Sympathy & Phonological Opacity[*]

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The Divine hand found the Two Limits: first of Opacity, then of Contraction. Opacity was named Satan, Contraction was named Adam.
William Blake *Milton*

Years from now, when you talk about this — and you will — be kind.
Tea and Sympathy (scr. Robert Anderson, dir. Vincente Minnelli)

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1 Statement of the Problem

In the rule-based phonology of Chomsky & Halle (1968) and successors, a central theoretical and analytic construct is the serial derivation. In a serial derivation, an underlying representation passes through a number of intermediate representations on its way to the surface:

(1) Serial Derivation

Underlying Representation
⇓
UR transformed by rule 1
⇓
Output of rule 1 transformed by rule 2
⇓
...
Output of rule *n*-1 transformed by rule *n* = Surface representation

For present purposes, it doesn't matter whether the order of rules is stipulated or derived from universal principles; it doesn't matter whether the steps are called "rules" or "cycles" or "levels"; it doesn't even matter whether the steps involve applying rules or enforcing constraints. The only defining characteristic of a serial derivation, in the sense I will use here, is the existence of intermediate representations that are similar to the underlying and surface representations but may differ from both. I will call any theory with this property "serialism".

Arguments in support of serialism, often only implicit, can be reduced to two observations:

(i) Linguistically significant generalizations are often not surface-true. That is, some generalization G appears to play an active role in some language L, but nonetheless there are surface forms of L (apart from lexical exceptions) that violate G. Serialism explains this by saying that G is in force and hence true only at the stage of the derivation when it applies. Generalizations in force at subsequent derivational stages hide G's truth and, in the limit, may contradict it completely.

(ii) Linguistically significant generalizations are often not surface-apparent. That is, some generalization G appears to play an active role in shaping the surface form F, but the conditions that lead to G's applicability are not apparent from F. Serialism explains this by saying that the conditions on G are relevant only at the stage of the derivation when G applies. Generalizations in force at later stages may obliterate the conditions that made G applicable (e.g., by destroying the triggering environment for a rule).

These two properties of serial derivations have been dubbed opacity by Kiparsky (1971, 1973a). A phonological rule that has been rendered non-surface-true or non-surface-apparent by the application of subsequent rules is said to be opaque.

Optimality Theory (Prince & Smolensky 1993) offers a very different but also incomplete picture of opacity. In OT, phonological generalizations are stated as markedness constraints on surface representation, interacting with faithfulness constraints. Markedness constraints are not always surface-true, since constraints often conflict and, by hypothesis, all the constraints are universal and universally in force. Constraints are ranked, with higher-ranking constraints able to compel violation of lower-ranking ones in case of conflict. Thus, a constraint can fail to be surface-true because it is violated under crucial domination.[1] In this way, constraint ranking and violation — the two central tenets of OT — give a non-serialist account of some kinds of non-surface-true opacity.

As OT is currently understood, though, constraint ranking and violation cannot explain all types of opacity. Unless further refinements are introduced (such as those discussed in §2 below), OT cannot contend successfully with *any* cases of non-surface-apparent generalizations and *some* cases of non-surface-true generalizations.

Tiberian Hebrew supplies an example of the non-surface-apparent variety. There is a process of epenthesis into final clusters (2a) and there is a process deleting ʔ when it is not in the syllable onset (2b). In derivational terms, epenthesis must precede ʔ-deletion because, when both apply (2c), the conditions that trigger epenthesis are not apparent at the surface.

(2) Interaction of Epenthesis and ʔ-Deletion in Tiberian Hebrew (Malone 1993)

a. Epenthesis into final clusters:

/melk/ → mele̲x	'king'

b. ʔ-Deletion outside onsets

/qaraʔ/ → qārā_	'he called'

c. Interaction: Epenthesis → ʔ-Deletion[2]

/dešʔ/ → deše̲ʔ → deše_	'tender grass'

From the OT perspective, this non-surface-apparentness of the conditions leading to epenthesis — that is, the need to syllabify ʔ — is problematic. The faithfulness violation incurred by the epenthetic vowel is therefore unexplained.

Bedouin Arabic supplies an example of a non-surface-true process that cannot be accommodated under OT's rubric of constraint violation under crucial domination. A process raising *a* in open syllables is rendered non-surface-true by subsequent vocalization of underlying glides:

[1]Strictly speaking, even an undominated constraint can be non-surface-true if no candidate obeys it. This situation does not seem to arise in phonology, which posits rich candidate sets, but it may occur in syntax.

[2]Or *dešē*, as in Malone (1993: 59f.). Hebrew vowel length presents significant philological difficulties and controversies; see Appendix B of Malone (1993). (I am grateful to Joe Malone for discussion of this matter.)

(3) Interaction of *a*-Raising and Glide Vocalization in Bedouin Arabic (Johnstone 1967, Al-Mozainy 1981)

a. Raising of *a* in open syllables

/katab/ → *ki.tab* 'he wrote'

b. Glide Vocalization (when not adjacent to a vowel)

c. Interaction: Raising → Vocalization

/badw/ → DNA → *ba.du* 'Bedouin'

From the OT perspective, the constraint responsible for the raising of *a* is violated by *ba.du*, yet there is no other constraint available to compel this violation. The failure of the expected /a/ → *i* mapping is therefore unexplained.

Epenthesis in Hebrew and raising in Bedouin Arabic are controlled by conditions that cannot be observed in surface structure (nor, for that matter, in underlying structure — see §2). In Hebrew, the process of epenthesis overapplies, occurring where it is not merited by the surface conditions.[3] In Bedouin Arabic, the process of raising underapplies, failing to occur where its surface conditions are met. These and many similar phenomena challenge OT's reliance on surface constraints and seem to demand serial derivations.

The issues that opacity raises for OT have been noted before (Archangeli & Suzuki 1996, 1997, Black 1994, Chomsky 1994, Goldsmith 1996, Halle & Idsardi 1997, Idsardi 1998, Jensen 1995, Kager to appear, McCarthy 1996b, McCarthy & Prince 1993a: Appendix, Prince & Smolensky 1993). In the view of some critics, the existence of phonological opacity means that OT is fundamentally misconceived and should be rejected entirely. I will not attempt to respond to these critics here; the very large body of empirical and conceptual results directly attributable to OT makes a brief response both impossible and unnecessary. Rather, my goal in this article is to address the opacity problem within the context of OT, relying on familiar and indispensable OT constructs as much as possible to serve as a basis for an approach to opacity.

Below in §2 I examine and criticize previous approaches to opacity within OT. This critique is followed in §3 by the introduction of the notion of sympathy,[4] which offers an account of opacity in terms of the core OT postulate, constraint ranking and violation. The idea is that the selection of the optimal candidate is influenced, sympathetically, by the phonological properties of certain designated failed candidates, such as **deše*ʔ in Hebrew. Derivational theories posit intermediate representations to determine, in part, the properties of the final output. Similarly, sympathy uses the constraints to select a member of the candidate set to determine, in part, the properties of the output form. The goal of §3 is to show precisely how the relevant failed candidate is designated (through

[3]The terms overapplication and underapplication come from R. Wilbur's (1973) work on reduplication. I am indebted to Laura Benua for suggesting their use here.

[4]The word "sympathy" is intended to recall technical terms in acoustics ("sympathetic vibration") and medicine ("sympathetic ophthalmia", inflammation of one eye in response to trauma to the other eye).

obedience to a specific faithfulness constraint), to show how it exercises its sympathetic influence over the output form (through faithfulness between candidates), and to illustrate the proposal.[5]

The article continues in §4 with a detailed analysis of the Kiparsky (1973a) definition of opacity, showing that all senses of opacity that it encompasses are addressed either with sympathy or with proposals that have been previously discussed in the OT literature. In addition, results about opaque interactions involving multiple processes are presented. Then in §5 I turn to a type of three-process opaque interaction, the "Duke-of-York" gambit (Pullum 1976), which finds ready expression in serialism but cannot be modeled with sympathy. I observe that convincing cases of the gambit do not seem to exist, supporting this claim of sympathy theory. Finally, §6 sums up the results and suggests some topics for future research.

2 Previous Approaches to Opacity in OT

The problem that opacity poses for OT has been recognized since the inception of the theory, and so there are many previous attempts to deal with it. They include approaches taken within the basic faithfulness model, extensions of faithfulness to relations among surface forms within paradigms, and accounts of specific kinds of phonological opacity (such as opacity involving epenthesis or assimilation). In this section I will sketch each of these approaches and then show why it is inadequate. This section also serves as an introduction to the range of empirical problems that any theory of opacity must address.

The earliest attempts to deal with opacity in OT have used refinements of faithfulness theory. Two principal approaches to faithfulness have been taken, and both have been applied to certain types of opacity.

In the PARSE/FILL theory of faithfulness (Prince & Smolensky 1991, 1993), the properties of the input are encoded structurally in the output. Deleted segments are present in the output but syllabically unparsed; epenthetic segments are not present in the output, but their syllabic positions are. The constraints PARSE and FILL militate against these two types of unfaithfulness.

The input that is immanent within the output gives a handle on a range of opacity phenomena. In Sea Dayak nasal harmony, for example, rightward spreading of nasality is blocked by oral consonants, even if they have been (optionally) deleted:

(4) Sea Dayak Nasal Harmony (Kenstowicz & Kisseberth 1979: 298; Scott 1957)

a. Rightward nasal harmony:

/naŋa/ → nãŋãʔ	'straighten'

b. Blocked by oral consonants:

/naŋga/ → nãŋgaʔ , *nãŋgãʔ	'set up a ladder'

c. Even if optionally deleted:

/naŋga/ → nãŋgaʔ → nãŋaʔ, *nãŋãʔ	id.

[5]Since this research was first presented, several works have come to my attention that apply and extend the sympathy notion in novel and insightful ways: Davis (1997a, b), de Lacy (1998), Dinnsen *et al.* (1998), Itô & Mester (1997a, b), Karvonen & Sherman (1997), Katayama (1998), Merchant (1997), Parker (1998), Sanders (1997), and L. Wilbur (1998).

In terms of PARSE/FILL faithfulness theory, the true representation of the output in (4c) is *nãŋ⟨g⟩aʔ*, with a latent, syllabically unparsed *g*. The presence of the unparsed *g* means that, segmentally, the output in (4c) is the same as that in (4b), and it equally shows the blocking effect of oral consonants on nasal harmony.

In the correspondence theory of faithfulness (McCarthy & Prince 1995, to appear), the output stands in a correspondence relation to the input. This relation records the similarities and differences between the two levels of representation. Deleted segments have no output correspondent; epenthetic segments have no input correspondent. The respective constraints MAX and DEP militate against these two types of unfaithfulness.

The correspondence relation subsumes almost exactly the same cases of opacity as the PARSE/FILL theory. It does so by permitting the formulation of "two-level" constraints (McCarthy 1996b; cf. Koskenniemi 1983, Lakoff 1993, Goldsmith 1993b, Orgun 1995). For Sea Dayak, one can say that an output vowel must be nasalized if its input correspondent is immediately preceded by a nasal consonant. Though the details differ, the main line of analysis is much the same as in the PARSE/FILL approach.

Both of these theories of opacity within OT are successful to a point, but, as was noted in McCarthy (1996b: 241), they fail to account for cases where the relevant conditions obtain only at the *intermediate* stage of a serial derivation. Such cases exist; indeed, they are relatively common under the following conditions. Suppose that, in serial fashion, an underlying representation is first syllabified, then submitted to a phonological rule R_1, and later submitted to another rule R_2 that alters its syllabic structure (by deleting or inserting segments, for instance).[6] In this case, R_1 will be opaque in a way that cannot be accommodated under the PARSE/FILL or correspondence theories, because R_1 is sensitive to a syllabificational environment that is not present underlyingly and, by virtue of R_2, not present at the surface either.

The Bedouin Arabic process raising /a/ in an open syllable (3) presents a clear example of this type. In serialist terms, syllabification occurs, then raising, then glide vocalization, so raising is conditioned by syllabification that is different from the surface: /badw/ → $[\text{badw}]_\sigma$[7] vs. surface $[\text{ba}]_\sigma$ $[\text{du}]_\sigma$. In this way, surface open syllables created by glide vocalization act as if they are closed for the purposes of raising. From a surface perspective, the failure of raising in *ba.du* is unexplained. It cannot be explained from an underlying perspective either, because the syllabification is not present in underlying representation. Yet these are the only perspectives that the PARSE/FILL and correspondence theories offer, and so they cannot account for the underapplication of raising in *ba.du*.

An alternative naturally comes to mind: why not assume the presence of syllable structure in the underlying representation, thereby permitting some refinement of the PARSE/FILL or correspondence theories to deal with *ba.du*? This idea might seem promising, but it is actually unworkable

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[6]Affixation or post-lexical phonology can also take the role of R_2 in this schematic description, altering the syllabification that crucially conditioned R_1. The Dutch example (7) is a typical case.

[7]For the purpose of this argument, it does not matter whether the initial round of syllabification produces $[\textit{badw}]_\sigma$ or, say, $[\textit{bad}]_\sigma$*w*, with final extrasyllabicity. What's important is that the *w* not yet be syllabic.

because it runs afoul of the OT premise of richness of the base (Prince & Smolensky 1993, Smolensky 1996). Under richness of the base, there are no language-particular restrictions on underlying representations, and thus there is no way to ensure that underlying representations are syllabified in just the right away, as /[badw]$_\sigma$/ and not /[ba]$_\sigma$dw/. Moreover, richness of the base is not lightly dispensed with; it is a central element of OT's solution to conspiracies (Kisseberth 1970) and the Duplication Problem (Kenstowicz & Kisseberth 1977).

Tiberian Hebrew (2) presents much the same problem as Bedouin Arabic. For concreteness, let us assume the PARSE/FILL theory, though the argument can be made with equal validity in correspondence theory. Epenthesis (i.e., violation of FILL) is compelled by the syllable-structure constraint *COMPLEX: /melk/ → _mel□x_. But the /ʔ/ of /dešʔ/ is deleted — that is, it is syllabically unparsed, and so it can have no role in compelling epenthesis. For this reason, we wrongly expect the output to be _*deš〈ʔ〉_ (phonetically _deš_), as the following tableau attests:

(5) Hebrew Opacity Problem

/dešʔ/	*COMPLEX	FILL
a. ☞ de.š□〈ʔ〉		* !
b. ☜ deš〈ʔ〉		

This tableau shows that _*deš〈ʔ〉_ is a kind of fell-swoop candidate, solving the problems posed by both *COMPLEX and the anti-ʔ coda condition through the simple expedient of deleting the /ʔ/. This candidate exposes the gratuitousness of the FILL-violation incurred by the actual output form _deše_, and so its problematic status is called out by the symbol ☜. In general, since deletion is syllabic non-parsing, the imperative to syllabify a deleted segment cannot trigger epenthesis. Hence, the wrong outcome _*deš〈ʔ〉_ is unavoidable.

