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January 2006

Prosodic morphology

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Recommended Citation
McCarthy, John J., "Prosodic morphology" (2006). *Encyclopedia of Language and Linguistics*. 62.
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Selting M (2000). 'The construction of units in conversational talk.' *Language in Society 29,* 477–517.

Walker G (2004). 'On some interactional and phonetic properties of increments to turns in talk-in-interaction.' In Couper-Kuhlen E & Ford C E (eds.). 147–169.

Wells B & Macfarlane S (1998). 'Prosody as an interactional resource: turn-projection and overlap.' *Language and Speech 41,* 265–298.

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Yule G (1980). 'Speakers' topics and major paratones.' *Lingua 52,* 33–47.

Prosodic Morphology

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The phrase 'prosodic morphology' (hereafter, PM) refers to a theory and to a class of phenomena to which that theory is applied. The theory of PM deals broadly with the relationship between phonological and morphological structure, particularly restrictions on the size and shape of words, stems, and morphemes. This article presents an overview of the theory of PM and its applications.

The Theory of Prosodic Morphology

PM is a theory of how morphological and phonological determinants of linguistic form interact. The theory focuses on understanding how prosodic structure impinges on certain kinds of morphology, such as reduplication and infixation. In McCarthy and Prince (1986/1996, 1990a), three essential claims are advanced about PM:

(1) Principles of PM
- a. Prosodic morphology hypothesis
  Templates are defined in terms of the authentic units of prosody: mora (μ), syllable (σ), foot (Ft), phonological word (PWd).
- 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.

A template is a restriction on the size and shape of an affix, stem, or word. According to the prosodic morphology hypothesis (1a), all such restrictions must be stated in prosodic terms. Since templates are defined prosodically, satisfaction of templates (1b) is determined by the same principles that govern prosodic structure generally, such as foot binarity (see (4) below). Circumscription (1c) is a mechanism for delimiting a prosodically defined portion of a word to which a morphological process is then applied; it is important in the analysis of infixation and other phenomena. In short, templates and circumscription must be stated in terms of the vocabulary of prosody and must respect the well-formedness requirements of prosody.

These principles are intended to address a fundamental explanatory goal: to reduce or eliminate the descriptive apparatus that is specific to particular empirical domains such as reduplication and instead derive the properties of those domains from general and independently motivated principles. Claims (1a, b, c) assert that prosodic theory is where these independent principles are to be found. Indeed, the goal of independent explanation is more important than the principles, and subsequent work has pursued the same explanatory goal while departing from these principles in certain respects. Some of this later work is reviewed below.

On the morphological side, the theory of PM incorporates few assumptions. The morphological constituents root, stem, and affix form a labeled bracketing, essentially along the lines of Selkirk's (1982) word-syntax. Most work in PM adopts a view of morphology that is morpheme-based, under the broad rubric of item-and-arrangement models, though the implementation of prosodic circumscription in McCarthy and Prince (1990a) is process-based.

On the phonological side, prosodic morphology presupposes the prosodic hierarchy in (2) (cf. Selkirk, 1980).

(2) Prosodic hierarchy

Phonological word	PWd
Foot	Ft
Syllable	σ
Mora	μ

The mora is the basic unit of syllable weight; in the most common syllable-weight typology, short open syllables such as *pa* are monomoraic, and long-voweled or closed syllables like *pa:* or *pat* are bimoraic.

The metrical foot typology assumed in PM is based on Hayes (1987, 1995) and McCarthy and Prince (1986/1996). The typology, given in (3), uses the notations L for a monomoraic (or light) syllable, H for a bimoraic (or heavy) syllable, and σ for a syllable of unspecified weight.

	Iambic foot	Trochaic foot	Syllabic foot
(3)	LH	H, LL	$\sigma\sigma$
	LL, H		

The basic foot typology does not include degenerate feet, those consisting of a single light syllable (if the foot is iambic or trochaic) or a single syllable (if the foot is syllabic). The general condition on foot form in (4) expresses the markedness of degenerate feet.

