2

Why the Phonological Component must be Serial and Rule-Based[1]

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2.1 Introduction

This chapter provides general arguments for replacing Optimality Theory with a theory that employs ordered rules and derivations.

Between 1968 and 1993 the majority of phonologists worked within Rule-Based Phonology (RBP), whose central proposition is that the surface representation of a sequence of morphemes derives from their abstract underlying representations by the application of a series of ordered rules. The introduction of Optimality Theory (OT) in the early 1990s by McCarthy, Prince, and Smolensky has resulted in a drastic realignment of the field of phonology, in terms both of the questions that are being asked and of the ways in which these questions are being addressed. In canonical OT the underlying and surface representations are related by means of universal violable constraints, and the differences among languages are claimed to be due exclusively to differences in the rankings of these constraints.

The rapid acceptance of OT in North America, Europe, and East Asia could be argued to have been due in part to a dissatisfaction among phonologists with aspects of RBP such as its perceived lack of universality, the stipulative nature of its extrinsic rule orderings, the clumsiness of its inviolable constraints *vis-à-vis* the rankable and/or weightable constraints of OT (cf. Pater 2000; Chen-Main 2007), and its perceived failure to formalize satisfactorily the interaction between the rules and constraints it employs.[2] I have summarized

[1] A shorter version of this paper was read at the LSA Annual Meeting in Atlanta on January 3, 2003. Thanks to Morris Halle, Andrea Calabrese, Andrew Nevins, Justin Fitzpatrick, Laurie Karttunen, John Frampton, Bill Idsardi, Eric Raimy, Ellen Kaisse, Donca Steriade, Cheryl Zoll, Joe Pater, Fiorien Bonthuis, and the members of the MIT Phonology Circle for comments on earlier drafts.

[2] Thanks to Joe Pater (pers. comm.) for these last two points. He adds that "it's [an open question] whether OT satisfactorily formalized that interaction (i.e. by placing operations in a constraint-blind Gen)."

in (1) the claimed advantages of OT that I have been able to find in the literature.

(1) Arguments adduced in favor of OT over RBP

a. **New directions, new empirical results** (McCarthy and Prince 1993; McCarthy 2002*a*)

b. **Generality of scope** (The OT framework can be used for all components of the grammar, not just phonology and morphology; McCarthy 2002*a*.)

c. **Parsimony** (McCarthy 2002*a*: 243: "if a constraints-only theory is workable, then it is preferable [to a theory combining rules and constraints], all else being equal"; cf. Kager 1999: 187: OT is "conceptually superior" in that "we find that a rule-based analysis uses excessive machinery to achieve effects that an OT analysis attributes to a single interaction".)

d. **Direct incorporation of markedness** (Constraints actually produce cross-linguistic distributions and markedness rather than restating them; McCarthy and Prince 1993: 19; Eckman 2005.)

e. **Compatibility with connectionism** (Constraint systems of the OT type are attractive for implementation in terms of connectionist networks (Smolensky 1999; Dell et al. 1999; Seidenberg and MacDonald 1999). McCarthy (2002*a*) points out in his FAQ section that OT differs from connectionism in having strict domination, and Legendre *et al.* (2006) demonstrate that weighted constraints predict the existence of unattested systems that ranked constraints are unable to produce (cf. also Kiparsky 2005). It is interesting in this connection to note the increasing popularity of weighted constraints, which bring OT even closer to connectionism; cf. Hayes and MacEachern 1998; Mohanan 2000; Flemming 2001; Boersma and Hayes 2001 (though they maintain strict domination for parsing); Pater 2007*a*.)

f. **Factorial typology derives from free ranking** ("By assuming that *all* constraints have to be universal, OT severely restricts the degrees of freedom in model formulation in linguistics (one of the core problems of linguistic description)… OT furthermore offers a restrictive theory of linguistic variation: differences between languages can arise only a different rankings of universal principles in different languages" (Féry and Fanselow 2002). McCarthy 2002*a*: 113 claims moreover that OT provides a clearer picture than RBP does of typological "overkill" (also called the Too Many Solutions Problem) such

as the absence of deletion as a repair for voiced coda obstruents: "OT, because of its inherently typological nature, calls attention to this problem [of overkill] and suggests where to look for a solution, based on harmonic bounding. In contrast, rule-based theories, at least in phonology, rarely address typological matters and offer no general solution to this problem.")

g. **Conspiracies** ("Compelling examples of homogeneity of target/heterogeneity of process tend to support constraint-based over rule-based theories" (McCarthy 1999*a*; cf. also McCarthy and Prince 1993: 4, Prince and Smolensky 1993: 1, etc.).)

h. **Morpheme Structure Constraints and the Duplication Problem** (Rules and phonotactics replicate each other; Kager 1999: 56 *inter alia*.)

i. **Problems with rules and levels** ("Besides the deus-ex-machina character of the level distinction itself, the additionally necessary manipulations indicate that this mode of phonological analysis [i.e. postulating word-internal levels without independent justification beyond the phenomenon under discussion] holds little promise" (Itō and Mester 2003*a*: *n*. 16 and associated text). "Compare the proliferation of strata in works like Halle and Mohanan (1985): four lexical strata, one of which includes a loop, plus the post-lexical stratum. This comes close to being a reductio ad absurdum of LP" (McCarthy 2004, handout on Stratal OT for Ling 730). Other problems cited with rules include their being unconstrained, arbitrary, language-specific, and requiring look-ahead and look-back power; rule systems are claimed to be unconstrained in their interactions and sometimes involve ordering paradoxes (cf. Anderson 1974) and pathologies (Prince and Smolensky 2002: 137).)

j. **Grammaticality judgements and gradient well-formedness** (Gradient well-formedness effects imply speaker knowledge of violated constraints; such effects are not modelable in RBP (Steriade 2000; cf. also Keller 1998; Hayes 2000; Coetzee 2004).)

k. **Back-copying/overapplication in reduplication** (e.g. oven → woven-way for a small percentage of Pig Latin speakers;[3] "Correspondence Theory is superior, empirically and conceptually, to serial derivational approaches. All serial theories are incapable of

[3] This is a subtype of the variety of Pig Latin that inserts -way after vowel-initial words (e.g. pig → ig-pay but ant → ant-way); see Vaux and Nevins 2003 for further details.

dealing with cases in which B copies (or, more neutrally, reflects) R" (McCarthy and Prince 1999: 290).)

l. "**Serial derivations are cognitively implausible"** (Orgun 1993; Sebregts 2001: 63; seriously undermined by OT-CC (McCarthy 2006, 2007).)

m. **Unification of description of individual languages with explanation of language typology** ("Joining of the individual and the universal, which OT accomplishes through ranking permutation, is probably the most important insight of the theory" (McCarthy 2002*a*: 1).)

n. **Learnability** ("If the constraint set is universal, this cuts down the [language learner's] analysis space considerably [as opposed to learning sets of ordered rules, especially extrinsic and opaque orderings]" (Zuraw 2004).)

o. **Separation of structural description and structural change** (Theories of structural descriptions and of structural changes are "loose and uninformative" and therefore "the locus of explanatory action is elsewhere" (Prince and Smolensky 2004: 4). Cf. "in a theory where phonological rules specify both context and change, as in SPE and much work following it, it is not possible to account for this asymmetry of [overkill] patterns except by stipulation" (Lombardi 2001: 13). Compare also Hayes (2004) on phonological acquisition: "within Optimality Theory, the learner must locate the Faithfulness constraint that must be ranked lower in order for underlying forms to be altered to fit the phonotactics. By way of contrast, earlier rule-based approaches require the learner to find both structural description and change for every alternation, with no help from phonotactic knowledge".)

Even in the earliest OT treatments these problems were mentioned only in passing;[4] I am not aware of any serious attempt by an OT supporter to explicitly examine or falsify an RBP analysis. This is not surprising, given that none of the points in (1) actually poses a legitimate problem for RBP.[5] McCarthy

[4] Cf. Prince and Smolensky's (2002: 22) critique of look-ahead power (cf. (1i)): "In I[mdlawn] T[achlhiyt] B[erber], however, as in many other languages, the availability of nuclei depends on the choice of onsets: an early step in the derivational constructive procedure, working on a low level in the structural hierarchy, depends on later steps that deal with the higher levels. Indeed, the higher level constraint is very much the more forceful. Technical solutions to this conundrum can be found in individual cases, Dell and Elmedlaoui's being a particularly clever one; but the theme will reappear persistently in every domain of prosody, defying a uniform treatment in constructionist terms."

[5] McCarthy's claim in (1f) that the OT treatment of overkill is superior to that of RBP, for instance, capriciously inverts the actual situation (no existing form of OT accounts successfully for overkill,

(1998: 4) states moreover in his discussion of serious problems posed for OT by opacity effects that "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." This variant of argument (1a) attempts to circumvent the scientific standards of accountability for falsification, which require that one formulate theories that are falsifiable and that one respond in good faith to subsequent falsifications, either by revising or abandoning one's theory, or by demonstrating that the attempted falsification was flawed. No amount of positive empirical or conceptual results is sufficient to override proof that a theory makes fundamentally incorrect predictions.

The parsimony argument in (1c) does not hold up, either. One can find just as many OT analyses that are forced by their framework to create byzantine appendages that are unnecessary in their RBP equivalent; a particularly clear example of this is Sympathy Theory as a response to the problem of opacity, as we will see later in this chapter.

Another of the advantages most often claimed for OT *vis-à-vis* RBP, factorial typology (1f), is nicely addressed by Kager 1999: 35: "the reranking approach would predict that any new grammar that arises from a reranking of any pair of constraints will precisely correlate with one of the world's languages. This prediction is based on the deeply naïve assumption that every possible ranking should be instantiated by some attested language. This is naïve, just as it is deeply naïve to expect that all logically possible permutations of genetic material in the human genome are actually attested in individual humans."

Space constraints prevent me from discussing the remaining points in (1) here; in what follows I focus on those that are mentioned most frequently in the OT literature. The issue in (1) that is most often cited involves conspiracies (1g); as McCarthy (1999*a*) puts it, "compelling examples of homogeneity of target/heterogeneity of process tend to support constraint-based over rule-based theories". Beyond that, work in OT to date, as exemplified by Prince and

whereas it is not a problem in RBP) and ignores the rich RBP tradition of Evolutionary Phonology (Ohala 1971, 1972, 1975, 1981, 2005; Ohala and Lorentz 1977; Chang, Plauché, and Ohala 2001; Hale and Reiss 2000; Vaux and Samuels 2004; Blevins 2004; Pycha *et al.* 2003, etc.) that provides an explicit account for overkill effects. McCarthy and Prince's claim concerning back-copying in reduplication (1k) is similarly false; Raimy's RBP model of reduplication (1999) can derive such effects, for example (see Raimy 2000*b* for pointed discussion). Baković 2007 asserts that cross-derivational feeding-on-environment in Lithuanian is a "teleological" problem for RBP, but acknowledges (p. 18) that Odden's rule-based analysis of the phenomenon (2005: 113–15) is "descriptively satisfactory". Since in my opinion there is no place for teleology in synchronic phonology, teleological objections of the sort raised by Baković (as opposed to substantive descriptive and predictive problems of the sort discussed in this chapter) are not a concern.

Smolensky's 1993 treatment of Berber syllabification, has consisted primarily of demonstrating that a constraint-based system can derive some of the same results as RBP.

