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Faithfulness and identity in prosodic morphology

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The prosody-morphology interface

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1. Introduction

The theory of Prosodic Morphology (PM)[1] addresses a range of empirical problems lying at the phonology-morphology interface: reduplication, infixation, root-and-pattern morphology, and canonical shape requirements (such as word minimality). Its goal is to explain the properties of these phenomena in terms of general, independently motivated principles of morphology, of phonology, and of their interface. If the enterprise is fully successful, then these principles alone will suffice, and there will be no PM-specific principles or apparatus lurking anywhere in linguistic theory. Put in this way, the goal of PM is the same as the rest of linguistic theory: to achieve greater empirical coverage and deeper explanation with fewer resources – in the happiest case, with no resources at all that are specific to the domain under investigation.

This program was initiated by identifying templates with prosodic categories, eliminating the freedom to stipulate the form of templates independent of the theory of prosodic forms. This is the Prosodic Morphology Hypothesis of McCarthy and Prince (1986). The successor to the Prosodic Morphology Hypothesis is Generalized Template Theory (McCarthy and Prince 1994a, b), which carries the explanatory goals of PM up to the next level: the elimination of templates *per se* in favor of widely applicable constraints on prosody, morphology, and their interface. In this view, typical templatic categories like the "Minimal Word" are given no independent status, but rather emerge in reduplicative contexts through appropriate ranking of constraints on foot parsing and grammar → prosody mapping (see section 4.3 below for discussion and illustration).

Another line of development in PM has been the study of infixation and related phenomena. The first effort at greater generality and explanation in this domain was the introduction of prosodic circumscription (McCarthy and Prince 1990) to connect the locus of infixation with extrametricality, which plays an independent role in the characterization of prosodic-structural domains. The theory of infixation and extrametricality has been much transformed by the perspective of Optimality Theory, and now infixation can be understood as the result of the domination of morphological affixal-placement constraints by prosodic-structural ones, all independently motivated (Prince and Smolensky 1991, 1993; McCarthy and Prince 1993a, b; McCarthy 1997a).

In these two areas, templates and infixation, the explanatory goals of PM have been advanced by first connecting PM-specific principles to external domains (prosodic structure, extrametricality), and then by eliminating the PM-specific principles and stipulations in favor of constraints of complete generality, ranked under Optimality Theory. This chapter follows the same course in relation to a third area of PM investigation: template satisfaction. Initially, template satisfaction under Optimality Theory was *sui generis*, based on a special relation of correspondence between a base and its reduplicative copy (called the "reduplicant").[2] Here we argue that correspondence should be generalized to include other kinds of linguistic relations, such as input-output faithfulness in particular (section 2). In this way, the apparatus of copying constraints is combined with faithfulness into a broadly applicable Correspondence Theory. The key notion underlying this generalization is "identity."

Reduplication is a matter of identity: the reduplicant copies the base. Perfect identity cannot always be attained, though; 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. This is "overapplication."[3] 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. This is "underapplication." Either way, a phonologically expected asymmetry between the base and the copy is avoided, and identity between the base and the copy is maintained. Phonological processes of all types, at all levels, have been observed to show such behavior.

Identity figures much more widely in phonology proper, though perhaps less obviously. According to Optimality Theory, *faithfulness* constraints demand that the output be as close as possible to the input, along all the dimensions upon which structures may vary (Prince and Smolensky 1993). Derivation is determined to a large degree by the interaction between faithfulness constraints, demanding identity, and constraints on output structural configurations, which may favor modification of the input, contravening faithfulness. Input-output faithfulness and base-reduplicant identity, we argue, are effectively the same thing, controlled by exactly the same set of formal considerations, played out over different pairs of compared structures. The interplay between them leads to a number of significant results concerning the direction of reduplicative copying (sections 4.2 and 4.3), the connection between Generalized Template Theory and Correspondence Theory (section 4.3), the typology of reduplication/phonology interactions (section 5), and underapplication (section 6). The conclusion (section 7) summarizes the results and offers some prospects for future work.

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 and Smolensky 1991, 1993). To provide a basis for the study of over- and underapplication, we need to develop a model of constraints on identity between the base and the reduplicant (expanding on McCarthy and Prince 1993a). These twin goals turn out to be closely related, since they are united in Correspondence Theory, thereby eliminating the need for special, distinct theories of input-output faithfulness and base-reduplicant identity.

The motivation for a unified theory of faithfulness and identity is particularly clear when we consider the range of parallels between them:

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 and Prince 1986, Pulleyblank 1988).

The parallel in the input-output domain is epenthesis, with default segments inserted 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 and 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 and Prince 1993a and references cited there): /tʰo/ → *tʰota*, **tʰato*; /ʈil/ → *ʈilta*, **ʈatil*, **ʈital*. Likewise, in Chukchee (Kenstowicz 1994, Spencer 1993), morpheme-edge epenthesis is preferred to morpheme-internal epenthesis: /miml-qaca-n/ → *mimləqacan*, **miməlqacan*. And in Diyari (Austin 1981, McCarthy and 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.

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 the *alignment* of edges of morphological and prosodic constituents (Prince and Smolensky 1991, 1993; McCarthy and Prince 1993a, b).

Featural identity

Copied segments in the base and the 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 *zaṃ–baṇin* (Voegelin 1935, Alderete *et al.* 1996).

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

This range of parallels is remarkable, and demands explanation. Linguistic theory must relate the constraints on the matching of reduplicant and base (the copying constraints) to the constraints on the 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 and 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 (UG) 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 (B-R) or input and output (I-O). To simplify the discussion, we focus on correspondence between strings.[4]

(1) Correspondence
Given two strings S_1 and S_2, *correspondence* is a relation $\Re$ 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 $\alpha \Re \beta$.

Here we will assume that the structural elements α and β are just (tokens of) segments, but it is a straightforward matter to generalize the approach to other units of phonological representation. For instance, correspondence of moras, syllables, feet, heads of feet, as well as tones, and even distinctive features or feature-class nodes, may be appropriate to support the analysis of quantitative transfer, compensatory lengthening, and floating features.[5]

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, circumscriptional, or truncating morphology (Benua 1995, McCarthy and Prince 1994b, McCarthy 1995), and they can be connected with the types of cyclic or transderivational relationships within paradigms explored by Benua (1995, 1997) and Burzio (1994a, b).

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. There is a correspondence relation for each (B, R) candidate-pair. There is also a correspondence relation for 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.[6] 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 (2a), we provide some (B, R) correspondences, and in (2b) 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.

(2) Hypothetical illustrations

a. Some B-R Correspondents

	Input = /RED–badupi/
$b_1 a_2 d_3 u_4 p_5 i_6 – b_1 a_2 d_3 u_4 p_5 i_6$	Total reduplication – perfect B-R correspondence.
$b_1 a_2 d_3 – b_1 a_2 d_3 u_4 p_5 i_6$ ʌ ʌ ʌ	Partial reduplication – *upi* in B has no correspondents in R.
$b_1 a_2 t_3 – b_1 a_2 d_3 u_4 p_5 i_6$ ʌ ʌ	The *t* in R has a non-identical correspondent in B, for phonological reasons (final devoicing).
$?\ a_2 d_3 – b\ a_2 d_3 u_4 p_5 i_6$ ʌ ʌ	The *?* is *not* in correspondence with the base-initial *b*. This is a type of fixed-segment reduplication (cf. Tübatulabal in Alderete *et al.* 1996).
$?_1 a_2 d_3 – b_1 a_2 d_3 u_4 p_5 i_6$ ʌ ʌ	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 = $/p_1 a_2 u_3 k_4 t_5 a_6/$
$p_1 a_2 u_3 k_4 t_5 a_6$	A fully faithful analysis – perfect I-O correspondence.
$p_1 a_2\ ?\ u_3 k_4 t_5 a_6$ ʌ	Hiatus prohibited by high-ranking ONSET, so epenthetic ? in O has no correspondent in I.
$p_1 u_3 k_4 t_5 a_6$ ʌ	Hiatus prohibited, leading to V-deletion. The segment a_2 in I has no correspondent in O.
$p_1 a_2 u_3 t_4 t_5 a_6$ ʌ	The k_4 in I has a non-identical correspondent in O, for phonological reasons (assimilation).
b l u r k ʌ ʌ ʌ ʌ ʌ	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 what is optimal, what is not, and what can never be optimal under any ranking of the constraints in UG.

2.2 Some 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 the string S_1 (base, input, etc.) to the string S_2 (reduplicant, output, etc.).

(3) The MAX constraint Family

General Schema

Every segment of S_1 has a correspondent in S_2.

Domain-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.)

(4) The DEP constraint family

General schema

Every segment of S_2 has a correspondent in S_1.

(S_2 is "dependent on" S_1.)

Domain-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.)

(5) 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 [γF], then β is [γF].

(Correspondent segments are identical in feature F.)

Domain-specific instantiations

IDENT-BR(F)

Reduplicant correspondents of a base [γF] segment are also [γF].

IDENT-IO(F)

Output correspondents of an input [γF] segment are also [γF].

Some constraints on other aspects of the correspondence relation are listed in the appendix. 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 (1996a, this volume) argues. It must be, then, that correspondence constraints are tied not only to specific dimensions (B-R, I-O), 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.

Now some comments on the specific constraints. MAX-IO is a reformulation of the constraint PARSE in Prince and Smolensky (1991, 1993) and other OT work, which liberates it from its connection with syllabification and phonetic interpretation. In addition, the MAX family subsumes the reduplication-specific MAX in McCarthy and Prince (1993a). Depending on which correspondence relation they regulate, the various MAX constraints will (*inter alia*) 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 and 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.

Various extensions of IDENT have emerged from continuing research. One, proposed by Pater (this volume), differentiates IDENT(+F) and IDENT(–F) versions for the same feature; the typological consequences of this move for the present theory are taken up in section 5.4 below. Another, adopted by Urbanczyk (1996a), posits identity of moraic analysis of correspondent segments. Extensions of IDENT to other aspects of prosodic structure are treated in Benua (1995) and McCarthy (1995). Another important development, pursued by Alderete (1996), Beckman (1997), and Selkirk (1995), is differentiation of IDENT and other correspondence constraints by position: onset versus coda, stressed versus unstressed, root versus affix.[7] The first-named, more prominent position typically receives more faithful treatment, as evidenced by phenomena of position-sensitive neutralization. Finally, in the light of work in feature geometry (Clements 1985b, Padgett 1995a, etc.), it is plausible that constraints of the IDENT family will quantify over classes of features.

The IDENT constraint family is constructed here on the assumption that segments alone stand in correspondence, so identity of features is always demanded indirectly, through the segments bearing those features. As we noted above, it is a reasonably straightforward matter, though, to extend the correspondence relation to features as well as segments. Then the constraint IDENT(F) would be replaced by the MAX(F)/DEP(F) pair, plus an apparatus of additional constraints to ensure faithfulness of features to their original segmental associations. Featural correspondence is arguably necessary to deal with some floating feature phenomena (Zoll 1996) and with entailments between segmental and featural deletion (Lombardi 1995).

In section 2.1 we listed many parallels between B-R Identity and I-O Faithfulness. These parallels now have an explanation: they follow from the fact that both B-R and I-O are related by correspondence and that identical constraint types apply to each (and to other domains of correspondence as well).

There is an important further parallel to be drawn, which the generality of correspondence affords us. The correspondence constraints proposed above and in the appendix are strongly reminiscent of some principles and rules of autosegmental association. For example, MAX, DEP, and LINEARITY recall the clauses of Goldsmith's (1976) Well-Formedness Condition: every tone-bearing element is associated with some tone; every tone is associated with some tone-bearing element; association lines do not cross. Likewise, CONTIGUITY and ANCHORING can be analogized to the requirement of directional one-to-one linking and the Initial Tone Association Rule in Clements and Ford (1979). These parallels are explained if we generalize correspondence still further, to include not only identity relations (like I-O and B-R) but also the relation of autosegmental association. The phenomena comprehended by the theory of autosegmental association are therefore a special case of correspondence.[8]

These parallels, and the consequent reduction of autosegmental association to correspondence, recapture one of the original ideas of Prosodic Morphology, one which was lost in the solely reduplicative correspondence theory of McCarthy and 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 and 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 Correspondence theory and the PARSE/FILL Model

Most work within OT since Prince and Smolensky (1991, 1993) 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 and Prince 1993a;[9] 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.

Because they reduce the prohibition on deletion to an easily stated structural constraint, these moves provide a direct and convenient way to handle a variety of basic cases. But this is by no means the only possible approach to faithfulness in OT (cf. Prince and Smolensky 1993: 25, note 12; Yip 1993; Myers 1993; and Kirchner 1993 for some other 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 afterwards. OT's architecture admits this as a possible line of attack on the problem, but since all manners of alteration 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 correspondence relations. An immediate (and desirable)[10] 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 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 over-application in the reduplicative theory.

Much OT work since Prince and Smolensky (1991) assumes as well that no segment can be literally *added* to the output. Phonological epenthesis is seen 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 and Kaye (1985), and Itô (1986, 1989). 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 (or better satisfy) the driving syllabic constraints. (See Prince and Smolensky 1993, ch. 9, Smolensky 1993, McCarthy 1993, and McCarthy and Prince 1994a for relevant discussion of featural markedness in epenthetic segments.) In addition, the actual featural value of epenthetic segments can figure in phonological generalizations (Spring 1994, Davis 1995), as is known to be the case in many situations (for example, Yawelmani Yokuts harmony, discussed in Kuroda 1967 and Archangeli 1985). This contrasts sharply with the FILL theory, in which the feature composition of epenthetic segments is determined post-phonologically, 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.[11] Correspondence also allows us to explain why certain constraints, such as Myers's tonal OCP, are totally insensitive to the 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 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, as several of the other contributions to this volume make clear. Readers interested in further exploring these matters might begin with the following (non-exhaustive) list: Agbayani and Harada (1996); Bat-El (1996); Beckman (1997); Beckman *et al.* (1995); Benua (1997); Burzio (1997); Bye *et al.* (1996); Chen (1996); Fulmer (1997); Gerfen (1996); Gnanadesikan (1997); Green (1997); Hermans and van Oostendorp (to appear); Itô, Kitagawa, and Mester (1996); Itô and Mester (1997); Kim (1997); Letterman (1997); Myers and Carleton (1996); Orgun (1996a, b); Spaelti (1997); Zoll (1996). All are relatively accessible, contain significant discussion of topics in Correspondence Theory, and provide further pointers to the literature.

