

Faithfulness and Reduplicative Identity

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1. Introduction

Reduplication is a matter of identity: the reduplicant *copies* the base. Perfect identity cannot always be attained; templatic requirements commonly obscure it. Base-copy parallelism is most striking when carried to an extreme — when otherwise well-behaved phonological processes are disrupted by the demands of reduplicative identity. It may happen that parallel phonological developments occur in both the base and the copy, even though the regular triggering conditions are found only in one or the other. Similarly, regular phonological effects may *fail to appear* in the base or in the copy, when the relevant environment is found in just one of them. Under either regime, a phonologically-expected asymmetry between base and copy is avoided, and identity between base and copy is maintained. Phonological processes of all types, at all levels, have been observed to show such behavior.

Identity figures much more widely in phonological derivation, though perhaps less obviously. According to Optimality Theory (Prince & Smolensky 1993), constraints of *faithfulness* demand that the output be as close as possible to the input, along all the dimensions upon which structures may vary. Derivation is determined to

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a large degree by the interaction between faithfulness constraints, demanding identity, and other constraints on output structural configurations, which may favor modification of the input, contravening faithfulness. Input-output *faithfulness* and base-reduplicant *identity*, we argue, are controlled by exactly the same set of formal considerations, played out over different pairs of compared structures. In aid of this conception, we revise the implementation of faithfulness presented in Prince & Smolensky (1993). In place of the PARSE/FILL type of system, in which the input is maintained as a literal substructure of the output, with special formal status accorded to deleted and inserted elements, we develop a notion of correspondence between representations. This extends the formalism of correspondence developed for the reduplicant-base relation in McCarthy & Prince (1993a), with the goal of covering every aspect of faithfulness, in all faithfulness-sensitive relations. Reduplication will provide us with a well-stocked laboratory for studying the implications of this Correspondence Theory of faithfulness.

The identity-preserving interactions between phonology and reduplication were named **overapplication** and **underapplication** in the pioneering work of Wilbur (1973abc). Although these terms emerge from a particular conception of rules and rule-application which is no longer viable, they can be given a more neutral characterization, in terms of relations rather than processes, and we will use them throughout in a strictly technical sense. A phonological mapping will be said to *overapply* when it introduces, in reduplicative circumstances, a disparity between the output and the lexical stem that is not expected on purely phonological grounds. A typical example is given in (1):

(1) Javanese intervocalic *h* deletion (Dudas 1976, Horne 1961)

<i>i. Stem</i>	<i>ii. — +C</i>	<i>iii. — +V</i>	<i>iv. Expected Red.</i>	<i>v. Gloss</i>
a. anɛh	anɛh-ku	anɛ-e		‘strange’
b. bəḍah	bəḍah-bəḍah	bəḍa_-bəḍa_-e	*bəḍah_-bəḍa_-e	‘broken’
c. ɖajɔh	ɖajɔh-ɖajɔh	ɖajɔ_-ɖajɔ_-e	*ɖajɔh_-ɖajɔ_-e	‘guest’

Javanese disallows *h* between vowels, and stem-final *h* is accordingly lost before vowel-initial suffixes (col. iii, a). But final *h* is lost in both base and reduplicant (col. iii, b,c), even though only one of them provides the relevant intervocalic environment. If reduplication is thought of as copying the underlying form of the stem, one might imagine that the very process of intervocalic *h*-deletion *overapplies* to eliminate *h* from both base and reduplicant. More neutrally, we will identify *overapplication* as unexpected disparity between the stem and the output — the loss of the extra *h* — regardless of the mechanism by which that disparity comes about.

Similarly, a phonological process will be said to *underapply* when there is a *lack* of expected disparity between the input stem and the output. Akan reduplication provides a typical example: palatalization fails in the reduplicant when it is not phonologically motivated in the base:

(2) Underapplication in Akan (Christaller 1875, Schachter & Fromkin 1968, Welmers 1946)

<i>i. Stem</i>	<i>ii. Reduplicated</i>	<i>iii. Expected</i>	<i>iv. Gloss</i>
a. kaʔ	kɪ -kaʔ	* tɕɪ -kaʔ	‘bite’
b. hawʔ	hɪ -hawʔ	* ɕɪ -hawʔ	‘trouble’

Though Akan typically disallows velars and other back consonants before front vowels, the offending sequence is found in reduplicated forms like *kɪ-kaʔ*. In Wilbur’s terms, the velar palatalization process *underapplies* in the reduplicant. More neutrally, we can observe that the general phonological pattern of the language leads us to expect a disparity between the underlying stem (with *k*) and the reduplicant (where we ought to see *tɕ*), and we do not find it. The effect is to make the actual reduplicant more closely resemble the stem.

The third relevant descriptive category is that of *normal application*, whereby both base and reduplicant are entirely well-behaved phonologically, being treated as completely independent entities. Tagalog flapping provides an instance: there is an allophonic alternation between *d* and *r* in Tagalog, with the flap found intervocalically, much as in English. Reduplication makes no inroads on this generalization:

(3) Normal Application in Tagalog (Carrier 1979)

<i>i. Stem</i>	<i>ii. Reduplicated</i>	<i>iii. Over</i>	<i>iv. Under</i>	<i>v. Gloss</i>
a. datiŋ	d -um-ā-ratiŋ	*r-um-ā-ratiŋ	* d -um-ā- d atiŋ	‘arrive’
b. dingat	ka-ka-ringat- d ingat	*ka-ringat-ringat	*ka- d ingat- d ingat	‘suddenly’

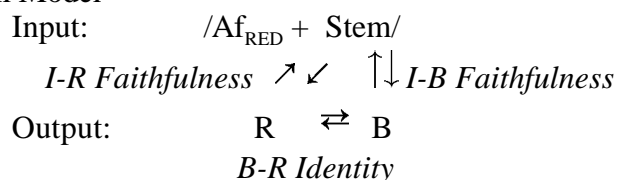
As with “under-” and “over-application,” it must be emphasized that the expression “normal application” is a term of art, describing a certain state of affairs, and there is no implication that normal application is particularly usual or more commonly encountered than its rivals, or even universally available. Indeed, we will see a case in §3.2 where the theory proposed here doesn’t even admit normal application, allowing only overapplication.

These and other examples will be discussed in detail below; this brief sketch indicates the dimensions of the problem. Since the earliest work on this subject (e.g., Wilbur 1973a), it has been recognized that over- and underapplication support reduplicant-base identity. Suppose the cited phonological processes in Javanese and Akan had applied *normally*, yielding the results in the columns labeled “Expected”: they would then increase disparity between base and reduplicant. If reduplication, by its very nature, involves identity between base and reduplicant, then any special interaction with phonology that serves to support base-reduplicant identity is functioning in aid of the reduplicative pattern itself. This is the insight we will explore, by examining the range of interactions between the competing and often irreconcilable demands of faithful correspondence between different representations.

1.1 Outline of the Argument

The model of identity advanced here, **Correspondence Theory**, is set within Optimality Theory, and our argument will call crucially on three fundamental ideas of OT: parallelism of constraint satisfaction, ranking of constraints, and faithfulness between derivationally-related representations. Correspondence Theory extends the reduplicative copying relation of McCarthy & Prince (1993a) to the domain of input-output faithfulness, and indeed to any domain where identity relations are imposed on pairs of related representations. The full theory of reduplication involves correspondence between stem and base, between base and reduplicant, and between stem and reduplicant. The following diagram portrays the system of relations:

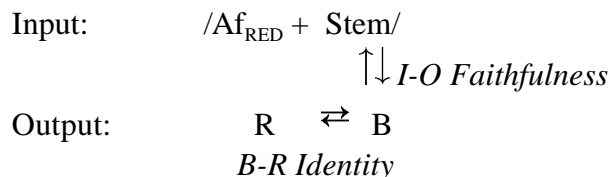
(4) Full Model



We employ a purely terminological distinction between “identity” and “faithfulness” solely to emphasize the distinct dimensions along which these perfectly homologous notions are realized.

The relation between stem and reduplicant — *I-R faithfulness* in the diagram — turns out to play a subsidiary role in the theory, essentially because of a universal metacondition on ranking, discussed in §6, which ensures that faithfulness constraints on the stem domain always dominate those on the affixal domains. From this, it follows that I-R faithfulness appears in a subordinate position in every ranking, dominated by I-B faithfulness, significantly limiting its effects. In many rankings, its presence will be completely or almost completely hidden; it therefore becomes convenient to study a simplified model, a proper sub-theory, in which I-R faithfulness is not considered. Let us call this the *Basic Model*, which directly follows McCarthy & Prince (1993a).

(5) Basic Model



The Basic Model will be studied in §§3-5; the extension to the Full Model will be examined in §6. Throughout, we make note of those occasions where Full-Model issues come into play.

Working now within the Basic Model, we sketch the overall lay of the land. Constraints demanding B-R identity are evaluated in parallel with the constraints on

phonological sequences and on I-O faithfulness that are responsible for relations like Javanese $h \sim \emptyset$ and Akan $k \sim tɕ$ mentioned above. With B-R identity constraints dominant, we need only take seriously those candidates in which base and reduplicant actually match. With the relevant phonological constraint dominant as well, overapplication can result. Consider the Javanese case, under the assumption that the morphological structure is Base+Reduplicant+Affix. We have the following comparison of potential outputs:

(6) Overapplication of h -loss in Javanese

<i>Candidate</i>	<i>Chief Flaw</i>	<i>Type</i>
a. $bəda_ - bəda_ - e$	*I-O faithfulness: h -loss in stem. <i>Forced viol.</i>	Over
b. * $bədah - bədah - e$	*Phonological constraint against VhV . <i>Fatal.</i>	Under
c. * $bədah - bəda_ - e$	*B-R identity. <i>Fatal.</i>	Normal

The doubly h -lacking form (a) is optimal, because it achieves perfect identity of base and reduplicant while still avoiding the forbidden VhV sequence. Because the h is lost from the stem, though, faithfulness to the input must suffer, indicating that the relevant I-O faithfulness constraint is crucially subordinated. Such considerations lead to a ranking for this kind of overapplication, which characterizes the interplay among constraints on B-R identity and I-O faithfulness relative to some structural condition *Phono-Constraint*:

(7) Skeletal Ranking for Overapplication as in Javanese

B-R Identity, Phono-Constraint \gg I-O Faithfulness

This ranking asserts that reduplicative identity and some phonological requirement (like the prohibition on intervocalic h) both take precedence over faithfulness to the input, specifically over a faithfulness constraint whose violation better satisfies Phono-Constraint and/or B-R identity. The primacy of base-reduplicant identity leads here to overapplication, examined in §3. The responsible rankings, including (7) and others, are examined there and in the factorial typology of §4.

Strikingly, classic underapplication does not emerge in this theory as a separate descriptive category that can be freely imposed via B-R identity constraints. The reason is not far to seek. B-R identity is equally respected in both underapplication and overapplication; by itself, therefore, B-R identity cannot decide between them. Compare forms (6a) and (6b): $bəda_ - bəda_ - e$ vs. * $bədah - bədah - e$. Base and reduplicant are entirely identical in both candidates. Any decision between them must be made on other grounds.

To get phonology happening at all, the relation Phono-Constraint \gg I-O faithfulness must be maintained. In Javanese, this is what yields h -loss in the language at large. In reduplication, if Phono-Constraint is the final arbiter, then overapplication must result, because the underapplicative candidate fails to satisfy it. There is simply no way that the force of Phono-Constraint can be blunted by B-R identity.

Normal application, however, remains an option, when B-R identity can be crucially subordinated to I-O faithfulness. In this case, the dominance of I-O faithfulness means that reduplicative identity cannot compel the extension to the stem of phonology that is motivated in the reduplicant. Base and reduplicant are therefore independent entities, and the connection between them is not effective in determining the optimal form.

The theory, then, basically distinguishes two conditions: one in which B-R identity is respected (to some degree, along certain dimensions), yielding both under- and over-application; and one in which B-R identity is set aside, yielding normal application. The choice between under- and over-applicational candidates must be made on other grounds than B-R identity, often straightforwardly phonological. In the Javanese case just reviewed, the overapplicational candidate is chosen because it alone satisfies the phonological constraint banning *VhV*. How, then, does classic under-application come about? It can only be that an independent constraint excludes the expected result of overapplication.

The underapplication of palatalization in Akan provides an example. The independent constraint here is the OCP, which can be independently observed in the language to prevent palatalization when a coronal/coronal sequence would result. Indeed, one might expect the OCP to feature commonly in such interactions, since reduplication often produces nearby replications of features; and this is exactly what the OCP can rule out, through high rank. In such cases, the reduplicative situation will reflect a more general restriction on the language — though it may be one that is not particularly salient to the casual observer. We will argue that all proposed cases of underapplication are of this type, leading to a scheme along these lines (where \mathbb{C} stands for, e.g., the relevant subcase of the OCP that is visibly active in Akan):

(8) Skeletal Ranking for Underapplication

B-R Identity, $\mathbb{C} \gg$ Phono-Constraint \gg I-O Faithfulness

This ranking results in underapplication, because the mapping due to the subhierarchy Phono-Constraint \gg I-O faithfulness is blocked in certain circumstances by \mathbb{C} , and reduplication happens to be one of those circumstances. B-R identity demands that base and reduplicant mirror each other quite closely, and the only way to attain this while satisfying \mathbb{C} is to avoid the mapping. This line of argument is pursued in §5.

A further significant property of Correspondence Theory emerges from parallelism of constraint evaluation. The base and the reduplicant are evaluated symmetrically and simultaneously with respect to the language's constraint hierarchy. The base does not have serial priority over the reduplicant, and reduplication is not, in fact, the copying or replication of previously fixed base. Instead, both base and reduplicant can give way, as it were, to achieve the best possible satisfaction of the entire constraint set. The result is that, under certain circumstances, the base will be predicted to copy the reduplicant. Indeed, the characterization of Javanese given above is exactly of this type: *h* is lost from the base because it cannot appear in the

reduplicant. (Another interpretation is possible — see §3.4.) A number of over-applicational cases of this type are examined in §3, with evidence drawn from Javanese, Tagalog, Chumash, Kihehe, and Axininca Campa, and underapplicational examples are discussed in §5, from Klamath and Southern Paiute. (Lushootseed may be yet another overapplicational case — see Urbanczyk 1995.) If such analyses prove correct, then we will have gained very strong evidence for Correspondence Theory as articulated here, and with it, for the claims of parallelist OT, particularly as contrasted with serialist theories of grammatical derivation.

For the theory of reduplicative phonology, the principal interest of the architecture proposed here is this: the phenomena called overapplication and underapplication follow in Correspondence Theory from the very constraints on reduplicant-base identity that permit reduplication to happen in the first place. The constraints responsible for the ordinary copying of a base also govern the copying of phonologically derived properties. Effectively, there is no difference between copying and over/under-application, and therefore such phonological interactions, along with normal application, turn out to be a fully expected concomitant of reduplicative structure, obtainable through the permutation of ranked universal constraints, as expected in OT and explored in detail in §§3–4.

1.2 Previous Approaches

Previous theories of reduplication have been framed within a serialist conception of grammar as a sequence of operations. On this view, **identity** is asserted by a rule of exact copying and has no special, durable status: like other rule-effects, it is guaranteed to hold only at the derivational instant when the copying rule applies, and it is as subject to the same vagaries of earlier and later derivation as any other rule product. Here is the first discussion of a serial model, due to Bloomfield (1933: 222), writing about nasal substitution in Tagalog:

the form [pa–mu–mu:tul] ‘a cutting in quantity’ implies, by the actual sequence of the parts, that the reduplication is made ‘before’ the prefix is added, but at the same time implies, by the presence of [m–] for [p–] in both reduplication and main form, that the prefix is added ‘before’ the reduplication is made.

Bloomfield’s ordering paradox can be untwisted into the following succession of stages (the interesting steps are highlighted by “►”):

(9)	Root	/pu:tul/
	Prefixation	paN–pu:tul
	►Nasal Sub.	pa–mu:tul
	►Redup.	pa– mu–mu :tul

The reduplicative copying operation targets the transformed root *mutul*, rather than the underlying root /putul/. The defining characteristic of the Ordering Theory is that some phonological process precedes reduplication, so that its effects are felt — or not felt — prior to copying, and thus are observed — or not observed — in both base and copy.

In the literature of generative phonology, Ordering Theory first emerges in analyses of Akan by Schachter & Fromkin (1968: 162) and of Luiseño by Munro & Benson (1973). The theory is worked out in detail by Wilbur (1973ab), and since then has been accepted almost universally. It has engendered a very substantial secondary literature, including detailed and important treatments by Aronoff (1976: 72f.), Carrier (1979), Kiparsky (1986), Marantz (1982), and Shaw (1976 [1980]), as well as less comprehensive treatments by Anderson (1974, 1975), Hollenbach (1974), Odden & Odden (1985), Schlindwein (1991), Sietsema (1988), and Steriade (1988: 107–108). This body of work has been extremely important in defining the character of the problem, in engendering insights into its properties, and in achieving substantial analytic and descriptive success.

This earlier literature is particularly concerned with comprehending the ordering phenomena in terms of rule typology: limits are imposed on the phonological processes that can precede reduplication (e.g., restricting them to allomorphic or cyclic rules) or the types of morphological processes that can follow phonology (i.e., reduplication but not simple affixation). But the core idea remains: if a rule is ordered before reduplicative copying, then its effects or non-effects will be seen in both base and copy. If the relevant phonological rule applies to the base, its output is copied; this is overapplication, ordering-wise. If the rule fails to apply to the base, as when its context appears through later affixation or across the juncture between base and reduplicant, then by the principle of strict serialism, it has forever lost its chance to apply; underapplication results.

The basic Ordering Theory gives an appealing account of reduplicative phonology: either phonology precedes reduplication, or reduplication precedes phonology. In §§3 and 5, we will show that the theory is deeply flawed in empirical predictions, and that it cannot, in fact, comprehend the range of phonology/reduplication interactions, even when subject to further refinements. Its fundamental defect, we suggest, is that it cannot reckon appropriately with the notion of **identity**. The identity-preserving character of the interaction between reduplication and phonology follows in Ordering Theory from the fact that reduplication gets the last crack at the representation, after the phonological rules have applied. We will instead find effects that depend crucially on parallel development of the base and reduplicant, in Malay, Axininca Campa, Chumash, Tagalog, and Kihehe (§§3.6–3.8) and in Klamath and Southern Paiute (§5.3).

Some versions of Ordering Theory also encounter conceptual difficulties. To the extent that late ordering of a morphological process is unique to reduplication, there are two special ways in which reduplication works in favor of base-reduplicant identity: reduplicative copying itself demands identity, but late ordering of reduplication serves to support it, in the face of phonological alterations. In contrast, Correspondence Theory sees identity as intrinsic to reduplication, with no separation between these two ways of achieving and maintaining it. (This issue in Ordering Theory has been recognized previously; Lexical Phonology responds to it by adverting to the possibility of late ordering of *any* morphological process, as in Kiparsky 1986.

This mitigates, but does not eliminate, the conceptual objection, since reduplicative identity is still achieved by means extrinsic to the notion of identity itself.)

Though she develops it fully, Wilbur herself ultimately rejects Ordering Theory and adopts a very different approach, Global Theory, that connects more closely with the fundamental insight that over- and underapplication support reduplicative identity. The proposal is that phonology can detect the results of copying, through global rule interaction. Wilbur writes (1973a: 115–117):

As I see it, the solution centers around the necessity for a rule to make use of the information that two segments ... are in a copy relationship to each other (one is the copy of the other) as a result of a morphological rule (Reduplication, Vowel Copy, etc.)... If the relationship of the original segment (in [the base]) and its copy (in [the reduplicant]) can be captured by the term “mate” and represented by a notation such as X and X', then a global condition on a phonological rule which *overapplies* (regardless of whether it overapplies to [the base] or [the reduplicant]) can be written as:

X (and X') → Y if AXB

When a rule *fails to apply*, it can be formulated as:

X (and X') → Y if X (and X') / A___B

In other words, a rule of reduplication establishes the “mate” relation between each original segment and its copy. Subsequent phonological rules have access to the mate relation, with identity-preserving effects. Rules can affect both mates, though only one meets the structural description, or rules can demand that both mates meet the structural description. These are overapplication and underapplication, respectively. Rules can also ignore the mate relation, applying freely in ways that disrupt identity of reduplicative mates. This is “normal” application. The choice among over-, under-, or normal application is made in the statement of each rule, through stipulation (or not) of the “(and X’)” codicils.

This is an important conceptual alternative to the Ordering Theory, because it tries to connect the phonological unity of reduplicated segments with the fact that one is a copy of the other. But Global Theory sits uneasily on the edifice of most phonological theory of the 1970's and 1980's. Early generative phonology relies on a step-wise serial derivation, in which each rule has access only to the output of the immediately preceding rule. The only global relation among rules is the stipulated ordering itself. The mate relation represents a major relaxation of this requirement with no compensating simplification or restriction elsewhere in the phonology. Indeed, rule ordering itself is still required within the phonology proper, even though the mate relation has been added to the theory.² In contrast, the Ordering Theory of phonology/reduplication interaction requires nothing except what standard generative phonology has in abundance: serial ordering of rules.

² Though the kinds of orderings possible are restricted slightly: pre-morphological phonology is no longer necessary.

For this reason, it is not surprising that the Global Theory received relatively little attention in the subsequent literature³ and that there has been a decided preference for solutions based on Ordering Theory. A significant exception to this development is the structural approach to base-reduplicant relations, studied in depth by Mester (1986: Chapt. 3), as well as variations in work by Clements (1985a), Hirschbühler (1978: 118f.), McCarthy (1979: 373f., 1983, 1985), McCarthy & Prince (1986: 102f.), Pulleyblank (1988: 265–267), Tateishi (1987), and Uhrbach (1987: 43ff.). Mester’s work is particularly significant in the present context, since it achieves considerable descriptive and explanatory success with many of the empirical issues that will be dealt with here.

The structural model works from an enriched phonological representation in which Wilbur’s “mate” relation can be inspected directly, in terms of across-the-board form, autosegmental spreading, or some other aspect of the representation. Rules confronted with this complex representation will over- or underapply, depending on context.⁴ This reification of the copying relation marks a significant advance over Ordering Theory, with connections to Wilbur’s (1973a) ideas on the one hand and Correspondence Theory on the other. Yet even the structural approach must also call on rule ordering to deal with normal application. After some phonology applies to the structure in which the mate relation is represented directly, the whole structure is regularized (“linearized” is the usual term), obliterating all traces of the copying relation. Later rules apply to it normally, without reference to the base-reduplicant connection, since no evidence of reduplication remains present. Thus, the linearization step in the derivation has much the same effect as the copying step in Ordering Theory proper, in that it severs the base-reduplicant tie.⁵

Though the Global Theory cannot be reconciled with the serial derivation of early work in phonological theory, more recent developments have greatly altered the field in which this matter is played out. Since the mid-1970’s, with the advent of metrical and autosegmental phonology, the serial Markovian derivation, which lies at the heart of Ordering Theory, has been progressively marginalized, with the greater explanatory weight (and the bulk of actual research) falling on structural conditions and global principles of well-formedness (see Padgett (to appear) for a recent review). In particular, most versions of Optimality Theory assume that constraints on all aspects of phonological structure are applied in parallel (Prince & Smolensky 1993).⁶ Inputs are mapped directly to outputs, in an essentially flat derivation whose outcome is determined by a parochial constraint hierarchy.

³ Exceptions are Dudas (1976: 218f.) and Shaw (1976 [1980]: 319f.), who entertain this possibility along with others, Onn (1976 [1980]), and the brief discussion in Kenstowicz (1981).

⁴ For further discussion, see §3.8. Compare the role of geminate structures in determining the (non-) application of phonological processes (Hayes 1986, Schein & Steriade 1986, McCarthy 1986b).

⁵ Another type of representational theory is presented in Cowper & Rice (1985). They propose that the base and copy melodies are on different autosegmental tiers, with locality of phonological operations observed over both tiers.

⁶ A sampling of other works that discuss parallelism in OT includes Itô, Mester, & Padgett (1994), McCarthy & Prince (1993a), Cohn & McCarthy (1994), and McCarthy (1993).

From an *a priori* perspective, it is not too surprising that Ordering Theory should be replaced by parallelism within OT. The principal function of rule ordering in standard phonology is to state generalizations that aren't surface true (cf. Bromberger & Halle 1989); this has significance in the context of a restrictive Universal Grammar that severely delimits the set of possible generalizations. Rule ordering operates with that limited set by asking that every rule be a true generalization, but only at the stage of the derivation when it applies; subsequent rules may very well obscure its result or the conditions that led to its application. Adherence to the doctrine of truth-in-generalization leads immediately to the need for multiple (sub-)levels of representation. At each (sub-)level, rules are literally, if momentarily, true.

In contrast, the constraints of OT are evaluated at the output (with faithfulness determined by reference to the input), but they are not guaranteed to be true of the output, because the language-particular ranking establishes precedence relations among them. Rather, they are guaranteed only to be *minimally violated* in optimal forms, in the technical sense explicated in Prince & Smolensky (1993). With the recognition that universal linguistic constraints can have significant force in determining representational form, even when they are not *true*, it becomes possible to reckon in parallel, while preserving, and indeed strengthening considerably, the universality of Universal Grammar. Reduplicative identity is just a special case of this general property of OT.

1.3 Reduplicative Identity and Prosodic Morphology

The results of this research also relate directly to the theme of explanation in Prosodic Morphology (McCarthy & Prince 1986 *et seq.*). The goal of Prosodic Morphology (PM) is to derive the regularities of reduplication and similar phenomena from general properties of morphology, general properties of phonology, and general properties of the interface between morphology and phonology. If the enterprise is fully successful, then the PM-specific apparatus will be reduced to nothing at all, beyond the necessary lexical specification of the morphemes involved. This is, of course, the same goal as all of linguistic theory: to achieve greater empirical coverage with fewer resources — in the happiest case, with no resources at all that are specific to the domain under investigation.

A first step was taken by identifying templates with prosodic categories, eliminating the freedom to stipulate the form of templates independent of the theory of prosodic forms. A further step resolves templates into the effects of universal constraints on prosody, eliminating PM-specific categories such as “Minimal Word” in favor of satisfaction of the set of constraints on foot distribution and Prosodic Word shape (McCarthy & Prince 1994a). A final step involves eliminating all reference to prosody that is not encoded in universal alignment constraints defining the canonical prosodic realization of different morphological categories (stem, affix, external affix). Prosodic morphological entities would then have their shapes defined by adherence to general, widely applicable constraints on the morphology-phonology

interface (McCarthy & Prince 1994b). At present, this represents a fairly speculative program, but its promise is significant.

In this article, we pursue another instantiation of the overall explanatory goal: the reduction of the formal content of reduplicant-base identity constraints to that of input-output faithfulness. The theory of Correspondence developed in §2 applies equally to input-output faithfulness, base-reduplicant identity, and other relations among phonological representations. In this way, the reduplication-specific apparatus of copying constraints is generalized, together with faithfulness, into a broadly applicable theory of Correspondence and constraints on correspondent elements.

2. Correspondence Theory

2.1 The Role and Character of Correspondence

To comprehend phonological processes within Optimality Theory, we require a model of constraints on faithfulness of the output to the input (expanding on Prince & Smolensky 1991, 1993). To provide a basis for the study of over- and under-application, we need to develop a model of constraints on identity between the base and the reduplicant (expanding on McCarthy & Prince 1993a). These twin goals turn out to be closely related, since they are united in Correspondence Theory.

The relation between them becomes clear when we observe that there are many parallels in the details of base-reduplicant identity and input-output faithfulness:

Completeness of mapping:

- In the domain of base-reduplicant identity, completeness is total reduplication and incompleteness is partial reduplication, normally satisfying some templatic requirement on the canonical shape of the reduplicant.

- In the domain of input-output faithfulness, incompleteness is phonological deletion.

Dependence on input/base:

- In the domain of base-reduplicant identity, the phonological material of the reduplicant normally is just that of the base. This dependence on the base is violated in systems with fixed default segments in the reduplicant: e.g., Yoruba, with fixed default *i*, as in /mu/ → *mí*–*mu* (Akinlabi 1984, McCarthy & Prince 1986, Pulleyblank 1988).

- The parallel in the input-output domain is epenthesis, with default segments under syllabic or other conditions.

Contiguity of mapping.

- In the domain of base-reduplicant identity, the copy is usually a **contiguous** substring of the base. For instance, in Balangao prefixing reduplication (Shetler 1976, McCarthy & Prince 1994a), contiguity protects

reduplicant-medial coda consonants, though not reduplicant-final ones: ...*tagta*–*tagtag*, *...*tata*–*tagtag*. Violation of the contiguity property is met with conspicuously in Sanskrit reduplication: *du*–*druv*.

••Contiguity effects are also known in the input-output domain, though they are less well studied than other constraints on epenthesis or deletion. In Axininca Campa and Lardil, epenthetic augmentation is external to the root (McCarthy & Prince 1993a and references cited there): /t^ho/ → t^hota, *t^hato; /ʃil/ → ʃilta, *ʃatil, *ʃital. Likewise, in Chukchee (Kenstowicz 1994b, Spencer 1993), morpheme-edge epenthesis is preferred to morpheme-internal epenthesis: /miml–qaca–n/ → mimləqacan, *miməlqacan. And in Diyari (Austin 1981, McCarthy & Prince 1994a), a prohibition on all syllable codas leads to deletion of word-final consonants, but not of word-medial ones, with the effect that all words are vowel-final; this provides an exact parallel to the Balangao reduplicant. (Also see Kenstowicz 1994b on Korean cluster simplification.)

Linearity of mapping.

•Reduplication normally preserves the linear order of elements. But in Rotuman (Churchward 1940 [1978]), there is metathetic reduplication of disyllabic roots: /RED–pure/ → *puer*–*pure*.

••Similarly, the I-O map typically respects linear order, but metathesis is a possibility. In the phonology of Rotuman, for example, a metathesis similar to the reduplicative phenomenon is observed in a morphological category called the incomplete phase (McCarthy 1995): *pure* → *puer*.

Anchoring of edges.

•The reduplicant normally contains an element from at least one edge of the base, typically the left edge in prefixed reduplicants and the right edge in suffixed reduplicants.

••Edge-anchoring has been observed and studied even more extensively in the input-output domain, where it has been identified with the class of constraints on **alignment** of edges of morphological and prosodic constituents (Prince and Smolensky 1991, 1993; McCarthy & Prince 1993ab).

Featural identity.

•Copied segments in base and reduplicant are normally identical to one another, but may differ featurally for phonological reasons. For instance, nasal place-assimilation in Tübatulabal leads to imperfect featural identity of copied segments, as in *lam*–*banin* (Voegelin 1935, McCarthy & Prince in prep.).

••The same sort of identity, or phonologically-motivated non-identity, of segments in input and output is the very heart and crux of phonological alternation.

This range of parallels is remarkable, and demands explanation. Linguistic theory must relate the constraints on matching of reduplicant and base (the copying constraints) to the constraints on matching of phonological output and input (the faithfulness constraints). We propose to accomplish this by generalizing the notion of

correspondence. Correspondence was introduced into OT as a base-reduplicant relation (McCarthy & Prince 1993a); here, we extend it to the input-output domain, and other linguistic relationships besides. The parallels observed above are accounted for if Universal Grammar defines *types* of constraints on correspondence, with distinct realizations of the constraint-types for each domain in which correspondence plays a role.

Correspondence itself is a relation between two structures, such as base and reduplicant or input and output. To simplify the discussion, we focus on correspondence between strings:⁷

(10) Correspondence

Given two strings S_1 and S_2 , **correspondence** is a relation \mathcal{C} from the elements of S_1 to those of S_2 . Elements $\alpha \in S_1$ and $\beta \in S_2$ are referred to as **correspondents** of one another when $\alpha \mathcal{C} \beta$.

Here we will assume that the structural elements in question are just (tokens of) segments,⁸ but it is a straightforward matter to generalize the approach to higher-order units of prosodic structure such as moras, syllables, feet, heads of feet, as well as tones and even distinctive features or feature nodes, in support of theories of quantitative transfer, compensatory lengthening, and the effects of floating features.⁹

Correspondence need not be limited to the B-R and I-O relations. For example, the same notions extend directly to relations between two stems, as in root-and-pattern, circumscriptive, or truncating morphology (Benua 1995, McCarthy & Prince 1994b, in prep., McCarthy 1995), and they can be connected with the types of cyclic or transderivational relationships within paradigms explored by Benua (1995) and Burzio (1994ab).

In a correspondence-sensitive grammar, candidate reduplicants or outputs are subject to evaluation together with the correspondent base or input. Each candidate pair (S_1, S_2) comes from Gen equipped with a correspondence relation between S_1 and S_2 that expresses the relation, if any, between S_2 and S_1 . There is a correspondence relation for each (B,R) candidate-pair. There is also a correspondence relation for

⁷ We will simplify the discussion in a further respect: we will speak of \mathcal{C} relating string to string, though relations are properly defined on **sets**. To remedy this imprecision, observe that a string can always be regarded as a set of ordered pairs of its members with positional indices, and similar constructions can be put together for structures more complex than strings. Ultimately, \mathcal{C} can be defined over such sets.

⁸ Correspondence is treated as relation rather than a function (as in McCarthy & Prince 1993a), to allow for one-to-many relationships, as in diphthongization, for example, or coalescence. On these phenomena, see among others Cairns (1976), de Haas (1988), Hayes (1990), and, using correspondence, Gnanadesikan (1995), Lamontagne & Rice (1995), McCarthy (1995), and Pater (1995).

⁹ For formal development relevant to the full complexity of phonological structures, see Pierrehumbert and M. Beckman (1988), Kornai (1991 [1994]), and van Oostendorp (1993). On quantitative transfer, see Levin (1983), Clements (1985a), Mester (1986: 239fn.), McCarthy & Prince (1988), and Steriade (1988). On floating features, see among others Archangeli & Pulleyblank (1994), Akinlabi (1994).

each (I,O) candidate-pair. Indeed, one can simply think of Gen as supplying correspondence relations between S_1 and all possible structures over some alphabet.¹⁰ Eval then considers each candidate pair with its associated correspondence relations, assessing the completeness of correspondence in S_1 or S_2 , the featural identity of correspondent elements in S_1 and S_2 , and so on.

A hypothetical illustration will make these ideas more concrete. In (11a), we provide some (B,R) correspondences, and in (11b) we do the same for (I,O) correspondence. The comments on the right describe any interesting imperfections of correspondence. Correspondent segments are indicated here by subscripted indices, a nicety that we will usually eschew in the discussion later.

(11) Hypothetical Illustrations

a. *Some B-R Correspondents: Input = /RED-badupi/*

b₁ a₂ d₃ u₄ p₅ i₆ – b₁ a₂ d₃ u₄ p₅ i Total reduplication — perfect B-R correspondence.

b₁ a₂ d₃ – b₁ a₂ d₃ u₄ p₅ i₆ Partial reduplication — *upi* in B has no correspondents in R.
▲ ▲ ▲

b₁ a₂ t₃ – b₁ a₂ d₃ u₄ p₅ i₆ The *t* in R has a non-identical correspondent in B, for phonological reasons (final devoicing).
▲ ▲

? a₂ d₃ – b a₂ d₃ u₄ p₅ i₆ The ? is **not** in correspondence with the base-initial *b*. This is fixed-segment reduplication (cf. Tübatulabal).
▲ ▲

?₁ a₂ d₃ – b₁ a₂ d₃ u₄ p₅ i₆ The ? in R has a non-identical correspondent in B. This and the preceding candidate are formally distinct, since Eval considers candidates with their correspondence relations.
▲ ▲

b. *Some I-O Correspondents: Input = / p₁ a₂ u₃ k₄ t₅ a₆ /*

p₁ a₂ u₃ k₄ t₅ a₆ A fully faithful analysis — perfect I-O correspondence.

p₁ a₂ ? u₃ k₄ t₅ a₆ Hiatus prohibited (by high-ranking ONSET), so epenthetic ? in O has no correspondent in I.
▲

p₁ u₃ k₄ t₅ a₆ Hiatus prohibited, leading to V-deletion. The segment *a* in I has no correspondent in O.
▲

p₁ a₂ u₃ t₄ t₅ a₆ The *k₄* in I has a non-identical correspondent in O, for phonological reasons.
▲

b l u r k No element of O stands in correspondence with any element in I. Typically fatal.
▲ ▲ ▲ ▲ ▲

The variety of candidates shown emphasizes some of the richness of the Gen-supplied set. It falls to Eval, and the language-particular constraint hierarchy, to determine

¹⁰ This way of characterizing Gen under correspondence was suggested to us at the Utrecht workshop by Sharon Inkelas and Orhan Orgun.

what is optimal, what is not, and what can never be optimal under any ranking of the constraints in UG.

2.2 Constraints on Correspondent Elements

Constraints must assess correspondence and identity of correspondent elements. There are separate (and therefore separately rankable) constraints for each correspondence relation (input/output, base/reduplicant, etc.). The following are three of the constraint families that will play a leading role in our discussion; all relate strings S_1 (base, input, etc.) to S_2 (reduplicant, output, etc.):

(12) The MAX Constraint Family

General Schema

Every segment of S_1 has a correspondent in S_2 .

Specific Instantiations

MAX-BR

Every segment of the base has a correspondent in the reduplicant.
(Reduplication is total.)

MAX-IO

Every segment of the input has a correspondent in the output.
(No phonological deletion.)

(13) The DEP Constraint Family

General Schema

Every segment of S_2 has a correspondent in S_1 .
(S_2 is “dependent on” S_1 .)

Specific Instantiations

DEP-BR

Every segment of the reduplicant has a correspondent in the base.
(Prohibits fixed default segmentism in the reduplicant.)

DEP-IO

Every segment of the output has a correspondent in the input.
(Prohibits phonological epenthesis.)

(14) The IDENT(F) Constraint Family

General Schema

IDENT(F)

Let α be a segment in S_1 and β be any correspondent of α in S_2 .
If α is $[\gamma F]$, then β is $[\gamma F]$.
(Correspondent segments are identical in feature F).

Specific Instantiations

IDENT-BR(F)

Reduplicant correspondents of a base $[\gamma F]$ segment are also $[\gamma F]$.

IDENT-IO(F)

Output correspondents of an input $[\gamma F]$ segment are also $[\gamma F]$.

Proposed constraints on other aspects of the correspondence relation are listed in Appendix A. Note further that each reduplicative affix has its own correspondence relation, so that in a language with several reduplicative affixes there can be several distinct, separately rankable constraints of the MAX-BR type, etc. This means that different reduplicative morphemes within a language can fare differently with respect to constraints on correspondence — for example, one can be total reduplication, obeying MAX-BR, and one can be partial, violating MAX-BR. It also means that reduplicative morphemes can differ in how they interact with the phonology, in one and the same language, as Urbanczyk (1995) argues.¹¹ It must be, then, that correspondence constraints are tied not only to specific dimensions (B-R, I-O, even I-R in the Full Model of §6), but also, in some cases at least, to specific morphemes or morpheme classes. Thus, the full schema for a faithfulness constraint may include such specifics as these: the element preserved, the dimension of derivation along which the two structures are related, the *direction* of inclusion along that dimension (as in the contrast between MAX and DEP), and the morphological domain (stem, affix, or even specific morpheme) to which the constraint is relevant.

