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Prosodic morphology

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0 Introduction

Prosodic morphology (McCarthy and Prince 1986 et seq.) is a theory of how morphological and phonological determinants of linguistic form interact with one another in a grammatical system. More specifically, it is a theory of how prosodic structure impinges on templatic and circumscriptional morphology, such as reduplication and infixation. There are three essential claims:

(1) Principles of Prosodic Morphology
   (a) Prosodic Morphology Hypothesis
      Templates are defined in terms of the authentic units of prosody: mora (μ), syllable (σ), foot (F), prosodic word (PrWd).
   (b) Template Satisfaction Condition
      Satisfaction of templatic constraints is obligatory and is determined by the principles of prosody, both universal and language-specific.
   (c) Prosodic Circumscription
      The domain to which morphological operations apply may be circumscribed by prosodic criteria as well as by the more familiar morphological ones.

In short, the theory of prosodic morphology says that templates and circumscription must be formulated in terms of the vocabulary of prosody and must respect the well-formedness requirements of prosody. Earlier proposals for including prosody in templatic morphology include McCarthy (1979), Nash (1980, p. 139), Marantz (1982), Yip (1982, 1983), Levin (1983), Broselow and McCarthy (1983), Archangeli (1983, 1984), McCarthy (1984a, 1984b), and Lowenstamm and Kaye (1986). Prosodic morphology extends this approach to the claim that *only* prosody may play this role, and that the role includes circumscription as well.

Reduplicative and root-and-pattern morphology are typical cases where the principles of prosodic morphology emerge with full vigor. In reduplicative and root-and-pattern morphology, grammatical distinctions are expressed by imposing a fixed phonological shape on varying segmental material. For example, the Ilokano reduplicative plural in (2) specifies a prefix whose canonical shape is constant – a heavy syllable – but whose segmental content depends on the base to which it is attached:

(2) Ilokano Reduplication (McCarthy and Prince 1986, 1991b; Hayes and Abad 1989)

kaldíŋ	"goat"	kal-kaldíŋ	"goats"
púsa	"cat"	pus-púsa	"cats"
kláse	"class"	klas-kláse	"classes"
jyánitor	"janitor"	jyan-jyánitor	"janitors"
róʔot	"litter"	roː-róʔot	"litter" (pl.)
trák	"truck"	traː-trák	"trucks"

In the root-and-pattern morphological system of Arabic, the productive plural and diminutive are expressed by imposing a fixed light-heavy syllable sequence (an iambic foot) on the singular noun base. As shown in (3), this canonical shape holds only of the initial boldface sequence, as a consequence of prosodic circumscription (see sec. 4 below).

(3) Arabic Productive Plural and Diminutive

Singular	Plural	Diminutive	Gloss
ħukm	/**ħakaam**/	**ħukay**m	"judgment"
ʕinab	/**ʕanaab**/	**ʕunay**b	"grape"
jaziir + at	**jazaaʔir**	**juzayy**ir	"island"
šaaɣil	**šawaaɣil**	**šuwayɣ**il	"engrossing"
jaamuus	**jawaamiis**	**juwaym**iis	"buffalo"
jundub	**janaadib**	**junay**dib	"locust"
sulṭaan	**salaaṭiin**	**sulay**ṭiin	"sultan"

As in Ilokano, the Arabic categories "plural" and "diminutive" are expressed by an invariant shape or canonical form, rather than by invariant segmental material.

The morphemes or formatives that yield these fixed shapes are called *templates*, and the Prosodic Morphology Hypothesis regulates their form in a fundamental way. Under the Prosodic Morphology Hypothesis, templates can impose prosodic conditions, but not ordinary phonological ones – for example, they can require that the plural affix be a heavy syllable, but not that it have the shape vCv, because vCv is not a prosodically-definable unit (C and v are informal abbreviations for consonant and vowel, respectively, not to be confused with the C and V skeletal units discussed in section 5 below). The Template

Satisfaction Condition requires that a template be exactly matched in the output, within independently necessary limits on what constitutes a syllable, foot, or other prosodic constituent. Prosodic Circumscription of Domains is a distinct notion from templates, but related; its prosodic character demands that phenomena like the locus of infixation also be characterized in terms of prosodic constituents.

The goal here is to lay out and illustrate the fundamental tenets and empirical results of prosodic morphology theory. We begin (sec. 1) by describing the assumptions about prosody in which prosodic morphology is embedded, with particular focus on the important subtheory of word minimality. We turn then to the two principal types of templatic phenomena, in which the template functions as the stem or base of a form (sec. 2) and in which the template functions as an affix, leading to reduplication (sec. 3). Prosodic circumscription is the topic of section 4, and the results of sections 1 through 4 are then called on to construct a set of arguments in support of the Prosodic Morphology Hypothesis and the Template Satisfaction Condition (sec. 5). The chapter concludes (section 6) with an overview of some recent results emerging from the integration of prosodic morphology into optimality theory (Prince and Smolensky 1993; McCarthy and Prince 1993).

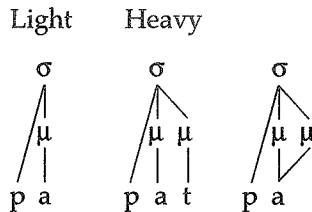# 1   Prosodic Theory within Prosodic Morphology

The Prosodic Morphology Hypothesis requires that templatic restrictions be defined in terms of prosodic units. The Prosodic Hierarchy in (4), evolved from that of Selkirk (1980a, 1980b), specifies what those units are:

(4)   Prosodic Hierarchy

$$\begin{array}{c} \text{PrWd} \\ | \\ \text{F} \\ | \\ \sigma \\ | \\ \mu \end{array}$$

The units of prosody are the mora, μ, the syllable, σ, the metrical foot, F, and the prosodic word, PrWd. The mora is the familiar unit of syllable weight (Prince 1980; van der Hulst 1984; Hyman 1985; McCarthy and Prince 1986; Zec 1988; Hayes 1989; Itô 1989; etc.). The most common syllable weight typology is given in (5), where Cv syllables like *pa* are light and Cvv or CvC syllables like *paa* or *pat* are heavy.

(5) Syllables in Moraic Theory – Modal Weight Typology

Light   Heavy

$$
\begin{array}{ccc}
\sigma & \sigma & \sigma \\
\mid\!\!\mu & \mu\;\mu & \mu\;\mu \\
\mid & \mid\;\mid & \vee \\
p\;a & p\;a\;t & p\;a
\end{array}
$$

This equivalence between two types of heavy or bimoraic syllables can be seen in morphological phenomena like the Ilokano plural (2) and in phonological ones like stress, closed syllable shortening, compensatory lengthening, and versification.

Metrical feet are constrained both syllabically and moraically. The inventory laid out in (6) below is proposed in McCarthy and Prince (1986) and Hayes (1987) to account for Hayes's (1985) typological findings. (Subsequent work along the same lines includes Hayes (1991), Kager (1989, 1992a, 1992b, 1993), Prince (1991), Mester (1993), and others.) We write *L* for light syllable, *H* for heavy syllable:

(6) Foot Types

Iambic	Trochaic	Syllabic
LH	H, LL	σσ
LL, H		

Conspicuously absent from the typology are degenerate feet, consisting of just a single light syllable, though they may play a marked role in stress assignment (Kager 1989; Hayes 1991; but see Kiparsky 1992). The following general condition on foot form is responsible for the nonexistence (or markedness) of degenerate feet (Prince 1980; McCarthy and Prince 1986, 1991a, 1993, sec. 4; Hayes 1991):

(7) Foot Binarity
     Feet are binary under syllabic or moraic analysis.

Under strict Foot Binarity, single, therefore unfootable light syllables will occur, especially at edges. Unfooted syllables are immediately dominated by PrWd, rather than by F, in a "loose" interpretation of the Prosodic Hierarchy (see sec. 3 below, and Itô and Mester 1992; McCarthy and Prince 1993, sec. A.2).

The Prosodic Hierarchy and Foot Binarity, taken together, derive the notion "Minimal Word" (Prince 1980; Broselow 1982; McCarthy and Prince 1986, 1990a, 1991a, 1991b). According to the Prosodic Hierarchy, any instance of the category prosodic word must contain at least one foot (F). By Foot Binarity, every foot must be bimoraic or disyllabic. By transitivity, then, a prosodic word must contain at least two moras or syllables. In *quantity-sensitive* languages, which distinguish syllable weight, the minimal word is bimoraic; in *quantity-insensitive*

languages, all syllables are presumptively monomoraic, and so the minimal word is disyllabic.

This notion of word minimality turns out to have broad cross-linguistic applicability; see among others McCarthy and Prince (1986, 1991a, 1991b, 1993); Cho (1992); Cole (1990); Crowhurst (1991b, 1992a); Dunlap (1991); Golston (1991); Hayes (1991); Itô (1991); Itô and Hankamer (1989); Itô, Kitagawa, and Mester (1992); Itô and Mester (1992); McDonough (1990); Mester (1990, to appear); Myers (1987); Orgun and Inkelas (1992); Piggott (1992); Spring (1990a, 1990b); Tateishi (1989); Weeda (1992); and Yip (1991). One particularly striking case of a word minimality effect occurs in the Australian language Lardil; it was first analyzed in these terms by Wilkinson (1988) based on work by Hale (1973) and Klokeid (1976); Kirchner (1992) and Prince and Smolensky (1991b, 1993) offer further analysis. In Lardil, Cvv(C) syllables are heavy or bimoraic, while Cv(C) syllables are light, so Lardil prosody is quantity-sensitive. The entailed bimoraic minimum is responsible for the following alternations, which involve both augmentation and truncation phenomena:

(8) Lardil

	Underlying	Nominative	Accusative	
(a)	Bimoraic base			
	/wiṭe/	wiṭe	wiṭe-n	"inside"
	/peer/	peer	peer-in	"ti-tree species"
(b)	Monomoraic base			
	/wik/	wika	wik-in	"shade"
	/ter/	tera	ter-in	"thigh"
(c)	Long bases			
	/mayara/	mayar	mayara-n	"rainbow"
	/kantukantu/	kantukan	kantukantu-n	"red"

Bimoraic roots remain unchanged in the nominative (8a). But monomoraic, hence subminimal roots are augmented to two moras (8b), guaranteeing licit PrWd status. Final vowels are deleted in the nominative with consequent loss of whatever consonants are thereby rendered unsyllabifiable, shown in (8c). Final vowels are, however, preserved in stems like *wiṭe*, which could not be made any shorter and still fulfill the minimality requirement. In Lardil, constraints on PrWd well-formedness therefore both promote augmentation and inhibit truncation. Optimality Theory (see sec. 6 below) provides the analytical tools needed to make sense of such complex interactions; a complete analysis is presented in Prince and Smolensky 1991b, 1993.

This succinct conception of prosodic word minimality, as devolving from just Foot Binarity and the Prosodic Hierarchy, has a number of correlative properties (McCarthy and Prince 1991a, 1991b):

- *Economy.* There is no "Minimal Word Constraint" in any language. Rather, observed word minimality restrictions are the result of the combination of two requirements, the Prosodic Hierarchy and Foot Binarity, that themselves never mention the notion "minimal word".

- *Role of quantity.* The nature of the smallest prosodic word in any language is fully determined by its prosody, disyllabic if quantity-insensitive, bimoraic if quantity-sensitive. (But cf. Piggott 1992; Itô and Mester 1992.)
- *No iambic minimum.* Though LH is a type of foot (the iamb), no language can demand a LH minimal word (cf. Spring 1990b, p. 79n.). Even in a language with iambic prosody, the minimal prosodic word will be the *minimal* iamb, which is simply any iamb that satisfies Foot Binarity.
- *Enforcement.* Because prosodic word minimality follows from Foot Binarity, enforcement of minimality will be by the same means as enforcement of other prosodic well-formedness requirements. Thus, just as syllabic well-formedness requirements may lead to epenthesis or block syncope, so too prosodic word minimality may lead to augmentation or block truncation.

Departures from these correlations will only be possible in cases where the underlying constraints are also violated. For instance, if there can be languages with no feet at all or with free distribution of unit feet, then such languages should not show effects of word minimality.[1]

Thus, the theory of prosodic word minimality is a very simple one, with broad universal consequences. There is, though, one important language-specific aspect to it, the level at which the minimality requirement is imposed. In Lardil, for example, the minimality restriction is visibly enforced at the level of the stem or morphological word, since the root may be subminimal. Languages differ in this respect; in other Australian languages, Dyirbal (Dixon 1972), Warlpiri (Nash 1980, p. 67f.), or Yidiɲ (Dixon 1977, p. 35; Hayes 1982), even bare roots are minimally disyllabic, and in Boumaa Fijian (Dixon 1988), with quantity-sensitive prosody, roots are minimally bimoraic. This parameter of interlinguistic variation is expressed by differing values of MCat in the following schema (McCarthy and Prince 1991a, 1991b, 1993, sec. 7):

(9)   MCat = PrWd
       where MCat ≡ Root, Stem, Lexical Word, etc.

In Lardil, MCat is Stem or Lexical Word, while in the other languages mentioned, it is Root. Imposition of this schema demands that the morphological constituent MCat correspond to a PrWd, which leads to the attendant observed word minimality restrictions. The difference is in whether the minimality restriction holds of bare roots, as a kind of morpheme structure constraint, or only of the surface, thereby typically leading to alternations of the Lardil type.

There are several correlative properties of the MCat = PrWd schema, important in prosodic word minimality theory and elsewhere:

- *Upward inheritance.* Once the MCat = PrWd requirement has been imposed, all superordinate MCats must also contain PrWd. Thus, if MCat = Root, as in Dyirbal and the other languages mentioned, there

can be no minimality-related alternations, since Stem and Lexical Word, because they contain Root, will also contain PrWd, at least.

- *Fineness of grain.* Finer lexical distinctions of MCat can lead to differences between, e.g., nouns and verbs in the level at which word minimality is imposed.
- *Function word escape.* MCat is typically restricted to the lexical vocabulary, so nonlexical items are usually not PrWds. Hence, they are frequently exceptions to word minimality regularities.
- MCat = PCat. By generalizing the schema to *any* morphological category and *any* prosodic category, we obtain an abstract specification of what a template is – the requirement that the exponent of some morphological unit be a prosodic unit of a particular type. This idea is pursued in McCarthy and Prince (1993, sec. 4 and sec. 7), where it is interpreted within a general theory of constraints on the *alignment* of grammatical and prosodic categories.

The schema MCat = PrWd, then, provides the interface between the phonological theory of word minimality, based on the Prosodic Hierarchy and Foot Binarity, and the morphology and lexicon of a language.