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

The advent of Optimality Theory (Prince and Smolensky, 2004) has had a significant influence on the development of the theory of PM. In Optimality Theory, constraints on linguistic forms are ranked and violable. Constraint violability turns out to be an extremely useful concept in PM, as some of the analyses below will show.

Word and Stem Shape Restrictions

The prosodic hierarchy and foot binarity, taken together, derive the key notion of a minimal word (Broselow, 1982; McCarthy and Prince, 1986/1996; Prince, 1980). According to the prosodic hierarchy, any instance of the category phonological word must contain at least one foot. By foot binarity, every foot must be bimoraic or disyllabic. By transitivity, then, a phonological word must contain at least two moras or two syllables.

The grammatical significance of word minimality is determined by constraints on the interface between morphological and prosodic structure. In nearly all languages, every lexical or content word – that is, every member of the open classes noun, verb, and adjective – corresponds to a phonological word. Therefore, if phonological words are minimally binary, lexical words will be observed to have a minimum phonological size. In some languages, not only lexical words, but also the stems embedded in them must correspond to phonological words and may be subject to binarity requirements as well.

Both of these minimality effects can be illustrated with data from Axininca Campa (Ashéninca Pichis) (Arawakan, Peru). In this language, word-final vowels are shortened (5a), but not in monosyllables (5b) (Payne, 1981; Spring, 1990).

(5)	a.	/sampa:/	sampa	'balsa'	cf. no-sampa:-ti 'my balsa'
		/sawo:/	sawo	'case'	cf. no-sawo:-ti 'my case'
	vs.	/sima/	sima	'fish'	cf. no-sima-ni 'my fish'
	b.	/mi:/	mi:	'otter'	cf. no-mi:-ni 'my otter'
		/so:/	so:	'sloth'	cf. no-so:-ni 'my sloth'

Final vowel shortening is blocked in monosyllables by the joint effects of the three constraints mentioned: every lexical word corresponds to a phonological word, so 'otter' has the phonological structure [*mi:*]$_{PWd}$; every phonological word contains a foot as its head, so 'otter' has the foot structure [(*mi:*)$_{Ft}$]$_{PWd}$; and feet are binary, so *[(*mi*)$_{Ft}$]$_{PWd}$ is ruled out.

Axininca Campa also shows word-minimality effects at the level of the stem. Before certain suffixes, monomoraic roots are augmented by adding the syllable *ta*, thereby making them bimoraic, as shown in (6).

(6) Root — Morphological structure
Prosodic structure
/na/ {{{na}$_{St}$ piro}$_{St}$ a:nʦ^{h}i}$_{St}$
[[(nata)$_{Ft}$]$_{PWd}$ pirota:nʦ^{h}i]$_{PWd}$
/t^{h}o/ {{{{{t^{h}o}$_{St}$ RED}$_{St}$ wai}$_{St}$ ak}$_{St}$ i}$_{St}$
[[(t^{h}ota)$_{Ft}$]$_{PWd}$ t^{h}otawaitaki]$_{PWd}$
(Glosses: 'to carry well', 'has continued to kiss more and more'

Under standard assumptions about word syntax, affixed forms are bracketed into recursive stem structure, and the most deeply embedded stem is the root. Before suffixes such as *-piro* or reduplicative -RED, that innermost stem must correspond to a phonological word. For reasons already given, phonological words are minimally bimoraic. Monomoraic roots such as /na/ or /t^{h}o/ are not big enough to support a properly footed phonological word, so epenthetic *ta* must be added. Taken together with the observations about the lack of vowel shortening in monosyllables, this shows that word minimality can both block and trigger phonological processes.