Here is another example of the same type, equally problematic: in Levantine Arabic (Broselow 1992, Farwaneh 1995, Kager to appear), there are processes of epenthesis (6a) and closed syllable shortening (6b). When they interact (6c), shortening is sensitive to the step in the derivation after the initial round of syllabification but before epenthesis:

(6) Shortening and Epenthesis in Levantine Arabic

a. Epenthesis

/katab+l+ha/ → katabi̱lha — 'he wrote to her'

b. Closed Syllable Shortening

/šāf+ha/ → ša̱fha — 'he saw her'

c. Interaction: Shortening → Epenthesis

/šāf+l+ha/ → ša̱flha → šafi̱lha — 'he saw for her'

Just as in Hebrew, there is no way to use the PARSE/FILL or correspondence theories of faithfulness to avoid having the fell-swoop candidate _*šāfilha_ emerge as optimal.

A final example comes from Dutch (Booij 1995: 174f, Peperkamp 1997). There is a general process of syllable-final obstruent devoicing (7a). There is also resyllabification of word-final consonants before vowel-initial clitics (7b). Devoicing is sensitive to the stage in the derivation before resyllabification (7c):

(7) Devoicing and Resyllabification in Dutch

a. Final Devoicing

/vɔnd/ → vɔnt 'found'

b. Resyllabification

c. Interaction: Devoicing → Resyllabification

/vɔnd ik/ → vɔnt.ik → vɔn.tik 'found I'

These and like cases show that there is a class of opacity phenomena that cannot be analyzed by either PARSE/FILL or correspondence. The feature common to all cases is that they would require crucial reference to an intermediate derivational stage in a serial theory — so access to the surface and underlying representations is not enough. In Hebrew, the intermediate derivational stage at which epenthesis applies is one where an initial round of syllabification has occurred, but ʔ-deletion has not yet occurred. Likewise for the other examples.

Another approach to opacity within OT might seem to hold promise for some problematic cases, though. The OO (output-output) correspondence model of Benua (1997) posits faithfulness relations among surface forms within paradigms, from one output form (called the "base") to another.[8] Applied to opacity cases (as in Kager to appear), it requires that some member of the paradigm undergo or fail to undergo the potentially opaque process transparently. This word is called on to serve as the base to which the other members of the paradigm are faithful. For instance, the Dutch case (7) is amenable to analysis in OO terms (though see Peperkamp (1997)). The otherwise unexpected devoicing in *vɔn.tik* can be analyzed as an effect of OO faithfulness to the base *vɔnt*, where devoicing occurs transparently.

Though OO faithfulness is appropriate for many phenomena (but see §6), it does not provide a complete solution to the opacity problem, as Benua (1997), Itô & Mester (1997a), and Karvonen & Sherman (1997) also observe. For OO faithfulness to work, somewhere in the paradigm there must be a form where the otherwise opaque process applies transparently (like *vɔnt*), since otherwise we are just swapping opacity in one part of the paradigm for opacity in another part. But many instances of opacity are transparent nowhere in the paradigm. Tiberian Hebrew (2) is just such a case. The paradigms of words like /dešʔ/ do not contain any form where epenthetic *e* and the ʔ are present together on the surface; indeed, no such form could exist, since epenthetic *e* is triggered by the need to syllabify the following ʔ, but ʔ never appears in coda position.

The same problem for OO faithfulness — transparency nowhere in the paradigm — arises whenever an underlying phonological contrast undergoes absolute neutralization. For example, the underlying pharyngeal /ʕ/ in Maltese is observed to condition a number of phonological processes, though it is always deleted at the surface (Brame 1972, Borg 1997). One process lowers vowels next to pharyngeal consonants (8a). This process is conditioned opaquely by the deleted /ʕ/ (8c):

[8] For further discussion of OO correspondence and related approaches, see Archangeli (1996), Buckley (to appear), Bybee (1985), Burzio (1994a, b, 1996, 1997), Crosswhite (1996), Kager (to appear), Kenstowicz (1996), Kraska-Szlenk (1995), Orgun (1994, 1996), and Pater (1995).

(8) Absolute Neutralization in Maltese

a. Gutturals trigger vowel lowering (etc.)

/nimsiħ/ → nimsa̠ħ 'I wipe'

b. Absolute neutralization: ʕ → Ø

c. Interaction: Lowering → Neutralization

/nismiʕ/ → nisma̠ʕ → nisma_ 'I hear'

Nowhere in the paradigm of /smiʕ/ or, indeed, any other word of Maltese is the /ʕ/ preserved on the surface, to transparently condition lowering. Thus, there is no base for a putative OO faithfulness constraint to refer to. Similarly, in Barrow Inupiaq (Kaplan 1981, Archangeli & Pulleyblank 1994),[9] palatalization is triggered by an *i* derived from underlying /i/ (9a), but it is not triggered by a phonetically identical *i* derived from /ɨ/ (or perhaps archisegmental /I/) (9c):

(9) Absolute Neutralization in Barrow Inupiaq

a. Palatalization after *i* (can skip consonants)

/savig+lu/ → savigʎu 'wound+be able'

b. Absolute neutralization: /ɨ/ → *i*

c. Interaction: Palatalization → Neutralization

/kamɨk+lu/ → DNA → *kamiklu* 'boot+be able'

Nowhere in the paradigm of /kamɨk/ is there a form where /ɨ/ surfaces unchanged, where it would then transparently fail to palatalize the following *l*.

The Levantine Arabic example in (6) provides a more subtle (and theory-dependent) argument against OO approaches to opacity. According to Benua (1997), a form A can induce OO faithfulness effects on a form B only if B is immediately derived from A in the morphology.[10] But *šafilha* 'he saw for her' is immediately derived from *šāf* 'he saw', which has a long vowel (because word-final consonants are extra-syllabic). One might look elsewhere in the paradigm for possible bases (e.g., to *šaflu* 'he saw for him'), but that move brings its own price in rendering the notion "base" less restricted.

Other accounts of opacity in OT have involved ideas, often quite insightful in themselves, that are local to particular phenomena but do not generalize to the full range of observed opacity. For example, it is often observed that stress is rendered opaque by vowel epenthesis. In response, Alderete (to appear) proposes that universal grammar contains a type of positional faithfulness constraint (cf. Beckman 1997), HEAD-DEP, that requires output stressed vowels to have input correspondents.[11] By positing feature-domain structures that may be based on underlying rather than surface feature specifications, Optimal Domains Theory gives an account of opaque processes of assimilation (Cole & Kisseberth 1995). Many analysts (e.g., Causley 1997, Gnanadesikan 1995, 1997, Lamontagne & Rice 1995, McCarthy 1996a, McCarthy & Prince 1995, Pater to appear) analyze a

[9]Thanks to André Isaak for bringing up this example.

[10]Other work on OO faithfulness allows a broader range of effects — compare, for example, Burzio (1994a, b, 1996, 1997).

[11]Another approach is to assume that epenthetic syllables have a special, defective prosodic structure that influences the placement of stress as in Broselow (1982, 1992), Farwaneh (1995), and Piggott (1995).

similar phenomenon, assimilation with deletion of the triggering segment (e.g., French /vin/ → *vĩn* → ***vĩ*** → *vɛ̃*), as phonological coalescence, thereby folding two derivational steps into one.

However successful they are in dealing with specific types of opacity, none of these ideas extends to the full range of observed opacity phenomena. For example, the HEAD-DEP constraint can explain why the epenthetic vowel is unstressed in Levantine Arabic *šáfi̱lha*, but it will not explain why the syllable preceding the epenthetic vowel acts like it is closed for the purposes of the shortening process. Similarly, ODT can be straightforwardly applied to Maltese and Barrow Inupiaq, because the opaque process involves assimilation to an underlying feature specification, but it will not extend to Bedouin Arabic, in which a process of feature shift is conditioned by opaque syllabification.

Though I have not yet seen this suggestion in the OT literature, there is another move to be made: deny that opaque generalizations are ever linguistically significant, "psychologically real", or of the same formal status as transparent generalizations.[12] This tack was taken in work on natural (generative) phonology in the decade following *SPE* (such as Stampe (1969) and Hooper (1976)). It did not excite much interest in the past, and the situation seems little different now. One problem is that some opaque generalizations have exactly the same character as transparent generalizations, except for being opaque. Thus, the claim that opaque generalizations have a distinct status is an empty one, since nothing correlates with this putative distinction. Another problem is that there is a significant body of literature arguing that even opaque generalizations may be supported by external evidence of psychological reality: speech errors — Fromkin (1971); language games — Sherzer (1970), Al-Mozainy (1981); historical change — Dresher (1981); versification — Halle & Zeps (1966). (This list is by no means exhaustive.) For example, Al-Mozainy is at pains to show that evidence from both a language game and an informal psycholinguistic experiment supports the productivity of the Bedouin Arabic *a*-raising process in (3). It seems clear, then, that the move of simply dismissing all opaque generalizations does not seem promising.

This brings us to a final and even more obvious move: combine OT constraint ranking and violation with the serial derivation of rule-based phonology, thereby treating opaque alternations in exactly the same way as classic serialism does. Proposals like this are widespread in the literature — see McCarthy & Prince (1993a: Appendix), Black (1994), Potter (1994), Kiparsky (1997), etc.[13] The core idea is that the phonology of a single language may consist of several OT constraint hierarchies connected serially, with the output of one serving as the input to the next. Each hierarchy is distinct from the others — that is, they rank some constraints differently. In Hebrew, for example, the first hierarchy would take input /dešʔ/ and give the output *dešeʔ*, supplying the epenthetic vowel but not yet deleting the ʔ. Then the second hierarchy would take *dešeʔ* as input and give *deše* as final output. In this way, OT+serialism can straightforwardly duplicate the effects of standard rule-based accounts.

However appealing it may initially seem, this move is fundamentally misconceived. For one thing, as Benua (1997) argues, two arbitrary constraint hierarchies can differ from one another in many ways, but the actual differences between strata in a single language are quite limited, leaving

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[12]Thanks to Bruce Hayes for a challenge on this point.

[13]When this work was presented at the Hopkins Optimality Theory Workshop/Maryland Mayfest '97, Sharon Inkelas brought to my attention a handout by Ronald Sprouse (Sprouse 1997) which describes another approach to opacity within OT now under development.

an unexplained (and perhaps inexplicable) gap between prediction and observation. For another, the Lexical Phonology notion of a stratum (Kiparsky 1982, Mohanan 1982) is trivialized by the kind of stratum that, say, Tiberian Hebrew or Levantine Arabic would require — a stratum of convenience rather than a meaningful correlation of phonological and morphological factors.

The most serious problem, though, is that OT+serialism does not provide a uniform theory of non-surface-apparentness and non-surface-trueness. Rule-based serialism has a single explanation for why phonological generalizations can be non-surface-true or non-surface-apparent: subsequent rules have hidden the generalization or the conditions leading to its applicability. OT+serialism has disparate explanations, in a thoroughly unprincipled way: constraint domination accounts for some non-surface-true generalizations, while stratal ordering must be called on to account for the remaining non-surface-true generalizations and all the non-surface-apparent ones. In this respect, OT+serialism is clearly inferior, explanatorily, to rule-based serialism.

This last criticism can be made a bit more concrete with a hypothetical example. Suppose there is a language with epenthesis of *t* in response to onsetless syllables, so ONSET >> DEP: /paka-i/ → *pakati*. Suppose, too, that onsetless syllables do appear on the surface under the following conditions:

(i) Word-initial onsetless syllables are permitted freely: /aka-i/ → *akati, *takati.*

(ii) Medial onsetless syllables can be created by deletion of intervocalic *h*: /mapuh-i/ → *mapu.i*.

The constraint ONSET is therefore non-surface-true in two respects, and OT+serialism has distinct modes of explanation for each. The non-surface-trueness in (i) can be obtained through crucial domination of ONSET by ALIGN-L (as in the McCarthy & Prince (1993a, b) analysis of Axininca Campa). The non-surface-trueness in (ii) must be accounted for serially, by assuming that there is a later stratum where *h* deletion occurs, and in that later stratum there is no *t* epenthesis because DEP >> ONSET. But rule-based serialism has a single explanation for both types of non-surface-trueness: epenthesis applies early in the derivation, when initial syllables are extrametrical and *h* hasn't deleted yet. OT+serialism must call on two different modes of explanation to accomplish what rule-based serialism does with just one.

OT's account of opacity should be no worse than rule-based serialism's. A satisfactory explanation for opacity in OT should be linked directly to the core elements of the theory: constraint ranking and domination. Providing that explanation is the next step in the argument.

3 Sympathy and Phonological Opacity

3.1 The Proposal Presented Informally

A serialist analysis of Tiberian Hebrew, as in (10), depends on the existence of the intermediate derivational stage *dešeʔ*, which differs in crucial ways from both underlying and surface structure:

(10) Serial Derivation

UR	/dešʔ/
Epenthesis	dešeʔ
ʔ Deletion	deše

Though the form *dešeʔ* has no status in either the lexicon or the surface phonology, it is an essential element of the serialist explanation for this case of opacity. In *dešeʔ*, the to-be-deleted ʔ is still present, and thus able to trigger epenthesis.

In OT, a form like *dešeʔ* also has a legitimate status: as a failed member of the candidate set emitted by Gen from the input /dešʔ/. In having an epenthetic vowel, the actual output form *deše* resembles (i.e., is faithful to) the failed candidate *dešeʔ* more than it resembles the underlying representation /dešʔ/. These two observations are the key to understanding how opacity is to be accommodated in OT: selecting a failed candidate to influence the output, and exercising that influence through a kind of faithfulness of the output to this failed candidate.

At first glance, selecting the *right* failed candidate seems like a daunting task, since the set of candidates for any given input is infinite and diverse. But in Hebrew and a range of other opaque systems (see §4), the relevant candidate is exactly the most harmonic member of the set of candidates that obey a designated input-output (IO) faithfulness constraint. Specifically, *dešeʔ* is the most harmonic member of the set of candidates that obey the constraint MAX-C_{IO}, which prohibits consonant deletion in the input→output mapping. In this way, the failed candidate that influences the output is selected by the same logic, Prince & Smolensky's "harmonic ordering on forms", that dictates choice of the actual output.

The influence of *dešeʔ* on the outcome is mediated by a kind of faithfulness, which I call <u>sympathy</u>. The research in correspondence theory cited in §2 shows that a single output form may participate in and be influenced by a variety of parallel faithfulness relations: to the input, of course, but also to morphologically-related output forms and between reduplicant and base. Therefore, the extension of faithfulness to inter-candidate relations is not wholly unexpected. The faithfulness of the actual output form *deše* to the failed candidate *dešeʔ* is MAX-like, reproducing the epenthetic *e* of *dešeʔ* at the expense of faithfulness to the input /dešʔ/. Significantly, faithfulness is not perfect, since *deše* lacks *dešeʔ*'s final ʔ. This observation shows that sympathetic constraints, like any faithfulness constraint, can be crucially dominated. (Here, the dominating constraint is the anti-ʔ CODA-COND.)

Faithfulness, then, plays two roles in the theory of sympathy. The failed candidate which is the object of sympathy is selected by an IO faithfulness constraint. And this candidate's effect on the outcome is mediated by candidate-to-candidate faithfulness. The following tableau shows somewhat informally how the different roles of faithfulness play out in an actual example:

(11) Informal Characterization of the Proposal

	/dešʔ/	CODA-COND	❀MAX-V$_{❀}$	MAX-C$_{IO}$	DEP-V$_{IO}$
opaque	a. ☞ deše			*	¡* !
transparent	b. ☜ deš		* !	*	
sympathetic	c. ❀ dešeʔ	* !		✔	*

The symbol ❀ points to the candidate that is the object of sympathy and to the candidate-to-candidate sympathetic faithfulness constraint. The actual output form's "extra" constraint violation, the seemingly gratuitous epenthetic vowel, is called out by the ¡ in the DEP-V$_{IO}$ column.

