Phonology **16** (1999) 331–399. Printed in the United Kingdom

*Sympathy and phonological opacity**

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1 Statement of the problem

A central idea in rule-based phonology is the SERIAL DERIVATION (Chomsky & Halle 1968). In a serial derivation, an underlying form passes through a number of intermediate representations on its way to the surface:

(1) *Serial derivation*

$$\begin{array}{c} \text{underlying representation} = \text{UR} \\ \downarrow \\ \text{UR transformed by rule 1} = \text{output}_1 \\ \downarrow \\ \text{output}_1 \text{ transformed by rule 2} = \text{output}_2 \\ \downarrow \\ \ldots \\ \text{output}_{n-1} \text{ transformed by rule } n = \text{surface representation} \end{array}$$

* This work was supported by the National Science Foundation under grant SBR-9420424. Versions of it were presented at MIT (April 1997), The Hopkins Optimality Workshop/Maryland Mayfest '97 (May 1997), the LSA Linguistic Institute (July 1997), the University of Amsterdam (September 1997), Ohio State University (October 1997) and UT Austin (November 1997). I acknowledge with particular gratitude the comments of Alan Prince; they helped to shape this work in significant ways. I have also received valuable feedback from (at UMass) John Alderete, Patrik Bye, Katy Carlson, Paul de Lacy, Diamandis Gafos, André Isaak, Caroline Jones, Young-Seok Kim, Greg Lamontagne, Ania Łubowicz, Elliott Moreton and Jen Smith; (at MIT) Jonathan Bobaljik, Morris Halle, James Harris, Michael Kenstowicz, David Pesetsky, Philippe Schlenker and Cheryl Zoll; (at HOT/MM '97) Eric Baković, Jill Beckman, Laura Benua, Ellen Broselow, Luigi Burzio, Nick Clements, Stuart Davis, Jason Eisner, Edward Flemming, Sharon Inkelas, Junko Itô, Dan Karvonen, Robert Kirchner, Armin Mester, Joe Pater, Adam Sherman [Ussishkin] and Paul Smolensky; (at the Linguistic Institute) Toni Borowsky, Mark Harvey, Bruce Hayes, Marzena Rochoń, Jin-Young Tak and Draga Zec; (at the University of Amsterdam) Harry van der Hulst, Helga Humbert, Claartje Levelt, Sharon Peperkamp, Nancy Ritter, Norval Smith and Laura Walsh Dickey; (at OSU) Mary Beckman, Brian Joseph, Beth Hume, David Odden and Sam Rosenthall; (at UT) Bob Harms and Scott Myers; and Trisha Causley, Elan Dresher, Paul Kiparsky, Chuck Kisseberth and Colin Wilson. I also wish to acknowledge the assistance of Ellen Kaisse, two anonymous reviewers and especially the anonymous associate editor, whose detailed, thoughtful and supportive comments did much to improve this article.

Implementational details can differ: the order of rules might be stipulated or it might be derived from universal principles; the steps might be called 'rules', 'cycles' or 'levels'; the steps might involve applying rules or enforcing constraints. But, details aside, the defining characteristic of a serial derivation, in the sense I will employ here, is the pre-eminence of the chronological metaphor: the underlying form is transformed into a succession of distinct, accessible intermediate representations on its way to the surface. I will call any theory with this property 'serialism'.

The phenomenon of phonological OPACITY (Kiparsky 1971, 1973) supplies the principal argument in support of serialism. Opacity comes in two basic forms:

(i) Linguistically significant generalisations are often NOT SURFACE-TRUE. That is, some generalisation G appears to play an active role in some language L, but there are surface forms of L (apart from lexical exceptions) that violate G. Serialism explains this by saying that G is in force only at one stage of the derivation. Later derivational stages hide the effect of G, and may even contradict it completely.

(ii) Linguistically significant generalisations are often NOT SURFACE-APPARENT. That is, some generalisation G shapes the surface form F, but the conditions that make G applicable are not visible in F. Serialism explains this by saying that the conditions on G are relevant only at the stage of the derivation when G is in force. Later stages may obliterate the conditions that made G applicable (e.g. by destroying the triggering environment for a rule).

A phonological generalisation that has been rendered non-surface-true or non-surface-apparent by the application of subsequent rules is said to be OPAQUE.

Optimality Theory (OT; Prince & Smolensky 1993) offers a different and arguably incomplete picture of opacity. In OT, phonological generalisations are expressed as markedness constraints that regulate surface representations; their activity is controlled by interaction with each other and with faithfulness constrains. 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. In this way, constraint ranking and violation – the two central tenets of OT – give a non-serialist account of certain instances of non-surface-true opacity.

As OT is currently understood, though, constraint ranking and violation cannot explain all instances of opacity. Unless further refinements are introduced, OT cannot contend successfully with any non-surface-apparent generalisations nor with a residue of non-surface-true generalisations.[1] (Here and throughout this article, I refer to PARALLEL OT, in

[1] A hypothetical example will help to distinguish the two kinds of non-surface-true generalisation, those that can and cannot be accommodated by constraint domination in classic OT. Suppose there is a language with epenthesis of *t* in response to

which fully formed output candidates are evaluated for the effects of all processes simultaneously. For discussion of various serial implementations of OT, see §8.4.)

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/ → mele̱x 'king'

b. [ʔ]*-deletion outside onsets*
/qaraʔ/ → qārā_ 'he called'

c. *Interaction: epenthesis* → [ʔ]*-deletion*[2]
/dešʔ/ → deše̱ʔ → deše_ 'tender grass' (cf. dāšʔū 'they sprouted')

The conditions leading to epenthesis are non-surface-apparent. From the OT perspective, this is problematic, because the faithfulness violation incurred by the epenthetic vowel cannot be justified in terms of surface markedness improvement.

Bedouin Arabic supplies an example of a non-surface-true process that cannot be accommodated in classic OT. A process raising [a] in open syllables is rendered non-surface-true by vocalisation of underlying glides:

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onsetless syllables, so ONSET dominates 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. The non-surface-trueness in (i) can be obtained through crucial domination of ONSET by ALIGN-L (McCarthy & Prince 1993a, b), but the non-surface-trueness in (ii) cannot. Serialism might analyse both phenomena derivationally, treating (i) as a result of assigning extrametricality before applying epenthesis (Spring 1990) and (ii) as a result of ordering [h]-deletion after epenthesis.

A reviewer asks whether it is possible to give a general characterisation of the situations where OT and serialism will differ in this way. The answer is no, because the two theories don't line up exactly. On the OT side, the universality of constraints means that a markedness constraint might be dominated for reasons that have nothing to do with opacity. And on the serialism side, the non-universality of rules means that we cannot in general know that generalisations like (i) are the result of derivational opacity instead of positing an epenthesis rule that is limited to medial syllables. For a bit more on this topic, see §7.2.

[2] Or [dešē], as in Malone (1993: 59f). Hebrew vowel length involves 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 vocalisation in Bedouin Arabic* (Al-Mozainy 1981, Johnstone 1967)

a. *Raising of* [a] *in open syllables*
/katab/ → ki.tab 'he wrote'

b. *Glide vocalisation* (when not adjacent to a vowel)

c. *Interaction : raising → vocalisation*
/badw/ → *n/a* → ba.du 'Bedouin'

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 in underlying structure – see §8.2). 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 many times before (Archangeli & Suzuki 1996, 1997, Black 1993, Booij 1997, Cho 1995, Chomsky 1995, Clements 1997, Goldsmith 1996, Halle & Idsardi 1997, Idsardi 1997, 1998, Jensen 1995, Kager 1997, to appear, McCarthy 1996, McCarthy & Prince 1993b, Noyer 1997, Paradis 1997, Prince & Smolensky 1993, Roca 1997b, Rubach 1997). (In fact, there are two collections of papers addressing this and related topics: Hermans & van Oostendorp, to appear and Roca 1997a). In the view of some critics, the mere existence of phonological opacity proves that OT is fundamentally misconceived and should be rejected entirely. I will not attempt to respond to these critics here; the body of empirical and conceptual results directly attributable to OT makes a brief response both impossible and unnecessary. Rather, this article has a narrower goal: 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 introduce the proposal, 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 *[dešeʔ] in Hebrew. Derivational theories posit intermediate representations to determine, in part, the properties of the final output. Similarly, sympathy uses the constraints to

[3] The terms overapplication and underapplication come from Wilbur's (1974) 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).

select a member of the candidate set to determine, in part, the properties of the output form.[5]

The article continues in §§3 and 4 by filling in the details of sympathy theory, first looking at the selection of the sympathetic candidate and then at its relation to the actual output form. The following sections, 5–7, present an extended illustrative example of non-surface-apparent, non-surface-true and multi-process opacity, covering all of the opaque interactions in Yokuts phonology. §§5 and 6 also include schematic examples which show how sympathy subsumes the same range of two-process interactions covered by Kiparsky's (1973) definition of opacity. Conversely, §7 looks at the ways in which the predictions of sympathy theory differ from those of serialism when multi-process interactions are considered. A particular focus of this section is the 'Duke of York' gambit (Pullum 1976), which finds ready expression in serialism but cannot be modelled with sympathy.

The article concludes (§§8–9) with a review of other approaches to opacity in OT and a summary of the results.

2 Overview of the proposal

A serialist analysis of Tiberian Hebrew, as in (4), depends on the existence of the intermediate derivational stage [dešeʔ], which differs in crucial ways from both underlying and surface structure:

(4) *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 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, called the SYMPATHETIC CANDIDATE, to influence the output, and exercising

[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: Baković (to appear), Davis (1997a, b), de Lacy (1998), Dinnsen *et al.* (1998), Fukazawa (1999), Harrikari (1999), Itô & Mester (1997b, c), Jun (1999), Karvonen & Sherman (1997, 1998), Katayama (1998), Kikuchi (1999), Lee (1999), McCartney (to appear), McGarrity (1999), Merchant (1997), Odden (1997), Parker (1998), Sanders (1997), Walker (1998, 1999).

that influence through a SYMPATHY RELATION between the sympathetic candidate and the output.

At first glance, selecting the right failed candidate seems like a daunting task, since the set of candidates derived from any given input is infinite and diverse. But in Hebrew and, arguably, all other opaque systems, the relevant candidate is exactly the most harmonic member of the set of candidates that obey a designated input–output (IO) faithfulness constraint, called the SELECTOR. The form [dešeʔ] is the most harmonic member of the set of candidates that obey the IO faithfulness constraint MAX-C, 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 SYMPATHY CONSTRAINT. There are two ways to think about this constraint, and both will be discussed below (§4). For the purposes of the informal presentation right now, I will stick to the more familiar approach, which treats sympathy as a kind of faithfulness. Research in the correspondence theory of faithfulness shows that a single output form may participate in and be influenced by a variety of parallel faithfulness relations: to the input, to morphologically related output forms (Benua 1997 and others) and to the reduplicative base (McCarthy & Prince 1995, 1999). Therefore, it is not wholly unexpected that faithfulness might be extended to inter-candidate relations. 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 sympathy constraints, like all other constraints, can be crucially dominated. (Here, the dominating constraint is the anti-[ʔ] CODACOND.)

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, under one construal, mediated by inter-candidate faithfulness. The following tableau shows how the two different rules of faithfulness play out in this example:

(5) *Sympathy applied to non-surface-apparent opacity in Hebrew*

	/dešʔ/	CODACOND	*COMPLEX	❀MAX-V	✯MAX-C	DEP-V
opaque	☞ a. deše				*	¡*
transparent	☜ b. deš			*!	*	
sympathetic	❀ c. dešeʔ	*!			✓	*
faithful	d. dešʔ	*!	*!	*!	✓	

The various annotations are intended to help in reading the tableau. The symbol ❀ points to the sympathetic candidate. It is chosen by the selector constraint ✯MAX-C, which is called out by the symbol ✯. Obedience to the selector constraint is signalled by ✓. The sympathy constraint is ❀MAX-V, annotated by the same ❀ symbol used for the sympathetic candidate. Other important candidates are designated by their own symbols, ☞ in its usual role of marking the actual output form, and ☜ for the transparent candidate, which would be optimal if not for the effects of sympathy. Fatal constraint violations are, as usual, marked by !, and the actual output form's 'extra' constraint violation, the seemingly gratuitous epenthetic vowel, is called out by preposed ¡ in the DEP-V column.

The basic phonology of the language deletes [ʔ] from non-onset position (so CODACOND ≫ MAX-C) and resolves tautosyllabic clusters by epenthesis (so *COMPLEX ≫ DEP-V).[6] Sympathy is overlaid on that. The form ❀[dešeʔ] (5c) is the most harmonic member of the set of candidates that obey the selector constraint ✯MAX-C. The fully faithful candidate [dešʔ] is also in this set, but it is not as harmonic as ❀[dešeʔ], according to Hebrew's language-particular constraint ranking. Selection of ❀[dešeʔ] is not the whole story, however; it must also have a way of influencing the outcome. That influence is mediated by the inter-candidate faithfulness constraint ❀MAX-V, which requires one-for-one preservation of the vowels of the sympathetic candidate ❀[dešeʔ]. In short, the presence of the epenthetic vowel in the sympathetic candidate is demanded by the basic phonology of the language (i.e. because *COMPLEX dominates DEP-V), and this vowel is carried over to the actual output because the sympathy constraint ❀MAX-V also dominates DEP-V. On the other hand, deletion of [ʔ] occurs transparently, showing that CODACOND dominates ✯MAX-C. In sum, this is how non-surface-apparent opacity is addressed with sympathy.

There is an intuitive connection between this analysis and the standard serialist approach in (4). As I noted at the beginning of this section, the sympathetic candidate ❀[dešeʔ] has approximately the status of the intermediate stage of the serial derivation. It 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 sympathetic 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 sympathetic 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 empirical differences between sympathy and serialism, to be addressed below (§§3.2 and 7).

The same basic notions can be employed for non-surface-true opacity. In Bedouin Arabic, the general phonology of the language includes a process raising [a] in open syllables, so some markedness constraint – call it $*a]_\sigma$ (cf. Kirchner 1996, McCarthy, to appear) – dominates the faithfulness constraint IDENT(high). There is also a process of glide vo-

[6] Although CODACOND dominates DEP-V, stem-final [ʔ] cannot be dealt with epenthetically for alignment reasons (Benua 1997, Farwaneh 1995, McCarthy & Prince 1993a).

calisation, proving that *Complex dominates some appropriate faithfulness constraint – presumably Dep-μ, under the assumption that vocalisation of an underlying glide involves adding a mora.

There is also a sympathy effect. The sympathetic candidate is selected by the constraint ✯Dep-μ, so it is faithful to the underlying glide. In fact, as it happens, the sympathetic candidate ❀[badw]$_\sigma$ is identical to the underlying form /badw/, except that it has been syllabified.[7] The sympathy constraint ❀Ident(high) tests output candidates against the sympathetic candidate for matching vowel height. The opaque candidate [ba]$_\sigma$[du]$_\sigma$ satisfies this constraint, but the transparent candidate [bi]$_\sigma$[du]$_\sigma$ does not. By ranking the sympathy constraint above the markedness constraint *a]$_\sigma$, which drives the raising process, raising is blocked in syllables that are open by virtue of glide vocalisation. The following tableau fills in the details:

(6) *Sympathy applied to non-surface-true opacity in Bedouin Arabic*

	/badw/	*Complex	❀Id(hi)	*a]$_\sigma$	Id(hi)	✯Dep-μ
opaque	☞ a. [ba]$_\sigma$[du]$_\sigma$			¡*		*
transparent	☜ b. [bi]$_\sigma$[du]$_\sigma$		*!		*	*
sympathetic and faithful	❀ c. [badw]$_\sigma$	*!				✓

The raising process is non-surface-true because the constraint responsible for raising, *a]$_\sigma$, is dominated by the sympathy constraint. In this way, the syllabificational conditions obtaining in the sympathetic candidate, rather than in the actual output form, determine the outcome. Of course, in transparent situations like /katab/ → [kitab], the sympathetic candidate and the actual output are identical, since ✯Dep-μ is not at stake. In sum, this is how non-surface-true opacity is addressed in sympathy theory.

Both kinds of opacity, non-surface-apparent and non-surface-true, are subsumed under sympathy theory. But there is a difference in the details of ranking, and this difference makes a connection between this approach to opacity and the phenomena of overapplication and underapplication in other domains.[8] Work on reduplicative identity (McCarthy & Prince 1995, 1999) and OO faithfulness (Benua 1997) shows how other dimensions of faithfulness (base–reduplicant, output–output) can take precedence, through ranking, over markedness or IO faithfulness. In overapplication, such as Tagalog /paN-red-putul/ → [pamu**m**utul], BR faithfulness takes precedence over IO faithfulness. In underapplication, such as English *Lar'* [læɹ] for expected *[lɑɹ], OO faithfulness to untruncated *Larry* [læɹij] takes precedence over the markedness constraint prohibiting short front vowels before tautosyllabic [ɹ]. These precedence relations, and the

[7] For the purpose of this argument, it does not matter whether the sympathetic candidate is [badw]$_\sigma$ or, say, [bad]$_\sigma$w, with final extrasyllabicity. What's important is that the [w] not yet be syllabic. On why the underlying representation must be /badw/, see the discussion of the vowel/glide contrast in §3.2.

[8] I am grateful to Laura Benua for discussion of this point.

rankings that determine them, are parallelled in sympathy. Non-surface-apparent opacity is like overapplication: the sympathy constraint crucially dominates some IO faithfulness constraint, forcing unfaithfulness to the input that is not purely phonologically motivated. Non-surface-true opacity is like underapplication: the sympathy constraint dominates some markedness constraint, forcing it to be violated.