The constraint MAX-IO reformulates PARSE-segment in Prince & Smolensky (1991, 1993) and other OT work, liberating it from its connection with syllabification and phonetic interpretation. In addition, the MAX family subsumes the reduplication-specific MAX in McCarthy & Prince (1993a). Depending on which correspondence relation they regulate, the various MAX constraints will prohibit phonological deletion, demand completeness of reduplicative copying, or require complete mapping in root-and-pattern morphology.

The DEP constraints approximate the function of FILL in Prince & Smolensky (1991, 1993) and other OT work. They encompass the anti-epenthesis effects of FILL without demanding that epenthetic segments be literally unfilled nodes, whose contents are to be specified by an auxiliary, partly language-specific component of phonetic interpretation. They also extend to reduplication and other relations.

The IDENT constraints require that correspondent segments be featurally identical to one another. Unless dominated, the full array of these constraints will require complete featural identity between correspondent segments. Crucial domination of one or more IDENT constraints leads to featural disparity, and phonological alternation. (Thus, mappings other than outright segmental insertion or deletion typically involve violations of IDENT rather than MAX/DEP.) The IDENT constraint family is constructed here on the assumption that segments alone stand in correspondence, so featural relations must be transmitted through them. Extending the correspondence relation to features is possible and certainly worth exploring, to deal with phenomena like floating features (see fn. 9). Another extension, adopted by Urbanczyk (1995), posits identity of moraic analysis of correspondent segments. In

¹¹ Compare also the discussion of Luiseño (Munro & Benson 1973) in §5.4 below. In Luiseño, a phonological process is observed to underapply in adjectival reduplication, but not in verbal reduplication. Thus, different reduplicative morphemes can interact differently with the phonology, through constraint ranking.

light of work in feature geometry (Clements 1985b, Padgett 1995, etc.), it is plausible that IDENT will quantify over classes of features. A further development of IDENT, proposed by Pater (1995) and called on in §5.1 below, differentiates [+F] and [-F] versions for the same feature.

The parallels between B-R identity and I-O faithfulness observed in §2.1 are now seen to follow from the fact that both B-R and I-O are related by correspondence and that the constraints on correspondence come in families. In particular, the constraints on the B-R relation are the core elements of the reduplicative branch of Correspondence Theory, interacting through ranking with constraints on phonological form and on the I-O relation.

Once the basic patterns of faithfulness are sketched, it becomes clear that there is an important further parallel to be drawn, which the generality of correspondence affords us. Suppose the strings S_1 and S_2 related by \mathcal{R} are a string E of tone-bearing elements (vowels, moras, or syllables) and a string T of tones, respectively. Then MAX-ET requires that every tone-bearing element have a correspondent tone, and DEP-ET requires that every tone have a correspondent tone-bearing element. These are equivalent to two clauses in Goldsmith's (1976) "Well-Formedness Condition" for autosegmental phonology: every tone-bearing element is associated with some tone; and every tone is associated with some tone-bearing element. The other constraints on correspondence laid out in Appendix A, such as LINEARITY, CONTIGUITY, and ANCHORING, also have clear analogues in principles of autosegmental association, such as the line-crossing prohibition, the requirement of directional one-to-one linking and the Initial Tone Association Rule (Clements & Ford 1979). The phenomena comprehended by the theory of autosegmental association are therefore a special case of correspondence.¹²

This parallel, and the consequent reduction of autosegmental association to correspondence, are particularly significant because they recapture one of the original ideas of Prosodic Morphology, one which was lost in the solely reduplicative correspondence theory of McCarthy & Prince (1993a): that template satisfaction is a special case of autosegmental association, involving associating floating melodemes to a templatic skeleton (McCarthy 1979, Marantz 1982, Clements 1985a, Mester 1986, McCarthy & Prince 1986, etc.). We now see that exactly the same relation — correspondence — and the same constraints — MAX, DEP, etc. — are at work in both domains, just as they are in faithfulness.

2.3 Issues in Correspondence Theory

Differentiation of these correspondence relations raises several broad issues worth addressing before we turn to the specific matter of reduplicative phonology.


¹² Of course, stated as correspondence relations, the components of the "Well-Formedness Condition" and other autosegmental principles form a set of **rankable**, hence **violable**, constraints, leading to significant empirical differences from standard conceptions of autosegmental phonology. See Myers (1993) for an incisive discussion of tonal association under (pre-Correspondence) OT.

First, are the parallel constraints of B-R and I-O indeed **parallel**, and not **identical**? Why, for example, won't a single MAX constraint suffice to regulate all correspondence relations?

To show that two constraints are distinct in UG, it is necessary and sufficient to show that they are separately ranked in the grammar of some language — either one provably dominates the other, or some third constraint intervenes between them in the ranking. The distinctness of the MAX-BR/MAX-IO pair is demonstrated in McCarthy & Prince (1994a). The Philippine Austronesian language Balangao supplies a representative argument and a first illustration of how correspondence functions in an Optimality-Theoretic grammar.

Balangao has a disyllabic prefixed reduplicant without a final coda: /RED-tagtag/ → tagta-tagtag. This means that the constraint NO-CODA crucially dominates the reduplicant-maximizing constraint MAX-BR:


(15) NO-CODA ≫ MAX-BR in Balangao

/RED-tagtag/	NO-CODA	MAX-BR
a.  t ₁ a ₂ g ₃ · t ₄ a ₅ · -t ₁ a ₂ g ₃ · t ₄ a ₅ g ₆ ·	***	*
b. t ₁ a ₂ g ₃ · t ₄ a ₅ g ₆ · -t ₁ a ₂ g ₃ · t ₄ a ₅ g ₆ ·	**** !	

Form (a) violates MAX-BR, because final g_6 of the base has no correspondent in the reduplicant. It does so, as the tableau makes apparent, to spare a NO-CODA violation. Undominated CONTIG-BR (see Appendix A) protects the reduplicant-medial coda, ruling out the further codaic economy obtained by a reduplicant like $*t_1 a_2 t_4 a_5 -$.¹³

Though NO-CODA dominates MAX-BR in Balangao, it has the opposite ranking with respect to MAX-IO. The language obviously has codas, both medially and finally, so it must value faithfulness to the input higher than coda-avoidance:

(16) MAX-IO ≫ NO-CODA in Balangao

/ t ₁ a ₂ g ₃ t ₄ a ₅ g ₆ /	MAX-IO	NO-CODA
a.  t ₁ a ₂ g ₃ · t ₄ a ₅ g ₆ ·		**
b. t ₁ a ₂ g ₃ · t ₄ a ₅ ·	* !	*

¹³ The more deviously-constructed candidate $t_1 a_2 g_3 t_4 a_5 - t_1 a_2 g_3 t_4 a_5 g_6$ spares MAX-BR violation, but at the expense of violating two other constraints defined in Appendix A, LINEARITY-BR and UNIFORMITY-BR. It is an interesting further issue to explain why such fusion is, in all likelihood, impossible.

Here, form (b) violates MAX-IO, since input-final g_6 has no correspondent in the output. Violation is fatal, because NO-CODA ranks below the input-output faithfulness constraint.

Combining the two results, we have MAX-IO \gg NO-CODA \gg MAX-BR, with the two MAX constraints separately ranked. This shows that these two constraints, bound up with two different correspondence relations, are formally distinct. The parallels observed at the beginning of this section are just that — parallels — rather than equalities.

A second point needing further clarification concerns the conception of the phonological output in Correspondence Theory, and the contrast with other implementations of faithfulness. Most work within OT since Prince & Smolensky (1991) assumes that the phonological output is governed by a requirement that no input element may be literally removed. To-be-deleted elements are present in the output, but marked in some way. (This property is dubbed “Containment” in McCarthy & Prince 1993a;¹⁴ ideas like it have played a role throughout much of modern syntactic theory — e.g., Postal 1970, Perlmutter (ed.) 1983, and Chomsky 1975.) Under this assumption, phonologically deleted segments are present in the output, but unparsed syllabically, making use of the notion of *Stray Erasure* in Steriade (1982). The I-O faithfulness constraint PARSE regulates this mode of deletion, by prohibiting unsyllabified segments.

This interpretation of the output and PARSE reduces the prohibition on deletion to an easily-stated structural constraint, and thereby provides a direct and convenient way to handle a variety of basic cases. But it is by no means the only possible approach to faithfulness in OT (cf. Prince & Smolensky 1993: 25, fn. 12, Yip 1993b, Myers 1993, and Kirchner 1993 for some of the alternatives). Indeed, there are very significant differences in formal architecture between the serial operational theory from which Stray Erasure originated and OT’s parallel, evaluative-comparative approach to well-formedness. The shared goal of both theories is to derive the properties of deletion patterns from independent principles of syllabification. Under standard deterministic Markovian serialism, there is no clear way to combine rules of literal deletion with operational rules of syllabification so as to get this result. So the burden must be placed entirely on the rules of syllabification, with deletion postponed to sweep up afterward. OT’s architecture admits this as a possible line of attack on the problem, but since all manner of alterations of the input are considered in parallel, there is no intrinsic need to limit Gen to an output representation without deletions, so long as the relation between input and output is kept track of — for example, by the correspondence relations of the MAX family. An immediate (and desirable) consequence of the Correspondence/full-deletion approach is that deleted elements simply cannot play a role in determining the performance of output structures on constraints defined strictly on output representations. There is then no need to restrict

¹⁴ Observe that “Containment” is offered as a term of art; hence, free association from the ordinary language homophone is unlikely to provide a reliable guide to its meaning.

these constraints to seeing only *parsed elements*, as for example Myers (1993) demonstrates to be true of the OCP; the point applies with equal force to a class of alignment constraints, as shown by J. Beckman (1995). Along the same lines, B-R correspondence sees only what is manifest in B, a fact that leads directly to strong predictions about overapplication in the reduplicative theory.

Much OT work since Prince & Smolensky (1991) assumes as well that no segment can be literally *added* to the output. Phonological epenthesis is conceived as the result of providing prosodic structure with no segment to fill it, the phonetic identity of the epenthetic segment being determined by extra-systemic rules of phonetic interpretation, exactly as in Selkirk (1981), Lowenstamm & Kaye (1985), and Itô (1986). The constraint FILL militates against these unfilled prosodic nodes. Here again, a faithfulness issue is given a simple structural interpretation that allows for easy formulation and direct assault on the basic generalizations about the relation between epenthesis and syllabifiability. But, just as with deletion, the architectural shift opens new perspectives. Under OT, it is no longer formally necessary to segregate the cause of epenthesis (principles of syllabification) from the fact itself. Under Correspondence, the presence of epenthetic elements is regulated by the DEP constraint family, and they appear in optimal forms with whatever kind and degree of featural specification the phonological constraints demand of them. An immediate, desirable consequence is that the choice of epenthetic material comes under *grammatical* control: independently-required constraints on featural markedness select the least offensive material to satisfy (better satisfy) the driving syllabic constraints. (See Prince & Smolensky 1993, Chapt. 9; Smolensky 1993, McCarthy 1993, and McCarthy & Prince 1994a for relevant discussion of featural markedness in epenthetic segments.) In addition, the actual featural value of epenthetic segments can figure in grammatical generalizations, as is known to be the case in many situations (for example, Yawelmani Yokuts harmony, discussed in Kuroda 1967, Archangeli 1985). This contrasts sharply with the FILL theory, in which the feature composition of epenthetic segments is determined post-grammatically, by a further process of phonetic implementation. This “phonetics” nevertheless deals in the very same materials as phonology, and is subject to interlinguistic variation of a sort that is more than reminiscent of standard constraint-permutation effects. Correspondence makes immediate sense of these observations, which appear to be in principle beyond the reach of FILL-based theories.

This discussion has brought forth a significant depth of empirical motivation behind the proposal to implement faithfulness via correspondence of representations. A primary motive is to capture the parallels between B-R identity and I-O faithfulness. This is reinforced by the observation that mapping between autosegmental tiers is regulated by the same formal principles of proper correspondence, allowing us to recapture the formal generality of earlier, autosegmental-associative theories of template satisfaction. By contrast, a Containment or PARSE/FILL approach to inter-tier association is hardly conceivable. Correspondence also allows us to explain why certain constraints, such as Myers’s tonal OCP, are totally insensitive to presence of deletion sites, and why epenthetic elements show an unmarked feature composition,

which can nevertheless play a role in phonological patterns such as vowel harmony. To these, we can add the ability to handle phenomena such as diphthongization and coalescence (the latter taken up in §3.8 below) through the use of one-to-many and many-to-one relations. It is certainly possible, bemused by appearances, to exaggerate the differences between the PARSE/FILL approach and correspondence — both being implementations of the far more fundamental faithfulness idea, without which there is no OT — but it seems quite clear at this point that Correspondence is the more promising line to pursue.

Correspondence Theory also raises broader issues about the character of phonology and phonological constraints generally. Some phonological developments are explored by Alderete (1995), J. Beckman (1995), Gnanadesikan (1995), Holton (1995), Keer (1995), Lamontagne & Rice (1995), McCarthy (1995), Orgun (1995), Pater (1995), Rosenthal (1995), and Selkirk (1995). One topic worthy of future investigation is the potential for stating constraints *other than the faithfulness variety* on correspondent pairs in input and output. Developments along this line can produce the same general effect as the “two-level” rules introduced by Koskeniemi (1983) and further studied by Karttunen (1993), Lakoff (1993), Goldsmith (1993), and others. On a different tack, the re-casting of autosegmental association in terms of correspondence relations may be expected to have consequences for the analysis of tonal, harmonic, and related phenomena. We do not explore these ideas here, though they are clearly worth developing.

There is yet a third point to consider, closely related to issues of Containment and the character of the output. We have proceeded by generalizing correspondence from the B-R domain, where it first saw light of day, to the I-O domain, where it takes over the functions of PARSE, FILL and the like, with their attendant assumptions about the output. Could we have just as well developed reduplication theory by proceeding in the opposite direction — i.e., by generalizing PARSE from I-O to B-R, thereby eliminating Correspondence in favor of Containment? The question has already been answered: the far greater generality of Correspondence Theory recommends it unambiguously over Containment-based approaches.

The question has more than abstract interest, however, because in essence, this is what the Full Copy Model of reduplication does (Whitney 1924 [1977]: ¶259; Marantz 1982; McCarthy & Prince 1987, 1988; Steriade 1988). An implementation of Full Copy within OT would go something like this: in every reduplicative candidate, Gen supplies a complete and exact copy of the base, analogous to the complete and exact copy of the input contained in every output, under the PARSE model. Gen supplies different prosodic analyses of the full copy, just as it supplies different prosodic analyses of any input. Segments of the Full copy that are not parsed prosodically violate a reduplicant-specific constraint PARSE-R. This constraint is distinct, and separately rankable, from the base-specific faithfulness constraint PARSE-B. Applied to the Balangao example discussed earlier, this theory works as follows:

(17) PARSE-B \gg NO-CODA \gg PARSE-R in Balangao, under Full Copy

	/RED–tagtag/	PARSE-B	NO-CODA	PARSE-R
a.	☞ tagta⟨g⟩–tagtag		***	*
b.	tagtag–tagtag		**** !	
c.	tagtag–tagta⟨g⟩	* !	***	
d.	tagta⟨g⟩–tagta⟨g⟩	* !	**	*

Observe that every candidate has a full copy of the base, though sometimes incompletely parsed; this assumption is essential if PARSE-R is to take over the functions of MAX-BR. Therefore, candidates like *tagta–tagtag or *tagta–tagta play no role in this model, by hypothesis. Syllabically unparsed segments are bracketed; they violate PARSE-B or PARSE-R, depending on their morphological affiliation. Form (a) is optimal because it achieves some success on NO-CODA merely by non-parsing of a segment in the copy, a low-ranking PARSE-R violation.

On such superficial acquaintance, this approach might seem promising, but in fact it is fraught with difficulties. The problems arise when the reduplicative base undergoes a phonological alternation. Full Copy must assert, once and for all languages, whether the input or the output form of the base is copied by Gen.

•**Input Copy.** Gen supplies a full copy of the base in its **input** form, without regard to how it is parsed in the output form. (This is analogous to the proposal in Marantz 1982 and McCarthy & Prince 1988. It is assumed in (17) above.)

•**Output Copy.** Gen supplies a full copy of the base in its **output** form, duplicating every nuance of how it is parsed. (This is analogous to the proposal in Steriade 1988.)

Observe that these are decisions about *linguistic theory*, rather than about the grammars of particular languages. They will, then, have certain unavoidable (and unfortunate) consequences.

Input Copy entails total independence in the Gen-supplied parsings of the base and the reduplicant. Since parsing determines phonetic realization, this means that no aspect of the derived phonology of the base will be mimicked in the reduplicant, and no aspect of the derived phonology of the reduplicant will be mimicked in the base. Therefore, Input Copy can never yield overapplication (or underapplication). This is a fatal defect.

Output Copy claims that there is total dependence of the reduplicant's parsing on the base's parsing. An interesting issue immediately arises: the treatment of elements unparsed in the base. If these are dropped in copying, or copied but ignored in the parsing of the base, we get overapplication, and only overapplication. This

eliminates normal application, fatally. So unparsed elements must be retained: but then they must be reckonable-with in various distinct ways so as to support the distinction between normal application and overapplication. We leave it as a challenge to the committed Containmentist to work this out, along with the distinctions in value between the crossed varieties of R-(un)parsing B-(un)parsed elements. But however the formal development goes, notice that the overapplication obtainable within copying theory is only of the type where R copies B. The opposite effect — B copies R, as presented in §3.4, §3.6, §3.8, and §5.3 — is impossible. This, we assert, is empirically fatal.

Under either construal, then, Full Copy cannot contend with the full range of reduplication-phonology interactions. At best, under the most optimistic assumptions about formal development, it can deal with only some types of overapplication. Like the original Ordering Theory, it sees identity between base and reduplicant as a consequence of a one-time operation (copying by Gen) rather than a persistent relation. In contrast, the relational theory of identity under correspondence is supported by a fully instantiated factorial typology, in which the empirically justified types of reduplication/phonology interaction are predicted (see §§4 and 6).

Full Copy also suffers a considerable loss of generality in comparison with Correspondence Theory. Correspondence readily extends from the B-R and I-O relations to all types of autosegmental association, and it deals effectively with a range of phenomena including coalescence and diphthongization. No such generalization is possible in Full Copy, which has no analogue to the correspondence relation. In Full Copy, any resemblance between the constraints on autosegmental association, for example, and the constraints on parsing must be entirely accidental — an empirical disaster, given the exactness of the parallels.¹⁵ In light of these remarks, Full Copy will be dismissed from further consideration.

2.4 Summary

A correspondence relation between linguistic representations unifies constraints on faithfulness with constraints on reduplicative identity. Constraints of the two types are distinct and therefore separately rankable, but they come in formally related pairs, yielding identical effects in the I-O and B-R domains. The theory of Correspondence extends with no additional effort to general autosegmental association, and illuminates phenomena such as coalescence and diphthongization, as well as the featural properties of epenthetic elements and the blindness of certain constraints to deletion. This broad generalization, which transcends differences between ordinary phonology and reduplicative morphology, lends considerable interest to the enterprise of developing Correspondence Theory. It also directly

¹⁵ In some versions of Full Copy, the lack of generality is an even more severe problem. Thus, Steriade (1988: 81) conceives of template satisfaction in terms of reduplicative “matching procedures”. These are unrelated either to input-output faithfulness on the one hand or to autosegmental association on the other. They are, then, thoroughly reduplication-specific, with no connection to other, clearly very similar, string relations.

supports the overall Prosodic Morphology enterprise, which seeks to reduce or eliminate the apparatus that is peculiar to reduplication and other forms of non-concatenative morphology. We now turn to the analysis of reduplicative phonology within parallel OT.

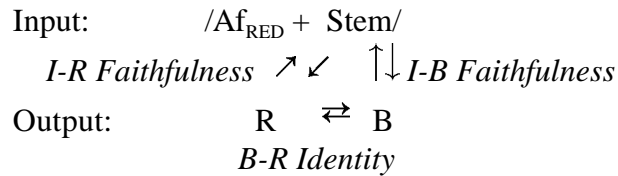
3. Correspondence Theory and Overapplication

3.1 Overview of the Argument

The literature is replete with examples of overapplication. Most cases known to us are collected in Appendix B, where they are classified according to the type of phonological process involved. (Several additional examples are also dealt with in §5.) Here we aim to provide and justify a general model of the overapplication phenomenon under Correspondence Theory, examining a number of particularly illuminating cases. We begin by setting out the model and then proceed to consider its empirical ramifications, focusing on those phenomena that bear most directly on the theory of correspondence and on its relation to contrasting serialist approaches.

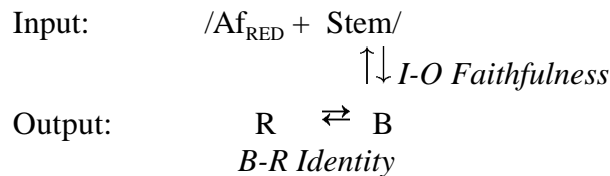
The Full Model of reduplicative identity (§1, §6) assumes three dimensions along which correspondence is reckoned:

(18) Full Model



In this discussion, we will largely omit discussion of I-R faithfulness, only adverting to it on the rare occasion when it discharges some necessary descriptive task, or, more significantly, when its existence becomes relevant to a general conclusion we wish to draw about the functioning of Correspondence Theory. This simplification is harmless, because, in the cases under scrutiny, I-R faithfulness is mostly dominated to the point of inactivity, and because its overall effects are limited anyway, as seen in §6, where the Full Model is taken up in its entirety. We will focus then, on the *Basic Model* (§1):

(19) Basic Model



In this diagram, and the one above, “+” should be understood to indicate mere combination, without directional prejudice. The terms “faithfulness” and “identity” are

distinguished for expositional clarity only, since they call on exactly the same formal system of correspondence relations — one of the major theses advanced here.

The model works like this: the I-O faithfulness system evaluates the correspondence between the *stem*, a morphologically-defined input construct, and the *base*, in the output; the base itself stands in correspondence with the *reduplicant*, a relation evaluated by the B-R identity system. The *reduplicant* is the output form of the reduplicative morpheme, which typically has no segmentism in the input. The faithfulness/identity constraints demand completeness of correspondence and identity of correspondent elements (§2, Appendix A).

Suppose there is a phonological alternation affecting the stem in (19). This introduces a disparity between stem and base: a breach of faithfulness. So long as there are faithful candidates supplied by Gen, this can only happen if some structural constraint \mathbb{C} dominates a relevant faithfulness constraint, forcing it to be violated. The mere fact of this phonological alternation means, then, that \mathbb{C} compels some imperfection of correspondence or some non-identity of correspondent elements between input stem and output base. (This is nothing but the standard Optimality-Theoretic view of phonological alternations, revised to construe faithfulness in terms of correspondence.)

But the B-R identity system is also at play, through the B-R correspondence relations shown in (19). Unless some conflicting, higher-ranked constraint intervenes, B-R identity requirements must be respected, and the reduplicant will take on all the attributes of the base, including those attributes that distinguish it from the input stem as a consequence of \mathbb{C} . The reduplicant relates to the base that it sees, *in output form*, so the reduplicant assumes the properties of the base, whether underlying or derived. When \mathbb{C} is relevant only to the conditions in the base, this yields the most obvious form of overapplication (§3.2, §3.3, §3.4). When \mathbb{C} is relevant to conditions only in R, or conditions created by the juxtaposition of R and B, far more interesting interactions can result, in which B actually copies R, or R copies from B the very phonology that R itself has imposed on B (§3.6, §3.7, §3.8). These interactions defy interpretation in serial terms, and provide uniquely strong empirical support for parallelistic Correspondence Theory.

3.2 Madurese Glide Formation

The very architecture of base-reduplicant correspondence can force the outcome in the simplest case, regardless of the details of ranking between I-O faithfulness and B-R identity. The copying of derived glides in Madurese reduplication, extensively analyzed by Stevens (1968, 1985), provides a telling example. In Madurese phonology, all potential V–V hiatus is resolved by the appearance of a glide: *y*, *w*, or *ʔ*. Reduplication copies the inserted glide, even though in the reduplicant it does not appear in intervocalic position: thus, *wʔ-k^huwʔ* from /RED+k^hoa/ ‘caves’. This effect is unavoidable under the Correspondence Theory advanced here, on the assumption that there are no special phonological constraints

on the content of the reduplicant. To see why, let us first establish the basic background phonology of the language.

(20) Madurese Hiatal Glide Formation

a. *Epenthetic y*

/seʌŋ/	seyʌŋ	‘afternoon’
/rop ^h ia/	rɔp ^h iyʌ	‘wife’

b. *Epenthetic w*

/k ^h oa/	k ^h uwʌ	‘cave’
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c. *Epenthetic ʔ*

/maen/	mãʔẽn	‘toy’
/leer/	lɛʔɛr	‘neck’
/soon/	sɔʔɔn	‘request _N ’

When possible, the glide is a *y* or *w* homorganic to the preceding vowel (20a, b), evidently the result of spreading from the first vowel into the onset of the following syllable. In two circumstances (20c), a homorganic glide cannot be obtained: when the first vowel is *a*, a segment that typically lacks a nonnuclear counterpart; and when the hiatal vowels are identical, in a kind of OCP effect, since spreading the first vowel would ensure its contact with the second. In those two cases, a *ʔ* is inserted instead.

The core phonology follows familiar lines. The constraint ONSET is responsible for unfaithful analysis of the input, demanding that each syllable begin with a consonant. It must dominate DEP-IO (13), which bans epenthesis. The following tableau contrasts an optimal glide-inserted form with a hiatus-preserving alternative:

(21) ONSET ≫ DEP-IO in Madurese

	/seʌŋ/	ONSET	DEP-IO
a.	seyʌŋ		*
b.	se.ʌŋ	* !	

According to DEP-IO, every segment of the output must have a correspondent in the input. The output *y* in *seyʌŋ* (a) has no input correspondent, so DEP-IO is violated. But the faithful analysis *se.ʌŋ* (b) fares even worse, because ONSET is dominant. As in all alternations of ordinary phonology, a high-ranking phonological constraint like ONSET compels violation of a constraint on stem-base (i.e., input-output) correspondence like DEP-IO.

To complete the argument, we must settle the ranking of the other faithfulness constraints relevant to the satisfaction of ONSET. All of these must be ranked above DEP-IO; otherwise another route to satisfaction of ONSET would be taken. Among them, for example, is the constraint MAX-IO, which forbids loss of segmental material; were it the lowest-ranked of the relevant faithfulness constraints, then

potential violations of ONSET would be avoided by selecting deleted forms: **seŋ*, or **saŋ*, rather than *seyan*. This yields the following schematic ranking:

(22) ONSET, $\mathcal{F}' \gg$ DEP-IO

where \mathcal{F}' is a strictly *ad hoc* notation meant to denote what's left when DEP-IO is removed from the set of faithfulness constraints relevant to resolving ONSET violations. Up to this point, we have done no more than recast the basic analysis of Prince & Smolensky (1993: Chapt. 6).

Selecting from among $\{y, w, \text{ʔ}\}$ in various contexts falls to structural constraints on the output. Here we merely suggest an analysis. (See Rosenthal 1994, Cohn & McCarthy 1994, and especially Keer 1995 and Thorburn 1995.) The segment ʔ must violate only the lowest-ranking anti-structure or markedness constraints on featural combination. The choice between ʔ and $\{y, w\}$ is the result of ranking the segmental/featural markedness constraint $*\text{ʔ}$ above, say, $*\text{SPREAD}$: this will favor *seyan* over **seʔan*. The OCP must be ranked above $*\text{ʔ}$, blocking glide-formation between identical vowels. When the OCP blocks spreading, the insertion of fresh features is required to fill out the onset consonant; the least offensive feature combination is chosen: ʔ .

There is a final twist in the basic phonology: glide insertion is strictly intervocalic, yet a purely syllabic analysis predicts that epenthesis will also take place word-initially. As in McCarthy & Prince (1993a: Chapt. 4), we attribute this to a morphology-prosody alignment condition requiring that stem-initial segments also be initial in the Prosodic Word:¹⁶ $\text{Align}(\text{Stem}, \text{L}; \text{PrWd}, \text{L})$. (See Appendix A for ANCHOR, the correspondence-based version of alignment.) Because inserted segments lack stem affiliation, initial epenthesis would separate the stem from the beginning of the PrWd. The undominated stem-PrWd alignment constraint bans this.

With the basics of glide phonology in hand, we turn to the behavior of the reduplicant. The correspondence constraint MAX-BR demands total reduplication, requiring every segment in the base to have a correspondent in the reduplicant. The reduplicant is nonetheless monosyllabic, indicating that a templatic constraint dominates MAX-BR.¹⁷ Within the constraint of monosyllabism, various segmental realizations are possible. Strikingly, the anti-hiatal glides are copied into the reduplicant:

¹⁶ Madurese also places an incompletely understood condition on ʔ , permitting it only postvocally — or in codas, according to Stevens (1968: 30; 1985: 98) and Cohn (1993a: 108). This is puzzling.

Spreading must only be allowed to go rightward, crossing syllable boundaries, probably due to a widely observed constraint against onset-nucleus homorganicity (Keer 1995, Thorburn 1995).

¹⁷ The reduplicant is also anchored at the wrong end. As in Madurese compounds and truncated words generally, reduction is to the *last* syllable.


(23) Overapplication of Hiatal Glide Formation in Madurese¹⁸

/moa/	w̃ã–mõw̃ã	‘faces’
/neat/	ỹāt–nẽỹāt	‘intentions’
/k ^h oa/	wɣ–k ^h uwɣ	‘caves’
/a–taña–a/	a–ñãʔ–tañãʔã	‘will ask often’
/boa–an/	wɣʔ–buwɣʔɣn	‘fruits’

Given the right conditions, derived glides are copied into both initial and final positions of the reduplicant, as seen in forms like *wɣʔ–buwɣʔɣn* from /*boa–an*/.

This result is unavoidable, given the phonology of the language and the existence of a correspondence relation between reduplicant and base. The following tableau certifies it:

(24) Madurese Reduplication

	/RED+k ^h oa/	MAX-BR	ONSET	DEP-IO
a.	 wɣ–k ^h uwɣ	**		*
b.	ɣ–k ^h uwɣ	*** (!)	* !	*
c.	ɣ–k ^h uɣ	**	* ! *	

The glide-copying form (a) wins on purely phonological grounds. Any role that MAX-BR can play in eliminating competitors is not crucial, and that constraint can be ranked anywhere. What’s truly crucial is that the reduplicant copies — stands in correspondence with — the base, and so it is obliged to take on the characteristics of the base, regardless of their source.¹⁹

¹⁸ In examples like /RED–ŋ–soon/ → *ʃn–ñ ʃʔʃn* ‘request (verb)’, the epenthetic *ʔ* is not observed to copy, because it is only found post-vocally (see fn. 16).

¹⁹ There are two potential threats to the unavoidability result. One involves the specific relation between featural markedness constraints and the constraints on B-R featural identity, IDENT-BR (F) in Madurese. For example, a markedness constraint having the effect of **w* could eliminate *w* — and concomitantly all segments that are universally more marked than *w* — from the reduplicant. This would render *wɣ–k^huwɣ* suboptimal, and rule in favor of some other candidate, which would nevertheless have to begin with a consonant or glide of some sort, due to the position of ONSET in the grammar. There is, however, no evidence that any segment is excluded from the reduplicant, and so IDENT-BR is not crucially subordinated to any featural markedness constraint. Hence, with no special limits on reduplicant segmentism in Madurese, overapplication is unavoidable.

The other potential threat arises in the *Full Model* of correspondence relations (§6 below), which recognizes an additional faithfulness system regulating the relationship between the underlying stem and the reduplicant. The constraint DEP-IR, which holds that the material in R should be drawn only from the underlying stem, could in principle exclude epenthetic elements in B from appearing in R. But under the metaconstraint-induced relation DEP-IB ≫ DEP-IR, the constraint DEP-IR cannot have such an effect in a Madurese-type situation. The dominance of ONSET, as in ONSET ≫ DEP-IB, winnows out the candidate set so thoroughly that even with DEP-IR ≫ B-R identity formally, the IR constraint would not have a chance to force an onsetless reduplicant from bases with anti-hiatal *y* or *w* in them. So this is no threat at all.

This kind of overapplication effect can also be construed in the serial-derivational approach referred to as Ordering Theory in §1. Imagine a rule system in which Reduplicative Copy follows Glide Insertion, either as a matter of parochial ordering between the two processes, or as a consequence of the lexical level structure. The copying process will then capture the results of the rule or rules that precede it. But any such ordering theory will also admit of the opposite ordering of processes, generating forms like (b) $\gamma-k^huvw\gamma$, an impossibility under Correspondence Theory. At the very least, then, the Madurese facts sharply separate Ordering Theory from Correspondence Theory, with the latter making the narrower prediction.

3.3 Madurese Nasal Harmony

In Madurese, nasality spreads rightward from a primary nasal segment until it encounters an oral obstruent: it spreads to vowels, y , and w , and passes unimpeded through γ and h . Such nasal spans are the only environment in which nasalized vowels and glides appear — except for reduplication. There, nasal vocoids appear in the reduplicant, echoing those in the base, even when the triggering nasal is present only in the base (Stevens 1968, 1985; Mester 1986: 197f.):

(25) Nasalization and Reduplication in Madurese

/neat/	$\tilde{y}\tilde{a}t-n\tilde{e}\tilde{y}\tilde{a}t$	‘intentions’
/moa/	$\tilde{w}\tilde{a}-m\tilde{o}\tilde{w}\tilde{a}$	‘faces’
/maen-an/	$\tilde{e}n-m\tilde{a}\tilde{e}n-\tilde{a}n$	‘toys’
/ŋ-soon/	$\tilde{\text{ʒ}}n-\tilde{n}\tilde{\text{ʒ}}\tilde{\text{ʒ}}n$	‘request (verb)’
cf. /soon/	$\text{ʒ}n-s\text{ʒ}\text{ʒ}n$	‘request (noun)’

The final example confirms that nasality does not spread leftward; there is no explanation, other than copying, for the nasality in the prefixed reduplicant. Indeed, the reduplicant in $\tilde{y}\tilde{a}t-n\tilde{e}\tilde{y}\tilde{a}t$ has no nearby nasal consonant at all, yet $\tilde{y}\tilde{a}$ is nonetheless nasalized. (These examples exhibit glide formation and other interesting phonology as well, which we will abstract away from in this discussion.)

Correspondence Theory asserts that such effects derive from the impact of reduplicative identity constraints on the independently established phonology of the language. We therefore begin, as before, with a characterization of the relevant phonological infrastructure.

The language lacks nasal vocoids except in specific circumstances. We take the lack of nasals to reflect the force of a universal markedness relation:

$$(26) \quad *V_{\text{nas}} \gg *V_{\text{oral}}$$

Following Prince & Smolensky (1993, Chapt. 9), we interpret pre-theoretic ideas of featural markedness as reflecting universally fixed rankings, as in (26), of constraints against featural combinations, rather than underspecification or privativity. The universal ranking (26) entails the elementary implicational markedness observation

that any language that has nasal vocoids will also have the corresponding oral vocoids.


But constraints like those in (26) are ineffectual unless they dominate a relevant faithfulness constraint. In the case at hand, we have:

(27) $*V_{\text{nas}} \gg \text{IDENT-IO}(\text{nas})$

The constraint $\text{IDENT-IO}(\text{nas})$ requires that segments in I-O correspondence show exactly the same value of nasality (see §2, ex. (14) for the family IDENT).

The effect of the hierarchy (27), taken by itself, is to eliminate all nasal vocoids from the output of the phonology. To see this, consider what happens to any hypothesized input containing a nasal vowel, for example $b\tilde{a}$:

(28) $*V_{\text{nas}} \gg \text{IDENT-IO}(\text{nas})$

	/bã/	$*V_{\text{nas}}$	$\text{IDENT-IO}(\text{nas})$
i.	 ba		*
ii.	bã	* !	

Denasalization occurs, due to compelled violation of $\text{IDENT-IO}(\text{nas})$. Any nasal vowel or glide will be mapped to its non-nasal counterpart. Under natural assumptions about lexicon optimization (Prince & Smolensky 1993: Chapt. 9, Stampe 1972 [1980], Dell 1980), no learner would bother to posit an underlying feature when its fate is merely to disappear without a trace. Consequently, given such a constraint system, it follows that the lexicon will be free of nasal vocoids, so long as there is no morphological advantage to positing them.

Thus far we have a language without nasal vowels. Madurese admits them in one general circumstance — post-nasally — in violation of the segmental markedness constraint $*V_{\text{nas}}$. This restriction can be understood as the effect of a constraint, $*\text{NV}_{\text{oral}}$, which militates against the sequence $[+\text{nas}] \wedge [-\text{nas}, \text{vocalic}]$:²⁰

(29) $*\text{NV}_{\text{oral}}$
 $*[+\text{nas}] \wedge [-\text{nas}, \text{vocalic}]$.

This constraint must dominate $*V_{\text{nas}}$ because it forces the presence of nasal vowels in the output. It also dominates $\text{IDENT-IO}(\text{nas})$, because it must also be able to force a change in nasality: any input oral vowel must gain nasality in a postnasal context.

²⁰ This constraint is understood to prohibit linear concatenation of segmental root-nodes with the indicated properties. The expression “vocalic” denotes glides as well as vowels. For full discussion of the phonology of the feature [nasal] and of nasal harmony, see Cohn (1990, 1993b). For a comprehensive treatment of nasal harmony within Optimal Domains Theory, see Cole & Kisseberth (1995).


In addition, the complete hierarchy must dispose of all other faithfulness constraints that could, through breach, aid in the satisfaction of $*NV_{\text{oral}}$ — for example, MAX-IO, which would allow segment deletion, and IDENT-IO(son), which, taken with IDENT-IO(nas), would force nasal consonants to suffer denasalization, turning into obstruents. Writing $\mathcal{F}'(\text{nas})$, as above, to indicate this class of constraints, we have the following as the full hierarchy:

$$(30) *NV_{\text{oral}}, \mathcal{F}'(\text{nas}) \gg *V_{\text{nas}} \gg \text{IDENT-IO}(\text{nas}), *V_{\text{oral}}$$

The constraints in the faithfulness set $\mathcal{F}'(\text{nas})$ must dominate $*V_{\text{nas}}$, for they provide means to satisfy $*NV_{\text{oral}}$ without introducing nasal vowels (say, by mapping /n/ → d, or /n/ → Ø, etc.). Were $*V_{\text{nas}}$ dominant over any member of that set, then such a mapping could be employed, in the interests of maintaining maximal freedom from nasality.²¹

The effects of hierarchy (30) are illustrated in the following tableau²², which examines the fate of various candidates from underlying /na/.