Here, the ❀-designating faithfulness constraint is MAX-C$_{IO}$, and (11c) ❀*dešeʔ* is the most harmonic member of the set of candidates that obey it. Other candidates are also in the set, but they are not as harmonic as ❀*dešeʔ*, according to Hebrew's language-particular constraint ranking. (For example, fully faithful *dešʔ* is also in the set, but it is less harmonic than ❀*dešeʔ*, because *COMPLEX >> DEP-V$_{IO}$.) Selection of ❀*dešeʔ* is not the whole story, however; it must also have a way of influencing the outcome. In this case, the influence is mediated by the candidate-to-candidate faithfulness constraint ❀MAX-V$_{❀}$, which requires one-for-one preservation of the vowels of the ❀-candidate ❀*dešeʔ*.

It is helpful to think about these dual functions of faithfulness at a more intuitive level. One intuition, introduced at the beginning of this section, is that the ❀-candidate has approximately the status of the intermediate stage of the serial derivation. I have proposed that the ❀-candidate is chosen by virtue of being the most harmonic candidate that obeys a designated faithfulness constraint. The intuition and the formal proposal are rather closely matched: by obeying a faithfulness constraint that the actual output form violates, the ❀-candidate more closely resembles the input, just as an earlier stage in a serial derivation does. As the most harmonic member of the set of candidates obeying this faithfulness constraint, the ❀-candidate may show the effect of other active phonological processes. This too leads to resemblance with an earlier stage in a serial derivation. Significantly, though, these resemblances are only approximate, and there are important differences between sympathy and serialism, to be addressed below (§3.5, §5).

There is another intuitive level where sympathy theory connects with ideas in serialism. Kaye (1974) proposes that some opaque rule orderings support the recoverability of underlying forms.[14] ("Recoverability" refers here to parsing rather than learning.) The Sea Dayak case in (4) supplies a straightforward example. That the second vowel is oral in *nãŋaʔ* means that there must an underlying oral consonant between it and the preceding nasal ŋ, hence underlying /naŋgaʔ/. Were the rules to apply in the opposite (transparent) order, the distinction between underlying /naŋaʔ/ and /naŋgaʔ/ would be neutralized in *nãŋãʔ*, and so neither underlying form could be recovered reliably.

[14]On recoverability, also see Kaye (1975) and Gussmann (1976).

Kaye's functionally-oriented insight receives formal expression in sympathy theory. The recoverability of underlying forms is supported when faithfulness constraints are obeyed. Sympathy provides another channel of faithfulness alongside the standard one — the ❀-candidate is chosen because it obeys a specified faithfulness constraint, and the output is compelled to resemble (i.e., be faithful to) the ❀-candidate. In this way, a sympathetic effect on the input→output mapping indirectly improves recoverability of the input from the output.

A third intuition, suggested to me by Benua (personal communication), is that sympathy theory addresses a kind of overapplication and underapplication in much the same way that work on reduplicative identity (McCarthy & Prince 1995, to appear) and OO faithfulness (Benua 1997) has addressed over- and underapplication in other contexts. As I noted in §1, vowel epenthesis can be thought of as overapplying in Hebrew *deše* — that is, it applies even though its phonological requirements are not met at the surface. Similarly, vowel raising can be thought of as underapplying in Bedouin Arabic *ba.du* — it fails to apply even though its environmental conditions are met at the surface. These types of opacity are directly paralleled in reduplication and "cyclic" phonology, where they can be understood in terms of other dimensions of faithfulness (base-reduplicant, output-output) taking precedence, through ranking, over markedness or input-output faithfulness. Sympathy proceeds along exactly the same lines: a further dimension of faithfulness, this time from candidate to candidate, also takes precedence through ranking.

Of course, these informal or intuitive statements are nothing more than pre-theoretic connections that can be made between sympathy and traditional ideas about opacity. What is important, and what must be the basis for testing and evaluating this proposal, is how it is worked out formally. I therefore turn now to the details.

3.2 Selecting the ❀-Candidate

According to (11), the ❀-candidate ❀*dešeʔ* is a member of the set of candidates obeying the input-output faithfulness constraint MAX-C_{IO}. It is the most harmonic member of that set, as determined by the same constraint ranking that selects the actual output.

Generalizing, any ❀-candidate must be the most harmonic member of the set of candidates obeying some designated IO faithfulness constraint (called the selector). It is "the most harmonic member" in the sense just described: it best satisfies the independently motivated constraint hierarchy of the language under consideration. The choice of the IO faithfulness constraint which it obeys must be determined on a language-particular basis. The range of possibilities in any given case is rather modest, however, since only IO faithfulness constraints that are crucially dominated will ever designate non-trivial ❀-candidates.[15]

Each IO faithfulness constraint F_i sorts the candidate set $\mathbf{C}$ into two non-overlapping subsets: $\mathbf{C}_{\langle -Fi \rangle}$, which violate F_i, and $\mathbf{C}_{\langle +Fi \rangle}$, which obey F_i. If $\mathbf{C}$ is sufficiently rich, as it usually is, then $\mathbf{C}_{\langle +Fi \rangle}$ will be non-empty. Therefore $\mathbf{C}_{\langle +Fi \rangle}$ has some most harmonic member, which can be called !$_{Fi}$. This is the ❀-candidate selected by F_i.

[15]For further discussion, see §4.3.

It is significant that only IO faithfulness constraints can be selectors of ❀-candidates.[16] These constraints, which demand identity in the IO correspondence relation, have a special status in the theory because they stand at the interface between two components of the grammar, the lexicon and the phonology, and because they are the OT counterpart to Kaye's functional notion of recoverability. Opacity of the non-surface-apparent type (as in Hebrew (2), Levantine Arabic (6), Dutch (7), or Maltese (8)) results when the conditions of a phonological generalization are not met in the actual output but are met in some form that is more similar to the lexical representation. Opacity of the non-surface-true type (as in Bedouin Arabic (3), Sea Dayak (4), or Barrow Inupiaq (9)) results when a phonological generalization is violated in the actual output but is nonetheless obeyed in some form that is more similar to the lexical representation. Either way, the crucial conditions are to be sought in some representation that more closely resembles the lexical form — that is, in some representation that obeys an IO faithfulness constraint violated by the actual output. That is the ❀-candidate.

It is also significant that the ❀-candidate is the *most harmonic member* of $\mathbf{C}_{\langle +Fi\rangle}$. Harmonic evaluation is a central element of OT, without a doubt independently necessary, and therefore readily available to be recruited for purposes in addition to selecting the actual output form. Harmonic evaluation is called on to select the input, as a kind of learning procedure, in situations where the choice of input is otherwise undetermined, by the principle of Lexicon Optimization (Prince & Smolensky 1993, Itô, Mester, & Padgett 1995).[17] Harmonic evaluation is also the method of determining the base in OO faithfulness (Benua 1995, 1997). It selects the attractor pattern in accentually dominant affixation (Alderete 1997b, 1998). And it plays a role in systems of multiple optimization like that proposed by Wilson (1997).

In languages with multiple opaque interactions, multiple faithfulness constraints can each select distinct ❀-candidates which will be subject to distinct sympathy relations. Hebrew is an example. As I have noted, the presence of the epenthetic *e* in *deše* is an effect of sympathy with the ❀-candidate ❀*dešeʔ*, which is !$_{\text{Max-C}}$. But Hebrew also has an opaque interaction between epenthesis and stress. The normal pattern places stress on a final closed syllable and otherwise the penult, but final closed syllables created by epenthesis are skipped: /melk/ → *mélex* 'king'. The locus of stress in *mélex* is determined by sympathy with the ❀-candidate ❀*mélk*, which is !$_{\text{Dep-V}}$. There is no barrier to having more than one sympathy relation in force simultaneously. Indeed, one could say that *déše*, which has penultimate stress, shows the effect of both sympathy relations at once.[18] The details of how to keep the different sympathy relations straight are given in §3.3. The question of whether multiple faithfulness constraints can be *combined* to select a single ❀-candidate (as would be necessary to simulate certain effects of deep serial derivations) is raised in §4.4.

[16] For further discussion of the ❀-selecting constraint, see §6 below. For a different view, cf. Itô & Mester (1997a).

[17] There may be a deeper connection between Lexicon Optimization and sympathy. As Moreton (1996) observes, the input itself is a member of the set of output candidates, in accordance with the conditions on Gen known as Containment and Freedom of Analysis (Prince & Smolensky 1993). Therefore, one might say that Lexicon Optimization is like selection of a ❀-candidate: it chooses the input-*qua*-output-candidate because it is the most harmonic candidate that obeys *all* faithfulness constraints.

[18] Or penult stress in *déše* could be derived transparently. The matter turns on nuances of the generalization about the locus of main stress in Hebrew. Compare Prince (1975: 19), Malone (1993: 53–4), and McCarthy (1981).

Before going on, it might be helpful to review the various examples in light of these developments:[19]

(12) ❀-Candidates and Their Selectors

Language	Input	Output	❀-Candidate
Tiberian Hebrew (2)	/dešʔ/	*deše*	! $_{\text{MAX-C}}$ = ❀*dešeʔ*
Bedouin Arabic (3)	/badw/	*ba.du*	! $_{\text{DEP-}\mu}$ = ❀*badw*
Sea Dayak (4)	/naŋga/	*nãŋaʔ*	! $_{\text{MAX-C}}$ = ❀*nãŋgaʔ*
Levantine Arabic (6)	/šāflha/	*ša.fil.ha*	! $_{\text{DEP-V}}$ = ❀*šaflha*
Dutch (7)	/vɔnd ik/	*vɔn.tik*	! $_{\text{ANCHOR}}$ = ❀*vɔnt.ik*
Maltese (8)	/nismiʕ/	*nisma*	! $_{\text{MAX-C}}$ = ❀*nismaʕ*

In Bedouin Arabic, the ❀-candidate which sympathetically affects *ba.du*, blocking raising in the first syllable, is the most harmonic candidate that is faithful to the underlying glide *w* (by virtue of lacking the added mora in *ba.du*). In Sea Dayak, the ❀-candidate which sympathetically blocks nasal harmony is ❀*nãŋgaʔ*, itself an alternative output form.[20] In Levantine Arabic, vowel shortening is transparently conditioned in the ❀-candidate ❀*šaflha*, where the syllable *šaf* is closed. In the Dutch example, devoicing is a result of sympathy to ❀*vɔnt.ik*, which is chosen for its obedience to ANCHOR(Stem, σ, Final), a constraint that requires the right edges of input stem and output syllable to be in proper alignment.[21] And finally in Maltese, vowel lowering and other processes are conditioned sympathetically in ❀-candidates like ❀*nismaʕ*, which preserve the deleted /ʕ/.

In each case in (12), the ❀-candidate is identical to a form that would be posited as an intermediate or initial stage of a serial derivation — concretely exemplifying the intuitive force of sympathy that was highlighted in §3.1. Significantly, these cases also concretely exemplify the intuitive connection with Kaye's idea of recoverability: sympathy establishes an indirect faithfulness chain between the output and the input, thereby enhancing retrieval of the input from the form of the output.

3.3 Sympathy as a Type of Faithfulness

According to (11), the grammar of Hebrew selects *deše* as the output from input /dešʔ/ because of the sympathetic influence of the ❀-candidate ❀*dešeʔ*. This sympathetic influence, I will now argue, is itself a type of faithfulness — faithfulness of one candidate to another. Specifically,

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[19]No examples in (12) involve a featural IDENT_{IO} constraint as a ❀-selector, but see Itô & Mester (1997b) for an example.

[20]The Sea Dayak situation, where a single form is observed to vary between being an actual output and a ❀-candidate, is also found in Japanese. See Itô & Mester (1997b).

[21]ANCHOR is one of the constraints of correspondence theory, hence a faithfulness constraint. See the definition below in (18).

candidates are tested for resemblance to ❀*dešeʔ* by ranked constraints on a correspondence relation between ❀*dešeʔ* and the members of the candidate set.

Research in OT has established a number of properties of faithfulness constraints (Prince & Smolensky 1993, McCarthy & Prince 1995):

•Faithfulness demands similarity between phonological representations and it is regulated by ranked, violable constraints.

•There are distinct constraints on faithfulness for different kinds of phonological properties. There is no general instruction to "Resemble!"; rather, there are more specific requirements like PARSE or MAX, FILL or DEP, and IDENT(feature).

•Though it was originally conceived as a relation between input and output, faithfulness has been extended to other pairs of linguistically associated representations, such as base and reduplicant, simple and derived words, and so on.

The goal of this section is to show that the sympathy relation shares these properties, and then to provide a way of capturing the formal resemblance between sympathy and faithfulness proper.

We have already seen (in §3.1) that sympathy is satisfied by greater resemblance between the ❀-candidate and the output. For example, the form *deše* emerges as the output because it more closely resembles the ❀-candidate ❀*dešeʔ* than does its transparent competitor **deš*. On a scale of crude resemblance, then, we can rank *deše* as closer to ❀*dešeʔ* than **deš* is. The same observation holds for the other cases considered. For instance, Sea Dayak *nãŋaʔ* is closer to ❀*nãŋgaʔ* than its transparent competitor **nãŋãʔ* is, and Maltese *nisma* is closer to ❀*nismaʕ* than *nismi* is.

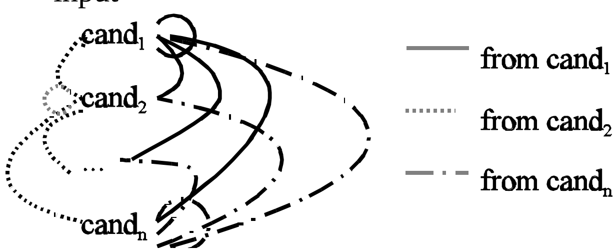
Sympathetic resemblance is enforced by specific constraints of the same formal character as faithfulness. This is shown by cases where some specific type of sympathetic resemblance is required, but where some other type of sympathetic resemblance is crucially banned. Any of the languages cited above could serve as an exemplar. For instance, the output *deše* in Hebrew echoes the second *e* of the ❀*dešeʔ*, but not its final ʔ. This indicates that ❀MAX-V$_{❀}$, but not ❀MAX-C$_{❀}$, is crucially obeyed. Likewise, Sea Dayak *nãŋaʔ* resembles ❀*nãŋgaʔ* in a way that conforms to ❀IDENT(nasal)$_{❀}$, but the two forms part ways on ❀MAX-C$_{❀}$. And Maltese *nisma* owes its *a* to ❀IDENT(high)$_{❀}$, but it is distinct from ❀*nismaʕ* by virtue of violating ❀MAX-C$_{❀}$. In these and other cases it is clear that sympathy, like faithfulness, is based on obedience to or violation of specific constraints on the resemblance between the ❀-candidate and the actual output form.