3. Approaches to reduplication/phonology interaction

3.1 Reduplication/phonology interaction in Correspondence Theory

The full theory of reduplication involves correspondence between underlying stem and surface base, between surface base and surface reduplicant, and between underlying stem and surface reduplicant. The following diagram portrays this system of relations:

(6) Full Model

$$\begin{tikzcd} \text{Input} & & /\mathrm{Af}_{\mathrm{RED}} + \mathrm{Stem}/ \arrow[dl, leftrightarrow, "\textit{I-R Faithfulness}"'] \arrow[d, leftrightarrow, "\textit{I-B Faithfulness}"] \\ \text{Output} & \mathrm{R} \arrow[r, leftrightarrow, "\textit{B-R Identity}"'] & \mathrm{B} \end{tikzcd}$$

In keeping with our practice so far, we will continue to employ a purely terminological distinction between identity and faithfulness, but we do this 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 McCarthy and Prince (1995: section 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 and Prince (1993a).

(7) Basic Model

$$\begin{tikzcd} \text{Input} & /\mathrm{Af}_{\mathrm{RED}} + \mathrm{Stem}/ \arrow[d, leftrightarrow, "\textit{I-O Faithfulness}"] \\ \text{Output} & \mathrm{R} \rightleftarrows \mathrm{B} \\ & \textit{B-R Identity} \end{tikzcd}$$

The Basic Model will be the major focus below; for extension to the Full Model, see McCarthy and Prince (1995: section 6).

The identity-preserving interactions between phonology and reduplication were named overapplication and underapplication in the pioneering work of Wilbur (1973a, b, c). 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 descriptive sense. A phonological mapping will be said to overapply when it introduces, in reduplicative circumstances, a disparity between the output and the lexical stem[12] that is not expected on purely phonological grounds. To put it even more neutrally, we can say that, in a situation where there is a two-way opposition between a marked element of limited distribution and an unmarked default element, overapplication is the appearance of the marked element outside of its normal distributional domain. A typical example is given in (8).

(8) Overapplication in Madurese nasal harmony (Stevens 1968, 1985; Mester 1986: 197–200)

Stem	Simple	Reduplicated	Expected	Gloss
/neat/	nẽỹãt	ỹãt-nẽỹãt	*yat-nẽỹãt	"intentions"

A nasal span runs rightward from nasal consonants (column two). In the reduplicated form (column three), nasal spreading in the base is replicated in the reduplicant, even though the triggering nasal consonant is not copied. If reduplication were thought of as copying the underlying form of the base, the expected result would be the one in column four; it is from this perspective that nasal harmony is thought to overapply to force nasalized *ỹ* and *ã* in the reduplicant. Regardless of the mechanism involved, the effect is to introduce an unexpected disparity between the presumed lexical stem and the output – the presence of the nasalized *ã*. In terms of the surface repertory, we can say that the marked member of the *ã*/*a* opposition is found outside its canonical, post-nasal position.

Similarly, a phonological process will be said to underapply when there is a *lack* of expected disparity between the input stem and the output. In the most straightforward case, this amounts to the unmarked member of an opposition putting in an appearance where the marked member is expected. Akan reduplication provides a typical example: palatalization fails to apply in the reduplicant when it is not phonologically motivated in the base:

(9) Underapplication in Akan (Christaller 1875, Schachter and Fromkin 1968, Welmers 1946)

	Stem	Reduplicated	Expected	Gloss
a.	ka?	kɪ-k̲a̲?	*t̲ɕ̲ɪ-k̲a̲?	"bite"
b.	haw?	h̲ɪ-h̲a̲w̲?	*ɕ̲ɪ-h̲a̲w̲?	"trouble"

Though Akan typically disallows velars and other back consonants before front vowels, the offending sequence is found in reduplicated forms like *kɪ-ka?*. 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. Put in markedness terms, the unmarked member of *k/tɕ* appears here not in its default environment, but in a position where, it seems, the marked member is required. 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:

(10) Normal application in Tagalog (Carrier 1979: 149f.)

	Stem	Reduplicated	Over	Under	Gloss
a.	datiŋ	d̲-um-ā-ɾatiŋ	*ɾ̲-um-ā-ɾatiŋ	*d̲-um-ā-d̲atiŋ	"arrive"
b.	diŋat	ka-ka-ɾiŋat-d̲iŋat	*ka-ɾiŋat-ɾiŋat	*ka-d̲iŋat-d̲iŋat	"suddenly"

As with underapplication and overapplication, 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, the typology we develop below (section 5) includes circumstances where the theory does not always admit normal application as an option (see also McCarthy and Prince 1995: section 3.2).

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 Madurese 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 reduplicant-base 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.

Working within the Basic Model, (7), we will sketch the overall lie of the land. The 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 Madurese V~Ṽ and Akan *k~tɕ*. With B-R Identity constraints dominant, we need only take seriously those candidates in which base and reduplicant actually match. With the relevant phonological constraints dominant as well, overapplication can result. Consider the Madurese case, which offers the following comparison of potential outputs:

(11) Overapplication of nasal harmony in Madurese (from /neat/)

	Candidate	Chief Flaw	Remarks	Type
a. ☞	ỹãt-nẽỹãt	*I-O Faithfulness: nasal V in stem	Forced violation	Over
b. *	yat-nẽyat	*Phonological constraint against NV_{Oral}	Fatal	Under
c. *	yat-nẽỹãt	*B-R Identity	Fatal	Normal

The sequence NV_{Oral} is disallowed in the language, where N = any nasal segment, including nasalized vowels and glides. The doubly nasalized form, (11a), is optimal, because it achieves perfect identity of base and reduplicant while still avoiding the forbidden sequence. The cost is the introduction of extra marked segments – nasal vocoids – into the representation; indeed, into an environment where they are not tolerated elsewhere in the language. Such considerations lead to a ranking requirement on this kind of overapplication. which characterizes the interplay among constraints on B-R Identity and markedness relative to some structural condition, "Phono-Constraint" (Phono-Con).

(12) An overapplication ranking pattern
B-R Identity, Phono-Constraint ≫ Markedness

This ranking asserts that reduplicative identity and some phonological requirement (like the prohibition on NV_{Oral}) both take precedence over another phonological requirement, here the markedness constraint against nasality in vocoids. (This accords with the observation that in case of a simple marked versus unmarked contrast, classic overapplication involves the otherwise unexpected appearance of a marked element.) The primacy of base-reduplicant identity leads here to overapplication, examined in section 4. The responsible rankings, including (12) and others that involve conflict between B-R Identity and I-O Faithfulness, are examined and refined in the factorial typology of section 5.

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 (11a) and (11b): *ỹãt-nẽỹãt*, versus **yat-nẽyat*. 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 ≫ I-O Faithfulness must be maintained. In Madurese, this is what yields nasal spread in the language at large. With Phono-Constraint as the final arbiter, overapplication must result, because the underapplicational 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 or reversion of the reduplicant to a less marked repertory, however, remains an option, when B-R Identity is crucially subordinated. In this case, reduplicative identity cannot compel the extension of phonology from base to reduplicant, or vice versa. Base and reduplicant therefore enjoy an independence measured by the number and kind of B-R Identity constraints that are crucially subordinated.

The theory, then, basically distinguishes two conditions: one in which B-R Identity is respected (to some degree, along certain dimensions), yielding overapplication; and one in which B-R Identity is set aside, yielding normal application or reversion to the unmarked in the reduplicant. The choice between under- and overapplicational candidates must be made on grounds other than B-R Identity. In the Madurese case just reviewed, the overapplicational candidate is chosen because it alone satisfies the phonological constraint banning NV_{Oral} while maintaining the required level of identity. How, then, does classic underapplication come about? It can only be that another independent constraint excludes the naively expected result, and that we are really looking at overapplication involving that other constraint.

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 (see McCarthy and Prince 1995: section 5 for the details). Indeed, one might expect the OCP to figure 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. Here and in McCarthy and Prince (1995: section 5) we argue that all proposed cases of underapplication are of this type, leading to a schema along these lines (where C stands for, for example, the relevant subcase of the OCP that is visibly active in Akan).

(13) A skeletal ranking for underapplication as overapplication
B-R Identity, C ≫ Phono-Constraint ≫ I-O Faithfulness

This ranking results in underapplication, because the mapping due to the subhierarchy Phono-Constraint ≫ I-O Faithfulness is blocked in certain circumstances by C, and reduplication happens to provide 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 C is to avoid the mapping triggered by Phono-Constraint. Thus, the full phonology – the mapping involving C – is *overapplied*. This line of argument is pursued in section 6.

A further significant property of Correspondence Theory emerges from the 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 a 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, when B-R Identity crucially dominates I-O Faithfulness, the base will be predicted to copy the reduplicant. An overapplicational case of this type (Malay) is examined in section 4.2; others can be found in McCarthy and Prince (1995: section 3.6 to section 3.8, section 5.3). (Lushootseed may be yet another overapplicational case; see Urbanczyk 1996a, this volume.) Such analyses offer 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- or underapplication, 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.

3.2 Correspondence Theory in relation to earlier work

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-muːtul] "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 ⋗).

(14)	Root	/puːtul/
	Prefixation	paN-puːtul
	⋗Nasal Substitution	pa-muːtul
	⋗Reduplication	pa-<u>mu</u>-<u>mu</u>ːtul

The reduplicative copying operation targets the transformed root *muːtul*, rather than the underlying root /puːtul/. 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. 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 (because its context is only met through later affixation, including reduplication itself), then by the principle of strict serialism, it has forever lost its chance to apply; underapplication results. Normal application is obtained when the phonological process applies after reduplicative copying.

Ordering Theory first emerges in generative phonology with analyses of Akan by Schachter and Fromkin (1968: 162) and of Luiseño by Munro and Benson (1973). The theory is worked out in detail by Wilbur (1973a, b), and since then has been accepted almost universally. It has engendered a very substantial secondary literature, including detailed treatments by Aronoff (1976: 72–78); Carrier-[Duncan] (1979; 1984); Kiparsky (1986); Marantz (1982); and Shaw (1976 [1980]); as well as less comprehensive discussions by Anderson (1974, 1975); Hollenbach (1974); Odden and Odden (1985); Schlindwein (1991); Sietsema (1988); Steriade (1988: 107–108). This body of work has been extremely important in defining the character of the problem and engendering insights into its properties. It has achieved substantial analytic and descriptive success.

The basic Ordering Theory gives an appealing account of reduplicative phonology: either phonology precedes reduplication, or reduplication precedes phonology. In section 4 and McCarthy and Prince (1995), we 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 instead find effects that depend crucially on parallel development of the base and reduplicant, in Malay, Tagalog, and Southern Paiute below, and in Axininca Campa, Chumash, Kihehe, and Klamath in McCarthy and Prince (1995).

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 then *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 somewhat 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:

> 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 (1973a: 115–17)

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, yielding overapplication. Or rules can demand that both mates meet the structural description, leading to underapplication when only one mate satisfies it. This second possibility arises from a key difference between Wilbur's proposal and the theory pursued here: by fundamental architectural construction, only *faithfulness* constraints work off correspondence. There is no way of stipulating that a structural constraint is violated only if its preconditions are met simultaneously in base and reduplicant; were this statable, it would parallel Wilbur's mate condition on satisfaction of the Structural Description of a rule. It follows that there can be no analogue of classic underapplication in the present theory. Finally, normal application is permitted in Wilbur's approach, because rules can also ignore the mate relation, applying freely in ways that disrupt identity of reduplicative mates. 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 1970s and 1980s. 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. In contrast, the Ordering Theory of phonology/reduplication interaction requires nothing except what early generative phonology had in abundance: serial ordering of rules.

For this reason, it is not surprising that the Global Theory received relatively little attention in later work[13] and that there has been a decided preference for solutions based on Ordering Theory. A significant exception to this trend is the structural approach to base-reduplicant relations, studied in depth by Mester (1986: ch. 3), as well as variations in work by Clements (1985a), Hirschbühler (1978: 118–21), McCarthy (1979: 373–87, 1983, 1985), McCarthy and Prince (1986: 102–108), Pulleyblank (1988: 265–67), Tateishi (1987), and Uhrbach (1987). Mester's work is particularly relevant 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.[14] 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.[15]

Though the Global Theory cannot be reconciled with the serial derivation that is typical of earlier work in phonological theory, more recent developments have greatly altered the field in which this matter is played out. Since the mid-1970s, 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 1995b 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 and Smolensky 1993). Inputs are mapped directly to outputs, in an essentially flat derivation whose outcome is determined by a parochial constraint hierarchy.

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 are not surface true (cf. Bromberger and 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 and 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.

4. Correspondence Theory and overapplication

In this section, we analyze overapplication under Correspondence Theory. We begin (section 4.1) with a relatively straightforward case, Madurese nasal harmony, where a phonological process active in the base is paralleled in the reduplicant. We then turn (section 4.2) to phenomena that prove the descriptive superiority of Correspndence Theory to Ordering Theory. These include *back-copying*, in which phonology that is derived in the reduplicant is replicated in the base, and copying of phonology that occurs at reduplicant-base juncture. The possibility of back-copying raises a signficant issue in connection with reduplicative templates, and this is addressed in section 4.3. Finally, section 4.4 sums up the results.

4.1 Simple overapplication: Madurese nasal harmony

In Madurese, nasality extends rightward from a primary nasal segment until it encounters an oral obstruent. It spreads to vowels, *y*, and *w*, and passes unimpeded through *ʔ* and *h*. Such nasal spans are the only environment in which nasalized vowels and glides appear – except for reduplication. The reduplicant will have nasalized vocoids to echo those in the base, even when the triggering nasal consonant is present only in the base (Stevens 1968, 1985; Mester 1986: 197; McCarthy and Prince 1995):

(15) Nasalization and reduplication in Madurese

	/neat/	ỹãt-nẽỹãt	"intentions"
	/moa/	w̃ã-mõw̃ã	"faces"
	/maen-an/	ẽn-mãẽn-ãn	"toys"
	/ŋ-soon/	ɔ̃n-nɔ̃ʔɔ̃n	"request (verb)"
cf.	/soon/	ɔn-sɔʔɔn	"request (noun)"

The final example confirms that nasality does not spread leftward. Indeed, the nasalized portion of the reduplicant in *ỹãt-nẽỹãt* isn't even adjacent to a nasal consonant. Thus, there is no explanation, other than copying, for the nasality in the prefixed reduplicant. (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 with a characterization of the relevant phonological infrastructure.