Further connections, consequences, and implications will be discussed below, in §§ 5–7. But first we need to look at the details of the theory, some alternative implementations of the basic idea and some examples.

3 Sympathy in detail I: selecting the sympathetic candidate

3.1 The proposal

The sympathetic candidate is the most harmonic member of the set of candidates obeying some designated IO faithfulness constraint, the selector. It is 'the most harmonic member' in that it best satisfies all non-sympathy constraints as they are ranked in the constraint hierarchy of the language under consideration. The choice of the selector is determined on a language-particular basis, though some heuristics are mentioned below.

First, some notation. Each IO faithfulness constraint F_i sorts the candidate set **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. As Moreton (1996) observes, the input itself is a member of the set of output candidates, in accordance with the conditions on Gen dubbed Containment and Freedom of Analysis in McCarthy & Prince (1993b). Hence, $\mathbf{C}_{\langle +Fi \rangle}$ is assuredly non-empty, since at least the fully faithful candidate is a member of it. Under the standard (though not uncontroversial) assumption that the constraint hierarchy is totally ordered and chooses some unique most harmonic member from any candidate set, there is some most harmonic member of $\mathbf{C}_{\langle +Fi \rangle}$, which can be called $\aleph_{Fi}$. This is the sympathetic candidate selected by the faithfulness constraint F_i.

There are three main principles involved in the choice of the sympathetic candidate:

(7) a. *Harmonic evaluation*
The sympathetic candidate is the most harmonic member of the subset of candidates available under (7b).

b. *Confinement to* $\mathbf{C}_{\langle +F \rangle}$
Selection of the sympathetic candidate $\aleph_F$ is confined to $\mathbf{C}_{\langle +F \rangle}$, the subset of candidates that obey the IO faithfulness constraint F.

c. *Invisibility of sympathy constraints*
Selection of sympathetic candidates is done without reference to sympathy constraints.

I will have more to say about each of these principles, taking them in turn.

Harmonic evaluation is a central element of OT, and therefore readily available to be recruited for purposes in addition to selecting the actual output form. Indeed, harmonic evaluation is called on to select the input, as a kind of learning procedure, in situations where the choice of input is otherwise underdetermined, by the principle of Lexicon Optimisation (Itô *et al*. 1995, Prince & Smolensky 1993, Tesar & Smolensky 1998). Harmonic evaluation also selects the base in OO faithfulness (Benua 1995, 1997), and it plays a similar role in systems of multiple optimisation (Wilson 1997).

Though it is, in principle, a straightforward matter to apply harmonic evaluation to $\mathbf{C}_{\langle +\mathrm{F} \rangle}$, there is a potential complication involving constraints, usually undominated, that are not rankable on independent grounds. Suppose two members of $\mathbf{C}_{\langle +\mathrm{F} \rangle}$ differ only in their performance on constraints that no actual output form violates. The relative ranking of these unviolated constraints would be essential for finding the sympathetic candidate. For example, in Bedouin Arabic the sympathetic candidate ❀[badw] should be the most harmonic member of $\mathbf{C}_{\langle \mathrm{DEP}\text{-}\mu \rangle}$. But the candidate [bi] is also in this set, and these two candidates crucially differ in performance only on undominated constraints: ❀[badw] violates *COMPLEX, while [bi] violates MAX-C (twice). *COMPLEX and MAX-C are not independently rankable in Bedouin Arabic, because coda clusters are always resolved by glide vocalisation or epenthesis and never by deletion. Nevertheless, the 'latent' ranking MAX-C ≫ *COMPLEX is required to select the correct sympathetic candidate, since this ranking is needed to select ❀[badw] over [bi]. And it's important that ❀[badw] be selected over [bi], because they also differ on whether they show the effects of the raising process.

It would be preferable to spare learners the burden of discovering such hidden rankings (though the situation seems worse in rule-based serialism, where learners must discover both the opaque rules and their ordering). Ideally, all such rankings would be part of the initial state of the learner, present in the grammars of languages even when there is no direct evidence of ranking (cf. Demuth 1995, Gnanadesikan 1995, Pater 1997, Smolensky 1996, Tesar & Smolensky 1998). If further investigation should fail to bear this out, however, it will be necessary to recognise the possibility of indirect arguments for ranking, based on selection of the sympathetic candidate rather than the output itself. This will have implications for learning, requiring at the very least some extension of the proposals in Tesar & Smolensky (1998).[9]

According to the principle of Confinement (7b), the set of potential sympathetic candidates is determined by obedience to some designated faithfulness constraint, the selector. Nothing excludes the possibility of a

[9] The reviewers and associate editor raise broader concerns about the consequences of sympathy for learnability and computability. Serious consideration of these topics would be a major research project in itself, at least equal to the present article, and off-the-cuff remarks are likely to be wrong or worse. For the purposes of theory comparison, the project would also need to deal with the as yet unstudied topic of learnability and computability of opaque derivations in rule-based serialism.

language designating more than one faithfulness constraint to be a selector. Two or more different sympathetic candidates can then be active, even in a single tableau (see §7.1 for exemplification). The effects of each sympathetic candidate are negotiated by their respective sympathy constraints, depending on where those constraints are ranked in the hierarchy.

Below in §§3.3 and 7.2 I will discuss an alternative to the assumption that only faithfulness constraints can act as selectors. For now, I will note some desirable consequences of this thesis. For one thing, it accords with the special status that faithfulness constraints have in OT: they stand at the interface between two components of grammar, the lexicon and the phonology. As I will suggest shortly, sympathy is also part of that interface.

It is also obviously a more restrictive hypothesis to demand that selectors always be faithfulness constraints than to allow any constraint whatsoever to function as a selector. Furthermore, as a matter of logic, only *dominated* faithfulness constraints will be of interest as selectors. An undominated faithfulness constraint is obeyed by every winning candidate. So choosing an undominated faithfulness constraint as selector will have no useful effect: it will simply pick out the candidates that would have won anyway, even if there were no sympathy effect in action. A useful heuristic is that the selector should choose a candidate in which the opaque process is motivated transparently. In Hebrew, for example, the selector ✯MAX-C requires preservation of underlying consonants, forcing epenthesis to resolve final clusters.

But perhaps the most striking consequence of the hypothesis that faithfulness constraints are the selectors is the connection it makes with certain ideas about opacity that had currency in the 1970s but have since been neglected.[10] Kaye (1974) proposes that certain instances of non-surface-apparent opacity contribute to the RECOVERABILITY of underlying representations. ('Recoverability' refers here to recognition, not learning.) If an opaque interaction produces a type of segment that occurs nowhere else, the derivation is unambiguously invertable, and so the underlying representation can be recovered from the surface representation. One of Kaye's examples comes from Ojibwa, where nasal place assimilation applies prior to simplification of final [ŋk] clusters:

(8) *Ojibwa serial derivation* (Kaye 1974)

UR	takossin-k	
Assimilation	takoššiŋk	
Deletion	takoššiŋ	'(if) he arrives'

Since [ŋ] comes from no other source in Ojibwa, its presence in the output is a cue to the missing input /k/. The same goes for otherwise non-occurring strings or other configurations. For example, nasal harmony and simplification of nasal + voiced stop clusters interact opaquely in Sea

[10] I am indebted to Edward Flemming and Charles Kisseberth for discussion of this point.

Dayak to produce sequences of a nasal followed by an oral vowel, which are met with nowhere else in the language:

(9) *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 *idem*

This case, involving non-surface-true opacity, is much the same as Kaye's Ojibwa example: the presence of the otherwise impossible configuration [ŋa] cues the presence of an oral stop in the underlying representation.

Donegan & Stampe (1979) start from different premises but end up at approximately the same spot. They see language as the result of conflict between phonetic (articulatory) and phonological (perceptual) aims. Transparent interaction of processes is phonetically motivated, since it presumably maximises articulatory ease. Opaque interactions of the non-surface-true variety are phonologically motivated, in their sense, because opacity 'bring[s] speech closer to its phonological intention' (1979: 147). As an example, Donegan & Stampe cite nasal deletion and intervocalic flapping in English *plant it*. For some speakers, they interact opaquely, as in the following derivation:

(10) *English serial derivation* (after Donegan & Stampe 1979)

other rules	pl̃ǣntɪt
Flapping	*n/a* (because [t] is not intervocalic)
Nasal deletion	pl̃ǣtɪt (flapping is non-surface-true *vs.* transparent [pl̃ǣɾ̃ɪ̃t])

According to Donegan & Stampe, 'suppressing the application of a process to the output of another … like suppressing its application altogether … lets this much of the phonological intention … manifest itself in actual speech' (1979: 147). The 'phonological intention' is, of course, the underlying representation.

In short, these earlier works and others, such as Kisseberth (1976) and Kaye (1975), argue that certain kinds of opacity are functionally motivated, in that they provide a kind of access to the underlying representation. OT provides 'access to the underlying representation' with faithfulness constraints. The recoverability of underlying forms, or the accurate manifestation of phonological intention, is enhanced when faithfulness constraints are obeyed. Sympathy provides a back-channel of faithfulness alongside the standard one – the sympathetic candidate is chosen because it obeys a specified faithfulness constraint, and the output is compelled by the sympathy constraint to resemble the sympathetic candidate. Sympathy does indirectly what faithfulness does directly.

The connections between these earlier ideas and sympathy can be taken somewhat further and made more precise. Donegan & Stampe's proposal, in essence, is that a process can be suppressed just in situations where it interacts with another process.[11] In their view, this is the basis of non-surface-true opacity. Now compare the sympathy account of non-surface-true opacity in Bedouin Arabic given in (6). The process of raising is blocked – that is, the markedness constraint $*a]_\sigma$ is overridden by the sympathy constraint – just in case it interacts with the process of glide vocalisation – because the selector constraint is ✭DEP-μ. Obviously, the two theories differ in how they treat processes: as indivisible units *vs.* markedness ≫ faithfulness rankings. But these differences aside, the two approaches to non-surface-true opacity seem almost identical.

Kaye's (1974) ideas about recoverability are not developed quite as fully, so the comparison is harder to make, but some progress is still possible. In Ojibwa, [ŋ] occurs only before a velar or, opaquely, where a velar once stood. In OT terms, this means that the constraint *[ŋ] is crucially dominated by a constraint requiring assimilation in NC clusters – and by a sympathy constraint. The output ☞[takoššiŋ] is sympathetic to $\aleph_{\text{Max-C}}$, which is ❀[takoššiŋk]. As in this example, a segment or configuration that occurs only in situations of opacity is an indication that an otherwise high-ranking markedness constraint is crucially dominated by a sympathy constraint, which provides an indirect channel to recovering the underlying representation.

A final remark. Sympathy is somewhat more general than the proposals by Kaye or Donegan & Stampe. Kaye (1974) addresses only the situation where non-surface-apparent opacity produces an otherwise impossible surface configuration. Donegan & Stampe (1979) analyse only non-surface-true opacity in these terms. There are cases that fall under neither rubric but are subsumed by sympathy. In general, non-surface-apparent opacity can act in a neutralising way, producing non-recoverable configurations. Tiberian Hebrew is an example, since there are other sources of final *e*. Other examples of this type include Dutch (60) and Maltese (61). Sympathy can be applied to these cases as well because nowhere does it incorporate an absolute requirement that opacity have a functional basis. The connections with the earlier functional proposals are more abstract than that.

Of the three basic principles governing the selection of the sympathetic candidate, one remains to be discussed, Invisibility (7c). The idea is that selection is done by a harmonic evaluation that ignores the sympathy constraints themselves – crucially unlike selection of the actual output candidate. Invisibility is most obviously necessary to avoid the threat of a cyclic dependency (an 'infinite loop'): the choice of $\aleph_{\text{Fi}}$ can't depend on

[11] 'Process' is a term of art in Donegan & Stampe's theory. It refers to rules which are innate and have a functional basis. Learning is suppression of those processes that are inactive in the target language. There are in addition 'rules' *per se*, which are learned and which typically express the non-productive synchronic residue of moribund processes.

performance on a constraint that needs to know what $\aleph_{Fi}$ 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 selector constraints: selection of $\aleph_{Fj}$ and $\aleph_{Fi}$ cannot mutually depend on one another.[12] But it 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 standard rule-based serialism. By virtue of Invisibility, the choice of $\aleph_{Fj}$ cannot depend on the choice of $\aleph_{Fi}$, 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 sympathy constraints. (For more about this, see §7.)

3.2 Some consequences

The goal of this section is to discuss some consequences of the basic proposal, with more to come in subsequent sections. The focus at this stage is on results that follow principally from the assumptions about the selector and the selection mechanism presented above.

Some key predictions involve situations where two notionally distinct processes produce overlapping sets of faithfulness violations. Since selection is based on obedience to a faithfulness constraint, two processes that produce identical faithfulness violations are indistinguishable to the selector. This leads to two predictions. First, if process A violates a proper subset of the faithfulness constraints that B violates, then B can act alone in rendering some third process opaque, but A cannot. Second, if A and B violate exactly the same faithfulness constraints, then they must always act together in rendering a third process opaque.[13]

Glide vocalisation and epenthesis in Bedouin Arabic exemplify the first prediction. Both vocalisation and epenthesis render the raising process opaque: /badw/ → [badu], /gabr/ → [gabur]. Glide vocalisation violates a proper subset of the faithfulness constraints violated by epenthesis: glide vocalisation and epenthesis both violate DEP-μ, but epenthesis also violates segmental DEP. By the logic of selection, then, if glide vocalisation renders raising opaque (because the selector is ✭DEP-μ), then epenthesis must also render raising opaque (since it also violates ✭DEP-μ). In principle, though, epenthesis could act alone in rendering raising opaque (by designating segmental ✭DEP to be the selector).

Here is a real example that illustrates the second prediction by challenging it. Yawelmani Yokuts has a process shortening long vowels in closed syllables. There is also a process lowering long high vowels. These

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

[13] Obviously, whether two processes produce distinct or overlapping faithfulness violations will depend on the details of a specific theory of faithfulness. Cf. note 19.

two processes interact opaquely, so lowering is non-surface-apparent. In a standard rule-based analysis, opacity is obtained by ordering closed-syllable shortening after long-vowel lowering: /ʔiliː-l/ $\rightarrow_{\text{Lowering}}$ [ʔileːl] $\rightarrow_{\text{Shortening}}$ [ʔilel] 'might fan'.

Now, according to Kisseberth (1973), there is another process of closed-syllable shortening, triggered only by word-final [ʔ], that is ordered *before* long-vowel lowering, to account for examples like /ʔiliː-ʔ/ → [ʔiliʔ] 'will fan'.[14] So there are two differently ordered closed-syllable shortening processes, one triggered by final [ʔ] and one triggered by any medial or final coda consonant. The first interacts transparently with long-vowel lowering and the second interacts opaquely with it.

If we attempt to restate Kisseberth's analysis in sympathy theory, we have a problem. High vowels lower in sympathy to a candidate that preserves underlying length. Therefore, the sympathetic candidate is $\aleph_{\text{Max-}\mu}$, and the actual output form is compelled to match it in vowel height (see §5.1 for the formal details). For instance, the sympathetic candidate derived from input /ʔuːt-hin/ is ❀[ʔoːthin], and the height of the vowel in the actual output form [ʔothun] is an effect of sympathy to that candidate. But the sympathetic candidate derived from the input /ʔiliː-ʔ/ is ❀[ʔileːʔ], and matching it for vowel height gives the wrong output form *[ʔileʔ]. Obviously, there is no way to use a faithfulness constraint as selector to give the same fineness of control over opacity that Kisseberth obtains by formulating and ordering two distinct closed-syllable shortening rules. Moreover, there's no obvious modification of sympathy or faithfulness theory that would change this conclusion. Yawelmani, then, challenges this prediction of sympathy theory: processes that produce identical faithfulness violations should act together in rendering a third process opaque.

Below in §7.1 I will argue that this prediction is actually a good consequence of sympathy theory. The seeming challenge comes from a fundamentally dubious analysis. On the empirical side, the early rule of shortening is motivated by alternations involving just two suffixes, the future and the absolutive (Kenstowicz & Kisseberth 1979: 95, Newman 1944: 26). This suggests we are dealing with allomorphy here rather than real phonology. On the theoretical side, it seems clear that the descriptive success of the rule-based analysis is not due to rule-ordering but to the capacity of a theory based on language-particular rules to make highly arbitrary stipulations. Positing two rules with identical structural changes and overlapping structural descriptions (/ __ ʔ# *vs.* / __ {C, #}) misses the generalisation that these two rules respond to the same prosodic requirement. Later research in phonological theory (e.g. Archangeli 1991, Borowsky 1986, Buckley 1991, Kahn 1976, Myers 1987, Noske 1984, Zoll 1993) has recognised that closed-syllable shortening is conditioned by syllabic well-formedness (i.e. the two-mora limit). But once the move is made to a prosodically conditioned shortening process, there is no

[14] Also see Kenstowicz & Kisseberth (1979: 95–96, 98).

reasonable way to distinguish the early and late shortening rules. Yawelmani, then, illustrates a situation that would counterexemplify sympathy theory – but utterly unconvincingly.

Itô & Mester (1998) have identified another class of opacity situations that have implications for sympathy theory.[15] Suppose the process 'causing' opacity is allophonic. According to richness of the base (Itô *et al.* 1995, Prince & Smolensky 1993, Smolensky 1996), there is no language-particular underspecification, morpheme structure constraints or similar restrictions on underlying representations. This means that the inputs to any allophonic process may be non-unique (Itô & Mester 1995, 1997a, Kirchner 1997, McCarthy & Prince 1995), with the grammar responsible for merging the potential underlying contrast. (For example, the grammar of English might map both /pɪt/ and /pʰɪt/ onto surface [pʰɪt] *pit*.) Since selection is based on faithfulness to the underlying representation, this ambiguity in the underlying representation has implications for how sympathy applies to allophonic processes.

