Phonetic faithfulness in counterfeeding opacity

This study aims to provide a novel account of counterfeeding opacity, which is grounded in a new finding on a substantive restriction on the patterns of counterfeeding interactions. The major claim is that the purpose of counterfeeding opacity is to preserve the phonetic properties specified in the input of a phonological operation. Specifically, I propose that *inputs* are enriched with phonetic auditory features, and surface opacity is achieved by processing these *realized inputs* (Flemming 2008).

(1) *input* → **PHONETIC REALIZATION** → *realized input* → **PHONOTACTICS** → *surface form*

To illustrate how it works, consider a hypothetical counterfeeding-on-environment example involving palatalization and vowel deletion, where /ti/ becomes [tʃi] but /toi/ remains [ti] (e.g., Kinyarwanda, Myers & Crowhurst 2006). The PHONETIC REALIZATION component of the grammar first generates phonetically enriched input forms for the inputs /ti/ and /toi/. This process is illustrated in (2), where numeric superscripts denote a degree of F2 coarticulation (higher numbers mean higher F2 values). Neutralizing candidates, such as [tʃ^{4}i], are assumed not to be supplied by GEN in this stage of grammar (cf. Flemming 2008). The crucial part here is that the REALIZE [t: F2] = 1 constraint, which requires the faithful realization of the F2 target value of /t/, has no effect by the *[t: F2] < 4 /__i constraint, which requires coarticulation before the underlying /i/. This grammar yields a greatly coarticulated outcome for /ti/ (2a) and a less coarticulated outcome for /toi/ (2b).

(2) a. PHONETIC REALIZATION: /ti/ → [t^{3}i]

I /ti/	*[t: F2] < 4 /__i	REALIZE [t: F2] = 1
a. [t^{1}i]	**!*	
b. [t^{2}i]	**!	*
c. ☞ [t̲^{3}i]	*	**

b. PHONETIC REALIZATION: /toi/ → [t^{1}oi]

I /toi/	*[t: F2] < 4 /__i	REALIZE [t: F2] = 1
a. ☞ [t^{1}oi]		
b. [t^{2}oi]		*!
c. [t̲^{3}oi]		*!*

The generated *realized inputs*, [t̲^{3}i] and [t^{1}oi], are then converted to output forms by PHONOTACTICS, where these *realized input* forms are evaluated by a larger number of constraints. The main idea is that opacity is for satisfying the need to ensure that multiple forms retain an appropriate contrast with each other and the need to maintain the auditory specifications of the realized input forms as much as possible. These motivations are formalized in terms of MINDIST and IDENT constraints, respectively.

(3) PHONOTACTICS (IDENT ≫ MARKEDNESS ≫ REALIZE): {[t^{1}oi]$_{i}$, [t̲^{3}i]$_{j}$, [tʃ^{4}i]$_{k}$} → {[t^{1}i]$_{i}$, [tʃ^{4}i]$_{j,k}$}

RI [t^{1}oi]$_{i}$ [t̲^{3}i]$_{j}$ [tʃ^{4}i]$_{k}$	*VV	MINDIST Δ[C: F2] = 3	IDENT [C: F2]	*[t: F2] < 4 /__i	REALIZE [t: F2] = 1
a. [t^{1}oi]$_{i}$ [t̲^{3}i]$_{j}$ [tʃ^{4}i]$_{k}$	*! (i)	* (j-k)		* (j)	** (j)
b. [t^{1}i]$_{i}$ [t̲^{3}i]$_{j}$ [tʃ^{4}i]$_{k}$		*!* (i-j, j-k)		*** (i), * (j)	** (j)
c. [t^{1}i]$_{i,j}$ [tʃ^{4}i]$_{k}$			**! (j)	*** (i, j)	
d. ☞ [t^{1}i]$_{i}$ [tʃ^{4}i]$_{j,k}$			* (j)	*** (i)	*** (j)
e. [tʃ^{4}i]$_{i,j,k}$			**!* (i), * (j)		*** (i), *** (j)

As in (3), the top-ranked MINDIST Δ[C: F2] = 3 constraint requires a [C: F2] difference of 3 between two surface forms. Because of this constraint, the form [t̲^{3}i]$_{j}$ cannot stand in contrast to other forms (3a-b). Given this pressure towards contrast neutralization, another highly ranked constraint, IDENT [C: F2], prefers the opaque outcome (3d) over the transparent result (3e).

We can similarly explain counterfeeding-on-focus, also known as synchronic chain shift. An example of this case is a hypothetical long-distance height assimilation triggered by a high vowel. In this scenario, /e…i/ becomes [i…i] but /a…i/is changed to [e…i] (e.g., Lena Spanish, Parkinson 1996). In the grammar presented below, numeric superscripts denote F1 values: lower F1 values mean a higher vowel, and higher F1 values mean a lower vowel ([a]: 7;[e]: 4, [i]: 1).