Some have argued that the rise of OT was a classic paradigm shift in the Kuhnian sense. In fact, the shift from RBP to OT was quite different than the SPE revolution of the late 1960s: the latter generated a barrage of (ultimately productive) criticism, whereas the paradigm shift of 1993 was bloodless. The usual resistance and conservatism conveyed in top journals was circumvented by the development of the Rutgers Optimality Archive, which enabled younger phonologists to circulate developments of the new theory without being answerable to the objections of scholars more familiar with the body of facts that had led phonologists to espouse RBP's complex derivational machinery in the first place. To paraphrase Kiparsky 2000, once we look at entire phonological systems, not just toy examples of a few interacting constraints, we see that OT results in very serious loss of generalization. Chomsky (1967: 110) observes along similar lines that "to study the questions . . . in a serious way, one has to investigate a real language system with dozens (if not hundreds) of phonological rules, with complex ordering conditions among them determined on empirical grounds;. . . it is of no use to study a subsystem with three or four rules." This task has been carried out in hundreds of books and theses written in the RBP framework, but remains to be carried out for any language in an OT framework.[6]

Subsequent rediscovery of the facts that were already known in the RBP literature thanks to detailed investigations of this type has led in recent years to the reintroduction of core principles of RBP into OT, including levels (Kiparsky 2000; Rubach 2000), the cycle (Orgun 1993, 1996; Bermúdez-Otero 2007), constraints on underlying representations (Vaysman 2002; cf. Vaux 2005*a*), and most recently rule-like derivations (McCarthy 2006; Pater 2007*b*), but these modifications are not enough to save the theory, as I suggest in what follows.

Returning to the larger issue of the paradigm shift from RBP to OT, its end result has been that phonologists have moved to a different set of theory-internal issues without asking the bigger questions in (2) that should have been raised by a confrontation of the two perspectives:

[6] Michael Hammond's 1999 *The Phonology of English: A Prosodic Optimality-Theoretic Approach*, for example, covers only a tiny fragment of the phonological component of English. A search of amazon.com in May 2007 revealed only a single peer-reviewed, book-length OT treatment of the phonological component of a single language's grammar, Wheeler's 2005 treatment of Catalan. The closest I have been able to find on the Rutgers Optimality Archive is Picanco 2006.

(2) Central questions

i. What are the phenomena that a descriptively and explanatorily adequate theory of phonology must account for? (Compare the first sentence in Kager 1999: "the central goal of linguistic theory is to shed light on the core of grammatical principles that is common to all languages.")

ii. What phenomena do the two competing theories predict to be possible and impossible? (Compare McCarthy's dichotomy *"Can you do this one?" vs. √"What can/can't you do?" (1997: 12).) In other words, how exactly do the two theories differ?

I suggest that answering these questions leads to a specific theory of phonology that is serial and rule-based, along the classic lines set out in Kenstowicz (1994). In this chapter I assume a theory of this sort, building on the work of Halle and Vergnaud (1987); Halle and Marantz (1993); Halle (1995); Calabrese (1995, 2005); and Vaux (1998).[7] Space constraints prevent me from rehearsing the details of this theory here; I would like instead to focus on providing general arguments for abandoning RBP's primary competitor, Optimality Theory. The arguments fall into four basic categories, which I outline below. In doing so it is important to bear in mind that any reasonable and falsifiable theory will deal well with some phenomena and not so well with others. I therefore focus on *overarching* problems and *insurmountable* problems, rather than on small language-particular problems for which one theory happens to have a more efficient account than the other. I also pass over legitimate problems that have been identified in OT but happen not to be robustly instantiated cross-linguistically.[8]

2.1.1 *Central phenomena of human language*

The first major problem is that OT fails to account for several of the central phenomena of human language—i.e. those that occur in all or most known languages—which any adequate theory of phonology must be able to explain.

[7] Each of these works individually, as well all of them taken collectively, presents a highly detailed and coherent derivational, rule-based model of the phonological component. In light of this fact, it is unclear why OT supporters so frequently assert that proponents of RBP do not have an explicit theory of the synchronic and diachronic components of phonology. (Kirchner 2001: 428–9 for instance states that "proponents of the diachronic critique might meet this objection by presenting an explicit model of some aspect of the phonetics, or other domains giving rise to relevant functional principles, together with an explicit model of phonological acquisition and synchronic phonological grammar," wrongly implying that such explicit models do not exist.)

[8] A nice example is Wilson's (2003) demonstration that Classic OT allows for unattested non-local interactions of the sort "vowel epenthesis applies to a form with a final cluster except when there is a preceding [+nasal] feature anywhere in the word that is blocked from spreading to the right edge."

These phenomena include opacity, optionality, exceptionality, unnaturalness, and ineffability.

2.1.1.1 *Opacity* Opaque interactions between phonological processes occur in all known natural languages. This fact receives an elegant explanation in derivational models, wherein opacity is a straightforward product of process ordering. OT in turn is actually organized around a specific sort of opacity, namely constraints not being surface-true. As has been shown in great detail, though (cf. *inter alia* Idsardi 1997, 1998; Odden this volume; Kager 1999; Kiparsky 2000; McCarthy 2002), canonical OT encounters severe problems when dealing with the complex sorts of opacity that we actually find in natural languages, notably counterbleeding and environment counterfeeding (McCarthy 1997*b*, 2003*a*) and self-destructive feeding-on-environment (Baković 2007). Opacity created by iterative rules creates even more profound problems for OT, since proposed patches such as Sympathy, level ordering, and output-output constraints cannot be brought to bear (Wolfe 2000; Hyman and VanBik 2002). I discuss this problem in more detail in Section 2.3 below.

2.1.1.2 *Optionality* The second phenomenon to be accounted for is optionality. All languages contain numerous optional processes, a fact that is not predicted by the fundamental architecture of OT, as Kager 1999 and others have pointed out. OT mechanisms such as cophonologies and tied constraints fail (with the exception of Riggle and Wilson's (2006) local optionality scheme) to account for a variety of optionality effects such as sequential iterative optionality, as I detail in Section 2.5.

2.1.1.3 *Exceptionality and unnatural processes* Thirdly we must account for unnatural processes. A grammar arises from the confrontation of the human language acquisition device with the arbitrary linguistic data to which it is exposed. Since these data encode layers of historical change, the resulting phonological grammar will in part be "unnatural". Classic OT, in contrast, is specifically designed to allow only "natural" grammars, constructed by ranking universal and/or functionally motivated constraints.[9] It thus fails to provide an adequate account for how accidents of history are incorporated into synchronic systems. I return to this issue later, but refer the reader to Kiparsky (1973) for detailed discussion of how unnaturalness develops in an RBP grammar.

[9] Several OT supporters now acknowledge the need for parochial/language-specific constraints; cf. Boersma 2000; Ellison 2000; Mohanan 2000; Green 2001, 2005; Hayes and Albright 2003; Bye forthcoming; and in a sense the targeted constraints of Wilson 2000 *et seqq*.

2.1.1.4 *Natural processes: Interlanguage* Interlanguage phenomena that reflect neither the native nor the target language, such as Hungarian- and Farsi-speaking learners of English producing final devoicing (Altenberg and Vago 1983 and Eckman 1984 respectively), do not make sense in OT. Most OT supporters assume that humans start with a default ranking of the universal constraint set, but this can't be what is surfacing in the Hungarian and Farsi speakers' interlanguage, which has neither the ranking of the native language nor of the target language (neither Hungarian, Farsi, nor English has a rule of final devoicing). In OT, once the learner reranks the constraints, the original (=UG) ranking is lost; one therefore predicts the non-existence of interlanguage effects, except for the oft-mentioned emergence of rankings that are underdetermined in the L1, especially in the treatment of loanwords. Since the rankings relevant to coda voicing are determined in Hungarian and Farsi, though, hidden rankings cannot be responsible for the observed interlanguage devoicing. (Uffmann (2004) tries to account for this effect in OT by assuming that second-language learners pass through an initial M >> F stage, but this wrongly predicts that second-language learners should show the same pronunciation patterns as first-language learners.) RBP, on the other hand, allows for second-language learners to postulate rules that are not part of their native or target languages. (This freedom of rule postulation is also essential in explaining spontaneous emergence of crazy rules in first-language acquisition and counterfeeding opacity in second-language acquisition (Idsardi 2002).)

2.1.1.5 *Ineffability* A fifth phenomenon that any theory of phonology must account for is ineffability. Some derivations produce no output whatsoever, such as schm-reduplication with words like *schmo* and *Schmidt* for many English speakers. Two central tenets of OT, Violability and Emergence of the Unmarked, explicitly predict that ineffability should not exist. Orgun and Sprouse (1999) show that the Null Parse account of this phenomenon proposed by Prince and Smolensky (1993) does not work; their own solution however requires abandoning Violability, which seriously undermines the OT enterprise. In RBP, on the other hand, such effects are derived by means of inviolable surface constraints.

Our serial, rule-based model is able to account straightforwardly for each of the five important classes of phenomena outlined above, whereas classic Optimality Theory, wherein as Itō and Mester (1997) put it, "there is no sequential phonological derivation in the sense of traditional generative phonology [and] there is no set of rules and operations applying in a certain order," is fundamentally unable to derive any of them in an insightful way.

2.1.2 *Overgeneration*

The second major problem with OT is that it predicts the existence of unattested phenomena. Steriade 2001 for example observes that some phonological constraints receive only one solution across languages, e.g. devoicing in syllable codas. One of the core tenets of classic OT, free ranking and factorial typology (McCarthy and Prince 1993: 145), explicitly and incorrectly requires that a wide range of repair strategies be employed cross-linguistically to deal with violations of this constraint. I expand on this problem in Sections 2.3 and 2.8.

2.1.3 *Failure to solve RBP problems*

The third major problem with OT is that it fails to provide satisfactory solutions to the problems it identifies in RBP, notably the problem of conspiracies. I return to this issue in Section 2.9.

2.1.4 *Acquisition as generalization formation*

Finally, OT misses the fact that grammar construction is driven by the extraction of generalizations from the data to which the learner is exposed. These generalizations are encoded directly in rules and inviolable constraints, whereas OT is forced to simulate their effects via complicated constraint rankings, which in turn can only be arrived at after comparing the outputs of an equally complicated array of competing rankings. In this sense the learning strategy employed in RBP is formally simpler than what is required in OT, and more insightfully captures our intuitions concerning the nature of the acquisition process.

In the remainder of this chapter I elaborate on the most important of the points outlined above. Before discussing these points, though, I would like to clarify what I am taking as the objects of comparison.

2.2 Definitions

The form of RBP employed here assumes that the surface representation of the morphemes in a sequence is derived from their underlying representations by the application of a series of ordered rules. These rules are subject to the cycle, Structure Preservation, the Derived Environment Condition, and inviolable constraints on underlying and surface representations.[10] The details of this theory are set out in Halle and Vergnaud 1987;

[10] There is a general misconception by OT supporters that RBP does not include constraints of any sort, but inviolable constraints such as the OCP and Final Consonant Extraprosodicity were in

Halle and Marantz 1993; Kenstowicz 1994*b*; Halle 1995; Calabrese 1995; and Vaux 1998.

OT on the other hand is currently a moving target. McCarthy (2000: 149) has stated that "the central thesis of OT is that a grammar is a language-particular ranking of violable, universal faithfulness and markedness constraints." Steriade recently offered a weaker formulation of this, namely that the central element of OT is the idea that constraints can be in conflict, and when they are their outcome is determined by ranking.