In some cases, the merged contrast is transferred, via sympathy, to another segment. In Bedouin Arabic, glides and high vowels are in complementary distribution, but opacity provides indirect evidence of an underlying contrast (cf. Guerssel 1986). Underlying /badw/ surfaces as [badu], but underlying /nasi/ 'he forgot' surfaces as [nisi], with the raising process occurring as expected. The selector constraint ✯Dep-μ chooses ❀$[badw]_\sigma$ for /badw/, but ❀$[ni]_\sigma[si]_\sigma$ for /nasi/, so the effect of sympathy is vacuous in the latter case, as usual when processes take place transparently. Hence, a contrast that is not realised directly is expressed indirectly, by conditioning an opaque alternation. English *writer*/*rider* is much the same (cf. Bromberger & Halle 1989, Chomsky 1964).

Now consider the following example, from Itô & Mester (1997a, 1998). In Japanese, voiced obstruents dissimilatorily block *rendaku* ('sequential voicing') but sonorants, though also voiced, do not: /satu-taba/ → [satsu**t**aba] 'wad of bills' *vs.* /teppoo-tama/ → [teppoo**d**ama] 'bullet'. In the Tokyo dialect, there is an allophonic alternation between initial [g] and medial [ŋ]: /Geta/ → [geta] 'clogs' *vs.* /kaGi/ → [kaŋi] 'key'. The [ŋ] allophone acts like a voiced obstruent in blocking *rendaku*: /hasami-toGi/ → [hasami**t**oŋi] 'knife-grinder'. This is an instance of opacity, but there is no transferred contrast – underlying /togi/ and /toŋi/, both of which are present in the rich base, are neutralised under all conditions.

Itô & Mester discuss some general analytic techniques for this and similar examples, using modifications of sympathy or an independently motivated aspect of OT, local constraint conjunction. Further research should show whether there are cases which cannot be accommodated as Itô & Mester suggest. This will then sharpen up another prediction of sympathy theory and expose another area in which to search for potential counterexamples.

[15] I am grateful to Junko Itô, Armin Mester and Colin Wilson for discussion of this topic.

3.3 Some variations

In this section, I will address some variations on the basic sympathy theme. I will consider a substantive proposal for broadening the class of potential selectors and an idea about how to implement the selection mechanism. Alternatives of a more far-reaching sort, not involving sympathy, are treated in §8.

First, the substantive proposal. According to Confinement (7b), only faithfulness constraints can act as selectors for sympathetic candidates. But Itô & Mester (1997c) and de Lacy (1998) present analyses of German truncation and Cairene Arabic stress 'conflation', respectively, where the selector is a markedness constraint governing syllable- or foot-parsing. They also note that considerations of symmetry favour extending to markedness constraints the privilege of selecting sympathetic candidates. Similarly, Walker (1998) shows how 'skipping' effects in nasal harmony can be obtained by allowing a feature-spreading markedness constraint to act as selector. And Davis (1997b) analyses a process that affects reduplicated words in Ponapean by recruiting a base–reduplicant, rather than input–output, correspondence constraint as selector.

Since there are other ways to look at these phenomena (see e.g. Crowhurst 1996, Féry 1999, Hayes 1995: 119), the matter is by no means settled on the empirical side. On the theoretical side, the considerations of symmetry noted by Itô & Mester and de Lacy, though noteworthy, are somewhat offset by the reduced restrictiveness brought on by enriching the class of selectors. And on the typological side there are serious issues, discussed below in §7.2, about the potential for markedness-as-selector to allow illegitimate Duke of York derivations, which sympathy theory might otherwise successfully eliminate.[16]

[16] A reviewer suggests yet another criterion for the selector: 'I observe that the sympathetic candidate is also the one that best satisfies the entire ranked constraint set minus one; in the Hebrew case, the constraint ruling out coda glottal stop'. Extrapolating this observation into a theory, as suggested by the associate editor, we might say that some markedness constraint is designated to be 'anti-selector', with the sympathetic candidate chosen by ignoring that constraint and otherwise evaluating as usual.

In the most elementary cases, the markedness-based anti-selector and the faithfulness-based selector are equivalent. Here's why: In OT, a phonological process $\mathscr{P}$ is approximated by a M(arkedness) $\gg$ F(aithfulness) ranking (see §5.2). In simple tableaux where $M \gg F$ is decisive, the most harmonic candidate that obeys F – i.e. a candidate not showing the effects of $\mathscr{P}$ – may also be the most harmonic candidate that violates M, precisely because M and F are in conflict.

Suppose, though, that we have a situation where *two* markedness constraints crucially dominate F:

(i)	M_1	M_2	$\gg$	F
$cand_1$	*	*		
$cand_2$				*

Designating F as selector will choose ❀$cand_1$ as the sympathetic candidate. But there is no way, under the anti-selector approach, to get ❀$cand_1$. Real-life examples of this are quite common; for instance, they arise whenever M_1 and M_2 are in a

Another variation on the sympathy idea involves an alternative implementation of the selection mechanism.[17] Jun (1999) and Odden (1997) propose to simplify the selection mechanism by enriching the theory of candidates. The idea is that the constraint hierarchy evaluates ordered pairs consisting of a potential sympathetic candidate and a potential output candidate – i.e. (❀Cand, ☞Cand). There are separate correspondence relations from input to ❀Cand and from input to ☞Cand, so there is a separate suite of faithfulness constraints on each of these relations (as usual in correspondence theory McCarthy & Prince 1995, 1999). The equivalent of the selector constraint is an undominated faithfulness constraint on the input → ❀Cand correspondence relation, whose counterpart on the input → ☞Cand relation is ranked lower. The markedness constraints are not relativised to the different correspondence relations (again as usual in correspondence theory), and so markedness constraints cannot be selectors (though cf. Jun 1999: §3). The sympathy constraints evaluate a relation between the two members of the ordered pair.

This view of the selection mechanism has a distinct advantage. The properties of Confinement (7b) and Invisibility (7c) need not be stipulated independently: only faithfulness constraints can be selectors, because only faithfulness constraints are relativised to different correspondence relations, by the key hypothesis of correspondence theory (McCarthy & Prince 1995, 1999); and there is no way that selection of the sympathetic candidate could depend on the sympathy constraint. It also has some distinct disadvantages: since every faithfulness constraint comes in two versions, it allows several faithfulness constraints to act in concert as the selector (cf. §7.2); and situations of multiple opacity, like Yokuts (§7.1), cannot be analysed, unless the hierarchy evaluates ordered n-tuples for some arbitrary value of $n > 2$.

More importantly, the Jun–Odden approach to selection emphasises the fully parallel character of sympathy theory. It is sometimes suggested that sympathy covertly appeals to a kind of serialism.[18] According to this view, selection of the sympathetic candidate must take place derivationally prior

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specific/general relationship. That's the situation in Bedouin Arabic (6), under the entirely reasonable assumption that *Complex actually stands for a hierarchy of constraints against clusters with different sonority-distance thresholds (cf. Baertsch 1998, Green 1997, Sherrard 1997: 54f, Steriade 1982).

Now suppose that M crucially dominates two faithfulness constraints:

(ii)

	M	$\gg$	F_1	F_2
$cand_1$	*			
$cand_2$			*	*

In (ii), either F_1 or F_2 can be designated to select ❀$cand_1$. This shows that the selector approach does not encounter the same problem as the anti-selector approach, when confronted with the symmetric counterpart of (i). (Alan Prince observes that the explanation for this difference can be found in the Cancel/Domination Lemma; Prince & Smolensky 1993: 148.)

[17] See Walker (1998) for another view of how the selection mechanism works.

[18] I am indebted to the reviewers and associate editor for their challenges on this point.

to selection of the actual output, because the latter depends on the results of the former. (The Invisibility property (7c) would be seen as a necessary consequence of this ordering of events.) But 'A depends on properties of B' doesn't necessarily imply 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 undergoes phonology prior to reduplication. Rather, the effects of phonology on the base and reduplicant can be determined together, in parallel (McCarthy & Prince 1995, 1999). (Similar remarks apply to OO faithfulness and similar ideas; Benua 1997, Itô & Mester 1997a: 420, Mohanan 1995: 64, Orgun 1996b.) The Jun–Odden implementation of sympathy has this same parallel character; indeed, Jun highlights the affinities between sympathy and the McCarthy–Prince approach to reduplication, in which the harmony of two expressions and the relation between them are all evaluated in parallel. The key is that correspondence provides a way to express dependencies without invoking serial derivation.

4 Sympathy in detail II: relating the output to the sympathetic candidate

The sympathetic candidate influences the output through the sympathy relation, which requires the output to resemble the sympathetic candidate in some respect. According to the overview of sympathy theory in §2, the sympathy relation is a kind of faithfulness, like the relation between input and output. In §4.1, I flesh out the details of that approach. Then in §4.2, I sketch an alternative based on sharing faithfulness violations, which I call CUMULATIVITY. Empirical differences between these two approaches are addressed in §7.2, in the discussion of multi-process opaque interaction.

4.1 Sympathy as inter-candidate faithfulness

The sympathy relation conveys information from the sympathetic candidate to the actual output form. One way to carry this information is with a faithfulness constraint – a constraint enforcing faithfulness to the sympathetic candidate. Research in OT has established a number of properties of faithfulness constraints (McCarthy & Prince 1995, 1999, Prince & Smolensky 1993):

(i) Faithfulness demands similarity between phonological representations. It is regulated by ranked, violable constraints.

(ii) 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).[19]

[19] Compare the undifferentiated Base-Identity constraint of Kenstowicz (1996) with the fully differentiated OO faithfulness constraints of Benua (1997).

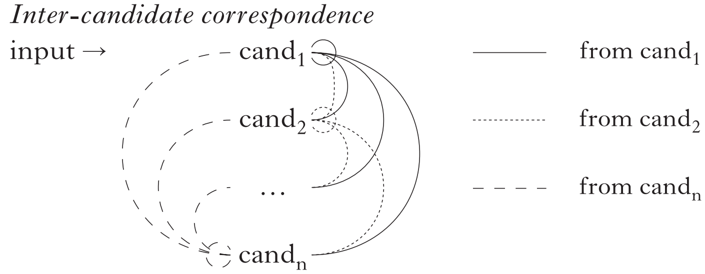
(iii) Though it was originally conceived as a relation between input and output, faithfulness has been extended through correspondence theory to other pairs of linguistically associated representations, such as base and reduplicant, simple and derived words and so on.

The goal of this section is to show that the sympathy relation shares these characteristics of faithfulness constraints, and then to implement the relation formally.

It is clear from all the examples discussed thus far that sympathy is satisfied by greater resemblance between the sympathetic candidate and the output. For example, the form [deše] emerges as the output because it more closely resembles the sympathetic 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. 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. Again, all of the examples discussed thus far exemplify this. For instance, the output [deše] in Hebrew echoes the second [e] of ❀[dešeʔ], but not its final [ʔ]. This indicates that ❀Max-V, but not ❀Max-C, is crucially obeyed. Sympathy, like faithfulness, is based on obedience to specific constraints.

The candidate-to-candidate sympathy relation is one of several distinct faithfulness relations provided by correspondence theory. Like classic IO faithfulness, sympathy relates an abstract phonological representation to a surface one. Like BR or OO faithfulness, sympathy relies on correspondence theory's extension of the faithfulness notion to other linguistically related forms. Formally, then, sympathy requires that there be a correspondence relation holding between the various candidates derived from a single input. Indeed, there are many such correspondence relations, one for each candidate:

(11) *Inter-candidate correspondence*



Here, each candidate is shown with a inter-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 $\aleph_{\text{Max-C}}$, so it is the sympathetic candidate. The sympathetic faithfulness constraint ❀Max-V pertains to the correspondence relation with ❀[dešeʔ] as base, and so it is the source of the sympathy effect. Low-ranking faithfulness constraints on the same inter-candidate correspondence relation, such as ❀Max-C, have no force, so the actual output is not identical to ❀[dešeʔ].

We may assume that the Gen-supplied correspondence relations in (11) and the sympathetic 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 $\aleph_{\text{Fk}}$ for some IO faithfulness constraint F_k. 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 I noted above, there are separate and therefore separately rankable faithfulness constraints on each correspondence relation. According to (11), 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 (see §§3.1 and 7.1 on this point). 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 $\aleph_{\text{Fi}}$ and cand_j as $\aleph_{\text{Fj}}$ – that is, different IO faithfulness constraints have selected cand_i and cand_j as sympathetic candidates. There are distinct, separately ranked sympathetic faithfulness constraints on these two correspondence relations. When necessary 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, I will when necessary call that constraint ❀Max_{Fi}, to indicate that this Max is active on a correspondence relation whose base is $\aleph_{\text{Fi}}$.

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 sympathetic candidate(s); distinct correspondence relations are subject to distinct but formally parallel faithfulness constraints. Arguably, this is *all* that is required to analyse 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 §7, arguing that the evidence comes down in favour of sympathy and against serialism.

4.2 Sympathy as cumulativity

The faithfulness-based approach developed in §4.1 is perhaps the most straightforward way to implement the sympathy relation. But it is also quite rich, allowing any information that can be named in a faithfulness constraint to be conveyed from the sympathetic candidate to the output form. There are circumstances, to be discussed below (§7.2), that suggest this is too rich, and so here I sketch an alternative from McCarthy (to appear), which should be consulted for additional details.

Consider once again the Hebrew and Arabic examples in (5) and (6). In those tableaux, the sympathy constraint is required to favour the opaque candidate over the transparent candidate relative to the sympathetic candidate. The approach taken in §4.1 compares them directly, but an indirect comparison is also possible, based on shared IO faithfulness violations. The following table shows the set of faithfulness violations incurred by each of the relevant candidates:

(12) *IO-faithfulness violations incurred by candidates in* (5) *and* (6)

language	*type of candidate*	*candidate*	*accumulated IO-faithfulness violations*	
Hebrew (5) /dešʔ/	*opaque*	☞ a. deše	Dep-V	Max-C
	transparent	☜ b. deš		Max-C
	sympathetic	❀ c. dešeʔ	Dep-V	
	faithful	d. dešʔ		
Arabic (6) /badw/	*opaque*	☞ a. $[\text{ba}]_\sigma[\text{du}]_\sigma$	Dep-μ	
	transparent	☜ b. $[\text{bi}]_\sigma[\text{du}]_\sigma$	Dep-μ	Id(hi)
	sympathetic and faithful	❀ c. $[\text{badw}]_\sigma$		

Intuitively, the sympathetic candidate is closer, in terms of its accumulated IO faithfulness violations, to the opaque candidate than it is to the transparent candidate. In Hebrew, the opaque candidate accumulates all of the sympathetic candidate's faithfulness violations (and adds one more); they are in a relationship of CUMULATIVITY. In contrast, the transparent candidate lacks the sympathetic candidate's Dep-V violation, so they are not in a cumulative relationship. In Arabic, the sympathetic candidate is fully faithful, so of course it has no faithfulness violations; therefore, the opaque and transparent candidates both stand in a relationship of cumulativity to the sympathetic candidate. But the opaque candidate is closer to the sympathetic candidate, in terms of shared faithfulness violations, because the opaque candidate has just one unshared violation, while the transparent candidate has two.

These two notions, cumulativity and distance in terms of shared faithfulness violations, are analogous to criteria that have sometimes been imposed on serial derivations. The requirement that derivations be monotonic (as in Declarative Phonology; see Scobbie 1993, and references there), meaning that they take a steady path away from the input, never back-tracking, is roughly equivalent to saying that later steps of the derivation are cumulative, in the sense described above, with respect to earlier steps. And derivational economy, meaning that the length of the derivational path is minimised (Chomsky 1995: 138ff), approximates the effect of checking the number of unshared faithfulness violations. The difference, of course, is that theories based on serial derivations usually do not have faithfulness constraints. But with faithfulness constraints in OT, it is possible to make good use of these notions.

There are various ways to implement these ideas formally, and here I will take an approach to formalisation suggested to me by Alan Prince (cf. McCarthy, to appear). Instead of the diverse inter-candidate correspondence constraints, suppose there are just two sympathy constraints (for each selector) which compare a candidate's faithfulness violations to those of the sympathetic candidate:

(13) *Cumulativity*

Given an IO faithfulness constraint ✭F which selects a sympathetic candidate ❀-Cand$_F$, to evaluate a candidate E-Cand:

a. ❀Cumul$_F$

E-Cand is cumulative with respect to ❀-Cand$_F$. That is, ❀-Cand$_F$ has a subset of E-Cand's IO faithfulness violations.

b. ❀Diff$_F$

Every IO faithfulness violation incurred by E-Cand is also incurred by ❀-Cand$_F$.

c. *Fixed universal ranking*

❀Cumul$_F$ ≫ ❀Diff$_F$

❀Cumul evaluates each candidate categorically for whether it accumulates all of the sympathetic candidate's faithfulness violations. ❀Diff evaluates candidates gradiently for how far they are from the sympathetic candidate in terms of unshared faithfulness violations. The fixed ranking places the more stringent test universally higher. Because of this fixed ranking, evaluation by ❀Diff will only be relevant when ❀Cumul is not decisive.