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

(16) $*V_{Nas} \gg *V_{Oral}$

According to Prince and Smolensky (1993: ch. 9), pretheoretic ideas of featural markedness reflect universally fixed rankings, as in (16), of constraints against featural combinations, rather than underspecification or privativity. The universal ranking (16) 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 (16) are ineffectual unless they dominate a relevant faithfulness constraint. In the case at hand, we have:

(17) $*V_{Nas} \gg$ IDENT-IO(nas)

The constraint IDENT-IO(nas) requires that segments in I-O correspondence show exactly the same value of nasality (see section 2.2, (5) for the family of IDENT constraints).

The effect of the hierarchy in (17), 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 *bã*:

(18) $*V_{Nas} \gg$ IDENT-IO(nas)

/bã/	$*V_{Nas}$	IDENT-IO(nas)
a. ☞ ba		
b. bã	*!	

Denasalization occurs, due to compelled violation of IDENT-IO(nas). Any nasal vowel or glide will be mapped to its nonnasal counterpart. Under natural assumptions about lexicon optimization (Prince and Smolensky 1993: ch. 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 – postnasally – in violation of the segmental markedness constraint $*V_{Nas}$. We assume that nasal vocoids are compelled by a constraint $*NV_{Oral}$, which militates against the sequence [+nas]⁀[–nas, vocalic]:[16]

(19) $*NV_{Oral}$
*[+nas]⁀[–nas, vocalic].

This constraint must dominate $*V_{Nas}$, because it forces the presence of nasal vowels in the output. It also dominates IDENT-IO(nas), because it must also be able to force a change in nasality: any input oral vowel must gain nasality in a postnasal context. In addition, the complete hierarchy must dispose of all other faithfulness constraints whose violation would aid in the satisfaction of $*NV_{Oral}$ – 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 F'(nas) to indicate this class of constraints, we have the following as the full hierarchy:

(20) $*NV_{Oral}$, F'(nas) $\gg$ $*V_{Nas}$ $\gg$ IDENT-IO(nas), $*V_{Oral}$

The constraints in the faithfulness set F' (nas) must dominate $*V_{Nas}$, because they speak to ways of satisfying $*NV_{Oral}$ other than by introducing nasal vowels.

The effects of the hierarchy in (20) are illustrated in the following tableau, which examines the fate of various candidates from underlying /na/.

(21) /na/ → nã

/na/	$*NV_{Oral}$	F' (nas)	$*V_{Nas}$	IDENT-IO(nas)
a. ☞ nã				
b. na	*!			
c. 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 1994 and Kirchner 1995 for parallel developments.) The alternation is allophonic because no hypothetical lexical contrast between V_{Nas} and V_{Oral} can survive to the surface. A potential input /bã/, just like an input /ba/, will surface as *ba*; underlying /na/, just like /nã/, as *nã*. As a structuralist analysis would assert, no phonemic contrast between /ã/ and /a/ is possible.

The hierarchy in (20) characterizes, *via* constraint ranking, a 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 (16) which asserts, by fixing a ranking in Universal Grammar, that nasalized vowels are more marked than oral ones. Generalizing from the allophonicity schema (20) and the markedness relation (16), 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 α ~ β alternation. In this way, Optimality

Theory relates observations about the 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 $*NV_{Oral}$ in (20)), 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.

A final representational question arises: 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 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 crucially lexical constraint *β that bars one segment type, say β, from all underlying representations; and a rule α→β/E__F that introduces lexically banned β in another component (the phonology).[17] OT shifts the burden of explanation to output constraints, thereby removing the lexical situation from the explanatory focus. Under OT, *β is recognized as an output constraint – a structural markedness constraint – as is *EαF, 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 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 and Smolensky 1993: chs. 4, 9) than in previous conceptions. For further discussion, see also Stampe (1972), Dell (1980), and Itô, Mester, and Padgett (1995).

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

(22) Nasalization and reduplication in Madurese

/neat/	ỹãt-nẽỹãt	"intentions"
/moa/	w̃ã-mõw̃ã	"faces"

No independent word could have the form *ỹãt*, as is predicted by the constraint hierarchy just developed. The independent appearance of *ỹãt*, *w̃ã* and the like can only be an effect of a reduplication-specific constraint, demanding featural identity between base and copy. Several possibilities exist for the exact formulation of the crucial constraint: does the constraint demand identity in all features, in some subset of features, or just in the feature [nasal]? Here we conservatively characterize the constraint as demanding identity only in the feature [nasal]:[18] IDENT-BR(nas). IDENT-BR(nas) must dominate $*V_{Nas}$, thereby compelling nasalized vocoids to appear in places where they are not otherwise allowed. 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:

(23) Full ranking for nasality in Madurese

IDENT-BR(nas) $*NV_{Oral}$ *F′*(nas)

$*V_{Nas}$

IDENT-IO(nas)

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

(24) /RED + neat/ → *ỹãt-nẽỹãt*

/RED + neat/	IDENT-BR(nas)	$*NV_{Oral}$	$*V_{Nas}$[19]	IDENT-IO(nas)
a. ☞ ỹãt-nẽỹãt				
b. yat-nẽyat		*!		
c. yat-nẽỹãt	**!			

The imposition of B-R Identity eliminates the phonologically transparent form (c), in which nasal vocoids only occur postnasally. 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 (**nẽyat*). (Recall that $*NV_{Oral}$ is violated whenever a nasal segment is immediately followed by an oral vowel or glide.) Only form (a) succeeds in achieving the requisite identity of base and reduplicant, while also satisfying the dominant phonological constraint $*NV_{Oral}$ 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 *ỹãt-nẽỹãt* 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 antinasal constraint $*V_{Nas}$, identity of base and reduplicant infringes on the perfection of complementary distribution; the system is allophonic except in this special circumstance. Identity-driven interactions of this type are common in reduplicative morphology (see appendix B of McCarthy and Prince 1995 for a list of cases) and in truncating and "cyclic" morphology as well (Benua 1995, 1997).

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 *over*applies, 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 $*V_{Nas} \gg$ IDENT-IO(nas). Thus, the analysis here could be better described, in terms internal to the present theory, as involving underapplication, or blocking, of denasalization (see section 5.4 below for further discussion of this point).

Because OT is inherently typological in nature, it is important to scrutinize the analysis for predicted interlinguistic variation through permuted ranking (see section 5 for a more fine-grained version of the typology). Holding the basic phonology constant, the B-R Identity constraint can be intercalated at various positions in the ranking. A glance at tableau (24) 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} ≫ 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 a kind of *normal application*, in which the reduplicant correspondents revert to their unmarked state along the nasal dimension, as exemplified in candidate (24c) **yat-nẽỹãt*.

There is yet a third type of candidate, **yat-nẽyat*, (24b), 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; or more neutrally yet, an unmarked element appears in a context where a marked element is generally demanded. As we have emphasized, it is impossible to produce this effect by reranking of B-R Identity constraints. The constraint *NV_{Oral} must be crucially dominated to elevate the classically underapplicational candidate (24b), **yat-nẽyat*; yet no matter where it sits in the hierarchy, Ident-BR(nas) simply cannot interfere with the effectiveness of *NV_{Oral}. The choice between the two candidates respecting B-R Identity – here, *ỹãt-nẽỹãt* and *yat-nẽyat* – 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} ≫ *V_{Nas} and this dooms all output representations containing oral vocoids in a postnasal environment. Thus, the correspondence theory of faithfulness entails an important general limitation: classical underapplication can never be achieved by reranking of B-R Identity; *some other constraint must be involved*. We believe this to be a correct result, and we return in section 6 to the interpretation of underapplication phenomena.

From these examples, 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 are responsible.

Under Ordering Theory (section 3.2), any phonological process that overapplies must occur prior to reduplication, as in the following schematic derivation for Madurese nasal harmony:[20]

(25) Madurese nasal harmony, serially

Underlying Form	/neat/	
Glide Epenthesis	neyat	
Nasal Harmony	nẽỹãt	
Reduplicative Copy	ỹãt-nẽỹãt	
Surface Form	ỹãt-nẽỹãt	Matched nasality

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 noneffects of re-ranking in parallel OT are not the same as those of reordering under operational serialism. Indeed, there are circumstances where only overapplication is possible (see the discussion of Madurese glide copy in McCarthy and Prince 1995: section 3.2). In such cases, Correspondence Theory predicts a more limited range of possibilities than Ordering Theory.

4.2 Parallelism in reduplicative correspondence

There are circumstances where Correspondence Theory predicts a wider range of interactions than can be accommodated in serial theories. These involve effects deriving from parallel evaluation of output forms for phonology and goodness of B-R Identity. Two types can be observed, back-copying and copying of phonology that is derived at the reduplicant-base juncture.

In Tagalog *pa-mu-mu:tul*, the phonology of the reduplicant is transmitted back to the base by correspondence, an outright impossibility in operational theories, where the reduplicant copies the base and not vice versa. This is back-copying, and the analysis of it relies on parallel evaluation of the phonology of the reduplicant and the B-R match. Here, schematically, is the Tagalog situation (see also section 5.3):

(26) 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		*!	

Form (26a) simply fails to show the effects of Phono-Con, which is responsible for the nasal substitution process (on which see Pater this volume). Form (26c) is an instance of so-called normal application, with B-R mismatch. The actual output form (26b) satisfies B-R Identity but pays the price of violating low-ranking I-O Faithfulness, because the surface form of the base is different from its underlying form. This alternation in the base produces a good base-reduplicant match, back-copying the effect of a phonological process from the reduplicant to the base.

In general, back-copying will occur whenever the reduplicant undergoes a phonological process and, by virtue of the ranking B-R Identity ≫ I-O Faithfulness, the effects of that process are transmitted from reduplicant to base. No version of Ordering Theory can make sense of such interactions, except sometimes by the expedient of dodging them entirely (as in the Bloomfieldian derivation (14), with postphonological infixation of the reduplicative morpheme). Yet back-copying interactions are by no means uncommon; see the discussion of Southern Paiute below (section 6) and of Axininca Campa, Chumash, Kihehe, and Klamath in McCarthy and Prince (1995).

Perhaps even more striking are cases where the transmitted phonology occurs at the reduplicant-base juncture itself (a phenomenon whose significance was first noted by Wilbur 1973a, c). Under parallelism, the reduplicant can provide an environment that determines properties of the base, which must then, by correspondence, also appear in the reduplicant itself. Similarly, the base can impose phonology on the reduplicant, which is back-copied to the base. But Ordering Theory excludes back-copying entirely and allows no interaction between the reduplicant and

the base until after the reduplicant has been brought into existence by the copying operation, after which it is too late to do anything about base-reduplicant identity. Thus, these effects raise severe difficulties for Ordering Theory, and, if well-substantiated, provide definitive evidence in favor of reduplicative Correspondence Theory.

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. Wilbur (1973a, c) 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: 114) and Kenstowicz (1981) provide the example of nasal harmony in Malay, and we will examine it closely here.

The basic distribution of nasality in Malay is identical to Madurese (see section 4.1): nasal and oral vocoids are in complementary distribution, with nasals appearing only in a postnasal environment. As in Madurese, base and reduplicant are featurally identical, and thus the very same constraint hierarchy (23) must be at work. In Malay, however, nasal spreading also applies across the reduplicant-base juncture. This establishes the precondition for the kind of interactions we're interested in. The consequences for reduplication are shown below:

(27) Malay reduplication[21]

hamə̃	hãmə̃-hãmə̃	"germ/germs"
waŋĩ	w̃ãŋĩ-w̃ãŋĩ	"fragrant/(intensified)"
aŋãn	ãŋãn-ãŋãn	"reverie/ambition"
aŋẽn	ãŋẽn-ãŋẽn	"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, nasality spreads from the *ŋ* of /waŋɪ/ rightward to yield *waŋĩ*. But in *w̃ãŋĩ-w̃ãŋĩ*, the nasal span anchored in the first *ŋ* runs across the R-B juncture, incorporating the following *wa* in the base; and the nasalization of the second instance of *w̃ã* compels the first *w̃ã* to nasalize, extraphonologically, as well.

Observe that nasality spreads only to the right: witness examples like *tahan/mə̃nãhãn* "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*. Since there is no leftward spreading, the only possible source of nasality in the first syllable of *w̃ãŋĩ-w̃ãŋĩ* is reduplicative identity – its nasality matches the phonologically motivated nasality of its correspondent in the second conjunct.

Because reduplication is total, it is unclear from available information which conjunct is the reduplicant and which is the base. We will explore both alternatives, showing that the difference has essentially no significance for the analysis under Correspondence Theory.

Let us first assume that reduplication is pre-positive, with the order R+B. The copying of nasality follows directly from the hierarchy in (23) above. The important candidates are contrasted here:

(28) Malay reduplicative identity, assuming pre-positive reduplication

/RED–waŋi/	IDENT-BR(nas)	$*NV_{Oral}$	$*V_{Nas}$	IDENT-IO(nas)
a. ☞ <u>w̃ãŋĩ</u>$_R$-<u>w̃ãŋĩ</u>$_B$				
b. <u>waŋĩ</u>$_R$-<u>waŋĩ</u>$_B$		*!		
c. <u>waŋĩ</u>$_R$-<u>w̃ãŋĩ</u>$_B$	**!			

In forms (28a) and (28b), reduplicant and base match in nasality. Form (28b) is out for very general reasons, discussed above, in reference to tableau (24): B-R Identity can never block a dominant phonological constraint in its native environment. Candidate (28c) exemplifies normal application, which can be achieved *via* subordination of B-R Identity. In fact, B-R Identity is undominated, so candidate (28a) 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.

