Opacity deconstructed

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1 Introduction

The phonology of a language is an integrated system, with many and varied types of processes and — most importantly — interactions among them. The result of this integrated system is a set of surface forms the ultimate token realizations of which serve as the input that language learners are exposed to and presumably use to acquire the system. To the extent that this system is composed of individual phonological processes, it is not unreasonable to assume that the easier it is to isolate the operation of those individual processes from the input, the easier it is to acquire those processes and hence the system.

But phonological processes do not generally operate in isolation, nor even in simple pairwise interactions with each other. Although phonologists often find it useful, for expository or pedagogical purposes, to (attempt to) isolate the operation of a single phonological process or the interaction between two processes, it is always important to be mindful of the overall system. Could the actions of other processes affect any conclusions drawn from this individual process or interaction between processes? Could attention to other parts of the system be necessary to understand the workings of an individual process or interaction?

This is especially true with the notion of OPACITY, because this notion involves comparing the set of surface representations with the generalization expressed by a (hypothesized) single phonological process. The crucial assumption underlying opacity is that phonological processes interact in ways that may obscure the applicability or application of a given process. Opacity was first introduced by Kiparsky (1971, 1973b) and is defined in (1) below.[1]

(1) Opacity (Kiparsky 1973b: 79; wording follows McCarthy 1999: 358)

A process $\mathbb{P}$ of the form $A \longrightarrow B \;/\; C\_\_D$ is OPAQUE if there are surface structures with either of the following characteristics:

a. instances of A in the environment $C\_\_D$.

b. instances of B derived by $\mathbb{P}$ that occur in environments other than $C\_\_D$.

[1] A third characteristic, 'instances of B not derived by $\mathbb{P}$ that occur in the environment $C\_\_D$', is put aside here as it is in most if not all work on opacity, including Kiparsky (1973b).

Phonologists frequently equate each of the two types of opacity in (1) above with a particular type of pairwise interaction between serially-ordered rules in the rule-based serialism approach of Chomsky & Halle (1968) and subsequent work in that tradition. Opacity of type (1a) is equated with COUNTERFEEDING rule order, and opacity of type (1b) is equated with COUNTERBLEEDING rule order. (These and other rule orders are discussed in §2.) But straightforward dissociations exist between each type of opacity on the one hand and the supposedly corresponding type of rule interaction on the other. In §3 I show that not all cases of type (1a) opacity result from counterfeeding nor do all cases of counterfeeding result in opacity of type (1a), and in §4 I show that not all cases of type (1b) opacity result from counterbleeding nor do all cases of counterbleeding result in opacity of type (1b).

Each of these other cases of opacity is well-established in its own right, but for one reason or another has not been typically classified as an example of opacity as defined in (1). Doing so reveals a more complicated picture of opacity than previously thought. This is especially significant given the debate between proponents of rule-based serialism and proponents of Optimality Theory (OT; Prince & Smolensky 1993), more often than not centering around the topic of opacity. Both sides of the debate agree on one thing: that opacity is central to phonological theory.[2] The point of contention is whether OT does or should provide a 'unified treatment for opacity' (Kaisse 2009). The sobering result emerging from §3–§4, further elaborated on in §5, is that neither OT nor rule-based serialism does so.

2 Pairwise rule ordering

2.1 Relations

There are four basic recognized pairwise ordered rule relations in rule-based serialism: feeding, bleeding, counterfeeding, and counterbleeding. These are defined informally in (2).

(2) Pairwise ordered rule relations (adapted from McCarthy 2007a, 2007b)

Given two rules $\mathbb{A}$, $\mathbb{B}$ such that $\mathbb{A}$ precedes $\mathbb{B}$,

a. $\mathbb{A}$ FEEDS $\mathbb{B}$ iff $\mathbb{A}$ creates additional inputs to $\mathbb{B}$.
b. $\mathbb{A}$ BLEEDS $\mathbb{B}$ iff $\mathbb{A}$ eliminates potential inputs to $\mathbb{B}$.
c. $\mathbb{B}$ COUNTERFEEDS $\mathbb{A}$ iff $\mathbb{B}$ creates additional inputs to $\mathbb{A}$.
d. $\mathbb{B}$ COUNTERBLEEDS $\mathbb{A}$ iff $\mathbb{B}$ eliminates potential inputs to $\mathbb{A}$.

Kiparsky (1968) was one of the first to explicitly distinguish among these relations (see also Chafe 1968, Wang 1969, and Koutsoudas *et al.* 1974), and was certainly the first to use the feeding/bleeding terminology; Newton (1971) appears to have introduced the 'counter-' prefix. Kenstowicz & Kisseberth (1971) used a 'non-' prefix in the same sense, but this clearly did not catch on (in later work, Kenstowicz & Kisseberth (1977, 1979) use 'counter-').

[2] '[Opacity is] *the* single most important issue in current phonological theory' (Idsardi 2000: 337); 'the analysis of opacity has been one of the central themes of generative phonology' (McCarthy 2007b: 2).

Note that counterfeeding and counterbleeding are *counterfactual inverses* of feeding and bleeding, respectively, because counterfeeding *would be* feeding and counterbleeding *would be* bleeding if the two rules involved were ordered in the opposite way; the terminology, though notoriously difficult to learn, is thus not completely misleading.

Note that two rules may interact in different ways in different derivations. Consider (3), for example. In (3a), Deletion bleeds Palatalization: the deleted /i/ is [–back] and thus would have induced palatalization of the preceding /t/ if it hadn't been deleted. In (3b), on the other hand, Deletion feeds Palatalization: deletion of the /u/ crucially places the preceding /t/ before a [–back] vowel. In both (3c) and (3d), the two rules are mutually nonaffecting: in (3c), neither vowel is [–back] and so the /t/ is never in a context to be palatalized; in (3d), both vowels are [–back] and so the /t/ is in a context to be palatalized either way.

(3) Different interactions in different derivations (hypothetical)

		a. /tio/	b. /tue/	c. /tou/	d. /tei/
Deletion:	$\mathrm{V} \longrightarrow \emptyset$ / __ V	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
Palatalization:	t $\longrightarrow$ ʧ/ __ [–back]		ʧ		ʧ
		[to]	[ʧe]	[tu]	[ʧi]

Although (2) constitutes a useful picture of the typology of possible ordered rule relations predicted by the fundamental assumptions of rule-based serialism, it is still defined (almost) exclusively in terms of interactions between just two ordered rules. I hardly hesitate to qualify this statement because most if not all definitions of pairwise ordered rule relations provided in textbooks and in the scholarly literature are insufficiently precise about situations involving more than two rules, which may counterintuitively fit or not fit a given definition.[3] But the fact remains that the bulk of the relevant literature focusses on pairwise interactions.

2.2 Classification

There have been two significant proposals for classifying the relations in (2). The first was the relatively formal hypothesis of that 'rules tend to shift into the order which allows their fullest utilization in the grammar' (Kiparsky 1968: 200). This privileges feeding and counterbleeding orders, grouping them together as 'unmarked' because these are the orders in which both rules apply nonvacuously — that is, in which the two rules are maximally utilized (but see §4.4). Conversely, bleeding and counterfeeding orders are 'marked' because these are the orders in which one of the two rules fails to apply nonvacuously.

There were several challenges to Kiparsky's 'maximal utilization' hypothesis; see Kenstowicz & Kisseberth (1977: 159*ff*) for a summary critique. Kiparsky's response was a relatively substantive second hypothesis, that 'rules tend to be ordered so as to become maximally transparent' (Kiparsky 1971: 623). A transparent rule is one that does not meet either of the two conditions defined in (1), repeated in (4).

[3]For example, one can ask: do the definitions in (2) allow for the possibility that $\mathbb{A}$ feeds $\mathbb{B}$ because $\mathbb{A}$ bleeds some intervening rule $\mathbb{C}$ that would otherwise bleed $\mathbb{B}$? (And: is the answer intuitively correct?)

(4) Opacity, repeated from (1)

A process $\mathbb{P}$ of the form $A \longrightarrow B \;/\; C\underline{\hspace{1em}}D$ is OPAQUE if there are surface structures with any of the following characteristics:

a. instances of A in the environment $C\underline{\hspace{1em}}D$.

b. instances of B derived by $\mathbb{P}$ that occur in environments other than $C\underline{\hspace{1em}}D$.

