Counter-Feeding Opacity As a Chain Shift Effect

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1. Statement of the problem

In Polish (Rubach 1984), there is a process of Nominal Strident Palatalization (henceforth, NSP), by which postalveolar voiceless fricatives /š/ become prepalatal [ś] before a high front vowel [i]. There is also a process of First Velar Palatalization (henceforth, FVP), by which velar segments /k g x/ become palatoalveolar [č ǰ š] before front vocoids [i e j].

(1a) Nominal Strident Palatalization (NSP): /š/→ś/_ i

nom. sg.	aug.	dimin.	
gro[š]	gro[ś]+isk+o	gro[ś]+ik	'a penny'
kapelu[š]	kapelu[ś]+isk+o	kapelu[ś]+ik	'hat'
arku[š]	arku[ś]+isk+o	arku[ś]+ik	'sheet'

(1b) First Velar Palatalization (FVP): /k g x/→č ǰ š/_i e j

nom. sg.	aug.	dimin.	
gro[x]	gro[š]+ysk+o	gro[š]+ek	'bean'
gma[x]	gma[š]+ysk+o	gma[š]+ek	'building'
fartu[x]	fartu[š]+ysk+o	fartu[š]+ek	'apron'

This paper focuses on the behavior of voiceless sibilants [š] and [ś] before [i]. The environment of a high front vowel is common to both NSP and FVP.

The key observation is that post-alveolar fricatives [š] derived by FVP, as in (1b), do not become pre-palatal (/x/→š, *ś/_i). But underlying fricatives /š/ do so in the same environment (see (1a)). This is known as *counter-feeding opacity* (Kiparsky 1973): a phonological process (in Polish, NSP) fails to apply to "derived" forms of the language. In Polish, it does not apply to [š] derived by FVP.

In rule-based phonology, counter-feeding opacity is accounted for by rule ordering. In Polish, it has been postulated that NSP precedes FVP (Rubach 1984). Thus, forms derived by FVP do not undergo NSP.

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(2) Counter-feeding derivation

/groš+isk+o/	/gma**x**+isk+o/	
groś+isk+o	N/A	NSP
---	gmaš+isk+o	FVP
---	gmaš+ysk+o	Other (retraction)

The interaction of FVP and NSP is problematic to standard OT (Prince and Smolensky 1993). Standard OT predicts that either (i) both underlying and derived š*'s* should become pre-palatal (3a), or (ii) neither should do so (3b). Both fricatives become prepalatal when markedness outranks faithfulness (*š >> IDENT(back)). With the opposite ranking (IDENT(back) >> *š), none of the fricatives maps onto a prepalatal.

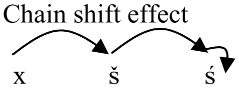
(3) OT prediction

a. NSP across the board b. NSP does not apply

Nonetheless, counter-feeding opacity is attested (Gussmann 1976; Kiparsky 1973; McCarthy 1999; 2002; Rubach 1984). Previous accounts of counter-feeding opacity in OT include: sympathy theory (McCarthy 1999), stratal OT (LPM-OT) (Kiparsky 2000), output-output correspondence (Benua 1997; Burzio 1998), local conjunction (Kirchner 1996; Bakovic 2000), targeted constraints (Wilson 2001), comparative markedness (McCarthy 2002), turbidity (Goldrick and Smolensky 1999), and scalar faithfulness constraints (Gnanadesikan 1997). [1]

This paper proposes that counter-feeding opacity is a *chain shift effect*. In Polish, underlying /š/ becomes [ś] but derived [š] does not change in the same environment. Thus, there is a chain shift effect of the form x→š→ś, as illustrated below.

(4) Chain shift effect



before [i]

The key claim is that chain shifts can be accounted for in terms of preserving/neutralizing sets of distinctive oppositions in surface forms. In particular, chain shifts preserve a given underlying contrast on the surface but manifest it in a different way than in the underlying form. This is at the

1. Łubowicz (2002) proposes a local conjunction account of counter-bleeding opacity.

cost of neutralizing some other contrast. I will refer to it as *contrast transformation.*

In Polish, due to NSP, contrast is preserved between /x/ and /š/ (contrast in *coronality*) despite FVP. The underlying contrast in *coronality* is manifested as surface contrast in *backness*, [š] vs. [ś]: gro[x] vs. gro[š] map onto gro[š]ysko vs. gro[ś]isko, respectively. Some instances of the original contrast in *backness* are lost as a result: gro[š] vs. gro[ś] map onto gro[ś]isko.[2] This is illustrated below:

(5) Contrast transformation

Input		*Output*
coronality	⟶	backness
backness	⟶	neutralized

In standard OT, contrast preservation follows from the interaction of markedness and faithfulness constraints. But, as we have seen, this type of interaction does not admit counter-feeding opacity (shown in (3)). Therefore, to account for contrast transformation, this paper proposes a modification of OT, called *Contrast Preservation Theory* (PCT). The proposal has far-reaching consequences, as discussed in the following sections. (For more extensive discussion, see Łubowicz 2003.)