Of course, sympathy is unlike classical faithfulness in one important respect: sympathy is a relation from candidate to candidate, while classical faithfulness is a relation from input to output. This difference turns out to be illusory, though, when more recent developments in correspondence theory are taken into account (see the references in §2). It is now clear that a number of parallel, co-existent systems of faithfulness regulate phonological representations. Not only input-output, but also base-reduplicant and simple and derived words (in analyses of "cyclic" phenomena) show the effects of formally similar though functionally distinct faithfulness constraints. In particular, these developments show that different output forms or different parts of a single output form can stand in correspondence and therefore be subject to faithfulness constraints. Constraints on, say, base-reduplicant identity are distinct and separately rankable from constraints on input-output faithfulness because they are based on distinct correspondence relations. Indeed, reduplicative over- and underapplication are a consequence of constraints on the base-reduplicant faithfulness relation taking precedence, through ranking, over input-output faithfulness.

As has already been noted, phonological opacity parallels reduplicative over- and underapplication. Just as there is a base-reduplicant correspondence relation, so too there is a correspondence relation holding between candidates derived from a single input. Indeed, there are many such correspondence relations, one for each candidate:

(13) Candidate-to-Candidate Correspondence

input →



Here, each candidate is shown with a candidate-to-candidate correspondence relation to itself and all other candidates. Sympathy effects are induced by high-ranking faithfulness constraints on these correspondence relations. For example, in the candidate set derived from Hebrew /dešʔ/ there is a candidate *dešeʔ*, and Gen provides a correspondence relation from *dešeʔ* to the whole candidate set. Recruiting standard correspondence theory terminology, I will refer to *dešeʔ* as the "base" of that particular correspondence relation. Harmonic evaluation selects *dešeʔ* as !$_{\text{MAX-C}}$, so it is a potential ❀-candidate. The grammar of Hebrew allots high rank to the constraint ❀MAX-V$_{❀}$ on the correspondence relation with ❀*deseʔ* as base, and that is the source of the sympathy effect. Low-ranking faithfulness constraints on the same candidate-to-candidate corrrespondence relation, such as ❀MAX-C$_{❀}$, have no force, so the actual output is not identical to ❀*deseʔ*.

We may assume that the Gen-supplied correspondence relations in (13) and the ❀-faithfulness constraints on those relations are universal, though not universally active. To be visibly active, the correspondence relation from some candidate cand_i must meet two conditions. First, cand_i must be !$_{\text{Fk}}$ for some IO faithfulness constraint F_k. This condition is only rarely met in the context of an infinite candidate set, and so the number of potential ❀-candidates is few. Second, some sympathetic faithfulness constraint on the cand_i-based correspondence relation, ❀F_{Fk}, must be high-ranking, crucially dominating some markedness constraint or IO faithfulness constraint. In this way, the familiar OT notion of factorial typology carries over to sympathy theory.

As work in correspondence theory has shown (§2), there are separate and therefore separately rankable faithfulness constraints on each correspondence relation. According to (13), each candidate serves as the base for a distinct correspondence relation to the other candidates. Thus, a single language may have more than one opaque interaction. Concretely, suppose that the candidate set derived from some input includes cand_i and cand_j. Gen supplies a correspondence relation with cand_i as base and a different correspondence relation with cand_j as base. Now suppose that harmonic evaluation selects cand$_i$ as ! $_{\text{Fi}}$ and cand$_j$ as ! $_{\text{Fj}}$ — that is, different IO faithfulness constraints have selected cand$_i$ and cand$_j$ as ❀-candidates. There are distinct, separately ranked sympathetic faithfulness constraints on these two correspondence relations. To keep them straight, I will annotate the sympathetic faithfulness constraint by subscripting the name of the IO faithfulness constraint that selects the base for its correspondence relation. So if cand$_i$ sympathetically influences the output via MAX$_{❀}$, from now on I will call that constraint ❀MAX$_{\text{Fi}}$, to indicate that this MAX is active on a correspondence relation whose base is ! $_{\text{Fi}}$.

For instance, in §3.2 I mentioned two distinct opaque interactions observed in Hebrew, /dešʔ/ → *deše* by sympathy to ❀*dešeʔ* and /melk/ → *mélex* by sympathy to ❀*mélk*. The ❀-candidates ❀*dešeʔ* and ❀*mélk* are chosen by different IO faithfulness constraints: the former is ! $_{\text{MAX-C}}$ and the latter is ! $_{\text{DEP-V}}$. There are, then, at least two relevant candidate-to-candidate correspondence relations in Hebrew, one whose base is ! $_{\text{MAX-C}}$ and the other whose base is ! $_{\text{DEP-V}}$. The sympathetic faithfulness constraint that is active on the correspondence relation based on ! $_{\text{MAX-C}}$ is called ❀MAX-V$_{\text{MAX-C}}$. The sympathetic faithfulness constraint that is active on the correspondence relation based on ! $_{\text{DEP-V}}$ is ❀IDENT-STR$_{\text{DEP-V}}$ (which requires preservation of the locus of stress). In this way, separately chosen ❀-candidates may have separate influences on the selection of a single output form.

The possibility of having multiple sources of opacity functioning together in a single language comes essentially for free from basic architectural principles of the theory: Gen supplies correspondence relations; harmonic evaluation selects the ❀-candidate(s); distinct correspondence relations are subject to distinct but formally parallel faithfulness constraints. Arguably, this is *all* that is required to analyze observed opaque interactions. It does not, however, simulate all of the interactions that are possible in serial derivations. In particular, sympathy cannot produce certain patterns observed in deep serial derivations where one rule undoes the effect of an earlier rule. I discuss this point of difference in §5, arguing that the evidence comes down in favor of sympathy and against serialism.

3.4 Overview

The exposition thus far has proceeded by giving separate treatment to the two major parts of sympathy theory — selection of the ❀-candidate(s) and sympathetic faithfulness constraints. This move makes for a clearer presentation of the ideas, but it doesn't show how the two parts function together. This section will remedy that deficit.

The principal proposal to be defended here is that selection of the ❀-candidate(s) and selection of the actual output (the ☞-candidate) take place in parallel. Two assumptions are necessary to carry this forward. The first is familiar from the discussion above; the second is justified immediately below:

(14) Confinement to $\mathbf{C}_{\langle +F\rangle}$

Selection of the ❀-candidate ! $_{F}$ is confined to $\mathbf{C}_{\langle +F\rangle}$, the set of candidates that obey the IO faithfulness constraint F.

(15) Invisibility of ❀-Faithfulness Constraints

Selection of ❀-candidates is done without reference to ❀-faithfulness constraints (on *any* sympathetic correspondence relation).

In all other respects, selection of the ❀-candidate(s) is done by harmonic evaluation in exactly the same way that selection of the ☞-candidate is done.

The Invisibility assumption (15) needs some discussion. The idea is that selection of ❀-candidate(s) is done by a harmonic evaluation that ignores the sympathetic faithfulness constraints themselves — crucially unlike selection of the ☞-candidate. Invisibility is most obviously necessary to avoid the threat of a cyclic dependency (an “infinite loop”): the choice of ! $_{Fi}$ can’t depend on performance on a constraint that needs to know what ! $_{Fi}$ is in order to be evaluated. Less obviously, Invisibility is necessary to prevent a different kind of cyclic dependency that might arise in languages with multiple opacity: selection of ! $_{Fj}$ and ! $_{Fi}$ cannot mutually depend on one another.[22]

Invisibility does more than just sidestep a potential pitfall, however. It also restricts the descriptive power of the theory in an important way, and this helps to sharpen the differences between sympathy and serialism. By virtue of Invisibility, the choice of ! $_{Fj}$ cannot depend on the choice of ! $_{Fi}$, so no opaque interaction can depend on any other opaque interaction. Rather, the determinants of opaque interactions are always isolated from one another, except as they interact through the ranking of their associated sympathetic faithfulness constraints. Some consequences of this are discussed in §4.4.

To see these assumptions in action, consider the following tableau (which is constructed with an eye toward showing all the relevant interactions rather than illustrating any linguistically plausible situation):

(16) A System with Multiple Sympathy Relations

Note to readers: Small variations in shading are not significant; they are caused by a word-processor bug.

/input/	❀F$_{Fi}$	❀F$_{Fj}$	M	F$_i$	F$_j$
☞ cand$_1$			*	*	*
☜ cand$_2$		* !		*	*
❀$_{Fi}$ cand$_3$			** !	✓	*
cand$_4$			*** !	✓	*
☜, ❀$_{Fj}$ cand$_5$	* !			*	✓
cand$_6$			** !	*	✓

The actual output form is cand$_1$; its transparent competitors are cand$_2$ and cand$_5$. Cand$_1$'s performance on the markedness constraint M is inferior to that of its transparent competitors, but nevertheless the competitors are non-optimal because M is crucially dominated by the sympathetic faithfulness constraints ❀F$_{Fi}$ and ❀F$_{Fj}$. Cand$_3$ is ! $_{Fi}$; the F$_i$-obeying set $\mathbf{C}_{\langle +Fi\rangle}$ has two members, cand$_3$ and cand$_4$, and cand$_3$ is the more harmonic of the two. The F$_j$-obeying set $\mathbf{C}_{\langle +Fj\rangle}$ also has two members, cand$_5$ and cand$_6$. Cand$_5$ has a violation of the sympathetic faithfulness constraint ❀F$_{Fi}$, while cand$_6$ violates

[22] I am grateful to Paul de Lacy, Alan Prince, and Philippe Schlenker for discussion of this material.

only lower-ranking M. Nevertheless cand$_5$ is !$_{Fj}$, because violations of sympathetic faithfulness constraints are invisible to selection of ❀-candidates. But cand$_5$'s violation of ❀F_{Fi} is fully visible when it comes to selection of the actual output form.

A final remark before we proceed to the applications of sympathy. It is sometimes suggested that sympathy covertly reintroduces a kind of serialism. According to this view, selection of the ❀-candidates must take place prior to selection of the ☞-candidate, because the latter depends on the results of the former. (The Invisibility property (15) would be seen as a necessary consequence of this ordering of events.) But it is simply wrong to insist that "A depends on properties of B" necessarily implies that "there is a serial derivation in which B is constructed earlier than A". Dependencies of one form on another can also be understood in terms of satisfaction of constraints in parallel rather than serially. For example, reduplication may involve copying the base as it has been altered by phonological processes, but this does not entail that the base undergo phonology prior to reduplication. Rather, the effects of phonology on the base and reduplicant can be determined together, in parallel (McCarthy & Prince 1995, to appear). (Similar remarks apply to the analysis of "cyclic" effects in Benua (1997).) In both reduplication and sympathy, correspondence provides a way to express dependencies that does not depend on serial derivation.

3.5 Applications

In this section, I will work through a small body of cases in order to illustrate how the theory is applied to real linguistic data. I have chosen three examples: Tiberian Hebrew (2) and Bedouin Arabic (3), which are representative of the two main types of simple opacity (counter-bleeding and counter-feeding — see §4) and Yokuts, which involves multiple sources of opacity in a single system. Generalizing from these results, the next section shows that sympathy is able to account for opaque systems in the abstract, starting from the original Kiparsky (1971, 1973a) definition of opacity.

I will begin by disposing quickly of the relevant transparent phonology of Hebrew and then turn to the opaque interaction. Hebrew resolves final non-geminate consonant clusters by inserting a vowel internally: /melk/ → *melex*.[23] This fact shows the need for a familiar markedness/faithfulness interaction, as in the following tableau (with epenthetic vowels underlined):

(17) Core Rankings for Hebrew

/melk/	*COMPLEX	MAX-C_{IO}	DEP-V_{IO}	ANCHOR$_{IO}$(Root, σ, Final)
a. ☞ mel<u>e</u>x			*	
b. melk	* !			
c. mel		* !		
d. melk<u>e</u>			*	* !

[23]Under certain morphological conditions, final clusters of falling sonority remain intact (Benua 1997).

The only noteworthy aspect of this tableau is the use made of the ANCHOR constraint, which is defined as follows:

(18) ANCHOR_{IO}(Root, σ, Final)

If $\varsigma_1 \in$ Input,
$\varsigma_2 \in$ Output,
ς_1 stands in correspondence with ς_2, and
ς_1 is final in the root,
then ς_2 is final in some syllable.

Anchoring constraints (McCarthy & Prince 1995, to appear, McCarthy to appear) refine and replace the Align(MCat, PCat) constraints of Prince & Smolensky (1993) and McCarthy & Prince (1993a, b). ANCHOR_{IO}(Root, σ, Final) says that, if the root-final consonant is preserved in the output, then it must be syllable-final. It therefore bans epenthesis after the root-final consonant, which is nearly universally prohibited in Semitic (McCarthy & Prince 1993b, Farwaneh 1995, Benua 1997), while permitting deletion of root-final consonants, which is not uncommon. Here, ANCHOR merely settles the tie between (17a) and (17d), so it is active but not rankable on the basis of this tableau.

Glottal stops are permitted only in onsets in Hebrew by a CODA-COND, which must dominate MAX-C_{IO}:

(19) CODA-COND >> MAX-C_{IO}

/qaraʔ/	CODA-COND	MAX-C_{IO}
a. ☞ qārā		*
b. qāraʔ	* !	

This example also shows the effect of compensatory lengthening and other processes.[24] Since CODA-COND could equally well be satisfied by epenthesis after the final ʔ, but is not, the anchoring constraint must dominate MAX-C_{IO}:[25]

(20) ANCHOR_{IO}(Root, σ, Final) >> MAX-C_{IO}

/qaraʔ/	ANCHOR_{IO}(Root, σ, Final)	MAX-C_{IO}
a. ☞ qārā		*
b. qāraʔe̱	* !	

This completes the picture of the transparent phonology.

[24]Because of difficulties of philological interpretation, it is not clear whether or not there is compensatory lengthening in *deše*. See fn. 2 on the philological question and §6 on compensatory lengthening generally.

[25]Coda ʔ's in root-medial position receive inconsistent treatment, sometimes undergoing epenthesis (*yeʔes* φ 'he will gather' from root /ʔsp/) and sometimes deleting (*y mar* 'he will say' from root /ʔmr/).

We can now see in detail why cases like /dešʔ/ → *deše* are problematic for an OT approach without sympathy:

(21) Attempting to Analyze /dešʔ/ → *deše* Without Sympathy

/dešʔ/	*COMPLEX	ANCHOR$_{\text{IO}}$	CODA-COND	MAX-C$_{\text{IO}}$	DEP-V$_{\text{IO}}$
a. ☞ deš<u>e</u>				*	¡* !
b. ☜ deš				*	
c. dešʔ<u>e</u>		* !			*
d. deš<u>e</u>ʔ			* !		*
e. dešʔ	* !		* !		

Form (21a) is the actual output, but it is not the most harmonic member of the candidate set. That status goes to its transparent competitor, (21b), which avoids violation of the high-ranking markedness constraints and dodges an IO faithfulness violation as well. The remaining candidates, included for completeness, have fatal anchoring or markedness violations and thus would seem to be of no further interest.