Though word minimality restrictions have no independent status in the phonology, the minimal prosodic word (MinWd) is an important category-of-analysis in templatic and circumscriptional morphology. For instance, in the Australian language Diyari (Austin 1981; McCarthy and Prince 1986; Poser 1989), the minimal prosodic word is the template in prefixing reduplication:

(10)   Diyari MinWd Reduplication

Singular	Plural	
wila	<u>wila</u>-wila	"woman"
ŋankanti	<u>ŋanka</u>-ŋankanti	"catfish"
tʲilparku	<u>tʲilpa</u>-tʲilparku	"bird species"

The underscored reduplicated string in Diyari is exactly two syllables long, in conformity with the quantity-insensitive prosody of the language. Like any prosodic word of Diyari, the reduplicative morpheme must be vowel-final. This explains why the last two examples are not *<u>ŋankan</u>-ŋankanti* and *<u>tʲilpar</u>-tʲilparku*, which would have been expected since they more completely copy the base (sec. 3). In essence, Diyari reduplication consists of compounding a minimal word with a full one.

In Yidiɲ (Dixon 1977; Nash 1979, 1980), the minimal word is the base to which total reduplication applies (McCarthy and Prince 1990a):

(11)   Yidiɲ MinWd Circumscriptional Reduplication

Singular	Plural	
.mu.la.ri.	<u>mula</u>-mulari	"initiated man"
.tʲu.kar.pa.	<u>tʲukar</u>-tʲukarpa-n	"unsettled mind"
.kin.tal.pa.	<u>kintal</u>-kintalpa	"lizard species"
.ka.la.ᵐpa.ɽa.	<u>kala</u>-kalaᵐpaɽa	"March fly"

In Yidiɲ, the disyllabic minimal prosodic word *within* the noun stem is targeted and copied completely. The syllabification of the stem determines whether the prosodic word so obtained is V-final, like *mula* from *mulari*, or C-final, like *kintal* from *kintalpa*. Further details are provided below, in section 4.

2   The Template as Base

The templatic target may be imposed on an entire stem, word, or other morphological base. It is useful to distinguish among three formally distinct types of base/template relation. One is truncation, found especially in the morphology of nicknames and hypocoristics, and exemplified below with Japanese and Yup'ik Eskimo. Another is root-and-pattern morphology, in which entire paradigms or morphological classes are organized along templatic lines. This is exemplified below with the shapes of the canonical noun stem in Arabic. The most complex cases where the template functions as a base compose template-mapping with prosodic circumscription. This is illustrated below (sec. 4) with the Arabic broken plural and diminutive, though other cases in the literature include the Choctaw *y*-grade (Lombardi and McCarthy 1991; Ulrich 1992; Hung 1992) and the Cupeño habilitative (Hill 1970; McCarthy 1984a; McCarthy and Prince 1990a; Crowhurst, to appear).

An extremely common mode of nickname or hypocoristic formation, broadly attested in the world's languages, is the result of mapping a name onto a minimal word template, bimoraic or disyllabic, depending in the usual way on the prosody of the language. This type of prosodic morphology was first identified by McCarthy and Prince (1986, 1990a), with subsequent developments including Weeda's (1992) exhaustive survey and studies of individual languages including Arabic (McCarthy and Prince 1990b), Swedish (Morris 1989), French (Plénat 1984; Steriade 1988), Spanish (de Reuse n.d.; Crowhurst 1992a), Nootka (Stonham 1990), and Japanese. (Other species of truncation, involving circumscription rather than template-mapping, are discussed in sec. 4 below.)

Truncation in Japanese has been most extensively investigated in these terms, starting with Poser (1984, 1990) and continuing with Tateishi (1989), Itô (1991), Mester (1990), Itô and Mester (1992), and Perlmutter (1992). The formation of the hypocoristics in (12) is typical:

(12)   Hypocoristics in Japanese (Poser 1984, 1990)

Name	Hypocoristic
ti	tii-tyan
syuusuke	syuu-tyan
yoosuke	yoo-tyan
taizoo	tai-tyan
kinsuke	kin-tyan
midori	mii-tyan ~ mit-tyan ~ mido-tyan
wasaburoo	waa-tyan ~ wasa-tyan ~ sabu-tyan ~ wasaburo-tyan

As usual in systems of nickname formation, personal preferences may influence the form, and idiosyncrasies of segment-to-template mapping may be found (e.g., *sabu-tyan*). With complete consistency, though, the hypocoristic stem consists of an even number of moras, usually two, and it is realized in all the ways that an even number of moras can be, within the syllable canons of Japanese.

Though prominential stress is not found in Japanese, there is considerable evidence that it has a system of trochaic feet (Poser 1990) and that the minimal word is, as expected, bimoraic (Itô 1991). Thus, the template for the hypocoristic can be characterized fully prosodically as F^+ (one or more feet) or $MinWd^+$, the latter perhaps to be analyzed as a kind of MinWd-compound. The segments making up a name are mapped onto some expansion of this template, usually from left to right, to obtain the hypocoristic form.

In Central Alaskan Yupik Eskimo (Woodbury 1985; McCarthy and Prince 1986, 1990a), the template for the "proximal vocative" nicknaming system is, exactly like Japanese, F or MinWd. This is despite the fact that there are vast differences in the surface shape of the nicknames, because of independent differences in the prosody of the two languages:

(13)   Proximal Vocatives in Central Alaskan Yupik Eskimo (Woodbury 1985)

Name	Proximal Vocative
Aŋukaɣnaq	Aŋ ~ Aŋuk
Nupiɣak	Nup ~ Nupix ~ Nupik
Cupəłːaq	Cup ~ Cupəł
Kalixtuq	Kał ~ Kalik
Qətunɣaq	Qət ~ Qətun

As in Japanese, there are individual preferences and idiosyncrasies of form, but the supervening regularity is that the hypocoristic template is a foot, iambic in Yup'ik and corresponding to the minimal word of the language.[2]

In some languages, the template-as-stem is much more firmly entrenched in the grammatical system, and it may be the fundamental organizing principle of the morphology. This is notoriously true in Arabic and other Afro-Asiatic languages (McCarthy 1979, 1981, 1984a, 1984b, 1989, 1993; Bat-El 1989, 1992; Dell and Elmedlaoui 1992; Hayward 1988; Hoberman 1988; Inkelas 1990; Lowenstamm and Kaye 1986; McCarthy and Prince 1986, 1990a, 1990b, 1991b; Moore 1989; Prince 1991; Yip 1988), but also in the Penutian languages Sierra Miwok (Freeland 1951; Broadbent 1964; Bullock 1990; Crowhurst 1991b, 1992b; Goldsmith 1990; Lamontagne 1989; Sloan 1991; Smith and Hermans 1982; Smith 1985, 1986), Yokuts (Newman 1944; Archangeli 1983, 1984, 1991; Steriade 1986; Prince 1987, 1991), and Takelma (Sapir 1922; Goodman 1988; Lee 1991), and to a lesser extent in Chinese (Yip 1991) and Salish (Montler 1989; Stonham 1990).[3]

These phenomena are all richly articulated, so it is not possible here to do more than sketch an approach to one of them, the canonical nouns of Standard

Arabic, abstracted from McCarthy and Prince (1990b), Prince (1991), and McCarthy (1993). Canonical nouns are integrated into the morphological system, based on their ability to form broken plurals (see (3) and sec. 4) and other criteria. The vast majority of nouns in the language are canonical, but many (such as recent loans like *tilifuun* "telephone") are not. The basic data appear in (14), which provides a classification by Cv-pattern of all the canonical noun stems of Arabic. The percentages given in (14) were obtained by counting all of the canonical noun stems occurring in the first half of the large Wehr (1971) dictionary ($N \approx 2400$).

(14) The Canonical Noun Patterns

(a) H	(b) LL	(c) LH	(d) HL	(e) HH
CvCC	CvCvC	CvCvvC	CvvCvC	CvvCvvC
baħr	badal	waziir	kaatib	jaamuus
33%	7%	21%	12%	2%

(f) HL	(g) HH
CvCCvC	CvCCvvC
xanjar	jumhuur
14%	11%

Glosses: "sea", "substitute", "minister", "writer", "buffalo", "dagger", "multitude"

All patterns are well represented except for CvvCvvC (14e), which is probably an historical innovation in Arabic.

The classification of nouns in (14) according to the syllable-weight patterns (H, L) assumes final consonant extraprosodicity, which is independently motivated in Arabic. Analysis of these patterns of weight leads to two principal prosodic conditions on canonical noun stems (NStem):

(15) Prosodic Conditions on Canonicity of NStem

    (a) Minimally bimoraic   (b) Maximally disyllabic

        NStem = PrWd   NStem $\leq \sigma\sigma$

Because the morphological category NStem is equated with the prosodic category PrWd, a NStem must contain a foot, under the Prosodic Hierarchy, and so it is minimally bimoraic, under Foot Binarity (7). That is, the minimal canonical noun stem of Arabic is a single heavy syllable (14a) or a sequence of two light syllables (14b). Furthermore, no canonical noun stem is longer than two syllables (14b–g). The maximality condition is a natural one under considerations of locality, which impose an upper limit of two on rules that count (McCarthy and Prince 1986 and sec. 5 below), but it can perhaps be given an even more direct prosodic interpretation in terms of conditions on branching (Itô and Mester 1992) or through an additional foot type, the

generalized trochee of Prince (1983), Hayes (1991), and Kager (1992a, 1992b). Indeed, the generalized trochee combines the properties of (6); like the canonical noun stem of Arabic, it is minimally bimoraic, maximally disyllabic.

Within the limits set by these conditions, the bimoraic lower bound and the disyllabic upper bound, every combination of heavy and light syllables is actually attested.[4] This result shows that prosody supplies the right kind of vocabulary for describing the fundamental regularities of the system, and thus it confirms the Prosodic Morphology Hypothesis in a general way. But even more prosodic structure emerges when we look beyond the superficial properties of the system.

Specifically, all licit *templates* in the Arabic noun consist of feet or sequences of feet. In particular, this entails that there are no anti-iambic or HL noun templates in the morphological system of Arabic. The evidence of this is that the anti-iambic noun patterns like *kaatib* and *xanjar* have a very restricted role in Arabic morphology, even though such nouns are quite common. Anti-iambic nouns are derived not by mapping to a template but by other resources of prosodic morphology, to be described below. The remaining noun patterns – H, LL, LH, and HH – are actually templatic, and so they are broadly distributed in the lexicon of Arabic and used independently by the morphology.

The noun patterns H, LL, and LH are also all quantity-sensitive feet; in fact, they are all expansions of the iamb (sec. 1). The remaining authentic template HH is a sequence of two (iambic) feet; in fact, it is the only sequence of feet that meets the disyllabic upper bound on canonical nouns in (15b). In contrast, the anti-iamb HL does not have a foot-level analysis; at best it consists of a monosyllabic foot (H) plus an unfootable light syllable. The Iamb Rule (16) formalizes these observations about the difference between templatic and nontemplatic noun patterns:

(16)   Iamb Rule

   NStem *template* → F_I^+

The Iamb Rule requires that the template of a noun stem consist of a whole number of iambic feet. The actual noun stem templates – H, LL, LH, and HH – are each analyzeable in this way, subject to the overall disyllabic upper bound in (15b).

McCarthy and Prince (1990b) and McCarthy (1993) review a number of arguments for the special, nontemplatic status of HL noun stems. Two are recapitulated here. The first, which is due to Fleisch (1968), involves an asymmetry between the anti-iambic noun stems and their apparent mirror images, the true iambic ones. All the nouns occurring in the first half of the Wehr dictionary were collected and grouped according to their vowel quality, a good indicator of their inherent diversity in a language like Arabic, where vowel quality is often used to distinguish morphological categories. The results appear in (17):

(17)   CvvCvC vs. CvCvvC Noun Stems

HL		LH	
CaaCiC	263	CaCiiC	265
CaaCaC	7	CiCaaC	106
CaaCuC	1	CaCaaC	37
		CaCuuC	29
		CuCaaC	25
		CiCiiC	1
Total	271	Total	463

It is immediately apparent that the anti-iambic pattern is massively skewed to one vowel pattern, but the iambic one is not. Iambic nouns are more common and occur with more vocalic patterns in a more even distribution than anti-iambic ones. Nearly all anti-iambic nouns are vocalized like *kaatib*, with *aa* in the first syllable and *i* in the second. The reason is that they have just a single morphological function in Arabic, as participles of the basic or "Measure I" form of the verb. Specifically, a participle like *kaatib* "writing, scribe" is derived from a Measure I verb like *katab* "wrote". Since almost all anti-iambic nouns in Arabic are participles of Measure I, anti-iambs are found only with the characteristic *aa-i* vocalism of this participle. In contrast, true iambic nouns like those on the right in (17) have a variety of morphological functions, and some are basic lexical items, with no special morphological function at all. Therefore they occur with a variety of vocalizations.

A parallel argument can be made for anti-iambs like *xanjar*, this one based on the asymmetry between HL and HH nouns with a doubled root consonant (e.g., *sukkar* "sugar" vs. *jabbaar* "giant"). The data are in (18):

(18)   CvCCvC vs. CvCCvvC Noun Stems With Doubling

HL		HH	
CvC_iC_ivC	8	CvC_iC_ivvC	109
$CvCC_ivC_i$	0	$CvCC_ivvC_i$	14
Total	8	Total	123

It is clear that there is a very strong bias in favor of the HH pattern in nouns with a doubled root consonant, either with the common medial doubling (*jabbaar*) or the rarer final doubling (*jilbaab* "a type of garment"). HL nouns of this type are rare and exceptional in other respects, such as plural formation. Remarkably, this asymmetry is limited to nouns with a doubled root consonant. Anti-iambic quadriliteral nouns like *xanjar*, without doubling, are actually slightly more common than HH nouns like *jumhuur*, though both are well represented in the lexicon.

If anti-iambic nouns are not templatic, what are they? The two types of anti-iambic nouns, *kaatib* and *xanjar*, have nontemplatic sources that correspond to their limited roles in the language.

According to the evidence presented in (17), anti-iambic nouns like *kaatib* are almost entirely restricted to active participles of Measure I verbs. Thus, there must be a direct morphological relation between the anti-iambic noun *kaatib* "writing, scribe" and the corresponding verb form *katab* "wrote". Plausibly, this morphological relationship is affixational in character: the noun *kaatib* is derived from the corresponding verb *katab* by left-adjoining a mora to the initial syllable[5] (and supplying a new vowel melody, as is quite typical in Arabic morphology). Hence there is no anti-iambic template underlying the noun *kaatib*, because the source of this noun is complex, involving affixation to the verb stem *katab*.