2. The proposal (Contrast Preservation Theory, PCT)

2.1. The main claim

The main claim of PCT is that contrast preservation exists as a primitive in the grammar, which, within OT, can be expressed as a family of rankable and violable constraints on preserving contrasts, PRESERVE CONTRAST constraints, $PC_{IN}(P)$. These constraints refer to phonological properties P, such as *height, coronality, voicing, presence vs. absence of a segment,* etc., thus regulating preservation and distribution of phonological contrasts in a scenario. The definition is given below.

(6) $PC_{IN}(P)$

For each pair of inputs contrasting in P that map onto the same output in a scenario, assign a violation mark. Formally, assign one mark for every pair of inputs, in_a and in_b, if in_a has P and in_b lacks P, $in_a \rightarrow out_k$, and $in_b \rightarrow out_k$.

2. The form gro[ś] is hypothetical. Actual mappings involving the prepalatal sibilant include: stru[ś] → stru[ś]+isk+o → stru[ś]+ik "ostrich," ry[ś] → ry[ś]+isk+o → ry[ś]+ik "lynx," pty[ś] → pty[ś]+isk+o → pty[ś]+ik "(cream) puff," Bry[ś] → Bry[ś]+isk+o → Bry[ś]+ik "dog's name."

"If inputs are distinct in P, they need to remain distinct."

PC constraints, unlike standard faithfulness, are satisfied when contrast transformation takes place and thus, as will be shown below, admit chain shift mappings. For example, a PC constraint that refers to *coronality*, PC_{IN}(coronal), is satisfied when the original contrast in *coronality* is manifested as surface contrast in *backness*. This is the main difference between PC constraints and standard faithfulness. Standard faithfulness would be violated in this case, while PC is satisfied.[3]

2.2. The candidates

Constraints on contrast compare sets of input-output mappings. Therefore, to evaluate constraints on contrast, candidates must be sets of input-output mappings, called *scenarios* (Flemming 1995; Padgett 1997). Some examples of scenarios in a candidate set are given below.

(7) Examples of scenarios in a candidate set

Scenarios	A. Identity	B. Transparent	C. Chain shift
Output	[x] [š] [ś]	[š] [ś]	[š] [ś]
Input	/x/ /š/ /ś/	/x/ /š/ /ś/	/x/ /š/ /ś/

Scenarios represent various mapping coexistence patterns. Scenarios differ on the set of outputs and/or input-output relations even if outputs are the same. For example, as shown above, the identity scenario has a different set of outputs than the transparent and chain shift scenarios. But the transparent and chain shift scenarios differ in the input-output relations, even though they have the same outputs.

PCT proposes a principled way of generating scenarios. The inputs of a scenario are generated by a function Gen (similar to Gen in Correspondence Theory). Gen takes an underlying form and generates a set of inputs that can potentially interact with it.

(8) Scenario-inputs

Gen (underlying form_i) $\rightarrow$ scenario-inputs_i

2. Lubowicz (2003) also proposes output-oriented and relational PC constraints.

Scenario inputs represent all possible combinations of all phonological properties P. A sample input set for a three-segment underlying form *bad* is given below.

(9) Sample input set
Gen (bad) → {bad, bud, bat, bata, ugh, pa, ∅ etc. }

To avoid inputs of unlimited length, there is a limit put on insertion of segments. For an underlying form of length *n*, Gen emits inputs of length 0…2n+1. Thus, a scenario is finite. This is necessary to evaluate constraints on contrast. In effect, the same scenario inputs are generated for any underlying form of length *n*. The same inputs are generated for *bad* as for *but* etc. in any language.

Outputs of a scenario are a subset (possibly improper) of the input. Thus, a scenario is a mapping of the input set onto itself (see (7)).

The optimal scenario is chosen by the interaction among constraints. These are discussed in the following section.