Kiparsky's substantive claim is that an opaque rule $\mathbb{P}$ is *hard to learn*, either (4a) because there are surface counterexamples to $\mathbb{P}$, or (4b) because there are surface contexts in which $\mathbb{P}$ appears to have mistakenly applied. Diachronic change is thus hypothesized to proceed from harder-to-learn opacity-promoting rule orders to easier-to-learn transparency-promoting ones. Kaye (1974, 1975), Kisseberth (1976), and Kenstowicz & Kisseberth (1977: 170*ff*) question this learnability claim by pointing out the benefits of phonological opacity for *semantic* transparency; see Łubowicz (2003) for a recent rearticulation of this view.[4]

McCarthy (1999) adapts a couple of terms from Wilbur's (1974) work on reduplication, UNDERAPPLICATION and OVERAPPLICATION, to elucidate the two types of opacity in (4).[5] Type (4a) describes situations in which there are surface representations to which $\mathbb{P}$ could apply nonvacuously; $\mathbb{P}$ has thus *underapplied*. Type (4b) describes situations in which there are surface representations to which $\mathbb{P}$ has applied nonvacuously, but which do not otherwise meet $\mathbb{P}$'s structural description; $\mathbb{P}$ has thus *overapplied*. Kiparsky's explicit and subsequently generally accepted classification of the four pairwise rule interactions in (2) is shown in (5).

(5) Classification of pairwise ordered rule interactions (Kiparsky 1971, 1973b)

transparent
- feeding
- bleeding

opaque
- type (4a) *(underapplication)*
  - counterfeeding
- type (4b) *(overapplication)*
  - counterbleeding

As it turns out, however, this standard classification is misleading at best. I demonstrate in §3 that counterfeeding is but one of several devices that can be and have been used to describe actual examples of underapplication (= type (4a) opacity), and furthermore that counterfeeding does not always lead to underapplication. Similarly, in §4 I demonstrate that counterbleeding is not the only way to describe actual examples of overapplication (= type (4b) opacity) and moreover that counterbleeding does not always lead to overapplication.

[4] See also recent work by the research team of the Learnability Project at Indiana University (e.g. Barlow 2007, Part II of Dinnsen & Gierut 2007, Dinnsen & Farris-Trimble 2008), which documents cases of opacity that arise spontaneously during the course of acquisition.

[5] The usefulness of these terms in describing the often special phonology of reduplication was highlighted by McCarthy & Prince (1995, 1999) and was first adapted to other phenomena by Benua (1997); see §3.3.1.

3 Underapplication and counterfeeding

The definitions of underapplication opacity in (4a) and of the counterfeeding relation in (2c) are repeated (in suitably modified forms) in (6) and (7), respectively.

(6) A process $\mathbb{P}$ of the form $A \longrightarrow B$ / C__D UNDERAPPLIES if there are surface structures with instances of A in the environment C__D.

(7) $\mathbb{B}$ COUNTERFEEDS $\mathbb{A}$ iff $\mathbb{B}$ creates additional inputs to $\mathbb{A}$ and $\mathbb{A}$ precedes $\mathbb{B}$.

I begin in §3.1 by explaining how some examples of counterfeeding lead to underapplication as defined in (6). But counterfeeding is not the only source of underapplication: in §3.2 I discuss BLOCKING, the most obvious type of underapplication that is not typically categorized as such in the literature, and I discuss a handful of other, somewhat less obvious phenomena contributing to underapplication opacity in §3.3. Counterfeeding also does not always lead to underapplication, at least not as defined in (6), as I discuss in §3.4.

3.1 Counterfeeding

The counterfeeding relation in (7) describes situations where a later-ordered rule $\mathbb{B}$ creates representations to which an earlier-ordered rule $\mathbb{A}$ could have applied nonvacuously. Modulo the action of other, even later rules (see §3.4), $\mathbb{A}$ underapplies in such situations.

Following McCarthy (1999), I distinguish COUNTERFEEDING ON ENVIRONMENT from COUNTERFEEDING ON FOCUS interactions (see also Baković 2007: 221*ff*). In a rule of the form $A \longrightarrow B$ / C__D, the *focus* is A, the element to be changed by the rule, and the *environment* is C__D, the necessary context surrounding the focus. In counterfeeding on environment interactions the later-ordered rule $\mathbb{B}$ creates the environment of the earlier-ordered rule $\mathbb{A}$, and in counterfeeding on focus interactions $\mathbb{B}$ creates the focus of $\mathbb{A}$. The significance of this distinction is discussed at the end of this subsection, in §3.1.3.

3.1.1 Counterfeeding on environment

Consider as an example of counterfeeding on environment the following two rules of Lomongo.

(8) Counterfeeding in Lomongo (Hulstaert 1961, Kenstowicz & Kisseberth 1979)

		a. /o+bina/	b. /o+isa/	c. /ba+bina/
Gliding:	[–low] $\longrightarrow$ [–syll] / __V		w	
Deletion:	$\begin{bmatrix}+\text{voi}\\ -\text{son}\end{bmatrix} \longrightarrow \emptyset$ / V__	∅		∅
		[o+ina]	[w+isa]	[ba+ina]

Glosses: (8a) 'you (sg.) dance', (8b) 'you (sg.) hide', (8c) 'they dance'

The derivations in (8b-c) illustrate the independent action of each of the rules: Gliding applies alone in (8b) and Deletion applies alone in (8c), with no interaction in either case. In (8a), Deletion counterfeeds Gliding by creating the environment (a following vowel) that Gliding could have used to apply to the /o/. Gliding thus underapplies because there are surface representations with nonlow prevocalic vowels that have not become glides.

There are also more complex interactions involving counterfeeding on environment, for instance where $\mathbb{A}$ feeds $\mathbb{B}$ but $\mathbb{B}$ in turn counterfeeds $\mathbb{A}$; I borrow from Kavitskaya & Staroverov 2009 the term 'fed counterfeeding' to refer to this type of interaction. For example, in Lardil:

(9) Fed counterfeeding in Lardil (Hale 1973, Kavitskaya & Staroverov 2009)[6]

		a. /dibirdibi/	b. /yiliyili/	c. /wangalk/
Apocope:	$\mathrm{V} \longrightarrow \emptyset$ / $\sigma\ \sigma$ __ #	$\emptyset$	$\emptyset$	
Deletion:	[–apical] $\longrightarrow \emptyset$ / __ #	$\emptyset$		$\emptyset$
		[dibirdi]	[yiliyil]	[wangal]

Glosses: (9a) 'rock cod', (9b) 'oyster species', (9c) 'boomerang'

The derivations in (9b-c) again illustrate the independent action of each of the rules: in (9b), application of Apocope leaves a word-final apical consonant behind, which is not subject to Deletion; in (9c), there is no word-final vowel before nor after application of Deletion. In (9a), Apocope feeds Deletion: removal of the word-final vowel places the preceding nonapical consonant in a position to be deleted. But Deletion also counterfeeds Apocope here, as noted by Kavitskaya & Staroverov (2009): deletion of the nonapical consonant places the preceding vowel in a position to be removed by Apocope, but Apocope does not apply to this vowel. Apocope thus underapplies because there are surface representations with word-final vowels.

3.1.2 Counterfeeding on focus

Now consider as an example of counterfeeding on focus the following rules of Western Basque.

(10) Counterfeeding in Western Basque (de Rijk 1970, Hualde 1991, Kawahara 2002)

		a. /alaba+a/	b. /seme+e/
Raising I:	[–low] $\longrightarrow$ [+high] / __V		i
Raising II:	[+low] $\longrightarrow$ [–low] / __V	e	
		[alabe+a]	[semi+e]

Glosses: (10a) 'daughter', (10b) 'son'

The derivation in (10b) illustrates the independent action of Raising I, which applies alone here to raise the prevocalic mid vowel to high without interacting with Raising II. In

[6]The '$\sigma\ \sigma$' in the environment of Apocope is meant to denote the fact that the rule is blocked from creating monosyllabic words (Wilkinson 1988, Prince & Smolensky 1993), and the *ad hoc* feature [–apical] denotes the disjoint set of [–coronal] and [+distributed] consonants that are targeted by Deletion.

(10a), Raising II applies and counterfeeds Raising I by changing the focus from a low to a mid vowel that Raising I could have applied to. Raising I thus underapplies because there are surface representations with mid prevocalic vowels that have not become high.