The other class of anti-iambs is the set of CvCCvC nouns like *xanjar*. The fundamental observation about this pattern, documented in (18), is that it is restricted to true quadriliterals, nouns with four (different) root consonants. Nouns of this type are essentially never found with a geminated or doubled root consonant. The explanation is that these nouns are *a-templatic*. In other words, the lexical specification of a noun like *xanjar* consists of just its four root consonants, without any templatic constraint on form. This does not mean that its form is free; on the contrary, the canons of Arabic syllable structure – obligatory onset and no tautosyllabic consonant clusters – limit the ways in which four consonants can be organized into a phonotactically well-formed word. The constraints on canonical nouns in (15) and note 4 limit the options still further, by imposing a disyllabic upper bound and requiring that any consonant cluster be medial. The actual surface form of CvCCvC nouns like *xanjar* is uniquely determined by these conditions. It is simply the result of organizing four consonants into a stem according to the constraints on Arabic syllable structure and noun canonicity. There is no template, nor is there any need for one. This analysis obviously provides an immediate explanation for why nouns of this type are limited to true quadriliterals: a triliteral root cannot force the CvCCvC shape without calling on an otherwise prohibited anti-iambic template.

A-templatic prosodic morphology, proposed in various forms by Archangeli (1991), Bat-El (1989, p. 40f.), and McCarthy and Prince (1990b, p. 31f.), is nothing more than the absence of a template in a morphological category; then the segmental melodemes simply organize themselves according to their lexical specifications or whatever principles of phonological well-formedness, such as epenthesis or Stray Erasure, obtain in that language.

The most striking cases of a-templatic prosodic morphology are those where it accounts for departures from *shape-invariance* – the fixed canonical form that holds within a morphological class in templatic morphology. In the Ethiopian Semitic language Chaha (19), a morphological category called the jussive is formed by imposing a CCəC or CəCC structure on the verbal root:

(19) Chaha Jussive (Leslau 1964)

	Root	Jussive Verb	
(a)	gfr	yägfər	"release"
	k'βr	yäk'βər	"plant"
	ft'm	yäft'əm	"block'
	nks	yänkəs	"bite"
(b)	srt	yäsərt	"cauterize"
	trx	yätərx	"make incision"
	gmt'	yägəmt'	"chew off"

The choice between the two surface shapes of the Chaha jussive – *yägfər* vs. *yäsərt* – depends on the relative sonority of the last two root consonants.[6] That is to say, the schwa is inserted by a phonological rule of epenthesis, sensitive to local sonority relations in a familiar way. Because the location of the schwa in the jussive is straightforwardly predictable on purely phonological grounds, it should not be encoded in the template. This observation led McCarthy (1982a) and Hayward (1988) to conclude that the actual template of the Chaha jussive is a vowelless CCC skeleton, obviously problematic for the Prosodic Morphology Hypothesis.

But really a vowelless CCC template is the same as no template at all, since it says only that the underlying representation of the jussive consists of bare root consonants (with the agreement prefix). This is precisely what is meant by a-templatic prosodic morphology – without a template, the root consonants are organized prosodically by phonological rules of syllabification and epenthesis. An actual template is appropriate for morphological formations with a fixed, unpredictable canonical shape; where the shape is variable and phonologically predictable, as in the Chaha jussive, then no template is necessary or even possible.

Archangeli (1991) shows that the system of stem formation in Yawelmani Yokuts is partially templatic, partially a-templatic. The examples in (20) are given in their phonologically justified underlying representations, abstracting away from the results of epenthesis, closed syllable shortening, and other rules.

(20) Yawelmani Yokuts Stems

Root size	(a)	(b)	(c)
Biliteral "devour"	CvC c'um	CvvC c'uum	CvCvv c'umuu
Triliteral "walk"	CvCC hiwt	CvvCC hiiwt	CvCvvC hiwiit
Longer (nouns only)	CvCCC t'on'ṭm "transvestites"		CvCvvCCC yaw'iilmn "Yawelmani"

Consider first columns (20b) and (20c). The stems in these columns are based on a heavy syllable template and a LH iambic foot template, respectively. These templates, like all templates, express the invariance structure of the stems – that which is constant throughout all the stems in a column. Roots are associated to these templates from left to right, leaving a residue of one or more a-templatic consonants. These remaining consonants have no templatically-specified role, so they are organized prosodically by the regular, well-studied rules of syllabification and epenthesis in this language. Only the initial substring of the stem has a fixed canonical shape specified by the template, while the final consonant sequence is a-templatic.

Column (20a) is analyzed by Archangeli (1991) with a light syllable template, but Prince (1991) argues that in this case the entire stem is a-templatic, like the Chaha jussive (19). The CvC⁺ canonical pattern of (20a) requires no template at all; it is simply the result of imposing a minimal prosodic organization on the single vowel and two or more consonants that make up a Yokuts root. Elimination of the light syllable as a stem-template in Yokuts yields a worthwhile theoretical result: the true stem-templates of Yokuts, the heavy syllable and the iambic foot, are both types of minimal words, so Stem = MinWd (cf. (9)). This then accords with the special role of the minimal word as a stem-template or stem substitute in root-and-pattern morphology (12, 13, 15a), reduplication (10, 23), and prosodic circumscription (41).

A-templatic prosodic morphology may initially seem completely antithetical to the enterprise; after all, isn't the present theory of prosodic morphology a theory of *templates*? It is indeed, at least in part, but phenomenologically it is a theory of shape-invariance. Where shape-invariance does not hold, as is patently true in Chaha and Yawelmani, then there can be no template consistent with the Prosodic Morphology Hypothesis and the Template Satisfaction Condition. In these cases, and even more clearly in the Axininca Campa example analyzed in McCarthy and Prince (1993, sec. 5, sec. 7), the invariance structure is not templatic, but emerges out of other prosodic constraints of the language.

3   The Template as Affix

A template that is affixed to a base will lead to copying or reduplication of the segments of that base, which then satisfy the template. This is reduplication. There are three fundamental issues in the theory of reduplication: the form of the templatic affix; the satisfaction of the templatic affix; and the interaction between reduplication and the phonology. We will not address the last issue here, but see Carrier (1979), Carrier-Duncan (1984), Kiparsky (1986), Marantz (1982), Mester (1986), Munro and Benson (1973), Odden and Odden (1985), Uhrbach (1987), and Wilbur (1974).

The literature on reduplication within prosodic morphology theory and its predecessors is now vast, including at least the following: Marantz 1982;

McCarthy and Prince 1986, 1988, 1991b, 1993; Archangeli 1991; Aronoff 1976, 1988; Aronoff et al. 1987; Bagemihl 1991; Bao 1990; Bates and Carlson 1992; Bell 1983; Black 1991; Broselow 1983; Broselow and McCarthy 1983; Chiang 1992; Clements 1985; Cole 1991; Crowhurst 1991a, 1991b; Davis 1988, 1990; Everett and Seki 1985; Finer 1985; French 1988; Goodman 1993; Hayes 1982; Hayes and Abad 1989; Hewitt and Prince 1989; Hill and Zepeda 1992; Janda and Joseph 1986; Kim 1984; Kiparsky 1986; Kroeger 1989a, 1989b; Lee and Davis 1993; Levelt 1990; Levergood 1987; Levin 1983, 1985, 1989; McCarthy 1979, 1982b; McNally 1990; Mutaka and Hyman 1990; Nash 1979, 1980; Nivens 1992; Noske 1991; Plénat 1984; Poser 1982, 1989; Prince 1987, 1991; Schlindwein 1988, 1991; Shaw 1980, 1987, 1992; Sietsema 1988; Sloan 1988; Smith 1985, 1986; Spring 1990a, 1990c, 1992; Steriade 1988; Stonham 1990; Weeda 1987; Williams 1984, 1991; Yin 1989; Yip 1982, 1991, 1992. Obviously, we cannot review even a fraction of this here; rather, our goal, as in the previous section, is to highlight some of the main results that have emerged within prosodic morphology.

On the face of it, the idea that reduplication involves affixing a template may seem surprising, since one might expect reduplicative operations to say something like "copy the first syllable," as illustrated in (21). Moravcsik (1978) and Marantz (1982) observe that syllable-copying, in this sense, does not occur:

(21) "Copy First Syllable," Hypothetically

ta.ka   →   <u>ta</u>-ta.ka

tra.pa   →   <u>tra</u>-tra.pa

tak.pa   →   <u>tak</u>-tak.pa

Rather, monosyllabic prefixal reduplication always specifies a *templatic target*, following one of the patterns in (22), both from Ilokano (Hayes and Abad 1989):

(22) Monosyllabic Prefixal Reduplication: Real Cases

(a) σ_μ – e.g., Ilokano *si* + σ_μ "covered/filled with"

bu.neŋ   →   si-<u>bu</u>-bu.neŋ   "carrying a buneng"

jya.ket   →   si-<u>jya</u>-jya.ket   "wearing a jacket

pan.di.liŋ   →   si-<u>pa</u>-pan.diliŋ   "wearing a skirt"

(b) $\sigma_{\mu\mu}$ – e.g., Ilokano plural

pu.sa   →   <u>pus</u>-pu.sa   "cats"

jya.nitor   →   <u>jyan</u>-jya.nitor   "janitors"

kal.diŋ   →   <u>kal</u>-kal.diŋ   "goats"

Whether the initial syllable of the base is closed or open has no effect on the affix; rather, the prosodic shape of the affix remains constant throughout a particular morphological category. Thus, it is the morphology – via the template – and not the syllabification of the base that is the determinant of the outcome. Reduplication specifies a templatic target, not a constituent to be copied.

Cross-linguistically, the observed possibilities for reduplicative templates

are rather limited, once they are properly classified in prosodic terms. The smallest template is the light syllable, seen in (22a) above and other cases. Another common reduplicative template consists of some species of minimal word, such as a heavy syllable in Ilokano (2, 22b), a disyllabic sequence in Diyari (10), or a bimoraic sequence in Manam (23):

(23) Suffixing Reduplication in Manam (Lichtenberk 1983; McCarthy and Prince 1986, 1991b)

salaga	salaga<u>laga</u>	"long"
moita	moita<u>ita</u>	"knife"
ʔarai	ʔarai<u>rai</u>	"ginger species"
laʔo	laʔo<u>laʔo</u>	"go"
malaboŋ	malabom<u>boŋ</u>	"flying fox"
ʔulan	ʔulan<u>laŋ</u>	"desire"

Many cases can be reduced to these two reduplicative templates: the light or monomoraic template, necessarily monosyllabic of course, and the heavy or bimoraic template, sometimes specified as monosyllabic too, and equivalent to MinWd. This is precisely what we would expect under the Prosodic Morphology Hypothesis, since light versus heavy is a fundamental prosodic dichotomy.

A third type of templatic reduplicative formation does not involve an *affixal* template at all: this is quantitatively complementary reduplication, light with heavy bases and heavy with light bases. McCarthy and Prince (1986, 1991b) identify two cases of this, the Sanskrit aorist and the Ponapean verb (on which also see Rehg and Sohl 1981; Goodman 1993). Hill and Zepeda (1992) provide a third, from Tohono O'odham (Papago). The Ponapean examples in (24) are typical:

(24) Quantitative Complementarity in Ponapean Reduplication
    (a) Heavy base, Light prefix

duup	<u>du</u>-duup	"dive"
mand	<u>ma</u>-mand	"tame"
laud	<u>la</u>-laud	"big, old"
kens	<u>ke</u>-kens	"ulcerate"

    (b) Light base, Heavy prefix

pa	<u>paa</u>-pa	"weave"
pap	<u>pam</u>-pap	"swim"
lal	<u>lal</u>-lal	"make a sound"
par	<u>par</u>-a-par	"cut"

In Ponapean, based on independent word-minimality criteria, final consonants are extrametrical. Therefore a base like *pap* is light, while bases like *duup* and *mand* are heavy. With monosyllabic bases like these, there is perfect complementarity between the weight of the base and the weight of the prefix.

(With polysyllabic bases, a more complex pattern emerges; see Rehg and Sohl 1981; McCarthy and Prince 1986, 1991b.)

The explanation for quantitative complementarity is that the template is an output target imposed on the entire stem, prefix plus base, rather than on just the prefix. That is, quantitatively complementary reduplication has more in common formally with root-and-pattern morphology (sec. 2) than with templatic affixation. To see what the template is, assume an analysis of the reduplicant (the copied string) plus base into trochaic feet, as in (25):

(25)   (a) $\underline{du}$-[duu]$_F$ ⟨p⟩   (b)   [$\underline{paa}$]$_F$-pa

Descriptively, Ponapean reduplicated monosyllables contain one and only one foot, but they also contain an unfooted syllable, either as affix (25a) or base (25b). This structure is the *loose minimal word* (cf. discussion of (7) above and McCarthy and Prince 1991a, 1991b; Itô, Kitagawa, and Mester 1992), a prosodic word that contains one foot but not two, with additional unfooted (and unfootable) material present at an edge. Therefore the prefixal syllable is maximal, subject to the overall templatic target that the stem be a MinWd, loosely parsed.

This brief typological survey suggests that all reduplicative templates can perhaps be reduced to a set of expressions involving the category MinWd, as follows (McCarthy and Prince 1991b):

- The heavy template – a bimoraic foot or a heavy syllable $\sigma_{\mu\mu}$ – is exactly equal to the category MinWd (sometimes with further specification of monosyllabism). In languages without weight contrasts, like Diyari, all syllables are presumptively monomoraic, so the MinWd template is expressed by disyllabism. The MinWd template, as an affix on a form which is itself a prosodic word, can be thought of as a kind of PrWd compound. This is a type of *external morphology*, applying an affix outside the prosodic word.
- The light syllable template is < MinWd – i.e., less than a minimal prosodic word, and so prosodically dependent on the base, as a kind of *internal morphology*. In languages without weight contrasts, < MinWd specifies a monosyllabic template, since the minimal word is disyllabic.
- The template in systems with quantitative complementarity like Ponapean is also MinWd, but loosely parsed. This too is internal morphology, but in the specific sense that the template functions as an output condition on the entire base plus affix, rather than on the affix itself.

These are obviously broad generalizations, subject to further empirical testing and refinement. Nonetheless, like the Iamb Rule (16) of Arabic, they offer a way in which the Prosodic Morphology Hypothesis might be further sharpened in specifying the role of prosodic categories in templatic morphology.

Whatever the form of the template, the mapping of melody to template is governed by the Template Satisfaction Condition, just as in root-and-pattern morphology (sec. 2). But the reduplicative situation is somewhat more complex, involving several constraints dictating the relation between the base (abbreviated below as B) and the reduplicant (abbreviated R). We take the fundamental copying constraints to be Contiguity, Anchoring, and Maximality, which restate principles in McCarthy and Prince (1986). These constraints are developed at length, within optimality theory, in McCarthy and Prince (1993, sec. 5).

(26)   Contiguity[7]
       R corresponds to a contiguous substring of B.

This is a formulation of the "no-skipping" requirement of McCarthy and Prince (1986, p. 10).[8]
   A second constraint places a further structural restriction on the B-R relation:

(27)   Anchoring[9]
       In R + B, the initial element in R is identical to the initial element in B.
       In B + R, the final element in R is identical to the final element in B.

The reduplicant R and the base B must share an edge element, initial in prefixing reduplication, final in suffixing reduplication (McCarthy and Prince 1986, p. 94).[10]
   The third constraint governs the extent of match between B and R:

(28)   Maximality
       R is maximal.