Sympathy changes this picture. According to (13), there is a correspondence relation from each candidate to the other members of the candidate set, and so even a failed candidate can sympathetically influence the outcome. The failed candidate of interest is one that preserves ʔ and consequently shows epenthesis: *dešeʔ*. It is ! $_{\text{MAX-C}}$, the most harmonic member of the set of candidates that obey MAX-C$_{\text{IO}}$. It is able to exercise this influence because the sympathetic constraint ❀MAX-V$_{\text{MAX-C}}$, which demands faithfulness to ! $_{\text{MAX-C}}$, is ranked above the IO faithfulness constraint DEP-V$_{\text{IO}}$:

(22) Analyzing /dešʔ/ → *deše* With Sympathy

/dešʔ/	❀MAX-V$_{\text{MAX-C}}$	*COMPLEX	ANCHOR$_{\text{IO}}$	CODA-COND	MAX-C$_{\text{IO}}$	DEP-V$_{\text{IO}}$
a. ☞ deš<u>e</u>					*	*
b. ☜ deš	* !				*	
c. dešʔ<u>e</u>			* !		✓	*
d. ❀$_{\text{MAX-C}}$ deš<u>e</u>ʔ				* !	✓	*
e. dešʔ	* !	* !		* !	✓	

The set of MAX-C-obeying candidates **C**$_{\langle\text{+MAX-C}\rangle}$ includes (22c, d, e). Apart from *dešʔe*, which is discussed immediately below, the most harmonic member of this set is ❀*dešeʔ*, which is therefore ! $_{\text{MAX-C}}$. Output candidates must match the vowels of ❀*dešeʔ*, even at the expense of seemingly gratuitous epenthesis, because ❀MAX-V$_{\text{MAX-C}}$ dominates DEP-V$_{\text{IO}}$. Other sympathetic faithfulness constraints may be ranked differently. For instance, the output obviously violates ❀MAX-C$_{\text{MAX-C}}$, since the ʔ of ❀*dešeʔ* is not carried over to *deše*.

As for *dešʔe*, it actually rivals *dešeʔ* for ❀-status. These two candidates do conflict on ANCHOR$_{IO}$ and CODA-COND, but those constraints are undominated and hence not rankable on the basis of any direct argument. We could perhaps see the conflict over ❀-status as the basis for a novel type of ranking argument, concluding that ANCHOR$_{IO}$ >> CODA-COND. But the facts do not provide a strong basis for this conclusion since, even if *dešʔe* were accorded ❀-status, the sympathetic faithfulness constraint ❀MAX-V$_{MAX\text{-}C}$ would still correctly favor the output *deše*.[26] For now, then, the question is of purely academic interest: does choice of the ❀-candidate ever crucially depend on conflict between constraints whose ranking is otherwise unknown? It would be remarkable if examples with this property did not emerge.

In summary, this tableau shows at the level of formal detail what was first suggested in §3.1: faithfulness of the output to a failed candidate selected for its performance on a faithfulness constraint is sufficient to account for opacity in the derivation of Hebrew *deše*. The process of epenthesis is non-surface-apparent in this case because the conditions that lead to epenthesis are not met in the output form; rather, they are met in a failed candidate derived from the same input.

Before we leave the Hebrew case, it is important to show that introducing sympathy has no untoward effects on the derivation of unproblematic cases like /melk/ → *melex*. And that is indeed the case, as the following tableau certifies:

(23) Sympathy Does Not Affect /melk/ → *melex*

/melk/	*COMPLEX	ANCHOR$_{IO}$	❀MAX-V$_{MAX\text{-}C}$	MAX-C$_{IO}$	DEP-V$_{IO}$
a. ❀$_{MAX\text{-}C}$, ☞ mel<u>e</u>x				✓	*
b. melk	* !		* !	✓	
c. melk<u>e</u>		* !		✓	*

The set **C**$_{\langle +MAX\text{-}C\rangle}$ includes all of the candidates given here. Its most harmonic member is, of course, the actual output, and so there is convergence between the ❀-candidate and the ☞-candidate. In situations of such convergence, any sympathetic faithfulness is satisfied without further ado. The outcome is therefore transparent.[27]

We will now proceed somewhat more rapidly through the Bedouin Arabic example. The main generalization is that /a/ is raised to *i* in open syllables: /katab/ → *ki.tab*. Raising fails to occur under a number of conditions (Al-Mozainy 1981, McCarthy 1993, 1994); for present purposes, it is important that raising fails in an open syllable created by vocalization of an underlying glide: /badw/ → *ba.du*, **bi.du*.

We begin as usual with the transparent phonology. Simple cases like /katab/ → *ki.tab* show that some markedness constraint — call it $*a]_\sigma$ — dominates the faithfulness constraint IDENT(high)$_{IO}$.

[26] Ania Łubowicz points out to me that this is true only if ❀CONTIG$_{MAX\text{-}C}$ is low-ranking.

[27] Davis (1997b) and Karvonen & Sherman (1997) emphasize the importance of such "vacuous sympathy" in the context of their respective analyses of Ponapean and Icelandic.

Similarly, the process of glide vocalization shows that the markedness constraint *COMPLEX dominates some appropriate faithfulness constraint — presumably DEP-μ_{IO}, under the reasonable assumption that vocalization of an underlying glide involves adding a mora. And since *ba.du* obeys *COMPLEX at the expense of violating *$a]_\sigma$, we need to rank *COMPLEX (which is undominated) above *$a]_\sigma$.

Putting these rankings together, but without calling on sympathy, leads to an obvious problem:

(24) Attempting to Analyze /badw/ → *badu* Without Sympathy

/badw/	*COMPLEX	*$a]_\sigma$	IDENT(high)$_{IO}$	DEP-μ_{IO}
a. ☞ ba.du		¡* !		*
b. ☜ bi.du			*	*
c. badw.	* !			

The problem is that all of (24b)'s marks are ranked lower than (24a)'s worst mark, so (24b) should be optimal. In short, the process of raising is non-surface-true.

Sympathy addresses this problem. The form ❀*badw* is ! $_{\text{DEP-}\mu}$, and it exercises sympathetic influence via the cross-candidate faithfulness constraint ❀IDENT(high)$_{\text{DEP-}\mu}$, which crucially dominates *$a]_\sigma$:

(25) Analyzing /badw/ → *badu* With Sympathy

/badw/	*COMPLEX	❀IDENT(high)$_{\text{DEP-}\mu}$	*$a]_\sigma$	IDENT(high)$_{IO}$	DEP-μ_{IO}
a. ☞ ba.du			*		*
b. ☜ bi.du		* !		*	*
c. ❀$_{\text{DEP-}\mu}$ badw.	* !				✓

In summary, the raising process is non-surface-true because the constraint responsible for raising, *$a]_\sigma$, is dominated by ❀IDENT(high)$_{\text{DEP-}\mu}$. In this way, the syllabificational conditions obtaining in the candidate ❀*badw*, rather than in the actual output form, are determinant of the outcome.

In Tiberian Hebrew, Bedouin Arabic, and the other examples introduced in §2, the ❀-candidate of interest is identical to a form that would be posited at the intermediate stage of a serial derivation. That situation is typical when just two processes are interacting opaquely. But when multiple processes interact, sympathy and serialism part company more dramatically. Some imaginable multi-process interactions, though readily describable in serialist terms, cannot be modeled with sympathy at all (§5). Others are straightforward once it is understood that several ❀-candidates can be active simultaneously (§3.2, §3.4).

The well-known vowel alternations in Yokuts provide an excellent example of the latter type:

(26) Yokuts Vowel Alternations (Newman 1944, Kuroda 1967, Kisseberth 1969, Archangeli 1985, Lakoff 1993, Cole & Kisseberth 1995, Archangeli & Suzuki 1997)

a. Vowels are shortened in closed syllables:

/saːp/	saphin	'burn (aorist)'
/goːb+hin/	gobhin	'take in (aorist)'

b. Long high vowels are lowered:

/miːk+it/	meːkit	'swallow (aorist passive)'
/ʔuːt+it/	ʔoːtut	'steal (aorist passive)'

Vowels shortened in accordance with (a) are also lowered:

/miːk+hin/	mekhin	'swallow (aorist)'
/ʔuːt+hin/	ʔothun	'steal (aorist)'

c. Suffix vowels are rounded after a round vowel of the same height:[28]

/dub+hin/	dubhun	'lead by the hand (aorist)'
/bok'+al/	bok'ol	'find (dubitative)'

But not if height differs:

/hud+al/	hudal	'recognize (dubitative)'
/gop+hin/	gophin	'take care of an infant (aorist)'

Vowels lowered in accordance with (b) are treated as high:

/c'uːm+it/	c'oːmut	'destroy (aorist passive)'
/c'uːm+al/	c'oːmal	'destroy (dubitative)'

In serialist terms, Lowering precedes Shortening, while Rounding Harmony precedes Lowering. The familiar serial derivations go like this:

(27) Yokuts in Serialist Terms

UR	/ʔuːt+hin/	/c'uːm+al/
Rounding Harmony	ʔuːt+hun	*does not apply*
Lowering	ʔoːt+hun	c'oːmal
Shortening	ʔot+hun	"

The condition leading to lowering — that is, vowel length — is non-surface-apparent in words like *ʔothun*. The conditions leading to rounding harmony — agreement in height between trigger and target — are also non-surface-apparent in *ʔothun*. Morever, rounding harmony is also non-surface-true in words like *c'oːmal*. What we have here, then, is three kinds of opacity with two rule interactions. Because rule ordering is transitive, the serial derivation appears to require two intermediate stages, unlike the simpler cases discussed thus far, which are modeled serially with just one intermediate stage.

Turning now to OT, we begin with the phonology of the transparent interactions:

•Long vowels are shortened in closed syllables. Therefore, assuming that codas are moraic, $*[\mu\mu\mu]_\sigma$ >> MAX-μ_{IO}.

[28] Rounding harmony treats *a* and *o* as vowels of the same height.

•Long high vowels are lowered. I assume a constraint LONG/–HIGH “if long, then non-high”, ranked as follows: MAX-μ_{IO}, LONG/–HIGH >> IDENT(high)$_{IO}$. (The ranking MAX-μ_{IO} >> IDENT(high)$_{IO}$ ensures that long high vowels are lowered rather than shortened.)

•Suffix vowels agree in rounding with root vowels of the same height. Side-stepping the interesting but irrevelant questions by raised this process, I will simply assume a constraint RH with the relevant properties,[29] ranked so: IDENT(high)$_{IO}$, RH >> IDENT(round)$_{IO}$. (The ranking IDENT(high)$_{IO}$ >> IDENT(round)$_{IO}$ ensures that suffix vowels harmonize rather than change their height.)

With these rankings in hand, it’s immediately apparent why opacity in Yokuts is problematic for classical OT:

(28) Attempting to Analyze /ʔuːt+hin/ → *ʔothun* Without Sympathy

/ʔuːt+hin/	*[μμμ]$_σ$	LONG/–HIGH	RH	MAX-μ_{IO}	IDENT(high)$_{IO}$	IDENT(round)$_{IO}$
a. ☞ ʔothun				*	¡* !	*
b. ☜ ʔuthun				*		*
c. ☜ ʔothin				*	* !	

(29) Attempting to Analyze /c’uːm+al/ → *c’oːmal* Without Sympathy

/c’uːm+al/	*[μμμ]$_σ$	LONG/–HIGH	RH	MAX-μ_{IO}	IDENT(high)$_{IO}$	IDENT(round)$_{IO}$
a. ☞ c’oːmal			¡ * !		*	
b. ☜ c’oːmol					*	*

Tableau (28) shows that lowering of long high vowels is non-surface-apparent, there being no constraint available to compel (28a)’s violation of the faithfulness constraint IDENT(high)$_{IO}$. Indeed, two candidates, (28b) and (28c), have lesser violations than (28a) and so constitute its transparent competitors. And tableau (29) shows that rounding harmony is non-surface-true, there being no constraint available to compel (29a)’s violation of the markedness constraint RH. We have seen both types of opacity separately, but not together in a single language.

Co-existence of multiple types of opacity presents no difficulties under the premises of §3.4. Each IO faithfulness constraint is in principle capable of selecting its own distinct ❀-candidate, and each sympathetic faithfulness constraint is relativized to that distinction. Two separate sympathy effects are visible in Yokuts:

[29]See Archangeli (1985) and Archangeli & Suzuki (1997) for detailed discussion of Yokuts rounding harmony.

•High vowels lower in sympathy to a candidate that preserves underlying length. Therefore, the ❀-candidate is ! $_{\text{MAX-}\mu}$ (e.g., ❀*ʔoːthin*), and its sympathetic influence is exercised via the ranking ❀IDENT(high)$_{\text{MAX-}\mu}$ >> IDENT(high)$_{\text{IO}}$. This ranking accounts for the non-surface-apparentness of the conditions leading to IDENT(high)$_{\text{IO}}$ violation in forms like *ʔothun*.

•Suffix vowels are round or not in sympathy to a candidate that preserves underlying height. Therefore, the ❀-candidate is ! $_{\text{IDENT(high)}}$ (e.g., ❀*ʔuthun*, ❀*c’uːmal*), and its sympathetic influence is exercised via the ranking ❀IDENT(round)$_{\text{IDENT(high)}}$ >> RH >> IDENT(round)$_{\text{IO}}$. This ranking accounts for the non-surface-trueness of RH in forms like *c’oːmal* and the non-surface-apparentness of the conditions leading to IDENT(round)$_{\text{IO}}$ violation in forms like *ʔothun*.

The following tableaux supply the formal details:

(30) Analyzing /ʔuːt+hin/ → *ʔothun* With Sympathy
[On following page]

(31) Analyzing /c’uːm+al/ → *c’oːmal* With Sympathy
[On following page]

(30) Analyzing /ʔuːt+hin/ → *ʔothun* With Sympathy

	/ʔuːt+hin/	*[μμμ]$_{\sigma}$	LONG/–HIGH	❀IDENT(high)$_{\text{MAX-}\mu}$	❀IDENT(round)$_{\text{IDENT(high)}}$	RH	MAX-μ$_{\text{IO}}$	IDENT(high)$_{\text{IO}}$	IDENT(round)$_{\text{IO}}$
a.	☞ ʔothun						*	*	*
b.	☜, ❀$_{\text{IDENT(high)}}$ ʔuthun			* !			*	✓	*
c.	❀$_{\text{MAX-}\mu}$ ʔoːthin	* !			* !		✓	*	
d.	☜ ʔothin				* !		*	*	
e.	ʔuːthun	* !	* !	* !			✓	✓	*

(31) Analyzing /c'uːm+al/ → *c'oːmal* With Sympathy

	/c'uːm+al/	*[μμμ]$_{\sigma}$	LONG/–HIGH	❀IDENT(high)$_{\text{MAX-}\mu}$	❀IDENT(round)$_{\text{IDENT(high)}}$	RH	MAX-μ$_{\text{IO}}$	IDENT(high)$_{\text{IO}}$	IDENT(round)$_{\text{IO}}$
a.	☞ c'oːmal					*	✓	*	
b.	☜, ❀$_{\text{MAX-}\mu}$ c'oːmol				* !		✓	*	*
c.	❀$_{\text{IDENT(high)}}$ c'uːmal		* !	* !			✓	✓	
d.	c'uːmol		* !	* !	* !		✓	✓	*

In (30), the set of candidates that obey IDENT(high)$_{\text{IO}}$ includes (30b, e). Of these, (30b) ❀$_{\text{IDENT(high)}}$*ʔuthun* is the most harmonic (disregarding, as usual, the sympathetic faithfulness constraints) and is therefore selected as ! $_{\text{IDENT(high)}}$. Similarly, the set of candidates that obey MAX-μ$_{\text{IO}}$ includes (30c, e), with (30c) ❀$_{\text{MAX-μ}}$ʔoː*thin* being the most harmonic. By virtue of the high rank of the sympathetic faithfulness constraints, the actual output must match these candidates in vowel height and rounding. Only (30a) ʔ*othun* does that, and so it is optimal.