Examples of counterfeeding on focus like this one, particularly when the environments of the rules are the same, are referred to as CHAIN SHIFTS: an underlying A becomes a B and an underlying B becomes a C, but an A that becomes a B does not go on to become a C.[7]

There are also examples of fed counterfeeding on focus, for example in Nootka:

(11) Fed counterfeeding in Nootka (Sapir & Swadesh 1978, McCarthy 1999, 2003b, 2007ab)

	a. /muː q /	b. /ħaju+ q i/	c. /ɬaːkʷ+ʃit͡ɬ/
Labialization:			
[+dors] ⟶ [+rnd] / [+rnd] __	qʷ	qʷ	
Delabialization:			
[+dors] ⟶ [–rnd] / __ $]_\sigma$	q		k
	[muː q]	[ħaju+qʷi]	[ɬaː k +ʃit͡ɬ]

Glosses: (11a) 'throwing off sparks', (11b) 'ten on top', (11c) 'to take pity on'

The derivations in (11b-c) yet again illustrate the independent action of each of the rules. In (11b), Labialization applies to a dorsal that is preceded by a round vowel but that is not syllable-final, and so Delabialization is inapplicable; in (11c), Delabialization applies to a syllable-final dorsal that is not preceded by a round vowel, and so Labialization is inapplicable. In (11a), Labialization both feeds and is counterfed by Delabialization: the dorsal is preceded by a round vowel and so it labializes, but this creates a syllable-final labialized dorsal that is subsequently delabialized — which puts the dorsal back in the position of being nonvacuously subject to Labialization. Labialization thus underapplies.

Examples of fed counterfeeding on focus are referred to as DUKE OF YORK DERIVATIONS (Pullum 1976, McCarthy 2003b): an underlying A becomes B only to end up as A again.

3.1.3 Counterfeeding in Optimality Theory

A significant difference between examples of (fed) counterfeeding on environment and examples of (fed) counterfeeding on focus is that the latter are easily accounted for within so-called 'classic OT'; that is, under the assumption that the grammar is a ranking of violable markedness constraints (penalizing output structures) and faithfulness constraints (penalizing input-output disparaties). In the case of chain shifts, all that is required is a faithfulness constraint blocking the undesired $A \longrightarrow C$ mapping (Kirchner 1996, Gnanadesikan 1997, McCarthy 1999, Kawahara 2002, Moreton & Smolensky 2002, Baković 2007), whereas Duke of York derivations simply require ranking between the relevant markedness constraints driving the processes involved (McCarthy 1999, 2003b, 2007ab). Counterfeeding on environment, on the other hand, requires assumptions beyond classic OT (McCarthy 1999: 366).

[7]See Łubowicz, this volume, and references therein for more details on chain shifts and their analysis.

3.2 Blocking

Cases of counterfeeding like those discussed above, repeated over and over again in the relevant literature, have convinced many phonologists that underapplication opacity is fully accounted for by the basic principles of rule ordering; after all, if a demonstrably active rule's input structural description is met by a surface representation, it makes sense to think that another, later-ordered rule must have created that representation. But there are also sources of underapplication other than counterfeeding, all of which have received ample attention in the phonological literature. I begin with the most obvious such source, blocking.

The very definition of blocking belies its contribution to underapplication: a rule is said to be blocked when it fails — presumably by some principle — to apply to a form that meets its input structural description. I discuss here three types of blocking. The first is DISJUNCTIVE BLOCKING (§3.2.1), in which a process is blocked if a strictly more specific process is also applicable. The second is NONDERIVED ENVIRONMENT BLOCKING (§3.2.2), in which a process is blocked if its structural description is not derived phonologically or morphologically. The third is (for lack of a better term) DO-SOMETHING-EXCEPT-WHEN BLOCKING (§3.2.3), in which a process is blocked from creating structures that for independent reasons are not allowed to surface. All three types of blocking are well-established and have prompted the postulation of principles beyond rule ordering to account for them. I also briefly discuss how TRIGGERING (do-something-*only*-when) interactions involve underapplication in §3.2.4, and conclude with the view of blocking and triggering from Optimality Theory (§3.2.5).

3.2.1 Disjunctive blocking

Disjunctive blocking has a long and celebrated history in phonological theory (see Baković, forthcoming, for detailed discussion). It all started with the analysis of stress in Chomsky, Halle, & Lukoff (1956), Chomsky & Halle (1968), and Halle & Keyser (1971). Consider the Latin stress rules in (12), stated in standard *SPE* notation (after Anderson 1974: 97).

(12) Latin stress rules

a. $\mathrm{V} \longrightarrow [+\mathrm{stress}]$ / __ $\mathrm{C_0\breve{V}C_0^1VC_0\#}$ (stress the antepenult if the penult is light)

b. $\mathrm{V} \longrightarrow [+\mathrm{stress}]$ / __ $\mathrm{C_0VC_0\#}$ (stress the penult)

c. $\mathrm{V} \longrightarrow [+\mathrm{stress}]$ / __ $\mathrm{C_0\#}$ (stress the ultima)

Any form fitting the structural description of one of the longer rules in (12) also fits the structural description of any shorter rule. Application of these rules to any form that meets the structural description of more than one of the rules will thus result in multiple stresses on the form, regardless of the order of the rules. However, only (12a) applies to words that fit the structural descriptions of all three rules (*paˈtricia*, *ˈreficit*), only (12b) applies to words that fit the structural descriptions of (12b,c) but not that of (12a) (*reˈfectus*, *reˈfēcit*, *ˈaqua*, *ˈamō*), and only (12c) applies to words that fit its structural description and not those of the other two rules (*ˈmens*, *ˈcor*, *ˈrē*). Application of a shorter, more general rule must thus be blocked by application of a longer, more specific rule; the shorter, more general rules thus underapply, again in a way that cannot be accounted for with rule ordering alone.

Complementary stress rules such as those in (12) were eventually superceded by the interaction of principles of metrical phonology (as noted by Kiparsky 1982b: 173, fn. 2), but other types of examples of disjunctive blocking were identified by Anderson (1969, 1974) and Kiparsky (1973c) and that have since been generally accepted as being subject to some version of Kiparsky's Elsewhere Condition (Kiparsky 1973c, 1982ab). The Elsewhere Condition imposes disjunctive ordering between two rules the structural changes of which are incompatible and the structural descriptions of which are in a proper inclusion relationship. Many but not all such examples can in fact also be accounted for by a Duke of York derivation (recall §3.1.2). An example of this kind is the interaction between (Trisyllabic) Shortening and (*CiV*-)Lengthening in English (Chomsky & Halle 1968, Kenstowicz 1994).

(13) English rules (adapted from Kenstowicz 1994: 218)

a. Trisyllabic Shortening — e.g. *o(ˈpāque)* ∼ *o(ˈpăci)ty*

$$\mathrm{V} \longrightarrow \breve{\mathrm{V}} \;/\; \underset{(\text{ˈ}\sigma}{\underset{|}{\_\_}}\ \mathrm{C}_0\ \underset{\sigma)}{\underset{|}{\mathrm{V}}}$$

b. *CiV*-Lengthening — e.g. *(ˈremĕ)dy* ∼ *re(ˈmēdi)al*

$$\begin{bmatrix}\mathrm{V}\\ +\text{high}\end{bmatrix} \longrightarrow \bar{\mathrm{V}} \;/\; \underset{(\text{ˈ}\sigma}{\underset{|}{\_\_}}\ \mathrm{C}\ \underset{\sigma)}{\underset{|}{i}}\ \mathrm{V}$$

Application of these rules to forms that meet both structural descriptions results in the right surface representations, whether the rules are ordered normally (= conjunctively) or disjunctively. I explain this fact in what follows, employing as key examples the forms /*remĕdi+al*/ and /*jōvial*/ (⟶ |*re*(ˈ*mĕdi*)+*al*| and |(ˈ*jōvi*)*al*| after footing, respectively).

Kenstowicz (1994: 218) advocates a disjunctive analysis, specifically as mediated by the Elsewhere Condition. The structural changes of the rules are incompatible: one rule shortens vowels while the other lengthens them. Moreover, the structural description of Lengthening is properly included in that of Shortening: both apply to the heads of bisyllabic feet, but Lengthening applies more specifically to a [–high] head of a foot the nonhead of which is an /*i*/ in hiatus. The EC thus predicts that Lengthening blocks Shortening, and Lengthening thus applies alone to |*re*(ˈ*mĕdi*)+*al*| (⟶ [*re*(ˈ*mēdi*)*al*]) and |(ˈ*jōvi*)*al*| (⟶ [(ˈ*jōvi*)*al*]).

Chomsky & Halle (1968: 181, 240*ff*) propose a conjunctive analysis, with extrinsic ordering between the two rules.[8] Shortening applies first and gives the intermediate representations |*re*(*mĕdi*)+*al*| and |(*jŏvi*)*al*|; Lengthening then undoes the effects of Shortening in these cases, rendering the correct surface representations [*re*(*mēdi*)*al*] and [(*jōvi*)*al*]. This is a clear feeding and counterfeeding interaction: Lengthening feeds Shortening which in turn counterfeeds Lengthening; Lengthening thus underapplies (recall Lardil, §3.1, (9)).

[8] In Kiparsky (1982a: 154*ff*, 1982b: 44), Shortening is independently classified as a cyclic rule (because it is blocked in nonderived environments; see §3.2.2) while Lengthening is independently classified as a postcyclic rule; Lengthening is thus *intrinsically* ordered after Shortening in this analysis (see §3.3.1).