Under the Template Satisfaction Condition, Maximality asserts that R is as big as it can be and yet not exceed the template.[11]
   All of these constraints have correlates and predecessors in autosegmental theory. Contiguity harkens back to the principle of one-to-one association in Clements and Ford (1979), McCarthy (1979, 1981), and Marantz (1982). Anchoring echoes the directionality of association in Clements and Ford (1979) and McCarthy (1979, 1981), and more directly Marantz's (1982) dictum that melody-to-template association proceeds from left to right in prefixes, from right to left in suffixes (cf. Yip 1988; Hoberman 1988). Finally, Maximality is a remote descendant of the "Well-formedness Condition" of Goldsmith (1976), with its prohibition on unassociated melodemes.
   Consider how these constraints will apply to an example like Ilokano heavy syllable reduplication (2). Assume that they must evaluate a set of candidate reduplicants (as in Optimality Theory – Prince and Smolensky 1993 and below, sec. 6) for the base *jyánitor*. As the following table shows, all candidates other

than *jyan-* violate at least one of the reduplicative constraints or the Template Satisfaction Condition:

(29) Failed Candidate Reduplicants for $\sigma_{\mu\mu} + jy\acute{a}nitor$

Violate TSC	Violate Contiguity	Violate Anchoring	Violate Maximality
jya-	jan-	yan-	jyaː
jyani-	jyat-	nit-	jiː
. . .	jyor-	tor-	. . .
	. . .	. . .	

The procedure or operation by which the copy is made is irrelevant; the point is that the constraints must evaluate the relation between reduplicant and base according to these constraints, which essentially require a special kind of identity. This conception of reduplication is developed and exemplified in McCarthy and Prince (1993, sec. 5, sec. 7).

In (29), the Template Satisfaction Condition demands that the templatic requirements of Ilokano be matched exactly, excluding candidate reduplicants like *jya-* (too small) or *jyani-* (too big). The Template Satisfaction Condition also requires that language-particular prosodic constraints be obeyed in templates, and this can be observed with forms like *roː-róʔot*. Ilokano bars glottal stop from syllable-final position (Hayes and Abad 1989), overriding Maximality, which would otherwise require *roʔ-róʔot*. Here, an absolute phonotactic requirement of the language blocks Maximality, but it seems clear that prosodic markedness conditions may have the same effect, as proposed in Steriade (1988) and McCarthy and Prince (1993, sec. 7).

Besides universal and language-particular prosodic constraints, three other factors are known to impinge on template satisfaction, particularly in reduplicative systems. One is the prosodic structure of the base. In the phenomenon of *quantitative transfer* (Levin 1983; Clements 1985; Hammond 1988; McCarthy and Prince 1988; Steriade 1988; Selkirk 1988), base vowel length is copied in the reduplicant, showing that the base and reduplicant cannot always be regarded as strings of segments, since the segmental level alone does not encode quantitative oppositions. An example of this is heavy-syllable reduplicative prefixation in Mokilese:

(30) Mokilese Heavy σ Prefix (Harrison 1976; Levin 1983, 1985, 1989; McCarthy and Prince 1986, 1988, 1991b)
    (a) CvC... stems

pɔdok	pɔd-pɔdok	"plant"
mʷiŋe	mʷiŋ-mʷiŋe	"eat"
kasɔ	kas-kasɔ	"throw"
wadek	wad-wadek	"read"
pilɔd	pil-pilɔd	"pick breadfruit"

(b) Cvː ... stems

kookɔ	<u>koo</u>-kookɔ	"grind coconut"
sɔɔrɔk	<u>sɔɔ</u>-sɔɔrɔk	"tear"
čaak	<u>čaa</u>-čaak	"bend"

Various mechanisms of transfer have been proposed and possible cases of transfer of prosodic characteristics other than length have been identified. Facts like these indicate that the copying constraints Contiguity, Anchoring, and Maximality evaluate at least some aspects of the prosodic structure of the base and reduplicant together with their segmental structure. But it remains to be seen how to obtain this result in, e.g., Mokilese without also predicting the impossible syllable-copying situation illustrated in (21).

   Second, because the base also has a morphological analysis of its own, there can be competition between respecting the prosodic requirements imposed by the templatic affix and the inherent morphological analysis of the base. Cases of this sort have been discussed by Aronoff (1988), Carrier-Duncan (1984), Marantz (1987), McCarthy and Prince (1993), Mutaka and Hyman (1990), Odden and Odden (1985), Silverman (1991), Spring (1990a, 1990c), and Uhrbach (1987). For example, according to Mutaka and Hyman (1990), the Kinande noun reduplicates as in (31). (The augment, a prefix *e-* or *o-*, has been suppressed in these examples, since it does not participate in reduplication.)

(31)   Kinande Noun Reduplication

(a)	ku-gulu-<u>gulu</u>	"real leg"
(b)	mú-twe-<u>mú-twe</u>	"real head"
(c)	mw-aná-<u>mw-ana</u>	"real child"
(d)	m-bulí-<u>m-buli</u>	"real sheep"
(e)	n-dwa-<u>n-dwa-n-dwa</u>	"real wedding"
(f)	swa-<u>swa-swa</u>	"real cabbage"
(g)	tu-gotseri-No Reduplication	"sleepiness/*real sleepiness"

Example (31a) shows that the root reduplicates exactly if disyllabic, while (31b) shows that a classifier prefix is reduplicated if the root is monosyllabic. Examples (31c–f) show reduplication of a complete onset cluster *mw, mb, ndw,* and *sw*. Examples (31e, f) also evidence one of the peculiarities of Kinande: when the classifier + root collocation is monosyllabic like *ndwa* or *swa*, there is double reduplication to achieve template satisfaction. Example (31g) displays the other peculiarity: trisyllabic or longer roots cannot undergo reduplicative morphology at all.

   The fundamental observation is that the reduplicant in the Kinande noun is always exactly disyllabic, corresponding to a MinWd template. In the case of polysyllabic roots, exact disyllabicity is enforced by suspending reduplication altogether. Mutaka and Hyman's (1990, p. 83) explanation for this is that Kinande reduplication is subject to a Morpheme Integrity Constraint, which bars incomplete reduplication of a morpheme. A form like **tu-gotseri-<u>gotseri</u>*

violates the Template Satisfaction Condition, since the template is disyllabic, while a form like *tu-gotseri-tseri* violates the Morpheme Integrity Constraint, since only part of the root is copied. The result is complete failure of the reduplicative morphology, an outcome also sometimes seen in prosodic delimitation (sec. 4). In other languages, morphological integrity has other effects, such as barring reduplication of nonroot material (McCarthy and Prince 1993, sec. 5).

Finally, since the earliest treatments of templatic and reduplicative morphology (McCarthy 1979; Marantz 1982), a special melody/template relation called *prespecification* has been recognized. In prespecification, invariant prior linking of a melodic element to a templatic position overrides or supplants productive, rule-governed linking of a melodic element to the same position. For example, Marantz analyzes the C*i* reduplication of Yoruba (*lo, li-lo* "to go/going") with a CV prefixal template whose V is prelinked to the invariant *i*.

There is considerable evidence, discussed in McCarthy and Prince (1986, 1990a), that the phenomenon of melodic invariance in reduplicative affixes cannot be reduced to prespecification. This evidence comes in part from so-called echo words, a type of total word reduplication in which some systematic change is effected in one copy. Echo word formation seems to be nearly universal; it is found in English (*table-shmable*) or, with more instructive results, in the Dravidian language Kolami:

(32) Kolami Echo-Word Formation (Emeneau 1955)

pal	pal-gil	"tooth"
kota	kota-gita	"bring it!"
iir	iir-giir	"water"
maasur	maasur-giisur	"men"
saa	saa-gii	"go (cont. ger.)"

Descriptively, the entire word is reduplicated with the initial Cv(v) of the second copy fixed at *gi*. The sequence *gi* appears even when the original is vowel-initial, and the vowel *i* occupies both moras of an original long vowel.

This widespread phenomenon is incompatible with templatic prespecification. For one thing, there is no template to prespecify. The copying constraints alone, especially Maximality, are sufficient to ensure complete identity (modulo *gi*) between base and reduplicant, so any template would be completely supererogatory (McCarthy and Prince 1986, p. 105; McCarthy and Prince 1988, 1990a, 1993, sec. 5). Thus, Maximality alone, without a template, is responsible for total reduplication, here and elsewhere.

Suppose, though, that a suffixal template were provided, gratuitously. This template would have to be PrWd, which matches any word, regardless of its size. To what, then, would the melodic invariant *gi* be prelinked in the reduplicative affix, as prelinking theory requires? The grammar does not enumerate the terminal elements of PrWd – it cannot, since PrWd has unboundedly many terminal elements – yet it is exactly to those terminal

elements that the melodic invariant *gi* would have to be prelinked. Needless to say, this problem exists independently of the choice of terminal elements: syllables, moras, onsets, nuclei, or segments all are unboundedly many in PrWd. Moreover, even if it were somehow possible to enumerate the terminal elements of PrWd, it would then be necessary to fix long *ii* in the initial syllable of the template, to obtain *maasur-giisur*. But this wrongly predicts long *ii* in all cases, yielding **kota-giita*.

Instead of melodic prespecification, what we are witnessing here is the same kind of melody-to-template mapping seen in root-and-pattern morphology, as proposed by McCarthy (1979, p. 319) and McCarthy and Prince (1986, 1990a).[12] The melody *gi* has an autonomous status as a purely melodic entity with its own autosegmental plane, just like *ktb* or *a-i* in the Arabic verbal system; the difference is that *ktb* and *a-i* are mapped to empty templatic slots in a "feature-filling" fashion, whereas the melody *gi* is applied in a "feature-changing" manner, *overwriting* the original melodic material of the base.

The echo morphology of Kolami, then, consists of exact reduplication in perfect obedience to Maximality, plus the melodic echo morpheme *gi*, along with the information that this melody links to the second member of the compound. The base itself supplies the array of prosodic positions that the melody anchors to, in a further type of a-templatic prosodic morphology (see sec. 2). Coming in on its own plane, with free access to the prosodic positions of the base, the melodic morpheme associates in the usual left-to-right fashion, delinking the base phonemes as it goes. As with feature-filling association in Arabic, the vocalic melodeme must link to both vocalic moras in a heavy syllable, so that we obtain *maasur–giisur* rather than **maasur-giasur*.[13] From this interpretation of melody-to-template mapping, which is inevitable in the context of recent rule typology, melodic invariance follows without prespecification. Within the theory of Prosodic Morphology, there is the further prediction that prosodically null positions like the onset may be supplied by melodic overwriting, so that *iir-giir* is possible, while prosodically genuine positions – like a long vowel or a moraic coda consonant – cannot be an invariant part of echo formation. Only templates, not melodies, can supply invariant prosody. Thus, we predict the nonexistence of an echo-word system that takes arbitrarily long input and that specifies both the quality and the quantity of some segment in the output (e.g., an echo-word system with *kota* → *kota-giita* and *koota* → *koota-giita* or one with *kota* → *kota-gita* and *koota* → *koota-gita*). So far as we know, this prediction is borne out.

4   Prosodic Circumscription

There is one remaining aspect of prosodic morphology theory to discuss: prosodic circumscription. Typically, a morphological operation like affixation

is applied to a base specified as a grammatical category like root, stem, or word. The result is ordinary prefixation or suffixation. Under prosodic circumscription, though, a morphological operation is applied to a base that is a prosodically-delimited substring within the grammatical category. The result is often some sort of infix, though there are many applications of prosodic circumscription extending beyond infixation.

Ulwa, a language of the Atlantic coast of Nicaragua, presents a remarkably clear case of infixation by prosodic circumscription. Ulwa is analyzed by Hale and Lacayo Blanco (1989), though Bromberger and Halle (1988) first brought this example to our attention. The possessive in Ulwa is marked by a set of infixes located after the stressed syllable of the noun:

(33) Ulwa Possessive

súːlu	"dog"	súːkinalu	"our (excl.) dog"
súːkilu	"my dog"	súːnilu	"our (incl.) dog"
súːmalu	"thy dog"	súːmanalu	"your dog"
súːkalu	"his/her dog"	súːkanalu	"their dog"

Stress is iambic, assigned from left to right (though there is optional retraction of stress from a final syllable); that is, stress falls on the initial syllable if it is heavy, otherwise the peninitial syllable. Hence, the possessive infixes follow the first syllable if heavy, otherwise the second syllable:

(34) Location of Ulwa Infixes (noun + "his")
   (a) after initial syllable

bás	bás-ka	"hair"
kíː	kíː-ka	"stone"
súːlu	súː-ka-lu	"dog"
ásna	ás-ka-na	"clothes"

   (b) after peninitial syllable

saná	saná-ka	"deer"
amák	amák-ka	"bee"
sapáː	sapáː-ka	"forehead"
siwának	siwá-ka-nak	"root"
kulúluk	kulú-ka-luk	"woodpecker"
anáːlaːka	anáː-ka-laːka	"chin"
arákbus	arák-ka-bus	"gun"
karásmak	karás-ka-mak	"knee"

The fundamental idea in prosodic circumscription theory is that the Ulwa infixes *-ka, -ki, -ma,* . . . are actually suffixes, but suffixes on the prosodically circumscribed initial foot within the Ulwa noun stem.

The analysis of Ulwa and the overall theory of circumscription on which it

is based are presented in McCarthy and Prince (1990a), though some aspects of the theory recall earlier proposals (Broselow and McCarthy 1983; McCarthy and Prince 1986). Central to prosodic circumscription is a parsing function $\phi(C, E)$ which returns the designated prosodic constituent C that sits at the edge E of the base B. The function ϕ induces a factoring on the base B, dividing it into two parts: one is the *kernel* B:ϕ, the part that satisfies the constraint (C, E); the other is the *residue* B/ϕ, the complement of the kernel within B.[14] Assuming an operator "*" that gives the relation holding between the two factors (normally left- or right-concatenation), the following identity holds:

(35)   factoring of B by ϕ
       $B = B{:}\phi * B/\phi$

In *positive* prosodic circumscription, of which Ulwa is an example, the B:ϕ factor, the specified prosodic constituent, serves as the base for the morphological operation. Let O(X) be a morphological (or phonological) operation defined on a base X. We define O:ϕ – the same operation, but conditioned by positive circumscription of (C, E) – in the following way:

(36)   Operation Applying under Positive Prosodic Circumscription
       $O{:}\phi(B) = O(B{:}\phi) * B/\phi$

That is, to apply O to B under positive prosodic circumscription is to apply O to B:ϕ, concatenating the result with B/ϕ in the same way ("*") that the kernel B:ϕ concatenates with the residue B/ϕ in the base B. In this way, the operation O:ϕ inherits everything that linguistic theory tells us about O, except its domain of application.