To be interesting and falsifiable, though, a theory of grammar must say things (or, more technically, *make predictions*) about human language and human languages. OT as defined by McCarthy and Steriade above says nothing about either of these. Put more starkly, a theory that contains nothing more than the principle of constraint ranking is *uninteresting*; without Richness of the Base, parallelism, factorial typology, and the rest of what is normally called "classic OT," as set out in Kager 1999, OT says nothing about conspiracies, abstractness, etc., because, as McCarthy himself points out, it could be implemented derivationally.

It is only by adding in specific constraints and principles of constraint construction, UR construction, levels (or absence thereof), and so on, that one is able to deal with actual data and thereby evaluate and attempt to falsify the theory. OT supporters therefore tend in practice to employ a more fleshed-out version of OT, which I label "Classic OT," that contains something like the elements in (3).

(3) Classic Optimality Theory (McCarthy and Prince 1993: 144–5; Kager 1999; McCarthy 2002*a*: 109):
universal set of markedness and faithfulness constraints + GEN + EVAL + constraint ranking + strict domination + violability + parameterization via ranking + parallelism of constraint satisfaction + alignment + ROTB

In this chapter the label "OT" generally refers to Classic OT as outlined in (3) and wherever possible to the core set of assumptions common to all forms of the theory; where variation in the theory plays an important role, as in the treatment of opacity, I try to account for the different options.[11]

common use long before the appearance of OT, and continue to be part of most rule-based theories. See Sections 2.7 and 2.9 for further discussion.

[11] Some readers might object that the generalized form of OT evaluated here is not espoused in this particular form by any phonologist, to which I respond that this represents my best attempt to strike a balance between Kager (1999) and the other leading forms of OT, "in an attempt to capture what [is] essential to the [theory], eliminating the inconsistencies and the debilitating unclarities of the various approaches that are developed in the literature. As an interpretation, it might be incorrect;

2.3 Opacity

Thus armed with working definitions of RBP and OT, let us return to comparison of the two theories, starting with the problem of opacity (4). The classic take on opacity (excluding a number of interesting modifications by Baković 2007) comes from Kiparsky (1973: 79):

(4) Opacity according to Kiparsky (1973)

A phonological rule 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 P that occur in environments other than C _ D

What are the predictions of OT and RBP with respect to opacity? Phonologists generally acknowledge that RBP predicts the existence of opaque rule interactions within grammars cross-linguistically, assuming that children are exposed to data that justify the postulation of opaque orderings. Classic OT on the other hand allows only focus counterfeeding, according to McCarthy (1997*b*). Counterbleeding interactions, which RBP produces in the form outlined in (5), would have to be modeled in classic OT as in (6) (McCarthy 1997*b*).

(5) Counterbleeding

UR	ABC#
B → D / _ C	ADC#
C → E / _ #	ADE#

(6) OT version: *BC >> Faith(B→D); *C# >> Faith(C→E)

/ABC/	*BC	Faith(B→D)	*C#	Faith(C→E)
[ADE] (opaque)		*		*
[ABE] (transparent)				*
[ADC]		*	*	
[ABC]	*		*	

We can see in (6) that the second candidate, [ABE], incurs a subset of the violations of the first candidate, [ADE]. Hence there is no ranking of the as-yet unranked constraints that will yield the first candidate as the output. As McCarthy (1997*b*) points out, classic OT allows only transparent interaction in such cases.

but to reject attempts at such interpretation is pointless, since the only alternative is to reject what exists as inconsistent and vague, overlooking the important insights embedded in it." (Chomsky 1967: 110)

We have seen so far that RBP predicts the existence of both counterfeeding and counterbleeding opacity, whereas classic OT predicts that only focus counterfeeding should be attested. The actual facts of language support the RBP prediction and not the OT prediction: every known language (as well as many forms of child language and adult interlanguage, as we'll see later) has opacity effects, and the types that Classic OT rules out, including counterbleeding opacity, are in fact quite common. A well-known example occurs in Tiberian Hebrew, where glottal deletion counterbleeds epenthesis (7) (cf. Idsardi 1997).

(7) Tiberian (Masoretic) Hebrew

a. epenthesis into final clusters
/melk/ → [melex] 'king'
/ʔerts/ → [ʔerets] 'land'

b. ʔ-deletion in coda
/qaraʔ/ → [qa:ra:] 'he called'

c. interaction: counterbleeding (Epenthesis >> ʔ-deletion)
/deʃʔ/ → [deʃe]'tender grass' (not *[deʃ])

Two objections that I am aware of have been raised against the RBP treatment of opacity. The first maintains that opaque rule orderings pose a learning problem (cf. Peng 2002). In reality, though, the acquisition scenario for opacity in RBP is simple, as has already been demonstrated formally by Kiparsky (1973) (cf. also Johnson 1984 for formal discussion): the child first learns two independent generalizations, based on an underdetermined data set, and then later, when confronted with data that bring the two generalizations into conflict, makes a decision about how to order them relative to one another. (This process is actually directly analogous to the mechanism by which constraints come to be ranked in OT.) The learning schema just outlined directly produces the range of attested opacity effects. OT, on the other hand, encounters serious learnability problems with respect to opacity, as I discuss at the end of this section.

The second problem claimed for the RBP take on opacity is that it predicts the existence of counterbleeding Duke of York interactions, which putatively do not exist (McCarthy 2003*a*). This turns out not to be a problem for RBP, since several such cases are known to exist; cf. Greek (Newton 1972), Catalan (Bermúdez-Otero 2002), Polish (Rubach 2003), and Karaim (Nevins and Vaux 2004).

Classic OT, on the other hand, by virtue of its monostratal architecture wrongly predicts a large class of opacity effects to be impossible (McCarthy

2002*a*). Given the rampant and undeniable attestation of opacity effects of diverse sorts in the languages of the world, OT supporters have proposed a number of patches, including **local conjunction** (for counterfeeding opacity: Kirchner 1996; Baković 2000; Łubowicz 2002; Moreton and Smolensky 2002; Itō and Mester 2003*a*), **OO constraints** (Benua 1997; Burzio 1998), **sympathy** (McCarthy 1999*b*, 2003*a*), **stratal OT** (Bermúdez-Otero 1999; Kiparsky 2000; Rubach 2000, 2003; Itō and Mester 2003*b*), **turbidity** (Goldrick 2001), **targeted constraints** (Wilson 2001), **comparative markedness** (McCarthy 2003*c*), and **virtual phonology** (Bye 2001). As I outline in the rest of this section, though, none of these patches deals with the opacity problem in a satisfactory manner.[12]

Local constraint conjunction (LCC) makes it possible to derive a subset of opacity effects by teaming a markedness constraint with a faithfulness constraint. By allowing for a potentially unlimited set of constraints to be constructed on a language-specific basis, though, LCC seriously undermines the central OT tenet of Universality, and creates non-trivial learning problems (it is not clear how or when such constraints would be constructed in a learning model such as Tesar and Smolensky's). Moreover, as McCarthy 2003*c* points out, "th[e] greater flexibility of local conjunction is unwarranted and typologically problematic. By conjoining the wrong constraints or conjoining them in the wrong domain, it is possible to produce D[erived] E[nvironment] E[ffect]s [and grandfathering effects] that are not only unattested but quite implausible." Van Oostendorp (2005) elaborates that LCC does not capture the locality of DEEs: a faithfulness violation anywhere in a word combined with a markedness violation elsewhere could generate a DEE, but this is unattested and implausible. McCarthy 2003*c* adds that conjoining the wrong faithfulness constraints can produce impossible results, such as unconditional augmentation and circular chain shifts.

Attempts to deal with opacity via Output-Output (OO) constraints fare no better. McCarthy (1997*b*: 5) points out that such constraints do not work in cases where no form in the paradigm shows the desired phonological process, such as the famous Hebrew form deʃe in (7). Potts and Pullum (2002) add that OO (and sympathy) constraints are not easily expressed using modal logic, and "introduce serious conceptual worries." Kissock, Hale, and Reiss (1998,

[12] I do not consider here McCarthy's (2006) theory of candidate chains (OT-CC) or Pater's (2007*b*) Local Harmonic Serialism, as they essentially concede the opacity problem to the derivational camp. As McCarthy (2006) states in his abstract, "In the revised theory, candidates consist of chains of forms that somewhat resemble the derivations of rule-based phonology." OT-CC moreover predicts the existence of a type of opacity that appears not to be possible in human languages: "OT-CC predicts a type of interaction, referred to as counterfeeding from the past, in which phonological process P1 is able to feed process P2 except when some other process P0 applies earlier in the derivation." (Wilson 2006)

2000) adduce a number of additional problems with OO theory, such as the lack of consistent and explicit principles governing the selection of the base, and making predictions that turn out to be empirically incorrect.

McCarthy's Sympathy Theory is perhaps the most obviously and broadly flawed of the OT attempts to deal with opacity effects. Kiparsky (2000) observes that "once we look at entire phonological systems, not just toy examples of a few interacting constraints, sympathy results in very serious loss of generalization." Idsardi 1997 adds that Sympathy fails to eliminate the existence of conspiracies, the central advantage claimed by OT, adducing examples such as stress shift in Russian and epenthesis and spirantization in Hebrew. (Myers (2002) makes a similar point for the famous *NC̥ constraint, on which see also Blust (2004).) Sympathy moreover creates chaos in systems with multiple opacities (Idsardi 1998; Kiparsky 2000); is unable to deal with opacity of allophonic processes such as nasal harmony in Sea Dayak, rendaku in Japanese, and Canadian French vowel harmony (Poliquin 2006), thanks to the requirements of the rich base and restricting sympathetic constraints to the family of faithfulness constraints (McCarthy 2003*c*, 2005*a*: 28; Itō and Mester 2003*a*: §3.2); relies on otherwise unmotivated constraints and rankings (Kiparsky 2000); predicts non-occurring types of constraint interactions, e.g. mutual non-bleeding (Kiparsky 2000); is unable to distinguish between lexical and postlexical epenthetic vowels (Kiparsky 2000); fails to derive transitivity of opacity (if A is opaque with respect to B and B with respect to C then A is opaque with respect to C; Kiparsky 2000: 14); wrongly predicts that if "two notionally distinct processes . . . violate exactly the same faithfulness constraints, then they must always act together in rendering a third process opaque" (McCarthy 1999: §3.2; for counterevidence from Hebrew, see Idsardi 1997; Idsardi and Kim 2000; and Levi 2000); is unable to mimic serial derivations requiring two or more intermediate representations, such as the Catalan case discussed by Bermúdez-Otero 2002; fails to capture the link between opacity in non-alternating items (dealt with via sympathy constraints) and paradigmatic misapplication (handled by OO correspondence) (Bermúdez-Otero 2003); is unable to identify a sympathetic candidate in Itelmen epenthesis (Cable 2004); lacks a sensible phylogenetic origin (Bermúdez-Otero 2003), which violates the central OT tenet of functional grounding; violates evaluationism,[13] the essence of constraint-based grammar (List and Harbour 2001); provides no trigger for the acquisition of opaque grammars (Bermúdez-Otero 2003); results in undergeneration (Itō and Mester 1997; de

[13] "Evaluationism [is] the claim that the constraint violation scores of any two candidates contain sufficient information to rank them in a global harmony ordering." (List and Harbour 2001)

Lacy 1998; Bermúdez-Otero 1999, 2003) by confining sympathetic candidates to a subset of those that obey an IO-faithfulness constraint F (McCarthy 1999*b*: 339); requires that the sympathy constraint be invisible to selection of flower candidate (McCarthy 1999*b*: 339; Kager 1999: 391; Bermúdez-Otero 2003); and can depend on cumulativity (McCarthy 1999*b*: §4.2), which is *ad hoc* and wrongly excludes non-paradigmatic non-vacuous Duke of York gambits (Bermúdez-Otero 2003).