(31) /na/ → nã

/na/	$*NV_{\text{oral}}$	$\mathcal{F}'(\text{nas})$	$*V_{\text{nas}}$	IDENT-IO(nas)
i.  nã			*	*
ii. na	* !			
iii. da		* !		*

In this grammar, oral and nasal vocoids are placed in complementary distribution — it is, then, a canonical case of allophonic alternation through constraint interaction. (See Baković (to appear) and Kirchner 1995 for parallel developments.) The alternation is allophonic because no hypothetical lexical contrast between V_{nas} and

²¹ Strictly speaking, we should distinguish two classes in the residue of relevant faithfulness constraints left over after IDENT-IO(nas) is removed from consideration:

(i) Those which are relevant only to satisfaction of $*V_{\text{nas}}$, whose violation leads to elimination of nasal vocoids by other means than denasalization: these must crucially dominate only IDENT-IO(nas), so that denasalization is the least offensive route to satisfaction of $*V_{\text{nas}}$.

(ii) Those which are relevant to $*NV_{\text{oral}}$, allowing it to be satisfied without introducing nasal vocoids: these must crucially dominate $*V_{\text{nas}}$.

Since the first class is likely contained in the second, we blur the distinction here.

There are important substantive issues in the characterization of nasal-related phenomena which we do not address here: for example, it seems to be clearly impossible in languages to satisfy $*NV_{\text{oral}}$ via many of the alternative mappings mentioned in the text. This shows that the full theory of nasal-related processes has significant further structure, in it that imposes universal restrictions on possible rankings. Whatever further sophistication is achieved, the faithfulness rankings noted must still hold; and some of them will hold universally, for principled reasons yet to be made clear.

²² We suppress mention here and below of the constraint $*V_{\text{oral}}$, universally ranked below $*V_{\text{nas}}$, which is irrelevant to the matter at hand.

V_{oral} can survive to the surface. Underlying /bã/ will surface as *ba*; underlying /na/, as *nã*. As a structuralist analysis would assert, no phonemic contrast between /ã/ and /a/ is possible.

The hierarchy (30) characterizes, via constraint ranking, a fairly typical situation of allophonic distribution: nasalized vowels occur in nasal contexts and oral vowels occur elsewhere. The default or “elsewhere” status of oral vowels follows from the universal markedness relation (26) which asserts, by fixing a ranking in Universal Grammar, that nasalized vowels are more marked than oral ones. Generalizing from the allophonicity scheme (30) and the markedness relation (26), we can see that universal markedness relations will have consequences for the analysis of allophonic alternation. If $*\alpha \gg * \beta$ universally, then β must have the elsewhere status in any $\alpha \sim \beta$ alternation. In this way, Optimality Theory relates observations about markedness of phonological systems to alternations within those systems. Furthermore, the mere fact of such an alternation means that UG must provide a constraint with the effect of banning β or requiring α in some context (like the constraint $*NV_{\text{oral}}$ in (30)), since otherwise the more marked α member of the alternation would never emerge. On the other hand, when there is no universal markedness relation between α and β , either one is free to assume default status in any allophonic alternation between them. These considerations will take on some importance when we look at several other (near-)allophonic alternations in §5.3 and §5.4.

There is a final representational question before we continue: are nasal vowels in the lexicon? — is *nã* underlyingly /na/ or /nã/? In either case, the surface output is the same, and the answer turns on assumptions about lexicon optimization which are largely independent of OT *per se*, and perhaps lose some of their interest in this context. Is it better to have optimal forms derived with less violation — delivered by /nã/? or is it better to have a more sparsely or uniformly specified lexicon — delivered by /na/? Under earlier structuralist and generative views, complementary distribution between segment-types α and β devolves from two types of conditions: a lexical constraint that bars one segment-type, say β , from all underlying representations, and a rule $\alpha \rightarrow \beta/E_F$ in another component (the “phonology”), which introduces lexically-banned β as a replacement for α in just the environment E_F . Here the constraint $*\beta$ is crucially lexical.²³ Shifting the burden of explanation to output constraints removes the lexical situation from the explanatory focus. Under OT, $*\beta$ is recognized as an output constraint — a structural markedness constraint — as is $*E\alpha F$, and their relation to each other and to relevant faithfulness constraints through ranking determines the outcome. When, as in Madurese, both dominate a relevant faithfulness

²³ It is worth emphasizing that use of underspecification does not change the basic point of the argument. With underspecification, the lexicon is barred from containing both β and α ($*\alpha$ at least in the environments where β shows up). In their place is some underspecified entity Γ . The phonology proper provides both the fill-in rule $\Gamma \rightarrow \beta/E_F$ and the default rule $\Gamma \rightarrow \alpha$ to spell out Γ . (See Archangeli 1988, and the references cited therein.) The default rule resembles the lexical implication $[\Gamma] \rightarrow [\alpha]$ that disallows β in full-specification theories; default status of α is derived in this case not by specification at the lexical level, but through later specification via the default rule. Nevertheless, lexical form is crucial to the descriptive mechanism, and some sort of constraint must still guarantee that β cannot appear lexically alongside Γ .

constraint such as IDENT-IO(nas), lexical specification is irrelevant to the outcome, and lexical representation will be decided, if at all, on less tangible grounds (such as “Lexicon Optimization” in Prince & Smolensky 1993: Chaps. 4, 9) than in previous conceptions. For further discussion, see also Stampe (1972 [1980]), Dell (1980), and Itô, Mester, & Padgett (1994).

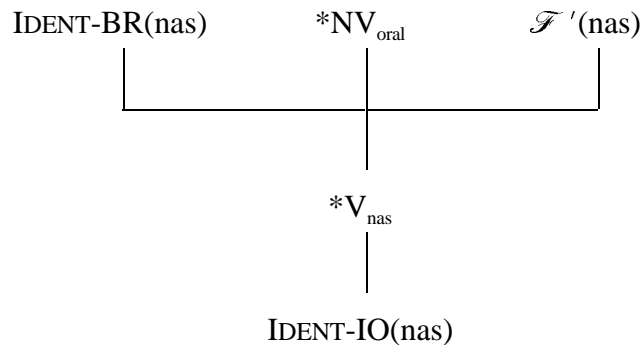
Reduplication complicates the distributional situation: it introduces nasal vowels in non-nasal contexts. We repeat some of the typical data here:

(32) Nasalization and Reduplication in Madurese

/neat/	ỹāt –nēỹāt	‘intentions’
/moa/	wã –mōwã	‘faces’

No independent word could have the form *ỹāt*, as indeed is predicted by the constraint hierarchy just developed. The independent appearance of *ỹāt*, *wã* and the like can only be an effect of a reduplication-specific constraint, demanding featural identity between base and copy. Several possibilities exist for exact formulation of the crucial constraint: does the constraint want identity in all features, in some subset of features, or just in the feature nasal? Deciding this point requires a more solidly-founded theory of featural faithfulness than is currently available. Here we conservatively characterize the constraint as demanding identity only in the feature [nasal]:²⁴ IDENT-BR(nas). IDENT-BR(nas) must dominate $*V_{nas}$, thereby compelling nasalized vocoids to appear in places where they are not otherwise wanted. This is the only addition that need be made to the basic grammar of nasalization in Madurese to encompass reduplication. The resulting hierarchy looks like this:


(33) Full Ranking for Nasality in Madurese



The following tableau illustrates the reduplication of /neat/, comparing a few of the most plausible candidates. (We suppress mention of the residual faithfulness constraints as well as of $*V_{oral}$.)

²⁴ Since the reduplicant is featurally identical to its correspondent substructure in the base, it is clear that all such featural identity constraints are undominated in Madurese. We could regard them as being just one constraint, IDENT-BR(F), quantifying universally over all features. This would not allow individual feature identity constraints to be ranked separately.

(34)

/RED + neat/	IDENT-BR(nas)	*NV _{oral}	*V _{nas} ²⁵	IDENT-IO(nas)
a.  ỹāt–nēỹāt			*****	**
b. yāt–nēyat		* !	*	*
c. yāt–nēỹāt	* !		***	**

The imposition of B-R identity eliminates the phonologically transparent form (c), in which nasal vocoids occur only in a nasal span initiated by a nasal consonant. Forms (a) and (b) both satisfy B-R featural identity in different ways. The choice between them is therefore governed by the background phonology of the language. Form (b), a kind of underapplication, fatally violates the constraint responsible for nasal harmony, since it has oral vocoids in a postnasal context (**nēyat*). Only form (a) succeeds in achieving the requisite identity of base and reduplicant, while also satisfying the dominant phonological constraint that drives the nasal harmony alternation. The downside of (a) is extra violation of *V_{nas}, but the necessary subordination of *V_{nas} renders this inevitable.

The existence of forms like *ỹāt–nēỹāt* means that the distribution of nasality in Madurese vowels does not accord perfectly with the structuralist requirements for allophonicity — nasal and oral vowels are fully predictable except in the reduplicant. But this follows, very simply, from the high rank of B-R identity. Because it dominates the anti-nasal constraint *V_{nas}, identity of base and reduplicant infringes on the perfection of complementary distribution, so the system is allophonic except in this special circumstance. Identity-driven interactions of this type are common in reduplicative morphology (see Appendix B for a list of cases) and in truncating morphology as well (Benua 1995).

The Madurese outcome is of the sort termed “overapplication”: and in the Global Theory of Wilbur (1973a), the very *rule* of Nasal Spread literally applies to the vocoids in the reduplicant, as “mates” of the vocoids in the base. Nasal Spread then truly *overapplies*, since it operates outside its canonical domain. Correspondence Theory works quite differently. The enforcement of B-R identity — exactness of the copying relation — suppresses the *denasalization* ordinarily evoked by the subhierarchy *V_{nas} ≫ IDENT-IO(nas). Thus, the analysis here could perhaps be better described as involving “underapplication,” or blocking, of denasalization. As noted in §1, we will nevertheless retain Wilbur’s terms for classificatory purposes, using overapplication for those cases in which there is phonologically unexpected disparity between the *stem* and the reduplicant: in the present case, the unexpected disparity is between the presumptively non-nasal vowel of the stem and the nasal vowel in R.

²⁵ The marks in the tableau follow the assumption that *V_{nas} pertains to all vocoids, including glides. The *y*, because epenthetic, suffers no defects in IDENT-IO(nas), since it has no underlying commitments to remain faithful to.

OT is inherently typological in nature, and it is important to scrutinize the analysis for predicted interlinguistic variation through permuted ranking. Holding the basic phonology constant, the B-R identity constraint can be intercalated at various positions in the ranking. A glance at tableau (34) indicates that the crucial pivot point is the constraint $*V_{nas}$. When dominated by the relevant B-R identity constraint, the outcome is overapplication, as we have seen. When this ranking is inverted, so that $*V_{nas} \gg \text{IDENT-BR}(nas)$, the phonologically unmotivated nasal vocoids are no longer admitted, and the base and the reduplicant each show no more than their locally-expected phonology: this is *normal application*, exemplified in candidate (34c) $*yat-n\tilde{e}\tilde{y}\tilde{a}t$.

There is yet a third type of candidate, $*yat-n\tilde{e}yat$ (34b), in which the general phonological process of nasal spread is inhibited, yielding another form of identity between base and reduplicant. This is “underapplication” in the classic sense, where a phonological rule is said to be blocked by considerations of identity, or, in our somewhat more neutral formulation, an expected stem-output disparity is not found. Strikingly, it is impossible to produce this effect by re-ranking of B-R identity constraints. The constraint $*NV_{oral}$ must be crucially dominated to elevate the classically underapplicational candidate (34b) $*yat-n\tilde{e}yat$; yet no matter where it sits in the hierarchy, $\text{IDENT-BR}(nas)$ simply cannot interfere with the effectiveness of $*NV_{oral}$. The reason is clear: there are always two candidates respecting B-R identity — here, $\tilde{y}\tilde{a}t-n\tilde{e}\tilde{y}\tilde{a}t$ and $yat-n\tilde{e}yat$ — so that choice between them has to be made on grounds other than B-R identity. Phonology will always favor the one that does best on the higher-ranking phonological constraint. If the language is to have nasal spread at all, it must have $*NV_{oral} \gg *V_{nas}$ and this dooms all output representations containing oral vocoids in a postnasal environment. Thus, Correspondence Theory entails an important general limitation: classical underapplication can never be achieved by re-ranking of B-R identity; *some other constraint must be involved*. We believe this to be a correct result, and we return in §5 to the interpretation of underapplication phenomena.

The copying of nasal vocoids in Madurese can also be modeled in serial terms. Any theory that allows reduplicative copying to come after (some) phonological rules will provide a means for dealing with this sort of interaction. Similarly, any theory that allows reduplicative copying to be ordered before (some) phonology will have a means of representing normal application. Madurese nasal harmony therefore does not distinguish parallelist reduplicative Correspondence Theory from the serialist Ordering Theory. The salient property of all such cases is that base phonology, determined independently, is carried over to the reduplicant. We turn now to a series of cases in which — either plausibly or necessarily — the *reduplicant* influences the *base* by virtue of identity constraints. Such cases shed considerable light on the serial/parallel distinction, and strongly favor Correspondence Theory.

3.4 Javanese *h*-Deletion

Just as the effects of featural processes can be broadened through B-R correspondence, so too can the effects of phonological deletion. The relevant constraint is MAX-BR, which demands that each segment in the base have a correspondent in the reduplicant. This is the reduplicative cognate of MAX-IO, which forbids deletion in the input-output mapping. Under one construal (post-positive reduplication), Javanese provides a case of this kind.

The language has a general process deleting *h* in intervocalic contexts, as shown in the following forms (Horne 1961, Dudas 1976):

(35) Javanese Intervocal *h*-Loss

<i>Root</i>	<i>Root</i> + 'my'	<i>Root</i> + <i>Dem.</i>	<i>Gloss</i>
anɛh	anɛh-ku	anɛ ₌ -e	'strange'
arah	arah-ku	ara ₌ -e	'direction'

Since this process is visibly active in Javanese, some phonological constraint must dominate MAX-IO in the grammar of Indonesian. For the purposes of discussion, we assume a constraint *VhV which summarizes the effect adequately enough for our purposes. This constraint, whatever its ultimate character, is ranked as follows:

(36) *VhV ≫ MAX-IO in Javanese

	/arah-e/	*VhV	MAX-IO
a.	↗ ara ₌ -e		*
b.	arah-e	* !	

The form *arae* avoids intervocalic *h* at the expense of unfaithfulness — the segment *h* in the input has no correspondent in the output. Of course, the ranking *VhV ≫ MAX-IO gives only the core of the analysis, which in its full form requires consideration of other relevant structural and faithfulness constraints. For example, the structural constraint ONSET must also be dominated by *VhV, and all other faithfulness constraints — those whose violation would lead to success on *VhV — must dominate MAX-IO. (But from now on, in the interests of conciseness, we will tacitly ignore the disposition of the residual structural and faithfulness constraints in the presentation of analyses.)

Javanese has a pattern of reduplication which interacts with the process of *h*-deletion, as shown by the following examples (Horne 1961, Dudas 1976):²⁶

²⁶ According to Horne (1961), there is some variation, with forms like *bəḍah-bəḍa-e* being observed as well.

(37) Overapplication in Javanese

Bare Root	Reduplicated Form	id. + V-initial Suffix	Gloss
bəḏah	bəḏah –bəḏah	bəḏa _̣ –bəḏa _̣ –e	‘broken’
ḏajoh	ḏajoh –ḏajoh	ḏajɔ _̣ –ḏajɔ _̣ –e	‘guest’

The bare roots and simple reduplications are unremarkable. But in the suffixed reduplications, *h* has deleted not only in its proper intervocalic context, but also in the other reduplicative conjunct, where it is not intervocalic. This is overapplication.

In Javanese, reduplication is total, and we have been unable to find evidence indicating which twin is the reduplicant and which is the base. The choice determines important details of the analysis, so we must examine both possibilities.

Let us assume first that reduplication is prepositional. The structure of a reduplicated word is then /Af_{RED}–Stem(–e)/. Under this assumption, *h*-loss from the base is transmitted to the reduplicant through B-R correspondence. Because reduplication is totally exact, no B-R constraint is in fact crucially dominated. The identity constraint that does the interesting work is DEP-BR (dependence of the reduplicant on the segmentism of the base — see §2, (13)), the B-R counterpart of the anti-epenthesis constraint DEP-IO. The constraint DEP-BR bars non-base segments from the reduplicant. Regardless of where it is ranked, DEP-BR will bar an *h*, and indeed any other segment, from the reduplicant, whenever it does not appear in the base in the actual output form under evaluation.²⁷ The following tableau illustrates this effect:

(38) Overapplication in Javanese, Assuming Prefixation²⁸

/RED–bəḏah–e/	DEP-BR	*VhV	MAX-IO
a.  bəḏa _R – bəḏa _̣ –e _B			*
b. bəḏah _R – bəḏah –e _B		* !	
c. bəḏah _R – bəḏa _̣ –e _B	* !		*
d. bəḏag _R – bəḏa _̣ –e _B	* !		*

Form (a) is optimal, because it is phonologically perfect and at the same time satisfies B-R identity, conditions met jointly by no other candidates. Form (b) is also consistent with B-R identity, but violates the phonological constraint *VhV. Forms (c) and (d) are as sound phonologically as the optimal candidate, yet their reduplicants fatally include non-base material.


²⁷ The suffix –e is also part of the base, but not copied. Presumably there is a morphological restriction on the domain of copying, along the lines of R=ROOT in McCarthy & Prince (1993a).

²⁸ In the tableau, subscripted R and B identify the hypothesized reduplicant and base respectively.

Form (c), the underapplicative candidate, has a certain appeal, because it happens to include an *h* that echoes the segmentism of the underlying form of the stem. But from the point of view of B-R correspondence, the *h* is simply an unmotivated intruder, no more welcome than the *g* that presents itself in form (d). No ranking of B-R and I-O correspondence constraints can resurrect the disappeared *h*.²⁹ “Overapplication” of *h*-deletion is really just the absence of *h* from the base against which the reduplicant is matched.

We now turn to the other possibility, that Javanese has suffixing reduplication, arising from an input structure /Stem-Af_{RED}-e/. As before, the exact totality of reduplication indicates that no B-R constraints are crucially dominated; but now it is MAX-BR that is directly challenged by the inability of *h* to appear intervocalically. The following tableau, paralleling (38), illustrates the situation:

(39) Overapplication in Javanese, Assuming Suffixation

	/bəḁah-RED-e/	MAX-BR	*VhV	MAX-IO
a.	 bəḁa _B - bəḁa _R -e			*
b.	bəḁah _B - bəḁah _R -e		* !	
c.	bəḁah _B - bəḁa _R -e	* !		

Here, MAX-BR must crucially dominate MAX-IO, for it is reduplicative identity alone that forces preconsantal *h*-loss from the base in the optimal candidate (a). Form (b) is the other good B-R match, but its phonology is fatally defective. Form (c) is phonologically perfect, but the consequent lack of B-R identity is intolerable. Just as with Madurese nasalization (§3.3), overapplication can be secured (MAX-BR ≫ MAX-IO), as can normal application (MAX-IO ≫ MAX-BR), but underapplication — with candidate (b) optimal — is out of reach.

If Javanese reduplication is indeed suffixing, then it supplies a very clear argument in support of Correspondence Theory. Ordering theories are completely incapable of handling this situation, as was first noted by Wilbur (1973a). A fundamental premise of operation-based approaches is that the reduplicant copies the base. Here, contrariwise, the base copies the reduplicant. The purely phonological constraint *VhV is enforced at the reduplicant-base juncture; dominant reduplicative identity compels an otherwise unmotivated deletion in the base. The force of the result is mitigated somewhat by the uncertainty over whether reduplication is pre-positive

²⁹ The full correspondence system must, as noted above, include an IR system that allows the *h* to be recovered. This falls under the general metaconstraint Faith(Stem) ≫ Faith(Affix), so that we must have MAX-IO ≫ MAX-IR. In the present case, we can recover the opaque *h* with the ranking MAX-IR ≫ MAX-BR, which is consistent with that metaconstraint. Seen within the context of the entire theory, the present case does not have the inevitability of the Madurese glide copying interaction of §3.2. See §6 for further exploration and analysis of an underapplication case (Klamath) with the R→B character of (38c).

or post-positive; further examples, where there is no such doubt, are adduced below, in §3.6 (Malay Nasal Harmony), §3.7 (Axininca Campa), and §3.8 (fusional overapplication).

3.5 Ordering Theories

From these three examples — Madurese glide formation, Javanese *h*-deletion, and Madurese nasal harmony — one main line of analysis is now clear. When a phonological process is observed to affect both base and reduplicant, though the conditions for its application are met only in the base or only in the reduplicant, B-R identity requirements lead to overapplication, in which derived characteristics appear in both base and reduplicant.

The Ordering Theory of most of the earlier literature (cited in §1) analyzes overapplication in serial terms. Any phonological process that is observed to overapply must occur prior to reduplication, as in the following schematic derivation for Madurese nasal harmony:³⁰

(40) Madurese Nasal Harmony, Serially

Underlying Form	/neat/	
Glide Epenthesis	neyat	
Nasal Harmony	něỹāt	
Copy	ỹāt–něỹāt	
Outcome	ỹāt–něỹāt	<i>Matched nasality</i>

In this model, overapplication is a consequence of a particular rule-ordering configuration, in which reduplication happens to apply after some phonological rules. Similarly, normal application — independence of phonology and reduplication — is attributed to the opposite ordering, in which reduplication precedes phonological rules. All effects of identity must follow from the one identity-imposing event of reduplicative copy. Once made, the copy is no more related to the base than any other morpheme is, and it is freely subject to the vagaries of further derivation.

We argue, on the contrary, that reduplicative identity is a relation defined on the output; and that constraints on reduplicative identity are evaluated in parallel with other constraints on output structure and on input-output correspondence (faithfulness). Reduplicative identity is a part of the output: it is never lost. Reduplicative Correspondence Theory is not commensurable with the Ordering Theory; the effects and non-effects of re-ranking in parallel OT are not the same as those of re-ordering under operational serialism. Under the current proposal, for example, Madurese glide

³⁰ There are, however, particular versions of Ordering Theory that cannot account for any of the examples discussed thus far. According to Marantz (1982: 460–461), only morpholexical (that is, allomorphic-selection) processes can “overapply”. Yet no process analyzed above is morpholexical by standard criteria: they are not morphologically conditioned nor do they even have exceptions. Indeed, Madurese nasal harmony is essentially allophonic, and a morpholexical allophonic process is an oxymoron. See Stevens (1985) for further discussion.

copy (§3.2) is stable under all permitted re-rankings, while the ordering theory readily admits the alternative “normal” outcome. Here, Correspondence Theory predicts a more limited range of possibilities than Ordering Theory.

In other circumstances, reduplicative Correspondence Theory predicts a wider range of interactions than can be accommodated in serial theories. These crucially involve effects deriving from the full presence of the reduplicant in the evaluated output. As we have just seen in §3.3, phonology at the R+af juncture can be transmitted back to B by correspondence, an outright impossibility in operational theories, where R copies B and not vice versa. Even more striking, the transmitted phonology can occur at the B+R juncture itself (a phenomenon whose significance was first noted in Wilbur 1973ac). Under parallelism, R can provide an environment that determines properties of B, which must then, by correspondence, also appear in R itself. Similarly, B can impose phonology on R, which is back-copied to B. But serialism excludes back-copying entirely and allows no interaction between R and B until after R has been brought into existence by the copying operation. Thus, these effects raise severe difficulties for the Ordering Theory, and, if well-substantiated, provide definitive evidence in favor of reduplicative Correspondence Theory. We turn now to such cases.

3.6 Malay Nasal Harmony

Critical to the parallelism/serialism contrast are phenomena in which the reduplicant-base juncture provides the basic context for an overapplying process. Cases of this type will not be thick on the ground, because they require the coincidence of several independent factors, some rare. Quite aside from overapplication, phonological interaction between reduplicant and base is relatively uncommon: most reduplication is total or near-total, with base and reduplicant in a compound structure, so that the usual processes of intra-word phonology will typically not apply between them. Because of their potential significance, however, such cases are worthy of careful scrutiny.

The importance of the R-influences-B configuration was first recognized within Global Theory by Wilbur (1973ac), and she tentatively cites two possible examples, from Chukchee and Serrano. Both have turned out to have empirical problems, and we will not consider them here, though further examination may be merited. In later work, Onn (1976 [1980]: 114) and Kenstowicz (1981) provide the example of nasal harmony in Malay, which is of particular interest in the present context.

The basic distribution of nasality is identical to that in Madurese (see §3.3): nasal and oral vocoids are in complementary distribution, with nasals appearing only in a post-nasal environment. As in Madurese, base and reduplicant are featurally identical, and thus the very same constraint hierarchy (33) must be at work. In Malay, however, nasal spreading also applies across the reduplicant-base juncture. This

establishes the pre-condition for the kind of interactions we're interested in. The consequences for reduplication are shown below:

(41) Malay Reduplication³¹

ham $\tilde{\text{o}}$	h ām $\tilde{\text{o}}$ – hām $\tilde{\text{o}}$	'germ/germs'
waŋ $\tilde{\text{i}}$	w āŋ $\tilde{\text{i}}$ – wāŋ $\tilde{\text{i}}$	'fragrant/(intensified)'
aŋ $\tilde{\text{ān}}$	ā ŋ $\tilde{\text{ān}}$ – āŋ $\tilde{\text{ān}}$	'reverie/ambition'
aŋ $\tilde{\text{ēn}}$	ā ŋ $\tilde{\text{ēn}}$ – āŋ $\tilde{\text{ēn}}$	'wind/unconfirmed news'

Remarkably, nasality whose source is a nasal consonant in the *first* conjunct reappears in that very morpheme, outside the context where Malay phonology admits nasals. Thus, the η of /waŋi/ spreads nasality rightward to yield waŋ $\tilde{\text{i}}$. But in $\tilde{w}\tilde{a}\tilde{\eta}\tilde{i}$ – $\tilde{w}\tilde{a}\tilde{\eta}\tilde{i}$, the nasal span anchored in the first η runs across the R–B juncture, incorporating the following *wa* in the base; and the nasalization of the second instance of $\tilde{w}\tilde{a}$ compels the first $\tilde{w}\tilde{a}$ to nasalize, extra-phonologically, as well.

Observe that nasality spreads only to the right: witness examples like *tahan/māhāhān* 'withstand', in which prefixation of /mən/ and nasal substitution lead to an alternation in the nasality of the root vowels, even though the root itself ends in *n*. The only possible source of nasality in the first syllable of $\tilde{w}\tilde{a}\tilde{\eta}\tilde{i}$ – $\tilde{w}\tilde{a}\tilde{\eta}\tilde{i}$ is reduplicative identity — its nasality matches the phonologically-motivated nasality of its correspondent in the second conjunct.

As in Javanese, it is unclear from available information which is reduplicant and which is base. Remarkably, the difference has essentially no significance for the analysis under Correspondence Theory, as we will see in exploring both alternatives.

Let us first assume that reduplication is pre-positive, with the order R+B. The copying of nasality follows directly from the hierarchy in (33) above. The important candidates are contrasted here:

(42) Malay Reduplicative Identity, Assuming Pre-positive Reduplication

/RED–waŋi/	IDENT-BR(nas)	*NV _{oral}	*V _{nas}	IDENT-IO(nas)
a. $\tilde{w}\tilde{a}\tilde{\eta}\tilde{i}_R$ – $\tilde{w}\tilde{a}\tilde{\eta}\tilde{i}_B$			*****	***
b. waŋ \tilde{i}_R – waŋ \tilde{i}_B		* !	**	*
c. waŋ \tilde{i}_R – $\tilde{w}\tilde{a}\tilde{\eta}\tilde{i}_B$	** !		****	***

Forms (a) and (b) have identical R+B pairs. Form (b) is out for very general reasons, discussed above, in reference to tableau (34): B-R identity can never block a dominant phonological constraint in its native environment. Candidate (c) exemplifies normal

³¹ Onn (1976 [1980]) does not transcribe nasality in glides; we have altered his transcriptions in this respect.

application, which can be achieved via subordination of B-R identity. In fact, B-R identity is undominated, so candidate (a) wins easily, and the reduplicant must take on the nasality of the base, even though the reduplicant is itself a crucial source of that nasality.³²

No familiar version of Ordering Theory can account for examples like this one. Neither way of ordering the rules of nasal harmony and reduplication yields the right result, as the following derivations show:

(43) Serial Theory: Reduplication Precedes Phonology

Underlying Form	/RED – waŋi/	
Copy	waŋi – waŋi	
Spread Nasal	waŋĩ – ĩwaŋĩ	
Outcome	*waŋĩ – ĩwaŋĩ	<i>Mismatched nasality</i>

(44) Serial Theory: Phonology Precedes Reduplication

Underlying Form	/RED – waŋi/	
Spread Nasal	RED – waŋĩ	
Copy	waŋĩ – waŋĩ	
Outcome	*waŋĩ – waŋĩ	<i>Matched orality</i>

When reduplication precedes, as in derivation (43), normal application is the result, echoing the outcome when B-R identity is crucially subordinated. When phonology precedes, as in derivation (44), the result is underapplication of nasal spreading, a pattern not obtainable by any ranking in Correspondence Theory.³³ This shows once again that the standard Ordering Theory is incommensurable with the parallel Correspondence Theory advocated here — and it is wrong too, if Malay truly has R+B reduplication.

The correct output can be obtained serially if Reduplicative Copy is allowed to re-apply. The most general reformulation of the theory would treat Copy as a persistent or everywhere rule, which applies whenever its structural description is met (Chafe 1968, Myers 1991). The process would then proceed as follows, incorporating derivation (43), on the (random) assumption that Copy gets the first crack:

(45) Persistent Serial Theory: Derivation I

³² Madurese cannot show similar effects, because it follows the more typical pattern of resisting phonological processes across compound juncture, including R-B juncture (Stevens 1985: 241). We abstract away from the alignment issues that differentially restrict the domain of nasalization in the two languages. See Cole & Kisseberth (1995) for relevant discussion.

³³ In the Full Model of §6, the result might seem to be at risk, due to the presence of IDENT-IR(nas), which demands that the reduplicant show the same nasality pattern as the underlying stem. This constraint would favor a non-nasalized reduplicant (from underlying /waŋi/), whose featural composition could then be forced on the stem by means of B-R identity (which is complete in Malay). But this can never happen. Under the metaconstraint fixing the dominance of stem-faithfulness over affix-faithfulness, we necessarily have IDENT-IB(nas) >> IDENT-IR(nas). Domination of IDENT-IB(nas) gives us the nasal phonology of the language, and by transitivity, the reduplicant must show the same phonology.

Underlying Form	/RED – waŋi/	
<i>Copy</i>	waŋi – waŋi	
Spread Nasal	waŋĩ – ṽaŋĩ	
<i>Copy</i>	ṽaŋĩ – ṽaŋĩ	
Outcome	ṽaŋĩ – ṽaŋĩ	<i>Matched nasality</i>

If, on the other hand, Spread Nasal applies first, we must extend derivation (44), and assume as well that Spread is also persistent:³⁴

(46) Persistent Serial Theory: derivation II


Underlying Form	/RED – waŋi/	
<i>Spread Nasal</i>	RED – waŋĩ	
<i>Copy</i>	waŋĩ – waŋĩ	
<i>Spread Nasal</i>	waŋĩ – ṽaŋĩ	
<i>Copy</i>	ṽaŋĩ – ṽaŋĩ	
Outcome	ṽaŋĩ – ṽaŋĩ	<i>Matched nasality</i>

The persistence theory may seem like no more than an extension of familiar (if controversial) proposals, but there is a significant twist when free iteration of rules is set loose in the reduplicative realm. A persistent rule applies whenever its structural description is met: but what is the structural description of Reduplicative Copy? To work in the present context, the answer must be this: persistent Copy applies whenever R and B are *not* identical; equivalently, unless they *are* identical. One may also think of it as an output condition: apply Copy until R=B; this frames the requirement like a convergence condition on an iterative process. In either case, direct reference must be made to reduplicative identity, above and beyond copying itself. The B-R identity requirements of Correspondence Theory must therefore be recapitulated in the Persistent Serial Theory, no doubt in excruciating detail once a finer level of analysis is undertaken. (This embodies an odd conceptual quirk as well: the very operation of copying exists to produce identity; persistence superadds another identity requirement to ensure its success.) Thus, Persistent Serialism really *abandons* the serialist goal of reducing identity to the existence of a copying operation, and fails to solve the identity problem in a satisfactorily unitary way.

Let us now explore the consequences of the assumption that Malay Reduplication is post-positive, yielding the order B+R. This has no effect whatever on the prediction of the theory developed here, as the following tableau makes clear:

³⁴ See Mester (1986: 190f.), where Sanskrit *ruki* is posited to be an everywhere rule to obtain combined overapplication and normal application effects.

(47) Malay Reduplicative Identity, Assuming Post-positive Reduplication

/waŋi – RED/	IDENT-BR(nas)	*NV _{oral}	*V _{nas}	IDENT-IO(nas)
a.  wãŋĩ_B – wãŋĩ_R			*****	***
b. waŋĩ_B – waŋĩ_R		* !	**	*
c. waŋĩ_B – wãŋĩ_R	** !		****	*

The only difference is that candidate (c) now accumulates but one violation of IDENT-IO(nas), a fact that plays no role in the outcome.

With this B+R structure, it is the base that accommodates itself to the reduplicant. Nasalization of the initial vocalic sequence of the reduplicant springs from the base, and to the base it returns, under compulsion of B-R identity. This result is clearly unobtainable in copying theories, for the simple reason that the reduplicant copies the base and never vice-versa. Even more striking, perhaps, is the pathological interaction between the B+R structure and the theory of Persistent Serialism. Examine the following partial derivation:

(48) Persistent Serialism on B+R

Underlying Form	/waŋi – RED/
<i>Spread Nasal</i>	waŋĩ – RED
Copy	waŋĩ – waŋĩ
<i>Spread Nasal</i>	waŋĩ – wãŋĩ
Copy	waŋĩ – waŋĩ
<i>Spread Nasal</i>	waŋĩ – wãŋĩ
Copy	waŋĩ – waŋĩ
<i>etc...</i>

Each application of Spread Nasal from the base introduces a difference between base and reduplicant: the initial round of Copy yields the result *waŋĩ_B – waŋĩ_R*, which then undergoes nasal spreading to become *waŋĩ_B – wãŋĩ_R*, thereby triggering yet another round of Copy, which triggers another hit from Spread Nasal, triggering yet another round of reduplicative copying, *etc. ad inf.* The derivation, in short, does not converge;³⁵ it has no single output. This appears to be a disastrous result, with consequences extending far beyond the success or failure of one analysis of one pattern of Malay reduplication. It shows that constraints of identity cannot be casually invoked to trigger rule application in Persistent Serialism, because the very notion of “output of a derivation” then loses well-definition, in the general case. In sharp contrast, identity constraints are perfectly well-behaved in non-serial OT.

The interaction of nasal spread and reduplicative identity in Malay provides a compelling argument in favor of the parallel-evaluation Correspondence Theory. If

³⁵ “Converge” as opposed to “diverge” rather than “crash.” Thanks to Bruce Tesar for the contrast.

the B+R construal of the pattern is correct, then no serial base-copying theory can even generate the facts. If the R+B construal is correct, then a revised serial theory can be made to work, one that incorporates the option of free iterative application of rules. The revision is drastic, however, in its formal consequences. It requires the direct inclusion of special identity criteria to determine convergence of the iterative process — that is, when to re-apply a rule and extend the derivation; these criteria mirror those in Correspondence Theory. A burden of proof falls on the speculative iterativist to demonstrate that reduplicative Correspondence Theory needn't be re-created entire within Persistent Serialism. Even more seriously, the notion “output of a derivation” falls prey to endless iterative looping in a perfectly plausible range of cases; this indicates that Persistent Serialism, driven by identity conditions, may well not even be minimally workable as a linguistic theory.

3.7 Augmentation and Epenthesis in Axininca Campa

Another example of the same type as Malay comes from the prosodic morphology of Axininca Campa.³⁶ The reduplicant is observed to match the derived phonological structure of the base. Significantly, these alterations in the form of the base are themselves triggered by the reduplicant. Since there is no doubt in Axininca which is the reduplicant and which is the base — reduplication is unambiguously suffixing — we have a structurally-unambiguous version of the Malay situation: the reduplicant both triggers and copies the same alternation, in a way that is possible only in a theory with parallel evaluation of fully-formed output structures.

One respect in which the reduplicant matches the derived base is augmentation. When the base consists of a simple root /CV/ or /C/, it is augmented to achieve bimoraicity. (Throughout the discussion of Axininca Campa, epenthetic segments, though not their copies, will be shown in boldface.)

(49) Augmentation in B is Matched in R

<i>i. Root</i>	<i>ii. Root + RED</i>	<i>iii. Prefix+Root+RED</i>	<i>iv. Gloss</i>
/na/	nata–nata *nata–na	no-na–no-na	‘carry’
/t ^h o/	t ^h ota–t ^h ota *t ^h ota–t ^h o	non-t ^h o–non-t ^h o	‘kiss, suck’
/p/	paa–paa *paa–p	no-wa–no-wa	‘feed’

The reduplicant is suffixed in Axininca Campa. These examples show it copying the augment *ta* or *aa* from the base. The forms with agreement prefixes prove that augmentation is not a constant property of the reduplicant: when the base is not augmented, then neither is the reduplicant.

³⁶ This material is abstracted from McCarthy & Prince (1993a); important earlier work includes Payne (1981), Spring (1990), and Black (1991).

Another way in which the reduplicant matches the derived base is vowel epenthesis. A C-final root has epenthetic *a*, and the result of this epenthesis process is copied by the reduplicant:

(50) Epenthesis in B is Matched in R

<i>i. Root</i>	<i>ii. Root + RED</i>	<i>iii. Prefix+Root+RED</i>	<i>iv. Gloss</i>
/č ^h ik/	č ^h ika–č ^h ika *č ^h ika–č ^h ik	noñ-č ^h ika–č ^h ika *noñ-č ^h ika–č ^h ik	‘cut’
/tasoŋk/	tasoŋka–tasoŋka *tasoŋka–tasoŋk	non-tasoŋka–tasoŋka *non-tasoŋka–tasoŋk	‘fan’
/aacik/	aacika–cika *aacika–cik	n-aacika–cika *n-aacika–cik	‘stop’
/amin/	amina–mina *amina–min	n-amina–mina *n-amina–min	‘look’

In these forms, the result of an *a*-epenthesis process in the base is copied in the reduplicant. When the root is V-final, of course, there is no epenthesis in base or reduplicant: *kawosi–kawosi* ‘bathe’.

These two ways in which the reduplicant picks up derived properties of the base have secondary consequences, through other aspects of Axininca Campa prosodic structure:

First, observe in (49) that the form of the augment varies depending on the shape of the root: *ta* with /CV/ roots and *aa* with /C/ roots. This same distinction in the form of the augment is preserved in the reduplicant, so the result of augmenting and reduplicating /na/ is *nata–nata* and not **nata–naa*.