There are other examples of disjunctive blocking that can be shoe-horned into conjunctive analyses, but only at the expense of the descriptive adequacy of the individual rules themselves. Consider, for example, the interaction between Assimilation and Deletion in Diola Fogny (D. Sapir 1965, Kiparsky 1973c), starting with the disjunctive analysis in (14).

(14) Diola Fogny rules (disjunctive analysis, adapted from Kiparsky 1973c: 98)

a. Assimilation e.g. /ni+gam+gam/ ⟶ [nigaŋgam] 'I judge'

$$\begin{bmatrix} \text{C} \\ \text{+nasal} \end{bmatrix} \longrightarrow [\alpha\text{place}] \ / \ \_\_ \begin{bmatrix} \text{–cont} \\ \alpha\text{place} \end{bmatrix}$$

b. Deletion e.g. /let+ku+ʤaw/ ⟶ [lekuʤaw] 'they won't go'

$$\text{C} \longrightarrow \emptyset \ / \ \_\_ \ \text{C}$$

The structural description of Assimilation is properly included in that of Deletion: both apply to preconsonantal consonants, but Assimilation applies more specifically to nasals followed by noncontinuants. Moreover, the structural changes of the two rules are incompatible: a consonant can either be assimilated or deleted, but not both (not discernibly, anyway). Assimilation thus applies alone, blocking Deletion when both are applicable.

Unlike the English rules in (13), the Diola Fogny rules as stated in (14) cannot be ordered conjunctively: under either order, Deletion will delete all preconsonantal consonants, whether they (were destined to) undergo Assimilation or not. A conjunctive analysis of the interaction between these two processes requires rules as stated and as ordered in (15).

(15) Diola Fogny rules (conjunctive analysis, adapted from Kiparsky 1973c: 97)

a. Deletion′ e.g. /na+laɲ+laɲ/ ⟶ [nalalaɲ] 'he returned'

$$\begin{bmatrix} \text{C} \\ \langle\text{+nasal}\rangle \end{bmatrix} \longrightarrow \emptyset \ / \ \_\_ \begin{bmatrix} \text{C} \\ \langle\text{+cont}\rangle \end{bmatrix}$$

b. Assimilation′ e.g. /ku+bɔn+bɔn/ ⟶ [kubɔmbɔn] 'they sent'

$$\text{C} \longrightarrow [\alpha\text{place}] \ / \ \_\_ \begin{bmatrix} \text{C} \\ \alpha\text{place} \end{bmatrix}$$

Deletion′ deletes a nasal only if it is followed by a continuant, and otherwise deletes all preconsonantal consonants. The relevant residue of this rule — nasals followed by noncontinuants — is then passed on conjunctively to Assimilation′. This means that Assimilation′ needn't specify the noncontinuancy of the consonant being assimilated to, because Deletion′ will have already removed the relevant strings from consideration. The continuancy of the following consonant is thus a condition on Deletion′ under this conjunctive analysis, as opposed to being a condition on Assimilation as it is in the disjunctive analysis — and herein lies the problem with the conjunctive analysis. That the following consonant must be [–cont] in order for Assimilation in (14a) is a natural condition on nasal place assimilation rules (Padgett 1994), but the condition on Deletion′ in (15a) — that the following consonant should be [+cont] if the consonant-to-be-deleted is [+nasal] — is not similarly justified.

In summary, disjunctive blocking represents yet another example of underapplication that cannot be accounted for with rule ordering alone. Even factoring out examples like the Latin stress case (instead accounting for them via the interaction of principles of metrical phonology) and examples like the English lengthening/shortening case (which can be inconsequentially reanalyzed as a Duke of York derivation), there remains a residue of cases that are best described as involving the underapplication of a rule due to disjunctive blocking by another rather than conjunctive ordering with respect to another.

3.2.2 Nonderived environment blocking

A classic example of nonderived environment blocking is found in Finnish (Kiparsky 1973b, 1993; see also Burzio, this volume, and references cited there) and is shown in (16).

(16) Nonderived environment blocking in Finnish

		a. /tilat+i/	b. /äiti/	c. /vete/
Raising:	e $\longrightarrow$ i / __ #			i
Assibilation:	t $\longrightarrow$ s / __ i	≀ s	≀	s
		[tilas+i]	[äiti]	[vesi]

Glosses: (16a) 'ordered', (16b) 'mother', (16c) 'water'

The examples in (16) show that Assibilation only applies if its structural description is morphologically or phonologically derived; that is, only when the conditions for (nonvacuous) application of the rule are met by virtue of the concatenation of morphemes or by the application of a prior phonological rule. In (16a), the morpheme-final /t/ assibilates because the conditioning vowel is in a separate morpheme; the initial /t/ does not, however — as indicated by the *ad hoc* '≀' symbol — because the would-be conditioning vowel is in the same morpheme. The example in (16b) has a /t/ in virtually the same phonological context as the assibilated /t/ in (16a) and yet it does not assibilate because, like the unassibilated initial /t/ of (16a), the conditioning vowel is in the same morpheme. Finally, the /t/ in (16b) assibilates because the conditioning vowel is derived by an earlier application of Raising. Assibilation clearly underapplies in Finnish, given that there are surface representations that could have in principle undergone Assibilation but have in fact not.

Note that the conditions that hold of nonderived environment blocking are essentially the opposite of those that hold of counterfeeding. In cases of counterfeeding, earlier-derived strings undergo a rule that later-derived strings do not; ordering this rule earlier than another rule that is responsible for those later-derived strings is thus possible. In cases of nonderived environment blocking, by contrast, later-derived strings (whether by morpheme concatenation or by phonological rule) undergo a rule that earlier-derived strings do not. Rule-based serialism is clearly insufficient to the task in this case: early ordering can only hope to achieve counterfeeding-type underapplication, and late ordering will if anything only increase the set of forms to which the rule can apply. As the ample literature on the topic attests, some additional principle ensuring the blocking of relevant rules in nonderived environments (or, alternatively, their application only in derived environments) is necessary within rule-based serialism, in the form of either the Revised Alternation Condition (Kiparsky 1973b, 1982ab), the Strict Cycle Condition (Kean 1974, Mascaró 1976), a combination of lexical identity rules and the Elsewhere Condition (Kiparsky 1982ab), or the judicious use of underspecification and feature-filling rule application (Kiparsky 1993; *cf.* Poser 1993).

3.2.3 Do-something-except-when blocking

Do-something-except-when blocking encompasses a wide range of cases in which a process is blocked from creating certain structures for independently-motivated reasons. It is usually motivated by the *general absence* of a particular structure in a language, one that is otherwise expected to be created by the process in question. It differs from disjunctive blocking in that another process (formally related or otherwise) is generally not involved, and it differs from nonderived environment blocking in that the relevant structures are generally blocked from being created across the board, not only in nonderived environments. But it is like both of these other forms of blocking in that it involves underapplication of the blocked process.

The earliest argument for do-something-except-when blocking was made by Kisseberth (1970). In Yawelmani Yokuts (Newman 1944, Kuroda 1967, Kisseberth 1969), short vowels are deleted between consonants *except when* such deletion would result in a tautosyllabic consonant cluster (#CC, CCC, or CC#). One way to achieve this result is, of course, to build the blocking condition into the statement of the vowel deletion rule, the environment of which can be stated as a 'doubly open syllable', VC___CV, thereby including all but those contexts in which a tautosyllabic consonant cluster is in danger of being created. Kisseberth (1970) argues that this solution misses a significant generalization uniting a suite of processes in Yawelmani phonology that are either blocked or triggered (see §3.2.4 below) by the avoidance of tautosyllabic consonant clusters. He argued instead that the environment of vowel deletion could instead be simplified to C__C with the surrounding vowels of the more complex VC__CV environment being derivative properties of a CONSPIRACY.[9] To the extent that such derivative properties can indeed be factored out of the formal statement of the environment of a conspiracy-blocked process, then, that process underapplies.[10]

This is also true of processes that are blocked for other do-something-except-when reasons. For example, assimilation processes are often subject to the same conditions as the underlying segment inventory itself, such that the product of assimilation cannot be a segment outside the inventory. Vowel harmony processes offer some of the most consistent evidence for this. In the vowel inventory of the Fante variety of Akan (Stewart 1967, Clements 1981, O'Keefe 2003), all vowels have a [±ATR] pair /i ∼ ɪ, e ∼ ɛ, u ∼ ʊ, o ∼ ɔ/ except the low, [−ATR] vowel /a/. As a result, the [±ATR] vowel harmony process is blocked from applying to /a/. In this case, this blocking condition can be built in to the statement of the focus

[9] See McCarthy (2002: 63) for a comprehensive bibliography of 1970s-era work on conspiracies.