2.3. The constraints

Scenarios are evaluated along three dimensions: (i) contrast preservation, (ii) output well-formedness, and (iii) the difference between inputs and corresponding outputs. To begin with, scenarios differ on types of neutralizations that take place in a scenario and the number of them. Scenarios can also contain various outputs, and finally, scenarios can differ on which inputs map onto what outputs. Formally, in PCT this is evaluated by positing three distinct families of constraints:

(10) Constraints in PCT
PC constraints
Markedness constraints
Generalized faithfulness constraints

In what follows, I will discuss each of the constraints in turn.

The core of the proposal are PC constraints. PC constraints, as defined in (6), militate against neutralizations of underlying contrasts. Consider the scenarios shown in (7). As will be shown below, PC_{IN} constraints prefer the identity scenario over the transparent and chain shift scenarios, since the identity scenario does not incur any neutralizations in the system. PC_{IN} constraints also distinguish between transparent and chain shift scenarios. The transparent scenario neutralizes *coronality* while the chain shift scenario merges *backness.*

PC constraints interact with each other and with conflicting markedness (well-formedness) constraints, resulting in preservation or neutralization of underlying oppositions in surface forms (For a discussion of oppositions, see Trubetzkoy 1971.)

Finally, in addition to PC and markedness constraints, there are generalized faithfulness constraints that evaluate input-output disparity in a scenario. As expected, generalized faithfulness constraints are limited in their role, and in that, they are different from standard faithfulness constraints. Generalized faithfulness constraints do not distinguish among different featural changes. Their definition is given below.

(11) Generalized faithfulness

An output is identical to its input correspondent in every property. Assign a violation mark for any type of disparity (e.g., feature change, deletion, and insertion).[4]

In PCT, constraints belong to two stages of Eval(uation). PC constraints and markedness belong to stage one of Eval. Generalized faithfulness constraints are in stage two. This is shown below.

(12) Eval in PCT

Stage 1 PC and markedness
Stage 2 Generalized faithfulness

As a result, generalized faithfulness constraints apply only after PC, and markedness have a chance to apply. In effect, generalized faithfulness resolves ties from stage 1 of Eval in favor of a scenario where outputs are more similar to their inputs, but it does not directly interact (cannot be re-ranked) with respect to PC and markedness constraints.

3. Illustration of the proposal

This section illustrates the proposal on a simple case of neutralization and the lack of it.

3.1. Case I: Neutralization

Assume a language with final devoicing. In this language, voiced obstruents are avoided syllable-finally. In terms of contrast, voiced and voiceless obstruents map onto the same output; thus, contrast in obstruent

4. Lubowicz (2003) argues that, in addition, generalized faithfulness constraints need to partition faithfulness violations among different output types, [αP]-FAITH.

voicing is neutralized syllable-finally. Formally, markedness against voiced obstruents syllable-finally outranks a constraint on preserving contrast in voicing. The constraints and their ranking are given below.

(13) The constraints

$*\text{VoiObs}]_\sigma$	Avoid voiced obstruents syllable-finally
PC_{IN}(voice)	Do not merge inputs distinct in voicing

(14) Neutralization ranking

$*\text{VoiObs}]_\sigma >> \text{PC}_{\text{IN}}(\text{voice})$

This is illustrated in (15). The tableau in (15) compares three scenarios: a neutralization scenario, an identity scenario and a permuted scenario. Each of the scenarios contains the same inputs, but they differ on the set of outputs and the input-output relations. Inputs are generated by Gen and outputs are a subset of the inputs. A detailed description of scenario construction is given in Section 2.2. The neutralization scenario, scenario A, is the winner, since it avoids voiced obstruents in surface forms syllable-finally, and thus satisfies high-ranked markedness. The remaining two scenarios, the identity and permuted scenarios, violate markedness and so are ruled out.

(15) Polish

Scenarios		$*\text{VoiObs}]_\sigma$	PC_{IN}(voice)	FAITH
A. Neutralization ☞	/va**d**/ → va**t** /va**t**/ → va**t**		* {/vad/,/vat/}	* d→t
B. Identity	/va**d**/ → va**d** /va**t**/ → va**t**	*!		
C. Permuted	/va**d**/ → va**t** /va**t**/ → va**d**	*!		** d→t t→d

Thus, with this ranking, final devoicing takes place.

Altogether, the schema for contrast neutralization is when markedness outranks conflicting PC constraints. This is shown below.

(16) Schema for contrast neutralization

Markedness-*P >> PC(P)

Forms violating markedness against P are ruled out even at the cost of neutralizing contrast in P. In the case of final devoicing, forms with voiced obstruents syllable-finally are ruled out at the cost of neutralizing the voicing contrast in syllable-final position.

