Handling Opacity in OT

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1 OT and interacting processes

There are some phonological phenenomenon that can be described with rule ordering.

1. feeding
2. bleeding
3. counterfeeding
4. counterbleeding

OT can handle only the transparent cases (feeding, bleeding), not the opaque ones (counterfeeding, counterbleeding).

Below we study some ways the problem of opacity has been addressed in OT.

1. Constraint Conjunction
2. Two-level Constraints
3. Stratal OT
4. Harmonic Serialism

2 Constraint Conjunction

Constraint Conjunction is one strategy people have used to handle overapplication kinds of opacity including saltation (McCarthy, 2007).

The basic idea is introduce into CON new constraints of the form C1&C2 where C1 and C2 are already constraints in CON.

Recall Paluan. Underlying long unstressed vowels surfaced as short as in /ʔiːs-ɛ́l/→ [ʔisɛ́l]. This violates IDENT(long) but not *V̆ː. Also, underlying short unstressed vowels surfaced as schwa as in /sɛsəb-ɛ́l/→ [səsəb-ɛ́l]. This violates IDENT(place) but not *V̆. If we added a higher ranked constraint IDENT(long)&IDENT(place) then we could account for why underlying long unstressed vowels do not surface as schwa.

/ʔiːs-ɛ́l/	ID(long)&ID(place)	*V̆ː	*V̆	ID(long)	ID(place)
a. ʔiːs-ɛ́l		*!			
b. ʔəs-ɛ́l	*!			*	*
c. ☞ ʔis-ɛ́l			*	*	

The generalization being expressed here is "Don't change both vowel length and place." So we can move one step along the scale V̆ː → V̆ → ə, but not two.

It is important the constraint conjunction "be local" in the sense that the locus of violation of the two constraints has to be the same. The below tableaux indicates what can happen when constraint conjunction is not local; it fails to express that the generalization "Don't change both vowel length and place" is referring to a single vowel, not different vowels within a word.

/ðɛkóːl/	ID(long)&ID(place)	*V̆ː	*V̆	ID(long)	ID(place)
a. ðɛkóːl		*	*		
b. (surface form) ðəkól	*!			*	*
c. ?☞ ðɛkól			*	*	
d. ?☞ ðəkóːl		*			*

Introducing locally conjoined constraints then raises at least two questions.

1. What constraints can be conjoined?
2. What counts as local?

It is also important to consider the typologicals effect of conjoined constraints. Are we only adding opaque types into the factorial typology, or do we add other, undesirable types as well? We'll see an example shortly.

Conjoining two faithfulness constraints as above won't work for Campidinian Sardianian which **requires** the form to 'leap' over an intermediate step. Recall the Campidinian Sardianian data which illustrates a saltatory alternation. Intervocalic lenition of voiceless stops /p, t, k/ and the voiceless affricate /t͡ʃ/ (underlying forms justified by appearance in isolation):

/bɛlːu **p**iʃːi/	→	[bɛlːu **β**iʃːi]	'nice fish'
/sːu **t**rintaduzu/	→	[sːu **ð**rintaduzu]	'the thirty-two'
/dɛ **k**uatːru/	→	[dɛ **ɣ**uatːru]	'of four...'
/sːu **t͡ʃ**ɛlu/	→	[sːu **ʒ**ɛlu]	'the heaven'

However, underlying intervocalic /b, d, g/ are preserved.

/sːa **b**ia/	→	[sːa **b**ia]	'the road'
/sːu **g**atːu/	→	[sːu **g**atːu]	'the cat'
/donːia **d**ominiɣu/	→	[donːja **d**ominiɣu]	'every Sunday'

Lubowicz's (1999) proposal is to conjoin a faithfulness and markedness constraint.

*IDENT(VOICE) & *V[-cont]V

Intuition: "Don't have a intervocalic stop if you're also changing voice"

Fill in constraints and reassure yourself that this gets you what is needed:

/apa/	Id(vce) & *V[-cont]V	*V[-vce]V	ID(voice)	*β	ID(cont)	*V[-cont]V
a. ☞ aβa						
b. apa						
c. aba						

/aba/	Id(vce) & *V[-cont]V	*V[-vce]V	ID(voice)	*β	ID(cont)	*V[-cont]V
a. aβa						
b. apa						
c. ☞ aba						

/βa/	Id(vce) & *V[-cont]V	*V[-vce]V	ID(voice)	*β	ID(cont)	*V[-cont]V
a. βa						
b. pa						
c. ☞ ba						

What are some of the consequence of allowing conjoined constraints in CON?