Axininca Campa also illustrates how Optimality Theory can contribute to the understanding of PM. The suffixes that induce augmentation of a preceding monomoraic root are exactly those that begin with consonants. Suffixes that begin with vowels in underlying representation do not trigger augmentation: /{tʰo}$_{St}$ aːntsʰi/→ *tʰotaːntsʰi*, **tʰota.aːntsʰi*, **tʰota-taːntsʰi* 'to kiss'. The reason for this difference lies in constraint interaction. In Optimality-Theoretic terms, the relationship between stems and phonological words is expressed by a ranked, violable constraint on the prosody–morphology interface. This constraint can be called ALIGN-STEM (for details, see McCarthy and Prince, 1993a). ALIGN-STEM is satisfied by [(*nata*)$_{Ft}$]$_{PWd}$ *piro* because the suffix *-piro* is immediately preceded by the right edge of a phonological word. But ALIGN-STEM is violated by *tʰotaːntsʰi* because the alternatives, [(*tʰota*)$_{Ft}$]$_{PWd}$ *aːntsʰi* and *[(*tʰotat*)$_{Ft}$]$_{PWd}$ *aːntsʰi*, violate the constraint ONSET, which prohibits the vowel-initial syllable *aːn*. The interaction of ONSET and ALIGN-STEM through ranking is shown in (7).

(7) ONSET >> ALIGN-STEM

/{tʰo}$_{St}$ aːntsʰi/	ONSET	ALIGN-STEM
a. ☞ tʰotaːntsʰi		*
b. [(tʰota)$_{Ft}$]$_{PWd}$ aːntsʰi	*!	
c. [(tʰotat)$_{Ft}$]$_{PWd}$ aːntsʰi	*!	

To sum up, augmentation in Axininca Campa is a response to word-minimality requirements that derive from the prosodic hierarchy and foot binarity. Presuffixal augmentation further calls on a constraint on the morphology–prosody interface, ALIGN-STEM, that imposes phonological-word status on the stems to which suffixes are attached. Constraint interaction through ranking is crucial in explaining why consonant-initial suffixes induce augmentation and vowel-initial suffixes do not. The consonant-initial/vowel-initial dichotomy is purely descriptive; the real difference is between suffixes like *-piro* that can satisfy both ONSET and ALIGN-STEM versus suffixes such as *-aːntsʰi* that can satisfy one or the other of these constraints, but not both. As these constraints are ranked in (7), ONSET prevails: vowel-initial suffixes are not preceded by stems that are also phonological words, and so there is no need for augmentation.

Templatic Morphology

In some languages, restrictions on the size and shape of words or stems are used to mark morphological distinctions. This phenomenon is called templatic, template-mapping, or root-and-pattern morphology.

The best attested type of templatic morphology is subtractive: nicknames and the like are formed in many languages by mapping the full name onto a minimal-word template. Descriptively, all of the segments of the original name are discarded, leaving only enough to make a single metrical foot, the minimal phonological word. Some examples appear in (8).

(8) a. Central Alaskan Yupik Eskimo (Central Yupik) (A. Woodbury, personal communication)

Name	Proximal Vocative
aŋukaʁnaq	aŋ ~ aŋuk
nupiʁak	nup ~ nupix/nupik
aŋivʁan	aŋif

b. Japanese (Poser, 1990)

Name	Hypocoristic
ti	tiː-tʃan
ʃuːsuke	ʃuː-tʃan
taizoo	tai-tʃan
kinsuke	kin-tʃan
midori	miː-tʃan ~ mit-tʃan ~ mido-tʃan

c. English

Name	Nickname
Mortimer	Mort, Mortie
Cynthia	Cynth, Cindy
Marjorie	Marge, Margie
Angela	Ange [ænʤ], Angie,
Edward	Ed, Eddie, *but* *Edwie
Abraham	Abe, Abie, *but* *Abrie
Jacqueline	Jackie, *but* *Jacquie (=[ʤækwiː])

The stress system of Yup'ik (8a) is based on the iambic foot, and the truncated names exactly match the expansions of the iambic foot that are consistent with foot binarity (see [3]). The template in Yup'ik, as in the other two languages, is the minimal word (MinWd). Though Japanese (8b) does not have a stress system, there is abundant evidence from various quarters in support of trochaic feet (Ito, 1990; Poser, 1990), and the hypocoristic nicknames consist of a single heavy syllable or two light syllables, which are the licit expansions of the trochee. English (8c) also has trochaic feet, and English nicknames typically contain a single heavy syllable, to which the diminutive suffix *-ie* may be added. In accordance with the template satisfaction condition (1b), the mapping of a name to the minimal-word template respects independently motivated restrictions on prosodic structure in English. That is why **Edwie* and **Abrie* are ill formed: the suffix *-ie* is external to the MinWd template, and **Edw* or **Abr* are not possible monosyllables.