Applied to the Hebrew and Arabic examples, these constraints can replace the inter-candidate faithfulness constraints in (5) and (6). First Hebrew:

(14) *Hebrew with cumulativity* (*cf*. (5))

	/dešʔ/	CodaCond	*Complex	❀Cumul	❀Diff	✭Max-C	Dep-V
opaque	☞ a. deše				*	*	¡*
transparent	☜ b. deš			*!	*	*	
sympathetic	❀ c. dešeʔ	*!				✓	*
faithful	d. dešʔ	*!	*!	*!		✓	

The key is the transparent candidate's violation of ❀CUMUL. Using ⟦⟧ to enclose the list of faithfulness violations associated with each candidate, we can represent the intended (opaque) output as ⟦MAX-C, DEP-V⟧ and its transparent competitor as ⟦MAX-C⟧. Since the sympathetic candidate has the violation ⟦DEP-V⟧, only the intended output, and not the transparent competitor, stands in a relationship of cumulativity to it – and that is fatal, given ❀CUMUL's undominated status in Hebrew.

Next Arabic:

(15) *Arabic with cumulativity* (*cf*. (6))

	/badw/	*COMPLEX	❀CUMUL	❀DIFF	$*a]_\sigma$	ID(hi)	★DEP-μ
opaque	☞ a. $[ba]_\sigma[du]_\sigma$			*	¡*		*
transparent	☜ b. $[bi]_\sigma[du]_\sigma$			**!		*	*
sympathetic and faithful	❀ c. $[badw]_\sigma$	*!					✓

The sympathetic candidate is associated with no faithfulness violations, ⟦Ø⟧. Since any set is a superset of the null set, the opaque and the transparent candidates cannot fail to stand in a relationship of a cumulativity to it, so ❀CUMUL is not decisive. But ❀DIFF is, favouring the opaque candidate on the grounds that it has fewer unshared faithfulness violations ⟦DEP-μ⟧ than its transparent competitor ⟦DEP-μ, IDENT(high)⟧.

We have seen two different approaches to sympathy constraints. The richer one uses correspondence theory to transmit information from the sympathetic candidate to the output. The information that can be conveyed is limited only by the expressive power of correspondence-based faithfulness constraints. In contrast, the approach just sketched involves a novel way of looking at the relations between candidates, but is able to convey only very restricted information from the sympathetic candidate to the output. Both appear to be adequate for the cases discussed so far. There are differences, though, and these will be studied in §7.2.

5 Sympathy applied I: non-surface-apparent opacity

This section and the two that follow it have several goals. They are intended to provide a thoroughly worked-out example to secure the empirical basis of the theory presented above. For this example, I have chosen Yokuts, since it has been extensively studied in the past and since it illustrates both main types of opacity as well as opaque interactions involving more than two processes. These sections also develop some general results, divorced from the specifics of any given language. In §§5 and 6, I show that sympathy can analyse exactly the two-process interactions covered by Kiparsky's (1971, 1973) definition of opacity. In §7, on the other hand, I show that there are logically possible multi-process interactions that sympathy cannot analyse or that it analyses very differently from serialism. Where there are empirical differences, I suggest, they come down in favour of sympathy.

5.1 Illustrative analysis

Yokuts has figured prominently over the years in discussions about opacity, including opacity in OT, so it is a particularly appropriate choice for an extended case-study. There has also been much previous research on this language, and so the nature of the underlying representations and the processes affecting them have been securely established (see, among others, Archangeli 1985, 1996, Archangeli & Suzuki 1997, Cole & Kisseberth 1995, Dell 1973, Goldsmith 1993b, Hockett 1973, Kenstowicz & Kisseberth 1977, 1979, Kisseberth 1969, Kuroda 1967, Lakoff 1993, Newman 1944, Noske 1984, Prince 1987, Steriade 1986, Wheeler & Touretzky 1993, Zoll 1993). It is therefore safe to dispense with the preliminaries and move directly to the analysis.

As was noted earlier (§3.2), Yokuts has a process that shortens long vowels in closed syllables (16a). There is also a process lowering long high vowels (16b). These processes interact opaquely (16c), rendering the conditions for lowering non-apparent in surface representation:

(16) *Yokuts vowel alternations I*[20]

a. *Vowels are shortened in closed syllables*

/panaː/	panal	cf. panaːhin	'might arrive/arrives'
/hoyoː/	hoyol	cf. hoyoːhin	'might name/names'

b. *Long high vowels are lowered*

/ʔiliː/	ʔileːhin		'fans'
/c'uyuː/	c'uyoːhun		'urinates'

c. *Vowels shortened in accordance with* (a) *are still lowered*

/ʔiliː/	ʔilel		'might fan'
/c'uyuː/	c'uyol		'might urinate'

In a standard serial derivation, the opaque interaction of these processes is obtained by ordering the lowering rule before the shortening rule:

(17) *Yokuts serial derivation*

UR	ʔiliː-l
Lowering	ʔileːl
Shortening	ʔilel

Lowering, then, applies to a representation in which underlying vowel length is still present.

[20] The Yokuts data in this article have, for the most part, been cited from Kenstowicz & Kisseberth (1979). As is customary in studies of this language, these forms were constructed on the basis of attested examples but may not themselves occur in Newman (1944).

Turning now to OT, I will begin with the phonology of the individual processes, I will then show that their interaction is problematic without sympathy and finally I will show how sympathy solves this problem. One process shortens long vowels in closed syllables. Under the assumption that codas are moraic by dint of an undominated constraint, this alternation means that a markedness constraint against trimoraic syllables dominates the faithfulness constraint MAX-μ:

(18) *$[\mu\mu\mu]_\sigma \gg$ MAX-μ *in Yokuts*

/pana:-l/	*$[\mu\mu\mu]_\sigma$	MAX-μ
☞ a. panal		*
b. pana:l	*!	

The other process lowers long high vowels. This means that the markedness constraint LONG/−HIGH 'if long, then non-high' dominates the constraint demanding faithfulness to vowel height:

(19) LONG/−HIGH $\gg$ IDENT(high) *in Yokuts*

/ʔili:-hin/	LG/−HI	ID(hi)
☞ a. ʔile:hin		*
b. ʔili:hin	*!	

That covers the two processes in isolation from one another. There is also one transparent interaction: long vowels in open syllables are lowered, not shortened, so MAX-μ must dominate IDENT(high):

(20) MAX-$\mu \gg$ IDENT(high) *in Yokuts*

/ʔili:-hin/	MAX-μ	ID(hi)
☞ a. ʔile:hin		*
b. ʔilihin	*!	

That is sufficient background.

The interesting action occurs when these two processes interact opaquely. If we attempt to analyse derivations like /ʔili:-l/ → [ʔilel] without sympathy, we run into a familiar problem: classic OT favours transparent interaction. The following partially ranked tableau shows the problem formally:

(21) *Attempting to analyse* /ʔili:-l/ → [ʔilel] *without sympathy*

	/ʔili:-l/	*$[\mu\mu\mu]_\sigma$	LG/−HI	MAX-μ	ID(hi)
opaque	☞ a. ʔilel			*	¡*
transparent	☜ b. ʔilil			*	
	c. ʔile:l	*!			*
faithful	d. ʔili:l	*!	*!		

The transparent candidate has a proper subset of the opaque candidate's violation marks. In a situation like this, there is no way, using these constraints, that the opaque candidate could ever win. (To use Prince & Smolensky's 1993 term, the transparent candidate 'harmonically bounds' the opaque candidate.) The opaque candidate has a seemingly gratuitous violation of the faithfulness constraint IDENT(high), highlighted with ¡. In other words, the reasons for violation of this constraint are non-apparent in surface structure. The presence of an 'extra' faithfulness violation is typical of non-surface-apparent opacity.

Sympathy responds to this problem by providing a way to force the opaque candidate's otherwise unexplained faithfulness violation. Recall the heuristic mentioned in §3.1: the sympathetic candidate is one in which the opaque process occurs transparently. Therefore, the sympathetic candidate is (21c) ❀[ʔileːl], with a vowel that is faithfully long and unfaithfully lowered. It is the most harmonic member of the set of candidates that obey ✯MAX-μ, which must therefore be the selector constraint. It is the most harmonic member because, unlike its obvious challenger, (21d) [ʔiliːl], it satisfies the high-ranking markedness constraint LONG/−HIGH. The following tableau uses the inter-candidate faithfulness constraint ❀IDENT(high) to carry information from the sympathetic candidate to the output:

(22) *Applying sympathy to* /ʔiliː-l/ → [ʔilel]

	/ʔiliː-l/	*[$\mu\mu\mu$]$_\sigma$	LG/−HI	❀ID(hi)	✯MAX-μ	ID(hi)
opaque	☞ a. ʔilel				*	¡*
transparent	☜ b. ʔilil			*!	*	
sympathetic	❀ c. ʔileːl	*!			✓	*
faithful	d. ʔiliːl	*!	*!	*!	✓	

Sympathetic ❀IDENT(high) compels violation of the input–output faithfulness constraint IDENT(high). The lowering process has, in effect, overapplied, because the actual output form is non-high in sympathy with the non-high vowel in another candidate, $\aleph_{\text{Max-}\mu}$. In (22), the sympathy effect is conveyed by inter-candidate faithfulness, but it could equally well be done with cumulativity. The transparent candidate violates ❀CUMUL, because it does not have a superset of the sympathetic candidate's faithfulness violations (⟦MAX-μ⟧ *vs.* ⟦IDENT(high)⟧). Since the opaque candidate does satisfy ❀CUMUL, because its faithfulness-violation set is ⟦MAX-μ, IDENT(high)⟧, it is optimal.

5.2 Schematisation

In this section, I turn from concrete analysis to a more abstract consideration of the nature of opacity and the role of sympathy. Working from Kiparsky's original definition of opacity, I will present results about which kinds of opaque interactions are problematic for OT and why (also see

Roca 1997b: 6ff). I will then apply sympathy to these problems. Thus, this section and its counterpart later on (§6.2) show abstractly and generally how sympathy resolves the opacity problem for all two-process interactions subsumed by Kiparsky's definition.

Kiparsky (1971, 1973) defines opacity as follows:

(23) *Opacity* (Kiparsky 1973: 79)

A phonological rule $\mathscr{P}$ of the form A → 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 $\mathscr{P}$ that occur in environments other than C __ D.
c. instances of B not derived by $\mathscr{P}$ that occur in the environment C __ D.

Intuitively, the idea is that a rule is opaque if there are surface forms that look like they should have undergone it but didn't (23a) or surface forms that underwent the rule but look like they shouldn't have (23b). Additionally, a rule is opaque if it is neutralising (23c). I will not consider neutralisation further, since it is as unremarkable in OT as it is in rule-based phonology.

This section focuses on type (23b), non-surface-apparent opacity, with the other type to be addressed later (§6.2). In rule-based serialism, non-surface-apparent opacity arises when rules apply in counterbleeding order. Here is a schematic example:

(24) *Type (23b): non-surface-apparent or counterbleeding opacity*

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

The later rule wipes out the environment that induced the earlier rule to apply, so the conditions that allowed the earlier rule to apply are non-apparent at the surface. Had these rules applied in the opposite order, one rule would have prevented the other from applying – hence the term COUNTERBLEEDING. Counterbleeding interaction leads to non-surface-apparentness, which is invariably problematic for OT's output orientation.

In order to understand this serial derivation in OT terms, we need a way of translating a rule like X → Y/W __ Z 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 this rule in a constraint hierarchy is approximately the ranking *WXZ $\gg$ F$_{aith}$(X ↛ Y), where *WXZ is a markedness constraint and F(X ↛ Y) is violated if and only if input /X/ corresponds to output *Y* (e.g. MAX is F(seg ↛ Ø) and DEP is F(Ø ↛ seg)). This ranking supplies necessary (but not sufficient) conditions for the X → Y map to occur in the specified context.

Translating (24) into constraint rankings in the way just described, we can now see abstractly why counterbleeding or non-surface-apparent opacity is problematic for classic OT:

(25) *Counterbleeding opacity: rankings*
*BC ≫ F(B ↛ D)
*C# ≫ F(C ↛ E)

(26) *Counterbleeding opacity: tableau (partially unranked)*

	/ABC#/	*BC ≫ F(B↛D)		*C# ≫ F(C↛E)	
opaque	☞ a. ADE#		¡*		*
transparent	☜ b. ABE#				*
faithful	c. ABC#	*!		*!	

The transparent form (26b) has a subset of the opaque form (26a)'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 (26a) to be more harmonic than (26b). The problem, specifically, is that (26a) is unfaithful in a way that has no apparent surface motivation, so the more faithful (26b) harmonically bounds it. The OT account is tripped up by the non-surface-apparentness of the conditions compelling the F(B ↛ D) violation. From a surface perspective, the process mapping /BC/ to [DC] has overapplied in (26a). This argument shows formally what has frequently been observed anecdotally: that counterbleeding interactions cannot be modelled in classic OT.

Adding the sympathy relation to OT solves this problem, since it provides a constraint that favours (26a) over (26b) and thus avoids the mark-subset conundrum.

(27) *Applying sympathy to counterbleeding opacity*

	/ABC#/	*BC, ❀F(D↛B) ≫ F(B↛D)			*C# ≫ ✯F(C↛E)	
opaque	☞ a. ADE#			*		*
transparent	☜ b. ABE#		*!			*
sympathetic	❀ c. ADC#			*	*!	✓

The candidate to which (27a) owes sympathetic allegiance is ❀[ADC#], which is the most harmonic member of the set of candidates that obey ✯F(C ↛ E). Assuming the faithfulness approach to the sympathy relation (§4.1), candidates can be tested for their resemblance to ❀[ADC#] through inter-candidate correspondence. The sympathy constraint is ❀F(D ↛ B), which asserts that the output cannot have a [B] where the sympathetic candidate has a [D]. The transparent candidate (27b) violates ❀F(D ↛ B); this violation is fatal because ❀F(D ↛ B) dominates the opaque candidate's worst mark, which is its violation of the IO faithfulness constraint F(B ↛ D). Alternatively, cumulativity produces the same result: the opaque candidate has the set of IO faithfulness violations

⟦F(B ↛ D), F(C ↛ E)⟧, and this is a superset of the IO faithfulness violations incurred by the sympathetic candidate (with ⟦F(B ↛ D)⟧), so the opaque candidate obeys ❀CUMUL. In contrast, the transparent candidate has the set ⟦F(C ↛ E)⟧, so it is not in a relationship of cumulativity to the sympathetic candidate, with fatal consequences.

Through the sympathy relation, counterbleeding opacity emerges from the basic ranking/violation texture of OT. The conditions leading to violation of F(B ↛ D) are indeed non-surface-apparent, because they are not present in the actual output form. Instead, this violation is induced by sympathy to another candidate where the reasons for F(B ↛ D) violation are apparent. Sympathy has approximately the function of the intermediate derivational stage in the rule-based analysis (24).

6 Sympathy applied II: non-surface-true opacity

6.1 Illustrative analysis

The analysis of Yokuts continues with a discussion of non-surface-true opacity, which is found when rounding harmony interacts with lowering. There is also multiple interaction when the shortening process is brought in, but I will not deal with that until §7.1.

In Yokuts, there is a process of height-stratified rounding harmony: high suffix vowels become round if the root contains [u] (28a.i), and non-high suffix vowels become round if the root contains [o] (28a.ii). This process interacts opaquely with the lowering of long high vowels. For the purposes of rounding harmony, a vowel's underlying height is what matters (28b):

(28) *Yokuts vowel alternations II*

a. *Suffix vowels are rounded after a round vowel of the same height*

i. *High*

	/dub-mi/	dubmu	'having led by the hand'
cf.	/bok'-mi/	bok'mi	'having found'
	/xat-mi/	xatmi	'having eaten'
	/xil-mi/	xilmi	'having tangled'

ii. *Non-high*

	/bok'-al/	bok'ol	'might find'
cf.	/hud-al/	hudal	'might recognise'
	/max-al/	maxal	'might procure'
	/giy'-al/	giy'al	'might touch'

b. *Underlying long vowels that have been lowered are treated as high*

	/c'u:m-al/	c'o:mal	'might destroy'
	/c'u:m-it/	c'o:mut	'was destroyed'
cf.	/do:s-al/	do:sol	'might report'
	/do:s-it/	do:sit	'was reported'

Derivations like /c'u:m-al/ → [c'o:mal] involve non-surface-true opacity: the surface form [c'o:mal] is inconsistent with the requirement that vowels of like height agree in rounding. In addition, derivations like /c'u:m-it/ → [c'o:mut] involve non-surface-apparent opacity: the vowels are not of the same height, so why has the suffix vowel become round?

As before, we begin with the basic phonology and then turn to the opaque interaction. I will adopt Archangeli & Suzuki's (1997: 207ff) analysis of the harmony process. They propose that a featural alignment constraint (29a) is ranked above the appropriate faithfulness constraint, but is itself ranked below a constraint (29b) demanding that vowels sharing [round] also share [high]. Faithfulness (29c) is bottom-ranked.

(29) *Constraints on* [round] *and* [back] (Archangeli & Suzuki 1997)

a. Align-Colour
   Align(Colour-R, Word-R)
   i.e. every instance of Colour (= [round, back]) is final in some word.[21]

b. Round/αHigh
   Every path including [round$_i$] includes [αhigh].
   i.e. every token of [round] must be linked to vowels of the same height.

c. Ident(colour)
   Two segments standing in IO correspondence have identical values for Colour.

The following tableaux shows how these constraints interact:[22]

(30) Round/αHigh ≫ Align-Colour ≫ Ident(colour) *in Yokuts*

		Rd/αHi	Align-Col	Id(col)
a.	/dub-mi/			
	☞ dubmu			*
	dubmi		*!	
b.	/bok'-mi/			
	☞ bok'mi		*	
	bok'mu	*!		*
c.	/bok'-al/			
	☞ bok'ol			*
	bok'al		*!	
d.	/hud-al/			
	☞ hudal		*	
	hudol	*!		*

[21] Colour is a feature class in the sense of Padgett (1995). The existence of a Colour class was proposed by Odden (1991).