3.2. Case II: Lack of neutralization

Let us now consider a case of no neutralization. In this situation, obstruent voicing contrast from the input is preserved in surface forms. Inputs distinct in voicing map onto distinct outputs. The ranking is given below.

(17) Contrast preservation ranking
PC_{IN}(voice) >> *VoiObs]$_\sigma$

This is illustrated in (18). The same scenarios are being compared as in the previous section. This time, the neutralization scenario loses as it violates the high-ranked PC constraint. The other two scenarios pass on to stage 2 of Eval since they satisfy PC and incur the same violation of markedness.

(18) English

Scenarios		PC_{IN}(voice)	*VoiObs]$_\sigma$	FAITH
A. Neutralization	/va**d**/ → va**t** /va**t**/ → va**t**	*! {/vad/,/vat/}		d→t
B. Identity ☞	/va**d**/ → va**d** /va**t**/ → va**t**		*	
C. Permuted	/va**d**/ → va**t** /va**t**/ → va**d**		*	**! d→t t→d

The choice between scenarios B and C cannot be made on either markedness or contrast. Generalized faithfulness favors scenario B (the identity scenario) over scenario C (the permuted scenario), since the identity scenario contains less input-output disparity.

The schema for contrast preservation is given below.

(19) Schema for contrast preservation (cf. contrast neutralization in (16))
PC(P) >> Markedness-*P

It is more important to preserve contrast than to avoid outputs that contain markedness-violating structures.

So far, PC works like standard faithfulness. When markedness outranks PC, contrast is neutralized. With the opposite ranking, contrast is preserved. The next section points to differences.

4. Application of the proposal

In counter-feeding opacity, a phonological process applies only to a subset of forms subject to it. In Polish, NSP applies to underlying postalveolar fricatives [š], turning them into prepalatal [ś], but it fails to apply to [š] derived by FVP. Thus, contrast is preserved between underlying *x* vs. *š* despite FVP and is manifested as surface contrast in backness, *š* vs. *ś*. Some instances of the *š/ś* contrast are neutralized as a result. I propose, therefore, that NSP in Polish is a result of FVP and a requirement on preserving contrast in *coronality* (cf. Kaye 1974; Kisseberth 1976).

In short, FVP needs to take place to avoid velars before front vowels and this in turn triggers a further change of underlying postalveolar fricatives into prepalatals in the same environment. This preserves the distinction between underlying velars and post-alveolars despite FVP. The following ranking expresses it formally:

(20) Contrast transformation
*xi, PC_{IN}(coronal) >> PC_{IN}(back)

The ranking is illustrated in the following tableau. The tableau shows three scenarios: scenario (A) where FVP and NSP apply in a counter-feeding order (Polish), scenario (B) where none of the processes applies (identity scenario), and scenario (C) with no NSP (transparent scenario). The set of inputs is generated by Gen, as described in Section 2.2, and outputs are a subset of the inputs.

(21) NSP takes place

	Scenarios	*xi	PC_{IN}(cor)	PC_{IN}(bk)
A. Polish ☞	grox+isk+o→gro[š]ysko groš+isk+o →gro[ś]isko groś+isk+o →gro[ś]isko			*
B. Identity	grox+isk+o →gro[x]isko groš+isk+o →gro[š]ysko groś+isk+o →gro[ś]isko	*!		
C. Transparent	grox+isk+o →gro[š]ysko groš+isk+o →gro[š]ysko groś+isk+o →gro[ś]isko		*!	

Scenario A wins since it preserves the *x/š* contrast (*grox* vs. *groš*). In this scenario, both inputs map onto distinct outputs. This is at the cost of neutralizing the *š/ś* contrast (*groš* vs. *groś*). The identity scenario loses, since it contains markedness-violating structures. The transparent scenario is ruled out, since it merges inputs that are distinct in coronality.

Altogether, the chain shift scenario wins, since it preserves contrast in coronality despite the application of FVP. A general schema for contrast transformation is given below.

(22) Contrast transformation (cf. (16), (19))
M-*P, PC(P) >> PC(Q)

Forms violating markedness against P are avoided but contrast in P needs to be preserved, and this is at the cost of merging some instances of the contrast in Q.[5]

5. Implications for the typology of chain shifts

Unlike standard OT, PCT predicts that there exist push shifts. In Polish, NSP is a result of FVP and a requirement on preserving contrast. We do not need a separate high-ranking markedness constraint to force NSP. This is a *push shift effect.*

In a push shift, there is no high-ranked markedness constraint to force the later step in the shift. The later step is an indirect consequence of the prior step and a requirement on preserving contrast. The Polish chain shift x→š→ś provides an example. There is a high-ranked markedness constraint against x, so *xi. But there is no high-ranked markedness against šɨ. Thus, the š→ś mapping (NSP) is an indirect result of the x→š mapping (FVP).

