]$ 'plate, slice' in (35a) 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 $[\text{t}^{\text{h}}\text{imj}\text{ʔ}]$ 'it rotted' can be derived on both orderings of the rules, as shown in (35b). Under this analysis, Tundra Nenets does not exhibit fed counterfeeding, since Debuccalisation does not feed Apocope'.

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

a.	<i>counterfeeding</i>			
input	$\text{lab}\Delta\text{S}$	(Tereshchenko 1965: 160)		
Debuccalisation	n/a			
Apocope'	$\text{lab}\Delta\text{S}$			
output	$\text{lab}\Delta\text{S}$			
b.	<i>ordering 1</i>		<i>ordering 2</i>	
input	$\text{t}^{\text{h}}\text{imj}\Delta\text{S}$	input	$\text{t}^{\text{h}}\text{imj}\Delta\text{S}$	
Debuccalisation	$\text{t}^{\text{h}}\text{imj}\Delta\text{ʔ}$	apocope'	$\text{t}^{\text{h}}\text{imj}\text{S}$	
Apocope'	$\text{t}^{\text{h}}\text{imj}\text{ʔ}$	debuccalisation	$\text{t}^{\text{h}}\text{imj}\text{ʔ}$	
output	$\text{t}^{\text{h}}\text{imj}\text{ʔ}$	output	$\text{t}^{\text{h}}\text{imj}\text{ʔ}$	

In OT-CC terms, the alternative analysis would most straightforwardly be translated into two constraints: $*_{\Delta}\text{C}\#$, penalising $[\Delta]$ separated from the right edge of the word by one consonant, and $*_{\Delta}\#$, penalising word-final $[\Delta]$. However, such an analysis could not easily implement the

²² Recall from §3.1 that it is not important for an OT-CC analysis whether $/\Delta/$ -deletion in absolute word-final position and before a word-final consonant are formulated as a single process or as two separate processes (the latter was suggested by Eric Baković (personal communication) 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'.

non-iterativity of the application of Apocope' (cf. Kaplan 2008 on non-iterativity as a dubious concept in general).

The constraint $*_{\Delta}C\#$ needs to dominate MAX, since it leads to the deletion of a vowel in the mapping $/tʲimj_{\Delta}S/ \rightarrow [tʲimjʔ]$. However, ranking this constraint above faithfulness would incorrectly predict the deletion of *two* vowels in the input $/lab_{\Delta}S_{\Delta}/$, i.e. $/lab_{\Delta}S_{\Delta}/ \rightarrow *[labS]$. If $*_{\Delta}C\#$ 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 $/_{\Delta}/$ -deletion and show that no such factor can apply in Tundra Nenets.

First, clusters like [bs] are allowed word-finally in Tundra Nenets (cf. $/pʲi'n_{\Delta}btsʲ_{\Delta}/$ [$pʲi'n_{\Delta}btsʲ$] 'fear', $/mebts_{\Delta}/$ [$mebts$] 'habit', $/\eta_{\Delta}abts_{\Delta}/$ [$\eta_{\Delta}abts$] 'in general'). Consonant phonotactics can therefore not 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 [lab_ΔS] does not undergo any process other than vowel deletion, and therefore the absence of deletion of $/_{\Delta}/$ 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 and 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 $/_{\Delta}/$ -deletion is categorical in Tundra Nenets. As was mentioned in note 4, labial and dental stops voice after vowels (and nasals), as shown in (36a). Examples in (36b) 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 (36c).

- | | | | |
|---------|--|-------------------------------|---|
| (36) a. | $/xar_{\Delta}t_{\Delta}/$ | $xar_{\Delta}d$ | 'house' |
| b. | $/nʲarma pas_{\Delta}koj_{\Delta}/$
red-ADJ beautiful | $nʲarma baskoj$ | '(that) red-cheeked (one) is beautiful' |
| | $/n_{\Delta}krʲo tara_{\Delta}/$
prepare need.3SG | $n_{\Delta}krʲo dara^{23}$ | 'it is necessary to get ready' |
| c. | $/wabtasʲ_{\Delta} tara_{\Delta}/$
overturn need.3SG | $wabtasʲ tara:$
* $dara:$ | 'it is necessary to overturn' |
| | $/pas_{\Delta}koj_{\Delta} pedara/$ | $paskoj pedara$
* $bedara$ | 'beautiful forest' |

²³ The long final vowel in [tara:] 'it is necessary' is a result of vowel coalescence (also exemplified in (10)). In such a case, the word-final $/_{\Delta}/$ does not delete. A complete analysis of this phenomenon would lead us too far astray. We hypothesise

If the nucleus of the last syllable were preserved on the surface, the first consonant of the second word in the phrases in (36c) could undergo voicing, just as it does in (36b). The absence of such voicing indicates that the vowel has been fully deleted, and apocope in Tundra Nenets does not preserve any aspects of the structure.