[22] That the suffix alternates, rather than the root (*[dibmi]), is typical of vowel harmony. McCarthy & Prince (1995) attribute this to a universal ranking, Root-Faith ≫ Affix-Faith.

In (30a), top-ranked Round/αHigh is not a problem, because both vowels are high. So Align-Colour is decisive, favouring the candidate with harmony. Only low-ranking faithfulness suffers. In (30b), though, the vowels disagree in height, so Round/αHigh blocks satisfaction of Align-Colour. The same goes, *mutatis mutandis*, for the examples with a non-high suffix vowel (30c, d).

Harmony interacts opaquely with lowering of long vowels. The opacity takes two forms: failure of a non-high suffix vowel to harmonise with a derived non-high root vowel (/c'u:m-al/ → [c'o:mal]); and harmony of a high suffix vowel with a derived non-high root vowel (/c'u:m-it/ → [c'o:mut]). It is clear that, without sympathy, these opaque outcomes cannot be obtained:[23]

(31) *Attempting to analyse* /c'u:m-al/ → [c'o:mal] *and* /c'u:m-it/ → [c'o:mut] *without sympathy*

			Lg/−Hi	Rd/αHi	Id(hi)	Align-Col	Id(col)
a.		/c'u:m-al/					
	opaque	☞ i. c'o:mal			*	¡*	
	transparent	☜ ii. c'o:mol			*		*
	faithful	iii. c'u:mal	*!			*	
		iv. c'u:mol	*!	*			*
b.		/c'u:m-it/					
	opaque	☞ i. c'o:mut		¡*	*		*
	transparent	☜ ii. c'o:mit			*	*	
		iii. c'u:mut	*!				*
	faithful	iv. c'u:mit	*!			*	

The problem in (31a) is that the opaque candidate incurs a fatal violation of Align-Colour, while the transparent candidate does not. Since the violation marks of the transparent candidate are either equal to or lower-ranked than those of the opaque candidate, the transparent candidate ought to win. This is typical of non-surface-true opacity: the intended output form violates a markedness constraint without visible motivation. The situation in (31b) is similar: the intended output has an unexplained violation of the markedness constraint Round/αHigh, which its transparent competitor avoids.

Sympathy supplies the additional constraint interaction needed to explain these markedness violations. By applying the heuristic technique introduced previously, we know that the sympathetic candidate ought to be one in which (non-)occurrence of the opaque process is transparently motivated: ❀[c'u:mal] (31a.iii) and ❀[c'u:mut] (31b.iii). This means that the selector constraint is ✯Ident(high). The other element of the analysis

[23] The tableaux in (31) incorporate two additional rankings: Long/−High ≫ Round/αHigh and Ident(high) ≫ Align-Colour. The first is necessary to ensure that (31b.i) is more harmonic than (31b.iii, iv). The second forecloses the possibility of altering vowel height just to achieve better harmony.

is the sympathy constraint itself. Under the inter-candidate faithfulness model, it is ❀IDENT(colour). To be effective, it must dominate the worse of the two marks called out by ¡, ROUND/αHIGH. Here are the tableaux:

(32) *Analysing* /c'uːm-al/ → [c'oːmal] *and* /c'uːm-it/ → [c'oːmut] *with sympathy*

a.

	/c'uːm-al/	LG/ −HI	❀ID (col)	RD/αHI	★ID(hi)	ALIGN-COL	ID(col)
opaque	☞ i. c'oːmal				*	¡*	
transparent	☜ ii. c'oːmol		*!		*		*
sympathetic and faithful	❀ iii. c'uːmal	*!			✓	*	
	iv. c'uːmol	*!	*!	*	✓		*

b.

	/c'uːm-it/	LG/ −HI	❀ID (col)	RD/αHI	★ID(hi)	ALIGN-COL	ID(col)
opaque	☞ i. c'oːmut			¡*	*		*
transparent	☜ ii. c'oːmit		*!		*	*	
sympathetic	❀ iii. c'uːmut	*!			✓		*
faithful	iv. c'uːmit	*!	*!		✓	*	

The key comparisons are between the opaque candidate and its transparent competitor. In each tableau, that comparison is resolved in favour of the opaque candidate by the sympathy constraint, which finds a mismatch in vowel colour between the transparent candidate and the sympathetic one.

The results are the same if the sympathy relation is implemented with cumulativity rather than correspondence. Imagine that the ❀CUMUL ≫ ❀DIFF hierarchy is substituted for ❀IDENT(colour) in (32). In (32a), since the sympathetic candidate is fully faithful, the opaque and sympathetic candidates both trivially accumulate its faithfulness violations, so both satisfy ❀CUMUL. But ❀DIFF decides in favour of the opaque candidate, since it has one unmatched faithfulness violation to the transparent candidate's two. And in (32b), top-ranked ❀CUMUL is decisive, since the opaque candidate, but not the transparent one, accumulates the faithfulness violations of the sympathetic candidate (opaque: ⟦IDENT(high), IDENT(colour)⟧; transparent: ⟦IDENT(high)⟧; sympathetic: ⟦IDENT(colour)⟧).

Later (§7.1), I will assemble the two halves of the Yokuts analysis into a fuller picture of the phonology. But first I will develop some general results about non-surface-true opacity under sympathy theory.

6.2 Schematisation

Non-surface-true opacity comes under clause (23a) of Kiparsky's definition. In serialist terms, this is COUNTERFEEDING 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, counterfeeding on the opaque rule's environment (33a) and counterfeeding on the opaque rule's focus (33b):

(33) *Type* (23a) *: non-surface-true or counterfeeding opacity*

a. *Counterfeeding on environment*

UR	ABC
B → D/ __ E	*n/a*
C → E/ __ #	ABE

b. *Counterfeeding on focus*

UR	ABC
D → E/A __	*n/a*
B → D/ __ C	ADC

From a surface perspective, it is not clear why the earlier rule has failed to apply, since its structural condition seems to be met. The earlier rule, then, states a generalisation that is non-surface-true. In (33a), the generalisation is non-surface-true because the rule's environment is met too late in the derivation. In (33b), the generalisation is non-surface-true because the rule's target is introduced too late in the derivation.

We will start with (33b), since with a little reasoning it can be set aside as irrelevant to sympathy. What we have in (33b) is a chain shift,[24] 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 (34), which are collected in the tableau (35):

(34) *Type* (33b) *counterfeeding opacity : rankings*

$*AD \gg F(D \not\rightarrow E)$

$*BC \gg F(B \not\rightarrow D)$

(35) *Type* (33b) *counterfeeding opacity : tableau* (*partially unranked*)

	/ABC/	$*AD \gg F(D \not\rightarrow E)$		$*BC \gg F(B \not\rightarrow D)$		$F(B \not\rightarrow E)$
opaque	☞ a. ADC	*			*	
transparent	☜ b. AEC					*

In (35) I have shown an additional constraint not included with the rankings in (34): $F(B \not\rightarrow E)$. This constraint specifically penalises 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

[24] As schematised, (33b) generalises the traditional notion of a chain shift. Traditionally, chain shifts involve rules with identical environments, whereas (33b) also includes rules with different environments.

Gnanadesikan (1997) and Kirchner (1996) argue. The ranking is straightforward: if F(B ↛ E) dominates all the constraints that the opaque candidate (35a) violates, then (35a) will be more harmonic than (35b).[25] 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 (Smolensky 1995). The conjunction of two constraints is violated just in case both constraints are violated together. Constraint conjunction is local to some constituent, called the domain, in which the co-occurring violations must be sought. The conjunction of constraints A and B in domain δ is written $[A \& B]_{\delta}$; it is violated if and only if A and B are both violated within some instance of the constituent δ. Kirchner's idea is that [AEC] in (35) actually violates both of the low-ranking faithfulness constraints, F(D ↛ E) and F(B ↛ D), and the constraint F(B ↛ E) is the high-ranking local conjunction of these low-ranking constraints. The constraint conjunction $[F(D \nrightarrow E)\ \&\ F(B \nrightarrow D)]_{Seg}$ is violated whenever F(D ↛ E) and F(B ↛ D) are both violated within the domain of a single segment. 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 counterfeeding opacity, both based on notions with significant independent motivation. Neither approach requires the invocation of sympathy.

Sympathy is, however, crucial to dealing with opacity involving counterfeeding on the environment, (33a). As before, we approximate the rules with rankings; in addition, it is necessary to rank *C# above *BE, so the two processes will not be blocked entirely:

(36) *Type* (33a) *counterfeeding opacity : rankings*
*BE ≫ F(B ↛ D)
*C# ≫ F(C ↛ E)
*C# ≫ *BE

(37) *Type* (33a) *counterfeeding opacity : tableau*

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

The problem is that the transparent output (37b) has lower-ranking marks than the opaque output (37a), so (37b) ought to beat (37a). As in the counterbleeding case, classic OT cannot obtain the opaque outcome, since

25 In addition, for (35a) to be optimal, it is necessary for *BC to dominate *AD, to rule out the fully faithful candidate [ABC].

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 (37a).

Bruce Hayes (personal communication) suggests that the problem in (37) could be solved by Kirchner's approach to chain shifts. Observe that the transparent candidate (37b) violates both of the faithfulness constraints. Under strict domination, this multiplicity of faithfulness violations is of no consequence, because both faithfulness constraints are ranked below the respective markedness constraints on independent grounds. But it is possible to make formal sense of (37b)'s excessive unfaithfulness by creating a third faithfulness constraint that is the local conjunction of the two low-ranking ones, $[F(B \nrightarrow D)\ \&\ F(C \nrightarrow E)]_{\delta}$. Ranked above *BE, this conjoint constraint accounts for *BE's non-surface-trueness, favouring the opaque candidate over the transparent one. Importantly, the unconjoined constraint $F(B \nrightarrow D)$ is still ranked below *BE, just as in (37), so the language will correctly map /BE/ onto [DE] in situations where $F(C \nrightarrow E)$ isn't also being violated. Thus, the normal transparent behaviour 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 centring around the problem of the domain of conjunction. In many instances of non-surface-true opacity, there is simply no constituent to serve as the domain. For example, in Bedouin Arabic (3), there is no constituent that subsumes the [adu] substring of [badu], or in Barrow Inupiaq (62) below, there is no constituent that subsumes the [ikl] substring of [kamiklu].[26] And if the domain is too big, it is easy to use local conjunction to rule out completely transparent mappings. For example, setting the domain to be the word, as in the conjunction $[F(B \nrightarrow D)\ \&\ F(C \nrightarrow E)]_{\mathrm{Word}}$, would not only block the opaque mapping above but also give an absurd non-local effect, blocking the fully transparent mapping /BEXYZC/ → [DEXYZE].

This last hypothetical case shows why local conjunction is not an adequate theory of non-surface-true opacity: conjunction in some domain is not an adequate theory of process interaction, but process interaction is a crucial element of opacity. The problem is that the domain of conjunction must exactly match the span in which the two processes interact. But the notion 'span in which two (arbitrary) processes interact' is not a phonological constituent, 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 problem is insuperable for the local conjunction approach, but it does not arise under sympathy because process interaction is determined in the usual way – by actual harmonic evaluation.

[26] Thanks to the associate editor for noting the relevance of these examples in this context. It might be objected that the Arabic or Inupiaq examples could be analysed with local conjunction if 'adjacent syllables' were specified as the domain. This will work technically, but suggests a need for new restrictions on what constitutes a possible domain of conjunction, since a pairing of adjacent syllables is not in general a phonological constituent.

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

(38) *Applying sympathy to type* (33a) *counterfeeding opacity*

	/ABC#/	*C#	❀F(B↛D)	★F(C↛E)	*BE	F(B↛D)
opaque	☞ a. ABE#			*	¡*	
transparent	☜ b. ADE#		*!	*		*
sympathetic and faithful	❀ c. ABC#	*!		✓		

The form exercising sympathetic influence on the outcome is (38c) ❀[ABC#]. It is $\aleph_{F(C \nrightarrow E)}$, that is, the most harmonic member of the set of candidates that obey the selector constraint ★F(C ↛ E). The sympathetic, inter-candidate faithfulness constraint ❀F(B ↛ D) 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) is responsible for the success of the opaque candidate and the consequent non-surface-trueness of *BE.

The results obtained are the same if cumulativity rather than correspondence is the approach taken to the sympathy relation. Since the sympathetic candidate is fully faithful, the opaque and transparent candidates both trivially accumulate its faithfulness violations, so both satisfy ❀Cumul. But ❀Diff decides for the opaque candidate, which is just one faithfulness violation 'distant' from the sympathetic candidate, to the transparent candidate's two. So the ❀Cumul ≫ ❀Diff hierarchy could be substituted for the sympathy constraint in (38) with no change in the outcome.

To complete the picture, it is necessary to show that sympathy has no untoward effects in situations of transparency, where there is no interaction between the processes. Consider the mapping /ABE#/ → [ADE#], where only one process is relevant. With input /ABE#/, $\aleph_{F(C \nrightarrow E)}$ is ❀[ADE#] – the same as the output would be without sympathy. Since the sympathetic candidate and the output form converge, the effect of sympathy is vacuous, as the following tableau shows:[27]

(39) *A transparent situation in a system with sympathy*

/ABE#/	*C#	❀F(B↛D)	★F(C↛E)	*BE	F(B↛D)
☞,❀ a. ADE#			✓		*
b. ABE#			✓	*!	

Hence, sympathy does not block the /B/ → [D] mapping generally. Rather,

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

blocking is limited to the situations of true opacity, where there is interaction with the mapping /C/ → [E].

The treatment of counterfeeding opacity shows that, under particular circumstances, the sympathetic candidate may coincide with the underlying or surface representation. When the sympathetic candidate is identical to the underlying form, as in (38), a sympathetic 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 sympathetic candidate is the same as what the surface form would be without sympathetic faithfulness, as in (39), then the sympathetic candidate and the actual output will be identical, and not merely similar, so sympathetic faithfulness is satisfied without further ado, and the sympathy effect is vacuous.

7 Sympathy applied III: multi-process interactions

The results of §§5 and 6 are valid for situations where just two processes interact opaquely. Because the interactional possibilities grow rapidly as the number of interacting processes increases, it is difficult in both rule-based phonology and OT to develop general results about multi-process interactions. Still, it is necessary to make some forays in this direction and, as a first instalment toward a fuller understanding, I pursue two lines of development below. First, in §7.1, I look at a specific case, the interaction of lowering, shortening and harmony in Yokuts. I also use the Yokuts example to highlight some more general results about empirical differences between sympathy and rule-based serialism. Then, in §7.2, I turn to a particular type of multi-process interaction, the Duke of York gambit (Pullum 1976). I argue that this is another important locus of empirical differences between sympathy and rule-based serialism, and I suggest that these differences favour sympathy.

7.1 Illustrative analysis

In previous encounters with Yokuts (§§5.1 and 6.1), we saw how shortening interacts with lowering and lowering interacts with harmony. We now need to check that the correct results are obtained when all three processes are active together.

First, some theory. Recall from §3.1 that a language may designate more than one selector constraint, thereby choosing more than one sympathetic candidate in a tableau. The sympathy constraints are indexed to the selector, so each sympathetic candidate has its own way of influencing the outcome. But because of Invisibility (7c), one sympathy constraint cannot influence the selection of the other sympathetic candidate. Therefore, each opaque interaction is insulated from the others.

Next, the data. In forms that combine shortening, lowering and harmony, the expected opaque interactions are observed:

(40) *Yokuts vowel alternations* III

	/ʔuːt-hin/	ʔothun	‘stole’
cf.	/goːb-hin/	gobhin	‘took in’
	/miːk-hin/	mekhin	‘swallowed’
	/saːp-hin/	saphin	‘burned’

In the derivation /ʔuːt-hin/ → [ʔothun], the root vowel lowers even though it is short at the surface. This is non-surface-apparent opacity. And the suffix vowel harmonises, even though it disagrees in height with the root vowel. This too is non-surface-apparent opacity.

In serialist terms, a three-step derivation is required: harmony precedes lowering which precedes shortening:

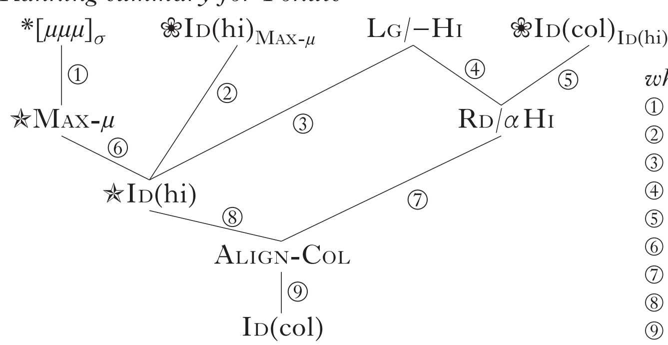
(41) *Yokuts serial derivation*

UR	ʔuːt-hin
Rounding harmony	ʔuːthun
Lowering	ʔoːthun
Shortening	ʔothun

Because rule ordering is transitive, the serial derivation appears to require two intermediate stages, unlike the simpler cases discussed thus far, which are modelled serially with just one intermediate stage.