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:

(29) Serial Theory: reduplication precedes phonology (assuming R+B)

Underlying Form	/RED–waŋi/	
Copy	<u>waŋi</u>–waŋi	
Spread Nasal	waŋĩ–<u>w̃ãŋĩ</u>	
Outcome	*waŋĩ–w̃ãŋı	Mismatched nasality

(30) Serial Theory: phonology precedes reduplication (assuming R+B)

Underlying Form	/RED-waŋi/	
Spread Nasal	RED-waŋ<u>ĩ</u>	
Copy	<u>waŋĩ</u>-waŋĩ	
Outcome	*waŋĩ-waŋĩ	Matched orality

When reduplication precedes, as in derivation (29), normal application is the result, echoing the outcome when B-R Identity is crucially subordinated. When phonology precedes, as in derivation (30), the result is underapplication of nasal spreading, a pattern not obtainable by any ranking in Correspondence Theory. 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 reapply. 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 (29), on the (random) assumption that Copy gets the first crack:

(31) Persistent Serial Theory: derivation I (assuming R+B)

Underlying Form	/RED-waŋi/	
Copy	<u>waŋi</u>-waŋi	
Spread Nasal	waŋĩ-<u>w̃ãŋĩ</u>	
Copy	<u>w̃ãŋĩ</u>-w̃ãŋĩ	
Outcome	w̃ãŋĩ-w̃ãŋĩ	Matched nasality

If, on the other hand, Spread Nasal applies first, we must extend derivation (30), and assume as well that Spread is also persistent:[22]

(32) Persistent Serial Theory: derivation II (assuming R+B)

Underlying Form	/RED-waŋi/	
Spread Nasal	/RED-waŋĩ/	
Copy	<u>waŋĩ</u>-waŋĩ	
Spread Nasal	waŋĩ-<u>w̃ãŋĩ</u>	
Copy	<u>w̃ãŋĩ</u>-w̃ãŋĩ	
Outcome	w̃ãŋĩ-w̃ãŋĩ	Matched nasality

The Persistent Serial 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:

(33) Malay reduplicative identity, assuming post-positive reduplication

/waŋi-RED/	IDENT-BR(nas)	*NV$_{Oral}$	*V$_{Nas}$	IDENT-IO(nas)
a. ☞ w̃ãŋĩ$_B$-w̃ãŋĩ$_R$				
b. waŋĩ$_B$-waŋĩ$_R$		*!		
c. waŋĩ$_B$-w̃ãŋĩ$_R$	**!			

The only difference is that candidate (33c) 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:

(34) Persistent Serial Theory (assuming B+R)

Underlying Form	/waŋi-RED/
Spread Nasal	waŋĩ-RED
Copy	waŋĩ-waŋĩ
Spread Nasal	waŋĩ-w̃ãŋĩ
Copy	waŋĩ-*waŋĩ*
Spread Nasal	waŋĩ-w̃ãŋĩ
Copy	waŋĩ-*waŋĩ*
etc...	... ...

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*$_B$-*w̃ãŋĩ*$_R$, thereby triggering yet another round of Copy, which triggers another hit from Spread Nasal, triggering yet another round of reduplicative copying, *ad infinitum*. The derivation, in short, does not converge;[23] 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 ceases to be well defined, in the general case. In sharp contrast, identity constraints are perfectly well behaved in nonserial OT.

The interaction of nasal spread and reduplicative identity in Malay provides a compelling argument in favor of the parallel-evaluation Correspondence Theory. If 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 reapply a rule and extend the derivation; these criteria mirror those in Correspondence Theory. The burden of proof falls on the speculative iterativist to demonstrate that reduplicative Correspondence Theory need not be recreated entire within Persistent Serialism. Even more seriously, the notion "output of a derivation" falls prey to endless iterative looping in one plausible range of cases; this indicates that Persistent Serialism, driven by identity conditions, may well not even be minimally workable as a linguistic theory.

To sum up, the material from Malay 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 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 pattern (and back-copying, as in Tagalog) emerges directly from parallel evaluation of fully formed outputs.

4.3 Back-copying and Prosodic Morphology

Correspondence Theory entails, as one of its central claims in the reduplicative realm, that there is symmetry of base-reduplicant identity. In overapplication situations, the base may be altered to match the reduplicant, just as the reduplicant is altered to match the base. This assumption follows from the conceptual structure of the theory. It is also essential to the analysis of back-copying cases like Tagalog /paN+RED+putul/ → *pa-mu-muːtul*, where the process of nasal substitution affects the reduplicant and, through high-ranking B-R Identity, the base is altered to match the nasal in the reduplicant. As we have emphasized, although back-copying cannot be reconciled with the demands of serial derivation, it is an expected consequence of an approach like OT that evaluates fully formed output candidates in parallel.

An important observation about back-copying has been brought to our attention independently by René Kager and Philip Hamilton, and the goal of this section is to explain it in terms of general properties of the theory of Prosodic Morphology. The issue is this: though phonological processes like Tagalog nasal substitution are observed to back-copy, the reduplicative template itself never does. Consider, for example, reduplication in the Australian language Diyari.

(35) Reduplication in Diyari (Austin 1981; Poser 1982, 1989; McCarthy and Prince 1986, 1991a, b)

Root	RED+Root	
wil̪a	wil̪a-wil̪a	"woman"
kanku	kanku-kanku	"boy"
kuɭkuŋa	kuɭku-kuɭkuŋa	"to jump"
tʲilparku	tʲilpa-tʲilparku	"bird species"
ŋankan̪t̪i	ŋanka-ŋankan̪t̪i	"catfish"

Descriptively, the reduplicant is identical to the first syllable of the base plus the initial CV of the second syllable. This is just exactly the shape of the minimal word of the language, and so it has in the past been standard Prosodic-Morphology practice to say that the reduplicative template for Diyari is the constituent MinWd (McCarthy and Prince 1986, 1991a, b).

No known language shows back-copying of this MinWd template, though. Such a language, referred to here as Diyari′, would be expected to show alternations like the following:

(36) Reduplication in (hypothetical) Diyari′

Root	RED+Root	
wil̪a	wil̪a-wil̪a	"woman"
kanku	kanku-kanku	"boy"
kuɭkuŋa	kuɭku-kuɭku !	"to jump"
tʲilparku	tʲilpa-tʲilpa !	"bird species"
ŋankan̪t̪i	ŋanka-ŋanka !	"catfish"

The interesting point about Diyari′ is that it achieves a perfect match between base and reduplicant – perfect B-R Identity – and perfect satisfaction of the MinWd template. It does so at the expense of (many) I-O Faithfulness violations, since unmatched segments of the underlying root are lost when the root is reduplicated.

From this example we can develop a somewhat more formal statement of the Kager–Hamilton problem. Assume that there is an undominated templatic constraint RED=MINWD, unviolated in any reduplicant of Diyari′ (or real Diyari). Likewise, there is perfect B-R matching in Diyari′ (unlike real Diyari), indicating that MAX-BR is also undominated. The following tableau shows that MAX-IO suffers in the encounter with these two top-ranked constraints:

(37) Red=MinWd, Max-BR ≫ Max-IO in hypothetical Diyari′

/red+tʲilparku/	Red=MinWd	Max-BR	Max-IO
a. ☞ tʲilpa-tʲilpa			
b. tʲilpa-tʲilparku		*!	
c. tʲilparku-tʲilparku	*!		

Unreduplicated forms receive a fully faithful analysis in Diyari′, though, because neither of the top-ranked reduplicant-specific constraints has anything to say, and so Max-IO emerges as decisive:

(38) Derivation of unreduplicated forms in hypothetical Diyari′

/tʲilparku/	Red=MinWd	Max-BR	Max-IO
a. ☞ tʲilparku			
b. tʲilpa			*!

The rankings in the two contrasting systems are therefore these:

(39) Ranking properties of the Kager–Hamilton problem
  a. Ranking in real Diyari – normal application of templatic constraint
  Red=MinWd, Max-IO ≫ Max-BR

  b. Ranking in hypothetical Diyari′ – back-copying overapplication of templatic constraint
  Red=MinWd, Max-BR ≫ Max-IO (cf. (61) below)

The constraint hierarchy for real Diyari in (39a) is typical of normal application (see (62) below). With Max-BR low ranking, neither templatic conformity nor I-O Faithfulness is sacrificed to achieve better B-R Identity. Diyari′, on the other hand elevates templatic conformity and B-R Identity above the dictates of I-O Faithfulness (cf. the ranking for Tagalog back-copying in (26)). Ranking permutations like these predict possible interlinguistic differences: the Kager–Hamilton problem, quite simply, is that languages like Diyari′ do not exist, contrary to prediction.

Of course, this prediction depends on the assumption that all the constraints in (39) are indeed part of UG; if they are not, then permutations

of their ranking are irrelevant. The status of Max-BR and Max-IO is not in doubt. Rather, the flaw in (39b) lies in the assumption that UG contains templatic constraints like Red=MinWd. There are no such constraints, and without them the Kager–Hamilton problem evaporates.

To deny that there are prosodic-morphological templates may seem nihilistic – after all, aren't templates the very essence of Prosodic Morphology? But recall the goal of Prosodic Morphology, as set out in section 1: to derive the characteristics of reduplication and like phenomena from general properties of morphology, general properties of phonology, and general properties of the interface between morphology and phonology. To the extent that PM-specific devices like templates are posited, this goal remains distant.

The program of deriving the descriptive effects of templates from independently required constraints on phonology, morphology, and their interface is called Generalized Template Theory (GTT – McCarthy and Prince 1994a, b; Carlson 1996; Colina 1996; Downing 1994, 1996a, b, this volume; Futagi to appear; Gafos 1995, 1996; Itô, Kitagawa, and Mester 1996; Moore 1995; Spaelti 1997; Urbanczyk 1996a, b; cf. Shaw 1987, Steriade 1988, Itô and Mester 1992 for precursors). The main thesis is that templates are obtained by entirely general constraints *via* the emergence-of-the-unmarked ranking pattern (McCarthy and Prince 1994a; section 5.2 below). A structural constraint rendered inactive in the language as a whole because of domination by I-O Faithfulness may nonetheless emerge as visibly active in situations where I-O Faithfulness is not relevant. In particular, it may determine the form of the reduplicant, which is subject to constraints on B-R Identity rather than I-O Faithfulness. The ranking schema that leads to this situation is the following.

(40) Skeletal ranking for emergence of the unmarked
  I-O Faithfulness ≫ Phono-Constraint ≫ B-R Identity

Because I-O Faithfulness dominates Phono-Constraint, its effects are typically not visible in the language as a whole. Phono-Constraint cannot compel inexact correspondence between the underlying stem and the surface base. It can, however, affect the perfection of correspondence in the horizontal, B-R dimension. This means that the reduplicant will obey Phono-Constraint even when obedience means inexactness of copying. The reduplicant then 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.

Let us apply these ideas to the Diyari MinWd template, based on McCarthy and Prince (1994b), which should be consulted for further discussion. As the irreducible starting point of the analysis, we observe that every morpheme must surely be categorized for its position in the morphological hierarchy: affix, root, stem, and so on. The core idea is that once this morphology has been fixed, constraints on the morphology-prosody relationship will define the prosodic correlates of morpheme-category membership. With the prosodic correlates thus broadly fixed, constraints on the canonical realization of prosodic categories will fully determine the lower-level details. In the case of Diyari, the key morphological observation is that the reduplicative morpheme is lexically categorized as a *stem*, so that reduplication is structurally a form of stem-stem compounding. The canonical realization of *stem*, accomplished via Generalized Alignment (McCarthy and Prince 1993b), is as prosodic word (PrWd). This much we take to be uncontroversial; the challenge is to make the transition from the coarse-grained characterization of *stem* as a prosodic word to the exact details of the bisyllabic, vowel-final reduplicant structure that is observed in the language. This, we claim, is emergent as the most harmonic possible prosodic word (PrWd), as defined by independently motivated constraints of metrical theory. The relevant constraints are these:

(41)

Constraint Name	Definition	Discussion	References
HEADEDNESS (PRWD)	Every PrWd must contain a foot.	A standard assumption about the Prosodic Hierarchy. Unviolated in Diyari (and perhaps universally).	Selkirk (1980a, b, 1995); McCarthy and Prince (1986, 1991a, b); Itô and Mester (1992).
FT-BIN	Feet are binary under syllabic or moraic analysis.	Unviolated in Diyari, which lacks monosyllabic feet.	Prince (1980); McCarthy and Prince (1986); Prince (1986); Hayes (1995).
PARSE-SYLL	Every syllable belongs to some foot.	Instantiates as a violable constraint the maximal parsing assumption of metrical theory.	Prince and Smolensky (1993); McCarthy and Prince (1993a, b).
ALL-FT-LEFT	Align(Ft,L,PrWd, L)≈Every foot stands in initial position in the PrWd.	Responsible for directional footing – see immediately below.	Kirchner (1993); McCarthy and Prince (1993b).

The stress pattern of Diyari (morphological complications aside – see McCarthy and Prince 1994b) locates main stress on the initial syllable and secondary stress on every odd-numbered syllable thereafter, except that lone final syllables are not stressed: (σ́σ)(σ̀σ)(σ̀σ)σ. This pattern of directional footing is obtained under the ranking PARSE-SYLL ≫ ALL-FT-LEFT. According to ALL-FT-LEFT, all feet should be at the left edge. But dominance of PARSE-SYLL requires that the form be fully footed (subject only to FT-BIN). Under minimal violation of ALL-FT-LEFT, a multi-foot form must have its feet as close to the left edge as possible. (See McCarthy and Prince 1993b, elaborating on the proposal of Kirchner 1993, for additional discussion.)

In a form with the stress pattern (σ́σ)(σ̀σ)(σ̀σ)σ, both PARSE-SYLL and ALL-FT-LEFT are violated. PARSE-SYLL is violated because there is always an unparsed syllable in odd-parity words, to preserve FT-BIN, which is undominated in this language. ALL-FT-LEFT is violated because the non-initial feet are misaligned. Both constraints, however, *can* be obeyed fully. In that case,

> every syllable is footed (PARSE-SYLL is obeyed), and
> every foot is initial (ALL-FT-LEFT is obeyed).

Only one configuration meets both of these requirements, the minimal word, since it has a single foot that parses all syllables and is itself properly left-aligned.

(42) $[\text{ Ft }]_{\text{PrWd}}$ *i.e.*, disyllabic $[\ (\sigma\ \sigma)_{\text{Ft}}\ ]_{\text{PrWd}}$ or bimoraic $[\ (\mu\ \mu)_{\text{Ft}}\ ]_{\text{PrWd}}$

Thus, the minimal word is the most harmonic PrWd possible, with respect to PARSE-SYLL and ALL-FT-LEFT – indeed, with respect to every form of Ft/PrWd alignment. Of course, the single foot contained within the minimal word is optimally binary, because of FT-BIN. Hence, the most harmonic PrWd with respect to these metrical constraints is a disyllable in any language that does not make quantitative (moraic) distinctions.

Returning to reduplication, we can apply this insight using the emergence of the unmarked ranking in (40). The reduplicant is a free-standing prosodic word (PrWd), as evidenced by its stress behavior and vowel-final status (Austin 1981). With PARSE-SYLL and ALL-FT-LEFT ranked so that their effects are emergent, the reduplicant is the most harmonic PrWd possible, even at the cost of imperfect copying. Thus, these constraints compel violation of MAX-BR, as shown in the following tableaux.