Though nickname formation is rather limited in scope, root-and-pattern morphology is an utterly pervasive feature of some morphological systems, particularly in the Afro-Asiatic family, but also in various Penutian languages such as Miwok (Southern

Sierra Miwok), Yokuts, and Takelma. These systems are all rather complex and difficult to summarize briefly, but it is possible to get a general feel for the mode of analysis by a brief glance at one of them.

The shapes of canonical noun stems in Arabic illustrate some basic principles (McCarthy and Prince, 1990b). (A noun stem is canonical if it has a broken plural, a concept to be explained below.) The permitted noun stems are summarized in (9), classified according to syllabic structure with an example of each type.

(9) a. H	b. LL	c. LH	d. HL	f. HH
bahr	badal	wazi:r	ka:tib, xanʤar	ʤa:mu:s, ʤumhu:r

'sea', 'substitute', 'vizier', 'writer', 'buffalo', 'dagger', 'multitude'

All patterns are well represented in the Arabic lexicon, with hundreds of examples of each.

The classification of nouns in (9) according to the syllable-weight patterns assumes final consonant extrametricality, which is independently motivated in Arabic. With the extrametrical consonant set aside, the shapes of these noun stems range from a lower bound at the bimoraic minimal word (H or LL) to an upper bound at the maximal disyllable HH. These observations can be expressed in terms of prosodic conditions on noun stems:

(10) a. Minimally bimoraic $Stem_N = PWd$ b. Maximally disyllabic $Stem_N \leq \sigma\sigma$

Because the morphological category $Stem_N$ is equated with the phonological word, a $Stem_N$ must contain a foot, under the prosodic hierarchy (2), and so it is minimally bimoraic, as required by foot binarity (4). The maximality condition is a natural one under general considerations of locality, which impose an upper limit of two on rules that count (McCarthy and Prince, 1986/1996). The minimality and maximality conditions define a family of templates in Arabic, with each member of that family available for particular morphological functions in the nominal system. This shows that the fundamental structural properties of root-and-pattern morphological systems can and should be characterized in prosodic terms.

Reduplication

In reduplicative morphology, a copy of a root or stem is mapped to a template. According to (1a, b), the reduplicative template must be defined and satisfied in accordance with prosodic principles.

A cursory survey of reduplicative templates across languages finds only a limited array of options. Total reduplication (11a) copies the entire root or stem, regardless of its size. Of the types of partial reduplication, the largest is disyllabic (11b), with a template consisting of a single foot or a minimal word. Monosyllabic templates can be heavy (11c) or light (11d); the smallest monosyllabic template is the core syllable, which consists of a single onset consonant and a vowel (11e).

(11) a. Indonesian total reduplication

rumah	rumah-rumah	'house/pl.'
ibu	ibu-ibu	'mother/pl.'
lalat	lalat-lalat	'fly/pl.'
harian	harian-harian	'newspaper/pl.'

b. Diyari (Dieri) minimal word reduplication (Austin, 1981)

ŋama	ŋama-ŋama	'to sit'
kanku	kanku-kanku	'boy'
kuɭkuŋa	kuɭku-kuɭkuŋa	'to jump'
tʲilparku	tʲilpa-tʲilparku	'bird species'

c. Ilokano (Ilocano) heavy syllable reduplication (Hayes and Abad, 1989)

kaldíŋ	kal-kaldíŋ	'goat/pl.'
púsa	pus-púsa	'cat/pl.'
ʤjánitor	ʤjan-ʤjánitor	'janitor/pl.'
kristʃjáno	kris-kristjáno	'Christian/pl.'
trabáho	ʔag-trab-trabáho	'to work/is working'

d. Ilokano light syllable reduplication (Hayes and Abad, 1989)

bunéŋ	si-bu-bunéŋ	'buneng/carrying a buneng'
ʤjáket	si-ʤja-ʤjáket	'jacket/wearing a jacket'
pandilíŋ	si-pa-pandilíŋ	'skirt/wearing a skirt'
dʒjánitor	ʔagin-dʒja-dʒjánitor	'janitor/pretend to be a janitor'
trabáho	ʔagin-tra-trabáho	'to work/pretend to work'

e. Sanskrit core syllable reduplication (Steriade, 1988)

pat	pa-pát-a	'fly/perf.'
prat^h	pa-prát^h-a	'spread/perf.'
mna:	ma-mná:-u	'note/perf.'
stamb^h	ta-stamb^h-a	'prop/perf.'