Ultimately, Sympathy introduces complexity and disorder without fully addressing the problems it purports to solve. In order to account for German x∼ç allophony, for instance, Itō and Mester (2003*a*) postulate a ranking Max >> *VC that is neither motivated by the transparent phonology nor the default ranking provided by UG, assuming an initial state where M outranks F. "[S]ympathy turns out to be not simply additive to the basic setup of the grammar induced on the basis of the transparent phonology (which surely takes acquisitional precedence). Rather, in order to be workable, sympathy requires further reranking of constraints in order to ensure that basic properties of the language to be generated are still correctly captured" (Itō and Mester 2003*a*, p. 15 in ROA version). In short, "[Sympathy Theory] gets more and more complicated, without succeeding in resolving the existing problems. Old and revised S[ympathy] T[heory] seem to be too perplexing or daunting . . . to be convincing or psychologically plausible." (Coutsougera 2000: 45)

Kiparsky (1997) attempts instead to account for opacity with a particular implementation of Stratal OT that "permits elimination of a type of alignment constraint and of OO, BR, and Sympathy." Although Kiparsky's Stratal OT handles some matters left unsettled by Sympathy (e.g. Japanese rendaku in Itō and Mester 2003*b*), it has its own particular set of problems. Fearing that proposing a multistratal model could be viewed as tantamount to reverting to a derivational system, some phonologists have (based on Koskeniemi 1983) restricted their models to two levels (Orgun 1996*b*; Rubach 2000). Others (notably Goldsmith 1993, Lakoff 1993, and Kiparsky 2000) have included three levels of representation in their frameworks, thereby trivializing the strata, according to McCarthy (1997*b*: 4). Although limiting the number of strata to two avoids a complete relapse into a traditional rule-based system, a two-level approach is not sufficient for resolving the famous Hebrew *deʃe* case (McCarthy 1997*b*). As we saw in Chapter 1, moreover, Orgun (1996*a*) has convincingly demonstrated on the basis of Uyghur data that the phonology needs to be able to have as many cycles as there are affixes, so that one cannot limit the phonology to two or three levels.

If there is no independent motivation within OT for postulating multiple strata, Kager (1999) argues, then introducing strata creates a hybrid framework

which would have to be abandoned for the more general derivation model (385). Kager is also puzzled by the lack of dramatically different rankings at different levels (385), given the potential for large-scale rerankings. McCarthy and Prince (1999) agree that "crucial evidence distinguishing serialist from parallelist conceptions is not easy to come by; it is therefore of great interest that reduplication-phonology interactions supply a rich body of evidence in favor of parallelism. Malay . . . Southern Paiute . . . and other examples cited in McCarthy and Prince 1995 . . . either cannot be analyzed serially or can be analyzed only in formally-problematic and conceptually-flawed recastings of conventional serialism" (291). (Raimy 2000 in fact accounts for the phenomena in question within a serialist framework; see ch. 5 of the present volume for further details.)

Setting aside the dilemma of how to incorporate serialism into OT without appealing to a derivational model, we find that there are practical shortcomings in Kiparsky's Stratal OT. Stratal OT allows Duke of York derivations (a problem according to McCarthy (1997*b*: 11) but not in my opinion); results in affix-ordering paradoxes (Sproat 1985, 1988; Halle 1987); and fails to obtain grandfathering effects, derived environment effects, and rules that counterfeed themselves (McCarthy 2003*c*, p. 50 in web version).

In order to account for these latter three phenomena, McCarthy proposes Comparative Markedness (McCarthy 2003*c*), in which a given candidate's markedness is compared with markedness of the most faithful candidate. Unlike stratal OT, Comparative Markedness predicts that all related processes should stand in the same counterfeeding relationship with the process with which they interact (McCarthy 2003*c*, pp. 51–2 in web version). CM also predicts that derived environment effects (which require nM >> F >> oM) and counterfeeding opacity (which require oM >> F >> nM) should not coexist, although there is evidence that they do in Meskwaki (Wier 2004). Like Sympathy and classic OT, CM cannot deal with opacity of allophonic processes, such as nasal harmony in Sea Dayak, because of what ROTB requires (McCarthy 2003*c*); it cannot account for voice inversion in Luo (McCarthy 2003*c*); and it doesn't trigger failure of rendaku in, e.g., sakatoŋe (McCarthy 2005*c*: 28) because of ROTB. OO-CM constraints moreover predict (apparently unattested and implausible) anti-cyclic effects wherein things happen only to forms once they are fully embedded in other forms, without the shape of the outer material being relevant; e.g. Turkish-prime [kitap], [kitep-lar] (van Oostendorp 2003). Finally CM allows circular chain shifts and violations of harmonic ascent in general (McCarthy 2003*c*).

Another attempt to deal with opacity effects within an OT framework is Targeted Constraints Optimality Theory (TCOT) as employed in Wilson 2000, Baković and Wilson 2000, and Chen-Main 2007. Wilson 2000 points out

that TCOT and Sympathy Theory deal with opacity in similar ways: a winning candidate is selected on the basis of similarity to an optimal transparent form, modulo a sympathetic/targeted constraint. The key difference between the two treatments of opacity, according to Wilson, is that TCOT, unlike Sympathy Theory, avoids Duke of York effects.[14]

TCOT does in fact contain a kernel of truth, insofar as it introduces into OT analogs of several essential components of RBP (sequential derivations, severely restricted GEN, language-specific constraints and repairs). It also encounters a number of problems, however. Firstly, McCarthy (2002*b*) asserts that targeted constraints do not solve Too Many Solutions problems such as First Consonant Deletion and Coda Devoicing, as Wilson (2001) claims, because the theory of targeted constraints (i) relies on inventory restrictions, which OT does not contain, and can be subverted by inventory-affecting constraints, and (ii) requires possible and impossible UR-SR mappings to incur identical faithfulness marks, which doesn't appear to be possible. Secondly, McCarthy notes that targeted constraints are unable to compare markedness of segments from disparate or epenthetic sources, which markedness constraints must be able to do in order to have the desired range of effects. Thirdly, McCarthy points out that targeted constraints can be trumped by other constraints in cases where the two relevant candidate outputs (one that is favored by a targeted constraint and one that would be expected to be able to win if the relevant constraint were conventional rather than targeted) are equal in faithfulness and equally marked with respect to constraints other than the targeted one (2002*b*: 287; cf. Blumenfeld 2006 for further cases). Fourthly, targeted constraints do not work well in cases where there is more than one attested way of avoiding a given configuration, e.g. a nasal followed by a voiceless obstruent. Myers 2002 (cf. also McCarthy and Pater 2004) observes that "one could posit different targeted constraints for the different ways of avoiding this configuration, but then one would lose the essential insight of Prince and Smolensky 1993 that the avoided configuration is the same in all these cases." Finally, Salting (2005) suggests that vowel height harmony cannot be dealt with by targeted constraints.

Further problems with recent unpublished versions of TCOT are presented by Pater (2003), Pater and McCarthy (2004), and Rubach 2004. Though many of the problems that have been pointed out with TCOT do not involve opacity *per se*, it should be clear from the above discussion that TCOT is unable to deal with OT's too-many-solutions and opacity problems while maintaining the perceived advantages of the OT architecture.

[14] Comparative Markedness (McCarthy 2003*c*) also resembles Sympathy Theory and TCOT insofar as it relies on comparisons to a maximally faithful shadow candidate to mimic certain types of opacity effects.

On top of the problems with individual OT treatments of opacity just described, there are numerous shortcomings shared by all OT treatments. First, Smolensky 1996 (cited by Idsardi 2002) states that special mechanisms like constraint conjunction are not postulated unless warranted by the data. This cannot explain the appearance of counterfeeding and counterbleeding and derived environment effects in second-language acquisition (see Idsardi 2002 for discussion). Second, List and Harbour (2001) point out that "some cases of NonPareto opacity [wherein] the set of violation scores for the optimal candidate of one selection process [is] too similar (in a technical sense) to the set of violation scores for a suboptimal candidate of another selection process [make] it impossible for any aggregation function using only violation scores to determine the right outcome in both cases and thus such cases are not accommodable within any constraint-based grammar."

Third, a recent investigation of the problem of phonological opacity in Optimality Theory, Virtual Phonology (Bye 2001), reveals a novel type of opacity, 'rule sandwiching', which cannot be derived using any of the optimality-theoretic accounts of phonological opacity discussed above. Specifically, three-rule interactions of the form P > Q > R (where > means 'ordered prior to'), where P and Q interact transparently, but R opacifies Q, and P and R introduce identical faithfulness violations, are ruled out by Sympathy Theory. Data from several languages, including Yawelmani Yokuts, Hebrew, Mohawk, and North Saami provide support for the existing of rule-sandwiching effects, contrary to the predictions of OT treatments of opacity.

Fourth, most OT theories of opacity have problems with counterbleeding of the deʃe type. Sympathy and LPM-OT can deal with this class, but each encounters problems of its own, as already discussed. Calabrese (2005) points out that the extra machinery introduced in order to account for opacity brings no additional insights to the theory, whereas RBP accounts for opacity via extrinsic rule ordering, which is independently required in the model. By Occam's Razor, the power of our theory should be extended only if this extension leads to greater insight than is available in the more constrained theory (Calabrese 2005). OT treatments of opacity fail to satisfy this requirement.

Finally, the RBP treatment of opacity is significantly more elegant than its OT counterparts: it predicts exactly the attested types of opacity effects and deals with them straightforwardly and in a unified way (see Idsardi and Kim 2000 for further elaboration and exemplification). Since opacity is one of the most fundamental phenomena in human language, we must prefer a theory that accounts for it straightforwardly (RBP) over one that seems unable to deal with it (OT).

Some supporters of OT have responded that what RBP treats as a unified phenomenon, opacity, is actually a heterogeneous set of unrelated facts that are only made to look like a coherent whole by the theory. My response to this is that, to paraphrase Sampson (1975), one fact needs one explanation. Our linguistic intuition, be we derivationalists or OT supporters, suggests that grammars involve generalizations that may conflict with one another; RBP provides a more successful account for this fact. One could add that, all else being equal, a theory that accounts for a range of phenomena via a single mechanism is to be preferred over a theory that accounts for the same facts with two or more mechanisms.

2.4 Iterativity and cyclic effects

I mentioned earlier that opacity created by iterative rules creates even more profound problems for OT, since proposed patches such as Sympathy, level ordering, and output-output constraints cannot apply (Hyman and VanBik 2002; Wolfe 2000). As McCarthy (2002*a*: 172) states, "within-level opacity, if it exists, will present exactly the same problems for [stratal OT] as it does for classic OT."

The problem for OT is that within-level opacity *does* exist. Consider for example the well-known Abkhaz stress system, outlined in (8)–(11). The basic rule is that Abkhaz assigns word stress to the leftmost (underlying) accented syllable not followed by another accented syllable, and otherwise to the final syllable (Dybo 1977; Wolfe 2000); the effects of this generalization can be seen in (8i–ii).