(43) PARSE-SYLL ≫ MAX-BR, from /RED+tʲilparku/

	PARSE-SYLL	MAX-BR
a. ☞ [(tʲilpa)$_{Ft}$]$_{PrWd}$ -[(tʲilpar)$_{Ft}$ ku]$_{PrWd}$	*	
b. [(tʲilpar)$_{Ft}$ ku]$_{PrWd}$ -[(tʲilpar)$_{Ft}$ ku]$_{PrWd}$	**!	

This tableau shows incomplete copying of odd-parity roots. Form (43b) is a perfect copy, but it also involves an extra PARSE-SYLL violation. Incomplete copying avoids this unparsed syllable, and, as (43a) shows, this is more harmonic prosodically.[24] The next tableau shows the same thing, but with ALL-FT-LEFT as the decisive constraint.

(44) ALL-FT-LEFT ≫ MAX-BR, from (hypothetical) /RED+ŋandawalka/

	ALL-FT-LEFT	MAX-BR
a. ☞ [(ŋanda)$_{Ft}$]$_{PrWd}$– [(ŋanda)$_{Ft}$ (walka)$_{Ft}$]$_{PrWd}$	*	
b. [(ŋanda)$_{Ft}$ (walka)$_{Ft}$]$_{PrWd}$– [(ŋanda)$_{Ft}$ (walka)$_{Ft}$]$_{PrWd}$	**!	

In (44b), the reduplicant fatally violates ALL-FT-LEFT, since it contains an unaligned foot, while form (44a) spares that violation by incomplete copying. The "minimalization" of the reduplicant follows from these rankings. But ordinary roots of the language can be nonminimal, indicating that MAX-IO dominates both PARSE-SYLL and ALL-FT-LEFT.

(45) MAX-IO ≫ PARSE-SYLL, from /tʲilparku/

	MAX-IO	PARSE-SYLL
a. ☞ [(tʲilpar)$_{Ft}$ ku]$_{PrWd}$		
b. [(tʲilpar)$_{Ft}$]$_{PrWd}$	**!	

(46) MAX-IO ≫ ALL-FT-LEFT, from /RED+ŋandawalka/

	MAX-IO	ALL-FT-LEFT
a. ☞ [(ŋanda)$_{Ft}$ (walka)$_{Ft}$]$_{PrWd}$		
b. [(ŋanda)$_{Ft}$]$_{PrWd}$	*****!	

The full ranking for Diyari, then, is this (cf. (40)):

(47) Diyari ranking using emergence of the unmarked
MAX-IO ≫ PARSE-SYLL, ALL-FT-LEFT ≫ MAX-BR

Minimality – here interpreted as prosodic optimality with respect to syllabic parsing (PARSE-SYLL) and foot alignment (ALL-FT-LEFT) – is an emergent property of the reduplicant. MAX-BR is subordinated to these requirements of prosodic harmony, but MAX-IO dominates them. No template or templatic constraint like RED=MINWD is necessary or desirable – the independently necessary constraints of the prosodic-morphology interface, of prosodic theory itself and of correspondence are enough. Indeed, it is not even possible, we assert, to declare that the Diyari reduplicant is a PrWd. It suffices to identify the lexical status of the reduplicative morpheme, surely an ineliminable property of its morphology. Once it is understood that *stem* is most harmonically aligned with a PrWd (McCarthy and Prince 1994b), there is a cascade of phonological consequences, controlled by emergence of the unmarked. Further direct evidence for the role in reduplication of morphology and its canonical expression is found in Downing (this volume), Itô, Kitagawa, and Mester (1996), and Urbanczyk (1996a, b).

This account of the shape of the Diyari reduplicant is superior, on explanatory grounds, to an analysis that posits templatic constraints like RED=MINWD, RED=PRWD, or the like. Significantly, it also provides an immediate explanation for the nonexistence of Diyari′. To get back-copying, the constraints defining the shape of the reduplicant must dominate MAX-IO (compare (39b)). But now every word of the language

– not just reduplicated words – will obey these constraints! That is not what Diyari′ is supposed to look like.

To put the matter more generally, back-copying an emergent template is impossible because it demands mutually incompatible rankings. Let C denote the constraints that define the shape of the reduplicant. For C to be emergent, it must fit the following ranking schema:

(48) Ranking for emergence of C (cf. (40))
I-O Faithfulness ≫ C ≫ B-R Identity

For a constraint C to be back-copied, a different ranking is necessary:

(49) Ranking for back-copying of C (cf. (26))
B-R Identity, C ≫ I-O Faithfulness

These rankings are inconsistent. In (48), C is obeyed only in the reduplicant, where BR-Identity suffers. But in (49), C is obeyed in the whole language. There is an obvious ranking contradiction, and by virtue of it we have a solution to the Kager–Hamilton problem – Diyari′ cannot exist because no constraint C can emerge and be back-copied in the same language, since emergence and back-copying require mutually incompatible constraint rankings.

Projecting from the Diyari situation, we can say that no template of any type can be back-copied. To secure this general result, two additional assumptions need to be made explicit. One is the Generalized Template Hypothesis, according to which UG countenances no templates or any other affix-specific constraints. As we have just seen, templatic constraints like RED=MINWD are the source of the Kager–Hamilton conundrum, and elimination of them through reanalysis under emergence of the unmarked is the main goal of Generalized Template Theory. A related assumption, brought to our attention by Ed Keer, is that the emergence of the unmarked must work by combining general markedness constraints (like PARSE-SYLL) with grammatically restricted faithfulness constraints (like MAX-IO versus MAX-BR), and not the other way around. Grammatically restricted markedness constraints are just another type of templatic constraint, and so their existence would subvert this result.

Templates are never back-copied, something of a surprise given the ubiquity of templates in reduplication. This gap is a principled one, and it is explained by uniting two hitherto distinct themes of Prosodic Morphology: Correspondence Theory and Generalized Template Theory. Templates are not back-copied because there are no templates; there are only rankings of universal constraints with templatic effect, and these rankings contradict those that lead to back-copying. This convergence of results from very different domains is encouraging and suggests that both aspects of the approach may very well be on the right track.

4.4 Summary

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 defines the background phonology of the language at hand. When B-R Identity constraints are also active, then phonological 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, 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 reapplication 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 empirical possibilities, many cells are as yet empty or incomplete. A meticulous and final argument would match every case of full reduplication with one or more of partial reduplication that has exactly the same properties; every case of overapplication with a case of normal application that assumes the same background phonology and templatic form. 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.[25] 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 (section 4.2) and other cases analyzed in McCarthy and Prince (1995). Indeed, one might ask whether there can be B-to-R overapplication of the same process, exemplified by /RED+an+bit/ → *am-ambit*. Again, we have located 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 stop clusters, offer a principled explanation for this sort of gap in R-to-B overapplication. 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. Similarly, free emergence of the unmarked allows for fine distinctions among different prosodic types, depending on which of the various relevant constraints are ranked above B-R Identity; yet the observed set of templatic forms shows a substantial clumping together of prosodic constraints. Given the success of the approach in providing a very general account of the character of canonical forms, including "templates," it will likely be useful to pursue the further explanatory and descriptive issues that it discloses.

5. Factorial typology

Permutation of ranking exposes the content of a proposed sub-theory of constraints. What mappings and relationships are admitted by the various rankings? Do all the rankings yield possible grammars? The full set of permuted rankings constitutes a *factorial typology* of a linguistic domain (Prince and Smolensky 1991, 1993: ch. 6).

The Basic Model posits faithfulness constraints on two distinct dimensions of correspondence, as represented here:

(50) Basic Model

Input /Af_{RED} + Stem/

$\uparrow\downarrow$ *I-O Faithfulness*

Output R $\rightleftarrows$ B

B-R Identity

In this section, we will examine the ways that phonology and reduplication interact in the Basic Model's factorial typology, which counterposes B-R Identity, I-O Faithfulness, and structural markedness constraints. Extension to the Full Model (6), which imposes I-R Faithfulness as well, is taken up in McCarthy and Prince (1995: section 6).

The project falls into two halves. First, we consider those systems where there is no relevant language-wide phonology at work; among these is a pattern in which the reduplicant shows phonology that the base does not ("emergence of the unmarked"). Second, we examine the cases where significant language-wide phonology exists and can interact nontrivially with reduplication. The most important results, adumbrated at various points, include the availability of reduplicant-to-base back-copying and the nonavailability of underapplication and even of certain kinds of "normal application." The model enforces a distinction between overapplication patterns that extend base phonology to the reduplicant and those that extend reduplicant phonology back to the base; this arises because only the back-copying pattern requires otherwise unmotivated violations of I-O Faithfulness.

5.1 Nonapplication

For a feature-changing map to be present in the phonology, a Phono-Constraint C must dominate *some* relevant constraint on I-O

Faithfulness[26] as well as every other phonological constraint *M that militates against the desired output M. For instance, in Madurese nasal harmony (section 4.1), 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. It is also necessary that $*NV_{Oral}$, *qua* "Phono-Constraint," dominate $*V_{Nas}$, so that the otherwise-banned nasal vocoids V_{Nas} are allowed into output representations.

(51) Necessary conditions for Phono-Constraint to be enforced in I-O mapping
Phono-Constraint ≫ I-O Faithfulness, {*M}

In this schema, the term "I-O Faithfulness" is used here to refer to *some* relevant constraint of that type, while "{*M}" means *every* relevant structural constraint. Though we will not be dwelling on formal details in this overview, the distinction between *some* and *every* seems worthy of note, and we will draw attention to it *via* an *ad hoc* notation: {X} will mean "every relevant constraint of type X," while unbraced X means simply "some relevant constraint of type X."

The force of Phono-Constraint is blunted when the negation of condition (51) holds. If all relevant I-O Faithfulness constraints crucially dominate the Phono-Constraint C, it will not be active in defining the input-output mapping. If some structural constraint *M dominates it, then typically nothing can be done to enforce C by introducing M: for example, if $*V_{Nas} \gg *NV_{Oral}$, then the constraint $*NV_{Oral}$ simply cannot be satisfied by the introduction of nasal vocoids.

(52) Phono-Constraint rendered ineffectual
{I-O Faithfulness} ≫ Phono-Constraint
OR *M ≫ Phono-Constraint

Things are similar on the reduplicative front. Subordination of some B-R Identity constraint to a sufficiently high-ranked Phono-Constraint C can force inexactness of copying; the reduplicant will respect C whether or not the base does.[27] But if all relevant B-R Identity constraints dominate C, then C cannot compel a base-reduplicant disparity. Thus, when Phono-Constraint C is subordinated to all relevant B-R Identity constraints *and* all relevant I-O Faithfulness constraints, it is completely out of action. This gives us the ranking in (53):

(53) A skeletal ranking for total nonapplication
{B-R Identity}, {I-O Faithfulness} ≫ Phono-Constraint

In its dominated position, Phono-Constraint can compel neither unfaithfulness nor inexact identity; it is inert.[28] Pursuing the second disjunct of (52), we note that nonapplication can also be obtained by ranking relevant *markedness* constraints above Phono-Constraint, regardless of the disposition of I-O Faithfulness and B-R Identity. Should $*V_{Nas}$ dominate $*NV_{Oral}$, nasal vocoids will be admitted in neither base nor reduplicant to assuage $*NV_{Oral}$.

Examples of non-application ranking patterns are legion, although they do not always attract attention. For example, the constraint $*NV_{Oral}$ is thoroughly dominated in many languages, so that it has no effects on either base or reduplicant. Such rankings allow constraints to be universally *available* without being universally *active*. Nonapplicational ranking 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.

5.2 Emergence of the unmarked

The universal availability of Phono-Constraint assumes particular importance in rankings where it dominates B-R Identity, though ranked below I-O Faithfulness.

(54) Skeletal ranking for emergence of the unmarked
{I-O Faithfulness} ≫ Phono-Constraint ≫ B-R Identity, {*M}

Because every relevant I-O Faithfulness constraint dominates Phono-Constraint, the effects of Phono-Constraint are not visible in the language generally. Phono-Constraint cannot compel disparity between input stem and output base, whose correspondence relation is indicated by the vertical arrows in the portrait of the Basic Model in (50). This amounts to "no application" in general. Phono-Constraint can, however, affect the perfection of correspondence in the horizontal, B-R dimension of (50). This means that the reduplicant will obey

Phono-Constraint even when obedience means inexactness of copying.[29] The reduplicant *obeys* a constraint that is otherwise violated freely in the language at large – one that may even be violated in the reduplicative base itself.

This state of affairs is a type of *emergence of the unmarked*. 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. Initially developed in McCarthy and Prince (1994a), where the ranking schema (54) is presented,[30] emergence of the unmarked supports the OT conception of constraints as ranked, rather than parameterized (Prince and Smolensky 1991, 1993): parameterization of Phono-Constraint would be an all-or-nothing matter and could never produce emergence of the unmarked. Emergence of the unmarked is invoked in section 4.3 above as the basis of Generalized Template Theory; the emergent unmarked structures include the kind of prosodic configurations realizing morpheme-types that have been previously understood as templates.

An illuminating example comes from the Philippine Austronesian language Balangao (Shetler 1976). The Balangao reduplicant copies the first two syllables of the base, minus the final coda: /RED–tagtag/ → *tagta-tagtag*. This means that the constraint NO-CODA crucially dominates the reduplicant-maximizing constraint MAX-BR.

(55) NO-CODA ≫ MAX-BR in Balangao

/RED–tagtag/	NO-CODA	MAX-BR
a. ☞ tag.ta.–tag.tag.	***	
b. tag.tag.–tag.tag.	****!	

Form (55a) violates MAX-BR, because the final *g* 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 the appendix) protects the reduplicant-medial coda, ruling out the further codaic economy obtained by a reduplicant like **ta.ta.–*.[31]

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:

(56) MAX-IO ≫ NO-CODA in Balangao

/tagtag/	MAX-IO	NO-CODA
a. ☞ tag.tag.		
b. tag.ta.	*!	

Here, form (56b) violates MAX-IO, since input-final *g* has no correspondent in the output. Violation is fatal, because NO-CODA ranks below the input-output faithfulness constraint. (To flesh out the analysis, we must have DEP-IO and all other relevant I-O Faithfulness constraints dominating NO-CODA, to ensure that every avenue of escape from faithful parsing is blocked off.)

Combining the two results, we have MAX-IO, ...≫ NO-CODA ≫ MAX-BR – a special case of the emergence of the unmarked schema (54).