[10] Kiparsky (1973b: 80*ff*) comes to the opposite conclusion about conspiracies, stating that 'the fact that languages tend to have conspiracies follows from the more general fact that languages tend to have transparent rules.' This is apparently because Kiparsky assumed that the rules participating in a conspiracy retain their full forms, without the conspiracy factored out; Kisseberth's intent was clearly otherwise.

of the vowel harmony rule by stipulating that it only applies to [–low] vowels, but this has been argued since at least Kiparsky (1981) to miss a significant generalization about the relationship between conditions on harmony and conditions on the inventory. Kenstowicz & Kisseberth (1977) discussed cases like this under the rubric of the DUPLICATION PROBLEM, explaining that, as with conspiracies, the rule-based serialism model of the time was forced to view this kind of relationship as a coincidence; later work addressed the duplication problem with the STRUCTURE PRESERVATION principle (Kiparsky 1981, 1982ab, 1985).

3.2.4 Do-something-*only*-when: triggering

Processes that are *triggered* by conspiracies or by inventory conditions (= 'do something *only* when') also underapply, at least to the extent that the relevant derivative properties can be factored out of the formal statement of the environment of the triggered process. For example, one of the conspiracy-triggered processes of Yawelmani discussed by Kisseberth (1970) epenthesizes a vowel after the first consonant of what would otherwise be a tautosyllabic consonant cluster; if the environment of the rule could thereby be reduced just to the position of epenthesis ('in any sequence of one or more consonants, epenthesize after the first consonant'), then it would technically underapply in all sequences of one or more consonants that are not in danger of surfacing as tautosyllabic consonant clusters.

Likewise, the vowel inventory of Maasai (Tucker & Mpaayei 1955, Archangeli & Pulleyblank 1994, Baković 2000) is in all relevant respects just like the vowel inventory of Akan described above, but the unpaired low vowel /a/ only blocks leftward [±ATR] harmony; in the rightward direction, /a/ becomes [+ATR] but only by further raising and rounding to become [o]. This raising-and-rounding process is clearly triggered by the independent absence of a [+ATR] low vowel in the vowel inventory; if the statement of the rule could thereby be reduced just to the result of rightward harmony ('raise and round a vowel that undergoes rightward harmony'), then it would technically underapply in all cases of nonlow vowels.

3.2.5 Blocking and triggering in Optimality Theory

Blocking and triggering interactions of the type discussed in this section are, practically speaking, the bread and butter of OT; 'do something except when' and 'do something only when' are the topics of chapters 3 and 4 of Prince & Smolensky (1993). Among all of these cases, only nonderived environment blocking has been shown to require some assumptions beyond those of classic OT (see Burzio, this volume, and references therein); all other cases of blocking and triggering are amenable to simple analysis in terms of constraint ranking.[11]

Loosely speaking, a process in OT is defined by a ranking of a markedness constraint above a faithfulness constraint: $\mathbb{M} \gg \mathbb{F}$. $\mathbb{F}$ discourages input-output disparities, but higher-ranked $\mathbb{M}$ forces violation of $\mathbb{F}$ in just those cases where (= 'only when') $\mathbb{M}$'s structural

[11] A recently proposed subclass of do-something-except-when blocking is represented by what McCarthy (2003a) calls a GRANDFATHER EFFECT, whereby a process is blocked from creating a representation that is otherwise allowed to surface if specified underlyingly (these underlying forms are thus 'grandfathered in'). Like nonderived environment blocking, grandfather effects are also beyond the purview of classic OT.

description is matched. Do-something-only-when triggering is thus directly expressed by this type of ranking. Blocking of a process defined as $\mathbb{M} \gg \mathbb{F}$ is achieved by some higher-ranked constraint $\mathbb{C}$ that conflicts with $\mathbb{M}$ in the blocking context: $\mathbb{C} \gg \mathbb{M} \gg \mathbb{F}$. Disjunctive blocking refers to those cases in which $\mathbb{C}$ is relevant only in a proper subset of structures relevant to $\mathbb{M}$ (see Prince & Smolensky 1993, Baković 2006, forthcoming), and do-something-except-when blocking refers to those cases in which $\mathbb{C}$ is the target of a conspiracy (Pater 1999) or an inventory-defining constraint (McCarthy & Prince 1995, 1999, among others).

This building-block approach to blocking and triggering proves to be an immensely useful and explanatory one in OT, quite apart from the question of whether such interactions involve underapplication or not. Under the standard assumption that OT constraints are universal and that only their relative ranking is specified on a language-specific basis, a blocking constraint $\mathbb{C}$ or a triggering constraint $\mathbb{M}$ can be motivated typologically as well as internally; see Pater (1999) and Casali (1996, 1997) for examples of typologically- and internally-motivated conspiracies, and Pulleyblank *et al.* (1995) and Pulleyblank (1996) for examples of typologically- and internally-motivated inventory conditions. Furthermore, otherwise unexplained situations such as 'a final syllable is extrametrical *except when* it is the only syllable in the word' and 'a VC affix is infixed *only when* the stem begins with a consonant' naturally submit to blocking/triggering analysis (Prince & Smolensky 1993).

By contrast, blocking and triggering interactions are anomalous phenomena within rule-based serialism, and work promoting more elaborate models with both rules and constraints (e.g. Paradis 1988, Calabrese 2005) rarely if ever acknowledges what blocking and triggering entail in practical terms: parallel derivations very much like the multiple output candidates of OT must be considered at every potential blocking or triggering turn. In order for a constraint to block a rule from applying to a form, a hypothetical application of the rule must be contemplated and found to violate the constraint; the result is thereby discarded, and the derivation proceeds without application of the rule. Not so similarly, in order for a constraint to trigger the application of a rule to a form, the form must be found to violate the constraint — but in this case it is not discarded because the derivation proceeds with application of the rule (the result of which must alleviate the violation of the constraint).

3.3 Other types of underapplication

3.3.1 Restriction to classes/levels

If a given process applies only to some but not all lexical classes or in some but not all levels, then that process by definition underapplies to some classes or in some levels and is thus opaque by (6). For example, the fact that Velar Softening in English (putatively responsible for e.g. *opa<u>que</u>* [k] ∼ *opa<u>c</u>ity* [s]) applies only to the Latinate vocabulary class means that the rule underapplies elsewhere; likewise, the fact that the rule responsible for antepenultimate main stress in English applies at Level 1 (*oríginal* ∼ *originálity*) means that the rule underapplies at later levels (*óbvious* ∼ *óbviousness; *obvíousness*).[12]

[12]Indeed, Benua (1997) adapts Wilbur's (1974) terms 'underapplication' and 'overapplication' to describe just these sorts of differences in rule applicability in different levels; recall footnote 5.

In the case of lexical classes, one could weaken this counterintuitive conclusion by further specifying (in a completely *ad hoc* way) the denotation of 'surface representations' in the definition of underapplication in (6) as the set of representations defined by the particular class to which the relevant process applies. This would not be desirable in the case of levels, however, because level ordering is generally an accepted mechanism for describing opaque interactions between phonological rules. For example, recall Kiparsky's (1982ab) analysis of Shortening and Lengthening in English noted in footnote 8 above: underapplication of Shortening is arguably due not to extrinsic within-level ordering nor to disjunctive blocking (by the Elsewhere Condition or otherwise), but rather to the independently-motivated assignments of Shortening to a cyclic level and of Lengthening to a postcyclic level. Some researchers have even claimed that *all* counterfeeding and counterbleeding interactions are due to the (independently-motivated) assignment of different processes to different levels that are serially ordered with respect to each other but within which there is no serial ordering.[13]

3.3.2 Optionality

If a given process is optional, then by definition that process sometimes underapplies and is thus opaque by (6). For example, consider the optional rule of *t/d*-deletion in many varieties of English (see e.g. Coetzee (2004) and references therein): a form like *west* is sometimes realized as [wɛs] and other times as [wɛst]; in the latter case, *t/d*-deletion underapplies.

It is not even clear that the definition of underapplication can be easily changed to avoid this counterintuitive conclusion. For example, specifying the 'process $\mathbb{P}$ of the form...' as 'obligatory' might appear to successfully, albeit stipulatively, render optional processes transparent. However, this would also incorrectly exclude cases in which optional processes are opaque not due to their optionality but due to their interaction with other processes.[14]

3.3.3 Exceptions

If a given process has (lexical) exceptions, then that process by definition underapplies in some cases and is thus opaque by (6). For example, the (independently optional) rule of postnasal /t/ deletion in English (/t/ $\longrightarrow \emptyset$ between /n/ and an unstressed vowel; see Hayes (2009: 191-192)) exceptionally underapplies in the case of *intonation* for many speakers of English: [ˌĩntə̃ˈneɪʃə̃n] ∼ *[ˌĩnə̃ˈneɪʃə̃n] (*cf. intellectual* [ˌĩntəˈlektʃwəl] ∼ [ˌĩnəˈlektʃwəl]).