In Ulwa specifically, the factor returned by ϕ is a foot at the left edge, so we characterize the Ulwa possessive as O:ϕ(F, Left), where O is the morphological operation "Suffix POSS". For example, the factoring of *karásmak* "knee" is as follows:

(37)   Factoring of Ulwa Nouns
       $O{:}\phi(karasmak) = O(karasmak{:}\phi) * karasmak/\phi$
       $\qquad\qquad\qquad = O(karas) * mak$
       $\qquad\qquad\qquad = karas\text{-}ka * mak$
       $\qquad\qquad\qquad = karaskamak$

The initial iambic foot, rather than the whole noun, functions as the base for suffixation of the possessive morpheme. Of course, with words consisting of a single iambic foot, like *bas* or *ki:*, the infixes are authentic suffixes, but with longer words they are infixed.

Positive prosodic circumscription is especially common with reduplicative affixes, perhaps because a reduplicative infix more robustly withstands the historical pressures of analogy. In Samoan (38), prefixing reduplication applies to the foot within the word, rather than to the word itself.

(38) Samoan Plural Reduplication (Marsack 1962; Broselow and McCarthy 1983; McCarthy and Prince 1990a, 1993, sec. 7; Levelt 1990)

táa	tataa	"strike"
nófo	nonofo	"sit"
alófa	alolofa	"love"
ʔalága	ʔalalaga	"shout"
fanáu	fananau	"be born, give birth"
maná?o	manana?o	"desire"

Feet in Samoan are trochaic, located on the last two moras. The function $\phi(F, Right)$ circumscribes the base to which light syllable reduplication – in our terms, prefixation of σ_μ – applies.

In the examples discussed thus far, positive prosodic circumscription leads to infixation. But prosodic circumscription is not merely a theory of infixation; it has other consequences in a surprisingly large variety of domains.

Recall from section 3 (21) the fundamental observation that reduplication is not syllable copying: that is, reduplication is never sensitive to the difference between *tak* in *taki* and *tak* in *takti*. But in the Australian language Yidiɲ (Dixon 1977; Nash 1979, 1980; Marantz 1982; McCarthy and Prince 1990a), reduplication of a disyllabic sequence does seem to be sensitive to precisely this distinction:

(39) Yidiɲ Plural Reduplication

Singular	Plural	
mula.ri	mula-mula.ri	"initiated man"
tʲukar.pa	tʲukar-tʲukar.pa-n	"unsettled mind"
kintal.pa	kintal-kintal.pa	"lizard species"
kala.mpaɽa	kala-kala.mpaɽa	"March fly"

For present purposes, *mula-mulari* and *tʲukar-tʲukarpa-n* are a near-minimal pair, in which the syllabic affiliation of *r* in the base determines whether it also appears in the reduplicant. This phenomenon, which is quite puzzling within the context of reduplicative theory in general, has a natural interpretation in terms of prosodic circumscription. Yidiɲ reduplicates nothing more or less than the first foot, which always includes exactly the first two syllables in this language. Thus, the foot within the word, $\phi(F, Left)$, is prosodically circumscribed and subject to total reduplication. It is prosodic circumscription, rather than the reduplication mechanism itself, that accounts for the sensitivity of Yidiɲ reduplication to the syllabic affiliation of consonants in the base.

Positive prosodic circumscription is also applicable to certain types of truncation phenomena (Mester 1990; Martin 1989; Lombardi and McCarthy 1991; Weeda 1992; Hill and Zepeda 1992). In the formation of a certain class

of nicknames in Japanese, called "rustic girls' names" by Poser (1990), all and only the initial bimoraic foot is retained:

(40)   Japanese Rustic Girls' Nicknames

Name	Nickname
Yuu-ko	o-Yuu
Ran-ko	o-Ran
Yuki-ko	o-Yuki
Kinue	o-Kinu
Midori	o-Mido

Bimoraic Cvv, CvN, and CvCv are all possible nicknames, exactly matching the first two moras of the original name. Mester (1990) proposes that the nickname is simply the kernel of prosodic circumscription ϕ(F, Left), with the residue discarded.[15]

A consistent observation about all the examples of positive prosodic circumscription we have discussed, and indeed about all of the examples we know, is that the circumscribed category is a foot. This is such a consistent finding that it demands some sort of account. A first step in that direction is to recall that the category foot is, because of the Prosodic Hierarchy, fully synonymous with MinWd. The observation, recast in this light, is stated in (41) as the Minimality Hypothesis:

(41)   Minimality Hypothesis
       In positive prosodic circumscription O:ϕ(C, E), C = MinWd.

A consequence of the Minimality Hypothesis is that morphological operations, even those subject to positive prosodic circumscription, will always apply to word-like entities, either to an actual word itself or to a prosodically-delimited minimal word within some larger word. Thus, the prosodic base, as a stem-substitute, must itself meet the MinWd requirement that holds of stems in general (see secs. 1–3). Moreover, the Minimality Hypothesis ensures that a prosodically circumscribed operation will always act like an uncircumscribed one over some central class of the vocabulary – the words that are minimal. (That is, ϕ(MinWd, Edge) will always be an identity operation on some substantial subset of the words of a language.) This restriction has obvious benefits for learnability: the morphological operation can be acquired in its simplest form from the minimal words and then extended by the application of prosodic circumscription to the supraminimal ones.

Another property common to all of the examples discussed thus far is that the foot (= MinWd) targeted by positive prosodic circumscription is already present in the form prior to circumscription. That is, prosodic circumscription picks out a preexisting foot and submits it to the morphological operation, leaving material outside that foot in the residue of circumscription. This is quite obviously true of Ulwa, Samoan, and Chamorro, essential to the analysis of Yidiɲ, and arguably the case even for Japanese, which offers no direct prominential evidence of foot structure.

This characteristic of prosodic circumscription is a very natural one, but it is nonetheless worth stating as a separate principle:

(42)   Law of Parsing
        Prosodic circumscription minimally restructures the input, subject to the conditions imposed by the constituent C and edge E.

In the cases of prosodic circumscription discussed above, the Law of Parsing is obeyed almost trivially: prosodic circumscription calls for a foot (= MinWd) at some edge, and the foot already present at that edge is returned by the parse, in full conformity with (42). In other words, prosodic circumscription simply picks out a constituent of the desired type from the input form. But there are various imaginable conditions when prosodic circumscription will be called on to parse out a constituent from the input, so some restructuring, albeit minimal, will be required. This will be the case whenever there is no constituent of the desired type at the desired edge – for instance, when parsing out a foot prior to stress assignment, or parsing out a foot at the left edge when feet are assigned at the right.

The principal cases in which prosodic circumscription parses out a new constituent in conformity with the Law of Parsing are the Arabic broken plural and diminutive (McCarthy 1983; Hammond 1988; McCarthy and Prince 1988, 1990a) and the Choctaw *y*-grade (Nicklas 1974, 1975; Ulrich 1986, 1992; Lombardi and McCarthy 1991; Hung 1992; cf. Montler and Hardy 1988, 1991). These examples are both quite complex, so they cannot be reviewed fully here. We will briefly sketch one of them, Arabic, focusing our attention on the circumscriptional aspects of the system.

In Arabic, the productive plural and diminutive are expressed by imposing a LH iambic foot on the singular noun base. Because singular nouns come in diverse shapes, this iambic template is imposed on only a portion of the noun. The circumscribed domain is underscored in the singular; the corresponding iambic template in the plural and diminutive is in boldface:

(43)   Arabic Productive Plural and Diminutive

Singular	Plural	Diminutive	
ḥukm	/ḥakaam/	ḥukaym	"judgment"
ʕinab	/ʕanaab/	ʕunayb	"grape"
jaziir+at	/jazaawir/	/juzaywir/	"island"
šaaɣil	šawaaɣil	šuwayɣil	"engrossing"
jaamuus	jawaamiis	juwaymiis	"buffalo"
jundub	janaadib	junaydib	"locust"
sulṭaan	salaaṭiin	sulayṭiin	"sultan"

The boldface portion of the plural and diminutive is the part of the stem expressed by the LH iambic template. The portion of the plural and diminutive in plain type is outside the template; it varies systematically among plurals

and diminutives depending on the canonical pattern of the corresponding singular. The underscored portion of the singular is the part whose consonants are mapped onto the iambic template. The portion of the singular in plain type is carried over unaltered to the corresponding plural and diminutive, except for changes in vowel quality (which are determined by independent principles) and the insertion of the onset-filling consonant *w* in /jazaawir/ (surface *jazaaʔir*) and /juzaywir/ (surface *juzayyir*).

The interpretation of these observations in terms of positive prosodic circumscription is now fairly straightforward. The underscored portion is the positively circumscribed domain, a moraic trochee, the MinWd of Arabic. This string, the kernel of prosodic circumscription, is mapped onto a LH iambic template, which realizes the plural and diminutive morphology. The residue of circumscription, which varies in size depending on the singular, is simply attached unchanged to the templatic portion. In addition, vowel quality is imposed on the templatic and nontemplatic portions by further rules.

Thus, the morphological operation O involves mapping to an iambic template, and the circumscriptional function is ϕ(MinWd, Left). Since the Arabic stress rule applies right to left, and since in any case there is no reason to assume that stress has already been assigned when plurals and diminutives are formed, the function ϕ must parse out a moraic trochee from the singular noun, rather than pick out a pre-existing foot as in Ulwa or Samoan. In cases like *ḥukm*, *šaaɣil*, *jaamuus*, *jundub*, and *sulṭaan*, ϕ simply returns the initial heavy syllable without restructuring the base at all, in conformity with the Law of Parsing (42). In *ʕinab*, the final consonant is extrametrical, so the intrametrical portion consists of a sequence of two light syllables, also matching the required moraic trochee without restructuring. But in iambic words like *jaziir*, restructuring of the input by ϕ is necessary to circumscribe a moraic trochee. The restructuring is *minimal* in that the parsed *jazi * ir* respects the moraic analysis of the input but not its syllabic analysis. That is, given the nature of the Prosodic Hierarchy, a minimal restructuring is one that preserves the hierarchy from the bottom up. Indeed, since the mora is the smallest prosodic unit that can be called by a constituent C, this guarantees that the parse will always respect the moraic analysis of the input, as of course it does in *jazi * ir*.

In positive prosodic circumscription, as we have seen, the kernel of the ϕ-parse is submitted to the morphological operation O. *Negative* prosodic circumscription is fully symmetrical: the residue of the parse is submitted to the morphological operation. Retaining the notation used above, we define O/ϕ(B) – the application of O to the base B minus some edge constituent – as follows:

(44)   Operation Applying Under Negative Prosodic Circumscription

$$O/\phi \ (B) = B{:}\phi \ * \ O(B/\phi)$$

This is essentially extrametricality. To apply O to B under extrametricality is just to apply O to B/ϕ, concatenating the result with B:ϕ in the same way that the residue B/ϕ concatenates with the kernel B:ϕ in the original base B.

Various examples of negative prosodic circumscription are discussed by McCarthy and Prince (1990a, 1991b), Crowhurst (to appear), Lee and Davis (1993), Lombardi and McCarthy (1991), McCarthy (1993), and Urbanczyk (1992).

Dakota provides a case of this sort (Boas and Deloria 1941; Moravcsik 1977; Shaw 1980; McCarthy and Prince 1993; sec. 7). In Dakota, the agreement system consists of a set of perhaps twenty affixes that are prefixed to monosyllabic verb roots and some polysyllabic ones, but infixed into other polysyllabic verb roots. The roots taking infixes are apparently a lexically specified subclass, though historically they may have been morphologically composite. The locus of infixation falls after the initial syllable, which is always open in Dakota:[16]

(45) Infixation of -*wa*- "I" in Dakota

pa–wa–xta	"I tie up"	ma–wa–ni	"I walk"
ma–wa–nų	"I steal"	c'a–wa–pa	"I stab"
ʔi–ma–ktomi	"I am Iktomi"	na–wa–pca	"I swallow it"
na–wa–tʰaka	"I lock the door"	la–ma–kʰota	"I am a Lakota"

The Dakota agreement markers are nominally prefixes, and in fact they are literally prefixes with verb roots that are not in the infixing subclass. Thus, the morphological operation is "Prefix AGR." The locus of infixation, after the first syllable, is defined by $O/\phi(\sigma, \text{Right})$:

(46) Dakota Infixation

$$O/\phi \; (\text{ʔiktomi}) = \text{ʔiktomi:}\phi * O(\text{ʔiktomi}/\phi)$$
$$= \text{ʔi} * O(\text{ktomi})$$
$$= \text{ʔi} * \text{wa-ktomi}$$
$$= \text{ʔiwaktomi}$$

It is the root minus its initial syllable, rather than the root as a whole, that serves as the base for prefixation of -*wa*- and the other AGR morphemes.

Negative prosodic circumscription may also involve some restructuring of the input, in conformity with the Law of Parsing. One simple case is exemplified by the Choctaw passive infix *l* in (47).

(47) Choctaw Passive (Nicklas 1974, p. 32; Ulrich 1986, p. 136; Urbanczyk 1992)

Active	Passive	Gloss
abani	albani	"to barbeque"
apisa	/alpisa/ ałpisa	"to set a date"
hokči	/holkči/ holokči	"to plant"
takči	/talkči/ talakči	"to tie"

This infix appears after the initial Cv sequence of the base, where it accommodates to the phonotactic requirements of the language via an independently motivated rule of epenthesis. Formally, *l* infixation is actually prefixation under negative prosodic circumscription of an initial light syllable σ_μ, requiring

Law-of-Parsing mediated restructuring of an initial heavy σ (Urbanczyk 1992). The morphological rule, restricted in this way, is expressed by $O/\phi(\sigma_\mu, \text{Left})$, where O = "Prefix".

Like infixation by positive prosodic circumscription, infixation by negative prosodic circumscription can be reduplicative as well. For example, reduplicative infixation in Mangarayi (Merlan 1982, pp. 213–236; McCarthy and Prince 1986, 1991b, 1993, sec. 7; Davis 1988, pp. 319–322) prefixes a σ template to a Base consisting of the word minus its initial consonant:

(48)   Mangarayi Plural Reduplication

Singular	Plural	
baraŋali	b-<u>ar</u>-araŋali	"father-in-law"
gabuji	g-<u>ab</u>-abuji	"old person"
yirag	y-<u>ir</u>-irag	"father"
jimgan	j-<u>img</u>-imgan	"knowledgeable person"
gambuṛa	g-<u>amb</u>-ambuṛa	"classificatory MB/ZC"
muyg–ji	m-<u>uygj</u>-uyg-ji	"having a dog"

This phenomenon may be analyzed as $O/\phi(C, \text{Left})$, where O = "Prefix σ" – that is, negative circumscription of an initial consonant.[17] In this way, the Base to which σ is prefixed and which it copies is the word minus its initial consonant:

(49)   Negative Prosodic Circumscription in Mangarayi Plural

$$O/\phi \text{ (jimgan)} = \text{jimgan:}\phi * O(\text{jimgan}/\phi)$$
$$= \text{j} * O(\text{imgan})$$
$$= \text{j} * \underline{\text{img}}\text{-imgan}$$
$$= \text{ji}\underline{\text{mg}}\text{imgan}$$

An interesting feature of the Mangarayi case is that part of the reduplicated string (the consonant *g*) is syllabified as the onset of a base syllable rather than as a coda of the reduplicative affix σ. This property, which is found in a number of reduplicative systems, is discussed in McCarthy and Prince (1986, 1993, sec. 7).