1. Conjunction has to be local to avoid insane results like: /tɪk/ → [tɪk], /pag-tɪk/ → [paktɪx] (the assimilatory voicing of the first /g/ permits the second /k/ to spirantize).

2. As constraint families grow, the constraints grow... If there are n constraints constraints, there are now $n \times n$ conjoined constraints....

3. Lubowicz's intent was to say something like "if you're unfaithful, don't be marked". These constraints, however, are of the form: "don't be both marked and unfaithful". Therefore, there is an additional consequence. These constraints also enforce the idea that "if you're marked, be faithful." This means we can get special entities arising only in marked contexts, which is going to be a problem.

Here is an example hypothetical language illustrating the problem. In this language, obstruents devoice so /ba/ → [pa].

/ba/	ID(voice) & *CCC	*CCC	*[−son +voice]	ID(voice)
a. ☞ pa				
b. ba				

But with the conjoined constraint ID(voice) & *CCC ranked high, we discover this language permits voiced obstruents, but only in CCC clusters!

/apdka/	ID(voice) & *CCC	*CCC	*[−son +voice]	ID(voice)
a. ☞ apdka				
b. abdka				
c. aptka				

To summarize: constraint conjunction is one idea which can address overapplication opacity in OT. However, there are undesirable typological consequences that occur because of conjoined constraints and so it remains an open quesiton which constraints ought to be conjoined.

3 "Two-level" constraints

This strategy introduces constraints that are neither markedness nor faithfulness constraints, but some combination. They are constraints on alternations (Kager, 1999).

Recall Polish counterbleeding opacity.

	sg.	*pl.*	
a)	trup	trupi	'horse'
b)	wuk	wuki	'bow'
c)	snop	snopi	'sheaf'
d)	kot	koti	'cat'
e)	nos	nosi	'nose'
f)	sok	soki	'juice'
g)	klup	klubi	'club'
h)	trut	trudi	'labor'
i)	grus	gruzi	'rubble'
j)	wuk	wugi	'lye'
k)	žwup	žwobi	'crib'
l)	lut	lodi	'ice'
m)	vus	vozi	'cart'
n)	ruk	rogi	'horn'

(1) For Polish /voz/ → [vus], we could propose a constraint like:

"An underlying nonlow back vowel followed (underlyingly) by a word-final voiced obstruent must be high on the surface."

★ Why/How is this different from markedness?

★ Why/How is this different from faithfulness?

This seems most straightforward solution but has not been widely favored, perhaps because it seems like a brute-force solution, and because people have seen little to constrain it. Such constraints also look very language-specific.

However, it does have one thing going for it: it is a true statement (to the extent that the generalization is accurate). I would argue that counterbleeding, counterfeeding, and saltation are all manageable with two level constraints, though no one has really checked. My hunch is also that they are not as unrestrained as people suspect... For example, Koskenniemi (1983) can be construed as one approach along these lines. It also was on of the earliest approaches that found utility in large-scale applications.

Chandlee *et al.* (2018) study a particular class of string-to-string transformations (string rewriting systems) to see how well they can cope with the variety of opaque cases discussed by Baković (2007). They show that every case there can be handled with such systems. These rewriting systems require that any changes be locally conditioned (so within some

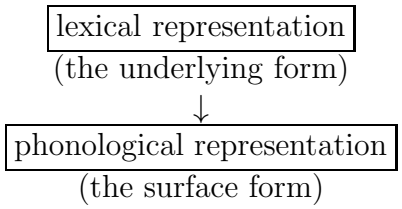
window of fixed size). These systems could be understood as a collection of 2-level constraints (though Chandlee et al. don't present them that way). One advantage of the particular class Chandlee et al. study is that there are theoretical results showing how such string-to-string transformations can be learned from examples.