The conclusion that exceptions contribute to opacity is perhaps not so counterintuitive, but the point remains that rule ordering is not responsible for arbitrary rule exceptions and thus is not responsible for all forms of underapplication opacity as defined in (6).

3.4 Surface-true counterfeeding

Another useful term introduced into the discussion of opacity by McCarthy (1999: 332) is SURFACE TRUTH: the generalization expressed by a process is *not surface-true* if there are

[13]Most notably Kiparsky (to appear) and Bermúdez-Otero (forthcoming); *cf.* McCarthy (2007b: 38*ff*).

[14]See Kawahara (2002), Anttila (2006), Ettlinger (2007), and Anttila *et al.* (2008) for examples.

surface counterexamples to that generalization. The definition of underapplication opacity in (6) technically evaluates the surface truth of a process, not whether the process 'applies' in all relevant derivations; however, the two notions are sufficiently coextensive, at least in the simplest case of a pairwise interaction, that 'process $\mathbb{P}$ underapplies' and 'process $\mathbb{P}$ is not surface-true' can be used interchangeably. Here I discuss an example in which a counterfed rule 'underapplies' in the sense that it does not apply in a relevant derivation, but in which the generalization expressed by that rule is nevertheless surface-true.

There are several processes affecting consonant clusters in Educated Singapore English (Mohanan 1992, Anttila *et al.* 2008), three of which are discussed here. Epenthesis inserts a schwa between near-identical tautosyllabic consonants, much as in standard English (/reɪz+z/ ⟶ [reɪz+əz] 'raises'; *cf.* /bæg+z/ ⟶ [bæg+z] 'bags'). Deletion deletes a plosive in a coda if it is preceded by an obstruent (/test/ ⟶ [tes] 'test'; *cf.* /test+iŋ/ ⟶ [test+iŋ] 'testing'). Finally, Degemination, fed by Deletion, deletes one of two tautosyllabic near-identical consonants (/list+z/ $\xrightarrow{\text{Del.}}$ |lis+z| $\xrightarrow{\text{Deg.}}$ [lis] 'lists').[15]

As Anttila *et al.* (2008: 185) explain, Deletion counterfeeds Epenthesis in the last of these derivations: application of Deletion results in an intermediate representation, |lisz|, to which Epenthesis is applicable, but Epenthesis does not apply; Degemination, which is also applicable, applies instead. Thus Epenthesis must apply before Deletion (= counterfeeding) and Deletion must apply before Degemination (= feeding). But despite the fact that this is counterfeeding, it does not strictly involve underapplication opacity. The fed application of Degemination ultimately removes the structural description of Epenthesis whenever Epenthesis is counterfed by Deletion, the end result being that there are in fact no surface representations to which Epenthesis could apply nonvacuously. Because Epenthesis itself is not responsible for this fact, it 'underapplies' — but only in a narrower sense than justified by the definition of underapplication opacity in (6) because Epenthesis is surface-true.[16]

The bottom line is that not all instances of counterfeeding involve underapplication opacity as defined in (6), despite intuitions to the contrary. Anttila *et al.* (2008: 185) state, for example, that '[t]he system [of processes affecting consonant clusters in Educated Singapore English—*EB*] exhibits remarkably deep opacity', with the counterfeeding interaction between Epenthesis and Deletion being one of five interactions claimed to contribute to this remarkable depth. The other counterfeeding interaction, between Epenthesis and Metathesis, also turns out not to be an example of underapplication because Metathesis also ultimately feeds Degemination; the examples of counterbleeding are discussed in §4.4 further below.

[15] In Mohanan's analysis, Degemination only applies to clusters of *strictly identical* consonants and must thus also be fed by a voicing assimilation rule not discussed here (/list+z/ $\xrightarrow{\text{Del.}}$ |lis+z| $\xrightarrow{\text{Assim.}}$ |lis+s| $\xrightarrow{\text{Deg.}}$ [lis]). The simplification in the text does not affect the point at issue; see §4.3 for more relevant discussion.

[16] On the other hand, if the conspiracy behind Epenthesis and Degemination — avoidance of surface (near-)geminates — is factored out of their formal statements, then both rules technically underapply; recall the discussion surrounding footnote 10.

4 Overapplication and counterbleeding

The definitions of overapplication opacity in (4b) and of the counterbleeding relation in (2d) are repeated (in suitably modified forms) in (17) and (18), respectively.

(17) A process $\mathbb{P}$ of the form $A \longrightarrow B \,/\, C\_\_D$ overapplies if there are surface structures with instances of B derived by $\mathbb{P}$ in environments other than $C\_\_D$.

(18) $\mathbb{B}$ counterbleeds $\mathbb{A}$ if $\mathbb{B}$ eliminates potential inputs to $\mathbb{A}$ and $\mathbb{A}$ precedes $\mathbb{B}$.

In §4.1 I explain how typical examples of counterbleeding lead to overapplication as defined in (17). In §4.2 I discuss two types of feeding interactions that also contribute to overapplication opacity, and in §4.3 I discuss a third type of feeding interaction with overapplication that cannot be handled within a single derivation. Finally, in §4.4 I show that counterbleeding does not always lead to overapplication as defined in (17). Along the way I will point out how classic OT can or cannot handle each type of overapplication opacity.

4.1 Counterbleeding

The counterbleeding relation (18) covers situations where an earlier-ordered rule $\mathbb{A}$ applies to a representation that is subsequently changed by a later-ordered rule $\mathbb{B}$ such that the application of $\mathbb{A}$ appears to have been unjustified; $\mathbb{A}$ overapplies in such cases. Consider as an example of both counterbleeding and overapplication the following two rules of Polish.[17]

(19) Counterbleeding in Polish (Bethin 1978, Kenstowicz & Kisseberth 1979)

		a. /ʒwob/	b. /sol/	c. /gruz/
Raising:	$\begin{bmatrix}+\text{back}\\ -\text{low}\end{bmatrix} \longrightarrow [+\text{high}] \,/\, \_\_ \begin{bmatrix}+\text{voi}\\ -\text{nas}\end{bmatrix}$	u	u	
Devoicing:	$[-\text{son}] \longrightarrow [-\text{voi}] \,/\, \_\_\,\#$	p		s
		[ʒwup]	[sul]	[grus]

<u>Glosses</u>: (19a) 'crib', (19b) 'salt', (19c) 'rubble'

The derivations in (19b-c) illustrate the independent action of each of the rules: Raising applies alone in (19b) and Devoicing applies alone in (19c), with no interaction in either case. In (19a), Devoicing counterbleeds Raising because the earlier application of Raising is justified in part by the fact that the following obstruent is voiced, and this critical fact about the context is subsequently changed by Devoicing. Raising thus overapplies because there are raised back round vowels that are not followed by voiced nonnasals on the surface.

This is an example of counterbleeding-on-environment: Devoicing crucially changes part of the environment that justified the prior application of Raising. There are also examples of counterbleeding-on-focus, such as the following two rules of certain dialects of Low German:

[17] See Buckley (2001) and N. Sanders (2003) for an alternative view of the Raising alternation.

(20) Counterbleeding in Low German (Kiparsky 1968, Kenstowicz & Kisseberth 1971)

		a. /taːg/	b. /taːg+ə/	c. /haʊz/
Spirantization:	$\begin{bmatrix}-\text{son}\\+\text{voi}\end{bmatrix} \longrightarrow [+\text{cont}]$ / V __	ɣ	ɣ	
Devoicing:	$[-\text{son}] \longrightarrow [-\text{voi}]$ / __ #	x		s
		[taːx]	[taːɣ+ə]	[haʊs]

Glosses: (20a) 'day', (20b) 'days', (20c) 'house'

Spirantization applies alone in (20b) and Devoicing applies alone in (20c). In (20a), Devoicing counterbleeds Spirantization because the earlier application of Spirantization is justified in part by the fact that the to-be-devoiced obstruent is voiced. Spirantization thus overapplies because there are spirantized obstruents on the surface that are not voiced.

In cases of counterbleeding overapplication like (19) and (20), undoing the application of the overapplying rule — or applying the rules in the opposite order, so that the relevant rule is bled rather than counterbled — results in a form in which both rules are still surface true; that is, in which neither rule underapplies. More concretely: if the application of Raising is undone in (19a), the result would be *[ʒwop]; not the correct surface representation, of course, but also not a representation to which either of the rules could apply nonvacuously. Likewise, if the application of Spirantization is undone in (20a), the result would be *[taːk], an incorrect surface representation to which neither of the rules could apply nonvacuously.