(8) Abkhaz

a. assigns word stress to the leftmost (underlying) accented syllable not followed by another accented syllable, and otherwise to the final syllable (Dybo 1977; Wolfe 2000).

b. lexically accented vowels underlined; surface stresses indicated by an acute accent

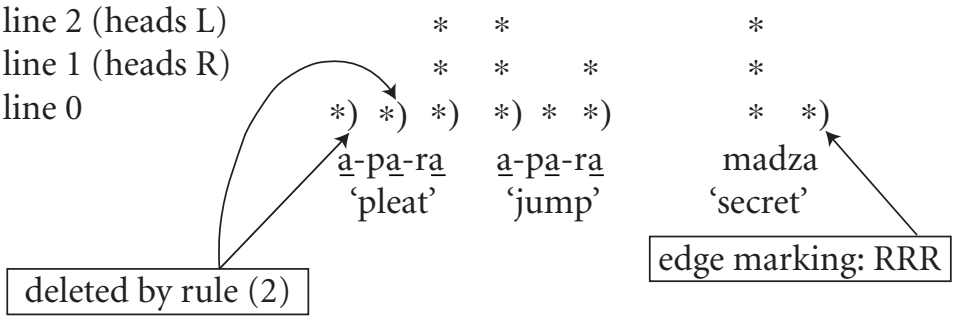
i. *verbs*	**accented root**		**unaccented root**	
	a̲-pa̲-rá̲	to pleat	á̲-pa-ra̲	to jump
	a̲-ja̲-rá̲	to lie down	á̲-fa-ra̲	to eat
	a̲-tsa̲-rá̲	to go	á̲-ta-ra̲	to give
ii. *nouns*	madzá	secret	(unaccented root; surfaces with final accent)	
	á̲-madza	def.-secret		
	madzá-k'	secret-indef.		

The fact that the leftmost underlying accent wins results from a familiar iterative rule of Clash Deletion, schematized in (9), which in terms of the Halle-Idsardi stress system deletes the leftmost of a pair of adjacent brackets. Default rightmost stress results from RRR edge marking in tandem with right-headedness on Line 1 of the stress grid.

(9) Clash Deletion:) → Ø / _ *) (Iterative, L → R)

I provide a sample derivatior in (10).

(10)



The key here for our purposes is that Clash Deletion produces edgemost effects, but the domain—an accent sequence—is not a prosodic constituent and therefore is not amenable to interpretation in terms of OT constraints, which we expect by dint of MAX to produce *VVV (e.g. á-pa-ra), not VVV, from an underlying V V V sequence, as depicted in (11).

(11)

/ a-pa-ra /	NOCLASH	MAXACCENT	LEFTMOST
ápara	*!*		
☞ apará		*	*!
💣 ápara			

Cases of this type cannot be handled in any currently accepted form of OT, because the opaque interactions involved occur within a single level of

derivation and therefore cannot be explained away by adding additional levels *à la* Kiparsky (2000), nor can they be attributed to paradigmatic pressures.

It would in theory be possible to generate effects of this type using interlevel constraints of the sort "do not have a bracket in an output form when its correspondent in the input is adjacent to another bracket," but such constraints have been demonstrated by McCarthy (1997*b*) to create significant problems for OT in other areas, and therefore should be excluded from the universal constraint set. (See also Kager (1999) for discussion of how two-level constraints do not work for Oromo compensatory lengthening.)

In sum, RBP again handles this sort of opacity straightforwardly, though this time the formal device involved is simple iterativity. In OT, on the other hand, this sort of intralevel opacity poses a serious problem.

2.5 Optionality

Now let us turn to optionality. Like opacity, optionality is not predicted by the architecture of Classic OT. Numerous devices have been proposed to deal with this problem within an OT setting, including but not limited to underdetermination (Hammond 1994), cophonologies, tied constraints (Anttila 1997*b*), and differential constraints (Horwood 2000), but all of these fail to account for the entire range of optionality effects. Most notable of these is sequential optionality (also called "local optionality" (Riggle and Wilson 2006)), which results from the interaction of optionality with iterativity.

To see how this works, let us return to the topic of predictions. The form of RBP endorsed here allows rules to be marked as [±optional] *and* as [±iterative]. This being the case, we predict that it should be possible for a rule to be marked as *both* [+optional] *and* [+iterative]. Such a rule would produce a nuanced type of optionality wherein both options for a rule, application and non-application, can appear within a single word.

On the other hand, in classic OT, which does not contain the [±optional] and [±iterative] variables, we predict only all-or-nothing optionality: a process should either apply or not in all of the environments in which its structural description is met. This is precisely what we find with Warao labial voicing (Howard 1972: 87): /p/ optionally surfaces as [b], but if it does then *all* ps in the word must surface as [b], as shown in (12). (RBP also predicts the existence of all-or-nothing effects: these result from optional rules that are [-iterative].)

(12) Sequential optionality: labial voicing in Warao (Howard 1972: 87)

- /p/ optionally surfaces as [b]

- If it does, then all ps in the word must surface as [b]
- [papa] ~ [baba] (*[paba], *[bapa])

It is important to note that the all-or-nothing effect is actually a direct consequence of one of the most central components of OT, parallelism, according to which entire, fully formed outputs are evaluated in parallel. In this system it is not possible for the constraints to peek at the intermediate workings of GEN, and hence heterogeneous outputs are emphatically predicted to be impossible.

In actual fact, though, heterogeneous outputs of the sort predicted to be impossible by OT *do* exist, just as we expect in RBP. Though statistical frequency is irrelevant for our purposes, such processes are actually quite common. One such example is English flapping (13). Though the precise environments for the flapping rule are difficult to pin down, its application appears to be optional when the target is flanked by two unstressed vowels, as in the word *marketability*. In RBP, the flapping rule is marked as both [+iterative] and [+optional], and therefore applies in the following manner. It proceeds directionally through the word, say left to right, scanning for an alveolar stop that meets its structural description. When it finds one, in this case the t at the end of *market*, it then either applies or not, depending on the outcome of the algorithm responsible for optionality. It then moves on to the next potential target, in this case the t of -ity, and again either applies or doesn't. Crucially, though, the choice of whether or not to apply to the second t *is independent of* the choice that was made for the first t. This is a necessary consequence of the rule being iterative, and actually appears to make the correct empirical prediction for the flapping rule, as can be seen in (13).

(13) Optional allophony in free variation: predictions for *marketability* with regard to English flapping

a. RBP: [mɑɹkəthəbɪləthi] ~ [mɑɹkərəbɪləɹi]~[mɑɹkəthəbɪləɹi]~ [mɑɹkərəbɪləthi]

b. OT: [mɑɹkəthəbɪləthi]~ [mɑɹkərəbɪləɹi]

c. Actual outputs (for my idiolect): [mɑɹkəthəbɪləthi]~ [mɑɹkərəbɪləɹi]~ [mɑɹkəthəbɪləɹi]~ [mɑɹkərəbɪləthi]

Similar results hold for English glottalization in words like *continental*.

In their discussion of optional complementizers in English, Baković and Keer (2001) argue that optionality originates from the richness of the base. The multiple surface forms are derived from multiple input forms and not from the application of optional constraints or rerankings on a single underlying form. When faithfulness contraints outrank markedness constraints, these

multiple input forms yield multiple outputs. In their analysis, ROTB allows all four forms listed in (13a) to be inputs, each of which then surfaces as an output.

The most famous case of sequential iterative optionality involves the French rule of schwa deletion, as discussed in a series of publications by François Dell. Dell shows that this rule optionally deletes schwa following a VC sequence, proceeding iteratively from left to right within a phonological phrase and subject to familiar phonotactic restrictions. Just like in the English flapping case, the combination of iterativity and optionality in French schwa deletion produces heterogeneous outputs; since French allows long strings of schwas, though, the heterogeneity is even more striking than in English, as shown in (14b), where a single string of four schwas produces a set of eight outputs.

(14) French schwa deletion

a. ə→ Ø / V (#) C _, L→R , optional across #

b. envie de te le demander 'feel like asking you' (Dell 1980: 225)

ãvidtəldəmãde
ãvidtələdəmãde
ãvidtələdmãde
ãvidətələdmãde
ãvidətlədmãde
ãvidətlədəmãde
ãvidətəldəmãde
ãvidətələdəmãde

A curious variation on the theme of sequential optionality appears in Dominican Spanish as described by Núñez Cedeño (1988) (see also Bradley 2006). This dialect possesses a rule that optionally inserts /s/ at the end of a syllable; the rule applies iteratively, which again produces a range of outputs for a given polysyllabic input. This rule differs from the English and French equivalents, however, in applying only once per word; in other words, it proceeds iteratively through a word looking for a target and then applies optionally to that target, but it appears that once the rule actually applies to one of its targets it then stops. The effects of this rule can be seen in (15b).

(15) Optional s-epenthesis in Dominican Spanish (Núñez Cedeño 1988)

a. Ø → s / _]$_\sigma$ (optional, structure-preserving)
b. /abogado/ 'lawyer' → asbogado, abosgado, abogasdo, abogados

It should be clear that *none* of the three types of sequential optionality just discussed can be accounted for in Classic OT, which can produce only all-or-nothing effects. Donca Steriade (pers. comm.) has suggested that the French facts might be obtainable if one assumes variable construction of

prosodic phrases, but we have no independent evidence for this variation,[15] nor will this trick work in the English case, where the prosodic conditions for the two targets are identical, or in the Dominican Spanish case, where phrasing does not appear to be involved.

One might also try marking constraints as optional, implementing this by having constraint evaluation proceed iteratively through a word, with EVAL then having for each target the option of assigning an asterisk. It is not clear that the Dominican facts can be derived in this way, though, and this strategy moreover undermines the spirit of the OT enterprise (Cheryl Zoll, pers. comm.).

Riggle and Wilson (2006) propose Local Optionality to account for some of the examples described here. Unlike Global Optionality, in which a process applies across the board in a single form, Local Optionality allows the existence of position-specific constraints. In addition, the reranking of these constraints occurs within rather than across derivations. Local Optionality, though able to account for a number of examples of optionality, including schwa deletion in French, fails to adequately explain the all-or-nothing effects we find in phenomena such as Warao labial voicing.

Boersma and Hayes (2001) propose to derive optionality via interaction between overlapping constraints. In their Gradual Learning Algorithm, constraints are associated with a range of values on a continuous ranking scale. The ranges of two constraints can overlap, leading to variation in the ranking of those constraints at the time of evaluating a particular UR/candidate set mapping, resulting in some cases in the selection of more than one output for a given input. Because these ranges are implemented as probability distributions, the free variation produced by the algorithm will be similar to the free variation found in the training data. Boersma and Hayes offer their algorithm as an alternative to Tesar and Smolensky's (1996, 1998) Constraint Demotion, which many (including Tesar and Smolensky themselves) have observed cannot effectively deal with optionality (Boersma and Hayes 2001). Boersma and Hayes's model has its own shortcomings as well, though, such as not producing local optionality effects, predicting unattested variation in metathesis in Ilokano glottal stop deletion (Horwood 2000), and being unable to converge on the correct analysis in cascading credit problems (Pater 2005).

2.6 Exceptionality and unnatural processes

Consider next the problem of naturalness. Classic OT inherits from Natural Phonology the belief that synchronic phonological systems are "natural," i.e.

[15] Until we have evidence that French phrasing is more complex than Dell assumes, the RBP analysis is to be preferred on grounds of parsimony.

everything in them makes synchronic sense. I argue to the contrary that phonological grammars can be "unnatural," as noted by Bach and Harms 1972, Kiparsky 1973, Anderson 1981, Hayes 1996, Blevins 1997, McMahon 1998, Hyman 2000, Calabrese 2005, and others. In fact, as Anderson points out, careful scrutiny reveals that *most* of the phonology of natural languages is non-natural. As I suggested in 2001, unnatural systems of this type are accounted for most efficiently and insightfully in a Chomskyan rule-driven framework. Existing OT implementations can be altered to account for the relevant phenomena, but only at the cost of abandoning the central theoretical tenets that have been claimed to give them the advantage over derivational theories. This loss of insight is inevitable, since OT is specifically designed to account for the (supposed) fact that all phonology is natural. Put in general terms, the search for explanation in language will not find everything in synchronic structure, just as natural selection does not explain everything in nature. In both areas, much of the explanation is to be found in history, as was already noted by Chomsky 1966 and Kiparsky 1973.