(57)

Schema	{I-O Faithfulness}	≫ Phono-Constraint	≫ B-R Identity
Instantiation	MAX-IO, ...	≫ NO-CODA	≫ MAX-BR

The following tableau shows the force of these constraints:

(58) Emergence of the unmarked in Balangao

/RED–tagtag/	MAX-IO	NO-CODA	MAX-BR
a. tag.ta.-tag.ta.	*!		
b. tag.tag.-tag.tag.		****!	
c. ☞ tag.ta.-tag.tag.		***	

The coda-sparing but inexact reduplicant (58c) 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). The situation can be diagrammed as in (59) below:

(59) Input /Af_{RED} + tagtag/
⇅ *exact faithfulness*
Output tagta ⇆ 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 (58a) and (58b). But form (58a) *tagta-tagta* fatally sacrifices input material (*MAX-IO) to gain codaic advantage, while form (58b) *tagtag-tagtag* has a final coda in the reduplicant (*NO-CODA) that can be avoided at the mere price of incomplete copying. This, then, is emergence of the unmarked: the constraint NO-CODA is better respected in the reduplicant than it is in the language as a whole.

Reduplicative emergence of the unmarked, derived from rankings like (57), enforces template-like conditions. A segmental theorist from the dawn of Prosodic Morphology would have been tempted to declare a template like "CVCCV" for the reduplicative morpheme. On this view, the lack of a reduplicant-final coda in Balangao is the result of a chance arrangement of Cs and Vs. But of course this CV-template echoes a familiar type of canonical restriction on general word-form (holding in Italian, for example, where there are closed syllables internally, e.g., *pasta*, but not word-finally). Emergence of the unmarked allows us to recruit the structural principles that delimit word- and morpheme-form for use in defining templatic restrictions on reduplicative affixes and other objects of Prosodic Morphology. Generalizing from this kind of initial success, the natural proposal (section 4.3) is that all conditions formerly attributed to templates follow from morphology-prosody interface constraints (such as "Stem aligns with PrWd") taken together with the various constraints on the shape of prosodic categories (such as NO-CODA) under the ranking regime of emergence of the unmarked. This provides a maximally general theory of "templates," building them from the interaction of constraints independently recognized as part of Universal Grammar. In addition to its generality, this approach immediately provides a principled limitation on reduplicative back-copying, resolving the Kager–Hamilton problem.

5.3 Modes of overapplication and normal application

In the grammatical patterns reviewed so far, there is either no relevant phonology (nonapplication) or it is restricted to the reduplicant (emergence of the unmarked). When language-wide phonology exists and when its conditioning environment is found in one member but not the other of the base-reduplicant pair, reduplicative identity is threatened and the potential for extending the phonology outside its normal venue arises. That is overapplication.

Since by assumption there is language-wide phonology at play, we will presuppose the following rankings throughout the discussion:

(60) Phonology with Phono-Constraint
 Phono-Constraint $\gg$ I-O Faithfulness, {*M}

Phono-Constraint will therefore be factored out of the ranking schemata adduced below in order to highlight the interactions of B-R Identity.

With an architectural distinction between I-O Faithfulness and B-R Identity, conflict can arise between analogous constraints on the two dimensions, and when it arises, it must be settled in favor of one or the other. This leads to a fundamental morphological distinction in the typology: overapplication from R to B (back-copying), where R is the target of the basic phonology, requires otherwise unnecessary violations of I-O Faithfulness to obtain optimal B; but overapplication from B to R, where B is already the primary target of phonological unfaithfulness, requires only that the extra markedness violations in R be forced. Consequently, back-copying requires not only Phono-Constraint $\gg$ I-O Faithfulness, but also B-R Identity $\gg$ I-O Faithfulness, since it is exactly the demand for B-R Identity that compels otherwise unmotivated faithfulness violations. The extra markedness violations must also be compelled, leading to the following schema:

(61) Back-copying overapplication in B, when R is the target of *Phono-Constraint*
 {B-R Identity} $\gg$ I-O Faithfulness, {*M}

This schema shows that B-R Identity formally parallels Phono-Constraint in schema (60) as a provider of impetus for I-O phonology.

The base is protected from incursions in all rankings that do not have this character. Holding constant the relation between Phono-Constraint and the I-O Faithfulness constraint that yields the relevant phonology, the ranking {I-O Faithfulness} $\gg$ B-R Identity will preserve the base from back-copying. Similarly, domination of B-R Identity by any member of the set {*M} will be sufficient to prevent the effects of

Phono-Constraint from being carried back to the base. These two conditions for normal application are collected in the following schema:

(62) Normal Application in B, When R is the Target of *Phono-Constraint*

{I-O Faithfulness} ≫ B-R Identity

OR *M ≫ B-R Identity

Under the first disjunct in (62), the base cannot be unfaithful to the input merely to take on Phono-Constraint-motivated phonology from the reduplicant – the excess cost in I-O Faithfulness violations is too high. The same base-protective effect also results when a relevant markedness constraint dominates B-R Identity, regardless of I-O Faithfulness, as in the second disjunct. Either of these disruptions of the back-copying ranking yields 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 schemata come from Austronesian nasal substitution (on which see Pater this volume). In (63a), we have data from Balangao (Shetler 1976), in which nasal substitution applies normally, with indifference to reduplicative structure. In (63b), Bloomfield's Tagalog example is recalled from section 1. Nasal substitution overapplies, with its effects transmitted from reduplicant to base:

(63) Contrast in application of Austronesian nasal substitution

a. Normal application in Balangao

/maN+tagtag/	ma-nagtag	"running"
/maN+RED+tagtag/	ma-nagta-tagtag[32]	"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 (62), faithfulness takes precedence over identity, so the base is not affected by changes in the reduplicant.

(64) Normal application in Balangao nasal substitution

/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 (64b) and (64c) is the interesting one. In (64b), the base has *n* for underlying /t/, violating the faithfulness constraint IDENT-IO(-nas), as in Pater (this volume), which forbids the relation /t/$_I$ ~ [n]$_O$. In (64c), though, only the reduplicant has the *n*, and this is optimal because all the B-R Identity constraints forbidding $t_B \sim n_R$ are decisively dominated.[33] 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.

Tagalog, by contrast, instantiates the ranking schema (61), where dominant B-R Identity can compel I-O unfaithfulness, transmitting changes in the reduplicant back to the base, as in section 4.2. The results are illustrated schematically in the following tableau.

(65) 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		*!	

The interesting comparison is between forms (65b) and (65c). The base in form (65b) pays the price of unfaithfulness to the input – /p/$_I$ ~ [m]$_O$ here, with nasal mismatch – in order to achieve a good base-reduplicant match.

The Balangao-Tagalog contrast 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 Phono-Constraint targets the *base*, the relative ranking of I-O Faithfulness is of no consequence, as we have noted, because modifications of the reduplicant are not reckoned as I-O violations. Control of overapplication must therefore fall to the relationship between B-R Identity and the relevant structural constraints (*M) other than the Phono-Constraint that is directly involved in the basic phonology: for example, segmental markedness constraints. Thus in a Madurese/Malay-type nasal harmony system (section 4), the crucial pivot is $*V_{Nas}$ – if the relevant B-R Identity constraint dominates it, then the additional identity-preserving nasal vocoids will be forced in the reduplicant, as in *ỹãt-nẽỹãt*. This is B-to-R overapplication descriptively, and here again the relevant B-R Identity constraint plays a role much like that of $*NV_{Oral}$ in forcing violations of $*V_{Nas}$.

(66) Overapplication in R when B is target
B-R Identity ≫ {*M}

This kind of overapplication ensures that the reduplicant accurately imitates the base, even when the phonological circumstances in B are different from those in R. Thus, in the Madurese/Malay case, given underlying input /ỹãt/, the grammar will produce denasalized output [yat]; but given base [...ỹãt...], we get reduplicant [ỹãt].

If the ranking runs the other way, with $*V_{Nas}$ ≫ B-R Identity, then any reduplicant vocoids corresponding to base vocoids will be nonnasal. The cost of faithfully echoing nasal vocoids as nasal is too high; the reduplicated form in this modified language would be *yat–nẽỹãt*. Observe that the nonnasality of such reduplicant vocoids does not come from exact copying of the input stem, which is not visible to the reduplicant (and which need not contain oral vocoids anyway – see section 4.1). Rather, the mapping of $[\tilde{y}\tilde{a}t]_B$ to $[yat]_R$ is a kind of emergence of, or reversion to, the unmarked: the correspondents of $[\tilde{y}\tilde{a}t]_B$ are chosen the same way that the grammar would deal with input /ỹãt/ in the absence of faithfulness restraints on nasality. In systems where there is no nasal-oral contrast in vowels, the unmarkedness that would emerge in the reduplicant is just that seen everywhere else in the language. In a language where free-standing nasal vowels are allowed, the situation would be classic emergence of the unmarked, with the reduplicant alone showing the less marked repertory. Thus, although this is "normal application," it should be clear that it is not at all guaranteed to be "normal" in any sense referring to the expected phonological development of a chunk of underlying stem to which the reduplicant owes its existence.

Thus, reversion to the unmarked is as close as the Basic Model comes to normal application in the reduplicant when the base is the target of phonology.

(67) Reversion to the unmarked in R
*M ≫ B-R Identity

The Full Model, or something like it, is required for those cases where access to the underlying stem is absolutely necessary in the construction of the reduplicant. See McCarthy and Prince (1995: section 6) for discussion.

The Basic Model, then, exhibits exactly four distinct modes of handling potential phonological asymmetries between base and reduplicant. (71) illustrates that when a reduplicant R is targeted by phonology, we have either (Ia) back-copying overapplication from R to B, securing B/R identity, (61), or (Ib) completely normal development of B, yielding B/R disparity, (62). Again in (71), when a base B is targeted, we have either (IIa) overapplication from B to R, (66), or (IIb) reversion to the unmarked in R, often a normal-looking pattern, (67). In the general case, the grammar can freely choose one from each of these two targeting categories, generating four predicted systems. For example, in one language the very same process can affect the reduplicant with no carry-over to the base, (Ib), but it can affect the base with overapplication in the reduplicant, (IIa). An instance of this behavior in Indonesian is examined in McCarthy and Prince (1995: section 4.3).

5.4 Illustration of the typology

In order to pursue the detailed force of the general points just surveyed, it is useful to run through a system that concretely embodies the entire typology of section 5.3.

Let us imagine a language with exactly the nasal harmony situation of Madurese or Malay, and a reduplication pattern similar to that of Madurese. Adopting a proposal by Pater (this volume), let us further divide the featural constraint IDENT(F) into IDENT(+F) and IDENT(–F). IDENT-IO(+F) means that +F-elements in the input should correspond to +F-elements in the output; it forbids a "denasalizing" I-O relationship, but it says nothing about -F-elements. More formally, one can write:

(68) IDENT-IO(+F) For $\alpha \in I$, $\beta \in O$, with α, β in correspondence, if α is [+F], then β is [+F].

(69) IDENT-BR(+F) For $\alpha \in B$, $\beta \in R$, with α, β in correspondence, if α if [+F], then β is [+F].

Parallel definitions apply to the [–F] case. Observe that the constraint IDENT(F) conflates the +F and the –F constraints; splitting IDENT into two independently rankable parts is necessary, as we will see, for developing the full fourfold typology.

The background phonology of the language is then given by the following ranking diagram.

(70) Vocoid is nasal in nasal span, otherwise oral.

$$
\begin{array}{ccc}
 & {}^{*}NV_{Oral} & \\
\swarrow & & \searrow \\
\text{IDENT-IO(-nas)} & & {}^{*}V_{Nas} \\
 & & | \\
 & & \text{IDENT-IO(+nas)}
\end{array}
$$

Observe that $^{*}V_{Nas}$ does not crucially dominate IDENT-IO(-nas), because this faithfulness constraint pertains only to the nasalizing map $/\text{-nas}/_I \rightarrow [\text{+nas}]_O$. However, the constraint $^{*}V_{Nas}$ must dominate IDENT-IO(+nas), in order to rid the output of free-standing nasals via a *de*nasalizing map, as $/\text{bã}/_I \rightarrow [\text{ba}]_O$.

The typology will emerge from interpolation of IDENT-BR(+nas) and IDENT-BR(–nas) into the purely phonological system, (70), in accord with the schemata of the previous section. Let us imagine two stems and some relevant morphology to provide the crucial test cases. Let one be /peyak/, suitable for receiving (or rejecting) overapplicative influence from a reduplicant lying in a nasal span; let the other be /meyad/, suitable for transmitting nasality to a nasal-free reduplicant. Let us also imagine a prefix /paŋ/, capable of initiating a nasal span. The range of attainable outputs, and their status in the typology, is outlined here, with the potential focus of overapplication underlined:

(71) Application types

I. Reduplicant targeted by phonology
/peyak/
Ia. R →B Overapplication paŋ-ỹãk-peỹãk
Ib. Normal paŋ-ỹãk-peyak

II. Base targeted by phonology
/meyad/
IIa. B →R Overapplication ỹãd-mẽỹãd
IIb. Reversion in R yad-mẽỹãd

Underlying forms such as /pẽỹãk/ and /mẽỹãd/ would give exactly the same outputs, since we are in a complementary distribution situation. There can be no candidates where postnasal vocoids are left oral in the output; these, which fatally violate $^{*}NV_{Oral}$ and cannot be redeemed by any ranking of BR-Identity, will be left out of the discussion.