In (31), the set of candidates that obey IDENT(high)$_{\text{IO}}$ includes (31c, d). Of these, the faithful candidate (31c) ❀$_{\text{IDENT(high)}}$ *c'uːmal* is the most harmonic (disregarding, as usual, the sympathetic faithfulness constraints in selecting the ❀-candidate) and so it is selected as ! $_{\text{IDENT(high)}}$. All candidates in (31) obey MAX-μ$_{\text{IO}}$; the most harmonic is the transparent competitor (31b) ❀$_{\text{MAX-μ}}$*c'*oː*mol*, again because sympathetic faithfulness constraints are disregarded in the determination of ! $_{\text{F}}$. By virtue of the high rank of the sympathetic faithfulness constraints, the actual output must match these candidates in vowel height and rounding. Only (31a) *c'oːmal* does that, and it is therefore optimal.

Apart from its complexity and use of multiple sources of opacity, the Yokuts case is of particular interest because it shows that ❀-candidates need not be identical to the intermediate stages of serial derivations. Neither ❀$_{\text{IDENT(high)}}$*ʔuthun* nor ❀$_{\text{MAX-μ}}$ʔoː*thin* nor ❀$_{\text{MAX-μ}}$*c'*oː*mol* occurs as the intermediate stage of a serial derivation. Though convergence between the ❀-candidate and the serialist's intermediate stage is a consistent finding with simple opaque interactions (see §4.2 and §4.3), it is neither expected nor observed in situations of multiple opacity. More on this below in §4.4 and §5.

4 Establishing the Generality of the Result

4.1 Introduction

In this section, I turn from the concrete discussion of the earlier parts of this article to a more abstract consideration of the nature of opacity and the role of sympathy. I will begin with Kiparsky's original definition of opacity, which I will attempt to restate in Optimality-Theoretic terms. I will show abstractly which kinds of opaque interactions are problematic for OT and why. I will then show how sympathy resolves these problems.

Kiparsky (1971, 1973a) defines opacity as follows:

(32) Opacity (Kiparsky 1973a: 79)

A phonological rule $\mathcal{P}$ of the form $A \rightarrow B\ /\ C\_\_\_D$ is **opaque** if there are surface structures with any of the following characteristics:

a. instances of A in the environment $C\_\_\_D$.
b. instances of B derived by $\mathcal{P}$ that occur in environments other than $C\_\_\_D$
c. instances of B not derived by $\mathcal{P}$ that occur in the environment $C\_\_\_D$.

Intuitively, the idea is that a rule is opaque if the fact that it has applied (32a) or the conditions of its application (32b) are not visible in surface structure. Additionally (32c), a rule is opaque if it is neutralizing. Our focus here has been and will be on types (32a) and (32b), since type (32c), neutralization, is as unremarkable in OT as it is in rule-based phonology.

4.2 Counter-Bleeding Interactions

We begin with type (32b), which is slightly more straightforward to describe. In rule-based serialism, type (32b) opacity arises when rules apply in counter-bleeding order. Here is a schematic example:

(33) Type (32b) or Counter-Bleeding Opacity

UR	ABC#
B → D /___C	ADC#
C → E /___#	ADE#
SR	ADE#

Here, the later rule wipes out the environment that induced the earlier rule to apply. Had they applied in the opposite order, one rule would have prevented the other from applying — hence the term counter-bleeding. Counter-bleeding interaction leads to non-surface-apparentness, which is invariably problematic for OT's output orientation.

In order to understand serial derivations like these in OT terms, we need a way of translating a rule like A → B / C___D into a ranking of markedness and faithfulness constraints. In real life, a direct translation will rarely be desirable, since it adds no new insight, but for present purposes let us say that the counterpart of A → B / C___D in a constraint hierarchy is the ranking *CAD >> $F_{aith}(A \to B)$.[30] We can then proceed to analyze (33) in detail.

Translating (33) into constraint rankings in the way just described, we can now see abstractly why counter-bleeding opacity is problematic for classic OT:

(34) Counter-Bleeding Opacity: Rankings

*BC >> $F(B \to D)_{IO}$

*C# >> $F(C \to E)_{IO}$

(35) Counter-Bleeding Opacity: Tableau (partially unranked)

		/ABC#/	*BC	$F(B \to D)_{IO}$	*C#	$F(C \to E)_{IO}$
opaque	a.	☞ ADE#		¡ * !		*
transparent	b.	☜ABE#				*

The transparent form (35b) has a subset of the opaque form (35a)'s marks. It follows, then, as a matter of ranking logic that there is no permutation of the as-yet unranked constraints that will cause (35a) to be more harmonic than (35b). (To use Prince & Smolensky's (1993) term, (35b) "harmonically bounds" (35a).) The issue, specifically, is that (35a) is unfaithful in a way that has no apparent surface motivation. The OT account is tripped up by the non-surface-apparentness of the

[30] I assume that F(A→B) is violated if and only if input /A/ corresponds to output *B*. Thus, F(A→B) and F(B→A) are distinct constraints.

conditions compelling the $F(B\to D)_{IO}$ violation. From a surface perspective, the process mapping /BC/ to *BD* has overapplied in (35a).

This argument shows formally what has long been understood informally and anecdotally: that counter-bleeding interactions cannot be modeled in Optimality-Theoretic terms. Classic OT makes the claim that there can be no opacity of this type, since the opaque output can never be optimal. But counter-bleeding opacity is certainly well attested: Tiberian Hebrew (2), Levantine Arabic (6), Dutch (7), and Maltese (8) are all instances of it.

Adding the sympathy relation to OT solves this problem, since it provides a constraint that favors (35a) over (35b) and thus avoids the mark-subset conundrum.

(36) Applying Sympathy to Counter-Bleeding Opacity

		/ABC#/	*BC	❀$F(D\to B)_{F(C\to E)}$	$F(B\to D)_{IO}$	*C#	$F(C\to E)_{IO}$
opaque	a.	☞ ADE#			*		*
transparent	b.	☜ ABE#		* !			*
sympathetic	c.	❀ ADC#			*	* !	✔

The ❀-candidate to which (36a) owes sympathetic allegiance is ❀*ADC#*, which is the most harmonic member of the set of candidates that obey $F(C\to E)_{IO}$. Through candidate-to-candidate correspondence, candidates can be tested for their resemblance to ❀*ADC#*. Here, the relevant cross-candidate sympathetic faithfulness constraint is $F(D\to B)_{F(C\to E)}$, which asserts that the output cannot have a *B* where ! $_{F(C\to E)}$ has a *D*. The transparent candidate (36b) violates $F(D\to B)_{F(C\to E)}$; the violation is fatal because $F(D\to B)_{F(C\to E)}$ dominates the opaque candidate's worst mark, its violation of $F(B\to D)_{IO.}$

Through the sympathy relation, counter-bleeding opacity emerges from the basic ranking/violation texture of OT, without invoking arbitrary strata or similar devices. The conditions leading to violation of $F(B\to D)_{IO}$ are indeed non-surface-apparent, because they are not present in the actual output form. Instead, violation is induced by sympathy to another candidate where the reasons for $F(B\to D)_{IO}$ violation are apparent. Cross-candidate faithfulness has approximately the function of the intermediate derivational stage in the rule-based analysis (33).

4.3 Counter-Feeding Interactions

Now we turn to type (32a) opacity. In serialist terms, this is <u>counter-feeding</u> order, where the later rule would have created the context for the earlier rule (had they been differently ordered). There are two cases to be considered, counter-feeding on the opaque rule's environment (37a) and counter-feeding on the opaque rule's focus (37b):

(37) Type (a) or Counter-Feeding Opacity

a. Counter-Feeding on Environment

UR	ABC
B → D / ___E	*does not apply*
C → E / ___#	ABE

b. Counter-Feeding on Focus

UR	ABC
D → E / A___	*does not apply*
B → D / ___C	ADC

From a surface perspective, it is not apparent why the earlier rule has failed to apply, since its structural conditions seem to be met. The earlier rule, then, states a generalization that is non-surface-true.

We will start with (37b), since it can be set aside as irrelevant to the sympathy notion. What we have in (37b) is a chain shift,[31] where /B/→*D* and /D/→*E*. The opacity lies in /B/'s failure to make a fell swoop all the way to *E*. Translating into OT terms, we have the rankings in (38), which are collected in the tableau (39):

(38) Type (37b) Counter-Feeding Opacity: Rankings

*AD >> F(D→E)

*BC >> F(B→D)

(39) Type (37b) Counter-Feeding Opacity: Tableau (partially unranked)

	/ABC/	*AD >> F(D→E)		*BC >> F(B→D)		F(B→E)
opaque	a. ☞ ADC	*			*	
transparent	b. ☜ AEC					*

In (39) I have shown an additional constraint not included with the rankings in (38): F(B→E). This constraint specifically penalizes the fell swoop from /B/ to *E*.

Understanding the faithfulness penalty for taking the fell swoop is the key to explaining why this type of opacity is unproblematic for OT, as Gnanadesikan (1997) and Kirchner (1996) argue. The ranking is straightforward: if F(B→E) dominates the constraints that (39a) violates, then (39a), the opaque form, will be more harmonic than (39b).[32] The only question, then, is what F(B→E) is.

According to Kirchner, cases like this are to be interpreted in terms of local constraint conjunction. The local conjunction of constraints A and B in domain δ (written $[A\&B]_{\delta}$) is violated

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[31] As schematized, (37b) is a somewhat generalized chain shift. Traditionally, chain shifts involve rules with identical environments, whereas (37b) is generalized to include rules with different environments as well.

[32] In addition, for (39a) to be optimal, it is necessary for *BC to dominate *AD, to rule out the fully faithful candidate *ABC*.

if and only if A and B are both violated within some constituent δ (Smolensky 1993, 1995, 1997).[33] According to Kirchner, the constraint dubbed F(B→E) in (39) is actually the local conjunction of F(D→E) and F(B→D) within the domain of a segment: $[F(D\rightarrow E) \text{ \& } F(B\rightarrow D)]_{Seg}$.

According to Gnanadesikan, cases like this are to be understood in terms of natural phonological scales: *B-D-E*. By the nature of faithfulness on scales, traversing the full length (/B/→*E*) is always less faithful than any individual step. Thus, there are two possible accounts of the chain-shift variety of counter-feeding opacity, due to Gnanadesikan and Kirchner. Neither approach requires the invocation of sympathy.

Sympathy is, however, crucial to dealing with opacity involving counter-feeding on the environment, (37a). (Examples of this type include Bedouin Arabic (3), Sea Dayak (4) and Barrow Inupiaq (9).) As before, we translate the rules into rankings:

(40) Type (37a) Counter-Feeding Opacity: Rankings
*BE >> F(B→D)
*C# >> F(C→E)

(41) Type (37a) Counter-Feeding Opacity: Tableau (partially unranked)

	/ABC#/	*BE >> F(B→D)		*C# >> F(C→E)	
opaque	a. ☞ ABE#	¡ * !			*
transparent	b. ☜ ADE#		*		*

The problem is that the transparent output (41b) has lower-ranking marks than the opaque output (41a). There is no ranking of the as-yet unranked constraints that will yield (41a) as the output, so (41b) sets a harmonic bound on (41a).[34] As in the counter-bleeding case, classic OT cannot obtain the opaque result, since there is no constraint which, through crucial domination of *BE, can explain *BE's non-surface-trueness. From a surface perspective, the process mapping /BE/ to *DE* has underapplied in (41a).

Hayes (personal communication) suggests that the problem with (41) can be solved by generalizing Kirchner's approach to chain shifts. Observe that the transparent candidate (41b) violates both of the faithfulness constraints. Under strict domination, this multiplicity of faithfulness violations is of no consequence, because both faithfulness constraints are low-ranking. But it is possible to make formal sense of (41b)'s excessive unfaithfulness by creating a third faithfulness constraint that is the local conjunction of the two low-ranking ones, $[F(B\rightarrow D) \text{ \& } F(C\rightarrow E)]_{\delta}$. Ranked above *BE, this conjoint constraint accounts for *BE's non-surface-trueness, favoring the opaque candidate over the transparent one. Importantly, the unconjoined constraint F(B→D) is still ranked below *BE, just as

[33]For other views and applications of constraint conjunction, see Alderete (1997a), Crowhurst (to appear), Crowhurst & Hewitt (1997), Downing (to appear), Hewitt & Crowhurst (1996), Itô & Mester (1996), Kirchner (1996) and Łubowicz (to appear).

[34]To get (41a) as output, it is also necessary to rank *C# above *BE. But that additional ranking is not sufficient to ensure (41a)'s triumph over (41b), and so the opacity problem remains.

in (41), so the language will correctly map /BE/ onto *DE* in situations where F(C→E) isn't also being violated. Thus, the normal transparent behavior of the two processes is not affected in forms where they do not interact.

This idea initially seems promising, but it has a fatal flaw. The problem is that local conjunction of constraints is not an adequate theory of process interaction, but process interaction is a crucial element of opacity. There is no interaction, and hence no possibility of an opacity effect, if two processes apply in distant loci within a single word. For instance, the high-ranking conjoint constraint [F(B→D) & F(C→E)]$_{\delta}$ must not rule out the mapping /BEXYZC/ → <u>*D*</u>*EXYZ*<u>*E*</u>, with two non-interacting faithfulness violations, though it correctly rules out the mapping /ABC#/ → *A*<u>*DE*</u>*#*, where the faithfulness violations interact. The domain argument δ is the only mechanism available to make this distinction, but it cannot solve the problem of counter-feeding relations in the general case. The problem is that, in order to work, δ must exactly match the domain in which the two processes interact. But the notion "domain in which two (arbitrary) processes interact" has no formal status in OT or any other theory, nor can it, since it can only be determined on a post-hoc case-by-case basis, by trying to apply the processes to a particular form.. This seems like an insuperable problem for a general local-conjunction approach to counter-feeding opacity.

We must therefore turn once again to the sympathy relation if we are to have a satisfactory account of counter-feeding opacity in OT.

(42) Applying Sympathy to Type (37a) Counter-Feeding Opacity

/ABC#/		❀F(B→D)$_{F(C\rightarrow E)}$ >> *BE >> F(B→D)$_{IO}$			*C# >> F(C→E)$_{IO}$	
opaque	a. ☞ ABE#		*			*
transparent	b. ☜ ADE#	* !		*		*
sympathetic	c. ❀ ABC#				* !	✓

The form exercising sympathetic influence on the outcome is (42c) ❀*ABC#*. It is ! $_{F(C\rightarrow E)}$, that is, the most harmonic member of the set of candidates that obey F(C→E). The sympathetic, cross-candidate faithfulness constraint ❀F(B→D)$_{F(C\rightarrow E)}$ evaluates resemblance to ❀*ABC#*. And according to this constraint, the opaque output *ABE* resembles ❀*ABC#* more than transparent *ADE#* does. In short, ❀F(B→D)$_{F(C\rightarrow E)}$ is responsible for the success of the opaque candidate and the consequent non-surface-trueness of *BE.