In sympathy theory, nothing new needs to be said, since rankings that have already been motivated are sufficient to account for the additional data. The constraint rankings and the arguments for them are summarised in the following diagram. To keep the two sympathy constraints straight, they are indexed with subscripts to their respective selectors (see §4.1):

(42) *Ranking summary for Yokuts*



where motivated:
① tableau (18)
② tableau (22)
③ tableau (19)
④ note 23
⑤ tableau (32b)
⑥ tableau (20)
⑦ tableau (30)
⑧ note 23
⑨ tableau (30)

This ranking can be applied, without changes or additions, to the doubly opaque /ʔuːt-hin/ → [ʔothun] derivation:

(43) *Analysing* /ʔu:t-hin/ → [ʔothun] *with sympathy*

/ʔu:t-hin/	*[μμμ]$_σ$	❀Id (hi)$_{\text{Max-}μ}$	Lg/ −Hi	❀Id (col)$_{\text{Id(hi)}}$	☆Max- μ	Rd/ αHi	☆Id (hi)	Align-Col	Id (col)
☞ a. ʔothun					*	¡*	¡*		*
☜, ❀$_{\text{Id(hi)}}$ b. ʔuthun		*!			*		✓		*
❀$_{\text{Max-}μ}$ c. ʔo:thin	*!			*!	✓		*	*	
☜ d. ʔothin				*!	*		*	*	
e. ʔu:thun	*!	*!	*!		✓		✓		*
f. ʔu:thin	*!	*!	*!	*!	✓		✓	*	
g. ʔo:thun	*!				✓	*	*		*

Since the selection of one sympathetic candidate cannot influence the other, we can consider each separately. In (43), the set of candidates that obey the selector Ident(high) includes (43b, e, f). Of these, (43b) ❀[ʔuthun] is the most harmonic (disregarding, as usual, the sympathetic faithfulness constraints) and is therefore selected as $ℵ_{\text{Ident(high)}}$. Similarly, the set of candidates that obey the other selector, Max-$μ$, includes (43c, e, f, g), with (43c) ❀[ʔo:thin] being the most harmonic. Each sympathetic candidate exercises its influence on the outcome through its respective sympathy constraint. One sympathy constraint requires that ❀$_{\text{Ident(high)}}$[ʔuthun] be matched for Colour; the other sympathy constraint requires that ❀$_{\text{Max-}μ}$[ʔo:thin] be matched in the feature [high]. The actual output (43a) [ʔothun] matches in both.

The results are the same if the sympathy relation is expressed by cumulativity. The sets of IO faithfulness violations associated with the interesting candidates are these:

(44) *Accumulated IO faithfulness violations of candidates in* (43)

/ʔu:t-hin/	Max-$μ$	Id(hi)	Id(col)
☞ a. ʔothun	*	*	*
☜, ❀$_{\text{Id(hi)}}$ b. ʔuthun	*		*
❀$_{\text{Max-}μ}$ c. ʔo:thin		*	
☜ d. ʔothin	*	*	
e. ʔu:thun			*
f. ʔu:thin			
g. ʔo:thun		*	*

If it is to be applied successfully, cumulativity must favour the actual output (44a) over its transparent competitors in (44b, d). (The remaining candidates in (44) have been shaded, since they fatally violate undominated

*[$\mu\mu\mu$]$_\sigma$.) ❀CUMUL$_{\text{ID(hi)}}$ is satisfied by any candidate with a superset of ❀$_{\text{IDENT(high)}}$[ʔuthun]'s faithfulness violations. One of the transparent candidates, (44d) [ʔothin], has a partly disjoint set of violations, so it receives a fatal mark from ❀CUMUL$_{\text{ID(high)}}$. Likewise, ❀CUMUL$_{\text{MAX-}\mu}$ is satisfied by any candidate with a superset of ❀$_{\text{MAX-}\mu}$[ʔoːthin]'s faithfulness violations. That requirement is deadly to the other transparent candidate. In short, substituting the respective ❀CUMUL constraints for the sympathy constraints in (43) produces the same outcome.

The really striking thing about Yokuts is that it shows that sympathetic candidates need not be identical to the intermediate stages of serial derivations. Neither of the sympathetic candidates in (44), ❀$_{\text{IDENT(high)}}$[ʔuthun] and ❀$_{\text{MAX-}\mu}$[ʔoːthin], occurs as the intermediate stage of the serial derivation (41). Though convergence between the sympathetic candidate and serialism's intermediate stage is usual with simple opaque interactions, it is not observed in situations of multiple opacity. Multiprocess opaque interaction, then, is a point of significant divergence between sympathy and rule-based serialism.

This divergence has empirical consequences, as the following hypothetical examples show. Imagine a phonological process that, in a serial derivation, crucially applied to the intermediate stage [ʔuːthun] (45a) or the intermediate stage [ʔoːthun] (45b):

(45) *Two hypothetical variations on Yokuts*

a.	UR	ʔuːt-hin	
	Rounding harmony	ʔuːthun	
	Labialisation I	ʔuːt^{w}hun	C → C^w/uː __ C$_0$u
	Lowering	ʔoːt^{w}hun	
	Shortening	ʔot^{w}hun	
b.	UR	ʔuːt-hin	
	Rounding harmony	ʔuːthun	
	Lowering	ʔoːthun	
	Labialisation II	ʔoːt^{w}hun	C → C^w/oː __ C$_0$u
	Shortening	ʔot^{w}hun	

The rules of labialisation were contrived to force these particular orderings. They are not especially realistic, but of course that has nothing to do with how they interact in a serial derivation.

To recast (45a, b) in sympathy terms, it would be necessary to designate ❀[ʔuːt^{w}hun] and ❀[ʔoːt^{w}hun] as sympathetic candidates. They would then transmit labialisation of the [t^w], via a sympathy constraint, to the actual output form. But in reality there is no way to designate either one of them as sympathetic candidates, because neither is the most harmonic candidate that obeys any specific faithfulness constraint. This can be quickly determined by looking at their counterparts in (43), [ʔuːthun] (43e) and

[ʔo:thun] (43g). Neither of these candidates is accessible with sympathy because neither is $\aleph_F$ for any faithfulness constraint F.[28]

In (45), then, we have two hypothetical examples of impeccable serial derivations that cannot be modelled with sympathy. This proves (and the results of the following section confirm) that multi-process opaque interaction is the locus of a major empirical difference between sympathy and rule-based serialism. By judicious exercise of rule ordering, serialism has quite precise control over multi-process interaction, as the different dispositions of labialisation in (45a, b) reveal. Sympathy is more limited; it can deal with some situations of multi-process interaction, as in real Yokuts, but not these hypothetical cases. In this respect and in others, sympathy is a more restrictive theory than serialism.

What precisely is this difference, and how well do the predictions of the two theories match the facts? The rules of labialisation in (45) apply to intermediate representations that are themselves doubly opaque. Intermediate [ʔu:thun], which is the input to labialisation in (45a), is non-surface-true with respect to both shortening and lowering. Intermediate [ʔo:thun], which is the input to labialisation in (45b), is non-surface-true with respect to shortening and non-surface-apparent with respect to harmony. In contrast, legitimate sympathetic candidates are at most singly opaque. For example, (43c) ❀[ʔo:thin] is non-surface-true with respect to shortening, and (43b) ❀[ʔuthun] is not opaque at all. This follows from the nature of selection: a sympathetic candidate is guaranteed to obey one faithfulness constraint, which may lead to a process being non-surface-true, but otherwise it accords with the remaining (transparent) phonology of the language. In general, rule-based serialism allows opacity nested within opacity in multi-process systems, but sympathy does not.

As for the match between prediction and facts, future research will have to decide. Though serial derivations are, of course, routinely employed, and there are many analyses to choose from, I am not acquainted with any work that has systematically explored the typology of multi-process interactions in rule-based serialism. A project like this would help to determine falsifiability conditions for serialism and create a basis for a more complete comparison between serialism and sympathy.

Before leaving Yokuts, I need to tidy up three remaining details: an apparent restriction on underlying representations; a raising process in the Wikchamni dialect; and the place of transparent interactions in this system. I consider each in turn.

Standard rule-based analyses of this language assume that there is a

[28] One conceivable way of getting ❀[ʔu:tʷhun] is to loosen sympathy theory by allowing conjoined faithfulness constraints to act as selectors, since this candidate is the most harmonic one that obeys *both* MAX-μ and IDENT(high). Similarly, one could select ❀[ʔo:tʷhun] with the markedness-faithfulness conjunction ALIGN-COLOUR & MAX-μ. Despite their seeming plausibility, though, these approaches do not generalise and do not even work for the cases mentioned. The problem is the same as the one identified in §6.1, when local conjunction of faithfulness constraints was rejected as a theory of non-surface-true opacity: the domain of conjunction cannot be defined, since it is the span in which two arbitrary phonological processes actually interact.

morpheme structure constraint ruling out underlying short and long /e/, limiting the underlying vowel system to short and long /i a o u/. Thus, all surface [e]'s, short or long, are derived from underlying /iː/ by lowering (and shortening). This assumption is necessary to explain why surface short [e] is found only in closed syllables, where it can be regularly derived from /iː/.[29] But this assumption cannot be carried over directly into OT (cf. Archangeli & Suzuki 1997: 205ff), because of richness of the base (see §3.2). Rather, in OT, the key is understanding the input → output mappings involved.

For reasons already discussed, underlying /i/ maps to surface [i], but /iː/ maps to [e] in a closed syllable or [eː] in an open syllable. (Suffix vowels may also show the effects of harmony, which I disregard as irrelevant in the present context.) We have no direct evidence of the disposition of underlying /e/ or /eː/, which are present in the rich base; the key is to assume that they map unfaithfully to surface [a(ː)]. We then have the following mappings:

(46) *IO mappings of non-round root vowels in Yokuts*

input	*output*	*context* (*when relevant*)
/i/	[i]	open or closed syllable
/iː/	[e]	closed syllable only
	[eː]	open syllable only
/e/	[a]	open or closed syllable
/eː/	[a]	closed syllable only
	[aː]	open syllable only
/a/	[a]	open or closed syllable
/aː/	[aː]	open syllable only

The important point is that, by assumption, underlying /e(ː)/ always maps to surface [a(ː)], never surviving unscathed. Surface [e(ː)] is always the result of an unfaithful mapping, accounting for its restricted distribution.

The situation described in (46) is just a chain shift: [iː] → [e(ː)] → [a(ː)]. We have already seen techniques for analysing chain shifts (§6.1), so it is not necessary to dwell on this. The idea is that the /iː/ → [a(ː)] mapping is ruled out as too unfaithful by some high-ranking constraint or constraint conjunction. Furthermore, as a check, we need to make sure that the unfaithful mappings affecting underlying /e(ː)/ will not lead to unwanted opacity effects. They will not: from the input /CeːC-hin/, the output will be [CaChin], with no visible influence from ❀$_{\text{Ident(high)}}$[CaChin] or ❀$_{\text{Max-}\mu}$ [CaːChin]. So there are no barriers to incorporating this chain shift into the analysis.

A second detail involves the interaction of the rest of Yokuts phonology with a vowel-raising process found in the Wikchamni dialect (Archangeli

[29] There are also various indirect arguments for underlying /iː/ as the source of all surface [e(ː)] in Yokuts (see Kenstowicz & Kisseberth 1979: 91ff).

& Suzuki 1997: 218ff). Raising changes [o] to [u] if the next syllable contains [i]:

(47) *Wikchamni raising* (Archangeli & Suzuki 1997: 218)

	/t'oyx-in/	t'uyxin	'will doctor'
	/potk'-in/	putk'in	'will sour'
cf.	/t'oyx-at/	t'oyxot	'might doctor'
	/potk'-at/	potk'ot	'might sour'
	/tawt-in/	tawtin	'will run'

Examples like /t'oyx-in/ → [t'uyxin] show that raising interacts opaquely with rounding harmony, just as lowering does. This behaviour is predicted by sympathy theory – though obviously not by rule-based serialism. As I argued in §3.2, if two distinct processes produce identical faithfulness violations, then they cannot differ in rendering a third process opaque. Both raising and lowering lead to violations of IDENT(high), and so if one interacts opaquely with harmony, both must. Wikchamni, then, supports this prediction.[30]

The last remaining detail concerns the role of certain transparent interactions in Yokuts phonology. Epenthesis of [i] interacts transparently with harmony (48a) and shortening (48b). Apocope also interacts transparently with shortening (48c):

(48) *Some transparent interactions in Yokuts*

a. *Epenthesis and harmony*

	/luk'l-hin/	luk'ulhun	cf. luk'lal	'buries/might bury'
cf.	/logw-hin/	logiwhin	cf. logwol	'pulverises/might pulverise'
	/ʔilk-hin/	ʔilikhin	cf. ʔilkal	'sings/might sing'

b. *Epenthesis and shortening*

/ʔa:ml-hin/	ʔa:milhin	cf. ʔamlal	'helps/might help'
/mo:yn-mi/	mo:yinmi	cf. moynol	'having become tired/ might become tired'

c. *Apocope and shortening*

/ʔili:-k'a/	ʔilek'	cf. giy'k'a	'fan!/touch!'
/c'uyu:-k'a/	c'uyok'	cf. dubk'a	'urinate!/lead by the hand!'
/taxa:-k'a/	taxak'	cf. xatk'a	'bring!/eat!'

Some reasoning reveals why these interactions are transparent. Since DEP constraints are not among the designated selectors in Yokuts, epenthesis

[30] As I emphasised previously (note 13), this prediction of sympathy theory can only be evaluated in the context of specific assumptions about what faithfulness constraints are supplied by Universal Grammar. In the case of Wikchamni, the prediction rests on the assumption that IDENT constraints are symmetric over [+F] and [−F]. Pater (1999), among others, has questioned this assumption, but recent work by Prince (1998) supports it.

will not be a source of opacity. Significantly, epenthesis of a high vowel does not violate IDENT(high), according to the definition of IDENT constraints given in McCarthy & Prince (1995, 1999). As for apocope, let us assume that it incurs a violation of MAX-μ – i.e. the same faithfulness constraint that is violated by vowel shortening. This means, for reasons discussed in §3.2, that apocope must show the same opaque interactions as shortening. In practice, it is impossible to decouple the two processes, so the prediction is satisfied somewhat trivially. For instance, from input /ʔiliː-k'a/ there will be a sympathetic candidate ❀$_{\text{MAX-}\mu}$[ʔileːk'a], without apocope or shortening, and it will be responsible for the opaque output [ʔilek']. Clearly, there is no problem with incorporating these additional data into the analysis.

7.2 Further differences from rule-based serialism: the Duke of York gambit

To my knowledge, there have been no studies dealing with the general properties of multi-process interaction in rule-based serialism.[31] But Pullum's (1976) article on the DUKE OF YORK GAMBIT suggests one possible entry into this complex topic. In a Duke of York (DY) derivation, two phonological processes with contradictory effects are ordered so that one undoes the effect of the other (thereby rendering it opaque). Potentially, a third process is also involved, applying at the intermediate stage between the contradictory processes.

In this section, I will examine two- and three-process DY interactions for what they can tell us about opacity, sympathy and serialism. I will first show that two-process DY interactions are completely compatible with classic OT – though there is no derivation where one process reverses the effects of another. It is important that OT be compatible with two-process DY systems, because they are abundant. I will then look at several multi-process DY interactions. This discussion has two main goals: to discover differences among the variant executions of the basic sympathy idea (faithfulness as selector *vs.* faithfulness or markedness as selector, inter-candidate faithfulness *vs.* cumulativity); and to argue in favour of sympathy over rule-based serialism, on the grounds that convincing cases of multi-process DY do not seem to exist. Therefore, multi-process opacity of the DY type is another locus of a major empirical difference between sympathy and rule-based serialism.

All of the DY examples cited by Pullum (1976) are of the two-process type. For instance, in Nootka (Campbell 1973, Sapir & Swadesh 1978), there is a contrast between plain and labialised dorsals (velars and uvulars). This contrast is neutralised in two situations: the plain dorsals

[31] Some of this material is dealt with at greater length in McCarthy (to appear), which should be consulted for further details and exemplification. I am particularly grateful to Junko Itô, Ed Keer, Paul Kiparsky, Paul de Lacy, Ania Łubowicz, Armin Mester and Alan Prince for comments related to this section.

become labialised after round vowels (49a), and the labialised dorsals lose their rounding at the end of a syllable (49b). These two processes interact in words that have a syllable-final dorsal after a round vowel (49c), with delabialisation taking priority through serial ordering:

(49) *Nootka labialisation and delabialisation* (Campbell 1973, Pullum 1976, Sapir & Swadesh 1978)

a. *Labialisation*: $\mathrm{K} \rightarrow \mathrm{K}^{w} / \underset{[\text{round}]}{\mathrm{V}}$ __

/kiːɬ/ ʔokʷiːɬ cf. kiːɬ 'making it/making'

b. *Delabialisation*: $\mathrm{K}^{w} \rightarrow \mathrm{K} / \_\_]_{\sigma}$

/ɬaːkʷ/ ɬaːk.ši(tl̥) cf. ɬaː.kʷiqnak 'to take pity on/pitiful'

c. *DY serial derivation*

UR	ʼmoːq	cf. ʼmo.qʷak 'phosphorescent'
Labialisation	ʼmoːqʷ.	
Delabialisation	ʼmoːq.	'throwing off sparks'

Delabialisation is decisive because it gets the last crack at the word. This is a classic DY derivation: two rules with contradictory structural changes and overlapping structural descriptions produce A → B → A derivations in circumstances where both structural descriptions are met.[32]

The DY derivation in (49c) is opaque. The labialisation process is non-surface-true in words like [ʼmoːq], since its application is masked by subsequent delabialisation. But, like some other instances of non-surface-true opacity (see note 1), this one does not require sympathy. Rather, it is simply a matter of conflicting markedness constraints, resolved in classic OT by ranking:

(50) /ʼmoːq/ → [ʼmoːq] *in Nootka*

/ʼmoːq/	$*\mathrm{K}^{w}]_{\sigma}$	$*\underset{[\mathrm{rd}]}{\mathrm{V}}\mathrm{K}$	Id(rd)
☞ a. ʼmoːq		*	
b. ʼmoːqʷ	*!		*

Obviously, there is no literal A → B → A derivation in (50). Instead, there is a choice between A and B, resolved like all such choices in OT, by harmonic evaluation. All two-process DY interactions known to me can be reanalysed in this way (McCarthy, to appear).