Another quite common type of infixing reduplication seems to require negative circumscription of an initial onsetless syllable. One example of this phenomenon comes from the Austronesian language Timugon Murut. Timugon Murut copies the first Cv sequence of the word, disregarding the first syllable of vowel-initial words:

(50)   Timugon Murut Reduplicative (Prentice 1971; McCarthy and Prince 1991b, 1993, sec. 7)

bulud	<u>bu</u>-bulud	"hill/ridge"
limo	<u>li</u>-limo	"five/about five"
ulampoy	u-<u>la</u>-lampoy	no gloss
abalan	a-<u>ba</u>-balan	"bathes/often bathes"
ompodon	om-<u>po</u>-podon	"flatter/always flatter"

With considerable enrichment of the theory of prosodic constituents that can be specified in negative circumscription, it is in principle possible to give an account of this pattern of infixing reduplication. But remarkably this locus is found *only* with reduplicative infixes, never with ordinary infixes. The theory of circumscription, which does not distinguish between reduplicative and ordinary infixes, cannot account for this asymmetry. As we will see in section 6, a very different account of the Murut reduplicative can be given, one that refers directly to the inherent defectiveness of onsetless syllables.

Positive and negative prosodic circumscription cover roughly similar empirical ground, so we should ask whether both are truly necessary. It turns out that they are, based on arguments ranging from the narrowly parochial to the broadly universal. Consider first the logical possibility of replacing one mode of circumscription with the other simply by complementing the parsed-out prosodic constituent C and the edge E. For instance, this would mean replacing the Ulwa schema $O{:}\phi(F, Left)$ with $O/\phi(X, Right)$, where X stands for some constituent at the right edge to which Ulwa *ka* may be prefixed. The problem is that X is phonologically incoherent, ranging from the null string (for *bas*) to one or more syllables (*karasmak, anaːlaːka*). Because words come in different sizes, it is not possible to reverse the edge at which the infix is anchored.

Consider next the simple alternative of replacing positive prosodic circumscription in Ulwa with negative circumscription: $O/\phi(F, Left)$, O = "**Prefix** *ka, ki, ma*, etc.". That is, *ka* would be a prefix on the residue of negative circumscription rather than a suffix on the parsed-out foot. Ulwa-internal considerations show that this alternative is inferior: in about 10 percent of the nouns collected by Hale and Lacayo Blanco (1989), *ka* is an actual suffix on a word that is longer than a single iambic foot: *gobament-ka* "government", *abana-ka* "dance", *bassirih-ka* "falcon", *ispiriŋ-ka* "elbow". (Of these, about two-thirds have doublets where *ka* is infixed as expected: *bas-ka-sirih, is-ka-piriŋ*.) So *ka* is a formal suffix, as the positive prosodic circumscription account requires.

Finally, the cases of infixing reduplication provide an unambiguous diagnostic for the distinction between positive and negative prosodic circumscription. In Samoan, for example, the locus of copying and the identity of the copied string are both determined in the same way, by reference to the foot. Samoan, then, is analyzed by positive prosodic circumscription, since the base of reduplication and the locus of reduplication are the same. But in Mangarayi, the locus of infixation – after the first consonant – and the base of reduplication – everything except the first consonant – are exactly complementary. Thus, infixation in Mangarayi is via negative prosodic circumscription, since the base of reduplication is the complement of the string that defines the locus of the infix.

Positive and negative circumscription are closely related, essentially symmetrical mechanisms for defining the base of a morphological operation within a larger word. More loosely connected to the theory of circumscription is the theory of prosodic delimitation, which accounts for the common situation where minimal and supraminimal bases are subject to different morphological

operations.[18] For example, in Dyirbal (Dixon 1972; McCarthy and Prince 1990a), disyllabic and longer bases take different allomorphs of the ergative suffix, while in Axininca Campa (Payne 1981; Spring 1990a, 1990b; McCarthy and Prince 1993, sec. 6), bimoraic and longer bases take different allomorphs of the "possessed" suffix:

(51)   Dyirbal Ergative

Noun	Ergative	
yaɽa	yaɽa-ŋgu	"man"
yamani	yamani-gu	"rainbow"
balagara	balagara-gu	"they"

(52)   Axininca Campa

Noun	Possessed (no-/n- "my")	
mii	no-mii-ni	"otter"
sima	no-sima-ni	"fish"
itʰo	n-itʰo-ni	"swallow"
cʰimii	no-cʰimii-ti	"ant"
sampaa	no-sampaa-ti	"balsa"
maini	no-maini-ti	"bear"
manaanawo	no-manaanawo-ti	"turtle"

In Dyirbal, the generalization is that the ergative suffix takes the allomorph -ŋgu with disyllabic bases, which are minimal in Dyirbal, and the allomorph -gu with longer bases. In Axininca Campa, the possessed suffix is -ni with minimal, bimoraic bases and -ti with longer ones. A minimality criterion partitions the lexicon into two sets, and suffixal allomorphy is determined by this partitioning. The suffix alternations in both languages are truly allomorphic, since they do not reflect any systematic phonological pattern.

Prosodic delimitation, like positive prosodic circumscription, calls on $\phi(\mathrm{MinWd})$, but it puts the result to different use. Specifically, prosodic delimitation partitions the lexicon into those bases where $\mathrm{B}{:}\phi$, the ϕ-circumscribed kernel of B, is identical to B, and those where $\mathrm{B}{:}\phi$ is less than B (that is, where B/ϕ, the residue, is non-null). The clearest formalization of this is to regard suffixation of -ŋgu/-ni to minimal bases as the special, prosodically delimited case, and suffixation of -gu/-ti as a default, applicable whenever the special case has failed to apply.

The set of minimal bases can be determined using the parsing function ϕ. When applied to the morphological Base $\mathrm{B_M}$, ϕ must return a prosodic Base B that is identical to the morphological Base. This special sense of ϕ, designated ϕ', is a partial function defined as in (53):

(53)   Definition of Partial Function ϕ'

$$\phi'(\mathrm{B_M}) = \mathrm{B} \quad \text{if } \mathrm{B_M} = \phi(\mathrm{B_M})$$
$$\text{else, undefined.}$$

The prosodically restricted operation $O:\phi'$ depends on the success of the function ϕ', and $O:\phi'$ is therefore undefined when ϕ' is. An operation applying under ϕ' applies only to words that exactly satisfy the prosodic criterion ϕ', always a (type of) MinWd.

The Dyirbal ergative, for example, consists of two morphological operations. One is "Suffix -ŋ*gu*," restricted prosodically by ϕ'(MinWd). The other is prosodically unrestricted "Suffix -gu", whose scope is limited only by the Elsewhere Condition. If ϕ' returns a value, in accordance with (53), then -ŋ*gu* is suffixed, since the target form is a monopod. But if ϕ' returns no value at all, then "Suffix -ŋ*gu*" cannot apply, and the default suffix -*gu* is provided instead. In general, a default operation needn't be specified; in other languages (McCarthy and Prince 1990a, 1993, sec. 7), the responses to blocking of the prosodically delimited morphological operation are quite diverse, ranging from complete failure (in Korean particle attachment [Cho 1992]) to zero affixation (in the Maori imperative [Hohepa 1967]) to syntactic periphrasis (in the English comparative). Such matters are outside the purview of prosodic circumscription theory and perhaps of linguistic theory more generally, to the extent that they reflect functional rather than formal factors.

In conclusion, we have seen that three types of prosodic circumscription can be subsumed under the parsing function ϕ, which applies to define a prosodically delimited base within some morphological base. There are alternative ways of characterizing a prosodic base without ϕ, and one is explored at length in McCarthy and Prince (1993, sec. 7) (also see below, sec. 6). Nonetheless, it seems clear that the notion of the prosodic base, common to all types of circumscription, must play a role in any analysis of infixation and the other types of phenomena discussed here.

5   The Prosodic Character of Templates and Circumscription

The discussion thus far has included a number of analyses that rely, often implicitly, on the fundamentally *prosodic* character of templatic and circumscriptional morphology, as embodied in the Prosodic Morphology Hypothesis, the Template Satisfaction Condition, and Prosodic Circumscription of Domains (sec. 0). The goal now is to make this reliance explicit – that is, to lay out an alternative to these principles and to show why that alternative is inferior.

Together, the Prosodic Morphology Hypothesis and the Template Satisfaction Condition demand that templates be defined in the grammar and realized in the derivation in terms of the categories and principles of prosody, as provided by the independently required theory of the syllable, the foot, and the prosodic word. Likewise, Prosodic Circumscription of Domains limits

circumscriptional and delimitative morphology to reference to prosodic units. A related claim is that only the categories of prosody, together with the featural decomposition of segments, are authentically essential to phonological representation. More generally, then, this theory is a claim about reference to structural information in phonology as well as morphology, though naturally the focus here is on the latter.

In this respect, Prosodic Morphology theory is in sharp contrast to segmentalist theories of template form, such as those in McCarthy (1979, 1981), Marantz (1982), Levin (1983, 1985), and Lowenstamm and Kaye (1986).[19] In segmentalist approaches, templates are composed of segment-sized slots, either C and V, if margin versus nucleus roles are to be distinguished directly, or X if they are not. The segmental positions are essential elements of the pure segmentalist template, though they may be annotated with prosodic structure (such as syllable, onset, nucleus, or rhyme nodes) as required.

Basic findings in prosody place strong conditions of adequacy on template theory. It is worth examining the chief interactions, since they establish the general constraints within which template theory must work, and they permit clear differentiation of prosodic morphology from segmentalism.

Consider first the role of *counting* in grammar. What elements may be counted? It is a commonplace of phonology that rules count moras, syllables, or feet, but never segments. Word-minimality effects, discussed in section 1, are typical in this respect. Since the theory of word minimality derives from Foot Binarity, observed word minima always reckon the same units as feet do: two moras (e.g., Lardil (8)) or two syllables (e.g., Dyirbal (51)). Similarly, the partitioning of the lexicon by word size in prosodic delimitation, discussed in section 4, also follows foot theory in relying on a count of two moras (e.g., Axininca Campa (52)) or two syllables (e.g., Dyirbal (51)). In templatic morphology proper, counting of prosodic units may be observed in the minimal bimoraicity and maximal disyllabicity of the Arabic canonical noun (15) or the bimoraic and disyllabic foot templates of Manam (23) and Diyari (10).

In contrast, no language process is known to depend on the raw number of *segments* in a form: a robust finding, given the frequency and pervasiveness of counting restrictions. A bisegmental minimal word or a bisegmental delimitation of the lexicon in allomorphy are impossible. Thus, it should come as no suprise that templatic morphology cannot count segments either. If a reduplicative prefix template could be XXX – three segments, unadorned with prosodic structure – the following impossible type of system should be common:

(54) Pure Segmentalism in Reduplication

Input	Output
XXX-badupi	<u>bad</u>-badupi
XXX-bladupi	<u>bla</u>-bladupi
XXX-adupi	<u>adu</u>-adupi

The system is prosodically incoherent, hence impossible under the Prosodic Morphology Hypothesis and indeed completely unattested. What is

prosodically incoherent here is the segmental equation of monomoraic *bla* with bimoraic *bad* or *adu*, or of monosyllabic *bla* and *bad* with disyllabic *adu*. Obviously, XXX is equally impossible as a template in truncation or a root-and-pattern morphological system, for the same reason. Of course, pure segmentalism can be annotated with prosodic structure, thus avoiding some of the untoward effects in (54); for instance, a template [XXX]$_\sigma$ would much improve the result. But the point is not to make segmentalism look like prosodic morphology. Rather, if there were any truth to segmentalism, then segments should stand on their own, exactly as in (54). Yet this is unknown.

How long may a count run? General considerations of locality, now the common currency in all areas of linguistic thought, suggest that the answer is "up to two": a rule may fix on one specified element and examine a structurally adjacent element and no other. For example, the End Rule of Prince (1983) focuses on one edge of a domain and selects the element adjacent to that edge for some specified operation; Foot Binarity (7) demands that a foot contain at least two elements, presumably the head and one other; the licit types of stress-feet (6) are all maximally binary. Similar cases can easily be multiplied.

As we have seen, analyses within prosodic morphology respect the binarity of counting. Word-minimality effects derive from Foot Binarity, so observed word minima are always two of something, either moras or syllables. The criteria for partitioning the lexicon in prosodic delimitation (51, 52) follow the same binary limit, as does the upper bound on the Arabic canonical noun (15b). Templates consist of at most two prosodic units, such as the bimoraic and disyllabic reduplicative templates in Manam (23) and Diyari (10).

In contrast, segmentalist theories must count segments, and must count many of them. Consider the template required to characterize the maximal expansion of the canonical noun in Arabic, disyllabic in prosodic terms:

(55)   Maximal Arabic Canonical Noun Template (Segmental Version)

    (a) CV Theory   (b) X Theory (N=nucleus of σ)

$$\begin{array}{cc} & N \quad N \\ & | \quad \Lambda \\ \text{CVXCVVC} & \text{XXXXXXX} \end{array}$$

By this, seven segments must be counted in order to characterize what in prosodic terms is two syllables.

General findings about prosody lead to another distinct form of argument in support of prosodic morphology. Prosodic theory must distinguish between optional and obligatory elements at all levels of structure. A syllable must contain a nucleus and, in many languages, an onset; a foot must contain at least two moras or syllables, thanks to Foot Binarity (7); a prosodic word must contain at least one foot, because of the Prosodic Hierarchy (4). In contrast, many elements of prosodic structure are entirely optional. Thus, syllables in some languages may have multisegmental onsets, but no languages require

this. Likewise, codas are optional, never obligatory, elements of syllables in some languages (though syllable weight, realized by a coda or vowel length, may be demanded in some contexts). The theory of feet (6) recognizes a variety of options, mono- versus disyllabism in the quantitative trochee, and H versus LL versus LH in the iamb. Though a prosodic word must contain one foot, it may contain more, since normally there is no upper bound on its size.

This characterization of what is optional and what is obligatory, which comes from prosodic theory, plays an essential role in prosodic morphology, as various analyses above reveal. In Japanese (12) or Manam (23), for example, the surface expressions of the template are quite diverse, ranging from disyllabic sequences like *mido* to monosyllables like *mii* or *mit-*. The constant of shape uniting all of these expressions is the quantitative trochee, and the various forms enjoy all of the optionality of the quantitative trochee in prosodic theory. In Ilokano (2, 22b), the realizations of the template are almost as diverse, including *kal-*, *klas-*, and *roː-*. Here, the constant of shape is the heavy syllable template, so whether the onset is simple or complex, and whether there is a coda or a long vowel, are entirely inconsequential.