Second, Axininca Campa has a high-ranking (though not undominated) constraint demanding disyllabicity of the reduplicant. This constraint is responsible for the contrast between the forms in (51a) and (51b):

(51) Evidence for Reduplicant Disyllabicity

<i>i. Root</i>	<i>ii. Root + RED</i>	<i>iii. Prefix+Root+RED</i>	<i>iv. Gloss</i>
<i>a. Polysyllabic Root — Prefix Not Copied</i>			
/osampi/	osampi–sampi	n-osampi–sampi	‘ask’
/kawosi/	kawosi–kawosi	noŋ-kawosi–kawosi	‘bathe’
/t ^h aaŋki/	t ^h aaŋki–t ^h aaŋki	non-t ^h aaŋki–t ^h aaŋki	‘hurry’
/kint ^h a/	kint ^h a– kint ^h a	noŋ-kint ^h a–kint ^h a	‘tell’
<i>b. Monosyllabic Root — Prefix Copied</i>			
/naa/	naa– naa	no-naa–no-naa	‘chew’
/na/	nata–nata	no-na–no-na	‘carry’
/p/	paa– paa	no-wa–no-wa	‘feed’

The default condition demands non-copying of the prefix, as in (51a): the reduplicant should be a copy of only the root material in the base. But the prefix must be copied when the reduplicant would otherwise be monosyllabic, as in (51b). Nonetheless, the reduplicant remains monosyllabic when there is no prefix to copy, as in (51b, col. ii).

The interesting feature of this phenomenon is that an epenthetic vowel copied from the base counts toward disyllabicity of the reduplicant. In the following examples, the prefix is not copied because the reduplicant is disyllabic by virtue of copying an epenthetic vowel from the base:

(52) Reduplicant Disyllabicity Satisfied by Copied Epenthetic Vowel

<i>i. Root</i>	<i>ii. Root + RED</i>	<i>iii. Prefix+Root+RED</i>	<i>iv. Gloss</i>
/oiriŋk/	oiriŋka–oiriŋka	n-oiriŋka–riŋka *n-oiriŋka–n-oiriŋk(a)	‘lower’
/aacik/	aacika–cika	n-aacika–cika *n-aacika–n-aacik(a)	‘stop’
/amin/	amina–mina	n-amina–mina *n-amina–n-amin(a)	‘look’
/č ^h ik/	č ^h ika–č ^h ika	noñ-č ^h ika–č ^h ika *noñ-č ^h ika– non-č ^h ik(a)	‘cut’

To the casual observer, it might appear that epenthesis in the reduplicant is triggered by the disyllabicity requirement, rather than copied from the base, as we claim. This is incorrect, for two reasons. It cannot explain why prefix copying isn’t chosen over epenthesis (**n-oiriŋka–n-oiriŋk*), nor can it explain why a monosyllabic reduplicant *is* possible, without epenthesis, in forms like *naa–naa* (**naa–naata*, from the root /naa/) or *paa–paa* (**paa–pata*).

In summary, we have seen that the reduplicant copies two derived properties of the base, augmentation and V-epenthesis, with subsidiary effects on the form of augmentation and disyllabicity of the reduplicant. These are straightforward effects of B-R identity. Since the reduplicant stands in correspondence with the output form of the base, it is obliged to copy the derived structure of the base, including epenthetic segments. In the case at hand, since the segments involved lie at the right edge of the base and the reduplicant is suffixed, the responsible B-R identity constraint is ANCHOR or, specifically, RIGHT-ANCHOR-RB, which requires that the rightmost element of the base have a correspondent in the reduplicant (see Appendix A). This constraint is the Correspondence-Theoretic analogue of the familiar reduplicative dictum that copying is “edge-in”, proceeding from left to right in prefixing reduplication and from right to left in suffixing reduplication (Marantz 1982, McCarthy & Prince 1986: 94, Yip 1988a). The application of this constraint can be illustrated by the following examples:

(53) RIGHT-ANCHOR-RB Applied

	<i>Root</i>	<i>Base</i>	<i>Reduplicants</i>	<i>RIGHT-ANCHOR-RB</i>
a.	/na/	$n_1a_2t_3a_4$	$n_1a_2t_3a_4$ ☞ n_1a_2	✓ *!
b.	/p ³⁷ /	$p_1a_2a_3$	$p_1a_2a_3$ ☞ p_1a_2 p_1	✓ *! *!
c.	/č ^h ik/	$č^h_1i_2k_3a_4$	$č^h_1i_2k_3a_4$ ☞ $č^h_1i_2k_3$	✓ *!

Other potential candidates like n_1a_4 for (a), though properly anchored, fatally violate CONTIGUITY (see Appendix A).

These results show that derived properties of the base are copied in the reduplicant to satisfy the B-R identity constraint RIGHT-ANCHOR-RB. But what is the source of these derived properties of the base? What induces augmentation (49) and V-epenthesis (50), instead of a faithful analysis of the underlying root? The answer to both is that the reduplicant itself is responsible, through independently motivated constraints that are high-ranking in Axininca Campa.

As a preliminary step toward establishing this claim, we observe that the reduplicant is consistently C-initial in all of the forms cited. This is a regular pattern of the language, whenever the reduplicant is suffixed. (The non-suffixed, compounded reduplicant is V-initial — see McCarthy & Prince 1993a: Chapt. 5.) This pattern follows principally from the ranking ONSET \gg MAX-BR, which favors *osampi-sampi* over **osampi-osampi*. The reduplicant, then, is a C-initial suffix.

C-initial suffixes generally — not just reduplicative ones — have two significant effects in Axininca Campa phonology. The first effect centers around CODA-COND-mediated epenthesis. Codas are restricted to nasals followed by homorganic stops (cf. Itô 1989, Itô & Mester 1994a). Potential violation of CODA-COND leads to epenthesis, showing that CODA-COND dominates the anti-epenthesis constraint DEP-IO:

(54) CODA-COND Motivates Epenthesis

/no-N-č ^h ik-wai-i/	noñ.č ^h i.ka.wai.ti	‘I will continue to cut’
/no-N-tasoŋk-wai-i/	non.ta.soŋ.ka.wai.ti	‘I will continue to fan’
/no-N-aacik-wai-i/	naa.ci.ka.wai.ti	‘I will continue to stop’

Epenthesis like this is observed whenever a C-final stem meets a C-initial suffix, since the alternative is violation of undominated CODA-COND.

³⁷ The example $p_1a_2a_3$ involves extension of correspondence from the segmental (=root-node) level to the moraic. We eschew consideration of the details here.

The examples in (50) show that the result of CODA-COND-mediated epenthesis is duplicated in the reduplicant, satisfying RIGHT-ANCHOR-RB. Epenthesis over-applies, yet it is also triggered by the reduplicant, because the reduplicant is C-initial. A particularly striking effect of overapplication is that it leads to a seeming excess of epenthesis in the following examples, whose significance was first noted by Spring (1990: 109):

(55) Overapplication of Epenthesis (Spring 1990: 109)

/no-č ^h ik-RED-akiri/	no.č ^h i.ka.-č ^h i.ka.- ta .ki.ri	‘I cut it and cut it’
	*no.č ^h i.ka.-č ^h i.k-a.ki.ri	
/no-N-kow-RED-iro/	noŋ.ko.wa.-ko.wa.- ti .ro	‘I will search for it
	*noŋ.ko.wa.-ko.w-i.ro	more and more’

The final *a* of the suffixed reduplicant is itself followed by epenthetic *t* at the boundary between the reduplicant and the following V-initial suffix sequence /-akiri/ or /-iro/. Syllabic well-formedness constraints alone could never lead to such double epenthesis, which involves seemingly gratuitous violation of DEP-IO. From the syllabic point of view, there can never be a reason to epenthesize into /C+V/; rather, the sequence should be syllabified, with complete faithfulness to the input, as [CV (Prince & Smolensky 1991, 1993: Chapt. 6). Abundant non-reduplicative examples show this:


(56) No Epenthesis in /C+V/ Juncture Normally

/i-N-č ^h ik-i/	iñ.č ^h i.ki	‘he will cut’
/i-N-č ^h ik-aa-i/	iñ.č ^h i.kaa.ti	‘he will cut again’
/i-N-č ^h ik-ako-i/	iñ.č ^h i.ka.ko.ti	‘he will cut for’

Yet the forms in (55) with this pattern of faithful syllabification are ungrammatical. Consequently, we must look outside of syllable-theory for any constraint forcing double epenthesis.

The answer lies with B-R Identity, specifically with RIGHT-ANCHOR-RB. Satisfaction of this constraint, together with CODA-COND, is responsible for the syllabically unmotivated epenthetic vowel in the reduplicant — it is really a copy of an epenthetic vowel that the reduplicant has itself imposed on the base. The following tableau shows this result formally:

(57) Summary Tableau for Overapplication of Axininca Campa Epenthesis

/no-č ^h ik-RED-akiri/	RT-ANCHOR-RB	CODA-COND	Dep-IO
a.  no-č ^h ika-č ^h ika-takiri			**
b. no-č ^h ika-č ^h ik-akiri	* !		*
c. no-č ^h ik-č ^h ik-akiri		* !	

Form (a) labors under the defect of *two* epenthetic segments and therefore *two* violations of the anti-epenthesis constraint DEP-IO. These are the *a* of the base and the *t* of the suffixal string *akiri*. Nonetheless, (a) is the most harmonic candidate, because the others violate top-ranked RIGHT-ANCHOR-RB or CODA-COND. Form (b), in particular, shows a fatal failure of the reduplicant to copy the epenthetic *a* of the base. This tableau shows formally what we have been explaining up until now in a more intuitive way: the reduplicant both *triggers* epenthesis in the base (because the reduplicant is C-initial) and copies it (because copying the epenthetic vowel is necessary for proper ANCHORING).

The argument from the augmentation data in (49) is similar, but it is somewhat more complex, because it rests on a longer chain of analysis. The Prosodic Hierarchy and Foot Binarity, taken together, derive the notion “Minimal Word” (Prince 1980, Broselow 1982, McCarthy & Prince 1986, 1990, 1991a, 1991b, Kager 1993). According to the Prosodic Hierarchy, any instance of the category Prosodic Word (PrWd) must contain at least one foot. By Foot Binarity, every foot must be bimoraic or disyllabic. By transitivity, then, a PrWd must contain at least two moras or syllables. The foot, and therefore the PrWd, is minimally bimoraic in languages that make distinctions of syllable weight (“quantity-sensitive” languages); it is minimally disyllabic in languages that make no weight distinctions (“quantity-insensitive” languages). Observed word minimality restrictions therefore follow from the grammatical requirement that a certain morphological unit, often stem or morphological word, must be realized phonologically as a PrWd.

By virtue of this result, identifying a morphological unit like the stem as a PrWd has characteristic prosodic consequences. A particularly interesting pattern of these minimality effects is found in Axininca Campa. As we have seen, short roots /CV/ and /C/ are augmented to bimoraicity under certain conditions. The conditions of augmentation or non-augmentation are exemplified in table (58), using the root *na* in combination with the suffixes *-aanc^hi* ‘infinitive’, *-piro* ‘verity’, *-wai* ‘continuative’, and the reduplicative *-RED* ‘more and more’:

(58) Conditions of Augmentation

	__+V...	__+C...	__+RED
<i>Aug.</i>		<i>nata-pirotaanc^hi</i>	<i>nata-nata-waitaki</i>
<i>Nonaug.</i>	<i>na-taanc^hi</i>	<i>no-na-piroti</i>	<i>no-na-nona-waiti</i>

The other sub-minimal root-type, represented by /p/ ‘feed’, behaves identically, except for the difference in form of augmentation already mentioned (yielding *paa* not **pata*). Augmentation is to bimoraicity, as predicted, since the prosody of the language is quantity-sensitive. Less obvious are the conditions under which augmentation occurs:

i. **Bareness.**

Only a bare root is augmented.

When a prefix is present, nothing happens.

ii. **Suffix-initial C** (Payne 1981:145)

Subminimal roots augment when reduplicated or when followed by a C-initial suffix;

Roots do not augment when followed by a V-initial suffix.

Of these conditions, the first, *Bareness*, is grounded in a grammatical property independent of augmentation. It reflects the fact that prefix and root join together to form a stem, as required by the lexical organization of the language (McCarthy & Prince 1993a: Chapt. 3). When a PrWd requirement falls on the stem, any prefix that is present must count toward satisfying it.

Condition (ii), *Suffix-initial C*, follows from a constraint on Alignment. The apparent phonological restriction to “C-initial suffixes” is a descriptive artifact. The linguistic principle responsible for augmentation demands that *every* suffix attach to a PrWd (which must then meet minimality requirements). This type of constraint can be formulated in terms of Generalized Alignment (McCarthy & Prince 1993b; cf. Prince & Smolensky 1993) as follows:

(59) ALIGN-SFX

Align(Suffix, L, PrWd, R)

“The left edge of every suffix coincides with the right edge of some PrWd”


i.e. “The base of suffixation is a PrWd.”

(extending a proposal about the reduplicative base in Spring 1990.)

Once this constraint has been properly integrated into the grammar through ranking, it will guarantee, through interaction with Foot Binariness and other prosodic constraints, that any structures obeying it will have a pre-suffixal string at least two moras in size. More importantly, interaction with other constraints will turn out to distinguish successfully between C-initial and V-initial suffixes.

First, the C-initial suffixes. The only crucial assumption here is that ALIGN-SFX dominates the anti-epenthesis constraint DEP-IO. In this way, ALIGN-SFX can compel augmentation:

(60) C-initial Suffixation in Axininca Campa

	/na-piro/	ALIGN-SFX	DEP-IO
a.	 [nata] _{PrWd} -piro		** !
b.	na -piro	*	

In (60a), the suffix *-piro* is preceded by a PrWd, which itself meets Foot Binarity, since it contains two light syllables. In contrast, the suffix in (60b) is preceded by just a light syllable, insufficient to make a proper PrWd. Form (60a) obeys ALIGN-SFX, because the right edge of a PrWd, indicated by “]”, immediately precedes the suffix-initial segment *p*. The cost is violation of DEP-IO, since augmentation is required for the PrWd to meet Foot Binarity.

In contrast, V-initial suffixes present an irreconcilable conflict between ALIGN-SFX and prosodic well-formedness. What ALIGN-SFX wants is the following configuration:

(61) ALIGN-SFX with V-initial Suffix

[**nata**]_{PrWd} –V

There is simply no way to achieve this result and remain consistent with syllabic well-formedness. The suffix-initial V in (61) has to be syllable-initial too since, under the Prosodic Hierarchy, no PrWd-edge can be internal to a syllable. But if the V is syllable-initial, a direct assault — augmenting in the style of the C-initial suffixes — runs afoul of ONSET:

(62) Hypothesized Augmentation of /na–aanc^{hi}/

*[na.**ta**].aan.c^{hi}

This candidate aligns the suffix to a PrWd, but the V.V hiatus is not tolerated. This observation establishes that ONSET must dominate ALIGN-SFX.

Further epenthesis avoids the ONSET violation but destroys the alignment of the suffix-edge and the PrWd-edge:

(63) Hypothesized Augmentation and Epenthesis of /na–aanc^{hi}/


*[na.**ta**].**taan**.c^{hi}

In this case, the sought-for PrWd does not immediately precede the suffix *-aanc^{hi}*; epenthetic *t* intervenes. This is fatal to proper alignment. Ill-aligned and augmented **nata]taanc^{hi}* must then face equally ill-aligned but *unaugmented na]taanc^{hi}*. With ALIGN-SFX out of the equation, failed by both serious candidates, the decision falls to DEP-IO, which has no care for word minimality. The most faithful candidate, most conservative in epenthesis, is selected: *nataanc^{hi}*, with no augmentation. V-initial suffixes, then, simply cannot be properly aligned with a PrWd-edge and at the same time satisfy the high-ranked constraints on syllable structure. Alignment plays no role in their phonology, and minimality of epenthesis determines the output.

With these preliminaries out of the way, we can return to our main point. As the rightmost column of (58) makes clear, there is augmentation of the base preceding the reduplicant, just as there is augmentation before C-initial suffixes. This follows without further ado from ALIGN-SFX. We have already observed that the reduplicant

is a C-initial suffix in Axininca Campa, so it wants and receives a preceding PrWd, just like any other C-initial suffix. The following tableau exactly parallels (60):


(64) Reduplication & Augmentation

	/na-RED/	ALIGN-SFX	DEP-IO
a.	 [nata] _{PrWd} -nata		**
b.	na-na	* !	

The details of the argument here are identical to those for tableau (60) above. The optimal form (a) obtains prosodic well-formedness (Foot Binarity) as well as proper alignment at the left suffix-edge (ALIGN-SFX), violating only DEP-IO, by virtue of augmentative epenthesis. The other candidate trades obedience to DEP-IO for bad suffixal alignment, a fatal exchange given DEP-IO's subordinate position in the hierarchy.

This argument establishes that the reduplicative morpheme not only *triggers* augmentation in Axininca Campa but also *copies* it. The reduplicated form is *nata-nata*, with the *ta* augment present in both base and reduplicant. This is an instance of overapplication — copying of the epenthetic *ta* is compelled by the high-ranking B-R identity constraint RIGHT-ANCHOR-RB, just as it is in the parallel case involving CODA-COND-induced epenthesis:

(65) Summary Tableau for Overapplication of Axininca Campa Augmentation

	/na-RED/	RIGHT-ANCHOR-RB	ALIGN-SFX	DEP-IO
a.	 [nata] _{PrWd} -nata			**
b.	[nata] _{PrWd} -na	* !		**
c.	na-na		* !	

This tableau shows no conflict between RIGHT-ANCHOR-RB and DEP-IO, but the ranking of these two constraints has already been established by (57). The point of our argument is sufficiently made by form (a), which, by “overapplication”, satisfies both the high-ranking B-R identity constraint *and* ALIGN-SFX. Through parallelism of constraint satisfaction, this form shows that it is possible, and in fact necessary, for the reduplicant to both trigger augmentation and copy it. The reduplicant triggers augmentation because it is C-initial and ALIGN-SFX is high-ranking; it copies augmentation because RIGHT-ANCHOR-RB must be satisfied as well.

We now have two types of overapplication in Axininca Campa, both involving alternations in the base that are triggered and copied by the reduplicant. (In

subsequent discussion, we will focus on the overapplication of augmentation, though the remarks apply with equal force to CODA-COND-induced epenthesis.) In terms of a serial conception of grammar, the analysis we have proposed makes no sense, as was emphasized in the discussion of Malay in §3.6. How can the reduplicant both trigger augmentation and copy it? Under serialism, either Copy or Augmentation must apply first. If Augmentation is first, then at the time of its application there is no triggering environment present — no consonant-initial suffix — and it cannot apply at all. If Reduplicative Copy applies first, then it finds no augmentative material to copy. These failed derivational paths are sketched below:

(66) Failed Derivational Attempts

a. *Serial Theory: Augmentation Precedes Copy*

Underlying Root	/ na /	
Augmentation	—	(no triggering C-initial suffix)
Copy	*na-na	

b. *Serial Theory: Copy Precedes Augmentation*

Underlying Root	/ na /	
Copy	na-na	
Augmentation	*nata-na	(too late to copy augment)

Even various elaborations of serialism, involving complex decompositions of the reduplication operation, cannot deal with this pattern. For example, suppose the reduplicative affix –RED is added, some phonology takes place, and only later does Reduplicative Copy apply (Odden & Odden 1985, Kiparsky 1986):

(67) Serial Derivation Through Delayed Copying

Underlying Root	/ na /
–RED Suffixation	na-RED
Augmentation	—
Copy	*na-na

This derivation fails because the phonological composition of –RED has not been determined at the point in the derivation when Augmentation applies. As we have shown above and in McCarthy & Prince (1993a: Chapt. 5), the reduplicant triggers Augmentation simply because it is a C-initial suffix, conforming to a fully regular pattern of the language. Postponing melody-copying until after Augmentation means that we don't yet know that –RED is C-initial; the phonologically-unspecified underlying –RED won't trigger augmentation on its own.

Another variation is Persistent Serialism, introduced in §3.6. Suppose for starters that Augmentation can both precede and follow Reduplicative Copy:

(68) Persistent Serialism: Augmentation Reapplies

Underlying Root	/ na /	
<i>Augmentation</i>	—	(no triggering C-initial suffix)
Copy	na-na	
▶?Augmentation	*nata-na	

The problem arises at the second Augmentation stage. Since Augmentation is a response to the small size of the form under consideration, it will not apply if the form is already bimoraic. After Copy, that's the case, so there is no Augmentation. Furthermore, even if Augmentation were induced to apply to the root, there would be no way to force it in the reduplicant as well.

Another conception of Persistent Serialism does not lead to such immediate problems. Suppose the serialist declares Copy, as well as Augmentation, to be persistent. The idea, as in the Malay derivation (48), is that every change in the base is mimicked in the reduplicant in a continuous fashion, so the derivation proceeds as follows:

(69) Persistent Serialism: Copying Reapplies

Underlying Root	/ na /
<i>Copy</i>	na- na
Augmentation	nata-na
<i>Copy</i>	nata- nata
Augmentation	—
<i>Copy</i>	—

The result is correct. The crucial move is to reapply Copy after Augmentation, when the form of the base has changed, continuously updating the base-reduplicant identity relation. Moreover, unlike Malay (48), this derivation converges on *nata-nata*, so in this case there is no unending oscillation between different outputs, as the derivation loops between phonology and reduplication.

Nevertheless, the divergence problem remains quite alive in the general case, and the theory can be taken seriously only if it turns out to be solvable. The R → B → R information flow of Axininca Campa augmentation leads to the conclusion that Persistent Serialism is the only version of serial theory that is even marginally viable; but this appears to be no more than a brief reprieve from *reductio*.³⁸

Another possible serialist approach to reduplicative problems of this type is the bracketing paradox (Marantz 1987) or head operation (Hoeksema 1985, Aronoff 1988). The way to apply these ideas to Axininca Campa would be to have some other C-initial suffix trigger Augmentation of the root. Later in the derivation, Reduplicative Copy targets the transformed root rather than the original:

³⁸ And if the postpositive B+R analysis of Malay is correct, no serial base-copying theory is admissible, for the B → R → B flow, with back-copying onto B, cannot be achieved by any manner of copying from R.

(70) Serial Derivation Through Head Operation/Bracketing Paradox

Underlying Root	/ na /	
C-initial Suffixation	na-piro	
Augmentation	nata-piro	
Copy	*na-na-ta-piro	(finds root as base)

The problem here is that Reduplicative Copy cannot properly target the “transformed root” *nata*. The root is /na/, and the addition of epenthetic material to the segmental string adjoining the root does not change it into something else. To put the matter differently, phonological theory has no way of guaranteeing that epenthetic *ta* is assigned to the root when it is introduced into the string. (The imperfection of our notation-of-convenience, with hyphens tracking the morphological junctures, should not be allowed to obscure this truth.)

In any case, this derivation has the facts wrong too. It is the reduplicant itself, and not some other C-initial suffix, that triggers augmentation in reduplicated forms. This fact and its significance were first recognized by Spring (1990: 148–9), who has unearthed examples like /p-RED-ak-i-na/ → *paa-paa-takina* ‘I have continued to feed more and more’.³⁹ The suffix *-ak* is V-initial at underlying representation, so it could not trigger augmentation, for the reason given in (61–63). Thus, the output of /p-RED-ak-i-na/, according to the derivation (70), would be something like **pa-pakina*.

A final analytical move that would save serialism is to derive augmentation independently in base and reduplicant. The way to do this is by imposing a templatic requirement on the reduplicant, as Eric Baković and Suzanne Urbanczyk have independently suggested to us. If the reduplicant not only subcategorizes for a preceding PrWd but also must, by separate stipulation, be a PrWd itself, then both base and reduplicant will augment independently:

(71) Templatically-Induced Augmentation in reduplicant

Underlying Root	/ na /
Copy	[na] _{PrWd} – [na] _{PrWd}
Augmentation	[na ta] _{PrWd} – [na ta] _{PrWd}

Furthermore, since a PrWd cannot be C-final in Axininca Campa (because CODA-COND is undominated), this proposal also accounts for overapplication of anti-codaic epenthesis. Here too there is no real overapplication; just parallel development of B and R, rather than copying from B to R.

³⁹ One interesting feature of this example is the seeming excess of epenthesis: augmentative *aa* in the base, a copy of this in the reduplicant, and epenthetic *t* in the suffix to relieve hiatus. For the explanation, see (57).

This analysis requires an otherwise unmotivated templatic requirement on the reduplicant.⁴⁰ More seriously, it cannot account for the indirect consequences of overapplication cited earlier. There are two such effects: the form of augmentation and the disyllabicity requirement on the reduplicant.

The form of augmentation is determined by the morphology/prosody Alignment constraint ALIGN-R:

(72) ALIGN-R

Align(Stem, Right, σ , Right)

“The right edge of every stem coincides with the right edge of some syllable.”

i.e. “Every stem ends on a syllable edge.”

A /CV/ root like *na* or *t^ho* can end on a syllable edge; therefore it must, and augmentation adds the full syllable *ta* — *na.ta*, *t^ho.ta*. A /C/ root like /p/ cannot end on a syllable edge, because CODA-COND dominates ALIGN-R. In that case, ALIGN-R is irrelevant to the form of augmentation, and low-ranking DEP-IO steps in, selecting *paa*, with minimal epenthesis, over **pata*, with greater epenthesis.

The reduplicant copies the exact form of augmentation in the base, *ta* with /CV/ roots and *aa* with /C/ roots, as shown in (49). But if the base and reduplicant were augmented separately, as they are in the derivation (71), then the similarity in form of augmentation between base and reduplicant does not follow. In fact, the expected result from /na/, according to (71), **nata-naa*. The reason for this is that ALIGN-R crucially relates an underlying string (the stem) to its output prosodic structure (a right syllable edge). The root /na/ is correctly aligned with a syllable edge in the augmented base *na.ta*. But the reduplicant has no segmental projection in underlying representation — its underlying form is just segmentally-unspecified RED. This means that there is *nothing to align* in the reduplicant, and so ALIGN-R is irrelevant to its form. With ALIGN-R out of the picture, the reduplicant should augment as the root /p/ does, minimally violating DEP-IO. This wrong result rests on the assumption, made explicitly in (71), that augmentation proceeds separately in base and reduplicant. In reality, the form of augmentation in the reduplicant is determined by copying augmentation in the base, through B-R identity.

Satisfaction of the reduplicant disyllabicity requirement also argues against (71). The data in (51) show that the agreement prefix is copied to ensure disyllabicity of the reduplicant, while the data in (52) show that the epenthetic vowel in the reduplicant counts toward satisfying disyllabicity, and so the prefix is not copied in these forms. The result, then, is *noñ-č^hika-č^hika* rather than **noñ-č^hika-noñ-č^hika*.

There is simply no way to obtain the *noñ-č^hika-č^hika* under (71) or, indeed, any other serial theory. Because the epenthetic vowel figures in determining the

⁴⁰ There is, however, a latent goal of relating the PrWd template to the disyllabicity requirement on the reduplicant, which, if achieved, would be a significant result.

syllable count of the reduplicant, it is necessary to know about epenthesis when the reduplicant is first formed, in order to know whether or not to copy the prefix. According to (71), though, epenthesis is a secondary effect of the PrWd template imposed on the reduplicant, enforced after the copying operation, so the effects of epenthesis aren't available until after the decision about prefix copying has to be made. Under the other serial approaches (66–70), the situation is even worse, because the reduplicant must somehow trigger the epenthetic vowel in the base, copy it, and use the copy to satisfy disyllabicity, without inadvertently copying the prefix. How can a copy of the vowel, which doesn't exist before the reduplicant is created, be called on to satisfy disyllabicity *in* the reduplicant as the reduplicant is being created? Regardless of the ordering of epenthesis and reduplication, as serial rules, the result is that the prefix is incorrectly copied: **noñ-č^hika-noñ-č^hika*.

To sum up, the material from Malay and Axininca Campa shows that phonological processes can be both triggered by the reduplicant and copied by it. Serial theories, even when assisted by various auxiliary assumptions, are unable to account for this type of behavior. The best serial theory is the persistent one, but it requires a theory of reduplicative correspondence to get off the ground, and is even then beset by fundamental problems of well-definition that come immediately from invoking identity within an iterative regime. If base-reduplicant identity is regarded as a relation, rather than the effect of a copying process (or as a condition on serial processing), and if phonological alternations are seen as consequences of constraint satisfaction, the Malay and Axininca Campa patterns emerge directly from parallel evaluation of fully-formed outputs.

3.8 Chumash Coalescence and Over-Copying

Vowel-initial stems create special problems for reduplicative prefixation, and in resolving them, otherwise unexpected forms may result. Where simple prefixation would give rise to V+V hiatus, infixation may be found instead (McCarthy & Prince 1986, 1991b, 1993a: 129-135). Another effect is copying beyond the bounds of the templatic requirement: in Mokilese, for example, the heavy syllable template yields *pɔd*–*pɔdok* with the C-initial root /pɔdok/, but *an.d*–*an.dip* from /andip/, copying one more C than fits into the template, to ensure the heaviness of the prefix. Yet another pattern is often found: when the reduplicative morpheme is itself preceded by a C-final prefix, as in the structure /...C+RED+Stem/, that preceding C can be recruited as part of the copying pattern. Some examples:

(73) Retrograde Over-Copying⁴¹

	<i>Underlying</i>	<i>Output</i>	<i>Expected</i>
a. Tagalog	naŋ-RED-isda	naŋi – ŋisda	*naŋ-i-isda *naŋ-i-ʔisda
b. Kihehe	ku-RED-ita	kwiita – kwiita	* kwiita-ita
c. Chumash	s-RED-ikuk	sik – sikuk	* sik-ikuk , * sik-ʔikuk
d. Chumash	s-iš-RED-expeč	s-išex – šexpeč	*s-iš-ex-expeč, *s-iš-exp-expeč

In the “expected” column, the source of the reduplicated material is strictly to the right of the morpheme labeled RED, as is usually the case in prefixal reduplication. The actual output shows RED reaching additionally leftward, as it were, evidently to avoid reduplicating a V-initial sequence.

A very similar pattern can arise in the /PREFIX+RED+STEM/ structure when there is coalescent phonology involving the final element of PREFIX.

(74) Coalescent Over-Copying

	<i>Underlying</i>	<i>Output</i>	<i>Expected</i>
a. Tagalog	paŋ-RED-putul	pamu – mutu	*pamu – putul
b. Chumash	k-RED-ʔaniš	k’an – k’aniš	* k’an – ʔaniš

In Bloomfield’s famous Tagalog case (74a), prefix final -ŋ coalesces with a following voiceless stop to yield a nasal homorganic with the stop. Surprisingly, the coalesced element shows up in both base and reduplicant. In Chumash, the sequence oral stop + ʔ/h coalesces to form a single glottalized or aspirated segment. Once again, the product of coalescence is mirrored in reduplication. Just as in the over-copying cases of (73), the reduplicant ends up composed of material from both the left and the right sides of the RED morpheme; the “expected” column shows what would result if reduplicated material were drawn only from rightward of the prefix.

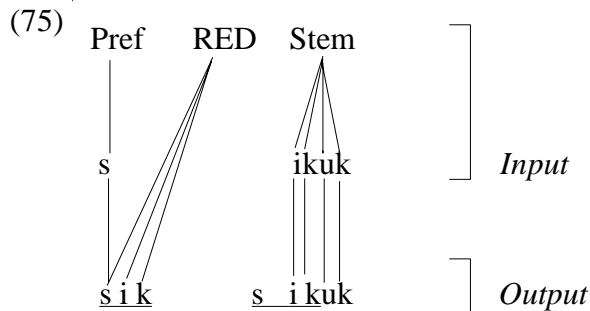
We argue that these forms, drawn from a variety of languages, show a particularly interesting type of base-reduplicant interaction: in a structure PREFIX+RED+Stem, there is a kind of fusion of PREFIX and RED, and due to the effects of B-R identity, a concomitant modification at the RED–Stem juncture. The base, then, copies the reduplicant. In serial theories, this is an impossibility: R copies B by its very nature, since R is simply the product of applying a procedure of Reduplicative

⁴¹ On Tagalog, see Schachter & Otones (1972), Carrier[-Duncan] (1979, 1984), Marantz (1982, 1987), Uhrbach (1987), Aronoff (1988), and Pater (1995). On Kihehe, see Odden & Odden (1984) and Silverman (1991); cf. also Mutaka & Hyman (1990). On Chumash, see Applegate (1976) and Mester (1986). Kihehe shows evidence of phonology beyond simple onset-attraction: /u/ is devocalized and there is compensatory lengthening of the following vowel. For an Optimality-Theoretic account of this alternation, see Rosenthal (1994, 1995).

Copy to B. But under correspondence, identity between R and B is a relation, with full symmetry of effect. Thus, it makes perfect sense to say that B copies R.⁴²

Because the over-copying and coalescence phenomena are complex, and because they also have complex consequences for the morphology, the argument requires a certain amount of technical development. We therefore proceed in stages, beginning with an account of simple onset-attracting over-copying and then proceeding to the coalescent cases. The argument continues by considering alternative accounts of over-copying. The first alternative, serialism in its variant forms, encounters immediate and serious empirical problems. The second alternative, the head operation or bracketing paradox, fails for the reasons explored in §3.7. The section concludes by examining a couple of important details: the character of coalescence in Correspondence Theory and the possibility of *exfixation* of RED as an alternative to over-copying.

We begin, then, with the onset-seizing form of retrograde over-copying. The desired relation between input and output can be pictured like this:



Correspondence and morphemic affiliation are diagramed (informally) by lines of linkage (which should not be confused with autosegmental representations). Under this analysis, the first *s* of *sik-sikuk* does double duty: it is the surface realization of the /s/ in PREF, and it also serves as the first segment in the exponence, the phonological content, of the morpheme RED. The second occurrence of *-sik*—therefore begins with an *s* that is introduced solely for purposes of reduplicative identity: it is epenthetic, without morphology, and hence in violation of the antiepenthesis constraint DEP-IO.

Such fusion of morphemes cannot be freely available; there must be a constraint against it. Faithfulness certainly excludes coalescence, in the straightforward sense that in the relation between strings S_1 and S_2 , if x and y are distinct elements of S_1 with correspondents in S_2 , then they may not correspond to the same element in S_2 .⁴³ This formulation doesn't apply here, since RED is associated with one

⁴² Another clear case of the B-copies-R type comes from underapplication in Southern Paiute and in Klamath root reduplication, discussed in §5.3 below.

⁴³ This is dubbed “UNIFORMITY” in Appendix A below. On coalescence under Correspondence Theory, see also Gnanadesikan (1995), Lamontagne & Rice (1995), McCarthy (1995), and Pater (1995).

string, not two; the kind of coalescence seen in (75) doesn't involve two input segments merging into one output segment. With further technical development, this formal obstacle can be overcome,⁴⁴ but for purposes of expositional ease, we will state here a constraint that is aimed specifically at morpheme fusion of this type.

A morpheme stands in a primitive relation of *exponence* with some structure of segments or autosegments. Typically, this is given by the lexical entry of the morpheme, but in the case of reduplicative morphemes, their only content is what's in the output, and this is then their exponence. We now define a more general notion of morphemic content, one preserved under correspondence.

(76) **Dfn.** Morpheme Associate. A segment (autosegment) x is an *associate* of morpheme M_k if x or some correspondent of x is an exponent of M_k . For this, we write, $x \sqsubset M_k$.

With this notion, we can now assert that morphemic contents should be disjoint:

(77) MORPHDIS (Morphemic Disjointness)

$x \sqsubset M_i \rightarrow x \not\sqsubset M_j$, for instances of morphemes $M_i \neq M_j$ and for x a specific segmental (autosegmental) token.

“Distinct instances of morphemes have distinct contents, tokenwise.”

The constraint MORPHDIS discriminates as well against all kinds of *haplogy*, in which two morphemes share overlapping contents (see Stemberger 1981, Russell 1995). In structure (75), MORPHDIS is clearly violated, since both PREF and RED share the associate s at the output level.

How, then, does this violation come to be optimal? The Chumash reduplicant is quite strictly defined, and satisfaction of its shape requirements can conflict directly with MORPHDIS. The reduplicant is always heavy (and therefore always C-final, since long vowels are not admitted in the language); in addition, it is exactly coextensive with a syllable. We summarize these weight and alignment properties with the constraint (78). (For further application of (78), leading to *underapplication* in Chumash, see §5.2.)

(78) $R = \sigma_{\mu\mu}$

Furthermore, the reduplicant is perfectly ANCHORED (see Appendix A for the constraint ANCHOR): the initial segment of the reduplicant is always in correspon-

⁴⁴ Suppose we distinguish M-indices from P-indices, where M-indices index the exponent of M, and P-indices index the output level. Using letters for M-indices and numbers for P-indices, we'd have e.g. $(s_a + i_b k_c u_d k_e, s_1 + i_2 k_3 u_4 k_5)$. Correspondence would be defined on the indices, so we'd have, in the example at hand, $a \rightarrow 1, b \rightarrow 2$, etc. In the case of reduplication, the exponent of RED would bear both types of indices. So, we'd have, for example, $(s_a - \text{RED} - i_b k_c u_d k_e, s_{1,f} i_{2,g} k_{3,h} - s_{89} - i_4 k_5 u_6 k_7)$, where f, g, h are indices owned by RED. And now correspondence says: $a \rightarrow 1, f \rightarrow 1, g \rightarrow 2, h \rightarrow 3$, etc. The noninjective map $a \rightarrow 1, f \rightarrow 1$ is coalescence pure and simple.

dence with the initial segment of the base. And correspondents in the reduplicant and the base are featurally identical, so IDENT-BR(F) is satisfied for every feature F. Finally, the reduplicant consists only of material copied from the base, so DEP-BR is honored completely.

These four reduplicant-defining constraints, none of them crucially dominated, severely cut down the set of viable candidates. Consider various possible forms coming from input /s-RED-ikuk/ which do not violate MORPHDIS, which are properly anchored and composed of base segmentism, but which fail to make the template:

(79) Bad Candidates from /s-RED-ikuk/

<i>Candidate</i>	<i>Constraints Violated</i>	<i>Flaws</i>
a. s- i.k - ikuk	R= $\sigma_{\mu\mu}$	R is light, R is incomplete σ .
b. s- ik.k - ikuk	R= $\sigma_{\mu\mu}$	R not coextensive with σ .
c. s- ik. - \mathbb{C} ikuk	R= $\sigma_{\mu\mu}$, ANCHOR	R $\neq\sigma$; R and B begin differently.
d. s- ik. - ikuk	R= $\sigma_{\mu\mu}$, ONSET	R $\neq\sigma$, medial onsetless σ

In no case does R include the onset, so R fails to be a complete syllable, a sufficiently fatal lapse. Other flaws abound, as well. In example (79a), R = *i.k* violates the weight requirement. In example (79b), R = *ik.k* has the right moraic content, but runs over the end of its syllable and introduces a geminate in so doing. In example (79c), R = *ik.* is also satisfactory weight-wise, but rests against the unmarked epenthetic consonant (notated \mathbb{C} , because of uncertainty about its Chumash value) to support its bimoraicity, de-ANCHORING the reduplicant in the process. Finally, in example (79d), setting R = *ik.* also leads to an unacceptable violation of ONSET in the next syllable.