[32] It might seem that the DY derivation in (49c) could be avoided by setting up a different underlying representation, such as /ʼmoːqʷ/. But this analysis requires a morpheme structure constraint that duplicates tautomorphemically what the labialisation rule does heteromorphemically. It is, then, a typical instance of the Duplication Problem (Clayton 1976, Kenstowicz & Kisseberth 1977).

In contrast to the well-attested two-process DY interaction, multi-process DY interactions may not exist at all. Specifically, there do not seem to be any good cases of feeding DY derivations, where A changes to B, then B conditions some third process and finally B changes back into A.[33] A simple hypothetical example will serve to illustrate:

(51) *Hypothetical three-process DY derivation I*

UR		barki
Epenthesis	$\emptyset \rightarrow ə/C]_\sigma$ __	barəki
Spirantisation	$[-\text{nas}] \rightarrow [+\text{cont}]/\text{V}$ __	barəxi
Syncope	$\text{V} \rightarrow \emptyset/\text{VC}$ __ CV	barxi

Epenthesis after coda consonants feeds a process of postvocalic spirantisation, but then the epenthetic vowel, among others, is deleted. Clearly, the rules involved in this derivation are completely natural, and their interaction is entirely compatible with the assumptions of rule-based serialism. But if real languages like this do not in fact exist – and I claim that they don't – then we have here a situation where rule-based serialism significantly overgenerates. By examining this and other hypothetical examples, I will show that sympathy theory does not share this liability. I will also use this as a basis to argue for certain specific properties of sympathy theory, settling certain questions that were first raised in §§3.3 and 4: whether markedness constraints can act as selectors, and how the sympathy relation is expressed.

First, some analysis. The hypothetical language exemplified in (51) has three processes, and their basic phonology is given by the (mostly ad hoc) constraints and rankings in (52):

(52) *Basic phonology of* (51a) *in OT terms*

NoCoda ≫ Dep-V	Epenthesis to eliminate codas
*VStop ≫ Ident(cont)	Postvocalic spirantisation
*VCVCV ≫ Max-V	Syncope to eliminate VCVCV sequence

There is in addition a crucial ranking between two markedness constraints (as in the two-process DY case (50)): *VCVCV must dominate NoCoda, since outputs like [barxi] show that *VCVCV takes precedence in forms where both of these constraints are relevant.

Now, with this much of the analysis in hand, we can ask whether it is possible to reproduce the DY derivation in (51) within sympathy theory. The idea is to select ❀[barəxi] as the sympathetic candidate. An appropriate sympathy constraint will then favour ☞[barxi] over its transparent competitor ☜[barki] on the grounds that ☞[barxi] shares ❀[barəxi]'s

[33] Some possible examples are examined in McCarthy (to appear), which also contains discussion of multi-process bleeding DY derivations, where the intermediate stage waits out a process that would otherwise affect it.

spirant. Momentarily setting aside the crucial problem of how ❀[barəxi] is selected, we get the following tableau:

(53) *Attempting to simulate* (51) *with sympathy*

	/barki/	$*[CV]_{\sigma}$	*VStop	❀Id (cnt)	NoCoda	Max-V	Id (cnt)	Dep-V
opaque	☞ a. barxi				*		¡*	
transparent and faithful	☜ b. barki			*!	*			
sympathetic	❀ c. barəxi	*!					*	*
	d. barəki	*!	*!	*!				*

The tableau appears to produce the right result, but it is incomplete until the selector constraint has been identified. In fact, there is none. If only faithfulness constraints can be selectors, in accordance with Confinement (7b), then it follows as a matter of logic that the sympathetic candidate must be more faithful on some dimension than its transparent competitor. (The transparent candidate is guaranteed to be the winner otherwise; that is precisely what makes it transparent.) But ❀[barəxi] is less faithful than ☜[barki] on every dimension where they differ, since ☜[barki] is fully faithful. Therefore, no faithfulness constraint can act as selector of ❀[barəxi].

The upshot: the DY derivation in (51) cannot be simulated with a faithfulness-based selector. With respect to multi-process DY interactions, sympathy theory is more restrictive than rule-based serialism, arguably providing a better match between theory and observation.

Under the hypothesis that markedness constraints can also be designated as selectors (see the discussion and references in §3.3), this result could be subverted. The sympathetic candidate ❀[barəxi] could be chosen by designating NoCoda to be the selector. In that way, a spurious phonological process, epenthesis in a VC __ CV context, is given quasi-authentic status in order to produce a side-effect of spirantisation. If, as I claim, real cases like this do not exist, then the ability of markedness-as-selector to simulate (51) must be counted as a strike against that looser hypothesis.

Another hypothetical example shows that, under the right circumstances, even faithfulness-as-selector can reproduce a side-effect of a spurious phonological process:

(54) *Hypothetical three-process DY derivation II*

UR		maːt
Epenthesis	$\emptyset \rightarrow$ i / CVːC$]_{\sigma}$ __	maːti
Palatalisation	t → č / __ i	maːči
Apocope	V → $\emptyset$ / __ #	maːč
Shortening	Vː → V̆ / __ C$]_{\sigma}$	mač

In this example, which was suggested to me by Paul Kiparsky, epenthesis 'repairs' a superheavy syllable. The epenthetic vowel then triggers palatalisation, only to be deleted by a later rule of apocope. Finally, the superheavy syllable is re-repaired by shortening. Clearly, every process in (54) is quite natural, and the ordering is certainly compatible with the tenets of rule-based serialism, yet the system as a whole seems quite dubious.

The basic phonology of the language, which includes two ways of 'repairing' trimoraic syllables and a palatalisation process, is given by the following rankings:

(55) *Basic phonology of* (54) *in OT terms*

$*[\mu\mu\mu]_\sigma \gg$ Dep-V	Trimoraic syllables are repairable by epenthesis.
$*[\mu\mu\mu]_\sigma \gg$ Max-μ	Trimoraic syllables are repairable by shortening.
Dep-V $\gg$ Max-μ	Shortening is preferred to epenthesis.
*ti $\gg$ Ident(high)	There is palatalisation.

To simulate the DY derivation, the actual output ☞[mač] must be preferred to its transparent competitor ☜[mat] on the basis of sympathy to ❀[maːči]. Since ❀[maːči] is more faithful than ☜[mat] on some dimension, there is no problem in designating a selector constraint, ✫Max-μ. Furthermore, inter-candidate faithfulness can effectively carry [č] from the sympathetic candidate to the actual output, as the following tableau shows:

(56) *Simulating* (54) *with faithfulness as selector and inter-candidate faithfulness*

	/maːt/	$*[\mu\mu\mu]_\sigma$	*ti	❀Id(hi)	Id(hi)	Dep-V	✫Max-μ
opaque	☞ a. mač				¡*		*
transparent	☜ b. mat			*!			*
sympathetic	❀ c. maːči				*	*!	✓
	d. maːt	*!		*!			✓
	e. maːti		*!	*!		*	✓
	f. maːč	*!			*		✓

The most harmonic candidate that obeys ✫Max-μ is ❀[maːči], and the sympathy constraint ensures that the output matches its palatalised [č]. In this more complex case, then, sympathy with faithfulness-as-selector and inter-candidate faithfulness constraints overgenerates like rule-based serialism.

This hypothetical example highlights an important difference between the two theories of how the sympathy relation is expressed, inter-candidate faithfulness *vs.* cumulativity (see §4). Inter-candidate faithfulness constraints allow essentially any arbitrary property, as long as it can be expressed using a correspondence constraint, to be transmitted from the sympathetic candidate to the actual output form. That is crucial in (56). In contrast, cumulativity allows only the IO faithfulness violations of the sympathetic candidate to influence the output – candidates are checked (in a way made precise in §4.2) to see whether their faithfulness violations are similar to those of the sympathetic candidate. Cumulativity does not produce a result like (56), as one can determine by a quick inspection. High-ranking ❀CUMUL is satisfied only by candidates that have a superset of ❀[ma:či]'s IO faithfulness violations, ⟦IDENT(high), DEP-V⟧; none do, except for ❀[ma:či] itself. Therefore, substituting ❀CUMUL for ❀IDENT(high) in (56) will not produce the intended result. So sympathy with cumulativity cannot simulate the DY derivation (54). This is a desirable result, since real examples like (54) arguably do not exist. Obtaining that result requires that we adopt cumulativity over inter-candidate faithfulness as the basis for the sympathy relation.

Indeed, cumulativity is incompatible with a wide range of multi-process DY interactions. The reason for this is not far to seek: ❀CUMUL bans the 'undoing' effect that is virtually definitional for DY. In a DY derivation, the final step undoes the rule that applied in the first step. This means that the final step does not accumulate all of the unfaithful mappings of its derivational predecessors. As I noted earlier, the equivalent of cumulativity in rule-based serialism would be some sort of monotonicity requirement: derivations can never back-track, but can only move progressively further away from the input. DY derivations are, by their nature, non-monotonic in this sense.

For this reason, cumulativity excludes a very wide range of DY interactions – including (51), even if markedness constraints are allowed to function as selectors. But the notion of a DY derivation is loose enough to allow interactions that, strictly speaking, are cumulative. Here is an example, suggested by the associate editor:

(57) *Hypothetical three-process DY derivation III*

UR		ka:ti
Apocope	$V \rightarrow \emptyset / \_\_]_{Word}$	ka:t
Shortening	$V\!: \rightarrow \breve{V} / \_\_ C]_{\sigma}$	kat
Augmentation	$\emptyset \rightarrow i / [CVC \_\_]_{Word}$	kati

A process of apocope deletes final vowels, leading to closed-syllable shortening. But monosyllabic words are sub-minimal, violating FOOT BINARITY (FTBIN), and so [kat] is augmented by epenthesis, which appears to undo the effect of apocope.

This derivation is technically cumulative, because the [i] inserted by augmentation is not literally the same as the one deleted by apocope, despite obvious resemblances. Correspondence theory, which requires precision in such things, makes the difference clear by using indices to express the correspondence relation that is proper to each individual candidate. From input /ka:ti$_j$/, there are two formally distinct output candidates, [$kati_j$] and [$kati_k$]. The latter, with non-correspondent [i], is the counterpart to the output in (57).[34]

Keeping this in mind, let's proceed to the analysis. The basic phonology of apocope, closed syllable shortening and augmentation in this hypothetical language is given by the ad hoc constraints ranked as in (58):

(58) *Basic phonology of* (57) *in OT terms*

$*V]_{Word} \gg$ MAX-V	Apocope
$*[\mu\mu\mu]_\sigma \gg$ MAX-μ	Closed syllable shortening
FTBIN $\gg$ DEP-V	Augmentation of monosyllables (to ensure foot binarity)

In addition, FTBIN must dominate $*V]_{Word}$, to force augmentation even though it involves creating the configuration that apocope eliminates. To simulate the DY derivation (57) using sympathy, the selector must choose ❀[kat], with apocope and consequent shortening, as the sympathetic candidate. But because ❀[kat] is less faithful than ☜[kaːti] on every dimension where they differ, faithfulness cannot be used to select ❀[kat]. Under the regime where markedness constraints can be selectors, however, it is possible to choose ❀[kat], since it is the most harmonic candidate that obeys $*V]_{Word}$. The following tableau shows that sympathy, if markedness constraints are permitted to be selectors, can simulate this DY derivation:

(59) *Simulating* (57) *with markedness as selector*

	/$ka{:}ti_j$/	FTBIN	$*[\mu\mu\mu]_\sigma$	❀CUM	✯$*V]_{Wd}$	DEP-V	MAX-μ	MAX-V
opaque	☞ a. $kati_k$				*	*	¡*	*
transparent and faithful	☜ b. $ka{:}ti_j$			*!	*			
sympathetic	❀ c. kat	*!			✓		*	*
	d. $kati_j$			*!	*		*	
	e. $ka{:}ti_k$			*!	*	*		*
	f. kaːt	*!	*!	*!	✓			*

I have used ❀CUMUL in this tableau to emphasise that either way of expressing the sympathy relation leads to the same result. The key is using the markedness constraint ✯$*V]_{Word}$ as the selector, since it chooses ❀[kat] as the sympathetic candidate. Any candidate that satisfies ❀CUMUL will have to share ❀[kat]'s faithfulness violations, MAX-μ and MAX-V. The output form does, because it is derived by deleting and then reinserting [i], but its transparent competitor does not. Thus, this tableau shows that an unattested and arguably impossible type of DY derivation can be simu-

[34] In other words, the minimality requirement undoes, rather than merely blocks, the effect of apocope. Compare Prince & Smolensky (1993: 111f).

lated in sympathy theory if markedness constraints can be selectors. The more restrictive hypothesis, where only faithfulness constraints can be selectors, is supported.

To sum up, I have discussed some aspects of Duke of York derivations. Two-process DY, where one rule undoes the effect of a previous rule but nothing crucially happens at the intermediate stage, is well attested and can be modelled in classic OT simply by the ranking of markedness constraints. But convincing cases of three-process DY, where another rule requires the intermediate stage in order to apply, may not exist at all. Rule-based serialism fails to distinguish between these two types of DY derivations, leading to significant overgeneration. In contrast, sympathy theory makes considerable headway toward providing a principled basis for excluding three-process DY interactions. If the sympathy relation is expressed by cumulativity, then a wide range of logically possible but non-occurring three-process DY systems cannot be modelled. The requirement that selector constraints be drawn from the faithfulness family excludes other three-process DY systems, such as (57). It is not yet clear whether these limitations exclude all imaginable three-process DY systems, though further research might be expected to answer this question, to sharpen the empirical basis for these claims, and to determine whether rule-based serialism can yield comparable results.

8 Other approaches to opacity in OT

The problem that opacity poses for OT has been recognised since the inception of the theory (see the references in §1), and so there are many previous attempts to deal with it. They include outright denial, approaches taken within the basic faithfulness model, extensions of faithfulness to relations among surface forms within paradigms and proposals to combine OT with serialism. In this section I will sketch each of these approaches and, where appropriate, compare them to sympathy.

Many of the most interesting ideas about how to analyse opacity in OT have involved specific phonological phenomena. 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, 1998, Casali 1997), Head-Dep, that requires output stressed vowels to have input correspondents.[35] Optimal Domains Theory posits feature-domain structures that may be based on underlying rather than surface feature specifications, supplying an account of opaque processes of assimilation like Yokuts (Cole & Kisseberth 1995). Many analysts have analysed assimilation with deletion of the triggering segment (e.g. French /vin/ → [vĩn] → [vĩ] → [vɛ̃])

[35] 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).

as phonological coalescence, skirting the opacity problem by folding two derivational steps into one (Causley 1997, Gnanadesikan 1995, 1997, Lamontagne & Rice 1995, McCarthy 1995, McCarthy & Prince 1995, Pater 1996).

However successful they are in dealing with specific types of opacity, none of these ideas extends to the full range of observed opacity phenomena. The alternatives sketched below, though, offer more comprehensive proposals.

8.1 Denial

One obvious strategy is simply to deny that opaque interactions exist.[36] The premise that opacity is not 'psychologically real' is a tenet of the theory of Natural Generative Phonology (Hooper [Bybee] 1976, Vennemann 1974), sometimes carried over, at least in part, into other frameworks (Koutsoudas *et al*. 1974). One problem with this move is that opaque generalisations have exactly the same character as transparent generalisations, except for being opaque. Thus, the claim that opaque generalisations have a distinct status may be empty, if nothing correlates with this putative distinction. Another problem is that there is a significant body of literature arguing that some opaque generalisations are supported by external evidence of their psychological reality: speech errors (Fromkin 1971); language games (Al-Mozainy 1981, Sherzer 1970); historical change (Dresher 1981); versification (Halle & Zeps 1966, Zeps 1973); language acquisition (Dinnsen *et al*. 1998, Kisseberth 1976); and intra- or inter-dialectal variation (Bromberger & Halle 1989, Donegan & Stampe 1979). (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 proves the productivity of the Bedouin Arabic [a]-raising process in (3). It seems clear, then, that the move of simply discarding all opaque generalisations is not very promising.

8.2 Faithfulness-based approaches to opacity

Other 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 (9), for example,

[36] Thanks to Bruce Hayes and Robert Kirchner for their challenges on this point.

rightward spreading of nasality is blocked by oral consonants, even if they have been (optionally) deleted. In terms of PARSE/FILL faithfulness theory, the true representation of the output in (9c) is [nãŋ⟨g⟩aʔ], with a latent, syllabically unparsed [g]. The presence of the unparsed [g] means that, segmentally, the output in (9c) is the same as that in (9b), and it equally shows the blocking effect of oral consonants on nasal harmony.

In the correspondence theory of faithfulness (McCarthy & Prince 1995, 1999), the output stands in a correspondence relation to the input. Correspondence permits the formulation of TWO-LEVEL CONSTRAINTS (cf. Archangeli & Suzuki 1997, Cole & Kisseberth 1995, Goldsmith 1993b, Karttunen 1993, Koskenniemi 1983, Lakoff 1993, McCarthy 1996, Orgun 1996a). For Sea Dayak, one can say that an output vowel must be nasalised 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 (1996: 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). 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.[37]

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 vocalisation, so raising is conditioned by syllabification that is different from the surface: /badw/ → $[\text{badw}]_\sigma$ *vs.* surface $[\text{ba}]_\sigma[\text{du}]_\sigma$. In this way, surface open syllables created by glide vocalisation 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]. Tiberian Hebrew (2) presents much the same problem.