In segmentalism, though, optionality of elements is a complex and weighty matter, requiring an elaborated theory for the realization or deletion of segmental slots in templates. Following Marantz (1982), segmental theories spell out the template as the longest observed realization (or even the union of the observed realizations, if distinct from the longest); when an insufficiency of melody leaves template slots empty, they are discarded. Thus, segmentalism must analyze the Ilokano prefix as CCVX or equivalent, explicitly counting out the maximal monosyllable. As example (7) illustrates, segmentalism is typically faced with an excess of underlying slots:

(56)   Excess Slots in Segmental Analysis

(a) CCVX +...   (b) CCVX +...   (c) CCVX +...
   | // | /// | /
  kaldiŋ   klase   roʔot

There are well-known ways in which unfilled slots influence phonology and morphology (Selkirk 1981; Clements and Keyser 1983; Lowenstamm and Kaye 1986). It is a remarkable fact that empty templatic slots have never been convincingly detected outside their endo-theoretic role in melody association.[20] In prosodic morphology, constrained by the Template Satisfaction Condition, they do not exist.

In essence, segmentalism must hold that all template elements are optional until they are filled by melodic material. It is thus in principle incapable of specifying, in the representation, that certain elements are obligatory, a common situation. In the Ilokano CCVX template, though the onset C slot is optional, the final X slot is obligatory, even at the expense of lengthening a vowel that

is short in the base form (56c). This is even more dramatically true in Ponapean reduplication (24b), where the base *pa*, which contains but a single mora, must reduplicate as <u>paa</u>-pa to satisfy the bimoraic template. The additional conditions follow immediately from the syllabic characterization, since complex onsets are of course optional and heavy syllables must have a postnuclear element. Nothing in the segmental theory guarantees this result.

The optional/obligatory distinction presents equally serious problems for segmentalism in a case like Japanese (12), which is analyzed prosodically with a trochaic template. In segmental terms, any one of the expressions in (57) is a licit hypocoristic.

(57) Japanese Hypocoristics, Segmentally
      VV   VCV
      CVV   CVCV
      VC
      CVC

The tack of taking the longest expansion as basic would, of course, give CVCV as the template,[21] and indeed all observed forms can be derived from it by deleting excess templatic elements. But so can V, CV, and even Ø, all impossible in Japanese hypocoristic formation (Poser 1990). If all templatic slots are optional, as indeed they must be if the diversity in (57) is to be obtained from a CVCV template, then, short of bald stipulation, it is impossible to demand that any truly licit expression of the template contain at least two Vs or VC.

One final observation seals the case against excess elements in templates. It is a stable empirical finding that templates imitate – up to extrametricality – the prosodic structure of the language at hand. The Ilokano template is not CCVCC; correlatively, the syllabification of the language disallows coda clusters. Segmental theory, however, cannot derive this result. Since excess or stray elements are erased, they are free to occur, and indeed must occur in other circumstances. Were they present, even fleetingly, they could perturb melody association in easily discoverable ways. Thus, left-to-right association of *kaldiŋ* to this template would yield /kald-kaldiŋ/. Applying the phonology to this form and deleting the first consonant of the unsyllabifiable triconsonantal cluster, *kad-kaldiŋ is obtained. This is not merely wrong in Ilokano but wrong universally; by exploiting a hole in segmental theory, we have obtained the impossible reduplicative pattern $C(C)VC_0$, where C_0 is the onset of the second syllable of the base, skipping over the coda of the first syllable, if any.

Within prosodic morphology, the actual shape-invariant underlying a templatic formation is identified in prosodic terms, and so it is possible to assume a natural condition on template interpretation like the Template Satisfaction Condition. This solves all three of the problems stemming from segmental approaches to shape specification:

1 Under the Template Satisfaction Condition, no excess templatic material is ever present in the representation, giving the easiest and least stipulative explanation for its unresponsiveness to phonological probing: nonexistence.

2 Patterns of obligatoriness and optionality will follow in general from independent characterization of the prosodic units, both universally and language-specifically. (This is merely an extension of reasoning well-established in phonology, where such optionality-stipulating notations as "(α)" and α_0 have faded in the face of accurate representation of prosody.)

3 The fact that the templates are bounded by a language's prosody follows from their being built from that prosody.

A third form of argument for prosodic morphology, essentially independent of the previous two, rests on the problem of redundancy or recapitulation in segmentalist theories. Without even calling on sophisticated analysis, it becomes clear when languages with moderately complex prosody are examined that prosodic categories must be admitted into template theory. "CVC" seems a plausible enough prefix when proposed for Agta (Healey 1960; Marantz 1982); but when the next language over (e.g., Ilokano) shows "CCVC," correlated with the appearance of 2-consonant onsets, it becomes harder to avoid the correct generalization. The Classical Arabic templates appear relatively simple (though, as noted above, spelled segmentally they violate counting norms); turn to Modern Hebrew, with a rich range of syllable-initial clusters to include, and the stipulative character of segmental spell-out becomes apparent (Doron 1981; McCarthy 1984a; cf. Bat-El 1989, 1992). There is, then, an obvious and direct correlation between the form of the templates in a language and the organization of that language's prosody as a whole. That correlation follows immediately from the Prosodic Morphology Hypothesis and the Template Satisfaction Condition; with those two principles, the situation could not be otherwise. Yet it is hard to see how segmentalism could even stipulate, much less explain, this remarkable coincidence; that templates routinely recapitulate the prosodic requirements of the language as a whole must remain an inexplicable redundancy in segmental approaches.

The arguments from optionality and recapitulation can be combined into a final argument-form, in this case drawn from the prosodic delimitation phenomenon in Axininca Campa (52). In that language, bimoraic bases take the "possessed" suffix -*ni*; longer bases take the suffix -*ti*. Consider the problem of specifying the *ni*-taking bases in purely segmental terms. The possible bimoraic word-shapes of Axininca Campa include VV (not actually attested), CVV, VCV, CVCV, VCCV, and CVCCV, all of which require -*ni*. Putting these together, we obtain the following schema for the subcategorization of the -*ni* allomorph:

(58) Axininca Campa *ni* Subcategorization, Segmentally
-*ni* / (C)V(C)CV____

This schema precisely recapitulates all that is optional or obligatory in a bimoraic sequence in Axininca Campa. Two vowels are obligatory, because only vowels project moras in this language. For the same reason, a medial coda is optional. Initial onsets are optional but medial ones are obligatory, exactly as in the prosody of the language as a whole (see McCarthy and Prince 1993, sec. 4 for an explanation). Obviously, the forest of stipulations in (58) has hidden the tree of explanation: the base of *-ni* is a bimoraic foot, whose optional and obligatory elements are determined fully by the prosody of the language as a whole.

6 Prosodic Morphology within Optimality Theory

Thus far, we have described some of the more familiar results of prosodic morphology – what could be called the standard theory. More recent developments, which are the subject of McCarthy and Prince (1993), focus principally on how the theory can be conceived of as a system of constraint interaction. Here we will illustrate briefly how the theory has evolved in this work.

Throughout prosodic morphology, as elsewhere in contemporary phonological research, constraints on well-formedness play an important role. Nevertheless, our use of constraints up to this point has not been placed within the context of an actual theory of constraint application and violation. Our goal in this section is to explore some of the consequences for prosodic morphology of the conception of the role and functioning of constraints embodied in *optimality theory* (Prince and Smolensky 1991a, 1991b, 1992, 1993). In optimality theory, the output representation is selected by a set of well-formedness constraints that are ranked in a hierarchy of relevance, so that a lower-ranked constraint may be violated in order to satisfy a higher-ranked one. These characteristics of ranking and violability of constraints are what distinguishes optimality theory from other approaches to constraint satisfaction.

Optimality theory, as conceived by Prince and Smolensky, has four basic tenets:

1 *Violability.* Constraints are *violable*; but violation is minimal.
2 *Ranking.* Constraints are *ranked* on a language-particular basis; the notion of minimal violation (or best-satisfaction) is defined in terms of this ranking.
3 *Inclusiveness.* The candidate analyses, which are evaluated by the constraint hierarchy, are admitted by very general considerations of structural well-formedness; there are no specific rules or repair strategies with specific structural descriptions or structural changes or with connections to specific constraints.

4   *Parallelism.* Best-satisfaction of the constraint hierarchy is computed over the whole hierarchy and the whole candidate set.

Optimality theory rejects the notion that a *constraint* is a phonotactic truth at some level of description. New possibilities for explanation are opened up, as new kinds of conditions on structure are recognized as legitimate constraints, usable as principles of grammar.

The satisfaction of a system of ranked well-formedness constraints is the core analytic concept in optimality theory. Except for ties, the candidate that passes the highest ranked constraint is the output form. A tie occurs either when more than one candidate passes the highest ranked constraint or when all candidates fail the highest ranked constraint. In case of ties, all surviving candidates are tested recursively against the rest of the hierarchy. Once a victor emerges, the remaining, lower-ranked constraints are irrelevant; whether the sole surviving candidate obeys them or not does not affect its grammaticality.

The following example illustrates schematically how satisfaction of a constraint hierarchy proceeds. Assume a grammar consisting of two constraints, A and B. Like any grammar, this one functions to pair underlying forms with surface forms: (in_1, out), (in_2, out), and so on. Suppose we have a certain underlying form $/in_k/$ which gives rise to a candidate set $\{k\text{-}cand_1, k\text{-}cand_2\}$, and that $k\text{-}cand_1$ is the actual output form.

If both A and B agree in their evaluation of the candidate set, then there is nothing to say. The optimal candidate – the output associated with $/in_k/$ – is just the one that meets both constraints, as in standard approaches to constraint satisfaction. If A and B *disagree*, however, we have a constraint conflict, represented by the following tableau:

(59)   Constraint tableau, A ≫ B, $/in_k/$

Candidates	A	B
☞ $k\text{-}cand_1$		
$k\text{-}cand_2$	* !	

Here candidate $k\text{-}cand_1$ meets A but fails B; while $k\text{-}cand_2$ meets B but fails A. Because $k\text{-}cand_1$ is, by assumption, the actual output form, we say that constraint A *dominates* constraint B (A ≫ B), in the sense that, when A and B disagree on a candidate-pair, the decision between them is made by A alone. This tableau observes certain notational conventions: constraints are written in their domination order, violations are marked by "*", and crucial violations are also called out by "!". Shading emphasizes the *irrelevance* of the constraint to the fate of the candidate. A loser's cells are shaded after a crucial violation; the

winner's, when there are no more competitors. As a reminder of their special status, constraints regarded as part of an optimality-theoretic hierarchy are in small capitals.

This perspective illuminates a number of problems in circumscriptional and templatic morphology, discussed at length in McCarthy and Prince (1993). Here we shall outline an Optimality-Theoretic approach to three such problems: the locus of *-um-* infixation in Tagalog and other Austronesian languages (following Prince and Smolensky 1991b, 1993); the problem of reduplicative infixation after an initial onsetless syllable in Timugon Murut, signalled above in (50); and the effect of a prosodic well-formedness constraint on reduplication in Axininca Campa.

The first example of prosodic morphology within optimality theory comes from the locus of infixation of the Tagalog morpheme *-um-*. This infix falls before the first vowel of a word:

(60) Tagalog *-um-* Infixation
      Root   -um-
      /alis/   /um-alis/   "leave"
      sulat   s-um-ulat   "write"
      gradwet   gr-um-adwet   "graduate" (French 1988)

Though McCarthy and Prince (1990a) analyze Tagalog *-um-* infixation circumscriptionally (essentially like Mangarayi (48)), this account now seems truly unsatisfactory.

Descriptively, *gr-um-adwet* is problematic. Without an Onset constituent, it is impossible to characterize the circumscribed domain either positively or negatively, since neither pre-infixal *gr* nor post-infixal *adwet* is a prosodic constituent (cf. Anderson 1992). Worse yet, the circumscriptional analysis can only stipulate, and not explain, why words with initial clusters, all of them relatively recent loans, consistently behave like *gr-um-adwet* and never like **g-um-radwet* in Tagalog and other Austronesian languages. If Onset is admitted as a constituent, circumscription theory must offer a free choice between the various options for which unit is to be circumscribed (single consonant versus whole Onset). But there is no choice: it is never just the initial consonant, but always the maximal initial cluster.[22]

A further problem of principle is that specifying the locus of the infix by circumscription cannot explain why it is just exactly a *v*C-shaped affix that falls in prenuclear position. A prenuclear, postconsonantal locus for a /vC/ affix makes eminent sense phonotactically, since it supports an unmarked ...CvCv... syllable structure, as Anderson (1972) and Cohn (1992) point out. But neither they nor the circumscriptional account make this fundamental observation follow from the analysis. Indeed, circumscription theory is designed to allow for complete independence between the shape of an affix and its mode of placement.

Clearly, then, *um*-infixation in Tagalog should not be analyzed by prosodic circumscription. Nonetheless, the locus of the infix is prosodically defined, since it responds to the prosodic well-formedness condition requiring open syllables. Prince and Smolensky (1991b, 1992, 1993) use optimality theory to determine the locus of *-um-* by the interaction of the constraints No-Coda and Leftmostness:

(61)   Tagalog Constraints
    (a)   No-Coda[23]
        Syllables are open.
    (b)   Leftmostness
        A prefix is located at the left edge of a word.

No-Coda is the constraint corresponding to the familiar markedness observation (Jakobson 1962, p. 526; Clements and Keyser 1983, p. 29). Violations of Leftmostness are reckoned in terms of the distance of any prefix φ from the designated edge, where each individual phonological element (segment, say) that intervenes between φ and the edge counts as a distinct violation. This means that Leftmostness will function as a gradient constraint, judging the nearness of φ to the edge of the domain. The morpheme *-um-* is a prefix, hence subject to Leftmostness. The constraint No-Coda is also visibly in force, selecting open syllables over closed ones.

In the current context, what is of interest is the relation between these two constraints. They are in direct conflict, as the following tableau shows:

(62)   Tagalog *gr-um-adwet*

Candidates	No-Coda	Leftmostness
um.grad.wet	* !	
gum.rad.wet	* !	g
☞ gru.mad.wet		gr
grad.wu.met		gradw !

Some forms (e.g., *um-gradwet*) may violate No-Coda in more than one location – for clarity, the tableau only records violations of No-Coda involving the prefix *-um-*, since only those will differ crucially among candidates. Violations of Leftmostness are shown by the string of segments separating the formal prefix *-um-* from the left edge of the word.