Only one candidate yields the required reduplicant shape: the to-be-desired morpheme-fusing *sik-s-ikuk*. As noted earlier, it violates the anti-epenthetic constraint DEP-IO, since the medial *s* has been introduced into the base solely to satisfy B-R identity requirements (see (75)). It follows, then, that R= $\sigma_{\mu\mu}$ \gg DEP-IO, since conformity to the template requires epenthesis and epenthesis-free, non-template-conforming candidates are clearly available, as seen in (79).

The results of this discussion are presented in the following tableau, in which three templatically successful candidates (a, b, c) are contrasted with each other and with one that is not (d):

(80) Exemplificatory Tableau, for Chumash /s-RED-ikuk/

/s-RED-ikuk/	ANCHOR	IDENT-BR(F)	R= $\sigma_{\mu\mu}$	DEP-IO	MORPHDIS
a. $\text{ʔ} \text{š} \text{ si kk - } \text{š} \text{ i ku k}$				*	*
b. $\text{š} \text{ si kk - } \text{C} \text{ i ku k}$	* !			*	*
c. $\text{š} \text{ si kk - } \text{C} \text{ i ku k}$		* !		*	*
d. $\text{s} \text{ ikk - } \text{i ku k}$			* !		

The reduplicant is bolded; double underlining heuristically indicates reduplicative correspondence.

All three candidates that obey the template (a–c) do so at the expense of epenthesis and fusion, violating DEP-IO and MORPHDIS. Candidate (b) is interesting in that it satisfies the template without mirroring the phonologically epenthetic C, but it runs afoul of undominated ANCHOR. As indicated, reduplicant-initial /s/ and base-initial C are not in correspondence in (b), de-ANCHORING R. Candidate (c) satisfies ANCHOR by having /s/ and C correspond, leading to violations of undominated IDENT-BR(F), equally fatal. Observe that $R=\sigma_{\mu\mu} \gg \text{MORPHDIS}$ is required by the contrast between (a) and (d), if there is no other constraint dominating MORPHDIS that eliminates candidate (d).⁴⁵

Almost entirely parallel is the treatment of cases where PREF is larger than a single C. Consider the following form, where the final consonant of the prefix /iš/ is recruited into the reduplicant:

(81) Behavior of -VC- Prefix

<i>Input</i>	<i>Output</i>	<i>Bad Candidates</i>	<i>Remarks</i>
/s-iš-RED-expeč/ 3p-Du.-Cnt.- sing	š-iš ex -š expeč	š-iš- exp -expeč š-iš- exx -expeč, š-iš- ex -C expeč š-iš- e.x -expeč š-iš- ex. - expeč š-i. šex - C expeč	R ≠ $\sigma_{\mu\mu}$ R ≠ $\sigma_{\mu\mu}$ R ≠ $\sigma_{\mu\mu}$ R ≠ $\sigma_{\mu\mu}$ R ≠ $\sigma_{\mu\mu}$ *ANCHOR

All of the cited candidates violate the template or the B-R identity constraint ANCHOR. There are, then, no satisfactory reduplicants among them, and the proper output is fully determined by the ranking given in (80).

One detail remains. We must contend with candidates that maintain morphemic disjointness by epenthesizing into *both* the reduplicant and the base,

⁴⁵ This is not quite a sure thing, because *GEMINATE must be in the grammar somewhere, as it is in all grammars.

thereby satisfying both the template and the B-R identity requirements without difficulty:

(82) Failed Candidates with Epenthesis in B and R

- | | |
|---------------------|-------------------------------------|
| a. /s-RED-ikuk/ | *s- <u>C</u> ik.-C ikuk |
| b. /s-iš-RED-expeč/ | *š-i <u>š</u> . <u>C</u> ex-C expeč |

Epenthesis into the base (DEP-IO) is not decisive, since the actual output suffers the same defect, noted in (80). Rather, it's epenthesis into the *reduplicant* that is the fatal flaw of these candidates, in comparison to the actual output forms, which recruit the prefixal consonant as onset of the reduplicant. The constraint against epenthesis into the reduplicant refers to *I-R* correspondence, developed for independent reasons in §6 below. Thus, these candidates are eliminated by DEP-IR, which must then dominate MORPHDIS.

With this, we have formally resolved the finding of Applegate (1976: 279) that for “vowel initial stems, the reduplicated sequence maintains an invariant CVC shape by including any consonant immediately preceding the stem.” Reduplicative over-copying is a matter of satisfying constraints on the form of the reduplicant ($R=\sigma_{\mu\mu}$) and its relation to the base (ANCHOR, IDENT-BR(F), DEP-IR) at the expense of positing a morphologically unaffiliated segment in the base. Reduplicative over-copying is, in all respects, a type of epenthesis, but epenthesis which is morphologically motivated and where the identity of the epenthetic segment is determined through reduplicative correspondence.

Chumash shows a similar pattern of *coalescent* over-copying, which can be analyzed very much along the same lines. The language has a phonological process fusing an obstruent with a following ʔ or h to form a single glottalized or aspirated segment: from, e.g., /kʔ/ we get $k^{\text{ʔ}}$, and from /kh/, k^h . The process overapplies, in the sense that the fused obstruent shows up in both base and reduplicant, as the examples in (83b) show:⁴⁶

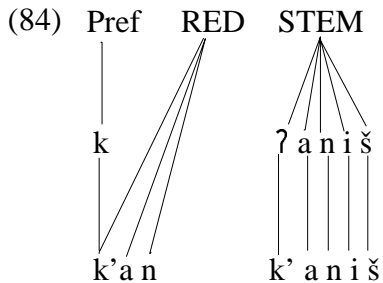
(83) Chumash C+G Coalescence (Applegate 1976)

- | | | |
|---------------------------------|---|-------------------------|
| a. <i>General (constructed)</i> | | |
| /k-ʔaniš/ | kʔaniš | ‘my paternal uncle’ |
| /k-hawaʔ/ | k ^h awaʔ | ‘my maternal aunt’ |
| b. <i>Reduplicative</i> | | |
| /k-RED-ʔaniš/ | kʔ an- kʔ aniš | ‘my paternal uncles’ |
| /p-RED-ʔayakuy/ | pʔ ay- pʔ ayakuy | ‘your baskets’ |
| /s-RED-ʔaminʔ/ | sʔ am-sʔaminʔ | ‘he is naked’ |
| /k-RED-hawaʔ/ | k^haw - k^hawaʔ | ‘my maternal aunts’ |
| /s-RED-hatinet/ | s^hat - s^hatinet | ‘its joints, junctures’ |

⁴⁶ According to Applegate (1976), overapplication is variable with h coalescence. He relates this observation to the generally lower frequency of aspirated than glottalized consonants in Chumash.

The reduplicative pattern clearly violates MORPHDIS, as in the onset-seizing cases just discussed.

The following diagram indicates the desired structure of correspondence and morphemic affiliation:



When straightforward concatenation of nonreduplicative morphemes leads to coalescence, as in (83a), then the process also violates UNIFORMITY, the string-based constraint against mapping multiple input elements to a single correspondent in the output. Both MORPHDIS and UNIFORMITY must therefore be subordinated to the constraint that militates against non-coalesced sequences of C+G. Disregarding various details, let us tentatively identify the relevant structural constraint as *COMPLEX (Prince & Smolensky 1993), which prohibits tautosyllabic clusters. (NOCODA may be active as well, if ...VC.ʔ... undergoes the same process; evidence is lacking on this point).

(85) COMPLEX \gg UNIFORMITY-IO, MORPHDIS, in Chumash

	/k ₁ -ʔ ₂ aniš/	*COMPLEX	MORPHDIS	UNIFORMITY-IO
a.	☞ k' _{1,2} aniš		*	*
b.	k ₁ ʔ ₂ aniš	* !		

The double index on the output segment indicates its bisegmental source in the input. The choice here is between the coalescent form (a) and the complex onset in (b). Coalescence is the favored outcome, by virtue of the ranking given.

Coalescence overapplies: the fused *k'* is observed in both reduplicant and base, though only the RED morpheme, and not the stem, is adjacent to the morpheme whose content is *k*. The pattern follows from the ranking just given, plus dominant B-R Identity:

(86) Overapplication in Chumash

	/k ₁ -RED-ʔ ₂ aniš/	IDENT-BR(F)	*COMPLEX	MORPHDIS
a.	☞ k' ₁ an-k' ₂ aniš			*
b.	k ₁ -ʔan-ʔ ₂ aniš		* !	
c.	k' ₁ an-ʔ ₂ aniš	* !		*

Remarks:

- ▶Form (b), with underapplication of coalescence, has the forbidden *kʔ* onset cluster.
- ▶Form (c) shows transparent phonology, with disregard for reduplicative identity. In this candidate, the *k'* of the reduplicant and the *ʔ* of the base stand in B-R correspondence with one another. But correspondent *k'* and *ʔ* differ featurally in many respects, among them place of articulation. This is a violation of IDENT-BR(Place), among other things, and it is fatal to (c), for IDENT-BR(F) is observed for all F, and must dominate UNIFORMITY-IO and MORPHDIS.
- ▶The optimal form (a) violates MORPHDIS.⁴⁷

Thus, domination of the anti-coalescence constraint(s) by various structural constraints such as *COMPLEX (and perhaps NOCODA) leads to coalescent behavior in the phonology. When, in addition, principles of reduplicative identity dominate anti-coalescence, there will be transmission of coalescent behavior between base and reduplicant.

The striking property of cases like Chumash is that the base/reduplicant negotiation crucially involves information flow from the *reduplicant* to the *base*, in a kind of reversal of copying. According to the account developed here, the second *s* of *sik-sikuk* is a copy of the first, which is itself an associate of the morpheme /s-/ '3sg.'. Similarly, the velar place assumed by the second occurrence of *k'* in *k'an-k'aniš* is copied from that of /k-/ '1sg.', whose correspondent is in word-initial position. (The glottalization of the first *k'*, like the featural composition of the sequence *-an*, comes from the base, and ultimately from the stem /ʔaniš/.) There is nothing remarkable about this two-way flow of influence in terms of the parallel theory of constraint evaluation — both reduplicant and base are evaluated symmetrically by the constraints IDENT-BR and *COMPLEX, and under parallelism neither the base nor the reduplicant has priority in determining the outcome with respect to B-R identity.

In contrast, no version of Ordering Theory, including Full-Copy, can contend with effects that are derived in the reduplicant and then realized by copying into the

⁴⁷ Form (a) doesn't however violate UNIFORMITY-IO. This inhomogeneity is a possible technical flaw in the conception of correspondence mooted here, likely to be remediable with improved understanding of the formal nature of correspondence, as outlined in fn. 44 above.

base. The reason for this is clear: on standard assumptions, accepted by Ordering Theory, the base does not copy the reduplicant. Consequently, any approach to such problems via Ordering Theory must deny the R-to-B influence. Serial ordering will be coupled to assumptions about morphological organization to get the result from standard B-to-R copying. To see this concretely, consider the ordering of morphological and phonological processes that would be called on in a generic Ordering-Theory analysis of Chumash:

(87) Chumash C+G Coalescence in Ordering Theory

Underlying Root	/ʔaniš/
Prefix <i>k-</i>	k- ʔaniš
C+G Coalescence	k' aniš
Reduplication	k'an- k'aniš

The key assumption here is that prefixation of *k-*, and of the other coalescing prefixes, occurs prior to reduplicative prefixation.

It turns out, though, that this assumption is incompatible with the basic morphology of the language, since the reduplicative affix is closely bound to the derivational stem, and the coalescing monoconsonantal prefixes (*k-*, *p-*, and *s-*, all of them agreement markers) are found well outside of it. This can be seen clearly in reduplicative constructions where coalescence is not at issue, cited in (a) below:

(88) Locus of Reduplication in Chumash Morphology

a. *RED attaches to the Root*

/k-ni-RED-č'eq/	kni č'eq č'eq	'I'm tearing it up'
/s-RED-tip ^h in/	š tip tip ^h in	'it is heavily forested'
/s-RED-kitwon/	s kit kitwon	'it is coming out'
/s-RED-pepeʔ/	s peh pepeʔ	'his older brothers'
/k-RED-su-pšeʔ/	k šup šupšeʔ	'I'm putting out a fire'
		(<i>su</i> 'caus.', <i>pšeʔ</i> 'go out')
/s-RED-pil-tap/	s pit pitap	'it is falling in'
		(<i>pil</i> 'through air', <i>tap</i> 'enter')

b. *Coalescent/Onset-seizing examples*

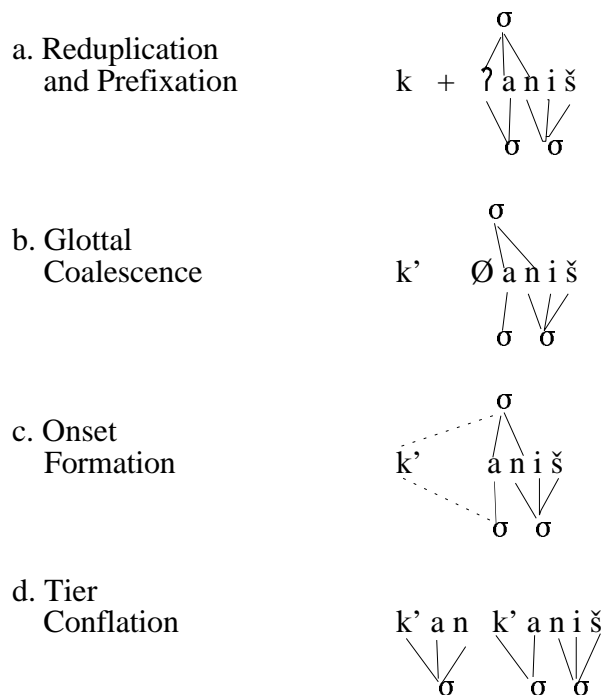
/s-RED-ikuk/	sik sikuk	'he is chopping, hacking'
/k-RED-ic'is/	kic' kic'is	'my sisters'
/s-iš-RED-expeč/	š išex šexpeč	'they two are singing'
/s-iy-RED-eqwel/	s iyeq yeqwel	'they are making'

The simple derivation (87) cannot then be correct as it stands: RED is inside the other prefixes. Ordering Theory can perhaps be enriched to accommodate some phenomena of this type by decoupling the serial order of affixes from the serial order of the derivation, departing from the bottom-up compositional building of structure. One approach of this kind posits bracketing paradoxes; another invokes head operations. (See the discussion and references above in §3.7.) Neither applies straightforwardly to the present case. We have a morphological structure [A[B[C]]]

in which B must sometimes be made to sit outside of AC. Rebracketing will not help. Regarding B as a process applying to the *head* of AC doesn't immediately solve the problem either: one must explain how in /s-ikuk/ the initial *s* becomes part of the "head" of the construction (cf. (70) and the associated discussion). Even if some non-bottom-up serial strategy could be developed, the identity-supporting effects of overapplication in Chumash and kindred examples would be portrayed as somehow special and unexpected — and therefore different from Madurese and the other cases discussed earlier — simply because the phonological process is apparently transmitted from reduplicant to base, rather than the other way around. In contrast, a parallel model, which assesses phonological well-formedness and reduplicative identity together, analyzes Chumash and the like as natural and unproblematic — under parallelism, other things being equal, the reduplicant can influence the form of the base just as the base can influence the form of the reduplicant.

There is, however, one successful and insightful treatment of Chumash to be found in the previous literature. Significantly, it has some of the parallelistic character of the model proposed here. Mester (1986: 200f.) shows how Chumash over-copying can be obtained from a parafixational theory of reduplication, in which the reduplicative template is a (structurally) parallel analysis of the same segmental string as the base. The derivation of *k'aniš* proceeds as follows:

(89) Derivation of *k'aniš* in Mester (1986: 205–6)



The central feature of Mester's proposal is that the reduplicative template (the topmost σ in each diagram) simultaneously parses the same segmental string as original syllabification, though the parse may be different (as is the case with *n*).

Glottal coalescence applies to both base and reduplicant together because base and reduplicant consist of a single segmental string. The product of glottal coalescence, the *k'*, is attracted into the onset of both parallel syllables. (This same derivational step is responsible for the simple onset-attracting over-copying of forms like *sik–sikuk*.) Subsequently, Tier Conflation is called on to produce a linear string of phonemes from the complex reduplicative representation. Phonological processes ordered after Tier Conflation (such as coda deglottalization in Chumash — see §4.3) will show normal application.

There are other variations on approaches of this type — in addition to Mester (1986) see Clements (1985a), Hirschbühler (1978: 118f.), McCarthy (1979: 373ff., 1983, 1985), McCarthy & Prince (1986: 102f.), Pulleyblank (1988: 265–267), Tateishi (1987), and Uhrbach (1987: 43ff.). The common insight is that base-reduplicant identity is given a structural basis, to be read off the phonological representation. The theories remain derivational, though; the derivational shift from one type of structure to another is essential for typological purposes. During the early phase of the derivation, reduplicant and base are structurally “the same thing”, so they must receive identical treatment from phonological processes and they cannot interact with one another. During the later phase of the derivation, reduplicant and base are structurally “different things”, with no lingering commitment to one another, so they will receive different treatment from phonological processes and they are free to interact with each other.

The structure-plus-derivation approach is antithetical to correspondence under Optimality Theory, which sees identity/non-identity and interaction/non-interaction in terms of ranking of substantive constraints rather than a shift from one structure to another. The evidence favors substance over structure: examples like Malay (§3.6), Axininca Campa (§3.7), and Klamath root reduplication (§5.3) display B-R identity effects even in B-R interactional phonology, an impossibility in structure-plus-derivation approaches. Conceptual considerations point in the same direction: there is a significant reduplication-specific component to a model like (89). The parallel syllabic structures are not required elsewhere in phonology or morphology. In contrast, Correspondence Theory generalizes over reduplicative identity, faithfulness, and other phonological relations, avoiding any reduplication-specific mechanism.

This exhausts the principal lessons we wish to draw from Chumash and similar cases of coalescent/onset-seizing overapplication. In support of the main line of argument, however, we need to delve into a couple of important auxiliary matters. One concerns the treatment of coalescence under Correspondence Theory. The other involves a type of “exfixational” candidate not yet considered.

Coalescence entails the existence of serious featural disparities between input and output, which have not been given their due here.⁴⁸ In the examples discussed, we have the following mappings:

- (90) /ʔ/ → k' *IDENT-IO(Place)
 /k/ → k' *IDENT-IO(Laryngeal)

To achieve these relations, faithfulness to Place and to Laryngeal State must be severely compromised along the I-O dimension, as indicated. We must therefore have “B-R identity” ≫ IDENT-IO(Place), IDENT-IO(Laryngeal). But then other competing maps will have the same apparent complexity; consider, for example, the following:

- (91) /ʔ/ → ʔ ▶entirely faithful
 /k/ → ʔ *IDENT-IO(Place), *IDENT-IO(Laryngeal)

Here *k* and ʔ would “coalesce” to ʔ. Thus from /k+RED+ʔaniš/, this map would yield *ʔan–ʔaniš. And, indeed, from simple nonreduplicated /k+ʔaniš/, we’d have *ʔaniš. We want to exclude these, but in terms of IDENT-IO violations, they are equivalent to the actual observed forms.

The very same effect can be seen with a different choice of output:

- (92) /ʔ/ → k *IDENT-IO(Place), *IDENT-IO(Laryngeal)
 /k/ → k ▶entirely faithful

Now **kaniš*, **kan–kaniš* join the list of expected optimal forms. Given a universal background of markedness constraints on features and combinations, the choice among the outputs ʔ, *k*, and *k*' would presumably be resolved in favor of ʔ, thereby wrecking the analysis developed so far.

In such maps, which have the form $xy \rightarrow x$ or $xy \rightarrow y$, outright deletion masquerades as coalescence. Though we cannot hope to resolve the issue here with any finality, we note a couple of lines of attack. First, we could distinguish between the two components of the IDENT relation (see Pater 1995 and the discussion in §5.1 below), essentially between *⟨+F → -F⟩ and *⟨-F → +F⟩, or in privative terms, between *⟨F → ∅⟩ and *⟨∅ → F⟩.⁴⁹ In the truly coalescent map ⟨*k*, ʔ → *k*'⟩, oral place is preserved on the one hand (*k* → *k*') and inserted on the other (ʔ → *k*'), violating only *∅→PLACE. By contrast, the pseudo-coalescent map ⟨*k*, ʔ → ʔ⟩ actually *eliminates* an oral place specification, violating *PLACE→∅. Thus, of IDENT-IO(Place), only the *∅→PLACE component is subordinated in the ranking; the map Place→∅ is still disallowed. Similar considerations apply to IDENT-IO(Laryngeal). In this way, the fundamentally additive character of coalescence may be expressed, under reasonable

⁴⁸ See Gnanadesikan (1995), Lamontagne & Rice (1995), McCarthy (1995), and Pater (1995) for discussion.

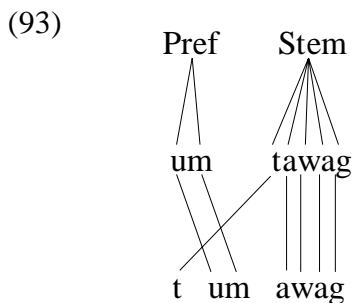
⁴⁹ The privative formulation makes it clear that this analyzes IDENT into MAX- and DEP-like components.

assumptions about privativity of specification.⁵⁰ This does not eliminate deletive pseudo-coalescence entirely; under factorial typology, nothing prevents all components of IDENT-IO from being subordinated, and therefore deletive pseudo-coalescence remains an option. Indeed, Gnanadesikan (1995) and McCarthy (1995) argue that deletive pseudo-coalescence does occur, though they observe it only in the context of systems where authentic coalescence is also found.

A second line of approach emerges from the observation that, in the undesired maps, both violations are *local* to the fate of a single segment, whereas in the truly coalescent situation, each member of the coalescing pair suffers a single separate defect. For instance, in pseudo-coalescent (91), it is the single segment /k/ that receives unfaithful treatment under both IDENT-IO(Place) and IDENT-IO(Laryngeal). In contrast, in authentic coalescence (90), the IDENT violations are dispersed across input /k/ and /ʔ/.

The greater force of locally clustered violations is noted and explored formally in Smolensky (1993, 1995). Under Smolensky's proposal, local conjunction of violations is universally worse than having the same violations simultaneously appearing in distant parts of the structure. From this it would follow that the undesired deletive maps are always less harmonic than authentic coalescence; consequently, they would be eliminated — or rather forced to fall under the theory of deletion, where they belong.

From coalescence we turn to exfixation, a rather different matter but important in the current context, where morphological boundaries are blurred for phonological reasons. The morphological order /PREF+RED+Stem/ is clear from the forms of (88a), but it is still possible for the phonological realization of such structures to differ from what is suggested by the underlying arrangement of morphemes. Infixation, according to Prince & Smolensky (1993) and McCarthy & Prince (1993), shows precisely this divergence: morphologically it is not distinct from ordinary external affixation, but in the output the usual alignment constraints on morphemic contents can be minimally violated, under compulsion of higher-ranked constraints, to displace an affix inward. The following diagram portrays the typical situation:

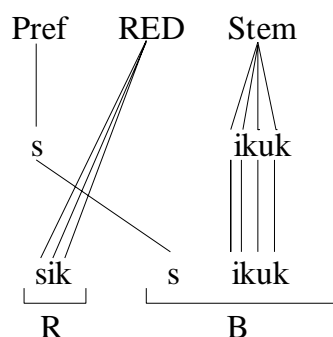


⁵⁰ See de Haas (1988) for an account of vowel coalescence with just this character, set within underspecification theory.

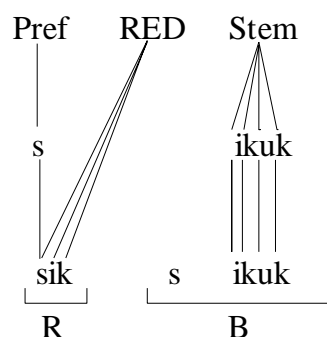
Here Tagalog /um+tawag/ is realized as *tumawag* (cf. Prince & Smolensky 1993).

If alignment can be violated in this fashion, the question immediately arises as to why the pattern we have been investigating doesn't fall under a similar rubric: maintain the motivated morphological relations, but let the output realization reflect a minimal disordering, compelled by considerations of phonology and reduplicative identity. This effect might be called *exfixation* — the placement of morpheme contents *outside* the domain where they are expected. Under this conception, a case like Chumash *sik-sikuk* would be analyzed as in (a) below;⁵¹ diagram (b) repeats the fusional analysis developed above:

(94) a. Exfixation of R

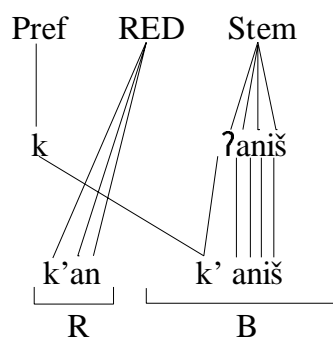


b. Pref/RED Fusion

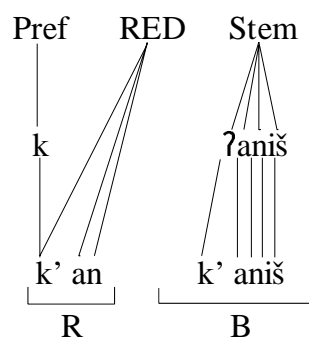


The exfixational analysis (94a) gives *siksikuk* a formal analysis that is very different from the fusional structure (94b). The surface associate of underlying /s-/ '3rd' in (94a) is the *second* occurrence of *s*. The first occurrence is merely an exponent of the reduplicant; there is no morpheme fusion at all. The glottal coalescence cases receive a similar treatment:

(95) a. Exfixation of R



b. Pref/RED Fusion



Under the exfixational conception, the base — the *scope* of R — includes the output associates of both *Pref* and *Stem*.

⁵¹ The analysis of the form *siksikuk* could also be interpreted as simple infixation of /s/, but other examples, like *š-išexš-expeč*, from /s-iš-RED-expeč/, clearly show unambiguous exfixation of R, since R appears amid the morpheme -iš-.

The exfixation analysis is immediately plausible, because it makes use of nothing more than the established notion of minimal displacement from perfect alignment. It also circumvents the issue of R to B information flow: observe that in (94a) and (95a), as in all cases of reduplicative exfixation, the reduplicant merely copies the base in the most unsurprising way. Indeed, exfixation allows the base to be defined so that straightforward reduplicative copy succeeds directly, redeeming the unfulfillable promise of the morphologically-based bracketing-paradox/head-rule idea.

We suspect, however, that exfixation may be simply impossible as an interpretation of input like /PREF+RED+Stem/, and therefore excluded at the level of Gen. In stark contrast to infixation, it appears that exfixation is *never* observed when the morphemes in question are nonreduplicative, with fixed segmentism. Yet, were it available, exfixation would be expected to show up under conditions parallel to those that drive infixation. For example, consider the fate of the hypothetical form /tup+ma+olbog/ in a language where ONSET is undominated. If constraints against insertion and deletion are also ranked above ALIGN(*ma*, R; Root, L), then misalignment will be the optimal mode of resolving the potential hiatus:

(96) Hypothetical Exfixational Morphology

<i>Underlying</i>	<i>Candidates</i>	<i>Chief Flaws</i>
tup+ma+olbog	☞ tu -ma- p +olbog	*ALIGN
	tup -ma- <u>?</u> olbog	*DEP-IO
	tup -m <u>?</u> - olbog	*MAX-IO
	tup -ma- <u>?</u> lbog	*MAX-IO

Normal infixation, as in *tup-omalbog*, is also a possibility, but exfixation can be guaranteed if CONTIGUITY(Root) dominates CONTIGUITY(Af). (On the difference between the two senses of CONTIGUITY, see §6.2.)

How, then, can exfixation be eliminated from the realm of the possible? There is little hope that infixes can be banned outright from being placed affix-internally: cf. Tagalog *bumi-bili* ‘buy (impf.)’ from /**um**+RED+bili/, or *pinag-kā-kāsya* ‘be making enough’ from /**in**-pag-RED-kasya/ (Bowen 1969). Rather, it appears that what’s illicit is *upward* displacement of the affix from its expected position. The relevant condition on Gen must therefore compare morphological structure with its expression in phonological structure, banning certain kinds of mismatches. We suggest the following approach, at least as a preliminary to deeper analysis of the problem. Let us distinguish two kinds of *scope* that an affix has, dependent on the level of structure under scrutiny. Define the *M-Scope* of an affixal category to be the morphological category that it c-commands (unambiguously well-defined, given binary branching). Thus, in a morphological constituent structure [A[BC]_D], C is the M-Scope of B, and the M-Scope of A is the category D embracing BC. Define the *P-Scope* of an affix to be that which follows a prefix, or precedes a suffix — its *base*, in the terminology we have been using throughout. The fundamental observation is that P-Scope must respect M-Scope in a certain way.

Since P-Scope is an output notion, we need to take more care with the definition just given: the term “affix” must mean the (output) *associates* of the relevant affixal category, where *associate* is as in (76) above. Writing $\wedge M \wedge$ for the output associates of morphological category M, we can formulate the relevant condition as follows:

(97) M/P Scope Concordance Condition

$$M\text{-Scope}(\beta) \subset M\text{-Scope}(\alpha) \Rightarrow P\text{-Scope}(\wedge\beta\wedge) \subset P\text{-Scope}(\wedge\alpha\wedge)$$

Observe that if $M\text{-Scope}(\beta) \subset M\text{-Scope}(\alpha)$, then α c-commands β , so we’re looking at structure $[\alpha[\beta[\gamma]]]$. The rough sense of the condition is that the scope of an affix can shrink, but cannot expand; so β can descend into γ , as it were, but cannot ascend into α . To see how the condition applies, recall the hypothetical example — /tup+ma+olbog/ → *tu-**ma**-p-olbog. The following table presents the relevant relations:

(98) Failure of Exfixation to Satisfy the Scope Concordance Condition

<i>Morphology</i>		<i>Phonology</i>	
[tup [ma [olbog]]]		*tu-ma-p+olbog	
<i>M-Scope of /tup/</i>	[ma [olbog]]	<i>P-Scope of \wedge/tup/\wedge</i>	olbog
<i>M-Scope of /ma/</i>	[olbog]	<i>P-Scope of \wedge/ma/\wedge</i>	polbog

According to condition (97), because /olbog/ — the M-Scope of /ma/ — is a substructure of /ma+olbog/ — the M-Scope of /tup/ , we must have $P\text{-Scope}(\wedge/m\wedge) \subset P\text{-Scope}(\wedge/tup\wedge)$. But [polbog] is not a substructure of [olbog], and the realization is not permitted. Contrast this with a legitimate (if equally hypothetical) infixation pattern:

(99) Infixation Satisfies the Scope Concordance Condition

<i>Morphology</i>		<i>Phonology</i>	
[am [tup [olbog]]]		t-am-up+olbog	
<i>M-Scope of /am/</i>	[tup [olbog]]	<i>P-Scope of \wedge/am/\wedge</i>	upolbog
<i>M-Scope of /tup/</i>	[olbog]	<i>P-Scope of \wedge/tup/\wedge</i>	olbog

Here the two scope relations are fully concordant.

Turning now to the Chumash examples, we find that the exfixational analysis is correctly ruled out, while the fusional analysis is permitted. Consider first the exfixation structure:

(100) Chumash Onset-Seizing as Exfixation

<i>Morphology</i>		<i>Phonology</i>	
[<u>s</u> [RED [ikuk]]]		*sik - <u>s</u> -ikuk	
<i>M-Scope of /<u>s</u>/</i>	/RED+ikuk/	<i>P-Scope of \wedge/<u>s</u>/\wedge</i>	ikuk
<i>M-Scope of /RED/</i>	/ikuk/	<i>P-Scope of \wedge/RED/\wedge</i>	sikuk

The scope inclusion patterns are clearly discordant.⁵² The fusional interpretation, however, encounters no difficulties:

(101) Chumash Onset-Seizing as Fusion

<i>Morphology</i>		<i>Phonology</i>	
[<u>s</u> [RED [ikuk]]]		<u>s</u> ik - s+ikuk	
<i>M-Scope of /s/</i>	/RED+ikuk/	<i>P-Scope of ^/s/^</i>	iksikuk
<i>M-Scope of /RED/</i>	/ikuk/	<i>P-Scope of ^/RED/^</i>	sikuk

Glottal-coalescent forms like *k'ank'aniš* show exactly the same patterning of scope inclusions, yielding the same result: exfixation cannot be generated.

Under the right circumstances, empirical evidence can be brought directly to bear on the argument between infixation and exfixation. What's needed is some way to distinguish phonologically between the output form of a morpheme and a mere copy of it. When copying is exact, no such distinction can be made; but inexactitudes can provide grounds for discrimination. Kihehe may well provide such a case. Odden & Odden (1985) examine the following reduplication pattern:

(102) Kihehe Reduplication

a. /haata/	kú-haáta	kú-haata-haáta	'to ferment' / 'to start <i>id.</i> '
b. /ita/	kw-íita	kwíita-kwiíta	'to spill' / 'to pour a bit'
c. /tíitu/	n-íitu	niitu-níitu	'black' / 'blackish'

The elements here are various roots, the prefixes /n-/ and /kú-/ (realized as *kw*-prevocally), and the penultimate H of the infinitive.⁵³ The forms derived from the tonally specified root *tíitu* (102c) clearly show that RED is prefixal: the reduplicant (showing *emergence of the unmarked*) fails to copy the root tones, while the root itself preserves them.⁵⁴

The vowel-initial stem /ita/ raises the usual problems for prefixal reduplication, and they are resolved in the onset-seizing manner. We can therefore set out to determine which occurrence of *kw* in *kwíita-kwiíta* is the direct descendant of /kú/, and which is the mere simulacrum. Exfixation predicts that the second *kw* is the genuine article; fusion points to the first. Observe now that the high tone of /kú-/

⁵² Observe that the Scope Concordance Condition (97), as a limit on admissible *configurations*, will also rule out some cases of infixation: for example, the output structure of *sik-g-ikuk* from /s+RED+ikuk/, as noted above, can be construed processually as either exfixation of the contents of RED, or *infixation* of the contents of /s/. This distinction cannot be made in the configurational terms assumed here. The limitation on infixation must be correct, if the present argument is to be maintained. An immediate prediction would be that *tumawag* would be impossible, if the morphological base of affixation had the analysis /t+awag/.

⁵³ Thanks to David Odden (e.c.) for clarifying the tonal situation. He should not, of course, be held responsible for any deficiencies in our understanding or analysis.

⁵⁴ For discussion of the (non-)copying of tone in reduplication, see Walsh (1992).

shows up on the first syllable of the (prefixed) reduplicant — exactly where it should be, if the first *kw* realizes the morpheme /kú-/ and the second *kw* is the toneless copy.⁵⁵

This brings the argument to a close. To summarize, then: we have examined a set of phenomena involving extension of the reduplicative pattern beyond its expected domain of operation. In the structure /PREF+RED+Stem/, the contents of PREF can be raided for onset material that shows up in both reduplicant and base, either by simply seizing prefixal material or by phonologically-driven coalescence. Such patterns are of deep interest to the theory of phonology-morphology interaction, with relevance to Ordering Theory (Bloomfield 1933, Wilbur 1973a), including Lexical Phonology (Kiparsky 1986), and to the theory of phonological structures (Mester 1986, etc.). We have argued that proper analysis of such structures involves a kind of fusion at the PREF-RED boundary that is transmitted, via the dominance of principles of reduplicative identity, from reduplicant to base. This is a form of reverse copying, completely intractable in standard serial theories, but entirely expected under a system of parallel evaluation of base and reduplicant. Among versions of Ordering Theory, only those based on reduplication-specific structural enrichments are able to cope with the phenomena, if the fusional analysis proposed here is correct. After developing the details of the analysis, we went on to establish the incorrectness of plausible alternatives: first, by arguing that the /PREF+RED+Stem/ structure could not be re-construed as /RED+PREF+Stem/ at the morphological level; then, by arguing that an exfixational realization of RED is impossible on the grounds of principled limitations on Gen. The fusional pattern therefore provides uniquely valuable evidence for the parallelistic approach to evaluation under OT and, concomitantly, strong support for the Correspondence Theory of reduplicative form.

3.9 Summary of Overapplication Argument

We have argued in this section for an account of reduplicative overapplication, set within parallelist Optimality Theory under the Correspondence Theory of faithfulness and identity. Phonological alternations or distributional restrictions require a ranking in which some phonological constraint dominates I-O faithfulness; this

⁵⁵ The argument is not without perils. Odden reports (e.c.) that “virtually all nouns (infinitives are nouns) have H on their prefixes...” If the high tone is independent of the prefix /ku-/ , it could be positioned independently of the segmental form of the prefix, in which case it would not be diagnostic of the location of the authentic prefix versus its copy.

Another dialect of Kihehe recently investigated by Odden (e.c.) poses a different challenge to the fusional theory. In this dialect, the reduplicant is somewhat more reduced, more subject to *emergence of the unmarked*, than in the dialect of Odden & Odden (1985): long vowels are not admitted at all in R, and R is completely toneless. Further, the correct output from /kú-RED-ita/ is the seemingly exfixational *kwita-kwíita*, where the prefix tone shows up on the root, excluding the penultimate infinitival H. One must, however, be equally careful here with the argument that seeks to equate the locus of prefixal H with the locus of prefixal segmentism. It is not unknown for input features to be preserved in reduplicative structures even when they are reduced to oblivion in phonological associates of their input sources (cf. §6 below). The fact that the reduplicant must be entirely toneless may be sufficient to explain the migration of prefixal high tone, without recourse to an exfixational account, which would reduce the tonelessness of R to a confluence of various coincidences. Now that the contrast between exfixation and infixation has emerged as an issue, we can expect further illumination as research on Kihehe advances.

defines the background phonology of the language at hand. When B-R identity constraints are also active, then effects on the base are carried over to the reduplicant. But effects may be carried as well from reduplicant to base, since the form of both is determined in parallel. Indeed, even phonological alternations arising from the interaction of base and reduplicant may be duplicated, because of parallel evaluation. All three types of overapplication — base to reduplicant, reduplicant to base, and interactional — have been exemplified in this section. Moreover, we have shown that all types of alternations may be observed to behave in this way — segmental and featural, morphophonemic and allophonic.