To sum up, if we assume that [Δ] in Tundra Nenets deletes before any word-final consonant, we face 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 1993, 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 Tundra Nenets 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 Tundra Nenets 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.

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

preliminarily that coalescence is only applicable when the full vowel is immediately adjacent to / Δ /.

²⁴ Another instantiation of OT that can capture the effects in question is Comparative Markedness (McCarthy 2003), one of the predecessors to OT-CC and an inspiration for the current analysis. However, Comparative Markedness cannot handle all relevant cases of vowel deletion in Tundra Nenets (see Kavitskaya & Staroverov 2008 for a discussion).

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) 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 $*V]_{P_{rWd}} \gg \text{MAXV}$, 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 Tundra Nenets data in Stratal OT. In order to do this, we would need to show that the two processes involved in Tundra Nenets 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 $*C\text{-PL}]_{P_{rWd}}$ 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.

Tundra Nenets 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 / Δ /-deletion 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.

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.

(37) *Predictions of Stratal OT*

input	/nʲenetsʲΔn sawa/ man good 'The man is good.'	/padar-Δn tʲaxana/ paper-GEN SG behind 'behind paper'
Stratal OT	nʲenetsʲΔʔ sawa	padarΔʔ tʲaxana
slow speech	nʲenetsʲʔ sawa	padarʔ tʲaxana
fast speech	nʲenetsʲΔn zawa	padarΔn dʲaxana

As it happens, the predictions of Stratal OT are not borne out by Tundra Nenets. 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 Tundra Nenets. 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 (38a), while in (38b), the underlying nasal does not debuccalise, but rather assimilates in place to the following velar.

(38) a.	/nʲe-ʔ xΔnΔ/ woman-GEN.PL sledge	nʲe kΔn	'a women's sledge'
b.	/nʲe-n xΔnΔ/ woman-GEN.SG sledge	nʲeŋ gΔn	'a woman's sledge'

If debuccalisation belonged exclusively to a stratum earlier than the postlexical stratum, the input /nʲen/ in (38b) would be mapped to /nʲeʔ/ 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.

We have shown that, in order for Stratal OT to account for fed counterfeeding in Tundra Nenets, 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

²⁸ In far Western Tundra Nenets 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 [nʲenetsʲ sawa] 'The man is good', [padar tʲaxana] 'behind paper'. These dialects appear to have lost the word-final glottal stop and the preceding vowel /Δ/.

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.

constitutes a problem for the Stratal OT analysis. On 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 stratum-internal interaction.

In general, stratum-internal 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 those in (37) and (38), would not constitute evidence for 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 Tundra Nenets 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)–(39) is transparent, which also points to the fact that no lexicalisation has taken place.^{30,31}

(39) input	/nil Δ n tara Δ /	/jil Δ n pas Δ koj Δ /
	rest need.3SG	life beautiful
	‘Rest is needed.’	‘Life is beautiful.’
slow speech	nilʔ tara:	jilʔ paskoj
fast speech	niln dara:	jiln baskoj

We have established the level affiliation of the processes involved in Tundra Nenets 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 Tundra Nenets must apply at the same level (evidence from opaque

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 Tundra Nenets 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 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 / Δ / in the first words of the input deletes in fast speech. This is due to an entirely different process of vowel deletion in Tundra Nenets: non-final / Δ / regularly deletes in even syllables, which is also evidenced by the deletion of / Δ / in the second syllable of the word /pas Δ koj Δ / ‘beautiful’ (see Kavitskaya & Staroverov 2008 for an analysis).

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, Tundra Nenets 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 Tundra Nenets 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 $E_{PREC}(A, B)$ 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 $E_{PREC}(A, B)$.

We hope to have contributed to the documentation of 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 Staroverov 2010, Jesney, 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.

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