To give this debate substance, let us consider the example of productive phonological consonant epenthesis, which is frequently maintained by OT supporters (Lombardi 1997, Steriade 2001, etc.) to employ only default consonants like homorganic glides, ʔ or h. Contrary to this belief, the Turkic language Uyghur employs consonant epenthesis in several situations, including the ones in (16a) and (16b), but regardless of the quality of neighboring segments chooses y or r, rather than any of the natural choices prescribed by OT.

(16) Uyghur (Hahn 1991: 25)
  a. y inserted between two vowels at morpheme boundary
     oqu+Al- → [oquyal-] 'to be able to read'
     iʃlä+Al- → [iʃläyäl-] 'to be able to work'
  b. y inserted between CV root and C suffix
     yu:-b → yuyup 'wash and . . . '
     su:-m → süyüm 'my liquid'

The seemingly unexpected selection of [y] and [r] as epenthetic segments can be directly connected to the fact that precisely these two segments undergo optional deletion in syllable codas (Hahn 1992: 77, 79), as can be seen in (17).

(17) optional r- and y-deletion in syllable coda
  a. kördüm ~ ködüm 'I saw'
     bazar ~ baza 'bazaar'

b. päyzi ∼ päzi ‘gorgeous’
hoyla ∼ hola ‘courtyard’
eytiŋ ∼ etiŋ ‘tell!’

Most interesting for our purposes is the possessive paradigm in (18), where we find alternation between y and r as the epenthetic consonant in cases that do not involve underlying /r/ or /y/.

(18) Uyghur possessive marking (Hahn 1992: 90)

	a. stem	**b. 1st person /-m/**	**c. 2nd person /-ŋ/**	**d. 3rd person /-(s)i/**
girls	qɪz-lar	qizlirim	qizliriŋ	qizliri
mother	ʔana	ʔanam	ʔanaŋ	ʔanisi
spring	baha:(r)	baharim	bahariŋ	bahari
street	kotʃa	kotŋam	kotʃaŋ	kotʃisi
ink	siya:	siyayim/siyarim	siyayiŋ/siyariŋ	siyasi
chicken	toxu:	toxuyum/toxurum	toxuyuŋ/toxuruŋ	toxusi

We can see in columns b and c of (18) that the first-person suffix /-m/ and the second-person singular suffix /ŋ/ attach directly to stems ending in short vowels, but give rise to a [+high] epenthetic vowel when following consonant-final stems. The third-person singular suffix in column d is also underlyingly consonant-initial, but in postconsonantal position this /s/ deletes rather than triggering epenthesis, as with [qizliri] rather than *[qizlirisi].

The interesting property of Uyghur for our purposes is that it avoids superheavy syllables. Adding monoconsonantal suffixes such as -m and -ŋ to stems ending in long vowels such as toxu: ‘chicken’ should produce forms containing superheavy syllables such as *toxu:m, but outputs of this type are ungrammatical. Uyghur chooses instead to epenthesize twice, yielding forms such as toxuyum and toxurum in (19); according to Hahn [y] and [r] are in free variation in these situations.

(19) /toxu:-m/ → [toxuyum] ∼ [toxurum], not *[toxu:m]

Why are [y] and [r] chosen for insertion here rather than say glottal stop or a homorganic glide? The variation between [y] and [r], which are precisely the segments that delete in the complementary environment in Uyghur, clearly demonstrates that these two segments are chosen for insertion because they are also targets of deletion. No manipulation of the feature specifications of y and r in tandem with homorganic glide insertion can save the day here.

One might try instead to say that all long-vowel roots have been historically reanalyzed as ending in y or r, and it is this y or r that surfaces in columns b and c in (18). This analysis runs into a number of problems. First, it requires systematic hypercorrection of all long-vowel roots, with subsequent postulation

of y- and r-final allomorphs for every single long-vowel stem, which relegates to the domain of arbitrary lexical content something that otherwise receives a simple phonological explanation. Second, as Hahn (1992: 90) observes, "If an inserted y or r had become an underlying segment in a given root, then such a root would be expected to take on the allomorph –i" in the third person, which it does not, as shown by minimal pairs like *bahari* vs *siyasi*. Finally, notice that forms with underlying /r/ such as *bahar* do *not* show the y∼r alternation, but instead surface with an [r] in all situations where it is not placed in a syllable coda during the course of the derivation: *baharim*, *yarim* 'my dear', etc.

It is therefore clear that Uyghur employs both r and y insertion, and that the choice of these particular segments results not from homorganic glide insertion but from hypercorrection. In other words, a synchronically arbitrary segment is chosen for insertion by a completely regular phonological rule for reasons that are ultimately historical. RBP correctly predicts that language learners will be able to postulate unnatural rules of this sort if exposed to the right kind of evidence, whereas universalist implementations of OT wrongly predict that they should be unlearnable.

In addition to the problem with unnatural rules, Calabrese (2005) notes that we also require idiosyncratic language-specific negative constraints in order to account for accidental gaps, such as the absence of the unmarked vowel /u/ in Huave (Noyer 1994) or of non-palatalized č in Russian.

2.7 Ineffability

Our next major phenomenon that runs counter to the predictions of OT is absolute ungrammaticality, or what is sometimes called "ineffability." One of the most robust cross-linguistic generalizations is that some derivations produce no output whatsoever; for example, many speakers of English find no output of schm-reduplication to be grammatical with schm-initial words like schmo and Schmidt (Nevins and Vaux 2003). In Vaux and Nevins's (2007) online survey of schm-reduplication, 128 out of 300 (43%) respondents preferred a null output for schmuck, 117/300 (39%) for schmooze, and 126/300 (42%) for Schmidt.[16]

Phenomena like this are easily analyzed in RBP, which has at its disposal inviolable output constraints with the power to crash a derivation. Within OT an analogous move is more troublesome, because it violates the central tenet of OT that *all* constraints are violable (Prince and Smolensky 2002: 6).

[16] Many other respondents opted for avoidance strategies not easily accounted for without postulating allomorphy: 17 respondents selected shluck/shlooze, 4 selected fluck/flooze, and 1 selected vluck/vlooze.

In order to deal with this problem, Prince and Smolensky (1993) propose that Gen produces a special candidate called the Null Parse, which lacks a morphological category and has no phonetic realization. This candidate is stipulated ("ex hypothesi" in the words of McCarthy and Wolf 2005) to satisfy all well-formedness and faithfulness constraints and to be the only candidate output that violates the special constraint MPARSE, which requires that all underlying forms have a surface realization.

Prince and Smolensky designed these propositions to ensure that any constraint C ranked above MPARSE would in effect be inviolable, because any candidate that violated C would lose to the Null Parse, as shown in (20).

(20) candidates:
X violates constraint C but not MParse
Ø the Null Parse candidate: violates MParse but not C

/input/	C	MPARSE
X	*!	
Ø		*

When the Null Parse ends up being selected as the optimal output the surface result is ineffability, as the ill-formedness of the Null Parse makes it "uniquely unsuited to life in the outside world" (Prince and Smolensky 1993: 51) and unpronounceable.

The Null Parse analysis encounters several serious problems. First, the stipulation that the Null Parse candidate satisfies all well-formedness and faithfulness constraints appears to be arbitrary and unmotivated by independent principles (Nevins and Vaux 2003; Rice 2005; see McCarthy and Wolf 2005 for an attempt to make these stipulations follow from revisions to Correspondence Theory). Second, the Null Parse analysis fails to capture the intuition that an output with no phonetic realization is qualitatively different than no output at all. In the case of *schm*-reduplication, for example, our intuition is that reduplication produces the output *schmuck-schmuck*, and this output is then discarded because it violates a constraint requiring that the base and the reduplicant be distinct. Our intuition crucially does *not* suggest that *schm*-reduplication produces an output with no phonetic content, which therefore is not pronounced. (Orgun and Sprouse 1999 make the same point with regard to Swedish *[rätt].) McCarthy and Wolf (2005) respond, building on Coetzee's (2004) theory that the output of EVAL is not a single optimal candidate but rather a ranking of all candidates for relative harmony, that

what is being accessed in conscious assessments of ineffability phenomena is not a rejected winner but rather a first runner-up to a victorious but ineffable Null Parse candidate. Resorting to this level of counter-intuitive, theory-internal sophistry when a simpler theory directly produces the attested facts and intuitions strikes me as one of the clearest indications that OT has gone down the wrong path in our quest to understand phonological cognition.

Rice (2007) points out that the expected form is in fact being produced, but only surfaces when the right phonological conditions are present. For instance, Norwegian imperatives generally consist of the bare verb root (21a). When the root ends in a consonant clusters of rising sonority, though, this form is not allowed to surface, resulting in a null output (21b).

(21) Norwegian imperatives
   a. /spis/ 'eat' → spis 'eat!'
   b. /padl/ 'paddle' → *padl 'paddle!'

Related to this is the fact that negative imperatives generally allow the negative *ikke* to surface on either side of the verb (22a), but only postverbally with rising-sonority roots, where the initial vowel of *ikke* is able to license the final consonant of the verb root as its onset (22b).

(22) Norwegian negative imperatives
   a. hopp ikke på møblene ~ ikke hopp på møblene 'don't jump on the furniture!'
   b. klatr ikke på møblene ~ *ikke klatr på møblene 'don't climb on the furniture!'

Similarly, rising-sonority infinitives are allowed when immediately followed by vowel-initial but not consonant-initial prepositions: *sykl opp bakken* 'bike up the hill!' but **sykl ned bakken* 'bike down the hill!'.

A third problem with the Null Parse analysis involves ranking paradoxes, as demonstrated for Turkish by Orgun and Sprouse (1999). In Turkish, suffixed forms must contain at least two syllables (23); ungrammatical monosyllabic forms are not augmented by epenthesis as one might otherwise expect (24).

(23) Suffixed forms in Turkish must contain at least two syllables

root	**gloss**	**suffixed form**	**gloss**
sol	the musical note G	sol-üm	my G
do:	the musical note C	*do:-m	my C

(24) Ungrammatical monosyllabic forms are not augmented by epenthesis
*do-yu-m (cf. /araba-a/ 'car-dat' → [arabaya])
*do:-u-m (cf. /el-m/ 'hand-my' → [elim])

The ranking required to generate these effects is DEP, LEX=PRWD, FTBIN ≫ MPARSE. There is a problem with this ranking, though: the ranking DEP ≫ MPARSE predicts that epenthesis should never be possible in Turkish, when in fact it is possible (cf. *arabaya* 'to the car', *elim* 'my hand'). We thus have a ranking paradox: the null output for 'my C' (23) requires DEP ≫ MPARSE, but the epenthesis in *arabaya*, *elim*, etc. requires MPARSE ≫ DEP.

Orgun and Sprouse remedy this problem by suggesting that individual constraints may be specified as inviolable, "Control" constraints in a given language (cf. also Pesetsky 1997, 1998; Fanselow and Féry 2002). As McCarthy (2005*b*) rightly points out, though, their solution requires abandoning Violability, which seriously undermines the OT enterprise and the notion that EVAL is a total function (one that yields an output no matter what the input is). McCarthy therefore attempts to explain away the facts adduced by Orgun and Sprouse, but the other problems just discussed remain.