The template for total reduplication (11a) is the unmodified phonological word, PWd. This template is as flexible in size as words themselves are, so it elicits complete and exact copying of the word to which it is attached. The foot or minimal word, MinWd, whose role as nickname template has already been discussed, also shows up as a rather common reduplicative template (11b). The various monosyllabic templates (11c–e) are differentiated by syllable weight and onset complexity. Sanskrit (11e) permits complex onsets in roots but not in the reduplicative affix; the consonant that is reduplicated is the less sonorous member of the cluster (*p* is less sonorous than *r* and *t* than *s*), or else the first when they are equal sonority.

The role and status of the template satisfaction condition (1b) in reduplication can perhaps best be appreciated by applying recent developments in Optimality Theory (McCarthy and Prince, 1993b, 1994, 1995a, 1999). Reduplication is a matter of reconciling the often competing demands of markedness constraints and MAX-BR. (MAX-BR requires *max*imal copying of the *b*ase's segments by the *r*eduplicative morpheme.) MAX-BR always militates in favor of copying more, whereas prosodic markedness often favors copying less. The ranking of these markedness constraints relative to MAX-BR is therefore crucial in determining the extent of reduplicative copying (*see also* **Morphology: Optimality Theory**).

Sanskrit will serve to illustrate this mode of analysis. Basic language typology shows that onset clusters are marked c – for example, although some languages permit onset clusters, no language literally requires them, and some languages prohibit them outright. There is, then, ample foundation for positing the syllable markedness constraint *COMPLEX-ONSET. In languages without onset clusters, *COMPLEX-ONSET must dominate some input-output faithfulness constraint, such as MAX-IO, which prohibits deletion. (MAX-IO requires *max*imal preservation of the *i*nput's segments by the output.) Sanskrit, however, allows onset clusters, so the ranking of these two constraints is the other way around. But Sanskrit bans onset clusters from the reduplicative affix, even at the expense of less than perfect copying. Example (12) provides an explanation for this difference:

(12) MAX-IO >> *COMPLEX-ONSET >> MAX-BR

/RED+druv/	MAX-IO	*COMPLEX-ONSET	MAX-BR
a. ☞ du-druv		*	**
b. dru-druv		**!	*
c. du-duv	*!		*

With this ranking, *COMPLEX-ONSET limits the reduplicative affix to unmarked structure at the expense of less complete copying. But where faithfulness to the input rather than completeness of copying is at stake, MAX-IO prevails. This allows the language as a whole, outside the reduplicative affix, to have complex onsets.

Axininca Campa supplies another example. Suffixing reduplication makes a complete copy of a consonant-initial root (13a), but it skips over the first syllable of a vowel-initial root (13b).

(13) a. kawosi-kawosi 'bathe'
t^ha:ŋki-t^ha:ŋki 'hurry'
kint^{h}a-kint^{h}a 'tell'
b. osaŋkina-saŋkina 'write'
osampi-sampi 'ask'

Total copying of vowel-initial roots would produce a vowel-initial syllable, which is a violation of ONSET. Since this outcome is avoided, ONSET must dominate MAX-BR in Axininca Campa (see [14]).

(14) ONSET >> MAX-BR

/osaŋkina + RED/	ONSET	MAX-BR
a. ☞ osaŋkina-saŋkina		*
b. osaŋkina-osaŋkina	*!	

This example is of particular interest because it shows that the basic typology of reduplication in (11) is incomplete. Even total reduplication can be limited by the force of markedness constraints.