Serial approaches are strikingly less successful in dealing with the diversity of overapplication effects. Indeed, the best serial theory departs markedly from standard assumptions, requiring the option of persistent re-application of rules, in order to assure output B-R identity in the face of B-R interaction effects. But it evidently presupposes a characterization of “identity” which, in all likelihood, merely recapitulates the very Correspondence Theory it is meant to replace. With this, because of its serialism, it suffers from grave problems of ill-definition arising from the existence of nonconvergent (oscillatory) derivations. Further, cases in which the base itself is shaped so as to match the reduplicant are absolute impediments to any serial theory which sees the copying operation as the basis of reduplicative identity. In Correspondence Theory, though, the same constraints responsible for copying are also responsible for overapplication. Therefore, with full symmetry, given parallelism, the base can copy the reduplicant and phonological effects conditioned jointly by reduplicant and base can be observed in both.

The book is not closed, of course. In the many-celled multidimensional matrix of predicted possibilities, many cells are empty or incomplete. A meticulous and final argument would match every case of full reduplication with one or more of partial reduplication that has the exactly same properties; every case of overapplication with a case of normal application that assumes the same background phonology and template type. Many contrasts between the effects of different types of phonology need to be examined, as well. In particular, broader cross-linguistic study is needed to establish more securely some of the typological results that emerge under permutation of the identity constraints with the variety of phonological constraints that drive alternations.⁵⁶ Consider, for example, the constraint responsible for nasal place assimilation. Is it possible to have R-to-B overapplication yielding a hypothetical relation like /RED+panit/ → *pam-pamit*? Cases of this specific type have not been observed, yet it is not clear how (or whether) they are to be distinguished from true R-to-B interaction in Malay (§3.6), Axininca Campa (§3.7), Chumash (§3.8) or Klamath (§5.2). Indeed, one might ask whether there can be B-to-R overapplication of the same process, exemplified by /RED+an+bit/ → *am-ambit*. Again, our survey (see Appendix B) contains no such cases, which are nonetheless predicted to exist under all theories of overapplication, serial and parallel alike. It could be that structural factors, here having to do with the formal properties of assimilated nasal

⁵⁶ We are indebted to Donca Steriade for remarks on this point.

stop clusters, offer a principled explanation for this sort of gap in R-to-B over-application. It could be that there is no real gap, merely ignorance. It could be that there are indeed real gaps like this, as yet unpredicted by Correspondence Theory, due to principles of R/B asymmetry that have not yet been uncovered. Further empirical and formal investigation will undoubtedly sharpen the questions, and even provide answers.

4. Factorial Typology

In Optimality Theory, a grammar of a language is a particular ranking of the constraints supplied by Universal Grammar. Permutation is therefore a crucial test of any proposed sub-theory of constraints: are all of the rankings of the constraints attested grammars, or at least possible ones? The permuted rankings constitute a **factorial typology** (Prince & Smolensky 1991, 1993: Chapt. 6).

In the Basic Model, there are faithfulness constraints on two distinct dimensions of correspondence, expressed diagrammatically as follows:

(103) Basic Model

$$\begin{array}{lcl}
 \text{Input:} & /Af_{\text{RED}} + \text{Stem}/ & \\
 & \updownarrow I\text{-O Faithfulness} & \\
 \text{Output:} & R \rightleftharpoons B & \\
 & B\text{-R Identity} &
 \end{array}$$

Our goal in this section is to explore the factorial typology of B-R identity and I-O faithfulness relative to some phonological constraint, which we will perspicuously dub “Phono-Constraint”. After we survey underapplication in §5, we go on in §6 to examine the (surprisingly mild) expansion of the typology that is introduced by the further correspondence relation between the stem and R in the Full Model (4).

Before we plunge in, we note that arguing exactly and abstractly about general properties of rankings is not a trivial enterprise. Determining whether a dominated constraint \mathbb{C} is active in a grammar may require knowledge of every candidate set it must face; and therefore fairly precise knowledge of Gen, and solid understanding of how other constraints, potentially higher-ranked, can winnow the candidate sets that the constraint \mathbb{C} actually sees in its position in the hierarchy. Our goal here is to provide a useful guide to the factorial typology of the Basic Model, and to do this we will cut various corners, rendering the discussion formally incomplete, but still, we believe, essentially accurate. Thus, when we say that a certain constraint is *inactive*, it may be possible to construct a (linguistically pathological) situation in which some activity is nonetheless squeezed out of it; and conversely, when we assert it to be active, it might be possible to construct an intricate hierarchy that hides it. The reader should think of our remarks as being indexed not against all logically possible conceptions of Gen and the universal constraint set Con, but as being aimed at a kind

of *generic* situation in which Gen and Con have the kind of properties that we see them to have in familiar linguistic analyses. Nailing down the precise meaning of “generic” is an important enterprise; but gaining a general grasp of the predictions of the model dominates it in the near term, and we sacrifice exactitude to pragmatism.

4.1 Non-Application

For Phono-Constraint to be active in the language as a whole, it must dominate *some* relevant constraint on I-O faithfulness, in the generic situation.⁵⁷ For instance, in Madurese nasal harmony (§3.2), the phonological constraints $*V_{nas}$ and $*NV_{oral}$ are active because they dominate the faithfulness constraint IDENT-IO(nas); this allows nasality values to switch between input and output forms. Contrariwise, if *all* relevant I-O faithfulness constraints crucially dominate Phono-Constraint, then nothing can be done (in the generic situation) to enforce Phono-Constraint and it will not be active in the input-output mapping.

Things are similar on the reduplicative front. Dominance of some B-R identity constraint by a sufficiently high-ranked *Phono-Constraint* impinges on the exactness of copying; the reduplicant will respect Phono-Constraint whether or not the stem does.⁵⁸ But if Phono-Constraint is subordinated to all relevant constraints on B-R identity, then it can have no effect on the copying relation. This means that Phono-Constraint is not active in the reduplicant. When Phono-Constraint is subordinated to all relevant B-R identity constraints *and* all relevant I-O faithfulness constraints, then it’s completely out of action. This gives us the ranking in (104):

(104) Skeletal Ranking for Non-Application⁵⁹

B-R Identity, I-O Faithfulness \gg Phono-Constraint

In its dominated position, Phono-Constraint cannot demand either unfaithfulness or non-identity; it is inert.⁶⁰ We’ve run up against — or run past — plenty of examples

⁵⁷ Why the qualification? Imagine the simplest possible Gen, $\{a\}^*$. Suppose Con contains just two constraints: MAX, demanding that input segments be preserved, and the Phono-Constraint $*a$. If we have $*a \gg$ MAX, we generate the empty language. Now suppose $MAX \gg *a$. From input $/a/$, let’s consider the candidate outputs *empty string*, *a*, *aa*. The empty string is ruled out by MAX, but *aa* is ruled out by Phono-Constraint (which it violates more than *a* does). So Phono-Constraint is in fact active even though every faithfulness constraint dominates it. This situation is non-generic because the model lacks DEP, which would rule out *aa* on grounds of faithfulness, thereby rendering $*a$ inactive.

⁵⁸ The qualification “sufficiently high-ranked” is meant to exclude the possibility that another phonological constraint dominating Phono-Constraint blocks it. For example, in the nasalization phenomena discussed in §3, $*V_{nas} \gg$ IDENT-IO(nas), but this does not mean that $*V_{nas}$ always gets its way; $*NV_{oral}$ has the final say. This kind of easily-supplied qualification will generally be left tacit in the following discussion.

⁵⁹ Observe that in this scheme, the terms “I-O Faithfulness” and “B-R Identity” are used to refer to *every* relevant constraint of that type. On other occasions, we use the very same terms to mean *some* relevant constraint. The distinction should be clear from context.

⁶⁰ We assume that “feature-changing” mappings are at issue. Some constraints can be active without faithfulness violation, so long as Gen supplies equally faithful alternatives: ONSET for example, distinguishes V.CV from VC.V, no matter where it is ranked (Prince & Smolensky 1993: 86.)

of this ranking, though we've not paid them much attention. For example, the constraint *NV_{oral} is thoroughly dominated in, say, Chumash, so that it has no effects on either base or reduplicant; or on anything else. Such rankings support the distinction between the universal *availability* of constraints and the universal *activity* of constraints. This ranking arrangement is one of the ways in which the activity of any constraint of Universal Grammar is controlled by its systematic relation to other constraints; in the limiting case, its activity can be entirely suppressed.

4.2 Emergence of the Unmarked

More interesting in its effects is the ranking where B-R identity stands at the bottom of the hierarchy, subordinated to Phono-Constraint:

- (105) Skeletal Ranking for Emergence of the Unmarked
 I-O Faithfulness \gg Phono-Constraint \gg B-R Identity

Because I-O faithfulness dominates Phono-Constraint, the effects of Phono-Constraint are typically not visible in the language as a whole. Phono-Constraint cannot compel inexact correspondence between stem and base, the relation indicated by the vertical arrows in the portrait of the Basic Model in (103). This amounts to “no application,” in general. Phono-constraint can, however, affect the perfection of correspondence in the horizontal, R-B dimension of (103). This means that the reduplicant will obey Phono-Constraint even when obedience means inexactness of copying. The reduplicant obeys a constraint that is otherwise violated freely in the language as a whole — one that may even be violated in the base of reduplication.

This state of affairs is a type of **emergence of the unmarked**; it is studied in McCarthy & Prince (1994a), where the ranking schema (105) is presented.⁶¹ The idea is that the phonologically unmarked structure — unmarked because it obeys Phono-Constraint — emerges in reduplicated forms, though it is not required in the language as a whole. This type of behavior supports the OT conception of constraints as ranked, rather than parametrized (Prince & Smolensky 1991, 1993): parametrization of Phono-Constraint would be an all-or-nothing matter and could never produce emergence of the unmarked.

A real-life example comes from Balangao, cited in §2.3, exs. (15, 16). The Balangao reduplicant copies the first two syllables of the base, minus the final coda. This, we argued, is a consequence of the ranking MAX-IO \gg NO-CODA \gg MAX-BR, recalled here by the following tableau:

⁶¹ See also see Shaw (1995) for further discussion.

(106) Emergence of the Unmarked in Balangao

/RED–tagtag/	MAX-IO	NO-CODA	MAX-BR
a. tagta–tagta	* !	**	
b. tagtag–tagtag		**** !	
c. $\text{[ɔ̃]} tagta–tagtag$		***	*

But this ranking is just a special case of schema (105) — emergence of the unmarked.

(107)

Schema: I-O Faithfulness \gg Phono-Constraint \gg B-R Identity
Instantiation: MAX-IO \gg NO-CODA \gg MAX-BR

The coda-sparing but inexact reduplicant (c) is optimal, even though the language as a whole allows codas. Indeed, the *base* in the very same form has a coda (two, even), as does the medial syllable of the reduplicant (where it is protected by CONTIG-BR — see Appendix A). The situation can be diagrammed as in (108) below:

(108) Input: /Af_{RED} + tagtag/
 \updownarrow *exact faithfulness*
 Output: tagta \rightleftharpoons tagtag
inexact identity

Here we see exactness of correspondence in the vertical dimension, because the input form of the base is identical to its output form, but inexactness in the horizontal dimension, because the base and reduplicant are distinct.

In comparison, B-R identity is respected in forms (a) and (b). But form (a) *tagta-tagta* fatally sacrifices input material (*MAX-IO) to gain codaic advantage, while form (b) *tagtag-tagtag* has a final coda in the reduplicant (*NO-CODA) that can be avoided at the mere price of incomplete copying.

Another example of emergence of the unmarked, this time with somewhat richer articulation, comes from Akan reduplication (Christaller 1875 [1964], Schachter & Fromkin 1968, Welmers 1946). (Further discussion of Akan can be found in §5.1.) In Akan, the reduplicant is a CV prefix. The vowel of the reduplicant is always high, but it agrees with the root vowel in [ATR], [back], and (usually) [nasal]:


(109) Reduplication in Akan (Schachter & Fromkin 1968: 156f.)⁶²

si-si?	‘stand’	bu-bu(?)	‘bend’
fi-fi?	‘vomit’	sʊ-sʊ(?)	‘carry on the head’
si-se?	‘say’	su-so?	‘seize’
sɪ-sɛ?	‘resemble’	sʊ-sɔ?	‘light’
tɔɣi-tɔɣə?	‘cut’		
sɪ-sa?	‘cure’		

A fairly standard analysis goes something like this: the template of the reduplicative prefix is *pre-specified* with the feature [+high], so it copies all properties of the base vowel except for the height specification (Marantz 1982, Lieber 1987). This pre-specificational analysis, though, fails to explain why the copied vowels are attracted to an unmarked feature value, [+high]. Why don't they become mid, for instance? Indeed, under radical underspecification (v. Archangeli 1988), it would only be possible to pre-specify *marked* feature values, quite the opposite of the factual situation.

As a case of emergence of the unmarked, though, this example is straightforward. One constraint of Universal Grammar is *[-HIGH], which asserts the markedness of non-high vowels. This constraint is richly violated in Akan, proving that I-O faithfulness is dominant: IDENT-IO(high) ≫ *[-HIGH]. But the reduplicant obeys *[-HIGH], showing that B-R identity is low-ranking: *[-HIGH] ≫ IDENT-BR(high). The relevant candidates are compared in the following tableau:

(110) Emergence of the Unmarked in Akan

/RED-so?/	IDENT-IO(high)	*[-HIGH]	IDENT-BR(high)
a. su-su?	* !		
b. so-so?		** !	
c.  su-so?		*	*

The following diagram shows how I-O faithfulness is maintained, though B-R identity yields to the constraint *[-HIGH]:

(111) Input:	/A _f _{RED} + so?/
	↑↓ <i>exact faithfulness</i>
Output:	su ⇔ so?
	<i>inexact identity</i>

⁶² Final (?) denotes a glottal stop whose presence varies dialectally. Schachter and Fromkin characterize Akan *a* as [-back].

Other candidates fail ignominiously. In particular, the fully faithful and exact (b) has two non-high vowels when one could be spared at no cost to the top-ranked faithfulness constraint.

4.3 Overapplication and Normal Application

In the rankings discussed thus far, Phono-Constraint is dominated by I-O faithfulness, so Phono-Constraint is either inactive generally or active only in determining the form of the reduplicant. With the opposite ranking, though, Phono-Constraint is able to compel unfaithful analysis of the input — i.e., language-wide phonology — with potential consequences for B-R identity. These were explored in §3, and we will not rehearse the full details here. It will be useful, though, to contrast overapplication with normal application, which has not figured prominently in the discussion so far.

One particularly interesting overapplicational pattern involves phonology whose primary target is the *reduplicant*, but whose effects are carried over to the *base*, in satisfaction of B-R identity. These are the “B copies R” cases of §3.4, §3.6, §3.7, and §3.8; Klamath root reduplication and Southern Paiute are two more (§5.3). In these cases, because the stem-base relation takes the reduplicative hit, B-R identity is satisfied at the expense of I-O faithfulness. The ranking is that in (112):

- (112) Overapplication in *B*, When *R* is Target of *Phono-Constraint*
 Phono-Constraint, B-R Identity \gg I-O faithfulness

Suppose now that the relationship of B-R identity and I-O faithfulness is inverted.

- (113) Normal Application in *B*, When *R* is Target of *Phono-Constraint*
 Phono-Constraint \gg I-O Faithfulness \gg B-R Identity

Under (113), the base cannot be unfaithful to the input merely to take on Phono-Constraint-motivated phonology from the reduplicant. This is a type of normal application: base and reduplicant go their separate ways phonologically, without regard to the B-R linkage between them.

Concrete examples of both ranking schemes come from Austronesian nasal substitution. In (114a), we have data from Balangao (Shetler 1976), in which nasal substitution applies normally, with indifference to reduplicative structure. In (114b), Bloomfield’s Tagalog example is recalled from §1. Nasal substitution overapplies, with its effects transmitted from reduplicant to base, as in §3.8:

(114) Contrast in Application of Austronesian Nasal Substitution

a. *Normal Application in Balangao*


/maN+tagtag/	ma- nagtag	‘running’
/maN+RED+tagtag/	ma- nagta-tagtag ⁶³	‘running everywhere’

b. *Overapplication in Tagalog*

/paN+putul/	pa- mu:tul
/paN+RED+putul/	pa- mu-mu:tul

In both cases, the reduplicant has the *N*+voiceless stop configuration that is the target of the responsible Phono-Constraint. The difference between the two lies in whether or not B-R identity is supported by duplicating the derived nasal in the base. In Balangao, with the ranking (113), faithfulness takes precedence over identity, so the base is not affected by changes in the reduplicant. But in Tagalog, with the ranking (112), B-R identity can compel unfaithfulness, transmitting changes in the reduplicant back to the base, à la §3.8. The results are demonstrated in the next couple of tableaux:

(115) Normal Application in Balangao Nasal Substitution⁶⁴

/maN-RED-tagtag/	Phono-Constraint	I-O Faithfulness	B-R Identity
a. man-tagta-tagtag	* !		
b. ma-nagta-nagtag		* !	
c.  ma-nagta-tagtag			*

The comparison between (115b) and (115c) is the interesting one. In (115b), the base has *n* for underlying /t/, violating the faithfulness constraint IDENT-IO(-nas), as in Pater (1995). In (115c), though, only the reduplicant has the *n*, and the reduplicant has no care for faithfulness.⁶⁵ This is one type of normal application, in which a phonological process, visibly active in the language as a whole, also applies to the reduplicant, leading to a B-R mismatch.

⁶³ The actual example in Shetler (1976) is *ma-nagta-tagta-tagtag*, with double reduplication. This form presents a further question: why not *ma-nagta-nagta-tagtag*? The matter is resolved by I-R correspondence, discussed in §6.

⁶⁴ The same type of analysis can be given for cases like the following, in which laryngeal neutralization in the reduplicant is not carried over to the base:

Madurese	/RED-orok ^h -a/	rɔk-ɔrɔk ^h -ʏ	‘will increase’	(Stevens 1968, 1985)
Chumash	/k-RED-ic’is/	kic-kic’is	‘my sisters’	(Applegate 1976)

On the analysis of laryngeal neutralization within Optimality Theory, see Lombardi (1995).

⁶⁵ The introduction of I-R correspondence in §6 does not change the treatment of these examples, because the I-R faithfulness constraints are low-ranking

(116) Overapplication in Tagalog Nasal Substitution

/paN-RED-pu:tul/	Phono-Constraint	B-R Identity	I-O Faithfulness
a. pam-pu-pu:tul	* !		
b. pa-mu-mu:tul			*
c. pa-mu-pu:tul		* !	

Here, the interesting comparison is between forms (116b) and (116c). Form (116b) pays the price of unfaithfulness to the input, because the output form of the base is different from the input. It does so to achieve a good base-reduplicant match.

The contrast between Balangao and Tagalog shows how the ranking of B-R identity relative to I-O faithfulness effectively distinguishes between normal application and overapplication, when the primary target of Phono-Constraint is the *reduplicant*. But when the primary target of Phono-Constraint is the *base*, the ranking of B-R identity relative to I-O faithfulness is of no consequence, because modifications of the reduplicant are not reckoned as I-O violations. Thus, under either ranking, B-to-R overapplication is compelled. With I-O faithfulness \gg B-R identity, as in (113), there is in effect an asymmetry in information flow, from base to reduplicant, but not vice-versa. Thus, in one language the very same process can affect the reduplicant without changing the base, but it can affect the base with overapplication in the reduplicant.

A concrete instance of this behavior comes from an otherwise unexplained phenomenon of Indonesian (Uhrbach 1987, Cohn & McCarthy 1994). In reduplicated forms, the nasal-substitution-triggering prefix /mƏN/ can either precede the reduplicative conjuncts (a) or it can fall between the two conjuncts (b), with a difference in meaning. Overapplication is observed only when /mƏN/ is preposed:

(117) Overapplication and Normal Application in Indonesian

a. *Preposed Prefix. /mƏN-B-R/ — Overapplication*

pototɔŋ	mƏmototɔŋ-mototɔŋ	‘cut (intens., repet.)’
tulis	mƏnulis-nulis	‘write (intens., repet.)’

b. *Interposed Prefix. /B-mƏN-R/ — Normal Application*

pukul	pukul-mƏmukul	‘hit (recip.)’
tari	tari-mƏnari	‘dance (recip.)’

Since reduplication is total, we have no direct evidence for which conjunct is B and which is R. Suppose, though, that the morphological analysis is the one given in (117): reduplication is postpositive, and /mƏN/ attaches to either B or R. From this assumption, coupled with a low rank for B-R identity, the observed pattern of overapplication and normal application is obtained immediately.

When /mən/ attaches to B, the effects of nasal substitution in B are necessarily transmitted to R:

(118) Overapplication in Indonesian Nasal Substitution (*mən*-B-R)

/mən-tulis-RED/	Phono-Constraint	I-O Faithfulness	B-R Identity
a. mən- tulis _B - tulis _R	* !		
b. ✎ mə- nulis _B - nulis _R		*	
c. mə- nulis _B -tulis _R		*	* !

Overapplication results from a phonological constraint that principally targets the base, even though B-R identity is low-ranking.

But when the phonological constraint principally targets the reduplicant, the low rank of B-R identity ensures that its effects will **not** be transmitted to the base, where they would have consequences for I-O faithfulness:

(119) Normal Application in Indonesian Nasal Substitution (B-*mən*-R)

/tari-mən-RED/	Phono-Constraint	I-O Faithfulness	B-R Identity
a. tari _B - mən- tari _R	* !		
b. nari _B - mə- nari _R		* !	
c. ✎ tari _B - mə- nari _R			*

These results show that asymmetry of information flow is possible, given appropriate constraint ranking. Specifically, low-ranking B-R identity can be decisive when the reduplicant copies a phonological alternation in the base, but not when the situation is reversed.

The discussion of Indonesian also brings out another point about language typology: the normal application option is *not always available* through ranking permutation. This is emphatically the case with the Madurese epenthetic glide, as we argued in §3.2 (see (24)), given that no segment admissible in the language is barred from the reduplicant. Because the copied glide satisfies the same constraint that motivates epenthesis in the base (i.e., ONSET), there is no permutation of I-O faithfulness and B-R identity that will bar copying of the glide.

Less obviously, perhaps, the tableau (118) shows that normal application simply cannot be obtained in the Basic Model when the primary focus of the phonological alternation is the base and the reduplicant is called on to copy it, even with low-ranking B-R identity. This point was also made previously, in the analysis

of Javanese *h*-deletion under the assumption that the reduplicant is prepositive (see (38) in §3.4). There, we observed that the “normal” result $*b\partial dah_R - b\partial da_{\underline{=}}-e_B$ posits an *h* in the reduplicant that has no justification in the output base. This is an impossibility in the Basic Model, because with only I-O and B-R correspondence, the reduplicant can never be more faithful to the input than the base is. Yet some phenomena of this type are actually observed; below in §6 we show how the Full Model (4), with I-R faithfulness, predicts such cases. This expands the range of conditions where normal application is possible, since I-R faithfulness \gg B-R identity favors the more I-R faithful reduplicant (e.g., $b\partial dah_R$) over the exact copy.

Permuting the ranking of identity *vis-a-vis* faithfulness is not the only way to obtain normal application in the Basic Model. As we observed in §3.3 (see (34)), the ranking of B-R identity relative to constraints on segmental markedness or distribution can determine whether overapplication ensues or not. If the hierarchy for Madurese nasal harmony is permuted so that $*V_{NAS} \gg$ IDENT-BR(nas), the phonologically unmotivated nasalized vocoids in the reduplicant are no longer permitted, so base and reduplicant each show their locally-expected phonology: $*yat-n\tilde{e}\tilde{y}\tilde{a}t$. This effect is somewhat similar to emergence of the unmarked; the difference is that in emergence of the unmarked, a structurally marked situation that exists in the language at large (e.g. codaic syllables in Balangao, mid vowels in Akan), due to the dominance of I-O faithfulness, is eliminated from the reduplicant, due to the subordination of B-R identity. In the case at hand, I-O faithfulness and B-R identity are both subordinated, so that structural unmarkedness prevails everywhere. In “normal”-ized pseudo-Madurese, with $*V_{NAS} \gg$ IDENT-BR(nas), there would be no nasal vowels at all that do not occur post-nasally. This is normal application, in that the phonological behavior of the reduplicant is nothing more or less than that found everywhere else.

Examples of this type are not hard to come by. Flapping in Tagalog (Carrier 1979) works this way. There is an allophonic alternation between *d* and *r* in Tagalog, the latter occurring intervocalically, as in English.⁶⁶ According to the general schema for allophony examined in §3.3, the universal contextual constraint against intervocalic *d* (with the effect $*VdV$, though surely framed in more fundamental terms) interacts with a universal context-free constraint against the flap ($*r$). (The anti-flap constraint presumably dominates context-free $*d$ universally, as well; we will not attend to this detail.) The constraints are ranked as follows:

⁶⁶ The process is nonetheless lexically conditioned. See Carrier (1979: 153f.).

(120) *VdV >> *r, in Tagalog

	/ma-Dāmōt/ ‘stingy’	*VdV	*r
a.	maṛāmōt		*
b.	madāmōt	*!	

Contrast the non-intervocalic situation:

(121)

	/Dāmōt/ ‘stinginess’	*VdV	*r
a.	rāmōt		*
b.	dāmōt		

As usual in allophonic alternations, the I-O faithfulness constraint (call it IDENT-IO(flapp)) stands at the bottom of the hierarchy, where its demands are irrelevant to the outcome. Thus, the character of the input does not matter — /d/, /r/, or /D/ all lead to the same result. (See §3.3 for discussion.)

Flapping is observed to apply normally in all reduplicative environments (Carrier 1979: 149f.). Tagalog has several types of reduplication, all of which are prefixing, and the flapped element can be located in either R or B:

(122) Normal Application of Flapping in Tagalog⁶⁷a. *Stop in R, Flap in B*

d -um-ā-ratiŋ	‘was arriving’
man- d ā-ramboŋ	‘bandit’
sunu d -sunuŋ-in	no gloss

b. *Flap in R, Stop in B*

ka-ringat- d ingat	‘suddenly’
ka-ragat- d agat	‘worthy’

c. *Stop in R1, Flap in R2, Stop in B*


d -um-ā-ratiŋ- d atiŋ	‘attends now and then’
-------------------------------------	------------------------

These observations show that B-R identity has no effect on the distribution of *d/r* in Tagalog. In constraint-ranking terms, that means that B-R identity is dominated by

⁶⁷ Many of these examples have variants with *d* instead of the flap. This variation is lexically determined, and unrelated to reduplicated status. See the previous note and Carrier (1979: 152)

all the constraints responsible for the distribution of *d* and *r*, that is $*VdV$ and $*r$. The result is normal application:⁶⁸

(123) Normal Application in Tagalog Flapping

	/RED–sunuD–in/	$*VdV$	$*r$	IDENT-BR(flapp)
a.	sunud–sunud–in	$* \downarrow$		
c.	sunur –sunur –in		$** \downarrow$	
b.	 sunud–sunur–in		$*$	$*$

This example shows that I-O faithfulness can be irrelevant in deciding normal application; when either way of satisfying B-R identity runs afoul of phonological requirements, then low-ranking B-R identity must suffer.

4.4 Summary

We have explored the consequences of permuted ranking for the Basic Model (103). When some phonological constraint is bottom-ranked, so it is superseded by both faithfulness and identity requirements, it is inactive under all relevant conditions, under generic circumstances. It may also stand between faithfulness and identity in the ranking, so its effects are felt only in the reduplicant, though not in the ordinary phonology of the language. This is emergence of the unmarked (McCarthy & Prince 1994a).

When the phonological constraint crucially dominates an appropriate faithfulness requirement, it is active in the language as a whole. Overapplication or normal application will ensue, depending on details of the ranking, the target of the constraint (base or reduplicant), and interaction with other constraints. Strikingly, underapplication is not a typological category of the Basic Model. This prediction is studied in §5. We then turn in §6 to the somewhat richer architecture of the Full Model.

⁶⁸ The same type of analysis can be given for root-final fricative voicing alternations in Dakota (Shaw 1976 [1980]: 55f.). Root-final fricatives are voiced before “stem formative *a*”; otherwise they are voiceless. This leads to non-identity in reduplicated forms:

/pus/z–RED/	pus–puz–a	‘be very dry’
/leš/z–RED/	leš–lež–a	‘urinate frequently’

As in Tagalog, there is no underlying contrast, so I-O faithfulness is irrelevant.

5. Underapplication

We have now seen the full array of ranking permutations of constraints on faithfulness and identity with a single phonological constraint. We have also explored some ranking permutations involving two interacting phonological constraints, as in the allophonic examples. The types of linguistic behavior corresponding to these rankings include overapplication and normal application, as well as non-application and reduplicant-restricted application (“emergence of the unmarked”). Remarkably, none of these is underapplication, a symmetric counterpart of overapplication according to Wilbur and many subsequent theorists.

Underapplication can be characterized as phonologically-unexpected *lack* of disparity between the input stem and the output B,R pair. The phenomenon is commonly thought of as the identity-based blocking of expected phonology. Recall, for instance, the example of Madurese nasal harmony, with forms like *yāt–nēyāt*. In a hypothetical *Madurese*’, the nasal harmony process would underapply to yield *yāt–nēyat*, as noted in §3.3. *Madurese*’ maintains identity of base and reduplicant by failing to apply the nasalization process in either, because conditions for application are met in only one of them. In unreduplicated forms, of course, *Madurese*’ is the same as real *Madurese*, so we’d still have *nēyāt* — postnasal nasalization is active in the language as a whole. In this version of underapplication, the phonological process is suppressed exactly in cases where B-R identity is at stake.

But, as we’ve emphasized throughout, there is no way that the Correspondence Theory developed here can produce the intended blocking configuration yet still permit nasal harmony in the language as a whole. Since nasal harmony is a general process of the language, the familiar ranking Phono-Constraint \gg I-O faithfulness must obtain. And since underapplicational *yāt–nēyat* violates Phono-Constraint, some still higher-ranking constraint must compel violation. The only other constraints ready at hand in the Basic Model are those of B-R identity. But B-R identity is equally well satisfied by *overapplication*, as in real *Madurese*. And since overapplication also satisfies the dominant Phono-Constraint, which underapplicational *yāt–nēyat* violates, underapplication can never be optimal. In short, B-R identity can only limit the candidate set to those forms where R matches B. Within that set, the best form will be chosen on other grounds.

Underapplication, then, can only come from the impact of some additional constraint, not yet considered, that successfully excludes an overapplicational candidate like *yāt–nēyāt*. This additional constraint must have a rather special character: it can rule out overapplication, but it cannot block the effects of Phono-Constraint everywhere. Thus, the constraint will be one that is relevant only to environments like those created by reduplication. In this respect, the lack of symmetry between underapplication and overapplication in Correspondence Theory recalls some of the most significant results in Mester (1986), which also sees overapplication as fundamentally tied to reduplicative structure (see §§1, 3.8), with underapplication as a more specialized response to particular situations.

Ultimately, though, underapplication and overapplication involve essentially the same interactional structure: B-R identity restricts the candidate set, and other considerations make the final decision. Depending on what the other constraints demand, either underapplication or overapplication can result. There is a close parallel to the OT construal of patterns conceived processually as the “blocking” and “triggering” of rules by constraints: in both cases, in OT, the same sort of abstract dominance structure is involved (Prince & Smolensky 1993: Chapt. 3-4), but as Myers (1993: 9) observes:

- a. Constraint \mathbb{C} *triggers* a process (“Do something only if...”):
 \mathbb{C} crucially dominates a faithfulness Constraint.
- b. Constraint \mathbb{C}' *blocks* a process (“Do something except if...”):
 \mathbb{C}' crucially dominates another constraint \mathbb{C} and \mathbb{C} crucially dominates a faithfulness Constraint.

Underapplication falls into pattern (b); in every underapplicational situation, there must be a blocking constraint \mathbb{C}' that is being satisfied along with (some aspect of) B-R identity, blocking the effects of the $\mathbb{C} \gg I-O$ *faithfulness* subhierarchy.

An interesting and perhaps unexpected consequence follows: since over- and underapplication are not designated properties of particular rules, the very same process may underapply in one set of circumstances and overapply in another. Recall the behavior of nasal substitution in Indonesian (§4), which varied circumstantially between overapplication and normal application. We will see exactly this behavior in Chumash *l*-deletion below, as well.

Correspondence Theory offers a very narrow account of underapplication: every case must fit into a tightly-defined pattern of constraint interaction, and the constraints needed to do the work can only be those provided by Universal Grammar. Madurese', for example, is declared to be simply impossible: no phonological constraint exists that can prevent maximization of the nasal span only in reduplicated forms. Let us see now how the logic of Correspondence Theory applies to a variety of central cases.

5.1 Akan and the OCP

Reduplication is about copying, and the Obligatory Contour Principle (OCP) has something to say about nearby segments that are similar or identical. Therefore, we should expect the OCP to impinge occasionally on reduplicative identity. In Akan palatalization (Christaller 1875 [1964], Schachter & Fromkin 1968, Welmers 1946, Wilbur 1973abc), a high-ranking OCP leads to underapplication.

In Akan generally, velars (*k*, *g*, *w*, and *ŋ*ⁿ) and *h* never precede the non-low front vowels *i/I* or *e/ε*; palatal consonants are found instead:

(124) Palatalization in Akan (Schachter & Fromkin 1968: 89)

tɔɛ	*kɛ	‘divide’
dje	*ge	‘receive’
ɟi	*wi	‘nibble’
ɕɪ	*hɪ	‘border’
ɲɟĩn	*ɲwĩn	‘weave’

The morphology of Akan does not provide opportunities where velar/palatal alternations could be examined directly, but this distributional generalization is clear.⁶⁹

As we observed in §4 (see (109)), Akan has a monosyllabic reduplicative prefix with the vowel fixed as [+high] by an emergence-of-the-unmarked ranking. Palatalization is observed to underapply before this vowel (Christaller 1875 [1964]: 5–7; Schachter & Fromkin 1968: 162; Welmers 1946: 10–11):

(125) Underapplication in Akan

kɪ–kaʔ	*tɕɪ–kaʔ	‘bite’
hɪ–hawʔ	*ɕɪ–hawʔ	‘trouble’

The OCP is responsible for this failure of palatalization, a fact that becomes apparent once the details of the process are comprehended.

The analysis begins by settling on some featural matters. We assume that the Akan palatals are coronal-dorsal complex segments (Keating 1987); thus, palatalization involves spreading the feature complex [+coronal, –anterior] from a front vowel to a preceding dorsal (Clements 1976, Hume 1992; cf. Ní Chiosáin 1991, 1994), preserving the consonant’s original [+dorsal] specification. The responsible constraint demands a kind of CV-linkage (Itô & Mester 1993) of the coronal feature. This constraint will be referred to as PAL.

To be visibly active, PAL must dominate some relevant faithfulness constraint. The constraint is IDENT-IO(–cor) — i.e., an input [–cor] segment is also [–cor] in the output. (Differentiation of [+cor] and [–cor] IDENT constraints follows a proposal by

⁶⁹ The lack of velar ~ palatal alternations is presumably what leads Marantz (1982: 461fn.) to make the following statement:

To understand more clearly why not all of Wilbur’s (1973[a]) examples are treated here, consider the case of the underapplication of Palatalization in Akan reduplicated forms. In an earlier version of this article, I claimed that Palatalization underapplied within a reduplicating prefix in Akan because it was a cyclic rule. Reviewing Wilbur’s source on Akan (Schachter and Fromkin (1968)) more carefully in preparation for rewriting the article, I realized that there was no evidence for the rule of Palatalization at all; it was simply a device used to reduce the underlying inventory of phonemes. The state of the art was such in 1968 that one freely exploited rule ordering and lexical exceptions to replace phonemes with rules.

But it is a fact of Akan that the sequence *ki* is **never** observed (except in reduplicated forms and the OCP cases discussed below). Any analysis, of any era, is obliged to capture this generalization, despite the lack of alternations.

Pater 1995.) IDENT-IO(-cor) is violated when input /k/ becomes output $tʃ$, under the compulsion of top-ranked PAL:

(126) PAL \gg IDENT-IO(-cor)

	/kɛ/	PAL	IDENT-IO(-cor)
a.	$tʃɛ$		*
b.	kɛ	*!	

This ranking is necessary to account for the non-existence of surface $*kɛ$ in Akan, regardless of whether the lexicon happens to contain /kɛ/.

PAL is itself dominated, and therefore violated, in situations involving several coronal consonants. According to Welmers (1946: 12):

The normal variant of /k/ occurs when the next consonant is /t, s/ (/g, h, y/ do not occur in this position, but would presumably follow the same rule)... E.g., the normal variants in /kísà/ ‘chew’, /kí’tà/ ‘polish’, /kesí/ ‘big’.

Similar statements are made by Schachter & Fromkin (1968: 89), Christaller (1875 [1964]: 5), Dolphyne (1988: 33), and Boadi (1988: 9).⁷⁰ The core observation is that palatalization is blocked when the next syllable begins with a coronal obstruent: *kita* not $*tʃita$ ‘polish’. The blocking of palatalization is evidently an OCP effect: cooccurrence of coronals in successive syllables is prohibited. We will refer to this constraint as OCP(+cor).⁷¹

Before going on, it is necessary to address some details of OCP(+cor) and its application in Akan. As many of the references in fn. 71 emphasize, the OCP cannot be regarded as a simple prohibition on adjacent identical elements, but rather must have significant internal articulation. In particular, it is necessary to distinguish between non-palatalizing cases like *kita* or *kɛsɪ* and palatalizing ones like reduplicated *ɔzi ɔze* ‘receive’, if derived from /ge/. Compare the candidates, with and without palatalization:

⁷⁰ Boadi (1988: 9) emphasizes that the velars are nonetheless fronted in this environment.

⁷¹ On the OCP and its relation to phenomena of this type, see Leben (1973), Goldsmith (1976), McCarthy (1986a), Myers (1987, 1993), Yip (1988b, 1989), Odden (1988), Hewitt & Prince (1989), Selkirk (1988, 1993), Padgett (1991), Pierrehumbert (1993), and others. One feature of such OCP effects, discussed in particular by Pierrehumbert (see also Selkirk and Padgett), is that greater similarity leads to greater strength (inter- or intra-linguistically) of the constraint. This is seen in Akan too. In the Fanti dialect analyzed by Welmers, the restriction bars $*tʃ...t$ and $*tʃ...s$, all of which are obstruents. In the Asante dialect, according to Christaller (1875 [1964]: 5), the restriction extends to $*tʃ...r$ too, prohibiting a coronal obstruent+sonorant combination. The Fanti situation is analogous to Arabic, where coronal obstruents cannot cooccur with other coronal obstruents, but cooccur freely with coronal sonorants.

Of course, in reduplicative candidates like $*tʃɪ-tʃa$, every property is shared by the segments involved. Thus, similarity is maximal, and there is no dialectal variation in the prohibition.