For example, it should be clear from the English schm-reduplication and Norwegian infinitive cases that the expected winner is running afoul of an inviolable constraint, something that is easily capturable in RBP and in OT endowed with Control. Rice (2007) demonstrates moreover that one can produce paradigmatic gaps using Optimal Paradigms theory (OP; McCarthy 2005*b*). Invoking OP raises a number of new problems, however.

Firstly, OP compounds the already serious extension problem raised by the GEN+EVAL component of OT. It seems unlikely from a computational and psychological perspective that speakers generate and consider vast numbers of possible outputs each time they produce a word, especially when compared to a theory (RBP) that accounts for the facts equally well or better and does not encounter the extension problem. OP compounds this problem by requiring that the selection of the surface form of a word involve generation and evaluation not only vast numbers of candidate outputs for the underlying representation of that word, but also of every permutation of the set of those outputs and the candidate outputs for other members of the paradigms to which that word belongs.[17]

[17] Kautz and Selman (1991) show that the problem of determining whether a given default nonmonotonic theory has an extension is highly intractable (NP-complete, to be precise), seemingly

Secondly, one of the two central predictions of OP is falsified by Trukese and Yiddish data. McCarthy (2005*b*) points out that OP predicts the impossibility of true underapplication within paradigms, because "OP has the same basic logic as base-reduplicant identity, so it similarly predicts that underapplication is only possible in inflectional paradigms when overapplication is ruled out by some high-ranking constraint." Cable (2004: 17) shows that underapplication of Trukese minimal word-induced vowel lengthening cannot be attributed to a higher-ranking constraint blocking the relevant overapplication candidate, thereby falsifying this prediction of OP. Albright (2004) shows that the underapplication prediction is falsified by Yiddish loss of final devoicing as well. (He deals with the underapplication effect in Yiddish by having bases in inflectional paradigms, which loses some of the claimed advantages of McCarthy's model.)

Thirdly, Bobaljik (2006) demonstrates that it is morphosyntactic category and not paradigm properties that determine phonological behavior in cases of the sort discussed by McCarthy (2005*b*).

Fourthly, Rice (2005) observes that "the motivation to have fewer violations [in OP] effectively rewards paradigms with gaps . . . Taking this line of reasoning to its absurd extreme, the evaluation of paradigms by constraints referring to the markedness or faithfulness of phonological properties of the members of the paradigms will reward the paradigm with the most gaps. Indeed, a paradigm with gaps in every cell—the null paradigm—will be optimal." Rice remedies this with MAX{CAT} constraints requiring realization of morphological categories, but his revised version of OP encounters problems as well.

Specifically, Rice (2007) points out that his analysis predicts that "if there is a phonotactic problem in two different potential words (infinitive, imperative, etc.) within the same category (verb, noun, etc.), they must be repaired in the same way." A case that may fit the description of what Rice predicts to be impossible involves the manifestation of root-initial geminates in Homshetsma, as described by Berens (1997). Homshetsma, a variety of Armenian spoken in northeastern Turkey, contains a verb /t^h:-/ 'hit', whose geminate /t^h:/ surfaces as such only in intervocalic position within a prosodic phrase (25a-c). When a preceding vowel is not available to license the first half of the geminate, the gemination surfaces on an immediately following consonant if one is available (25d). Elsewhere, i.e. if no consonantal host

because the problem requires checking all possible sequences of firings of defaults (cf. Antonelli (2006) and discussion in Section 2.10 of this chapter).

is available for the gemination (Homshetsma has no long vowels), the /t^h:/ surfaces as a singleton (25e).

(25) Manifestations of underlying geminates in Homshetsma

	UR	**gloss**	**SR**
a.	/gu-t^h:-a-m/	'I hit (pres.)' (imperfective-hit-theme.V-1sg)	[gut^h:om]
b.	/mi-t^h:-a-Ø/	'don't hit' (prohibitive-hit-theme.V-2sg.neg)	[mit^h:a]
c.	/indzi t^h:-a- Ø mi/	'don't hit me' (me hit-theme.V-2sg.neg prohib.)	[indzi t^h:a mi]
d.	/t^h:-v-i/	'I hit (past)' (hit-passive-1sg.aorist)	[t^hev:i]
e.	/t^h:-u/	'hit!' (hit-2sg)	[t^hu]

The Homshetsma data are thus a problem for Rice because, contrary to the explicit prediction of his model, a single phonotactic problem (syllable-initial geminates) triggers three different repairs within the same grammatical category.

Putting together this problem with what we have seen in the rest of this section, no known version of OT is able to deal with the robust empirical problem of ineffability without (in the case of Control Theory) abandoning one of the central tenets of the model, Violability, or (in the case of the Null Parse analysis, Rice's version of OP, and McCarthy and Wolf's 2005 theory) creating a swathe of incorrect predictions and psychological and computational problems. In contrast, the form of RBP assumed in this paper encounters no such problems, by virtue of containing inviolable constraints (cf. n.9).

2.8 OT predicts the existence of unattested phenomena

Let us now move on from phenomena that OT predicts not to exist (or at least cannot derive in a straightforward or insightful way) to the converse, phenomena that OT predicts to exist but do not. Given free ranking (e.g. McCarthy and Prince 1993: 145, Kager 1999; Section 1.7; McCarthy 2002*a*: 109; Féry and Fanselow 2002: ch. 3) and the absence of an appropriately restrictive general theory and inventory of constraints, it is strange that many OT papers start from the observation that a given phenomenon doesn't exist. To the contrary, without a constrained set of constraints almost anything can exist.

But what exactly is the overgeneration problem for OT? On top of the problematic predictions identified by Colin Wilson that we discussed in Section 2.3,

there is the specific subtype of overgeneration that McCarthy terms "overkill" (also known as "the too many repairs problem" or just "overgeneration"), wherein a constraint violation is repaired cross-linguistically in only a subset of the ways one might expect. In light of recent OT interest in this issue, it is ironic that OT supporters initially attacked RBP for linking target and repair and thereby constraining—purportedly without reason—the set of possible repairs (cf. (10)). In recent years, though, the OT supporters have "discovered" that the set of repairs is in fact constrained in certain ways, as has been maintained all along in RBP.

Consider the example of vowel deletion discussed in Casali (1997). He claims (p. 509) that at "the boundary between two lexical words . . . the constraints violated by V1 elision constitute a subset of those violated by V2 elision. In these contexts, therefore, I predict that only V1 elision is possible." His claim is empirically incorrect, as shown by languages such as Sanskrit, where word-initial *a-* deletes after word-final mid vowels (Whitney 1889: 47). Even if such languages did *not* exist, the fact remains that it would be easy to come up with an OT constraint system that would generate exactly the behavior that Casali claims to be impossible. In this case OT is *right* to allow for more possibilities than some of its proponents are aware of, but there is a more general problem, the "too many solutions problem": OT allows for a wide range of grammars that appear to be impossible (Steriade 2001; Lombardi 2001). Let us consider two examples, one from Steriade and one from Flemming.

Steriade (2001) observes that some phonological constraints receive only one solution across languages; for instance, she claims that the constraint punishing [voice] specifications in codas is invariably dealt with by devoicing. This generalization is incorrect—see Eckman (1981) and Edge (1991) for counterevidence and Vaux (2005*b*) for discussion—but let us imagine for the sake of argument that it is correct. Free ranking explicitly and incorrectly predicts that a wide range of strategies should be employed cross-linguistically to repair violations of this constraint.

Flemming (2001) observes along similar lines that "not all conceivable rankings of MAXIMIZE CONTRASTS correspond to possible languages. The balance between maximization of the number of contrasts and maximization of the distinctiveness of contrasts is determined by the ranking of MAXIMIZE CONTRASTS relative to the MINDIST constraints. Allowing all definable rankings predicts the existence of languages which value the number of contrasts very highly, resulting in a huge number of very fine contrasts, and languages which value distinctiveness very highly, resulting in a handful of maximally distinct contrasts. Neither of these extremes is attested."

He continues that "It seems that there is a lower bound on the distinctiveness required for a contrast to be functional, and that there is an upper bound beyond which additional distinctiveness provides a poor return on the effort expended. This could be implemented by specifying that certain MINDIST constraints, referring to the smallest acceptable contrastive differences, are universally ranked above MAXIMIZE CONTRASTS, and that MAXIMIZE CONTRASTS is in turn universally ranked above another set of MINDIST constraints which make 'excessive' distinctiveness requirements. However it would be desirable to derive these bounds from general considerations of perceptibility and communicative efficiency rather than simply stipulating them."

How should one deal with overkill problems of these types? The combination of unfettered GEN and free ranking make this a non-trivial problem in OT. Steriade (2001) proposes to constrain certain types of repair via the P-Map, a matrix of confusion-based similarity indices, but this solution is unsatisfactory for many reasons and is unlikely to cover all cases of overgeneration, particularly those that do not involve perceptual similarity.[18] In RBP, on the other hand, a relatively simple solution is available, since one is able to limit the inventory of repair strategies provided by UG. A plausible theory of this sort is developed in Calabrese (2005).

A further fertile avenue for constraining repairs (and typology in general) has been investigated in numerous articles by John Ohala (most of which are available at http://trill.berkeley.edu/users/ohala/index3.html), Hale and Reiss (2000), Blevins (2004), and Vaux and Samuels (2004, 2005). The basic idea of what I call the Ohala Theory is that many or all of the patterns we find in phonological systems are actually products of history—itself the product primarily of phonetic constraints and influences on the acquisition process—and need not, and in fact *should* not, be assumed to constitute part of synchronic grammars.

Steriade and Baković (in personal communications) have rightly pointed out that the Ohala Theory is not the exclusive property of RBP; it can be incorporated just as well within an OT framework. Though Steriade and Baković are technically correct, by saying they could use the Ohala Theory—but don't—they are using what Postal (2004: 292) terms the "Psychic Alternation Move": "this criticism of A's claim is not valid, because although A admittedly made the claim, he could easily have made a different, correct claim instead."

Why do OT supporters resort to the Psychic Alternation Move instead of adopting the Ohala Theory? I believe the primary reason is that the spirit

[18] See Blumenfeld (2006) for further discussion of problems with P-Map theory.

of OT for most OT supporters (and inherited, I would argue, from Natural Phonology) involves incorporating function, origins, and explanation in general into the synchronic grammar, which is not compatible with the Ohala Theory.

In this context it is important to bear in mind when considering using negative typological evidence the following quote:

> Certain apparent linguistic universals may be the result merely of historical accident. For example, if only inhabitants of Tasmania survive a future war, it might be a property of all then existing languages that pitch is not used to differentiate lexical items. Accidental universals of this sort are of no importance for general linguistics, which attempts rather to characterize the range of possible human languages. The significant linguistic universals are those that must be assumed to be available to the child learning language as an a priori, innate endowment.
>
> (Chomsky and Halle 1968)

Applying this notion to our present topic, I would suggest that the overkill problem is not a problem at all; consequently, OT supporters (and in fact all phonologists) should cease building theories (such as Steriade's P-Map and Wilson's TCOT) on (often faulty) negative typological evidence.

There is, however, one respect in which overkill may pose a legitimate problem for OT: to the extent that the theory by virtue of combining free ranking and a virtually unbounded inventory of constraints allows for virtually limitless possible systems, it is conceivable that a subset of these are ones that are not actually considered by children acquiring a language. This sort of mismatch, in the spirit of the Chomsky and Halle quote above, is one we should actually try to exclude.