5.1. PCT admits push shifts

In PCT, some phonological process can occur without a high-ranking markedness constraint to motivate them. A process can take place solely to preserve contrast. This occurs if, as in Polish, some other process, higher up in the chain, is compelled by a high-ranking markedness constraint. Thus, NSP takes place to preserve contrast.

5. Not all scenarios are shown here. For full typology, see Łubowicz (2003). Łubowicz develops a full typology of chain shift mappings evaluating contrast over a symmetrical scenario. In the Polish case, this is a scenario that contains inputs distinct along dimensions of *coronality* and *backness*: gro[x]+isk+o, gro[š]+isk+o, gro[ś]+isk+o, and an input that comes from richness of the base gro[ç]+isk+o.

Formally, NSP (š→ś) is forced by high-ranked PC_{IN}(coronal). Thus, there is no need for high-ranked markedness *šɨ. (This was illustrated in (21).)[6]

5.2. Previous OT approaches do not admit push shifts

In previous approaches (and in standard OT generally), a phonological process can only take place due to high-ranked markedness (cf. Moreton 1996/1999). For NSP to take place, we need a high-ranking markedness constraint against šɨ. Consider the local conjunction approach to chain shifts (Kirchner 1996), as applied to Polish.

As in standard OT, FVP and NSP are both forced by high-ranking markedness constraints. The relevant rankings are given in (23).

(23) M >> F rankings

*xi >> IDENT(coronal) FVP takes place

*šɨ >> IDENT(back) NSP takes place

Given the M-ness over F-ness rankings, we expect NSP to take place.

The role of local conjunction, then, is to block NSP from applying to šɨ derived by FVP. Formally, local conjunction blocks NSP if it results in a double violation of faithfulness in the same segment.

(24) The role of local conjunction

$[$IDENT(coronal) & IDENT(back)$]_{Seg}$ >> *šɨ>> IDENT(back)

As a result, underlying postalveolars turn into prepalatals to satisfy high-ranking markedness, but derived postalveolars do not do so, due to the high-ranking locally-conjoined constraint. This is shown below.

(25) /š/ undergoes NSP

ši	[IDENT(coronal) & IDENT(back)]$_{Seg}$	*šɨ	IDENT(back)
šɨ		*!	
☞śi			*

6. Additional evidence against having a high-ranking constraint *šɨ is that in Polish there are forms with a post-alveolar fricative followed by a central vowel: arku[š]→arku[š]+ɨ "sheet, gen.pl.," gro[š]→gro[š]+ɨ "penny, gen.pl." In the environment of palatalization, however, as expected, the postalveolar fricative in these forms turns into a prepalatal: arku[ś]+isk+o, gro[ś]+isk+o, thus lending further support to the push shift analysis. (Forms "arku[š]+ɨsk+o" and "gro[š]+ɨsk+o" are also acceptable.)

(26) /x/ does not undergo NSP

xi	[IDENT(coronal) & IDENT(back)]$_{Seg}$	*šɨ	IDENT(back)
☞šɨ		*	
śi	*!		*

Crucially, without high-ranking markedness *šɨ, NSP would not take place. The purpose of local conjunction, then, is to block the š→ś mapping from affecting underlying /x/. Both FVP (/x/→š) and NSP (/š/→ś) are forced by high-ranking markedness constraints. (The same is true of Gnanadesikan (1997).)

6. Summary

This paper proposes a modification of OT that recognizes contrast as an imperative in the grammar. At the core of the proposal are novel PC constraints that evaluate contrast over a finite set of input-output mappings, called a *scenario*.

PC constraints infringe on the territory of standard markedness and faithfulness:

(i) they are like faithfulness in that they preserve underlying contrasts, but
(ii) they are like markedness in that they can activate a phonological process.

Thus, PCT allows a phonological process to take place solely to preserve contrast iff there is a high-ranked markedness constraint that initiates the shift.

This has consequences for the typology of chain shifts: unlike in standard OT, PCT allows push shifts to take place.

Finally, by recognizing contrast as an imperative in a phonological system, transparent and opaque phonological processes are accounted for in a uniform way with no additional mechanisms required, unlike in previous approaches to opacity (cf. local conjunction, sympathy theory, levels, etc.).

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