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 because it runs afoul of the OT premise of richness of the base

37 Sprouse's (1997, 1998) theory of 'enriched input sets' is a proposal for addressing this problem with two-level models.

(see §3.2). 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 way, as /$[\text{badw}]_\sigma$/ and not /$[\text{ba}]_\sigma$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 (Clayton 1976, Kenstowicz & Kisseberth 1977).

Bedouin Arabic, Tiberian Hebrew and similar cases show that there is a class of opacity phenomena that cannot be analysed 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.[38]

8.3 Opacity via OO faithfulness

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) and others posits faithfulness relations among surface forms within paradigms, from one output form (called the 'base') to another. 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 in (60) can be analysed in OO terms (though see Grijzenhout & Kraemer 1999, Peperkamp 1997):

(60) *Devoicing and resyllabification in Dutch* (Booij 1995, 1996, 1997)

a. *Final devoicing*
   /vɔnd/ → vɔnt 'found'

b. *Resyllabification*

c. *Interaction : Devoicing → Resyllabification*
   /vɔnd ɪk/ → vɔnt.ɪk → vɔn.tɪk 'I found'

The otherwise unexpected devoicing in [vɔn.tɪk] can be analysed as an effect of OO faithfulness to the base [vɔnt], where devoicing occurs transparently.

Though OO faithfulness is appropriate for many phenomena, it does not provide a complete solution to the opacity problem (on this point, see also Benua 1977, Booij 1996, 1997, Itô & Mester 1997c, Karvonen &

[38] But see Goldrick & Smolensky (1999) for an approach to opacity which is conceptually related to the PARSE/FILL model but does not share its liabilities.

Sherman 1998, Noyer 1997, Paradis 1997, Rubach 1997). 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 some 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 coda [ʔ], but [ʔ] never actually appears in coda position.

The same problem for OO faithfulness – transparency nowhere in the paradigm – arises whenever an underlying phonological contrast undergoes absolute neutralisation. 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 (Borg 1997, Brame 1972). One such process lowers vowels next to pharyngeal consonants (61a). This process is conditioned opaquely by the deleted /ʕ/ (61c):

(61) *Absolute neutralisation in Maltese*
- a. *Gutturals trigger vowel lowering* (*etc.*)
  /nimsiħ/ → nimsa̲ħ 'I wipe'
- b. *Absolute neutralisation*: ʕ → ∅
- c. *Interaction : Lowering → Neutralisation*
  /nismiʕ/ → nisma̲ʕ → nisma_ 'I hear'

Nowhere in the paradigm of /smiʕ/ or, indeed, any other word of standard Maltese is the /ʕ/ preserved on the surface, to condition lowering transparently. Thus, there is no base for a putative OO faithfulness constraint to refer to. Similarly, in Barrow Inupiaq (Archangeli & Pulleyblank 1994), palatalisation is triggered by an [i] derived from underlying /i/ (62a), but it is not triggered by a phonetically identical [i] derived from /ɨ/ (or perhaps archisegmental /I/) (62c):

(62) *Absolute neutralisation in Barrow Inupiaq*
- a. *Palatalisation after* [i] (*can skip consonants*)
  /savig-lu/ → savigʎu 'wound + be able'
- b. *Absolute neutralisation*: /ɨ/ → [i]
- c. *Interaction*: *Palatalisation → Neutralisation*
  /kamɨk-lu/ → *n/a* → 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 palatalise the following [l].

Since OO faithfulness cannot supplant sympathy, we must naturally ask whether sympathy can supplant OO faithfulness (as Itô & Mester 1997c and Joe Pater (personal communication) have conjectured). Many cases where OO faithfulness have been invoked are like the Dutch example in

(60): a morphologically complex form shows phonological behaviour attributable to the prosodisation of the corresponding simplex form. Arguably, all such cases can be reanalysed using sympathy if the selector constraint is ✭ANCHOR(Stem, PrWd). ANCHOR constraints are the successor to the MCat-PCat alignment constraints of McCarthy & Prince (1993a). Unlike alignment, however, they are part of the correspondence-based faithfulness system (McCarthy & Prince 1995, 1999), and so they are legitimate selectors under Confinement (7b). ✭ANCHOR(Stem, PrWd) demands that the left (respectively right) edge of the input stem stand at the left (respectively right) edge of an output prosodic word; hence, it selects sympathetic candidates that are prosodically closed, with the prosodic structure (and consequent segmental phonology) of a free-standing prosodic word. Therefore, it chooses ❀[vɔnt.ɪk] as the sympathetic candidate from input /vɔnd ɪk/; the actual output [vɔn.tɪk] matches the voicing (though not the syllabification) of the sympathetic candidate.[39]

It follows, then, that decisive examples proving the need for OO faithfulness in addition to sympathy will have to come from cases of 'cyclic' behaviour that are not reducible to prosodic closure in the sense just described. The most compelling cases will involve processes that are utterly insensitive to prosodic constituency (syllable, foot, prosodic word) but still show effects of OO faithfulness (cf. Borowsky 1993: 221ff). Good examples do not immediately come to mind, though obviously this topic needs more study.

8.4 Stratal OT

The remaining theory of opacity in OT is perhaps the most obvious and the most successful:[40] 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. There are two basic ways of doing this, the first little known and the second quite familiar. HARMONIC SERIALISM is introduced and briefly discussed in another context by Prince & Smolensky (1993: 15–20, 79–80).[41] STRATAL OT combines several OT grammars like the strata of Lexical Phonology (for discussion, see Bermúdez-Otero 1999, Booij 1996, 1997, Clements 1997, Cohn & McCarthy 1994, Hale & Kissock 1998, Hale *et al*. 1998, Kenstowicz 1995, Kiparsky 1997a, b, 1998a, McCarthy & Prince 1993b: App., Noyer 1997, Paradis 1997, Potter 1994, Roca 1997b, Rubach 1997). I will examine each of these ideas in turn.

Harmonic Serialism (HS) iterates an OT grammar to produce a serial derivation like that of rule-based phonology. The underlying represen-

39 The syllabificational mismatch has implications for how cumulativity is understood. See McCarthy (to appear).

40 The reviewers and associate editor contributed significantly to improving this section.

41 Further discussion of Harmonic Serialism, with variants, can be found in Black (1993) and Blevins (1997).

tation is submitted to a restricted Gen which is allowed to perform only one elementary operation on each candidate – deletion, insertion, assimilation, etc. The grammar, which is (as usual) a ranking of universal constraints, selects the most harmonic member of this limited candidate set as output. This output then becomes the input to Gen, a new candidate set is formed, and the same grammar (with the same rankings) evaluates it, selecting a new output. When the output equals the old input, the derivation has converged and so it terminates. HS, then, approximates the serial application of a set of rules, with various intermediate stages lying between the input and the final output.

Despite its superficial resemblance to rule-based serialism, HS is not in general able to produce opaque derivations of either the non-surface-apparent or non-surface-true types. Consider non-surface-apparent opacity first, taking Tiberian Hebrew as an example. From the input /dešʔ/, the restricted Gen emits a candidate set including faithful [dešʔ], epenthesising [dešeʔ], deleting [deš], etc. – though not [deše], which differs from the input by two elementary operations. The grammar evaluates this candidate set and selects [deš] as most harmonic, since it violates none of the high-ranking markedness constraints. When [deš] is submitted as input to a new round of Gen and harmonic evaluation, the grammar again emits *[deš], converging on the wrong result. The problem for HS is much the same as the problem for classic OT: [deš] is a kind of fell-swoop candidate that simultaneously solves all structural problems by violating only a low-ranking faithfulness constraint. In a sense, the derivation converges prematurely, before epenthesis has occurred.

With non-surface-true opacity, the problem is that convergence is delayed rather than premature. Given the Bedouin Arabic input /badw/, the restricted Gen will produce candidates like $[\text{badw}]_\sigma$, $[\text{ba}]_\sigma[\text{du}]_\sigma$ and $[\text{bidw}]_\sigma$ – but not $[\text{bi}]_\sigma[\text{du}]_\sigma$. The grammar will select $[\text{ba}]_\sigma[\text{du}]_\sigma$ as most harmonic, and it will serve as input to another round. The candidate set this time includes faithful $[\text{ba}]_\sigma[\text{du}]_\sigma$, $[\text{bi}]_\sigma[\text{du}]_\sigma$ with raising, and other forms. The grammar will wrongly favour $*[\text{bi}]_\sigma[\text{du}]_\sigma$, since it does not have the prohibited configuration of a low vowel in an open syllable. In general, then, HS is not able to accommodate opacity of either type.[42] The problems it encounters are like those that affect classic OT: opacity is unexplained violation of faithfulness or markedness constraints.

Stratal OT (S-OT) is more successful in addressing the phenomenon of opacity. The general 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 (cf. Harmonic Phonology – Goldsmith 1993b). Each hierarchy is distinct from the others – that is, they rank some of the universal constraints differently. In Hebrew, for

[42] HS can deal with a specific kind of opacity. If a process is non-surface-apparent because of joint action by two other processes, there will in general be a solution possible within HS. This situation differs from the one in the text because no fell-swoop candidate is available on the first pass through Gen, precisely because two processes jointly contribute to opacity.

example, some early stratum would take the input /dešʔ/ and give the output [dešeʔ], supplying the epenthetic vowel but not yet deleting the [ʔ]. Some later stratum would receive [dešeʔ] as input and emit [deše] as final output. With more strata, additional layers of opacity are in principle possible.

It is not appropriate or even possible to comment in detail on S-OT, if only because specific implementations are rather diverse and the various assumptions are still evolving. I will, however, make some general remarks that may be helpful in evaluating any present or future implementation of S-OT and comparing it to sympathy.

One issue that arises is that of permissible differences among strata within a single language (Benua 1997). Without additional principles, S-OT predicts nothing at all about the relationship between the ranking in one stratum and the ranking in another stratum of the same language. Yet it seems improbable that two strata within a language each select freely from the permutational possibilities afforded by Universal Grammar. In the theory of Lexical Phonology, restrictions have been placed on when rules can turn on and off (such as the Strong Domain Hypothesis of Borowsky 1986, Kiparsky 1984). But comparable notions are not translatable into OT, where even demoting a constraint is not guaranteed to turn it off.[43] Taking a different tack, Kiparsky (1997b) suggests that only faithfulness constraints are re-rankable between levels (cf. Itô & Mester 1995), but he does not adhere consistently to that assumption in this or other work (such as Kiparsky 1997a, 1998b).

A related question is whether S-OT really shares properties, other than strata, with Lexical Phonology (LP). This question is important, because the answer will determine whether S-OT also shares in many of LP's various explanatory achievements. The central idea of LP is the 'lexical syndrome', a constellation of properties shared by lexical rules (Kaisse & Hargus 1993: 16–17, Kiparsky 1983):

[43] A reviewer suggests an alternative conception of S-OT 'in which the constraint hierarchies at each step differ from each other only in the presence or absence of certain constraints', pointing out that this opens up the possibility of making connections to notions like the Strong Domain Hypothesis. The associate editor comments, however, that 'this seems grossly incompatible with the standard OT assumption of a universal set of constraints, which disallows level-specific constraint presence/absence', going on to say that 'an alternative naturally suggests itself which is more in line with standard OT assumptions – level-specific constraint "deactivation", formalised as "constraint demotion".' But OT offers no easy equation *demotion* = *deactivation*, because even low-ranking constraints may be active. Prince & Smolensky (1993: 24ff) emphasise this for faithfulness constraints; reduplicative emergence of the unmarked illustrates the same point for markedness constraints (Alderete *et al*. 1999, McCarthy & Prince 1994). Known conditions of literal deactivation of a constraint, as in Pāṇini's Theorem (Prince & Smolensky 1993: 81f), are so specific that they are of little value in characterising differences between strata.

Bermúdez-Otero (1999) suggests that the limitations on differences among strata have a diachronic rather than synchronic basis. Since strata have diverse diachronic sources (accreted sound change *vs*. massive borrowing, as in English or Malayalam), it is difficult to understand how a unified diachronic explanation could be possible.

(63) *Characteristics of lexical* vs. *postlexical processes in LP*

	Lexical	*Postlexical*
a.	Word-bounded	Not word-bounded
b.	Access to word-internal structure assigned at same level only	Access to phrase structure only
c.	Precede all postlexical rules	Follow all lexical rules
d.	Cyclic	Apply once
e.	Disjunctively ordered with respect to other lexical rules	Conjunctively ordered with respect to lexical rules
f.	Apply in derived environments	Apply across the board
g.	Structure-preserving	Not structure-preserving
h.	Apply to lexical categories only	Apply to all categories
i.	May have exceptions	Automatic
j.	Not transferred to a second language	Transferable to L2
k.	Outputs subject to lexical diffusion	Subject to Neogrammarian sound change
l.	Apply categorically	May have gradient outputs

Of these properties, only those pertaining to domains (63a) and ordering ((63c), though not (63e)), carry over straightforwardly to S-OT. It may be possible to capture some of the others in a specific implementation of S-OT, but several of the key ideas, such as Structure Preservation and the Strong Domain Hypothesis, look unattainable because of fundamental differences between OT and rule-based phonology. It would appear, then, that the connection between S-OT and LP is not so robust as to lend any independent support for S-OT.

In its approach to opacity specifically, S-OT is also very different from LP. Standardly, LP has recognised within-stratum as well as between-stratum opaque rule orderings. For example, both are found in Kiparsky's (1984) analysis of Icelandic. But S-OT permits only between-stratum opaque orderings.[44] So, for instance, it is not possible to have two postlexical processes interacting opaquely. In general, if processes P_1 and P_2 interact opaquely, they must be assigned (by judicious ranking) to different strata and so their morphosyntactic domains (such as stem, word or phrase) must be different in exactly the way that the strata differ. This is a strong claim, and it remains to be fully tested (though see Noyer 1997: 515, Paradis 1997: 542, Roca 1997b: 14ff, Rubach 1997: 578 for various

[44] Some implementations of S-OT allow a single stratum to apply cyclically to morphologically complex words (Kenstowicz 1995, Kiparsky 1998b). In this case, within-stratum cross-cycle opaque orderings would be possible (though within-stratum cross-cycle differences in ranking are not). The point is the same, though: phonological opacity ought always to coincide with differences in the morphosyntactic domains of the processes involved.

critical remarks). Similarly, if the domains of P_1 and P_2 indicate that they are assigned to different strata, then they are necessarily ordered, and so opaque interaction can actually be forced by domain assignment.[45]

Sympathy theory makes no comparable claim about correlations between the domains of processes and whether they interact opaquely. On the other hand, sympathy, unlike S-OT, makes stronger claims about multi-process interaction. In S-OT, the possibilities of multi-process opaque interaction are limited only by the number of strata or cycles. With at least three strata (as in Kiparsky 1998b, McCarthy & Prince 1993b), three-process Duke of York derivations are easily modelled. With greater depth (such as the five strata of Halle & Mohanan 1985), the possibilities are even richer. This, then, is a final area where S-OT must make its case, by showing that the greater richness of multi-process interaction is actually required.

9 Conclusion

In this article, I have addressed the issue of phonological opacity within Optimality Theory. I have shown exactly why opacity is problematic for classic OT, and I have proposed a novel approach to opacity, sympathy theory, based on the central OT ideas of harmonic evaluation and constraint ranking and violation. Examples of counterbleeding, counterfeeding and multi-process opacity were analysed, and general results about these different types of opacity were presented. Comparisons with the mechanisms and predictions of rule-based serialism were made throughout; three points of particular interest include the consequences of sympathy for notionally distinct processes that produce identical faithfulness violations (§3.2), divergences in the treatment of multi-process interactions (§7.1) and Duke of York derivations (§7.2). I have also discussed the differences between sympathy theory and other approaches to phonological opacity in OT (§8).

It goes without saying that the consequences of this proposal have not been explored exhaustively. At various junctures I have raised questions that bear further examination: the nature of latent rankings (§3.1), the nature and source of restrictions on possible selectors (§§3.1, 3.3 and 7.2), the role of sympathy in systems where an allophonic process contributes to opacity (§3.2), the properties of the sympathy relation (§§4 and 7.2), the typology of multi-process and Duke of York opaque interactions (§7), the trade-offs between OO faithfulness and sympathy (§8.3) and the predictions of Stratal OT (§8.4). All of these questions seem in principle to be answerable, only requiring empirical work that is more extensive than can be undertaken in an article like this.

Although comparisons between sympathy and serialism have been a focus of attention, this aspect of the enterprise is limited by a dearth of

[45] These claims rest on the assumption that the domains of processes are determined *only* by their stratum assignments. If processes can in addition have domain specifications (as in Booij 1997, for example), then these predictions do not hold.

recent theoretical and typological work on serial rule interaction in the standard theory. There is, of course, an extensive literature on rule ordering from the 1970s (reviewed in Kenstowicz & Kisseberth 1979: ch. 8), but this work nearly always deals with two-rule interactions exclusively, and in any case the 1980s saw a return to stipulated, extrinsic ordering (except for the effects of lexical strata and more resilient principles like the Elsewhere Condition). The broad consequences of rule ordering and serialism remain largely unexamined in the current theoretical context – a context which includes, moreover, sophisticated theories of phonological representation. It is significant that the questions raised in a new theory force re-examination of a familiar theory, shedding light on topics that might have seemed to have nothing left to offer.

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