(4) a. PHONETIC REALIZATION: /e…i/ → [e̞^{2}i]

I /esi/	*[V: F1] > 1 /__Ci	REALIZE [e: F1] = 4
a. [e^{4}si]	**!*	
b. [e^{3}si]	**!	*
c. ☞ [e̞^{2}si]	*	**

b. PHONETIC REALIZATION: /asi/ → [a̟^{5}si]

I /asi/	*[V: F1] > 4 /__Ci	REALIZE [a: F1] = 7
a. [a^{7}si]	**!*	
b. [a^{6}si]	**!	*
c. ☞ [a̟^{5}si]	*	**

In (4), unlike the counterfeeding-on-environment case, both relevant forms are subject to the MARKEDNESS constraints on the same scale, where *[V: F1] > 4 /__Ci is inherently ranked over *[V: F1] > 1 /__Ci. However, as in the case of counterfeeding-on-environment, the difference shaped in PHONETIC REALIZATION by these constraints will eventually result in an opaque pattern in PHONOTACTICS.

(5) PHONOTACTICS (IDENT ≫ MARKEDNESS ≫ REALIZE): {[ạ^{5}si]$_{i}$, [ẹ^{2}si]$_{j}$, [i^{1}si]$_{k}$} → {[e^{4}si]$_{i}$, [i^{1}si]$_{j,k}$}

RI	[ạ^{5}si]$_{i}$	[ẹ^{2}si]$_{j}$	[i^{1}si]$_{k}$	*[V: F1] > 4 /__Ci	MINDIST Δ[C: F2] = 3	IDENT [V: F1]	*[V: F1] > 1 /__Ci
a.	[ạ^{5}si]$_{i}$	[ẹ^{2}si]$_{j}$	[i^{1}si]$_{k}$	*! (i)	* (j-k)		**** (i), * (j)
b.	[e^{4}si]$_{i}$	[ẹ^{2}si]$_{j}$	[i^{1}si]$_{k}$		*!* (i-j, j-k)	* (i)	*** (i), * (j)
c.	[e^{4}si]$_{i,j}$		[i^{1}si]$_{k}$			* (i), **! (j)	*** (i,j)
d.	☞ [e^{4}si]$_{i}$		[i^{1}si]$_{j,k}$			* (i), * (j)	*** (i)
e.			[i^{1}si]$_{i,j,k}$			***!* (i), * (j)	

Given that an opaque process should have a phonetic antecedent in PHONETIC REALIZATION, in the context of underapplication, the presence of MARKEDNESS in PHONETIC REALIZATION is crucial. If there is no relevant MARKEDNESS constraint in PHONETIC REALIZATION, a phonetic difference crucial to the surface opacity cannot be conditioned. In other words, it is predicted that a phonological process can be opaque only when there is a relevant markedness condition active in PHONETIC REALIZATION.

Results of the typological survey of 86 counterfeeding instances are consistent with this prediction, showing that opaque processes are subject to a very narrow range of markedness conditions. As summarized in (6), 78 out of 86 counterfeeding instances (90.7%) fell into six broad categories, which are predominantly either assimilatory or weakening processes.

(6)

type of opaque process	***CF-on-environment***	***CF-on-focus***	***example***
C-C assimilation	4 cases	5 cases	Hindi: /tp/ → [pp], /təp/ → [tp]
C-V assimilation	9 cases	5 cases	Haitian: /VN/ → [ṼN], /VrN/ → [VN]
long-distance V assimilation	5 cases	5 cases	Lena Spanish: /e..u/ → [i..u], /a..u/ → [e..u]
tone assimilation	-	5 cases	Hmong: /M↑H/ → [MH], /MHM/ → [M↑H]
consonant lenition/deletion	8 cases	11 cases	Corsican: /b/ → [β], /p/ → [b]
vowel reduction/deletion	15 cases	6 cases	Hidatsa: /V$_1$#/ → ∅, /V$_1$V$_2$#/ → [V$_1$#]
others	5 cases	3 cases	Šmartno Slovenian: /b/ → [p], /bi/ → [b]

The asymmetry in typology is evident: while most attested underapplied processes are assimilatory or weakening, other natural processes like dissimilation, fortition, and metathesis were infrequently or never observed as opaque processes. This finding is supportive of the theoretical prediction: assimilation and weakening processes are deeply rooted in language-specific coarticulation and durational adjustment (e.g., Flemming 2001, 2011), and thus, they are the most likely processes that are governed by not only PHONOTACTICS but also PHONETIC REALIZATION. In contrast, other phonological processes that are not attested in the typology are less likely to have phonetic antecedents shaped by PHONETIC REALIZATION, having different markedness conditions (e.g., perceptual enhancement for dissimilation, Gallagher 2010).

To sum up, this study makes contributions at two points. First, a new representation-based analysis is given for counterfeeding opacity. Second, this study presents an empirical finding that is consistent with the theoretical proposal: counterfeeding opacity is limited to a small group of phonological processes. This approach contrasts with other models that are relatively less constrained, such as OT-CC (McCarthy 2007) and Stratal OT (Kiparsky 2001, 2015), which do not posit any substantive restrictions on opacity.

References (selected)

Flemming, E. 2008 The Realized Input. Manuscript. MIT. // Flemming, E. 2011. The grammar of coarticulation. In M. Embarki and C. Dodane (eds.) *La Coarticulation: Indices, Direction et Representation*. // Kiparsky. P. 2015. Stratal OT: a synopsis and FAQs. In Y. Hsiao and L-H. Wee *Capturing Phonological Shades Within and Across Languages*. 2–44. // McCarthy. J. 2007. *Hidden Generalizations: Phonological Opacity in Optimality Theory*. Equinox.