2.9 OT fails to provide satisfactory solutions to the problems it identifies in RBP

Now that I have addressed the major problems concerning what OT predicts to be possible and impossible, I would like to address the fact that OT fails to provide satisfactory solutions to the problems it identifies in RBP, most notably conspiracies (cf. (1g)). As Kisseberth (1970) first observed, the basic problem with conspiracies is that the application or non-application of multiple phonological processes sometimes appears to be guided by a unitary output goal. Kisseberth then suggests that "by factoring out the target from the individual rules . . . we convert the generalization inherent in the conspiracy into a formal simplification. Given that formal simplicity is taken as the basis

of the evaluation measure, we thereby succeed in characterizing grammars as more highly valued insofar as they have conspiracies." (Kiparsky 1973: 59)

Calabrese (2005) points out that the ability to provide a single formal device to generate a conspiracy, namely a constraint, hardly constitutes an advantage for OT over RBP. It is true that the form of RBP addressed by Kisseberth in 1970, namely that of SPE, did not employ inviolable constraints in a prominent fashion. By 1993, though, most rule-based theories employed a suite of inviolable output constraints, such as the OCP, which were perfectly capable of generating conspiratorial effects. It is therefore unclear why OT supporters identify conspiracies as a problem for RBP.

Idsardi (1998, 2000) observes moreover that OT itself is still forced to postulate conspiratorial analyses for phenomena such as English r-deletion, stress shift in Russian, and Hebrew epenthesis and spirantization. I would add to this that single constraints never account for conspiracies on their own; one always needs at least two constraints operating in tandem to produce a given conspiratorial output (cf. McCarthy's (1998) recasting of opaque rule orderings in terms of ranked constraint pairs, discussed in Chapter 1). In the famous Yawelmani case, for example, production of a surface light syllable from an underlying cluster requires collaboration between not only the NoCoda markedness constraint that is commonly implied to underlie the conspiracy, but also a specific pair of Max and Dep faithfulness constraints, all three of which must be ranked in a specific manner with respect to one another in order to simulate the effects of the relevant rules.

We must also be careful to avoid reifying what superficially look like they may be language-internal conspiracies of the Yawelmani variety but are actually composites of independent phenomena in separate languages. As Blust (2004) points out in the context of his critique of Pater's (1999, 2001) work on *NC:[19]

> The notion of a conspiracy appears to be defensible so long as the evidence supporting it is drawn from a single language . . . One and the same conspiracy can, of course, be found in different languages, but if the argument for functionally related processes consists entirely of *comparative* data, the nature of the argument is fundamentally changed. Some 6,000 languages are still spoken, many with significant dialect differences, and the number of sound changes or synchronic residues of sound change is therefore at least 6,000 times what one can expect to find in a single language. Given the range of choices, it is hardly surprising that in different languages or language

[19] Blust points out literally dozens of further empirical and conceptual problems with Pater's conspiracy analysis of the Austronesian data; I refer the reader to Blust's original article for detailed discussion.

families one can find completely unrelated phonological processes that happen to overlap in eliminating a particular input. Yet this is precisely the form that many arguments in OT have taken in recent years, and for this reason they are precariously speculative.

I would also like to suggest, following Kiparsky (1972), that we should not be so quick to assume that a given set of processes is controlled by a conspiratorial global rule or constraint. Kiparsky (1972 (=1982*a*: 112)) suggests instead that elements putatively implicated in conspiracies, such as "three-consonant clusters, adjacent stresses, and so on, are linguistically complex configurations, and rules eliminating or avoiding them are accordingly highly natural and occur frequently in the languages of the world. It is therefore only to be expected that there should be some languages in which several rules should eliminate or avoid these configurations, and that there should be languages in which no instances of these configurations appear on the surface . . . What I am questioning, then, is whether there is any fundamental sort of difference between the cases in which just one or two rules reflect general phonological conditions of this type, and the cases in which several rules are involved, which would be termed a 'conspiracy'." He then adds, "concrete empirical differences are clearly also involved: for example, is there any evidence for a true 'functional unity' of the rules in a conspiracy which would not simply be characterizable by their sharing a common target? Are there cases in which they are subject to parallel historical changes at some point in the development of a language? Are there cases in which apparently diverse changes in the rules of a language at some point in time can be shown to be consequences of the imposition of a single derivational constraint? Are there cases where the rules in a conspiracy have the same set of lexical exceptions? This would be strong evidence in favor of derivational constraints. However, I have not found any such cases."

Kiparsky outlines several further formal objections to the conspiracy theory that remain relevant today. First, there is the problem of indirect participation in a conspiracy—cases where a rule participates in a conspiracy indirectly, by appropriately feeding or bleeding another rule. Kiparsky states that in order to deal with such cases "we would therefore have to say something like this: a rule [sc. constraint—BV] is highly valued (or 'free') if its application creates representations to which other rules [sc. constraints] are applicable in such a way as to implement the conspiracy." Second, Kiparsky points out (1982: 114) that the formal devices by which an output constraint can be effected are highly heterogeneous. Therefore, factoring out those parts of the structural analyses of processes involved in the conspiracy is technically feasible only in a small

part of the relevant cases. Third, Kiparsky mentions ordering paradoxes from Kenstowicz and Kisseberth 1970 as phenomena that might require derivational constraints, but then states that they might have functional underpinnings (1982: 114–15).

Given these problems with Conspiracy Theory, Kiparsky then develops (1973) a sort of selective evolutionary account for the appearance of supposed conspiracies, in which opaque rule systems are less likely to be acquired successfully by language learners, and conspiratorial rule orderings, being relatively transparent, are therefore more likely to survive than their opaque competitors. This line of thinking is quite compatible with the mechanisms expounded for the emergence of phonological typologies in Evolutionary Phonology (2004) and appears to be on the right track.

Closely related to the conspiracy problem is the so-called Duplication Problem, which refers to the isomorphism between Morpheme Structure Constraints and phonological rules that is sometimes called for in derivational analyses. Here Anderson (1974: 292) provides a similar explanation to Kiparsky's, which also finds echoes in the more recent work of Ohala, Hale, and Reiss: "the reason a language contains both a morpheme structure constraint of a given type and a phonological rule which results in much the same constraint applying to derived structures, though the two are distinct, is that both serve to enforce some natural constraint. Both the constraint and the rule, that is, have the same explanation, where an explanation in phonological terms is often provided by our substantive empirical knowledge of the physics and physiology (and perhaps, eventually, neurology) of speech." He adds that "both the constraint and the rule require independent statement in the grammar, since each may have (independent) idiosyncracies," a line of reasoning also raised by Kiparsky. Anderson concludes that "as far as the formal apparatus of a description is concerned, then, we see no alternative to positing separate rules and conditions of morpheme structure. The attempt to unify a rule and a constraint (or two rules) is not, properly speaking, a job for phonological descriptions."

There is another sort of Duplication Problem that does *not* arise in RBP but *does* afflict OT. Mohanan (2000) observes that if two processes within or across languages differ just in the domain of application of a pattern, such as nasal assimilation within vs. across words in Malayalam, OT is forced to split the pattern into two distinct constraints so that the two parts can be ranked differently. This requires an unnecessary and unwanted duplication of the same constraint. If one considers more than two parallel cases the situation becomes even worse; Mohanan demonstrates for instance that in order to account for place assimilation in English, Hindi, and Malayalam, OT would be

forced to split place assimilation into five distinct universal constraints. Crucially, each of the five constraints triggers the exact same process; an important linguistic generalization is therefore being missed. Mohanan observes that it was precisely this sort of duplication of a single generalization that led Halle (1959) to reject the classical phonemic level of representation; the same logic should apply to the OT case.

To sum up this final section, I have suggested that OT attributes to RBP problems that are not actually problems, that OT itself fails to solve these problems, that the problems themselves may not exist, and their apparent effects have plausible historical and physiological explanations that do not require duplication in the grammar.

2.10 Conclusions

To conclude this chapter, I have argued that OT has failed to surmount the problems its practitioners associate with Rule-Based Phonology, and also creates new insurmountable problems. The adoption of OT leads moreover to serious loss of generalization in many core areas.

When to OT's problems of undergeneration (e.g. sequential iterative optionality, ineffability, and crazy rules), overgeneration (e.g. Wilson's nasal blocking of epenthesis and counterfeeding from the past), and loss of generalization (especially concerning opacity) one adds the problems of unconstrainedness (Calabrese 2005), unrealistic modeling of linguistic performance (Clements 2000), indeterminacy (Clements 2000), substance abuse (Hale and Reiss 2000), and constraint duplication (Mohanan 2000), and the fact that the self-proclaimed OT successes in accounting for markedness, naturalness, and conspiracies are not an exclusive OT prerogative—see for example the derivational theory developed in Calabrese (1995, 2005)—one sees no reason to maintain OT in face of a descriptively and formally superior rule-based model.

To this conclusion one might add the larger computational problem that OT is non-monotonic (Besnard, Fanselow, and Schaub 2003), by virtue of the fact that one can override conclusions by adding new premises (constraints and rankings).[20] OT thus stands in opposition to generative theories such as RBP insofar as the point of a generative grammar (qua formal computational system) is precisely that it is decidable whether a string is well-formed or

[20] The rule for monotonicity is that if $\Gamma \vdash \varphi$ and $\Gamma \subseteq \Delta$ then $\Delta \vdash \varphi$ (if φ is a consequence of a set of premises Γ, then it is also a consequence of any set Δ containing Γ as a subset). Non-monotonic logics are logics for defeasible reasoning, as monotony is what in classical logic bars one from overriding conclusions by adding new premises; the non-monotonicity of OT is thus closely intertwined with the system of violable, ranked constraints.

not. Though defeasible logics such as the one OT assumes appear to have appealing applications to certain types of real-world scenarios (cf. Dresher 1996), they pose serious and thus far unsolved computational problems such as being NP-complete (Kautz and Selman 1991; Idsardi 2006) and requiring incomputable consistency checks (Antonelli 2006). As Antonelli (2006) states, "Non-monotonic logics appear to be stubbornly intractable with respect to the corresponding problem for classical logic."

RBP, on the other hand, is eminently and efficiently computable. It has been known at least since Johnson (1972) that the effects of phonological rewrite rules of the sort employed in RBP can be simulated using relatively straightforward finite-state machinery, with iterative application accomplished by sending the output from one transducer to the input of the next.

Given the empirical, formal, and computational superiority of RBP *vis-à-vis* OT that we have seen in this chapter, it should now be clear that the parallel constraint-based architecture that currently dominates phonological theory should be abandoned in favor of a serial rule-based architecture. But what then do we do about Orgun's (1993) assertion that serial derivations are cognitively implausible (cf. (1L))? Putting aside for the moment the fact that McCarthy (2006) and Pater (2007*b*) have introduced serial derivations in OT, I respond to the serialism objection that, as Calabrese (2005) observes, human behavior is set in a temporal continuum and therefore requires the acquisition and implementation of ordered sets of instructions. There is no reason for excluding knowledge of serial ordering of instructions, which is fundamental to so many human skills, from the realm of phonology. Itō and Mester (2003*b*, p. 20 in web version) already acknowledge the need for staged strata of phonological computation: "the monostratalism of strict parallel versions of OT undeniably has restrictiveness in its favor, as far as weak generative power is concerned. But the simultaneous loss of descriptive and explanatory adequacy is too high." The facts and arguments adduced in this chapter suggest that we must push phonological theory even further; as Clements 2000 puts it, "many areas of higher-level cognition are admittedly sequential in nature, and it may simply be the case that phonological competence is one of these."