(127) Palatalization and the OCP

a. *kita* vs. **tʃita*

i. PAL violated

k	i	t	a
	+cor	+cor	
	-ant	+ant	

ii. OCP(+cor) violated

*tʃ	i	t	a
	\ /		
	+cor	+cor	
	-ant	+ant	

b. **gige* vs. *dʒi dʒe*

i. PAL violated

*g	i	g	e
	+cor	+cor	
	-ant	-ant	

ii. OCP(+cor) obeyed (v. *infra*)

dʒ	i	dʒ	e
	\ /	\ /	
	+cor	+cor	
	-ant	-ant	

Forms like (127b.ii) *dʒi dʒe* are perfectly acceptable in Akan, in contrast to (127a.ii) **tʃita*. This difference makes a good deal of sense if we consider the difficulties in speech production that the OCP in part reflects. There is no production problem with a sequence like (127b.ii) *dʒi dʒe*, in which each CV syllable has a single sustained gesture of palatality, which is itself sustained from one syllable to the next. In contrast, **tʃita* has syllabic palatality followed by segmental coronality, a more complex sequencing of similar but crucially different gestures.⁷²

These somewhat loose considerations of ease and difficulty of production can be made more concrete with an explicit assumption about how violation of OCP(+cor) is measured. Suppose that violations are incurred not for simple featural duplication, but for featural duplication in dissimilar constituents. Specifically, the fault of (127a.ii) **tʃita* is that it has syllable-level palatality (which includes [+cor]) followed by a [+cor] segment. Thus, the forms in (127a) differ in assessment by OCP(+cor), which must dominate PAL, in a typical “blocking” configuration (cf. Prince & Smolensky 1993: Ch. 4):

(128) OCP(+cor) ≫ PAL in Akan

	OCP(+cor)	PAL
a. <i>kɛsɪ</i> (= (127a.i))		*
b. <i>tʃɛsɪ</i> (= (127a.ii))	*!	

In contrast, under this same assumption the forms in (127b) are assessed equally by OCP(+cor) — they obey it — so evaluation falls to PAL, which correctly selects *dʒi-dʒe*.

The effect of OCP(+cor) is limited to blocking palatalization; it can never lead to unfaithful analysis of a coronal input. Multiple coronals are in general permitted in

⁷² The production difficulties are, if anything, even greater with **tʃɛsɪ* for *kɛsɪ* ‘big’. In this case, the palatality of the initial syllable is matched against a plain coronal + palatal sequence in the second syllable.

Akan — besides (127a.i) and (127b.ii), witness reduplicated forms like *si-se* ʔ ‘say’. This shows that *de*-coronalization is not an option, proving that IDENT-IO(+cor) dominates OCP(+cor). Thus, the OCP is active only when it can block a change to [+coronal]. Likewise, high-ranking IDENT-IO(+cor) prevents decoronalization of vowels in response to PAL, so /kɛ/ will never be realized as something like *kɔ.

In summary, the ranking required to analyze palatalization in Akan is this:

(129) IDENT-IO(+cor) >> OCP(+cor) >> PAL >> IDENT-IO(-cor)

Palatalization is normal in velar+front vowel sequences, except when it would create an OCP violation. Otherwise, succession of coronal segments is permitted, because decoronalization is not possible.

The tools are now at hand to analyze the underapplication phenomenon. From an input like /RED+ka/, the following candidates need to be considered:

(130) /RED+ka/ Candidates

- | | |
|-----------------------|---------|
| a. Normal Application | tɕɪ-ka |
| b. Overapplication | tɕɪ-tɕa |
| c. Underapplication | kɪ-ka |

Each has its assets and its liabilities. Normal application satisfies PAL, but it does so at the expense of violating the B-R identity constraint IDENT-BR(-cor). Since this candidate is non-optimal, the identity requirement must be high-ranking (indeed, the reduplicant’s consonant is identical to its base correspondent in every respect). Over-application likewise satisfies PAL and has no problems with identity, but it runs afoul of OCP(+cor): *tɕɪ-tɕa* has the same prohibited configuration as (127a.ii) **tɕita* — the clash of syllabic and segmental palatality. This leaves the underapplicational candidate *kɪ-ka*, which satisfies OCP(+cor) at the expense of PAL, an interaction that is fully expected in light of the ranking motivated in (128). The disposition of these various candidates is shown in the following tableau.⁷³

⁷³ The Akan analysis presented here can be integrated with the results of §4.2. There, we argued that the ranking *[-HIGH] >> IDENT-BR(high) is responsible for emergence of the unmarked high vowel in the reduplicant. That ranking can be intersected with the one just given if we consider another failed candidate, **ka-ka*. It has much to recommend it: copying is exact and violation of PAL is not a problem, because there is no mid or high front vowel after a velar. It has achieved this degree of harmony at the expense of violating *[-HIGH] more severely than the actual form *kɪ-ka*. This shows, then, that *[-HIGH] dominates PAL, preferring an unmarked vowel in the reduplicant over perfect distribution of palatalization.

(131) Summary Tableau for Underapplication in Akan

/RED-ka/	OCP(+cor)	IDENT-BR(-cor)	PAL	IDENT-IO(-cor)
a. tɔɪ-tɔa	* ! **			*
b. tɔɪ-ka		* !		
c. ☞ kɪ-ka			*	

As was just noted, top-ranked OCP(+cor) rules out overapplication, seen in (a). This tableau also establishes the necessity for ranking IDENT-BR(-cor) above PAL, to rule out (b), with normal application.

The only surviving candidate is (c). Though we have termed it a product of underapplication, it is now clear that no process underapplies, and indeed no peculiar reduplication-specific interaction is responsible. The optimality of *kɪ-ka* follows from nothing more than the expected interaction between OCP(+cor) and PAL, as observed in Akan generally (see (128)). Akan therefore provides a concrete illustration of one of the consequences of the model developed here. Underapplication, when it occurs, must always involve some high-ranking constraint \mathcal{H} which has the effect of blocking overapplication. B-R identity is also high-ranking, so overapplication would be expected except for the intervention of \mathcal{H} . Together, \mathcal{H} and B-R identity banish the overapplying and normally applying candidates, in favor of the only remaining alternative: underapplication. As noted, this schema presupposes that \mathcal{H} excludes the overapplying candidate without inactivating the process everywhere else as well. This means that the force of \mathcal{H} is limited, at least in part, to the kind of environment provided by reduplicated forms. As Akan proves, the OCP is an excellent candidate for such a constraint.⁷⁴

5.2 Chumash and the Template

Another example of this type involves a templatic constraint which is, by its very nature, specific to the reduplicant, demanding that it conform to a particular prosodic shape. Under the right conditions, a template will be in conflict with the requirements of some phonological process. Chumash (Applegate 1976, McCarthy 1985, Mester 1986: 218f.) works this way.

⁷⁴ Laura Downing has suggested another interpretation of Akan to us: the vowel of the reduplicant is epenthetic, and epenthetic vowels will not trigger palatalization. This phonological inertia of epenthetic vowels would make sense particularly under the assumption that they are empty nodes, as in the FILL model of Prince & Smolensky (1993), following Selkirk (1981), Lowenstamm & Kaye (1985), and Itô (1986, 1989).

This type of analysis encounters two difficulties. First, B-R identity considerations must be invoked anyway to account for forms like *ɔzi-ɔze*, which become, in effect, instances of overapplication. Second, and more seriously, the property of the epenthetic vowel that is responsible for palatalization — its frontness or coronality — is *not epenthetic*. Rather, the front/back quality of the reduplicant's vowel is copied from the base, and only its height is fixed as an "epenthetic" property.

In Chumash, there is a general phonological process deleting *l* before a coronal consonant. (This too is presumably an OCP effect, and connected with the widespread avoidance of *tl* and *dl* sequences.) This fact alone shows the necessity for the ranking $*l[+cor] \gg \text{MAX-IO}$. The process of *l* deletion is observed to overapply from base to reduplicant in forms like the following:

(132) Overapplication of *l* Deletion in Chumash

<i>Input</i>	<i>Candidates</i>	<i>Gloss</i>
/s-RED-pil-tap/	s-pit- pi _{__} -tap	'it is falling in'
	*s-pi- pi _{__} -tap	
	*s-pil- pi _{__} -tap	
	*s-pil- pil-tap	

This earns the name of overapplication by virtue of the unexpected stem-reduplicant disparity: we'd expect *pil-* for R, just looking at the stem. Overapplication here is compelled, as usual, by B-R identity constraints. The form $*s\text{-}pil\text{-}pi\text{-}tap$ shows normal application, contrary to the dictates of DEP-BR, which demands that every segment of the reduplicant have a correspondent in the base (cf. the analogous Javanese example (38c)). On the other hand, MAX-BR rules out $*s\text{-}pi\text{-}pi\text{-}tap$, which has less complete copying. Of course, underapplicative $*s\text{-}pil\text{-}pil\text{-}tap$ is in violation of the responsible phonological constraint, $*l[+cor]$. Only $s\text{-}pit\text{-}pi\text{-}tap$ attains the requisite level of B-R identity, while satisfying the phonology.

Curiously, though, there are also circumstances where *l* deletion is observed to *underapply*. Underapplication occurs when the primary condition for deletion is met in R+B juncture, rather than in the base itself:

(133) Underapplication of *l* Deletion in Chumash


<i>Input</i>	<i>Candidates</i>	<i>Gloss</i>
/s-RED-tal'ik/	š-tal - tal'ik'	'his wives (i.e., of a chief)'
	*š-ta _{__} - ta _{__} ik'	
	*š-ta _{__} - tal'ik'	
/RED-c'aluqay/	c'al - c'aluqay'	'cradles'
	*c'a _{__} - c'a _{__} uqay'	
	*c'a _{__} - c'aluqay'	

B-R identity alone is insufficient to explain why underapplication would result. If it is high-ranking, it will favor forms like $*š\text{-}ta\text{-}ta\text{-}ik'$, with B-to-R overapplication, while if it is low-ranking (below $*l[+cor]$), it will have no effect on the outcome, and we should see normal $*š\text{-}ta\text{-}tal\text{-}ik'$.

The reason for preservation of *l* in the reduplicant, contrary to the dictates of $*l[+cor]$, lies with an undominated templatic requirement of Chumash. Without exception, the surface shape of the reduplicative affix is CVC, a heavy syllable. (This is the only possible type of heavy syllable in the language, which lacks long vowels.)

This consistent finding means that the templatic constraint $R=\sigma_{\mu\mu}$, introduced as (78) in §3.8, must be undominated (see McCarthy & Prince 1993a, 1994b for discussion). It is the template which leads to underapplication by preventing overapplication. The following tableau shows this result:

(134) Summary Tableau for Underapplication in Chumash

/RED-c'aluqay/	$R=\sigma_{\mu\mu}$	MAX-BR	*/[cor]	MAX-IO
a. c'a _u – c'aluqay'	* !	****		*
b. c'a _u – c'aluqay'	* !	***** !		
c.  c'al – c'aluqay'		****	*	

Both the overapplicational candidate (134a) and the normal candidate (134b) fatally violate the undominated templatic constraint $R=\sigma_{\mu\mu}$, leaving only one survivor, the underapplying candidate (134c). As is clear, in this particular case the B-R identity constraint MAX-BR does no crucial work, and its ranking is a matter of complete indifference.⁷⁵

Taken together, the evidence of Chumash and Akan accords with the conclusion derived in §§3-4 from the study of permuted rankings: there is no simple option of underapplication, but rather underapplication is obtained just in case a high-ranking constraint bars the alternatives. In Chumash, the templatic constraint $R=\sigma_{\mu\mu}$ is undominated, and through its position in the hierarchy it rules out the most serious competitor, the overapplicational one. In Akan, the constraint OCP(+cor) likewise excludes the overapplicational candidate, and B-R identity excludes the one with normal application. In both languages, this account of underapplication involves no loss of generality or, indeed, any special stipulations whatsoever, since the constraints involved — the OCP or the template — must be top-ranked in literally *any* analysis, to deal with observations that have nothing to do with underapplication.

In comparison, other approaches to underapplication can stipulate but not explain the facts of Chumash or Akan. The Global Theory, which involves specifying for each rule whether it overapplies, underapplies, or applies normally, is inadequate both descriptively and explanatorily. Descriptively, it fails to account for how one and the same rule in Chumash can overapply in some conditions (132) and underapply in

⁷⁵ There is another likely candidate in Chumash: *c'ah-c'aluqay', with normal application of *l* deletion combined with a template-filling epenthetic *h*. Epenthetic *h* to satisfy the template is required independently in Chumash: “CV(?) stems lacking final consonants are reduplicated with /h/ as final consonant of the initial CVC sequence *ku* – R > *kuhku?* ‘people’ (*ku* ‘person’)” (Applegate 1976: 278). This shows that DEP-BR, which militates against epenthesis into the reduplicant, is crucially dominated in the grammar of Chumash. But the impossibility of *c'ah-c'aluqay', in the face of underapplication, shows that DEP-BR >> */[cor].

Further constraints would also be seen to be active in a more complete analysis. For instance, *c'aq-c'aluqay' shows that CONTIG-BR (see Appendix A) is undominated, as is commonly the case.

others (133). Explanatorily, it cannot relate the conditions of underapplication to other facts of Chumash and Akan that independently motivate the high rank of the template or the OCP. It is an accident under the Global Theory that the alternatives to underapplication involve configurations that are not attested in these languages anyway. Nor can it predict the impossibility of certain underapplicational configurations.

Ordering Theory can deal descriptively with Chumash or Akan (see Applegate 1976, Mester 1986, Schachter & Fromkin 1968), but it has the same failures of explanation when confronted with this material. It cannot relate the templatic requirement or the OCP, which have entirely independent significance in the phonology of these languages, to underapplication. As in Global Theory, it is an accident under Ordering Theory that the result of underapplication conforms so well to these seemingly unrelated phonological requirements of the language.

5.3 Base Copies Reduplicant in Klamath and Southern Paiute

One particular type of underapplication provides an even more striking argument against Ordering Theory and serial approaches in general. Under parallel OT, information can flow from the reduplicant back to the base through B-R identity constraints. This is in contrast to Ordering Theory, which only countenances flow of information from base to reduplicant, through the copying operation. Cases of over-application involving flow of information from B to R were discussed in §3; now we turn to a case of underapplication with the same property.

The Penutian language Klamath (Barker 1964) has a very well studied process of vowel reduction and syncope. The process affects short vowels that are initial in a nonsuffixal morpheme, but not initial in the word; the result is deletion in open syllables and reduction to schwa in closed syllables. We will examine cases involving the reduplicative prefixes *DIST*ributive and *INTENS*ive. The following examples are cited from Clements & Keyser (1983: 143–144):

(135) Reduction & Syncope in Klamath

/hvs+conw+a/	hoscənwa	‘makes vomit’
/DIST+sipc+a/	sisəpca	‘puts out a fire (dist.)’
/sV+lt’oq’+a/	solt _q ’a	‘thumps self with finger & thumb’
/DIST+pag+a/	pap _g a	‘bark (dist.)’

(There’s an evident failure of B-R identity in the examples with distributive reduplication; this is addressed below in §6.1.) We cannot provide a full analysis of Klamath reduction and syncope here, but we can suggest that any analysis in terms of constraint interaction will make a special case of word-initial syllables, which neither reduce nor delete. Let us suppose, then, that there is a constraint that ensures faithful analysis word-initially, and that this constraint dominates the constraint involved in reduction/syncope.

The constraint demanding faithful analysis in the initial syllable plays a crucial role in accounting for a type of underapplication in Klamath. Intensive reduplication prefixes a copy of the whole root, sometimes with vowel length added (Barker 1964: 119f., 189f.). In most cases, the original vowel in the base resists reduction and syncope, even though it is not in an initial syllable:

(136) Klamath Root Reduplication (Clements & Keyser 1983: 149f.):

a.	/INTEN+Wic+l'i/	Wic–Wicl'i	'stiff'
	/INTEN+p'etq'+a/	p'etq–p'etq'a	'blinks'
	/INTEN+c'el'+l'i/	c'el–c'el'i	'shining'
b.	/INTEN+dop+a/	dop–dop'a ~ dop–t_p'a	'boils'
c.	/snV+INTEN+jiq'a/	sni–ji:q– jiq' a	'tickles'
d.	/sw'V+INTEN+ciq'+a/	sw'i–cəq–c_q'a	'shake the head'

The boldface vowels meet all phonological conditions for reduction/syncope, yet they remain intact. In the (136a) forms, they are preserved in support of identity with the prefixed reduplicant, which cannot itself reduce, because it is word-initial. In (136b), we see that there is some unpredictability in this underapplication effect. The form in (136c) evidences a case where the prefixed reduplicant imposes length on the vowel (with additional semantic force); even though the reduplicant is non-initial, long vowels never reduce or delete, so the vowel of the reduplicant remains intact. B-R identity preserves the vowel in the corresponding base as well, though it meets all phonological conditions for reduction/syncope. The final example (136d) shows a case where the reduplicant is not word-initial, as a result of further prefixation. Now both the reduplicant and the base meet the phonological conditions for reduction/syncope, and in this condition both do indeed reduce.⁷⁶

This is clearly a case of underapplication. With B-R identity high-ranking, the vocalism of base and reduplicant must match.⁷⁷ This, then, rules out forms like *Wic–Wəcl'i or *sni–ji:q–j_q'a. One way to satisfy B-R identity is through over-application, yielding *Wəc–Wəcl'i or *sni–jə:q–j_q'a. But then these forms violate undominated requirements of the language: word-initial and long-voweled syllables **never** show syncope or reduction.⁷⁸ The only remaining possibility is under-application, and that is precisely what is observed.

A case similar to Klamath is presented by Southern Paiute (Sapir 1930, McCarthy 1985, Mester 1986: 214f.). The labiovelar nasal η^v occurs only medially,

⁷⁶ In fact, the vowel of the base deletes entirely, so that there is an apparent failure of B-R identity: ə is matched with Ø in the base. Given the complementarity between reduction and syncope, an adequate analysis must comprehend them as closely related realizations of the same basic constraint. Perhaps a fully developed perspective along these lines will eliminate the apparent mismatch in (136d).

⁷⁷ This is clearly not the case with the distributive reduplicant — see §6. As we mentioned earlier (§2.1), there are separate identity constraints for each correspondence relation, and each reduplicative affix has its own correspondence relation.

⁷⁸ Like Clements and Keyser (1983), we abstract away from the general realization of /a/ in an open syllable as ə.

where it has two sources. It can be derived by morphologically-governed lenition of /m/ (Sapir 1930: 62), or it can be derived from /w/, which is realized simply as *w* initially (Sapir 1930: 49). The latter alternation is of particular interest; it is exemplified by forms like the following:

(137) Southern Paiute *w/ɲʷ* Alternations

wa'aŋi	tɪ'–ɲʷa'aŋi	'to shout/to give a good shout'
waix̣a–	nta'vɪ–ɲʷaix̣ap'I	'to have a council/council (of chiefs)'
WA'tci'	cu(w)a'–ɲʷA'tci'ɪ'ya'	'to catch up with/nearly caught up with'

The two-way prohibition — *w* is banned medially⁷⁹ and *ɲʷ* is banned initially — requires two context-sensitive constraints. One, *V_wV, militates against intervocalic glides, driving out unmarked /w/ from intervocalic position. The other is *[ɲʷ, prohibiting initial *ɲʷ* (cf. English and Japanese in §5.4 below). With both constraints in UG independently, issues of parsimony of description or non-redundancy at the language-specific level do not arise. Since both are active, they must dominate the relevant faithfulness constraint, IDENT-IO(nas).

Southern Paiute has CV prefixing reduplication, which will render root-initial *w* intervocalic. Thus, there is the potential for conflict: do we find *w*, *ɲʷ*, or both? When the contexts differ (138a), the *w* alternant is favored, satisfying B-R identity requirements as well as the constraint *[ɲʷ, at the expense of violating *V_wV. This shows, then, that *[ɲʷ >> *V_wV. When the contexts are the same, because further prefixation renders the reduplicant non-initial, B-R identity is still satisfied, *[ɲʷ is irrelevant, and *V_wV is obeyed as well (138b):

(138) Southern Paiute Underapplication

a. Differing Context in R and B

wɪ'ɪ–	wɪ– wɪ'xiA	'vulva/vulvas (obj.)' [underapplication]
	*ɲʷi'– ɲʷ'ɪxiA	[overapplication]
	*wɪ– ɲʷ'ɪxiA	[normal application]
wayi–	wa– wa'x'ɪpi'ya'	'several enter/all entered'
wɪn'nai–	wɪ– wɪ'n'nai–	'to throw/several throw down'
wɪnt–	wɪ– wɪn'nɪ-q'u–	'to stand/to stand (iterative)'

b. Same V–V Context in R and B

wɪnt–	ya– ɲʷ't'–ɲʷ'ɪnṭx̣a'	'to stand/while standing and holding'
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Case (138b) is nothing but a kind of normal application, since there is no relevant difference in the phonological conditions obtaining in base and reduplicant. (Nonetheless, it serves to establish that the reduplicant is not simply exceptional with respect to the process of interest.) But case (138a) proves that the *base* copies the

⁷⁹ Except that “[a]fter a primary *u* (*o*) a *w*, indicated as *w* if weak, often slips in before an immediately following vowel” (Sapir 1930: 57). An example is ‘nearly caught up with’ in (137). We take this variable and evanescent *w* to be a phonetic matter.

reduplicant, since satisfaction of B-R identity is achieved by favoring the alternant that is conditioned in the reduplicant, satisfying high-ranking $*[\eta^w]$. Abstractly, the situation here is the same as in Klamath. Indeed, it is formally similar to the cases of B-to-R *overapplication* discussed in §§3.4-3.8, such as Chumash (§3.8): a high-ranking constraint joins with B-R identity to make the stem look different from what would otherwise be expected; in Southern Paiute and Klamath, the high ranking constraint ends up enforcing stem-base non-disparity (e.g. /w/ → w) rather than change (as in Chumash $\text{ʔ} \rightarrow k'$).

It is important to notice just how rigidly Correspondence Theory prescribes the pattern of interactions leading to underapplication. For the analysis of Southern Paiute to be possible, there must be an actual constraint $*[\eta^w]$ banning initial η^w ; this cannot be a mere interactional consequence following from $*VwV$ and its domination of the context-free constraint banning η^w everywhere. Without $*[\eta^w]$ in the grammar, underapplication cannot be forced: the choice would be between overapplication ($\eta^w \dots \eta^w \dots$) and normal application ($w \dots \eta^w \dots$). Similarly, the reduction/syncope in Klamath must rely on a constraint against word-initial reduction/syncope, which dominates and overrules the more general constraint militating in favor of reduction/syncope. It is specifically the constraint against initial reduction/syncope that, when satisfied with B-R identity, compels underapplication. Without that constraint on word-initial position, we are once again thrown back on the choice between overapplication (reduction in both prefix and stem) and normal application (reduction in stem only). In both Klamath and Southern Paiute, the analytically-required constraints are well-motivated on general grounds—the velar nasal does indeed avoid word- and syllable-initial position cross-linguistically, regardless of other conditions; and word-initial position is known to be especially salient and therefore resistant to reductions and neutralizations (J. Beckman 1995, Selkirk 1995, Steriade 1994). Although further research is required to secure absolutely the premises of the argument, their basic plausibility gives good grounds for confidence in the predictions of Correspondence Theory.

Cases like Klamath and Southern Paiute are especially significant because of the way information flows in the candidates under evaluation. An example like Klamath *sni-ji:q-jiq'a* has a long — therefore unreducible — vowel in the prefixed reduplicant. To maintain identity with the reduplicant, the root vowel cannot reduce either, though it would otherwise be expected to do so. In this case, the *base* copies the *reduplicant*, failing to reduce because the reduplicant cannot reduce. This species of underapplication is fully expected and normal under Correspondence Theory (see §§3.4, 3.6, and 3.8); under serialist base-copying approaches it is impossible.

5.4 Further Underapplicational Interactions

The overall character of the Correspondence Theory approach to underapplication should now be clear. Whenever there is underapplication, some high-ranking constraint must bar the overapplying alternative. To further explore the analytic structure of the theory, we will examine, albeit briefly, two cases that have

received a great deal of attention in the literature (Dakota and Luiseño), and a third (Japanese) that, like Southern Paiute, involves the underapplication of allophonic alternation.

Certainly the best-studied case of underapplication is ablaut in Dakota (Wilbur 1973a, Shaw 1976 [1980], Marantz 1982, Kiparsky 1986, Patterson 1988, Sietsema 1988). Ablaut applies to certain lexically-specified morphemes before other lexically specified morphemes. The following examples are representative:

(139) Dakota ablaut (Shaw 1980: 350f.)

<i>i. Root</i>	<i>ii. Root+Sfx</i>	<i>iii. Root+RED+Sfx</i>	<i>iv. Gloss</i>
ap ^h á	ap ^h é-šni	ap ^h á-p ^h a-šni	‘to strike/he didn’t strike it/he didn’t strike it repeatedly’
háska	háske-?	háska-ska-?	‘to be tall/tall-decl./tall-redup.-decl.’

Column (i) shows that the underlying forms of these roots end in *a*. Column (ii) shows a case where the root-final *a* has ablauted to *e*. The fact of ablaut here proves that the roots /ap^há/ and /háska/ are in the lexical class of ablaut-undergoers and that the suffixes /-šni/ and /-?/ are in the lexical class of ablaut-triggers. Column (iii) is the one of interest: even though the same ablaut-undergoing roots and ablaut-triggering suffixes are involved, the reduplicant fails to undergo ablaut. This is the underapplication pattern of Dakota.⁸⁰

A full analysis depends on details of the treatment of allomorphy in OT that are not settled (but see Mester 1994); nevertheless, it is relatively straightforward to see how a reasonable approach would run. Chumash and Akan show that the important competitor for an underapplicational candidate is an overapplicational one, because both underapplication and overapplication respect B-R identity. This means that the analysis crucially contends with the following candidate-comparison:

- Underapplicational ap^há-p^ha-šni, without ablaut, versus
- Overapplicational *ap^hé-p^he-šni, with double ablaut.

The fatal defect of the overapplicational candidate must be this: it contradicts some aspect of the lexical specification of the reduplicative morpheme RED. Like any morpheme of Dakota, RED must specify whether it is an ablaut-undergoer and whether it is an ablaut-trigger. (These are arbitrary and independent lexical properties.) In *ap^hé-p^he-šni, RED gives the appearance of being **both** undergoer and trigger. Therefore, if RED is lexically specified as **either** a non-undergoer or a non-trigger⁸¹ — certainly a likely circumstance — the overapplicational candidate is doomed.

⁸⁰ Oddly, Dakota has two suffixes which, when they themselves reduplicate, show overapplication of ablaut (Shaw 1976 [1980]: 353f.).

⁸¹ Shaw (1976 [1980]: 351f.) emphasizes that reduplicated words **can** undergo ablaut, but this occurs only when the surface exponence of RED is unaffected. The ablauting vowel is the “stem-former” *a*, as in šap-šap-e-? ‘the dishes are dirty’.

Underapplication, then, is a consequence of satisfying B-R identity while obeying the lexical conditions on RED. This is, in essence, an updating of the analysis of Dakota in Marantz (1982). Since the lexical specifications of triggers and undergoers are arbitrary anyway, and since B-R identity is correctly called on to eliminate candidates with mis-matched ablaut in B and R, this solution entails no loss of generality. Even without a full formal treatment, the point is sufficiently made by these remarks: a RED-specific condition, this time lexical, leads to underapplication. Abstractly, the situation is the same as with the template in Chumash.

Allophonic and near-allophonic alternations also provide opportunities for underapplication, though, as we will see, the term has a particular inappropriateness in this context. The *g/ŋ* alternation in Tokyo Japanese (see Itô & Mester 1990, Vance 1987) is typical. The stop *g* occurs initially, alternating with the nasal *ŋ* medially:

(140) *g/ŋ* Allophony in Tokyo Japanese (Itô & Mester 1990)

geta	‘clogs’	kaŋi	‘key’
giri	‘duty’	oyoŋu	‘to swim’
garasu	‘glass’	oruŋaN	‘organ’
		tomodachi-ŋa	‘friend-NOM’
		isshuukaN-ŋurai	‘one week-ap- proximately’
gai-koku	‘foreign country’	koku-ŋai	‘abroad’
gaku-sei	‘student’	suu-ŋaku	‘mathematics’

Though universal markedness considerations can fully determine the “direction” of allophonic alternation, as we showed in the analysis of Madurese nasal harmony (§3.3), they are not relevant here. UG does not provide a fixed hierarchy, comparable to (26), of the form $*ŋ \gg *g$ or of the form $*g \gg *ŋ$, since neither segment is obviously more marked than the other. Therefore, other considerations must be entertained.

At first blush, the process looks like replacement of medial *g* by *ŋ*, in a kind of lenition, but observe that a preceding vowel (*kaŋi*) or consonant (*isshuukaN-ŋurai*) is sufficient to trigger the process. Usually, lenition would not be expected to yield *ŋ*, nor would this result be expected in both postvocalic and postconsonantal contexts. Furthermore, why does lenition only affect the voiced velar, out of all Japanese stops?

Rejecting a lenition analysis, we claim that the operative constraint here is a requirement that posterior stops (i.e., velars) be voiceless — to be referred to as POSTVCLS. This constraint phonologizes the familiar articulatory effect of Boyle’s Law: it is difficult to maintain voicing when the supraglottal cavity is small (Ohala 1983: 196–197 and *pace* Vance 1987: 111–112); indeed, some nasal airflow is a typical accommodation to this articulatory challenge. The difficulty of maintaining voicing is obviously greatest when the supraglottal cavity is smallest, and POSTVCLS is simply one way to phonologize this phonetic truth. Yet of course Japanese has *g*, indicating that POSTVCLS is crucially dominated by another constraint, one which bans

initial η : $*[\eta]$. As was noted above in the discussion of Southern Paiute, this constraint is also plausible on cross-linguistic grounds; for example, English speakers violate it only with great difficulty (but cf. Vance 1987: 124–125).

These constraints are ranked according to the typical schema for allophonic alternations (see §3.3): $*[\eta] \gg \text{POSTVCLS} \gg \text{IDENT-IO(nas)}$. This ranking asserts that g occurs only where η can't, and the character of inputs (g vs. η vs. underspecified) doesn't matter, so the alternation is allophonic. Of course, additional faithfulness constraints, not considered here, are necessary to limit the alternation to η and g .

In reduplication of mimetic adverbs, g is observed initially in both copies, though η would be expected in the second copy:

(141) g in Reduplicated Mimetics⁸²

gara-gara	'rattle'
geji-geji	'centipede'
gera-gera	'laughing'

When the voiced velar is root-medial, η is found in both copies: *moŋu-moŋu* 'mumbling'. This shows that the mimetic stratum of the vocabulary isn't simply exceptional in this respect (cf. Itô & Mester 1994b).

The traditional terminology is obviously unsuited to describing a case like this; is it overapplication of $\eta \rightarrow g$ or underapplication of $g \rightarrow \eta$? From the perspective of the phonetically-motivated analysis $*[\eta] \gg \text{POSTVCLS} \gg \text{IDENT-IO(nas)}$, we might as well say that $[\eta \rightarrow g]$ has overapplied. What's important, though, is that B-R identity is high-ranking, so it can compel violation of POSTVCLS. The full hierarchy is illustrated by the following tableau:

(142) Summary Tableau for Japanese⁸³

/gara-RED/	$*[\eta]$	IDENT-BR(nas)	POSTVCLS	IDENT-IO(nas)
a. η ara- η ara	* !			*
b. gara- η ara		* !	*	
c. ☞ gara-gara			**	

Form (a) (overapplication, from one perspective) fails the top-ranked constraint against initial η , and form (b) (normal application) fails the other top-ranked constraint, demanding B-R identity. This leaves only a single survivor, form (c), with

⁸² Other reduplicative constructions, possibly unproductive, like *kuni-ŋuni* 'various countries' (with *rendaku* (see fn. 84) and η from g), show normal application.

⁸³ This tableau shows the reduplicant as suffixed. The result is the same if the reduplicant is prefixed.

g in both copies.⁸⁴ As usual in allophonic situations, low-ranking I-O faithfulness is irrelevant to the outcome.

The hierarchy in (142) combines the ranking for allophonic alternation with high-ranking B-R identity. The top-ranked constraint is the distributional requirement $*[ŋ]$, undominated in Japanese. It excludes the candidate with duplicated *ŋ*, which B-R identity would otherwise favor. Satisfaction of B-R identity can be achieved with duplicated *g*, too, through violation of the lower-ranking constraint POSTVCLS, which asserts the markedness of voiced stops with a small supraglottal cavity. Abstractly, the situation here is really just the same as with nasal harmony in Madurese, which was analyzed in §3.3. As we observed there, the traditional classification and terminology of over- and underapplication is particularly unsuited to the description of allophonic alternations in OT. What is important about both Japanese and Madurese is the character of the interaction, through ranking, between B-R identity and phonological markedness.

Another very well-studied case of putative underapplication is the *čš* alternation in Luiseño (Munro & Benson 1973, Anderson 1974, 1975, Aronoff 1976, Davis 1976, McCarthy 1979, Marantz 1982, Mester 1986). It too is allophonic or near-allophonic. In non-reduplicated forms, the alternants are distributed as follows:

(143) *čš* Alternation in Luiseño (Munro & Benson 1973, Davis 1976)

a. *č* in Onsets

čáq ^w i-	‘to seize’
páči	‘to wash’
qé ^h ŋičum	‘squirrels’

b. *š* in Codas

qé ^h ŋiš	‘squirrel’
pášku-	‘to leach corn flour’
móšlat	‘belt’
néšmal	‘old woman’
pušróʔax	‘his leveling’

c. *č* in Codas Before a Fricative or Glide

ʔéčvaš	‘left hand’
páčxam-	‘to launder’
čáčwumal	‘ <i>Gilia capitata staminea</i> ’

⁸⁴ This is not a full account of the *g* ~ *ŋ* alternation in Tokyo Japanese. Indeed, it disregards what are probably the most interesting data, insightfully analyzed in Itô & Mester (1990). Though *ŋ* appears consistently when it is internal to a morpheme or when it begins a suffix or the second element of a Sino-Japanese (root) compound, there is *g* ~ *ŋ* variation in word-compounding:

(i) oki-go ~ oki-ŋo ‘handicap Go’
doku-gasu ~ doku-ŋasu ‘poison gas’

Even more intriguing is the consistent nasalization in forms where the *g* results from *rendaku*: /ori-kami/ → ori-ŋami ‘origami paper’. In terms of the analysis presented here, these facts show that defining “word-initial” for the purposes of exact statement of $*[ŋ]$ is a delicate matter, but not intractable, perhaps to be understood along the lines in Itô & Mester (1990).

d. *č* in Codas Before Certain Suffixes (Davis 1976: 202)

míč–kuʔ	‘strangler’
néč–kawut	‘one who pays’
wáč–qa	‘are a few (of things)’
wáč–quʂ	‘used to be a few’

e. *Other Examples of č in Codas* (Marantz 1982: 462)

po–xečla	‘its point, of an arrow’
čáčmis	‘a stone tool’

The rationale for the basic *č/š* alternation is not self-evident, so previous rule-based treatments disagree fairly profoundly. Some analyze the basic process as *š* → *č*, fortition in onsets, based on underlying /š/ (McCarthy 1979, Kiparsky 1986, Mester 1986). Others see the basic process as *č* → *š*, lenition in codas, based on underlying /č/ (Munro & Benson 1973, Anderson 1974, 1975, Aronoff 1976, Davis 1976, Marantz 1982). As in Japanese, universal markedness considerations are no help: it is not the case that either one of *š* or *č* is certifiably less marked than the other.

Suggestive evidence in favor of the onset-fortition analysis comes from the data in (143c, d, e). These examples show that *č* does occur in codas in Luiseño. In contrast, *š* is **never** found in onsets (with the exception of the exclamation *šóx* ‘indicative of surprise’ — Davis 1976: 197; Marantz 1982). The situation, then, is something like this: there is a literally unviolated constraint barring *š* from onsets, which dominates a context-free constraint against *č*. As usual, both dominate the relevant faithfulness constraint.⁸⁵

In reduplicated forms, when base and reduplicant have *č/š* in different syllabic conditions, the *č* alternant is optimal:

(144) Reduplicative Identity in Luiseño (Munro & Benson 1973, Davis 1976)

čaráčra–š	‘torn’
čukáčka–š	‘limping’
čakúčku–š	‘crest on roadrunner’
čijíčji–š	‘aboriginal Luiseño god’

Roots CVCV reduplicate as –CCV because of interaction with a syncope process. The root-initial consonant is *č* in both base and reduplicant, even though this puts *č*

⁸⁵ Improving the basis of the argument from “suggestive” to “sound” requires more understanding of exceptionality in OT than is currently available. The fortition or /š/ analysis involves this hierarchy: **[š]* >> **č* >> IDENT-IO(stricture), **š*. Under this analysis, sporadic exceptions to **č* are allowed, but not to **[š]*. The lenition or /č/ analysis would employ the hierarchy **[č]* >> **š* >> IDENT-IO(stricture), **č*. Here we would have to say that the sporadic exceptions are to **[č]*, and that **š* brooks no breaches. With fortition, it is the more narrowly defined (and higher ranked) constraint that admits no exceptions; with lenition, it is the broader (and lower-ranked) constraint that is porous. Note too that the matter involves questions of universal markedness. If either **š* >> **č* or **č* >> **š* is fixed universally (as seems rather unlikely), then the analysis of the Luiseño alternation is fixed as well.

in the coda.⁸⁶ The same analytical strategy used in Japanese and Madurese can be applied here:

- Top-ranked B-R identity rules out normal **čukáška-š*.
- Top-ranked *_o[š rules out **šukáška-š*, with š in an onset.
- The remaining candidate *čukáčka-š* is optimal; it incurs marks only for low-ranking *č.

We eschew further formal development here, since the basic interactional properties of the analysis are clear.

There are other cases of underapplication in the literature; we will mention them only briefly here. Stress subordination in Indonesian “underapplies” (Cohn 1989: 185, 188; Cohn & McCarthy 1994; Kenstowicz 1994a); in this case, overapplication makes no sense, so B-R identity cannot be satisfied in any other way. Nasal place-assimilation in Madurese is adduced as a case of underapplication by Wilbur (1973abc) — but Stevens (1985) shows that it is really a boundary-strength effect. Final “devoicing” in Javanese underapplies, according to Dudas (1976: 118–120, 203f.); we have been unable to confirm this observation with a native speaker⁸⁷ and phonetic considerations make it unlikely to be correct (see Fagan 1988, Hayward 1994, G. R. Poedjosoedarmo 1993; cf. Cohn 1993a, Cohn & Lockwood 1994). Umlaut in Rotuman appears to underapply (Churchward 1940 [1978], McCarthy 1985, Mester 1986); this is actually a side-effect of partial reduplication. The tense/lax alternations in Javanese vowels (Horne 1961, S. Poedjosoedarmo 1969, Dudas 1976, Hirschbühler 1978, Yallop 1982, Kenstowicz 1986, Kiparsky 1986, Schindwein 1991) are complex and difficult to analyze; under some interpretations, they too involve underapplication, and we do not yet understand all of the details. Similar issues arise in Malay (Teoh 1988). Another case of underapplication where the character of the basic process is obscure is Mende mutation (Cowper & Rice 1985, 1987; Tateishi 1987).