This is what makes counterbleeding overapplication generally problematic for classic OT (McCarthy 1999, 2007b): violations of constraints by optimal candidates must be motivated by the need to satisfy higher-ranked constraints, but counterbleeding overapplication involves the *gratuitous* violation of a faithfulness constraint because no higher-ranked constraint can be held responsible for it. Not all examples of overapplication involve gratuitous faithfulness violation in this way, however, as I demonstrate in the following section.

4.2 Opaque feeding

Kiparsky (1971: 612) claims that 'the unmarked status of feeding order is not subject to any serious doubt', meaning that both of Kiparsky's hypotheses discussed in §2.2 classify feeding as an order-to-be-diachronically-attained since it leads to both maximal utilization and transparency. But as it turns out, there exist types of overapplication opacity that involve feeding rule interactions. In this section I briefly discuss two such types of OPAQUE FEEDING orders, first identified as such and discussed in more detail in Baković (2007).

4.2.1 Self-destructive feeding

One such type of overapplication is what I call SELF-DESTRUCTIVE FEEDING, in which an earlier rule feeds a later rule that in turn crucially changes the string such that the earlier rule's application is no longer justified. An example from Turkish is shown in (21).

(21) Self-destructive feeding in Turkish (Kenstowicz & Kisseberth 1979, Baković 2007)

		a. /ajak + sɯ/	b. /ʧan+ sɯ/	c. /bebek+i/
Elision:	s/j $\longrightarrow \emptyset$ / C __	$\emptyset$	$\emptyset$	
Deletion:	k $\longrightarrow \emptyset$ / V __+V	$\emptyset$		$\emptyset$
		[aja+ɯ]	[ʧan+ɯ]	[bebe+i]

Glosses: (21a) 'his foot', (21b) 'his bell', (21c) 'baby (acc.)'

Elision applies alone in (21b) and Deletion applies alone in (21c). The derivation in (21a) shows the self-destructive feeding interaction between the two: the result of Elision crucially places the stem-final /k/ in the intervocalic position that causes it to undergo Deletion (that is, Elision feeds Deletion) but the /k/ itself was a necessary part of the environment justifying the application Elision in the first place (that is, Elision overapplies).

Much like the counterbleeding examples in §4.1, undoing the application of the overapplying rule in this self-destructive feeding interaction results in a form in which neither rule underapplies. Concretely, undoing the application of Elision in (21a) results in *[ajasɯ], an incorrect surface form to which neither of the rules could apply nonvacuously. Self-destructive feeding is thus also problematic for classic OT for the reasons already mentioned with respect to counterbleeding at the end of §4.1: the optimal candidate incurs a gratuitous violation of faithfulness, one that cannot be motivated by some higher-ranked constraint.[18]

4.2.2 Non-gratuitous feeding

Another non-counterbleeding type of overapplication is what I call NON-GRATUITOUS FEEDING. An example is found in Classical Arabic and is shown in (22).

(22) Non-gratuitous feeding in Classical Arabic (McCarthy 2007ab, Baković 2007)

		a. / ktub/	b. / al+walad+u/
V-Prothesis:	$\emptyset \longrightarrow V_i$ / # __ C_2V_i	u	
C-Epenthesis:	$\emptyset \longrightarrow$ ʔ / # __ V	ʔ	ʔ
		[ʔuktub]	[ʔal+walad+u]

Glosses: (22a) 'write! (m. sg.)', (22b) 'the boy (nom.)'

C-Epenthesis inserts a glottal stop before all word-initial vowels, whether underlying (22b) or inserted by V-Prothesis (22a); in the latter case, V-Prothesis feeds C-Epenthesis. Because V-Prothesis inserts a vowel before a word-initial consonant cluster, it technically overapplies because the subsequently-inserted glottal stop separates the inserted vowel from the word boundary that partly justified its insertion in the first place.

[18]This is only true of self-destructive feeding-on-environment, however, which the Turkish example in (21) represents. See Baković (2007: 247*ff*) for extensive discussion of an example of self-destructive feeding-on-focus, which does not involve overapplication and is not problematic for classic OT.

As the name implies, non-gratuitous feeding differs from both counterbleeding and self-destructive feeding in that undoing the application of the overapplying rule makes it underapply instead. Concretely, undoing the application of V-Prothesis in (22a) results in *[ʔktub], to which V-Prothesis could apply nonvacuously (producing *[uʔktub] — also not the correct surface representation, but nevertheless).[19] And, reversing the order of the two rules results in underapplication (due to counterfeeding) of C-Epenthesis: *[uktub]. Non-gratuitous feeding thus does not involve the gratuitous violation of a faithfulness constraint in an OT analysis; see Baković (2007: 231*ff*) for discussion.

4.3 Cross-derivational feeding

A third type of overapplication opacity that is not due to counterbleeding is what I call CROSS-DERIVATIONAL FEEDING. The name is meant to highlight the fact that this kind of feeding interaction cannot be handled within a single derivation; two separate derivations must be considered, one in which the feeding process creates the conditions for the fed process to apply in the other derivation. Because the opaque nature of cross-derivational feeding is the main thrust of Baković (2007), I attempt to merely summarize that discussion here.

Cross-derivational feeding can be demonstrated with the well-known example of the past tense alternation in English. Reviewing the facts: the past tense suffix /d/ becomes voiceless after stems ending in voiceless obstruents (e.g. /pæk+d/ ⟶ [pæk+t] 'packed') and is separated from the stem by an epenthetic vowel if the stem ends in a near-identical consonant /d/ or /t/ (e.g. /pæd+d/ ⟶ [pæd+əd] 'padded', /pæt+d/ ⟶ [pæt+əd] 'patted').

The standard analysis of this set of facts, illustrated in (23) below (see Baković (2005: 284*ff*) for extensive discussion and references), has it that Epenthesis applies between word-final near-identical consonants (that is, word-final consonants that differ at most in voicing), thus applying to both /pæt+d/ (23a) and /pæd+d/ (23b).[20] In the case of /pæk+d/ (23c), Assimilation applies to devoice the past tense suffix consonant. Given that Assimilation could in principle also apply to /pæt+d/ (23a), Epenthesis bleeds Assimilation in this derivation.

(23) English past tense alternation (standard bleeding analysis)

	a. /pæt+ d/	b. /pæd+ d/	c. /pæk+d/
Epenthesis:			
$\emptyset \longrightarrow$ ə/ C_i __ C_j#	ə	ə	
Assimilation:			
[–son] ⟶ [αvoi] / [αvoi] __ #			t
	[pæt+əd]	[pæd+əd]	[pæk+t]

Glosses: (23a) 'patted', (23b) 'padded', (23c) 'packed'

This bleeding interaction correctly describes the fact that Epenthesis rather than Assimilation applies in (23a), but at a cost: Epenthesis must arbitrarily ignore the difference in

[19] C-Epenthesis also overapplies in the hypothetical *[ʔktub] form, but that is neither here nor there.

[20] Near-identity is loosely represented in the statement of Epenthesis with differing subscripts: $C_i \approx C_j$.

voicing between the stem-final /t/ and the suffix /d/ — precisely the difference that would be neutralized by Assimilation were it to apply. A more explanatorily adequate analysis would eliminate this redundancy, making *strict identity* a requirement on Epenthesis (recall footnote 15) and relying on Assimilation to provide the necessary context in (23a).

But of course Assimilation does not *actually* apply in (23a); it only *potentially* applies, but this potential appears to be sufficient to 'feed' the application of Epenthesis instead. A reasonable way to model this type of interaction is with two parallel derivations, one in which Assimilation applies and another in which Epenthesis applies, as shown in (24).

(24) English past tense alternation (cross-derivational feeding analysis)

Assimilation: [−son] $\longrightarrow$ [αvoi] / [αvoi] __ # **Epenthesis′:** $\emptyset \longrightarrow$ ə/ C$_i$ __ C$_i$#

a.
$$\begin{tikzcd} & \text{/pæt+d/} \arrow[dl, dashed, "\mathbf{A}"'] \arrow[d, "\mathbf{E}'"] \\ \text{|pæt+t|} \arrow[r, dashed, "\mathcal{F}"] & \text{[pæt+əd]} \end{tikzcd}$$

b.
$$\begin{tikzcd} & \text{/pæd+d/} \arrow[dl, dashed, "\mathbf{A}"'] \arrow[d, "\mathbf{E}'"] \\ \text{|pæd+d|} \arrow[r, dashed, "\mathcal{F}"] & \text{[pæd+əd]} \end{tikzcd}$$

c.
$$\begin{tikzcd} \text{/pæk+d/} \arrow[d, "\mathbf{A}"] \\ \text{[pæk+t]} \end{tikzcd}$$

Assimilation is stated just as in (23) above, but Epenthesis′ is now stated to apply only between strictly identical word-final consonants. The idea here is that Epenthesis′ applies if and only if its structural description is met by the potential output of Assimilation; this is the case in (24a,b) — though vacuously so in (24b) — and so Epenthesis′ applies to those two examples. It is not the case in (24c), however, and so Assimilation applies in that example.