The behavior of the viable candidates with respect to the constraint hierarchy can be tabulated as follows:

(72) The viable candidates considered

R as Target: /peyak/	$^{*}NV_{or}$	IO(–nas)	$^{*}V_{Nas}$	IO(+nas)	BR(+nas)	BR(–nas)
Ia. paŋ-ỹãk-peỹãk		**	****			
Ib. paŋ-ỹãk-peyak			**			**
B as Target: /meyad/						
IIa. ỹãd-mẽỹãd		***	*****			
IIb. yad-mẽỹãd		***	***		***	

Since the comparison in each case is strictly pair-wise, a more perspicuous tabularization is possible, which notes the winner of the comparison rather than the low-level enumeration of constraint violations:

(73) Comparative representation of the viable candidates

R as Target: /peyak/	$^{*}NV_{or}$	IO(–nas)	$^{*}V_{Nas}$	IO(+nas)	BR(+nas)	BR(–nas)
Ia. paŋ-ỹãk-peỹãk						☞ a
Ib. paŋ-ỹãk-peyak		☞ b	☞ b			
B as Target: /meyad/						
IIa. ỹãd-mẽỹãd					☞ a	
IIb. yad-mẽỹãd			☞ b			

In this table, the four phonological constraints are ranked according to (70). We can now proceed to consider how the B-R Identity constraints are to be ranked among them:

(74) Normal application in B
  a. Winning candidate is Ib, so
   IDENT-IO(-nas) ≫ IDENT-BR(-nas)
  OR $*V_{Nas}$ ≫ IDENT-BR(-nas)
  b. Accords with schema (62):
   {I-O Faithfulness} ≫ B-R Identity
  OR *M ≫ B-R Identity

(75) Reversion to the unmarked in R
  a. Winning candidate is IIb, so
   $*V_{Nas}$ ≫ IDENT-BR(+nas)
  b. Accords with schema (67)
   *M ≫ B-R Identity

(76) R-to-B overapplication
  a. Winning candidate is Ia, so
   IDENT-BR(-nas) ≫ IDENT-IO(-nas), $*V_{Nas}$
  b. Accords with schema (61)
   {B-R Identity} ≫ I-O Faithfulness, {*M}

(77) B-to-R overapplication
  a. Winning candidate is IIa, so
   IDENT-BR(+nas) ≫ $*V_{Nas}$
  b. Accords with schema (66)
   B-R Identity ≫ {*M}

Comparing (77) to (76) shows that the B-to-R regime turns on a sense of B-R Identity different from the one relevant to R-to-B back-copying. For B-to-R overapplication, the pivotal constraint is IDENT-BR(+nas), which militates against a *de*nasalizing map from B to R, like $\tilde{a}_B$ ~ a_R in *yad-mẽỹãd*. By contrast, back-copying from R to B, as in *paŋ-ỹãk-peỹãk*, avoids the nasalizing relationship a_B ~ $\tilde{a}_R$, and the relevant identity constraint that must prevail is IDENT-BR(-nas), which forbids *paŋ-ỹãk-peyak*.

We conclude with some comments on key aspects of the theory brought to light in this constructed example.

Overapplication. The account developed here involves not one but two distinct featural maps: *oral* → *nasal* and *nasal* → *oral*. Each is

controlled by different faithfulness/identity constraints and each can play a role – either as active or as blocked – in every condition we have enumerated. Consider standard B-to-R overapplication (IIa), as in *ỹãd-mẽỹãd*. It earns the name "overapplication" because of the featural disparity between a hypothesized lexical stem /meyad/ and the reduplicant *ỹãd*. But what's really happening in the Basic Model is that the general default map *nasal* → *oral* is being blocked along the B-R dimension by the identity constraint IDENT-BR(+nas). Thus, from the internal point of view this has more the character of underapplication. B-to-R back-copying involves unexpected activity/inactivity by both maps. As before, there is inhibition of the default denasalizing map along the B-R dimension; furthermore, there is unexpected activity along the I-O dimension of *oral* → *nasal*, to deal with inputs like /peyak/, and therefore unexpected suppression of *nasal* → *oral* to handle possible inputs like /pẽỹãk/. (Under complementary distribution, free-standing input nasals must be eliminated from output representations; but in just this one non-postnasal case, when R falls in the nasal span, they are allowed to remain.) Thinking of overapplication as the appearance of a marked element in unexpected circumstances, it is clear that this can only be achieved by limiting the activity of the map that removes the marked element (*nasal* → *oral*), and by extending the map that introduces the marked element along the I-O dimension.

Faithfulness. The theory has significant sensitivity to the character of faithfulness constraints. Substantive assumptions about what kind of faithfulness constraints exist will determine predictions about the range of possible systems of overapplication. For example, if IDENT(F) is *not* split into two constraints, then there can be only two systems: Ia/IIa (symmetrical overapplication) and Ib/IIb (no overapplication).

Even more striking, perhaps, if there is no IDENT(–nas) or equivalent – no faithfulness constraint militating against the transition from unmarked to marked – then there can be no back-copying at all of [+nas], because the crucial driving constraint is IDENT-BR(–nas), as shown above in the discussion of type Ia overapplication.

Finally, observe that in the set of systems examined here, it is predicted that the occurrence of R-to-B back-copying and standard B-to-R overapplication are entirely independent of each other, since each submits to the control of independent faithfulness constraints – IDENT(+F) and IDENT(–F). However, if we assume a dependency between the two, recognizing IDENT(−F) and IDENT(±F), where failure on the first implies failure on the second – a "stringency" relationship of the type discussed in Prince (1997) – then we find that back-copying Ia implies B-to-R overapplication IIa, but not vice versa; a kind of implicational markedness prediction over possible systems.

Underapplication. As noted throughout, and as is evident from the factorial-typological survey, classical underapplication is not a category recognized by the present theory. Broadly speaking, underapplication requires the appearance of an unmarked or default element in circumstances where the marked, nondefault element is required by the phonology of the language. B-R Identity simply cannot force this to happen: there is always a choice between identity-satisfying overapplication (like Madurese *ỹãt-nẽỹãt*) and identity-satisfying but phonology-defying underapplication (as in impossible **yat-nẽyat*). Since the phonology is driven by an undominated structural constraint ($*NV_{Oral}$ here) that is not sensitive to correspondence, the choice between the two candidates is irresistibly in favor of the phonologically superior one, which is overapplicational.

The appearance of underapplication can be achieved, however, when the actual opposition in the phonology is not a simple two-way "marked/here" ~ "unmarked/there" type of pattern. If the phonology contains a further context in which the unmarked element appears, due to a constraint ranked *above* what we have called "Phono-Constraint," then something that looks quite like underapplication can result. For example, suppose (as René Kager has suggested to us) that there were a hypothetical constraint forbidding nasal vocoids in word-initial positions. With this constraint and IDENT-BR(+nas) ranked above $*NV_{Oral}$ in a Malay/Madurese type of system, the grammar would pick *yat-nẽyat* as the phonologically superior candidate. But this is really overapplication – the extension of word-initial denasalization to word-medial position *via* reduplicative correspondence. It is nothing more than an instance of the back-copying schema (61), with the Phono-Constraint implicit there reidentified as Kager's putative $*\#V_{Nas}$. In the absence of such a constraint – and we believe it to be absent in this case – the apparently underapplicational form can never be obtained. Classical underapplication, then, is admitted only as the overapplication of some aspect of the language's phonology, in accord with the overapplication schemata. We turn now to a particularly striking case.

6. Underapplication

In Southern Paiute, the segments *w* and η^w stand generally in complementary distribution: *w* is found word-initially, and η^w postvocalically, as illustrated in the following examples (Sapir 1930: 49; Mester 1986: 214).

(78) Southern Paiute *w*/η^w distribution

	Initial	Postvocalic	Gloss
a.	waʔaŋi-	tï·′-ŋʷaʔaŋi	"to shout/to give a good shout"
b.	waix̯a-	nɩa·′vɩ-ŋʷaix̯ap·ɪ	"to have a council/council (of chiefs)"
c.	wᴀ‘tcï′-	cu(w)a′-ŋᵂᴀ‘tcïp·ïɣa‘	"to catch up with/nearly caught up with"
d.	w(’)itsɩ’-	tï′raŋ’ᵂɯntsɩ’ɩts·	"bird/horned lark (literally, desert bird)"

Of postvocalic *w* like the one parenthesized in example (78c), column two, Sapir remarks

> After a primary *u* (*o*) a *w*, indicated as ʷ if weak, often slips in before an immediately following vowel. (1930: 57)

We therefore take the variable and evanescent *w* to be a phonetic matter. Morphophonemic lenition of /m/ to a labial glide (Sapir 1930: 62) results in intervocalic η^w (not *w*), just as would be expected, given the way the allophones are distributed.

The interaction with reduplication is remarkable: it is the base that copies the reduplicant, defying the distributional pattern, when there is an asymmetry of environments:

(79) Differing contexts in B and R

	Simple	Reduplicated	Gloss
a.	wïn·ai-	wï-wï′-n’nai-	"to throw/several throw down"
b.	waɣi-	wa-wa′x·ɪpïɣa‘	"several enter/all entered"
c.	wïɣï-	wï-wï′xïᴀ	"vulva/vulvas (obj.)"
d.	wï̥nɩ-	wï-wïn’nï-q·u-	"to stand/to stand (iterative)"

Here the reduplicant's word-initial *w* is transmitted back to the base; no other explanation is viable. It cannot be that the base-reduplicant boundary is word-like and impervious to lenition: observe that lenition runs across all other prefix boundaries, and even compound boundaries, as in (78b). Furthermore, the stress pattern (famously iambic and left-aligned) shows that the reduplicant is very much a part of the phonological word. Finally, when both base and reduplicant provide the same context, the lenited variant appears in both.

(80) Same context in B and R

Simple	Reduplicated	Gloss
wį̆nɩ-	ya-ŋ^{w}ɩ′-ŋ^{w}į̆nɩx̯a‘	"to stand/while standing and holding"

With equivalent conditions in B and R, there is no possible threat to reduplicative identity and normal application is found. This same-context case also shows that Southern Paiute is not easily analyzed as a freak of lexical-phonological level ordering or the like, with a $w \rightarrow \eta^w$ process stuck in a stratum prior to reduplication. Were this the case, other post-reduplicative affixation like that of *ya–* in (80) should be unable to lenite postvocalic *w*. The only way out – as in the structurally similar Tagalog case discussed above in section 5.3 (65) – would be to portray reduplication as a late "head rule" applying after all other morphology has been accomplished (cf. Aronoff 1988). Aside from resting on a theoretical move that severely compromises the affix-ordering generalization upon which so much of lexical phonology rests, this analysis seems particularly ill-founded because lenition is applicable to the results of all word-constructing morphology, including compounding.

Do forms like *wĭ-wĭ′-n'nai-* evidence under- or overapplication? If *w* is taken to be the default or unmarked element of the w/η^w alternation, then it must be *under*application in the descriptive sense we have used throughout, with the unmarked variant appearing in a context that ordinarily demands the marked one. As we have just seen, simple underapplication is not recognized by the general typology. To see how this works out in particular, let us analyze the complementary distribution relationship.

First, we must construct the neutralizing map $w, \eta^w \rightarrow w$, which will eliminate η^w from all surface representations unless inhibited. This makes *w* the default.

(81) *ŋ^w ≫ *w, IDENT-IO(nas)

Observe that this follows the form of the ranking schema (51), which gives necessary conditions for having a nontrivial map in the phonology. We simplify the discussion by mentioning only the change in nasality, and by collapsing together the separate faithfulness constraints having to do with + and – values of the feature.

The map defined by (81) fails to take place in the intervocalic (or perhaps merely postvocalic) environment. This indicates the force of a higher-ranked constraint against *w* in that context, which partly suppresses the activity of $*\eta^w$. We can assume that the constraint militates against VwV; it must sit in a dominant position in the hierarchy:

(82) *VwV ≫ *ŋ^w ≫ *w, IDENT-IO(nas)

Now, with the tacit understanding that the other relevant constraints are properly disposed of, it will happen that underlying ...*awa*... comes out as ...*aŋ^{w}a*..., just like potential underlying...*aŋ^{w}a*.... But underlying #*w* will be preserved, since if there is a less-marked state (say, *p*), unmentioned faithfulness constraints which dominate **w* will prevent it from slipping down the slope of unmarkedness. Furthermore, any potential input #ŋ^w will still be mapped to #*w*, in violation of the lowest rung of dominated constraints in (82). Thus, complementary distribution is established.

B-R Identity can demand that reduplicant and base match closely, but it cannot distinguish between matching ŋ^{w}s and matching *w*s. With *VwV undominated, as in (82), choice of the ŋ^w-matched form is inevitable. Yet it is *w* that prevails when there is contextual asymmetry between base and reduplicant:

(83) Differing context in R and B

Simple Form	Reduplicative Candidates		Remarks
wĭn·nai-	wĭ-wĭ′-n'nai-	☞	B back-copies phonology of R
	*ŋ^{w}ĭ-ŋ^{w}ĭ′-n'nai-		*R copies phonology of B
	*wĭ-ŋ^{w}ĭ′-n'nai-		*normal phonology; bad B-R Identity

Consequently, as observed in our earlier discussions of underapplication (sections 3.1, 4.1, 5.4), there must be another constraint in action, ranked above *VwV. We propose that this constraint, which we will write as *[ŋ, bans the velar nasal, labialized or not, from initial position. In support of framing the constraint at this level of generality, observe that of the nasals only *m* and *n*, and not *ŋ*, may begin a word (Sapir 1930: 62). By itself, this observation does not determine that there is a *constraint* embodying the fact; it could also emerge from interaction, just as the ban on initial $ŋ^w$ does in the system (82). If so, the [__ environment would merely be the complement of the real assimilatory context(s) in which *ŋ* is admitted (or from which other nasals are banned). McCarthy and Prince (1995: section 5.4) offer a specific argument to the contrary, showing that the *g* ~ *ŋ* alternation in Tokyo Japanese (Itô and Mester 1990, 1997) turns on the existence of exactly such a constraint. They further suggest, as Stampe has, that typological considerations show the need for the *[ŋ constraint independent of conditions on the appearance of assimilated and word-final elements. There is good evidence, then, that the constraint *[ŋ is part of the universal repertory, even though some of its effects are sometimes deducible from other constraints. According to this analysis, word-initial *w* in Southern Paiute is not merely a complementary default, as it first seems, but is rather the specific response to a specific constraint *[ŋ, just as $ŋ^w$ is a response to the specific constraint *VwV.

The grammar must therefore run as follows:

(84) *[ŋ, IDENT-BR(nas) ≫ *VwV ≫ $*ŋ^w$ ≫ *w, IDENT-IO(nas)

This hierarchy ensures that no velar nasals can appear in initial position under any circumstances, including reduplicative, and guarantees as well that the base and reduplicant must match *w* to *w* and $ŋ^w$ to $ŋ^w$. Under analysis, the apparent underapplication system of Southern Paiute has turned out to be a kind of back-copying overapplication: word-initial rejection of $ŋ^w$ in favor of *w* is transmitted back to the base.

Thus far we have assumed that *w* is the less-marked member of the opposition: formally, that $*ŋ^w$ ≫ *w, perhaps universally. This is certainly plausible on intrinsic structural grounds, since $ŋ^w$ has everything that *w* has, and more; and it is typologically plausible as well, since the presence of $ŋ^w$ may well entail the presence of *w*, and the converse implication is certainly invalid. It is worth noting, however, that if *w ≫ $*ŋ^w$ were allowed, the system could be portrayed as simple overapplication, with the *marked element w* being backcopied. In such a case, the constraint *[ŋ would still be present and active, driving the default $ŋ^w$ out of initial position in favor of "marked" *w*. The constraint *VwV would be descriptively superfluous; but there is no theoretical gain in

this result, since constraints militating against intervocalic glides are clearly motivated. (In Southern Paiute itself, for example, many such sequences coalesced historically into long vowels, creating the surface effect that long vowels can be stressed on either mora (K. Hale, personal communication.) Thus, the fundamental disagreement between the two analyses is not over which constraints are available in UG, but only over the relative markedness status of the allophones. If it is right to recognize *w* as universally the less marked member of $w/ŋ^w$, then the analysis of Southern Paiute is fixed once and for all.