The prefixed form **um-gradwet* and the post-C infixed form **g-um-radwet*

respect LEFTMOSTNESS more than the actual output *grumadwet* does, but they violate the constraint NO-CODA – this then is a constraint conflict. Since the actual output obeys NO-CODA at the expense of a LEFTMOSTNESS violation, the constraints are ranked NO-CODA ≫ LEFTMOSTNESS.

The account of Tagalog infixation in (61, 62) answers all the objections against a circumscriptional analysis. Because it relies on the prosodic well-formedness constraint NO-CODA, rather than prosodic circumscription, it does not have the liability of demanding that either *gr* or *adwet* be identifiable as a prosodic constituent. And because *g-um-radwet* violates NO-CODA just as *um-gradwet* does, this analysis explains why the infix must follow the entire onset in recent loans like *gradwet*. Finally, because the locus of *-um-* is determined directly by the phonology, via NO-CODA, the optimality-theoretic analysis provides a complete formal account of the observation that prenuclear *-um-* "makes sense phonotactically."

This perspective is confirmed by the optimality theory approach to the Timugon Murut type of reduplicative infixation (50), in which initial onsetless syllables are skipped over (McCarthy and Prince 1993, sec. 7). This pattern is found in a remarkably wide variety of languages. Descriptively, a light syllable (σ_μ) template is infixed after an initial onsetless syllable, otherwise it is prefixed.

Though it might be possible to construct a circumscriptional analysis of facts like these (see sec. 4 and McCarthy and Prince 1991b), the result is again profoundly unsatisfactory. For one thing, negative circumscription – extra-metricality – of initial onsetless syllables requires identifying such syllables as a particular type of prosodic constituent, thus enriching the theory of prosodic categories. Furthermore, it seems likely that the other arguments in the literature for the extrametricality of such syllables are not correct (McCarthy and Prince 1993, sec. 6, sec. 7). But these technical matters pale beside a far more serious empirical problem: a circumscriptional analysis cannot explain why, in all known cases (and there are many), it is always a *reduplicative* infix that skips over the initial onsetless syllable. Since the theory of prosodic circumscription completely divorces the morphological operation (in this case, prefixation of σ_μ) from the specification of the prosodic base (in this case, the residue of onsetless syllable extrametricality), by its very nature it cannot account for any dependencies between them. Indeed, this is precisely the same reason that prosodic circumscription cannot relate the vC shape of Tagalog *-um-* to its prenuclear locus.

But prosodic morphology within optimality theory provides a compelling noncircumscriptional account of infixation in Timugon Murut and similar cases. The key fact is that simple prefixation runs into problems with ONSET that infixation successfully avoids. ONSET is simply the well-known constraint prohibiting vowel-initial syllables Itô (1989):

(63) ONSET
      *[$_\sigma$V

Reduplicating #vCv as *#v̱-.vCv is manifestly less harmonic, syllable-wise, than reduplicating it as #v-C̱v-Cv, because *#v̱-.vCv duplicates an ONSET violation. Edgemostness of the affix suffers, just as in Tagalog.

The tableaux (64, 65) show how the correct result devolves from this ranking, assuming a set of candidates where the reduplicant exactly matches the light-syllable template:

(64)   Timugon Murut σ_μ – Reduplication. C-initial Words.

Candidates	ONSET	LEFTMOSTNESS
☞ bu̱.bu.lud		
bu.lu̱.lud		bu !

Both candidates obey ONSET, so they are referred to LEFTMOSTNESS, which selects *bu̱-bulud*, whose prefix is perfectly prefixal.

(65)   Timugon Murut σ_μ – Reduplication. C-initial Words.

Candidates	ONSET	LEFTMOSTNESS
u̱.u.lam.poy	* ! *	
☞ u.la̱.lam.poy	*	

But in (65) there is a crucial ONSET violation in *u̱-ulampoy* that is absent in *u-la̱-lampoy*. Since ONSET is ranked higher, it alone determines the outcome, though LEFTMOSTNESS would give the opposite result.

To our knowledge, only *reduplicative* infixes are found in this particular locus, never ordinary segmental infixes. The proposal here explains why, sharply distinguishing it from the account based on negative prosodic circumscription outlined in section 4. The core of the explanation is apparent: copying the initial onsetless syllable of *ulampoy* duplicates the ONSET violation. No comparable pressure exists for contentful infixes, regardless of their shape, since they of course cannot duplicate a violation of ONSET. This result submits to formal proof, as shown in McCarthy and Prince (1993, sec. 7).

As in Tagalog, phonotactic well-formedness, rather than prosodic circumscription, is responsible for infixation. Considered in this way, the Timugon Murut constraint system is not merely *analogous to* but actually *identical* to Tagalog's. In both cases, a constraint on prosodic well-formedness – ONSET in Timugon Murut, NO-CODA in Tagalog – dominates a constraint on morphological well-formedness – LEFTMOSTNESS, which characterizes the proper locus

of a class of morphological entities, the prefixes. The only difference between the two cases is in which prosodic constraint does the work, a fact that follows from the different lexical substance of the relevant morphemes, and merits no grammatical mention whatsoever.

The third example of an application of optimality theory in prosodic morphology is the complex pattern of reduplication in Axininca Campa, an Arawakan language of Peru (Payne 1981; Spring 1990a, 1990c, 1992; Black 1991; McCarthy and Prince 1993). Here we will focus on one small aspect of the system, drawn from the complete treatment in McCarthy and Prince (1993, sec. 5).

The normal pattern in Axininca Campa is total root reduplication (66a), but under certain circumstances, depending on the phonology of the root itself, more or less than the whole root may be reduplicated. In particular, when the root is vowel-initial (66b), its initial syllable is not reduplicated. To avoid dealing with further constraint interactions, we focus our attention here only on long (i.e., minimally bimoraic), unprefixed roots:

(66) Reduplication of Long Unprefixed Roots in Axininca Campa
    (a) Consonant-initial Roots
        /kawosi/   kawosi-<u>kawosi</u>   "bathe"
        /koma/   koma-<u>koma</u>   "paddle"
        /kinthᵃa/   kinthᵃa-<u>kinthᵃa</u>   "tell"
        /thᵃaaŋki/   thᵃaaŋki-<u>thᵃaaŋki</u>   "hurry"
    (b) Vowel-initial Roots
        /osampi/   osampi-<u>sampi</u>   "ask"
        /osaŋkina/   osaŋkina-<u>saŋkina</u>   "write"

Axininca Campa reduplication is clearly suffixing, as we have shown by underscoring the reduplicant, since the partial copy can be found in suffixal position (66b). The normal mode is total root reduplication, but this is subverted when the root is onsetless.

The constraint responsible for total reduplication of long consonant-initial roots like those cited in (66a) is Maximality (MAX), introduced in section 3. In total reduplication, there is no templatic requirement to be met (McCarthy and Prince 1986, 1988), so MAX is the sole determining factor. For the form *kawosi*, MAX imposes a ranking on candidate reduplicants in which *kawosi* itself stands at the top, ahead of all others, including especially *wosi*, and (ranked below it) *si*, both of which meet the other reduplicative constraints ANCHORING and CONTIGUITY, as well as the prosodic requirements of the language. The optimal candidate is therefore *kawosi*, which is obviously identical to the input. Unfettered MAX will always yield total reduplication – maximal identity between base and reduplicant.

The reason for the failure of maximal identity in (66b) is not far to seek. Any candidate reduplicant which exactly copied a base shaped /v . . . v/ would have to display an impossible hiatus at the base-reduplicant frontier: . . .

v-v . . . , as in *osampi-osampi*. Thus O~NSET~ ≫ M~AX~, compelling less-than-full copying but satisfying O~NSET~. The following tableau shows this for the root /osampi/.

(67)   /osampi–redup./

Candidates	O~NSET~	M~AX~
osampi.osampi	** !	
☞ osampi.sampi	*	*

Other logical possibilities, such as epenthesis at the base-reduplicant juncture, are barred by further constraints that dominate M~AX~ (see McCarthy and Prince 1993, sec. 5). The point here is that the reduplicant needn't violate O~NSET~, and indeed it doesn't, at the price of a mere M~AX~ violation. Failure on low-ranking M~AX~ – that is, partial reduplication – is irrelevant, since the O~NSET~ comparison decides the contest.

The property common to the Tagalog, Timugon Murut, and Axininca Campa examples is that a prosodic constraint (like N~O~-C~ODA~ or O~NSET~) is ranked above a morphological one (like L~EFTMOSTNESS~ or M~AX~). This ranking produces a pattern in which an essentially morphological phenomenon is determined in part by phonological conditions. Indeed, just this sort of interaction can be shown to lie at the core of all of prosodic morphology (McCarthy and Prince 1993, sec. 7).

NOTES

1   Other sources of violations of word-minimality regularities are lexical exceptionality, the Strict Cycle (Itô 1991; cf. Orgun and Inkelas 1992), and post-lexical, non–structure-preserving phonology (McCarthy and Prince 1991a, 1991b).

2   The variation between mono- and disyllabism seen in Japanese and Yup'ik nicknames is a possible, but not a necessary concomitant of the prosodic nature of templates. For example, the Arabic broken plural template (sec. 4) is the canonical or maximal iamb LH. McCarthy and Prince (1991a, 1991b) develop a pair of features for specifying a particular foot species, like LH, within a genus, like iambic. The features are minimal/maximal in the moraic dimension and minimal/maximal in the syllabic dimension.

Unspecified values for these features allow variation, as in Japanese and Yup'ik.

3   Not all of these studies assume the theory of prosodic morphology, of course.

4   There are two additional conditions on canonicity of noun stems in Arabic that are not our focus here, though they are dealt with in McCarthy and Prince (1990b):

(i)   Final Consonantality
All stems (noun and verb) are consonant-final.

(ii)   Cluster Rule
All and only monosyllables end in consonant clusters.

5   Cf. Lombardi and McCarthy (1991), Samek-Lodovici (1992, 1993).

6   Unexpectedly, the jussives of biliteral roots follow the pattern of *yäskək* "place a peg in the ground". This is perhaps related to the fact that Chaha nouns never have final geminates (see Leslau [1950, p. 15] on *qurər* for *qurr* "basket").

7   To proceed somewhat more exactly, we might identify a correspondence function f between R and B, which must meet three conditions:

(i)   Totality. $f(r)$ exists for all r in R.

(ii)   Element Copy. $f(r) = b \rightarrow [r] = [b]$, for r in R, b in B.

(iii)   Element Contiguity. $\widehat{r_i r_j} \rightarrow \widehat{f(r_i) f(r_j)}$

Totality says that everything in the reduplicant has a correspondent in the base. Element Copy says that the correspondent of an element is phonologically identical to it; the Reduplicant consists of material "copied" from the Base. Element Contiguity says that neighbors in R correspond to neighbors in B. The constraint we have called Contiguity then demands the existence of such an f: R → B.

8   Violations of Contiguity are found most prominently in Sanskrit, in a phenomenon of onset simplification that pervades the system (McCarthy and Prince 1986, Steriade 1988). Apparently, complex onsets are never found in Sanskrit affixes, though they occur in roots, suggesting a generalization over all affixes, not just reduplicative ones.

9   As stated, this is nothing more than a forced association between prefixing and initial-substring copying, suffixing and final-substring copying. A more interesting characterization is possible if we define "prefix" as a leftmost substring, "suffix" as a rightmost substring (as in Prince and Smolensky 1991a). Then we can say that R and $f(R)$ must, in their respective domains – {B, R}, {B} – both be prefixes, or both be suffixes. Prefixality/suffixality is a property, like various others, on which R and $f(R)$ must agree.

10   Apparent counterexamples to Anchoring are discussed in Marantz (1982), McCarthy and Prince (1986), and Weeda (1987).

11   Within optimality theory, where constraints may be violated, but violation is minimal, Maximality can be formulated simply as R = B (McCarthy and Prince 1993, sec. 5).

12   For further applications of melodic overwriting theory, see Steriade (1988), Bao (1990), and Yip (1992).

13   This presents some interesting complications, discussed by Katz (1991) and Urbanczyk (1992).

14   Some aspects of this approach to formalizing the theory of prosodic specification are influenced by Hoeksema's notion of a "head operation" (Hoeksema 1985). Compare also the developments in Aronoff (1988).

15   A similar case is presented by the formation of various auxiliary languages in Buin, of Papua New Guinea (Laycock 1969; Tateishi 1989; McCarthy and Prince 1991b). Other applications of prosodic circumscription to auxiliary or secret languages are proposed by Hammond (1993). Other work on secret languages, broadly related to the overall prosodic morphology program, includes Bagemihl (1988a, 1988b, 1989), Bao (1990), Chiang (1992), Duryea (1991), Hammond (1990), Itô, Kitagawa, and Mester (1992), Tateishi (1989), McCarthy (1982b, 1984b, 1991), Plénat (1985), Vago (1985), Yin (1989), Yip (1982), and many of the contributions to Plénat (1991). (Bagemihl 1988a and Plénat 1991 also include comprehensive bibliographies.)

16   The examples in (45) are cited directly from Moravcsik (1977) and they preserve the dialectal and transcriptional idiosyncrasies of her sources.

17   Circumscription of "consonant," in cases like Mangarayi, looks like a prima facie counterexample to the claim that only *prosodic* constituents are circumscribed. Thus, this phenomenon is analyzed very differently in more recent work; see McCarthy and Prince (1993, sec. 7) and the discussion of Tagalog below, section 6.

18   Prosodic delimitation is distinct from the "morphemic circumscription" of Hammond (1991b). It is, however, not unrelated to the prosodic subcategorization of Inkelas (1989); see McCarthy and Prince (1993, sec. 4, sec. 7) for further discussion.

19   Though Lowenstamm and Kaye (1986) require that templates be prosodic, they also specify the terminal positions of templates as segmental slots.

20   The one argument in the literature which crucially relies on unfilled template slots is Everett and Seki (1985); this case is analyzed differently in McCarthy and Prince (1986, 1993, sec. 7).

21   Strictly speaking, $(CVCV)^+$ is required, since Japanese has 4-mora hypocoristics as well as 2-mora ones. But of course this notation simply sneaks in the foot constituent without calling it that. Thus, we have here yet another argument against segmentalism.

22   The Austroasiatic languages of Southeast Asia, such as Temiar and Kammu, seem to counterexemplify this claim. The counterexample disappears, however, once the "sesquisyllabic" syllable structure of these languages is properly understood – see, inter alia Huffman (1972), Dell (1985), Sloan (1988), McCarthy and Prince (1991b), and cf. Anderson (1992).

23   It might be objected that Tagalog *has* closed syllables, and so No-CODA could not be active in the language. But in Optimality Theory, the presence of closed syllables in output forms of the language merely indicates that No-CODA is dominated, hence violated, not that it is entirely *hors de combat* – as indeed it is not. In Tagalog, No-CODA is dominated by the faithfulness constraints PARSE and FILL (see Prince and Smolensky 1993) so input /vCCv/ is parsed faithfully as [vC.Cv] in the output.