4 Stratal OT

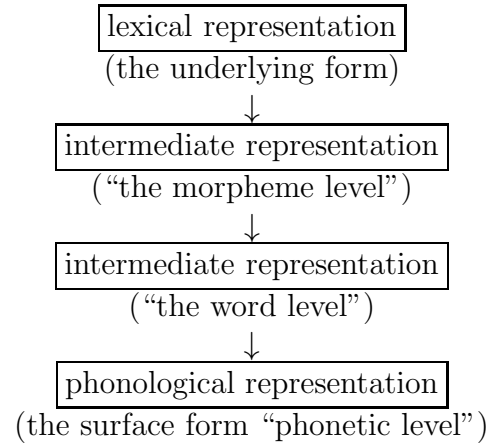
Counterbleeding, counterfeeding, and saltation, are also all manageable in OT *with levels*.

The basic idea is to permit a limited, prespecified number of levels of structure based on insights from Lexical Phonology. These, and only these, may be involved in serial derivation (Goldsmith, 1993). Goldsmith (1993) suggests an "M(orpheme)-level", a "W(ord)-level" and a "P(honetic)-level."

In other words the phonology mapping is actually divided into three maps. Here is the original mapping from the figure earlier.



It is now being conceived as follows.



Crucially, *constraints can ranked differently* at these different levels. So this brings back a limited amount number of *intermediate representations* into OT derivations. Recall that in rule-based approaches, there were many levels of intermediate representations. Kiparsky (2000) explicitly argues that these intermediate levels will be sufficient to address phonological opacity within an OT framework. See (Bermudez-Otero, 2018).

★ Let's see how Polish counterbleeding and Palauan counterfeeding are handled here.

★ Discussion. What are your thoughts on Stratal OT?

Can all opacity be accounted for with **three** levels? See Idsardi (1998, 2000).

The idea that the phonological mapping breaks down into these three other maps was not invented to handle opacity. It was invented pre-OT to handle how morphology and phonology interact. Kiparsky's claim was that there are exactly these three levels and that they are needed anyway to to explain how morphology interacts with phonology. We will return to these issues after the opacity unit concludes.

5 Harmonic Serialism

A recent version of OT being examined at the University of Massachussetts, Amherst is called Harmonic Serialsim. In this version of OT, GEN and EVAL are different than before. GEN generates only a finite set of candidates, each candidate differs *minimally* from the underlying form. There is some question as to what "minimal" means exactly, but in practice it has been interpreted as a single insertion, deletion, or change along a phonetic dimension (i.e. a single feature change). EVAL selects the most harmonic candidate and *resubmits* it to GEN which produces another set of candidates which differ minimally from this one. EVAL

★ Let's see whether Polish counterbleeding and Palauan counterfeeding could be handled here.

In fact, McCarthy concludes the abstract of his article on Harmonic Serialism with this line:[1]

> "A key finding is that Harmonic Serialism doesn't improve much on classic parallel OT in analyzing opacity, and in certain other respects does significantly worse."

One takeaway from this is that intermediate representations are not sufficient to deal with opacity. We can also ask if they are necessary (cf. Bromberger and Halle (1989)). Here again, the answer appears to be in the negative since the aforementioned Chandlee *et al.* (2018) handles opacity without any intermediate levels.

[1] The abstract and article are available at `http://works.bepress.com/john_j_mccarthy/79/`.

6 Opacity is not a disease but a phenomenon

It is useful to think pretheoretically and abstractly: what are the data patterns we seeks to describe? We should think of opacity as patterns of alternation.

Thinking about opacity as a form of alternation should help—this directly engages the phenomena, and may help avoid theories that lead to bizarre predictions. Perhaps we need a theory like that of phonotactics (i.e. which places constraints on surface forms) but instead which constrains alternations.

elements in a Set	elements in a Relation
a	(a,a')
b	(b,b')
c	(c,c')
d	(d,d')
...	...

Phonotactics: What are the constraints on phonologically possible sets (i.e. sets of well-formed words)?

Alternations: What are the constraints on phonologically possible relations (i.e. sets of well-formed alternations)?

Bakovi and Blumenfeld (2020) explore these ideas in the context of operations over string relations. Another approach is the aforementioned Chandlee *et al.* (2018) paper. They show that a particular local property of transformations is sufficiently expressive to handle many opaque cases.

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