To complete the picture, it is necessary to show that sympathy has no untoward effects on situations of transparency, where there is no interaction between the processes. In particular, consider the mapping /ABE#/ → *ADE#*, where only one process is relevant. With input /ABE#/, then ! $_{F(C\rightarrow E)}$ is ❀*ADE#* — the same as the output. Since this is the same as the output form, ❀F(B→D)$_{F(C\rightarrow E)}$ has no effect, as the following tableau shows:

(43) A Transparent Situation in a System with Sympathy

/ABE#/	F(B→D)$_{F(C→E)}$ >> *BE >> F(B→D)$_{IO}$			*C# >> F(C→E)$_{IO}$	
a. ☞, ❀ ADE#			*		✔
b. ABE#		* !			✔

Hence, sympathy does not block the /B/→*D* mapping generally. Rather, blocking is limited to the situations of true opacity, where there is interaction with the mapping /C/→*E*.

The treatment of counter-feeding opacity shows that, under particular circumstances, the ❀-candidate may coincide with the underlying or surface representation. When the ❀-candidate is identical to the underlying form, as in (42), the ❀-faithfulness constraint becomes a kind of ersatz IO faithfulness constraint, producing the same evaluation marks but potentially at a different point in the hierarchy. When the ❀-candidate is the same as what the surface form would be without ❀-faithfulness, as in (43), then the ❀-candidate and the actual output will be identical, and not merely similar, so ❀-faithfulness is satisfied without further ado.

Considerations like these are relevant to concerns about the restrictiveness of sympathy theory.[35] The objection goes something like this: there are many faithfulness constraints, so there are many potential ❀-candidates; there are also many ❀-faithfulness constraints on each of those candidates; so the inevitable result is a combinatoric explosion under factorial typology. There is no real basis for this concern, though, because the combinatoric possibilities are limited in two ways.

First, although there are many faithfulness constraints, most are undominated in any given language (else every word would turn into *ba*, as someone has observed). If a faithfulness constraint F is undominated, then the ❀-candidate that F selects is identical to the actual output form, because the ☞-candidate is in the F-obeying subset of the candidates. It follows, then, that almost all faithfulness constraints select a ❀-candidate that is the same as the actual output form — a logically possible but empirically vacuous exercise. Situations of opacity in any given language involve selection of a ❀-candidate by one of the rare faithfulness constraints that are crucially dominated.

Second, though there are many ways to demand similarity to the ❀-candidate by invoking different ❀-faithfulness constraints, most will be obeyed equally by all plausible candidates. That's because the ❀-candidate is selected by the same constraint hierarchy that evaluates the whole candidate set, and so a considerable degree of convergence is expected. Situations of opacity in any given language involve those nuanced respects in which the ❀-candidate differs from other highly-evaluated candidates, so ❀-faithfulness can exercise a decisive role in choosing among them. There is no combinatoric explosion because the number of ❀-candidates and the number of ways to be faithful to them are both in practice modest.

[35]Thanks to an audience at MIT for bringing up many of these issues.

4.4 Multiple Interactions[36]

Thus far, general results have been provided for systems with exactly two interacting processes, and a specific case with three interacting processes, Yokuts, was also analyzed. But I have not yet tried to address the general problem of what happens in a system where more than two processes interact opaquely in a single input→output mapping.

Below in §5 I show that certain kinds of multi-process interactions cannot be analyzed with sympathy. For now, though, we will look at some cases which can be accommodated within the model. The key idea (from §3.3) is that each IO faithfulness constraint is in principle capable of selecting its own distinct ❀-candidate, and each sympathetic faithfulness constraint is relativized to that distinction. Hence, there is no difficulty with co-existence of multiple sympathetic influences on a single output form.

The results presented here are suggestive, but not fully conclusive. It seems likely that serialism offers possibilities for interaction beyond those considered here. Unfortunately, research within the serialist framework has not yet reached the point where it is possible to say once and for all what the interactional possibilities are. (Indeed, Pullum's (1976) work on Duke-of-York derivations is a rare instance where the general properties of derivations longer than two rules have been contemplated.) Therefore, further study of serialism itself must be a prerequisite to better understanding of those areas where serialism and sympathy converge or diverge.

Focusing on serialism for the moment, consider a language with just three rules, R1, R2, and R3, which apply in that order. The logical possibilities for multiply opaque interaction are these:

(44) Opacity in Three-Rule Systems
- a. Counter-bleeding→Counter-bleeding
  - R1 counter-bleeds R2; R2 counter-bleeds R3
- b. Counter-feeding→Counter-bleeding
  - R1 counter-feeds R2; R2 counter-bleeds R3
- c. Counter-feeding→Counter-feeding
  - R1 counter-feeds R2; R2 counter-feeds R3
- d. Counter-bleeding→Counter-feeding
  - R1 counter-bleeds R2; R2 counter-feeds R3

Case (44a), counter-bleeding→counter-bleeding, is what we see in Yokuts ʔ*othun* (27). I do not have ready examples of cases (44b) and (44c), but I see no reason why they should not exist. On the other hand, case (44d) isn't something that can ever be observed in a single derivation because it involves a contradiction: if R1 counter-bleeds R2, then R2 applies; but if R2 counter-feeds R3, then R2 doesn't apply. There is, then, no point in discussing this case further.

I will begin with (44a), a succession of two interacting counter-bleeding orders. Here is a hypothetical case:

[36] I am particularly grateful to Alan Prince for discussion of the issues addressed in this section.

(45) Counter-Bleeding → Counter-Bleeding Opacity

		UR	ABC#
	a.	A → Z /___B	ZBC#
	b.	B → D /___C	ZDC#
	c.	C → E /___#	ZDE#

Rule (45a) is rendered opaque (non-surface-apparent) by rule (45b), which is itself rendered opaque (likewise non-surface-apparent) by rule (45c). Thus, the conditions that lead to rule (45a)'s application and the conditions that lead to its being non-surface-apparent are both hidden from surface inspection.

Turning to OT, we first make the translation of the rules in (45) into constraint interactions:

(46) Rules in (45) as Interacting Constraints

a. *AB >> F(A→Z)
b. *BC >> F(B→D)
c. *C# >> F(C→E)

Then we assemble these constraints into a partially-ranked tableau:

(47) Counter-Bleeding → Counter-Bleeding Opacity

		/ABC#/	*AB	$F(A\to Z)_{IO}$	*BC	$F(B\to D)_{IO}$	*C#	$F(C\to E)_{IO}$
opaque	a.	☞ ZDE#		¡ * !		¡ * !		*
transparent	b.	☜ ZBE#		*				*
transparent	c.	☜ ADE#				*		*

In multi-process counter-bleeding situations like this, a candidate is transparent if it avoids violation of the markedness constraints and is more faithful than the actual output. Here, the intended output *ZDE#* violates both $F(A\to Z)_{IO}$ and $F(B\to D)_{IO}$, but its transparent competitors show that it is possible to satisfy *both* *AB and *BC by changing *either* /A/ *or* /B/. The conditions leading to violation of both faithfulness constraints together are non-surface-apparent, as usual in counter-bleeding opacity.

The existence of two transparent competitors does not challenge sympathy theory; indeed, this case is little different from the Yokuts example in (30). What compels (47a)'s violation of $F(A\to Z)_{IO}$? If (47a) is to beat (47c), (47a) must be sympathetic to a ❀-candidate where the /A/ → *Z* mapping occurs transparently — and since *AB forces that mapping, this means we need to find a candidate which preserves underlying /B/ by obedience to $F(B\to D)_{IO}$. The ❀-candidate is, then, ! $_{F(B\to D).}$ Similarly, if (47a) is to beat (47b), (47a) must be sympathetic to a ❀-candidate where the /B/→*D* mapping occurs transparently — and that candidate is ❀*ADE#*, which is ! $_{F(A\to Z)}$. The remaining details are provided in the following tableau:

(48) Applying Sympathy to Counter-Bleeding → Counter-Bleeding Opacity

/ABC#/	*AB	❀F(Z→A)$_{\text{F(B→D)}}$	F(A→Z)$_{\text{IO}}$	*BC	❀F(D→B)$_{\text{F(A→Z)}}$	F(B→D)$_{\text{IO}}$
a. ☞ ZDE#			*			*
b. ❀$_{\text{F(B→D)}}$ ZBE#			*		* !	✓
c. ❀$_{\text{F(A→Z)}}$ ADE#		* !	✓			*

Sympathy to (48a)'s transparent competitor (48b) explains why (48a) is more harmonic than its other transparent competitor (48c). Likewise, sympathy to (48c) explains why (48a) is more harmonic than (48b). Therefore, sympathy can replicate the effects of nested counter-bleeding orders like (45).

This result is significant, since it shows that sympathy can contend with crucial interactions of more than two processes. It also shows that the ❀-candidate need not be identical to the intermediate stage of a serial derivation. Neither of the ❀-candidates in (48) appears in course of the serial derivation.

Next we examine case (44b), in which a counter-feeding order is followed by a counter-bleeding order:

(49) Counter-Feeding → Counter-Bleeding Opacity

	UR	ABC#
a.	A → Z /___D	*does not apply*
b.	B → D /___C	ADC#
c.	C → E /___#	ADE#

The generalization expressed by rule (49a) is non-surface-true because its contextual conditions are not met until after it has applied. As above, the conditions the led to application of (49b) are non-surface-apparent because of the subsequent application of (49c).

Proceeding in the familiar way, we obtain the rankings in (50) and the tableau in (51):

(50) Rules in (49) as Interacting Constraints

a. *AD >> F(A→Z)
b. *BC >> F(B→D)
c. *C# >> F(C→E)

(51) Counter-Feeding → Counter-Bleeding Opacity

	/ABC#/	*AD	F(A→Z)$_{\text{IO}}$	*BC	F(B→D)$_{\text{IO}}$	*C#	F(C→E)$_{\text{IO}}$
opaque	a. ☞ ADE#	¡ * !			¡ * !		*
transparent	b. ☜ ABE#						*
transparent	c. ☜ ZDE#		*		*		*

Form (51b) could be described as doubly transparent: it avoids both (51a)'s violation of *AD (non-surface-true or counter-feeding opacity) and its violation of $F(B{\rightarrow}D)_{IO}$ (non-surface-apparent or counter-bleeding opacity). Another, singly transparent candidate is *ZDE#*, which incurs the full suite of low-ranking faithfulness violations but dodges the *AD bullet.

To account for (51a)'s violation of *AD, it must be sympathetic to a candidate which preserves underlying /B/ (thereby satisfying *AD). That candidate is ! $_{F(B\rightarrow D)}$, which is ❀*ABE#*. And to account for (51a)'s violation of $F(B{\rightarrow}D)_{IO}$, it must be sympathetic to a candidate which preserves underlying /C/ (thereby transparently motivating the $F(B{\rightarrow}D)_{IO}$ violation). That candidate is ! $_{F(C\rightarrow E)}$, which is ❀*ZDC#*. The following tableau assembles the relevant parts of the analysis:

(52) Applying Sympathy to Counter-Feeding → Counter-Bleeding Opacity

/ABC#/	❀$F(A{\rightarrow}Z)_{F(B\rightarrow D)}$	*AD	$F(A{\rightarrow}Z)_{IO}$	*BC	$F(D{\rightarrow}B)_{F(C\rightarrow E)}$	$F(B{\rightarrow}D)_{IO}$	*C#	$F(C{\rightarrow}E)_{IO}$
a. ☞ ADE#		*				*		*
b. ❀$_{F(B\rightarrow D)}$ ABE#					* !	✓		*
c. ZDE#	*!		*			*		*
d. ❀$_{F(C\rightarrow E)}$ ZDC#	*!		*			*	* !	✓

As in the previous case, the ❀-candidates are not identical to the intermediate stages of the equivalent serial derivation. A final detail, not evident from (52), is that the sympathetic faithfulness constraint $F(D{\rightarrow}B)_{F(C\rightarrow E)}$ must also dominate the markedness constraint *AD to ensure that the transparent candidate ❀*ABE#* is not optimal.

The last three-process interaction to consider is (44c), in which one counter-feeding order is followed by another. Here is a hypothetical case:

(53) Counter-Feeding → Counter-Feeding Opacity

	UR	ABC#
a.	A → Z /___D	*does not apply*
b.	B → D /___E	*does not apply*
c.	C → E /___#	ABE#

The generalization expressed by the second rule, (53b), is non-surface-true, as usual in counter-feeding situations. But the generalization expressed by the first rule, (53a), *is* surface-true, since no *AD* sequences occur on the surface. This means that there is no double opacity and therefore no double sympathy in this example. It requires no further discussion, since the only interesting interaction, that between (53b) and (53c), is straightforwardly analyzed like any other counter-feeding case (see §4.3).

In summary, this section has examined a range of three-process opaque interactions. Some turned out to be irrelevant or otherwise unproblematic (44c, d). The others showed in abstract way what we had already seen concretely in Yokuts: that counter-bleeding→counter-bleeding (44a) and counter-feeding→counter-bleeding (44b) interactions are readily accommodated, given the possibility, inherent in the basic sympathy idea, that there can be multiple ❀-candidates acting on a single output form. This work, then, suggests that sympathy can simulate the interactional possibilities afforded by serialism (though see §5). More conclusive results must await fuller study of multi-rule interaction in serialism, a neglected area of research.

A further point of interest that emerged here (and in Yokuts) is that the ❀-candidates relevant to three-process interaction are not the same as the intermediate stages of the equivalent serial derivations. It seems that it is neither necessary nor possible, in the general case, to find ❀-candidates that are identical to serialism's intermediate stages. The argument that it is not necessary has been the burden of this section; to see why it is not possible, consider the following case. In the serial derivation (45), *ZBC#* is the earliest intermediate stage. Considered as a candidate, it is not the most harmonic member of the set obeying any single faithfulness constraint. Rather, it is the most harmonic member of the set of candidates that obey *two* faithfulness constraints together. That is, it is ! $_{\kappa}$, where κ=[F(B→D)&F(C→E)]$_{\delta}$, the local conjunction (in Smolensky's sense) of F(B→D) and F(C→E) within the domain δ.[37] The problem: depending on the substantive details of the particular case being analyzed, δ may not be a coherent "domain" at all, since it is simply the span within which two phonological processes happen to interact. Thus, this application of local conjunction encounters the same difficulties as the failed account of counter-feeding opacity that was rejected in §4.3.

4.5 Summary

I have examined the Kiparsky (1973a) definition of opacity and I have discussed its import for OT. One type of opacity in Kiparsky's sense, neutralization, was dismissed from further consideration, since it presents no special difficulties for OT. Another type, counter-feeding on the focus, is identified with chain-shifts, which have been successfully analyzed within the faithfulness component of OT. Two other species of opacity, counter-feeding on the environment and counter-bleeding, can also be analyzed in faithfulness terms if faithfulness is extended to the sympathy relation. In counter-bleeding opacity, the conditions leading to violation of an IO faithfulness constraint are non-surface-apparent. Sympathy provides those conditions by relating the output to a failed candidate in which the conditions of violation are apparent. In counter-feeding opacity, a markedness constraint is non-surface-true. Sympathy connects the output with a failed candidate where violation of the markedness constraint is motivated. The basic elements of OT, ranking and violation, are the essentials of these explanations, which moreover strongly parallel accounts of reduplicative and "cyclic" over- and underapplication in the literature.