Southern Paiute reduplication provides, then, a canonical example of how apparent underapplication must be resolved within the present theory. (Additional examples – from Chumash, Akan, Klamath, Dakota, Japanese, Luiseño, Javanese, and Malay – are discussed in McCarthy and Prince 1995: section 5.) Furthermore, since there is no ambiguity as to which member of the (B, R) pair is the affix and which the base, the pattern also serves as a striking instance of back-copying, supporting the results of section 4, no matter how the relevant alternation is construed. The Southern Paiute pattern, which eludes a principled serialist account, thus yields strong evidence for the most basic predictions of the parallel-evaluation theory of B-R Identity.

7. Conclusion

Correspondence Theory originates as a revision of the PARSE/FILL implementation of the key notion of *faithfulness*. The following remarks hint at the richness of the issues (yet to be) explored.

Correspondence generalizes over different types of linguistic relatedness: underlying-surface, base-reduplicant, simple-derived. It sees these in terms of a relation $\mathfrak{R}$ between forms, and it offers a family of rankable, violable constraints on the integrity of $\mathfrak{R}$. These constraints demand completeness of the $\mathfrak{R}$ map, in either direction, identity of individual elements standing in an $\mathfrak{R}$ relation, and other aspects of categorial or string-based identity.

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 and in McCarthy and Prince (1995) demonstrates that Correspondence Theory is superior, empirically and conceptually, to serial derivational approaches. All serial 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 → B → R cases under control, but brings in its wake major problems connected with nonconvergent (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 *re*inforce 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 high-ranking constraint, of general import in the language, that happens to bar 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 a hierarchy of ranked constraints, it is still entirely possible, as Prince and Smolensky (1993: ch. 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 and Smolensky 1993: 79–80 for a worked example.) By far the bulk of research in the theory has, of course, been conducted under the contrary assumption that candidate outputs are evaluated nonserially, 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 (section 4.2), Southern Paiute (section 6), and other examples cited in McCarthy and Prince (1995) (Axininca Campa epenthesis and augmentation; Chumash, Kihehe, and Tagalog coalescence; and Klamath syncope/reduction) either cannot be analyzed serially or can be analyzed only in formally-problematic and conceptually-flawed recastings 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 and Prince 1994a, b) and in eliminating circumscriptional infixation in favor of independently required alignment constraints (Prince and Smolensky 1991, 1993; McCarthy and Prince 1993a, b; McCarthy 1997a). We are therefore closer to realizing the Prosodic Morphology program of, effectively, generalizing itself out of existence.

The Correspondence Theory of faithfulness has phonological extensions well beyond the issues considered here; the interested reader might wish to consult some of the literature cited at the end of section 2. It is also possible to imagine using the correspondence relation to support constraints demanding *non*identity – antifaithfulness constraints, as it were. The result would be constraints with the same basic character as the "two-level" rules introduced by Koskenniemi (1983) (also see Karttunen 1993, Lakoff 1993, and Goldsmith 1993); an example is found in Baković (1996). This move would not only greatly loosen the theory, but also profoundly change its formal character (see Moreton 1996), and should accordingly be viewed with considerable scepticism. A major descriptive advantage of admitting antifaithfulness constraints lies in the area of treating certain opaque interactions; on this see McCarthy (1997b) for an approach that extends Correspondence Theory but maintains the limitation to faithfulness.

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 and Smolensky 1991, 1993; and others), with a variety of interesting consequences for the characterization of prosodic and segmental phonology. 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, 1997; McCarthy 1995). The most familiar serial mechanism recruited to account for transderivational relationships is the phonological cycle (Chomsky and Halle 1968); less familiar ones include prosodic circumscription (McCarthy and 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 nonserially. 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 section 4.2 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 (Benua 1997), connecting with proposals in Burzio (1994a, b).

Prosodic circumscription is another serial mechanism that can be reexamined in this light (McCarthy 1995, 1997a). Under prosodic circumscription, a form is first provided with prosodic constituency (syllable and foot structure); then a prosodic constituent is identified and 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 and Smolensky 1991, 1993; McCarthy and Prince 1993a, b). 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.

Appendix

A set of constraints on the correspondence relation

This appendix provides a tentative list of constraints on correspondent elements. Affinities with other constraint types are noted when appropriate. All constraints refer to pairs of representations (S_1, S_2), standing to each other as (I, O), (B, R), etc. The constraints also refer to a relation $\mathfrak{R}$, 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.

The formalization is far from complete, and aims principally to clarify. As in section 2, we imagine that a structure S_i is encoded as a set of elements, so that we can talk about $\mathfrak{R}$ 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 $\mathfrak{R} \subset A{\times}B$, $x \in \text{Domain}(\mathfrak{R})$ iff $x \in A$ and $\exists y \in B$ such that $x\mathfrak{R}y$; and $y \in \text{Range}(\mathfrak{R})$ iff $y \in B$ and $\exists x \in A$ such that $x\mathfrak{R}y$.

(A.1) MAX
Every element of S_1 has a correspondent in S_2.
$\text{Domain}(\mathfrak{R}) = S_1$

(A.2) DEP
Every element of S_2 has a correspondent in S_1.
$\text{Range}(\mathfrak{R}) = S_2$.

MAX (= (3)) and DEP are analogous respectively to PARSE-segment and FILL in Prince and 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 $x\mathfrak{R}y$ and x is $[\gamma F]$, then y is $[\gamma F]$.

IDENT (= (5)) replaces the PARSE-feature and FILL-feature-node apparatus of Containment-type OT. See Pater (this volume) and section 5.4 above for further developments. As stated, IDENT presupposes that only segments stand in correspondence, so all aspects of featural identity must be communicated through correspondent segments. Ultimately, the correspondence relation will be extended to features, to accommodate

"floating" feature analyses, like those in Archangeli and Pulleyblank (1994) or Akinlabi (1996). (Also see Lombardi 1995, Zoll 1996.)

(A.4) Contiguity
a. I-CONTIG ("No Skipping")
The portion of S_1 standing in correspondence forms a contiguous string.
$\text{Domain}(\mathfrak{R})$ 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.
$\text{Range}(\mathfrak{R})$ is a single contiguous string in S_2.

These constraints characterize two types of contiguity (see also Kenstowicz 1994). The constraint I-CONTIG rules out deletion of elements *internal* to the input string. Thus, the map *xyz* → *xz* violates I-CONTIG, because the Range of $\mathfrak{R}$ is {x, z}, and *xz* is not a contiguous string in the input. But the map *xyz* → *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* → *xyz* violates O-CONTIG, but *xz* → *xzy* 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 $x\mathfrak{R}y$.
LEFT-ANCHOR. Likewise, *mutatis mutandis*.

In prefixing reduplication, L-ANCHOR ≫ 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 and 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 (which is, 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 $x\Re x'$ and $y\Re y'$, 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 $x\Re z$ and $y\Re z$, 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 $w, z \in S_2$, if $x\Re w$ and $x\Re z$, 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 (1995, 1996) and McCarthy (1995). On coalescence, see Gnanadesikan (1995), Lamontagne and Rice (1995), McCarthy (1995), and Pater (this volume).

Notes

1 This chapter is excerpted from a longer work, which appeared as McCarthy and Prince (1995). We are grateful to René Kager for his extensive comments on a previous version, and to him, Harry van der Hulst, and Wim Zonneveld for arranging the workshop at which this material was first presented. For comments on this material, we are also grateful to several other workshop participants: Sharon Inkelas, Junko Itô, Armin Mester, Orhan Orgun, Joe Pater, David Perlmutter, Sam Rosenthall, Pat Shaw, and Suzanne Urbanczyk. Additionally, audiences at Harvard University, the University of Maryland, the University of Arizona, University of California, Irvine, University of California, Los Angeles, and the University of Texas at Austin have provided valuable feedback; and the comments, questions, and suggestions from the participants in the (eventually joint) University of Massachusetts and Rutgers Correspondence Theory seminars were particularly important for the development of this work. For useful discussion of numerous points, we would like to thank Akin Akinlabi, John Alderete, Diana Archangeli, Eric Baković, Jill Beckman, Laura Benua, Nicola Bessell, Luigi Burzio, Andrea Calabrese, Katy Carlson, Abby Cohn, Laura Walsh Dickey, Vicki Fromkin, Amalia Gnanadesikan, Mike Hammond, Bruce Hayes, Caroline Jones, Ed Keer, Michael Kenstowicz, Takeo Kurafuji, Claartje Levelt, Mark Liberman, Linda Lombardi, Ania Lubowicz, Scott Myers, Sharon Peperkamp, Paul Portner, Sharon Rose, Lisa Selkirk, Jen Smith, Donca Steriade, Bert Vaux, Rachel Walker, and Moira Yip; additional thanks are due to Alderete, Beckman, Benua, Carlson, Gnanadesikan, Jones, Lubowicz, Smith, and Urbanczyk for their contributions as grant research assistants. Special thanks to Paul Smolensky for discussion of key foundational issues. This work was supported in part by grant SBR-9420424 from the National Science Foundation and by research funds from Rutgers, the State University of New Jersey, at New Brunswick.

2 The term "reduplicant" is due to Spring (1990).

3 The terms "overapplication" and "underapplication" are due to Wilbur (1973a, b, c). See section 3.1 below.

4 We will simplify the discussion in a further respect: we will speak of $\Re$ relating string to string, though relations are properly defined on "sets." 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, $\Re$ can be defined over such sets.

Correspondence is treated as a relation rather than a function 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 and Rice (1995), McCarthy (1995), and Pater (this volume).

5 For formal development relevant to the full complexity of phonological structures, see Pierrehumbert and Beckman (1988), Kornai (1991), and van Oostendorp (1993). On quantitative transfer, see Levin (1983), Clements (1985a), Mester (1986: 239 note), McCarthy and Prince (1988), and Steriade (1988). On floating features, see among others Archangeli and Pulleyblank (1994), Akinlabi (1996), and Zoll (1996).

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

7 On differentiation of root versus affix faithfulness, see McCarthy and Prince (1995: section 6.2).

8 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.

9 "Containment" is offered here as a term of art; hence, free association from the ordinary language homophone is unlikely to provide a reliable guide to its meaning.

10 Usually desirable. There are cases, going under the rubric of "opacity" (Kiparsky 1973), where deleted elements do influence the outcome, on which see McCarthy (1997b).

11 A Containment or PARSE/FILL approach to B-R Identity is conceivable, but flawed empirically. See the discussion in McCarthy and Prince (1995: section 2.3).

12 In this discussion, we assume that underlying forms are represented in the familiar fashion with predictable allophonic information absent, so that "disparity" is disparity from this structure. Whether such predictable information appears in underlying forms is independent of the assumptions of OT, as noted below (section 4.1, discussion of (48)). The formulation of over- and underapplication in terms of marked/unmarked elements and defaults circumvents this ambiguity.

13 Exceptions are Dudas (1976: 218–26) and Shaw (1976 [1980]: 319–91), who entertain this possibility along with others, Onn (1976), and the brief discussion in Kenstowicz (1981).

14 For further discussion, see McCarthy and Prince (1995: section 3.8). Compare the role of geminate structures in determining the (non)application of phonological processes (Hayes 1986, Schein and Steriade 1986, McCarthy 1986).

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

16 This constraint is understood to prohibit linear concatenation of a nasal segment and an oral vocoid (glide or vowel). Obviously, a fuller treatment of the typology and theory of nasal harmony is required, but would be far removed from our concerns here. For relevant discussion, see Cohn (1990, 1993) and Cole and Kisseberth (1995).

17 It is worth emphasizing that the use of underspecification does not change the basic point of the argument. With underspecification, the lexicon is barred from containing both β and α (*α 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.

18 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. See Alderete *et al.* (1996) for some discussion of featural disparity in B-R correspondence.

19 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.

20 One particular version of Ordering Theory cannot account for Madurese, though. According to Marantz (1982: 460–61), only allomorph-selection rules can overapply. Madurese nasal harmony is obviously not an allomorph-selection process; on the contrary, it is allophonic. See Stevens (1985) for further discussion.

21 Onn (1976) does not transcribe nasality in glides; we have altered his transcriptions in this respect.

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

23 "Converge" as opposed to "diverge" rather than "crash." Thanks to Bruce Tesar for the contrast.

24 Failed candidates like *[(*t̪il-t̪il*)(*parku*)] or *[(*t̪ilpar*)(*ku-t̪il*)(*parku*)] incorporate the reduplicant into the same PrWd as the base. This option is ruled out by designating the reduplicative morpheme of Diyari as a root, from which PrWd status follows (McCarthy and Prince 1994b).

25 We are indebted to Donca Steriade for challenges on this point.

26 We are assuming that each feature- or structure-changing map is banned by at least one faithfulness constraint. This need not be the case logically – for example, epenthesis could in principle be controlled by markedness constraints alone – but it accords with most current practice.

27 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 section 4, $*V_{Nas} \gg$ IDENT-IO(nas), but this does not mean that $*V_{Nas}$ always gets its way; $*NV_{Oral}$ has the final say.

28 As noted, 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 and Smolensky 1993: 86).

29 Any relevant markedness constraints that militate against the desired output must also be subordinated to Phono-Constraint, as shown by the subordinate position of {*M} in (54).

30 See also McCarthy and Prince (1994b), Urbanczyk (1996a, b), Shaw (1994), and Alderete *et al.* (1996) for further discussion.

31 The more deviously constructed candidate *tag*$_{3,6}$*ta–tag*$_5$*tag*$_6$ spares MAX-BR violation via an odd correspondence relation, but at the expense of violating two other constraints defined in the appendix, LINEARITY-BR and UNIFORMITY-BR. It is an interesting further issue to explain why such fusion is, in all likelihood, impossible (as are many other LINEARITY-violating maps, here and elsewhere). Notice too that the banning of reduplicant-internal codas, in violation of CONTIG-BR, may be impossible as well, requiring further elaboration of the account.

32 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 McCarthy and Prince (1995: section 6).

33 A formal alternative, following the second disjunct of the anti-back-copying schema (62) above, would be to rank the markedness constraint *NASAL-C above B-R Identity. Then considerations of B-R Identity would never be able to force the appearance of an additional *n* into the base, regardless of the ranking position of I-O Faithfulness.

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