5.5 Summary

Underapplication responds to the problem of satisfying B-R identity requirements in the same general way that overapplication does. Significantly, though, underapplication is always a consequence of the intervention of some additional constraint that bars overapplication, which would otherwise be favored. Thus, underapplication in this model is a rather special matter, as the factorial typology of §4 emphasizes. This result stands in contrast to other theories, where underapplication plays a central role, often as a symmetric counterpart to overapplication. In our survey of relevant cases, the prediction made by Correspondence Theory has been supported, as we have seen that various phonological constraints may, through high rank, step in to force underapplication instead of overapplication.

⁸⁶ Some reduplicative constructions in Luiseño have normal application; see fn. 11.

⁸⁷ Thanks to Abby Cohn for checking this for us.

6. Input-Reduplicant Correspondence

6.1 I-R Correspondence in Klamath Distributive Reduplication

The focus thus far has been on the Basic Model, which recognizes just two relations holding in a reduplicated form: B-R correspondence, between the output reduplicant and the output base, and I-O correspondence, between the input stem and output base. A third correspondence relation is not only logically possible, but empirically necessary, as we have seen from time to time: I-R correspondence, holding between the input stem and the output reduplicant. Adding this relation yields the Full Model:

(145) Full Model

$$\begin{array}{l} \text{Input:} \quad \quad \quad /Af_{\text{RED}} + \text{Stem}/ \\ \quad \quad \quad \text{I-R Faithfulness} \nearrow \swarrow \quad \uparrow \downarrow \text{I-B Faithfulness} \\ \text{Output:} \quad \quad \quad R \quad \Leftrightarrow \quad B \\ \quad \quad \quad \text{B-R Identity} \end{array}$$

(To emphasize the difference between the two faithfulness relations, we rename the stem-base relation “I-B faithfulness”.) In this section we first will review some typical evidence that supports (145); then we will go on in §6.2 to examine the typological consequences of incorporating an I-R faithfulness relation into the model.

The absence of a direct relation between reduplicant and input in the Basic Model (5) entails that the reduplicant can never be more faithful to the input than the base is, since the output reduplicant has no access to the input stem, except through the output base. Yet there are clear cases where the reduplicant preserves input material that is lost in the base.⁸⁸ Klamath provides a compelling example (Barker 1964, Clements & Keyser 1983). As noted in §5.3, a phonological process of Klamath reduces or deletes

the first vowel of a prefix or stem, provided that the vowel ... is preceded by at least one syllable in the word. (Clements & Keyser 1983: 143)

Reduction to \emptyset occurs in closed syllables,⁸⁹ deletion in open syllables. The following examples, all involving light-syllable distributive reduplication, are typical:

⁸⁸ Thanks to Suzanne Urbanczyk for remarks on this point.

⁸⁹ In addition, a is realized as \emptyset in closed syllables.

(146) Reduplication/Reduction/Syncope in Klamath (Clements & Keyser 1983: 140f.)

a. *Syncope in base*

/DIST+mbody'+dk/	mbo-mp _{__} ditk	'wrinkled up (dist.)'
/DIST+sm'oq'y+dk/	sm'o-sm _{__} q'itk	'having a mouthful (dist.)'
/DIST+pniw+abc'+a/	pni-pn _{__} o:pc'a	'blow out (dist.)' ⁹⁰
/DIST+njoy+el'g+a/	njo-nj _{__} i:lga	'are numb (dist.)'
/DIST+poli:+k'a/	po-p _{__} li:k'a	'little policemen (dist.)'

b. *Reduction in base*

/DIST+dmesga/	de-dm _ə sga	'seize (dist.)'
/DIST+sipc+a/	si-s _ə pca	'put out a fire (dist.)'
/DIST+gatdk'+a/	ga-g _ə ttk'a	'are cold (dist.)'
/DIST+pikca+'a:k'/	pi-p _ə kca?a:k	'little pictures (dist.)'
/DIST+sa+la+ak'w+ebli/	sa-s _ə lk'obli	'puts round black object across oneself (dist.)'

From these alternations, it is clear that syncope and reduction occur with total indifference to the requirements of B-R identity, since they consistently interfere with identity of vocalism between reduplicant and base. In this respect, Klamath's partial DIST reduplication is quite different from the root-copying INTENS reduplication, which was analyzed in §5.3.

Reduction/syncope is not the only way in which base and reduplicant can differ in (146). Another aspect of B-R identity — or, better, non-identity — that can be discerned is in the laryngeal specification of consonants. Klamath obstruents lose any distinctive laryngeal specification (voicing or glottalization) in coda position (Kingston 1985, Steriade 1988, Lombardi 1991). The consequences of this process for B-R identity are apparent from examples like *mbo-mpditk*, with *b* in the reduplicant standing in correspondence with *p* in the base.

In both reduction/syncope and laryngeal neutralization, it is the reduplicant that reproduces underlying contrasts and the base that neutralizes them. The form just cited, *mbo-mpditk* (from /DIST+mbody'+dk/), illustrates this for both processes: the reduplicant's *b* is voiced because it is related to an underlying *b*, and the reduplicant has the vowel *o* because the underlying root has the vowel *o*. Both of these characteristics of the input are lost in the output base, so it is clear that, in this case, the reduplicant is more faithful to the input than the base is.

This result establishes the incompleteness of the Basic Model (5). Furthermore, it establishes the need for I-R faithfulness, the additional correspondence relation proposed in (145). Without I-R faithfulness, the reduplicant can do no better than copy the base in its output form; with it, the reduplicant can also show allegiance to the input. In Klamath, there is greater similarity of the reduplicant to the input, demanding the following ranking:

⁹⁰ The *o:* and *i:* in this example and the next one are the regular result in Klamath of vocalizing /w/ and /y/, respectively.

(147) I-R Faithfulness \gg B-R Identity, in Klamath⁹¹

	/DIST+mbody'+dk/	I-R Faithfulness	B-R Identity
a.	mbo-mpditk		*
b.	mpo-mpditk	* !	

In (147b), the reduplicant and base agree exactly in voicing of *p*, but this form is not optimal. The reason is that there is another candidate, (147a), in which the reduplicant preserves a characteristic of the input — voicing of *b* — that is lost in the base.

This is true normal application, in which the reduplicant completely disregards phonological alternations in the base and instead takes its phonological marching orders directly from the input. It is clearly impossible within the Basic Model (5). The Full Model supplies the crucial I-R correspondence relation, which allows the reduplicant direct access to the input form. In this way, the Klamath reduplicant can be more faithful to the input than the corresponding base is.

6.2 Typological Consequences of I-R Correspondence

Introducing the I-R faithfulness relation to the model increases the number of permuted rankings significantly and therefore has potentially ruinous consequences for the factorial typology explored in §4. In fact, the set of Full Model rankings cleaves naturally into two disjoint subsets: those in which I-B faithfulness \gg I-R faithfulness; and those in which I-R faithfulness \gg I-B faithfulness. We begin with ranking permutations that meet the I-B \gg I-R condition: these yield much the same system as that of the Basic Model, considered in §4, with a couple of useful extensions. We then go on to argue that those rankings of the I-R \gg I-B sort are impossible for reasons of principle; in support of this, we note a number of peculiarities that such rankings would entail.

To put the I-B/I-R split a little more precisely, let F_k be the k^{th} faithfulness constraint scheme, where $F_k\text{-IR}$ is the version that governs I-R correspondence and $F_k\text{-IB}$ is its I-B cognate. We then divide the ranking set of the Full Model into two non-overlapping classes:

Class 1. For every k , $F_k\text{-IB} \gg F_k\text{-IR}$.

Class 2. *Not in Class 1*: for some k , $F_k\text{-IR} \gg F_k\text{-IB}$

For the moment, we are interested in *Class 1*, where I-B faithfulness dominates I-R faithfulness. In this survey, all rankings investigated will involve a single, sufficiently

⁹¹ This ranking argument is made on the basis of the voicing alternation only. The parallel ranking argument for reduction/syncope cannot be made, because it would require comparison of the actual output with $*mp\text{-mpditk}$, which is independently excluded because reduction/syncope never occurs in initial syllables (see §5.3). Nonetheless, the need for an I-R faithfulness relation is established even without this additional ranking argument, since the underlying vowel of the root must be recoverable in the reduplicant.

high-ranked phonological constraint \mathbb{C} interacting with relevant faithfulness and identity constraints.⁹²

(148) Class 1 Factorial Typology, with a Single Phono-Constraint \mathbb{C}

- a. *Non-Application* — \mathbb{C} is not visibly active
 - i. I-B Faithfulness \gg I-R Faithfulness \gg \mathbb{C} (*B-R identity irrelevant*)
 - ii. B-R Identity, I-B Faithfulness \gg \mathbb{C} (*I-R faithfulness irrelevant*)
- b. *Emergence of the Unmarked*
I-B Faithfulness \gg \mathbb{C} \gg B-R Identity, I-R Faithfulness
- c. *Overapplication (bidirectional)*
 \mathbb{C} , B-R Identity \gg I-B Faithfulness \gg I-R Faithfulness
- d. *Asymmetric Overapplication (base to reduplicant only)*
 \mathbb{C} \gg I-B Faithfulness \gg B-R Identity \gg I-R Faithfulness
- e. *Normal Application (with I-R faithfulness active; else overapplication)*
 \mathbb{C} \gg I-B Faithfulness \gg I-R Faithfulness \gg B-R Identity

The nonapplicational rankings (148a) shows the effects of transitivity of identity. If I-B faithfulness is joined by either of the other two faithfulness/identity constraints in dominating \mathbb{C} , then \mathbb{C} is inactivated in generic circumstances, and can compel no faithfulness-defying phonology, even when \mathbb{C} formally dominates the remaining faithfulness/identity constraint. Ranking (148a.i) asserts that I=B and I=R in relevant respects; hence, by transitivity, we must have B=R in the same respects, regardless of where B-R identity sits in the hierarchy. Therefore, even if \mathbb{C} dominates B-R identity formally, \mathbb{C} can compel nothing to happen, because the I-R and I-B relations are already fixed. In exactly the same way, Ranking (148a.ii) guarantees I=B and B=R directly, and by transitivity, we must have I=R. So even if \mathbb{C} formally dominates I-R faithfulness in the hierarchy, there can still be no phonological action in support of \mathbb{C} . Not surprisingly, the Full Model, like the Basic Model, admits the possibility that a given constraint \mathbb{C} can be inactive in a particular language, if its activity demands the subordination of faithfulness constraint.

Rankings (148b, c, d) share the property that I-R faithfulness is ranked at the very bottom of the hierarchy. Having I-R faithfulness so thoroughly dominated is effectively the same as having no I-R faithfulness at all, in generic circumstances; again, this is just the Basic Model, explored in the factorial typology of §4. Ranking (148b) yields emergence of the unmarked: subordination of I-R faithfulness allows phonology to proceed in the reduplicant. Ranking (148c) yields full overapplication, running from base to reduplicant, reduplicant to base, or back and forth. Ranking (148d) yields overapplication when the focus of the constraint \mathbb{C} is B, and normal application otherwise, as in Indonesian (§4.3).

⁹² The same analytical caveats apply here as in §4, where we reviewed the typology of the Basic Model. We are assuming a kind of *generic* situation, from which logically possible but linguistically nonoccurring relations among constraints and candidate sets are excluded. And we leave it to context to disambiguate the quantificational sense of such terms as I-B faithfulness, I-R faithfulness, and B-R identity.

The authentically new ranking, then, is (148e), which strengthens the ability of the reduplicant to maintain stem-structure in the face of neutralizing phonology in the base. It combines the following elements:

$\mathbb{C} \gg$ I-B Faithfulness	<i>There is \mathbb{C}-driven phonology.</i>
I-B Faithfulness \gg I-R Faithfulness	<i>Class 1.</i>
I-R Faithfulness \gg B-R Identity	<i>Copy stem rather than base.</i>

So long as I-R faithfulness is active on a given input, this will produce normal application, in which reduplicant and stem behave as if separately derived from the same underlying stem. This is the ranking required for normal application in Klamath distributive reduplication (§6.1), allowing the reduplicant to contain a stem vowel lost or reduced in the stem.

When more than one candidate survives I-R faithfulness, though, this ranking yields *overapplication*, because B-R faithfulness is still present in the grammar and ready to be pressed into service, even though subordinated. Madurese Glide Formation (§3.2) provides a real example. In crucial cases like /k^hoa/, due to the dominance of \mathbb{C} = ONSET, I-R faithfulness must be violated by all viable candidates. These will each therefore contain an onset consonant lacking in the input stem, violating DEP-IR. B-R identity, though dominated, will make the decision, picking a glide that is identical to one in the base — here *w*, so *wʏ-kowʏ* comes out: straightforward overapplication.

In this ranking, B-R identity stands in the lowest position, so \mathbb{C} is enforced regardless of any consequences it might have for identity between reduplicant and base. (When the schema yields overapplication, as in Madurese, \mathbb{C} is consistent with B-R identity.) Furthermore, because \mathbb{C} dominates both I-R and I-B faithfulness, it is able to compel unfaithful analysis in the reduplicant, the base, or both. The Klamath example shows that the reduplicant may preserve a more faithful analysis of the input than the base does, at the expense of reduplicant-base identity. This is in accordance with the ranking I-R faithfulness \gg B-R identity in (148e). Significantly, this ranking produces normal application regardless of whether the reduplicant or the base is the primary target of the constraint and regardless of whether or not the phonological alternation is allophonic. Thus, it expands the range of possible cases of normal application beyond those permitted by the factorial typology of §4.

These patterns of constraint interaction are familiar, and they indicate that introducing I-R faithfulness to the model does not affect the basic results already achieved, beyond accommodating examples like Klamath. But the list in (148) is limited to Class 1 rankings, in which I-B faithfulness \gg I-R faithfulness. Stepping outside Class 1, by allowing crucial domination of some I-B faithfulness constraint by I-R faithfulness constraints, leads to results that are quite bizarre.

One such pathological result is obtained from the ranking given in (149):

(149) B-R Identity, I-R Faithfulness \gg \mathbb{C} \gg I-B Faithfulness

This is just (148a.ii), standard nonapplication, with I-R and I-B swapped. Harmless? Because \mathbb{C} dominates I-B faithfulness, the constraint \mathbb{C} is visibly active in the language as a whole. But low-ranking \mathbb{C} has no effect on the reduplicant, nor can it make the base differ from the reduplicant, so it might seem that this ranking leads to a kind of underapplication. And indeed it does, in the broadest sense of the term: but consider what happens when \mathbb{C} is met simultaneously in *both* reduplicant and base. In just this case, \mathbb{C} has no effect on the base.

To see why this is so, consider a hypothetical example. Suppose t palatalizes to \check{c} when preceded by i . Suppose too that we are provided with an underlying representation $/i+taki+RED/$. Under ranking (149), the result we obtain, contrary to all expectations, is *itakitaki*, with no palatalization whatsoever:

(150) A Pathological (But Hypothetical) Example from (149)

	B-R Identity	I-R Faithfulness	\mathbb{C}	I-B Faithfulness
a. $i+taki_B+taki_R$			**	
b. $i+\check{c}aki_B+\check{c}aki_R$		* !		*
c. $i+\check{c}aki_B+taki_R$	* !		*	*
d. $i+taki_B+\check{c}aki_R$	* !	* !	*	

In reduplicated forms, \mathbb{C} is inactive, and violable, even when satisfying it would have no effect at all on B-R identity. Yet palatalization is required in the language generally, because $\mathbb{C} \gg$ I-B faithfulness. This is not the kind of underapplication actually observed in nature, which involves inactivity of \mathbb{C} only when it is challenged in just one member of the B,R pair, putting B-R identity at risk. Here, there is perfect symmetry — the initial t of B and the initial t of R both stand in the palatalization environment. Contrast the entirely parallel Southern Paiute case (138):
 $w\ddot{i}-w\ddot{i}n'n\ddot{i}-q'u-$ •underapplication with asymmetry of environments.
 $ya-\eta^w\iota' -\eta^w\eta\iota\chi a'$ •normal application with symmetrical satisfaction = (150b).
 These show how true underapplication works.

B-R identity is obviously not at stake here, since (150b) is a \mathbb{C} -obeying candidate with a perfect B-R match. This ranking gives us a strange and completely unattested result in which \mathbb{C} is active in the language as a whole, but completely frozen out of reduplicated forms, simply to preserve stem phonology in R.

Another ranking with pathological results is given in (151):

(151) I-R Faithfulness \gg \mathbb{C} \gg B-R Identity, I-B Faithfulness

This ranking is obtained by swapping I-B and I-R faithfulness in (148b), the Class 1 ranking that leads to emergence of the unmarked, the pattern in which \mathbb{C} is obeyed in the reduplicant but not in the language as a whole. The reduplicant is “unmarked” in that it satisfies the structural constraint \mathbb{C} . Here, by contrast, \mathbb{C} is visibly active in the

language as a whole ($\mathbb{C} \gg$ I-B faithfulness), but it does *not* affect the reduplicant (I-R faithfulness \gg \mathbb{C}). Since B-R identity is low-ranking, \mathbb{C} will affect the base regardless of whether this leads to a base-reduplicant mismatch. In consequence, the reduplicant would contain a phonological structure that is otherwise *unknown* in the language — for instance, a closed syllable in a CV language, or the vowel *ü* in a language with an ordinary triangular vowel system. Ranking (151) thus produces emergence of the *marked*, with a reduplicant-specific marked phonological pattern. This type of behavior is also unattested and seems quite impossible.

The feature common to (149) and (151), and to other pathological permutations besides, is that the reduplicant is marked, along a certain dimension, in comparison to the language as a whole. In both cases, we have a constraint \mathbb{C} that is active in the entire language outside of reduplicative morphology, but violated systematically by the reduplicant. In effect, there is complete immunity of the reduplicant to \mathbb{C} , so that the \mathbb{C} -marked structure is emergent in the reduplicant. In (149) this markedness is even transmitted via B-R identity to the base. This inversion of the natural order is the source of the pathology.

In what sense are the pathological rankings *contra naturam*? It is a consistent finding that morphological affixes are unmarked relative to roots. For example, affixes tend to have reduced segmental inventories, favoring coronal consonants (e.g., Broselow 1984 on Amharic) and unmarked vowels (e.g. Yip 1987 on English). Root-controlled vowel harmony is the extreme case of vocalic unmarkedness in affixes. Likewise, affixes may avoid clusters, complex onsets (Sanskrit), long vowels, or geminates, even when roots permit them. On the other hand there are no segment types or configurations that are only permitted in affixes but barred from roots.⁹³

To make sense of these observations, we need to make two theoretical moves. First, we must segregate Root-faithfulness from Affix-faithfulness. A special case of this development has already been proposed, in (145). What we have called I-R faithfulness is simply a particular instance of Affix-faithfulness, since R, the reduplicant, is an affix, distinct from the base, which is a root or a root-containing stem. Second, because roots are never unmarked relative to affixes, the ranking of Root-faithfulness and Affix-faithfulness must be fixed universally:

(152) Root-Affix Faithfulness Metaconstraint (McCarthy & Prince 1994b)
 Root-Faith \gg Affix-Faith

⁹³ One might try to see this observation as a sampling artifact, as Orhan Orgun (e.c.) has suggested to us. The argument proceeds like this: typically, affixes are few and roots are many, so roots have more opportunities to display marked structures, for statistical rather than principled reasons. The response: the markedness differential is found even in relatively rich affixal systems coupled with relatively impoverished root systems. Furthermore, it holds even when the highly marked structures are rather common in roots. For instance, about 8% of Arabic verb roots contain the pharyngeals *ʕ* and *ħ*, but no affixes do.

Metaconstraints like this one are a familiar part of the theory of phonological markedness (Prince & Smolensky 1993: Chaps. 8, 9). They embody substantive universal claims about constraint priorities.

Under the metaconstraint (152), any phonological constraint \mathbb{C} that stands between the two types of faithfulness will hold true of the affixes in a language but not of the roots. Some typical examples are given in (153).⁹⁴

(153) Examples of Morphologically-Dispersed Faithfulness

a. *Turkish vowels are distinctively [\pm back] in roots, but not affixes:*

IDENT-ROOT(back) \gg *[back] \gg IDENT-AFFIX(back)

b. *Sanskrit roots contain onset clusters, but affixes do not:*

MAX-ROOT \gg *COMPLEX \gg MAX-AFFIX

c. *Arabic roots contain pharyngeals, but affixes do not:*

IDENT-ROOT(Place) \gg *[Pharyngeal] \gg IDENT-AFFIX(Place)

The mirror-images of these rankings are not permitted, under (152). Thus, no language can have a vowel-harmony system in which all roots are varying and all affixes are fixed, nor can any language permit onset clusters only in affixes, nor can a language restrict pharyngeals (or any other marked segment type) to its affixal system.⁹⁵

The implications of the metaconstraint (152) for the factorial typology of reduplication/phonology interactions are clear. Because of this metaconstraint, no I-R faithfulness constraint can ever dominate its I-B cognate, and the pathological interactions introduced in (149–151) can never occur. The definition of the Class 1 ranking subsystem follows as an instance of the metaconstraint, and the Class 2 rankings are all ruled inadmissible, on grounds of universal principle. In contrast to the pathologies of Class 2, the patterns of Class 1 interaction laid out in (148) are all attested: in most cases, well-attested. They are, by definition, fully compatible with the metaconstraint (152), since none require that I-R faithfulness dominate I-B faithfulness. In this way, the typological implications of the Full Model (145) are brought into sharp conformity with actual observation.

6.3 Summary

Reduplicative structures evidence a further correspondence relation, between the reduplicant and the input form of the base. This relation is necessary to support faithfulness effects in the reduplicant, required in the analysis of Klamath and other languages. This new type of correspondence has limited and desirable effects on

⁹⁴ For development and extension of this idea to “Strict Cycle” effects, see Selkirk (1995).

⁹⁵ Root-faith \gg Affix-faith is no guarantee that root will always triumph over affix in any encounter whatsoever. Higher-ranking constraints can intervene — e.g., right word-edge alignment in hypothetical /pati-a/ \rightarrow pata.

language typology, so long as no I-R faithfulness constraint is ever allowed to dominate its I-B faithfulness cognate. Very general markedness properties of roots versus affixes motivate a substantive metaconstraint on ranking — Root-faith \gg Affix-faith — which entails exactly this restriction.

7. Conclusion

Correspondence Theory treats identity between reduplicant and base just like faithfulness of output to input. Faithfulness and identity follow from the same kind of formal constraints on the *correspondence relation* between representations. Because B-R identity is a *relation* between B and R, rather than an *operation* creating R from B, the phonology of one conjunct may be matched in the other, and vice-versa, with full symmetry. When imposition of B-R identity leads to effects not expected in extra-reduplicative circumstances, the results earn the name of overapplication or of underapplication, depending on the character of the rest of the constraint system. High-ranking B-R identity narrows the candidate set down to B,R pairs that are sufficiently closely matched; other considerations select the optimal candidate.

The evidence analyzed here demonstrates that Correspondence Theory is superior, empirically and conceptually, to serial derivational approaches. All such theories are incapable of dealing with cases in which B copies (or, more neutrally, *reflects*) R. Other interactions make finer distinctions among the various serialist alternatives. The most familiar theories — those with fixed rule ordering — are incapable of expressing patterns in which R imposes phonology on B that then reappears in R. A fundamental revision of ordering theory to include *persistent rules*, which reapply freely, brings the R \rightarrow B \rightarrow R cases under control, but brings in its wake major problems connected with non-convergent (oscillating) derivations; and, of course, it does not solve the problem of comprehending R-to-B influence. Conceptually, serial theories are also prey to charges of non-unified explanation: the basic copying procedure enforces identity, and then other devices are called on exactly to reinforce it.

Correspondence Theory, as developed here, is accompanied by a well-instantiated factorial typology, which admits identity-defying *normal application* and *emergence of the unmarked* as well as aggressive imposition of reduplicative identity. Underapplication, a prominent feature of serial theories, cannot be freely obtained by some special ranking of B-R identity constraints. Rather, it is always the result of the intervention of some independently motivated high-ranking constraint that bars alternative ways of achieving identity between base and reduplicant; thus, in many situations, it will be predicted to be impossible.

Apart from their intrinsic interest, these results relate to several broad issues: parallelism versus serialism in Optimality Theory; explanation in Prosodic Morphology; the nature of faithfulness relations; the character of phonological constraints; and the formal properties of prosodic circumscription, the cycle,

“paradigm uniformity”, and other transderivational relationships. Here we briefly suggest how present work is relevant to these issues and what direction future investigations might take.

Although Optimality Theory in any form relies on parallel evaluation of a candidate set with respect to hierarchy of ranked constraints, it is still entirely possible, as Prince & Smolensky (1993: Chapt. 2) emphasize, to distinguish various serialist and parallelistic architectures within this basic commitment. For example, transition from step to step in a derivation based on application of simple constructional principles could be governed by an OT system evaluating possible outputs at each step. (See Prince & Smolensky 1993: 79-80n. for a worked-out example.) By far the bulk of research in the theory has, of course, been conducted under the contrary assumption that candidate outputs are evaluated non-serially, all at once, in complete parallel. 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 nasal harmony (§3.6), Axininca Campa epenthesis and augmentation (§3.7), Chumash, Kihehe, and Tagalog coalescence (§3.8), and Klamath and Southern Paiute (§5.3) either cannot be analyzed serially or can be analyzed only in formally-problematic and conceptually-flawed re-castings of conventional serialism. Yet the same phenomena are readily captured by a system where reduplicative identity and phonological constraints are assessed in parallel. A crucial aspect of this success is that reduplicative identity is seen as a relation, formalized within Correspondence Theory and subject to evaluation by ranked constraints.

The goal of Prosodic Morphology is to derive the properties of reduplication and kindred phenomena from general principles of phonology and morphology, reducing and ultimately eliminating the principles that are specific just to reduplication. Correspondence Theory recognizes B-R identity and I-O faithfulness as identical relations governed by identical constraints; there is no special reduplication-specific copying relation that is unconnected with faithfulness. Furthermore, the constraints on string-to-string correspondence are mirrored in the theory of autosegmental association of tone and other elements, allowing Correspondence Theory to recapture, and greatly extend, the original insight behind modern work on nonconcatenative morphology. Similar results have been achieved in eliminating the Prosodic-Morphological template in favor of independently required constraints on prosody and the prosody-morphology relation (McCarthy & Prince 1994ab) and in eliminating circumscriptive infixation in favor of independently required alignment constraints (Prince & Smolensky 1991, 1993; McCarthy & Prince 1993ab). We are therefore much closer to realizing the Prosodic Morphology program of, effectively, generalizing itself out of existence.

Correspondence Theory has phonological extensions that have scarcely been touched on. Thus far, we have only considered constraints that require integrity of the correspondence relation or identity of correspondent elements. But it is a straightforward matter to extend correspondence to constraints demanding **non-**

identity. The result: constraints with the same basic character as the “two-level” rules introduced by Koskeniemi (1983) (also see Karttunen 1993, Lakoff 1993, and Goldsmith 1993). This has implications for the analysis of various opaque interactions, such as Yawelmani vocalic phonology, that have been claimed to offer a fatal challenge to parallelism. And even within the faithfulness/identity system, Correspondence Theory presupposes a different view of the output from the familiar PARSE/FILL nexus of most previous OT work (Prince & Smolensky 1991 *et seq. et alii.*), with potentially interesting consequences for the characterization of prosodic and segmental phonology within OT, such as those explored in some of the references given in §2.3. Furthermore, the idea that autosegmental association instantiates the correspondence relation may be expected to impact on many aspects of phonology.

Finally, Correspondence Theory opens up a new way to look at the sorts of transderivational relationships among linguistic forms that have previously been understood in terms of a serial derivation (Benua 1995, McCarthy 1995). The most familiar serial mechanism recruited to account for transderivational relationships is the phonological cycle (Chomsky & Halle 1968 etc.); less familiar ones include prosodic circumscription (McCarthy & Prince 1990) and late ordering of morphological truncation rules (Anderson 1975). In each case, serial approaches see phonological identity in derivational terms: one representation must be created directly from another if they are to be similar. In contrast, Correspondence Theory provides a model of how to approach these transderivational relationships non-serially. With B-R correspondence, base and reduplicant are related to one another as parallel representations, and identity between them is demanded by rankable constraints. There is no need for a serial derivational relationship, in which the reduplicant is operationally copied from the base; in fact, the evidence of §§3.6–3.8 and §5.3 establishes the empirical inadequacy of serial relatedness.

In transderivational relationships, a correspondence relation holds between forms sharing the same root. The clearest case of this is afforded by interactions between phonology and morphological truncation, in a near-exact parallel to reduplicative over- and underapplication, as proposed by Benua (1995). But correspondence also engages with broader issues of supposed cyclic or level-based effects, connecting with proposals in Burzio (1994ab).⁹⁶ To pick a nearby example, this extension of Correspondence Theory offers a somewhat different perspective on reduplicative underapplication than the one pursued in §5: it may be that Akan *kɪ-ka* is more harmonic than **ɬɪ-ɬa* because the root is *ka* throughout the rest of the paradigm, and a constraint demanding identity of paradigmatically-related correspondent segments dominates PAL.

Prosodic circumscription is another serial mechanism that can be re-examined in this light. Under prosodic circumscription, a form is first provided with prosodic constituency (syllable and foot structure); then a prosodic constituent is identified and

⁹⁶ We are indebted to Luigi Burzio for raising this point. See Benua (1995) and McCarthy (1995) for discussion.

subjected to morphological derivation, up to and including provision of new prosodic structure via template-mapping. Many proposed cases of prosodic circumscription have been reanalyzed in other terms, as a result of developments in Optimality Theory (Prince & Smolensky 1991, 1993; McCarthy & Prince 1993ab). But a significant residue remains. This residue, it turns out, can be understood in terms of constraints demanding that certain segments have identical prosodic analyses in paradigmatically-related forms; appropriate constraints demand that correspondent segments within the paradigm share foot-initiality, main stress, or similar prosodic characteristics. Moreover, the same constraints are responsible for faithfulness to lexical prosody, thereby contributing to the Prosodic Morphology goal of relying only on mechanisms that are independently available. (See McCarthy 1995 and Benua 1995 for evidence and discussion.)

Correspondence Theory originates as a revision of the PARSE/FILL implementation of the key notion of *faithfulness*. These brief remarks hint at the richness of the issues waiting to be explored.

Appendix A: Constraints on Correspondent Elements

This appendix provides a tentative list of constraints on correspondent elements. Affinities with other constraint-types are noted when appropriate. All constraints refer to pair of representations (S_1, S_2), standing to each other as (I, O), (B, R), etc. The constraints also refer to a relation \mathcal{R} , the correspondence relation defined for the representations being compared. Thus, each constraint is actually a constraint-family, with instantiations for I-O, B-R, I-R, Tone to Tone-Bearer, and so on.

Formalization is far from complete, and aims principally to clarify. As in §2, we imagine that a structure S_i is encoded as a set of elements, so that we can talk about \mathcal{R} on (S_1, S_2) in the usual way as a subset, any subset, of $S_1 \times S_2$. We use the following standard jargon: for a relation $\mathcal{R} \subset A \times B$, $x \in \text{Domain}(\mathcal{R})$ iff $x \in A$ and $\exists y \in B$ such that $x \mathcal{R} y$; and $y \in \text{Range}(\mathcal{R})$ iff $y \in B$ and $\exists x \in A$ such that $x \mathcal{R} y$.

(A.1) MAX

Every element of S_1 has a correspondent in S_2 .

$$\text{Domain}(\mathcal{R}) = S_1$$

(A.2) DEP

Every element of S_2 has a correspondent in S_1 .

$$\text{Range}(\mathcal{R}) = S_2.$$

MAX (= (12)) and DEP are analogous respectively to PARSE-segment and FILL in Prince & Smolensky (1991, 1993). Both MAX and DEP should be further differentiated by the type of segment involved, vowel versus consonant. The argument for differentiation of FILL can be found in Prince & Smolensky (1993), and it carries over to FILL's analogue DEP. In the case of MAX, the argument can be constructed on the basis of languages like Arabic or Rotuman (McCarthy 1995), with extensive vocalic syncope and no consonant deletion.

(A.3) IDENT(F)

Correspondent segments have identical values for the feature F.

If $x \mathcal{R} y$ and x is $[\gamma F]$, then y is $[\gamma F]$.

IDENT (= (14)) replaces the PARSE-feature and FILL-feature-node apparatus of Containment-type OT. A further development of IDENT, proposed by Pater (1995) and called on in §5.1, differentiates [+F] and [-F] versions for the same feature. As stated, IDENT presupposes that only segments stand in correspondence, so all aspects of featural identity must be communicated through correspondent segments. Ultimately, this approach must be extended to accommodate “floating” feature analyses, like those in Archangeli & Pulleyblank (1994) or Akinlabi (1994).

(A.4) Contiguity

a. I-CONTIG (“No Skipping”)

The portion of S_1 standing in correspondence forms a contiguous string.

Domain(\mathcal{R}) is a single contiguous string in S_1 .

b. O-CONTIG (“No Intrusion”)

The portion of S_2 standing in correspondence forms a contiguous string.

Range(\mathcal{R}) is a single contiguous string in S_2 .

These constraints characterize two types of contiguity (see also Kenstowicz 1994b). The constraint I-CONTIG rules out deletion of elements *internal* to the input string. Thus, the map $xyz \rightarrow xz$ violates I-CONTIG, because the Range of \mathcal{R} is $\{x, z\}$, and x, z is not a contiguous string in the input. But the map $xyz \rightarrow xy$ does not violate I-CONTIG, because xy is a contiguous string in the input. The constraint O-CONTIG rules out internal epenthesis: the map $xz \rightarrow xyz$ violates O-CONTIG, but $xy \rightarrow xyz$ does not. The definition assumes that we are dealing with strings. When the structure S_k is more complex than a string, we need to define a way of plucking out a designated substructure that is a string, in order to apply the definitions to the structure.

(A.5) {RIGHT, LEFT}-ANCHOR(S_1, S_2)

Any element at the designated periphery of S_1 has a correspondent at the designated periphery of S_2 .

Let $Edge(X, \{L, R\})$ = the element standing at the $Edge = L, R$ of X .
RIGHT-ANCHOR. If $x = Edge(S_1, R)$ and $y = Edge(S_2, R)$ then $x \mathcal{R} y$.

LEFT-ANCHOR. Likewise, *mutatis mutandis*.

In prefixing reduplication, L-ANCHOR \gg R-ANCHOR, and vice-versa for suffixing reduplication. It is clear that ANCHORing should subsume Generalized Alignment; as formulated, it captures the effects of $Align(MCat, E_1, PCat, E_2)$ for $E_1 = E_2$ in McCarthy & Prince (1993b). It can be straightforwardly extended to (PCat, PCat) alignment if correspondence is assumed to be a reflexive relation. For example, in (*bí.ta*), the left edge of the foot and the head syllable align because *b* and its correspondent (reflexively, *b*) are initial in both.

(A.6) LINEARITY — “No Metathesis”

S_1 is consistent with the precedence structure of S_2 , and vice versa.

Let $x, y \in S_1$ and $x', y' \in S_2$.

If $x \mathcal{R} x'$ and $y \mathcal{R} y'$, then

$x < y$ iff $\neg (y' < x')$.

(A.7) UNIFORMITY — “No Coalescence”

No element of S_2 has multiple correspondents in S_1 .

For $x, y \in S_1$ and $z \in S_2$, if $x \mathcal{R} z$ and $y \mathcal{R} z$, then $x = y$.

(A.8) INTEGRITY — “No Breaking”

No element of S_1 has multiple correspondents in S_2 .

For $x \in S_1$ and $w, z \in S_1$, if $x \ll w$ and $x \ll z$, then $w=z$.

LINEARITY excludes metathesis. UNIFORMITY and INTEGRITY rule out two types of multiple correspondence — coalescence, where two elements of S_1 are fused in S_2 , and diphthongization or phonological copying, where one element of S_1 is split or cloned in S_2 . On the prohibition against metathesis, see Hume (1994) and McCarthy (1995). On coalescence, see Gnanadesikan (1995), Lamontagne & Rice (1995), McCarthy (1995), and Pater (1995).

Appendix B: Inventory of Overlapping Processes

Type	Language	Process	References
Segmental Deletion	Chumash	pre-coronal / deletion	Applegate 1976, McCarthy 1985, Mester 1986
	Javanese	intervocalic <i>h</i> deletion	Horne 1961, Dudas 1976, Kiparsky 1986
	Tagalog	syncope	Schachter & Otones 1972, Carrier[-Duncan] 1979, 1984
Segmental Epenthesis	Axininca Campa	augmentation & V-epenthesis	Payne 1981, Spring 1990, McCarthy & Prince 1993ab
	Koryak	?prothesis	Zhukova 1972, 1980, Kenstowicz 1976
	Madurese	hiatal glide insertion	Stevens 1968, 1985
	Tübatulabal	vowel rearticulation	Voegelin 1935: 108, Benki p.c.
Morphophonemic Alternation	Austronesian	nasal substitution	Schachter & Otones 1972, Dudas 1976, Onn 1976 [1980], Carrier[-Duncan] 1979, 1984, Marantz 1982, McCarthy 1985, Mester 1986, Uhrbach 1987, Stevens 1968, Pater 1995, etc.
	Chumash	C+glottal coalescence	Applegate 1976, McCarthy 1985, Mester 1986
	Copala Trique	tone sandhi	Hollenbach 1974
	Dakota	palatalization, ablaut	Shaw 1976 [1980], Marantz 1982, Kiparsky 1986, McCarthy 1985, Mester 1986
	Javanese	prenasalized stop formation	Dudas 1976
	KiKuria	vowel height assimilation	Cammenga 1994
	Sanskrit	<i>ruki</i>	Kiparsky 1982, Mester 1986, Whitney 1924 [1977]
	Sesotho	“strengthening”	McNally 1990
	Warlpiri	labial harmony	Nash 1980: 86, J. Beckman p.c.
	Yoruba	denasalization	Akinlabi 1984, Ladefoged 1968, Pulleyblank 1988
Allophonic Alternation	Javanese	medial <i>a</i> ~ final <i>ɔ</i>	Horne 1961, Dudas 1976, Kiparsky 1986, Yallop 1982
	Luisseño	<i>č</i> ~ <i>š</i>	Munro & Benson 1973, Anderson 1974, 1975, Davis 1976, Aronoff 1976, McCarthy 1979, Marantz 1982, Mester 1986
	Madurese	lax harmony nasal harmony	Stevens 1968, 1985, Mester 1986, Cohn 1993a, Cohn & Lockwood 1994
	Malay	nasal harmony medial <i>a</i> ~ final <i>ə</i>	Onn 1976 [1980], Kenstowicz 1981
	Rotuman	<i>a</i> umlaut [ATR] harmony	Churchward 1940 [1978], Besnier 1987, McCarthy 1995
	Sesotho	stress	McNally 1990 & references cited there
	Squamish	<i>i</i> lowering (by uvular)	Kuipers 1967, Wilbur 1973c
	Yapese	<i>a</i> umlaut	Jensen 1977, Kiparsky 1986

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