5 The Duke-of-York Gambit

There are situations of opacity that cannot be analyzed in terms of sympathy, though they can be readily analyzed serially. These are cases of the Duke-of-York gambit (Pullum 1976), where two phonological processes are ordered so that one undoes the effect of the other. Of course, merely undoing what an earlier rule has done is a uninteresting exercise empirically, so in any analysis where

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[37]Thanks to Alan Prince for suggesting that I look at ❀-candidate designation by conjoined faithfulness constraints.

the gambit is crucially employed, some other rule applies at the intermediate stage between the contradictory processes..[38]

Two types of Duke-of-York derivations can be identified, depending on what happens at the intermediate stage of the derivation:

(54) Duke-of-York Gambit: Feeding Type

α→β→α, with β conditioning an alternation at the intermediate stage

	UR	ABC
a.	B→D/__C	ADC
b.	A→E/__D	EDC
c.	D→B/E__	EBC
	SR	EBC

(55) Duke-of-York Gambit: Bleeding Type

α→β→α, with β waiting out an alternation at the intermediate stage

	UR	ABC
a.	B→D/__C	ADC
b.	B→Z/A__	*does not apply*
c.	D→B/A__	ABC
	SR	ABC

In Duke-of-York derivations of the feeding type, rule (54a) applies in order to create the conditions for rule (54b), and then the effect of (54a) is undone by a third rule, (54c). As a result, both of the earlier rules (54a, b) are opaque — (54a) is non-surface-true and (54b) is non-surface-apparent. In Duke-of-York derivations of the bleeding type, rule (55a) applies in order to allow certain forms to escape the effects of rule (55b) (which is independently motivated), and then the effect of (55a) is undone by a third rule, (55c). As a result, both of the earlier rules (55a, b) are opaque by virtue of being non-surface-true.

A Duke-of-York analysis is an impossibility in classic OT.[39] The Duke-of-York exercise is simply pointless — the mapping /B/→D→*B* simply reduces to the faithful mapping /B/→*B*, and so there is no way to simulate the effects of (54) and (55). With sympathy, the basic picture does not change. For sympathy purposes, the interesting candidates are those that match intermediate stages of the serial derivation: *EDC* in (54) and *ADC* in (55). The problem: the intermediate form *EDC* in (54) is less faithful to the input /ABC/ than the actual output *EBC* is, and likewise, *mutatis mutandis*, for (55). Since the ❀-candidate is the most harmonic member of the class obeying some IO faithfulness constraint, no candidate can achieve ❀ status unless it obeys some faithfulness constraint that the

[38] Halle & Idsardi (1997) propose to disallow certain types of Duke-of-York derivations by redefining the Elsewhere Condition (on which see Baković 1998). They evidently retain Kiparsky's (1973b) assumption that the EC is applicable only to rules that are ordered adjacently in the serial derivation. It follows, then, that the (revised) EC is relevant only to Duke-of-York derivations where the contradictory rules apply one right after the other. But any empirical consequences of Duke-of-York derivations will be evident only if some third rule applies at the intermediate stage between the two contradictory rules.

[39] This result was suggested to me by Moreton's (1996) argument that circular chain shifts — such as /A/→*B* and /B/→*A* — are impossible in classic OT. The core of the argument is that violation of faithfulness must always lead to improved markednss, but changing A to B and changing B to A cannot both lead to markedness improvement.

actual output violates. Therefore, *EDC* in (54) and *ADC* in (55) can never be selected as ❀-candidates, and so they can never have a sympathetic influence on the outcome.

What we have here, then, is a clear difference between the predictions of serialism and OT with sympathy. It is worth asking what the empirical situation is and whether putative Duke-of-York cases can be reanalyzed in a way that is consistent with the predictions of sympathy theory.

Real examples of this type are not exactly thick on the ground, but a few reasonably plausible cases can be found in the literature. One feeding-type Duke-of-York derivation comes from the analysis of Bedouin Hijazi Arabic in Al-Mozainy (1981) and Al-Mozainy *et al.* (1985):

(56) Bedouin Hijazi Arabic

UR	/ʔakal-at/	cf.	/ʔinkasar+at/	/kasar+at/
a. Stress	(ʔáka)$_{Ft}$ lat		ʔin(kása)$_{Ft}$ rat	(kása)$_{Ft}$ rat
b. Deletion	(ʔka)$_{Ft}$ lat		ʔin(ksa)$_{Ft}$ rat	(ksa)$_{Ft}$ rat
c. Stress Shift	(ʔká)$_{Ft}$ lat		ʔin(ksá)$_{Ft}$ rat	(ksá)$_{Ft}$ rat
d. Epenthesis	(ʔaká)$_{Ft}$ lat		*does not apply*	*does not apply*
	‘she ate’		‘it (f.) got broken’	‘she broke (s.t.)’

In this analysis, stress is assigned in accordance with the Latin pattern: a final trochaic foot, modulo final syllable extrametricality. There is a general process deleting the vowel of a light syllable that is followed by a non-final light syllable (56b). When the stressed vowel deletes, its stress is shifted onto the remaining syllable within the foot (56c). When deletion produces an unpronounceable initial ʔC cluster, however, epenthesis applies to undo it (56d) — but the effect of deletion is still seen indirectly because the stress has been shifted.

This example is reanalyzed in McCarthy (1993). The key idea, due to Hayes (1995), is that the stress system is actually left-to-right iambic, not right-to-left trochaic. (Final syllables are extrametrical either way.) The derivation of *(ksá)rat* or *(ʔaká)lat* is then completely transparent, with the former showing stress on the only non-final syllable and the latter showing expected iambic stress. There is no epenthesis in *(ʔaká)lat*; rather, the constraint barring initial ʔC clusters simply dominates the constraint responsible for deletion in *(ksá)rat*. The only complication is the opacity of the stress in ʔ*in(ksá)rat* (cf. transparent **(ʔín)ksarat*). The responsible ❀-candidate is ❀ʔ*in(kasá)rat*, which is ! MAX-V. No Duke-of-York derivation is necessary or desirable; all the significant regularities can be obtained from transparent interactions or by applying sympathy in the familiar way.

Another example of the feeding type comes from Prince’s (1975) analysis of Tiberian Hebrew.[40] Prefixed non-finite verb forms systematically differ in whether or not the second consonant of the root undergoes post-vocalic spirantization: [bixθ̲ōβ] ‘when writing’ vs. [lixt̲ōβ] ‘to write’. Prince proposes that the stem in both cases is /ktob/, with a difference in junctural strength between prepositional /ba/ and infinitival /la/ (a distinction that is certainly plausible on morphosyntactic grounds). Updating Prince’s analysis to reflect the assumptions of Lexical Phonology, we have something like this:

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[40]Thanks to Morris Halle and Harry van der Hulst for bringing up this example. Compare Idsardi (1998) for an approach to these alternations based on different assumptions about the underlying representation.

(57) Tiberian Hebrew[41]

Stratum I			
	Underlying	/ktob/	/ktob/
	Morphology	*none*	la-ktob
	Syllabification	k.tob	lak.tob
	ə Epenthesis	kə.tob	*does not apply*
	Spirantization	kə.θoβ	lax.toβ
Stratum II			
	Morphology	ba-kəθoβ	*no change*
	Syllabification	ba.kə.θoβ	*no change*
	Spirantization	ba.xə.θoβ	*no change*
	ə Deletion	bax.θoβ	*does not apply*
Other rules		bixθōβ	lixtōβ

Because /la/ is added in Stratum I, nothing interesting happens in the derivation of [lixtōβ]. But because /ba/ isn't added until Stratum II, syllabification and ə epenthesis get to apply on Stratum I to produce the stem [kə.tob]. When /ba/ is eventually added, the ə is superfluous, and it deletes, but it leaves a trace in the following spirant.

This kind of serial derivation immediately suggests how to approach these data in OT: OO faithfulness (§2). OO faithfulness is precisely a theory of stratal or cyclic effects, attributing them to faithfulness of a word to the output form of the word it is derived from. The base of [bixθōβ] is the free-standing word [kəθōβ] 'writing', and the spirants of the base are carried over to the derived word regardless of whether they are in the proper post-vocalic context. Thus, IDENT$_{OO}$(+cont) must be high-ranking. The difference in junctural strength between /ba/ and /la/ is interpreted in terms of distinct OO correspondence relations (paralleling the English Level 2/Level 1 distinction — see Benua (1997)); only the OO relation induced by /ba/ and similar clitic-like prefixes induces the correspondence relation associated with the high-ranking IDENT constraint.[42]

An example of the bleeding type can be found in James Harris's (1993) analysis of Catalan devoicing/spirantization interactions:

(58) Catalan

From lexical stratum	sub.lu.nar
Devoicing	sup.lu.nar
Spirantization	*does not apply*
Voicing Assimilation	sub.lu.nar

As a result of events in the lexical phonology, the form *sub.lu.nar* is syllabified as shown. The Duke-of-York derivation accounts for why the coda *b* does not undergo a general process spirantizing

[41]Here I assume that Spirantization applies on both strata. This assumption is not crucial to the present case, but see Malone (1993) for evidence that Spirantization is a "persistent" rule.

[42]Sympathy is also involved in Tiberian Hebrew spirantization, as shown by counter-bleeding mappings like /katabū/ → [kāθβ̱ū].

voiced stops after continuants (including vowels). Harris proposes that coda devoicing applies prior to spirantization, bleeding it, but then voicing assimilation from onset to coda restores the *b*.

A couple of alternative approaches are possible. One, which is implicit in Merchant's (1997) analysis, is to reinterpret the Duke-of-York $\alpha \rightarrow \beta \rightarrow \alpha$ schema as $\alpha \rightarrow \beta \rightarrow \gamma$, where α and γ are phonetically identical but structurally different. Specifically, output *sublunar* has a single [+voice] specification shared by the *bl* cluster, but input /sublunar/ does not. This move permits a sympathy analysis to go through, and that is exactly what Merchant provides.

Another alternative does not involve opacity at all. The point of the Duke of York derivation is to use devoicing to explain non-spirantization of coda *b* — without producing surface *p*. But this could also be seen as a blocking effect due to constraint domination. A universal constraint prohibiting coda fricatives can be documented in several unrelated languages: Korean, Kiowa (Zec 1995: 111–2), and Nancowry (Alderete *et al.* 1997). This constraint, through crucial domination of the constraint responsible for spirantization, provides a line of analysis for (58) that has nothing to do with devoicing.

Brief examination of these three putative cases of Duke-of-York derivations suggests that all can be reanalyzed within OT in equally (if not more) insightful ways. That result is significant, because the Duke-of-York derivation is an important type of opaque interaction that, while readily comprehensible in serialist terms, cannot be replicated in OT (without or with sympathy). If these results hold up under further scrutiny, then the absence of convincing cases of true Duke-of-York derivations is a serious liability of serialism and a significant advantage of OT and sympathy.

6 Conclusion

In this article, I have addressed the issue of phonological opacity within Optimality Theory. I have shown exactly why opacity is problematic for OT, and I have proposed a novel theory of opacity based on the central OT ideas of harmonic evaluation and constraint ranking and violation. Examples of counter-bleeding, counter-feeding, and multiple opacity were analyzed and general results about these different types of opacity were presented. Comparisons with the mechanisms and predictions of serialism were made throughout, with a point of particular interest being the significant divergence between serialism and sympathy on Duke-of-York derivations.

Needless to say, the questions and possibilities raised by this proposal have not been treated exhaustively. There are important questions about the criteria for selecting ❀-candidates and the relationship between sympathy and output-output faithfulness. And there are possible applications of sympathy to phenomena like reduplication, compensatory lengthening, and coalescence. I will conclude by saying a little about these topics.[43]

The results in this article have been developed under the assumption that only IO faithfulness constraints can act as selectors for ❀-candidates. But Itô & Mester (1997a) and de Lacy (1998) present examples (German truncation and Cairene Arabic stress "conflation", respectively) where the

[43]I am grateful to Eric Baković, Laura Benua, Trisha Causley, Stuart Davis, Paul de Lacy, Junko Itô, Chuck Kisseberth, Armin Mester, Joe Pater, Alan Prince, and Sam Rosenthall for discussion of these issues.

❀-selector is a markedness constraint on syllable or foot alignment. They also note that considerations of symmetry favor extending to markedness constraints the privilege of selecting ❀-candidates. On the other hand, the results about Duke-of-York derivations in §5 do not survive if markedness constraints are permitted to select ❀-candidates. More generally, while we now have some broad understanding of the typological consequences of allowing faithfulness constraints to select ❀-candidates (§4), we have no comparable grasp on the effect of extending this to markedness constraints. Undoubtedly this is a question that future research should focus on.[44]

Equally important questions arise about trade-offs between sympathy and approaches based on OO faithfulness. Benua (1997), Itô & Mester (1997a), Karvonen & Sherman (1997), and §2 above show that there are opacity phenomena that cannot be subsumed under OO faithfulness; Itô & Mester go on to suggest that all proper functions of OO faithfulness can be subsumed under sympathy theory. Certainly there is overlap: the Dutch example (7) is analyzable in OO terms[45] but can also be analyzed with sympathy, using the constraint ANCHOR(Stem, σ, Final) as the ❀-selector (see (12)). Dutch is an instance of a prosodic closure effect, where a morphologically complex form shows phonological behavior attributable to the syllabification of the corresponding simplex form. In general, prosodic closure effects can be analyzed equally well by OO faithfulness or by sympathy with an anchoring constraint as ❀-selector. Therefore, decisive evidence in support of OO faithfulness must come from cases of "cyclic" behavior that do not involve prosodic closure. Some possible examples: Belfast dentalization (John Harris 1990, Borowsky 1993, Benua 1997), Arabic stress and syncope (Kager to appear).

Other questions that arise are less central to sympathy but no less interesting. McCarthy & Prince (1995) argue that reduplicative copying of the input, rather than the output, shows the need for an input-reduplicant correspondence relation, as in Klamath /RED+mbody'+dk/ → *mbo–mpditk* 'wrinkled up (dist.)'. Sympathy provides an alternative — sympathetic influence on the form of the reduplicant by the ❀-candidate *mbo–mboditk*, which is ! $_{\text{MAX-V}}$ — that may supplant input-reduplicant correspondence entirely. The problem of compensatory lengthening in OT, first addressed in the PARSE/FILL model by Zec (1993), can be resolved through sympathy to the moraic structure of the ❀-candidate ! $_{\text{MAX-C}}$, which preserves input consonantism. Finally, the whole matter of coalescence bears re-examination. As I noted in §2, segmental merger has often been proposed as a solution to opacity in cases like French /vin/ → *vɛ̃*, where there is assimilation to a deleted segment. Under sympathy theory, it is possible to analyze these cases as literal assimilation, through sympathy to a ❀-candidate that is ! $_{\text{MAX}}$. With sympathy, then, "coalescence" is tied directly to the theory of assimilation, with the possibility of developing distinct predictions from segmental-merger approaches.

Finally, it is worth mentioning again that even serialism, a theory with a long history, is in need of further study. There has been little research on multi-process interaction in serialism, and so the comparative results for OT in §4.4 are of a very preliminary character. It is significant that the questions raised in a new theory force re-examination of a familiar theory, shedding light on areas that might have seemed to have nothing new to offer.

[44]The case of Ponapean, as analyzed by Davis (1997a, b), falls somewhere in between, since a BR faithfulness constraint selects the ❀-candidate.

[45]But see Peperkamp (1997) on the Dutch case.

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