Because the application of Epenthesis′ in (24a) is motivated only by the potential but not actual nonvacuous application of Assimilation, Epenthesis′ overapplies in this derivation in accordance with the definition of overapplication opacity in (17). Similar to non-gratuitous feeding (§4.2.2), this overapplication is not gratuitous; in this case, however, undoing the application of the overapplying process makes the other process underapply. Specifically, undoing the application of Epenthesis′ in (24a) results in *[pætd], to which Assimilation could apply nonvacuously — producing *[pætt], also not the correct surface representation but the result of the potential derivation necessary to cross-derivationally feed Epenthesis′.

As discussed in Baković (2005, 2007), the kind of interaction illustrated in (24a) is impossible to describe with the single derivation characteristic of rule-based serialism because the potential derivation with Assimilation applying is necessary to trigger Epenthesis′ in the actual derivation leading to the correct surface representation. This is in fact what makes the bleeding analysis in (23a) a necessary evil, with the arbitrary and redundant stipulation that voicing is the one feature that can be ignored in the determination of near-identity for the purposes of Epenthesis application. Cross-derivational feeding is thus yet another example of an opaque interaction that cannot be accounted for by rule ordering alone.

Cross-derivational feeding interactions make perfect sense from the perspective of classic OT, however: the three representations in (24a) are competing output candidates, and the actual surface form with an epenthetic vowel is the optimal way to satisfy both a markedness constraint penalizing geminates (otherwise responsible for (24b) and a markedness constraint penalizing voicing disagreement (otherwise responsible for (24c)).[21]

[21] See now Pająk and Baković (to appear) for additional arguments for this type of analysis.

4.4 Non-opaque counterbleeding

Just as there are more complex interactions involving feeding and counterfeeding — recall the Lardil example of Apocope and Deletion in §3.1, (9) — there are also more complex interactions involving bleeding and counterbleeding; that is, in which $\mathbb{A}$ bleeds $\mathbb{B}$ and $\mathbb{B}$ counterbleeds $\mathbb{A}$. Such cases are often referred to as *mutual bleeding*, following Kiparsky (1971: 600). Another relevant example is coincidentally furnished by Lardil.

(25) Mutual bleeding in Lardil (Hale 1973, Hayes 2009)

		a. /papi+ uɻ/	b. /tʲæmpæ+uɻ/
Epenthesis:	$\emptyset \longrightarrow$ w / i __ u	w	
Elision:	V $\longrightarrow \emptyset$ / V __		$\emptyset$
		[papi+wuɻ]	[tʲæmpæ+ ɻ]

Glosses: (25a) 'father's mother (acc. fut.)', (25b) 'mother's father (acc. fut.)'

The derivation in (25b) illustrates the independent action of Elision: the first vowel in hiatus is not an /i/, and so the second vowel is elided. In (25a), Epenthesis bleeds Elision because insertion of the glide separates the vowels in hiatus. Elision also counterbleeds Epenthesis here, as pointed out by Hayes (2009: 184-185): elision of the suffix vowel would have removed the necessary /u/ from the context of Epenthesis.[22]

This is an example of mutual bleeding-on-environment; there are also cases of mutual bleeding-on-focus, for example the following case from two different types of dialects of German (Vennemann 1970, Kiparsky 1971: 600). In one type of dialect, the Devoicing rule already discussed in (20) bleeds a rule that deletes /g/ after nasals: /laŋg/ $\longrightarrow$ [laŋk], *[laŋ] 'long (masc.)'; in the other type of dialect, the order is reversed so that Deletion bleeds Devoicing: /laŋg/ $\longrightarrow$ [laŋ], *[laŋk] (*cf.* /laŋg+ə/ $\longrightarrow$ [laŋ+ə] 'long (fem.)' in both types of dialect, given the inapplicability of Devoicing in this case).

Mutual bleeding interactions like these differ from feeding and counterfeeding interactions like those in (9) and (11) in that mutual bleeding does not involve opacity. Because Epenthesis bleeds Elision in Lardil, Elision does not change the context that justified the application of Epenthesis; in other words, Epenthesis does not overapply. Likewise, because Devoicing bleeds Deletion in some dialects of German and Deletion bleeds Devoicing in others, the bled rule does not change the context that justified the application of the bleeding rule and so the bleeding rule does not overapply.

There is also a mutual bleeding interaction between Epenthesis and Degemination in Educated Singapore English, when the intervening Deletion rule is not involved (recall §3.4): /reɪz+z/ $\longrightarrow$ [reɪzəz], *[reɪz]. Epenthesis bleeds Degemination here by removing the second member of the would-be geminate, but Degemination also counterbleeds Epenthesis, as

[22] A third example illustrating the 'independent' action of Epenthesis is impossible to provide, given that Epenthesis applies to a proper subset of cases to which Elision is applicable. Despite its relevance in this case, note that the Elsewhere Condition (§3.2.1) is not needed to block Epenthesis when Elision applies because the bleeding relation between the two rules does the trick, but Koutsoudas *et al.* (1974: 8*ff*) do propose that such rules are intrinsically ordered by the related Proper Inclusion Precedence Principle (G. Sanders 1974).

Anttila *et al.* (2008: 185) explain, because had it applied, Degemination would have removed one of the two necessary identical consonants from the context of Epenthesis. Again, despite the fact that there is counterbleeding here, there is no opacity. Degemination is bled by Epenthesis and so does not apply to affect the structural description of Epenthesis, and so there are in fact no surface representations to which Epenthesis has overapplied. Thus, not all instances of counterbleeding involve overapplication opacity as defined in (17).[23]

5 Conclusion: there is no unified theory

The resurgence of research on phonological opacity over the past fifteen years or so is a key part of a debate between proponents of rule-based serialism and proponents of Optimality Theory. Though the debate has been sharply polarized in most respects, there is one mistaken 'fact' on which nearly all researchers of both sides mysteriously appear to have decided to agree: that rule-based serialism offers a unified account of opacity while OT does not. Consider, for example, the following conclusion on this issue from a recent paper:

> [T]he [rule-based serialism] treatment of opacity is significantly more elegant than its OT counterparts: it predicts exactly the attested types of opacity effects and deals with them straightforwardly and in a unified way [. . .]. Since opacity is one of the most fundamental phenomena in human language, we must prefer a theory that accounts for it straightforwardly ([rule-based serialism]) over one that seems unable to deal with it (OT). Some supporters of OT have responded that what [rule-based serialism] treats as a unified phenomenon, opacity, is actually a heterogeneous set of unrelated facts that are only made to look like a coherent whole by the theory. My response to this is that [. . .] one fact needs one explanation. Our linguistic intuition, be we derivationalists or OT supporters, suggests that grammars involve generalizations that may conflict with one another; [rule-based serialism] provides a more successful account for this fact. One could add that, all else being equal, a theory that accounts for a range of phenomena via a single mechanism is to be preferred over a theory that accounts for the same facts with two or more mechanisms. — Vaux (2008: 38-39)

I have demonstrated here that it is not even the case that rule-based serialism 'treats [opacity] as a unified phenomenon', unless we decide to depart from Kiparsky's definition of opacity and instead perversely define it as just those opaque interactions that can be described with rule ordering. Just as counterfeeding-on-environment (§3.1.1) and gratuitous overapplication (§4.1, §4.2.1) show that OT is not a descriptively complete theory of known opaque process interactions, so do blocking (§3.2) and cross-derivational feeding (§4.3) show that rule-based serialism does not have any special purchase on the description of opacity.

[23] The mutual bleeding interaction in Educated Singapore English between Deletion and Metathesis is also not opaque for the same reasons. In the end, only one of the five interactions contributing to the 'remarkably deep opacity' of this system (counterbleeding between Epenthesis and Voicing Assimilation) is in fact an opaque one, and is the one interaction that Anttila *et al.* (2008: 194*ff*) ultimately deny the factual basis of.

Further discussions of the implications of opacity for theoretical framework comparison should either acknowledge this division of labor (as I have done here) or provide a new, principled definition of opacity on which to base such discussions.[24]

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[24] See e.g. Bermúdez-Otero (1999), Idsardi (2000), Ettlinger (2008), and Tesar (2008) for examples.

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