The broader theme emerging from examples such as Sanskrit and Axininca Campa is that template satisfaction can be affected by any markedness constraint if it is ranked appropriately. The bolder and therefore more interesting hypothesis is that the 'template' is a purely derivative notion: it is a description of a reduplicative pattern that emerges from constraint rankings like those in (12) and (14). In other words, templates are not primitives of morphological and phonological description, as they were in the original conception of PM theory. Rather, the work of templates is done by markedness constraints such as *COMPLEX-ONSET and ONSET, all of which are independently motivated on language typology. Through ranking, these constraints can affect reduplicative or other templatic structures in a language without affecting the language as a whole. The hypothesis just sketched and the research program in support of it are known as Generalized Template Theory (McCarthy and Prince, 1994, 1995a, 1995b, 1999).

Prosodic Circumscription

There is one remaining aspect of PM theory to discuss: prosodic circumscription. The base to which a morphological operation is applied is usually a grammatical category such as root, stem, or (morphosyntactic) 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. The explanation and examples below are drawn from McCarthy and Prince (1990a, 1995b).

Ulwa (Sumo Tawahka) (Misumalpan, Nicaragua) presents a remarkably clear case of infixation by prosodic circumscription. The possessive in Ulwa is marked by a set of infixes located after the stressed syllable of the noun, as shown in (15a, b) (Hale and Lacayo Blanco, 1989).

(15) a. Possessive paradigm

sú:lu	'dog'
sú:kilu	'my dog'
sú:malu	'thy dog'
sú:kalu	'his/her dog'
sú:kinalu	'our (excl.) dog'
sú:nilu	'our (incl.) dog'
sú:manalu	'your dog'
sú:kanalu	'their dog'

b. Further examples

bás-ka	'his hair'
kí:-ka	'his stone'
ás-ka-na	'his clothes'
saná-ka	'his deer'
amák-ka	'his bee'
sapá:-ka	'his forehead'
siwá-ka-nak	'his root'
aná:-ka-la:ka	'his chin'
arák-ka-bus	'his gun'

Ulwa has iambic feet assigned from left to right. An iambic foot consists of a single heavy syllable or a sequence of two syllables, the first of which is light (3). Therefore, stress falls on the first syllable if it is heavy (*sú:lu*, *ásna*), otherwise on the second syllable. The location of the possessive morphemes, then, is immediately after the first or main-stressed foot of the word.

The fundamental idea in prosodic circumscription theory is that the Ulwa possessive morphemes are actually suffixes, but suffixes on the prosodically circumscribed initial foot within the Ulwa noun stem. The central element of prosodic circumscription theory is a parsing function $\Phi(C, E, B)$, which returns the prosodic constituent C that sits at the edge E of the base B. The function Φ factors B into two parts: the kernel $B{:}\Phi$ is the part that satisfies the constraint (C, E), and the residue B/Φ is the rest of B. With '*' standing for the relation between the two factors (normally left- or right-concatenation), the identity in (16) holds.

(16) Factoring of B by Φ

$$B = B{:}\Phi * B/\Phi$$

There are two main types of prosodic circumscription, positive and negative. In positive circumscription, the $B{:}\Phi$ factor serves as the input to a morphological operation. Call that operation O(X). Then $O{:}\Phi$ – the same operation, but conditioned by positive circumscription of (C, E) – is defined as in (17).

(17) 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 $B{:}\Phi$, concatenating the result with B/Φ in the same way that the kernel $B{:}\Phi$ concatenates with the residue B/Φ in the base B. In this way, the operation $O{:}\Phi$ inherits everything that linguistic theory says about O, except its domain of application.

In Ulwa, the factor returned by Φ is a foot at the left edge, so the Ulwa possessive is characterized as $O{:}\Phi$(Ft, Left), where O is a morphological operation that can be called 'Suffix POSS.' For example, the factoring of *karásmak* 'knee' is shown in (18).

(18) O:Φ(karásmak) = O(karásmak:Φ) * karásmak/Φ
= O(karás) * mak
= karás-ka * mak
= karáskamak

The initial iambic foot *karás*, rather than the whole noun, functions as the base for suffixation of the possessive morpheme. With words consisting of a single iambic foot, such as *bas* or *ki:*, the infixes are authentic suffixes because B and $B{:}\Phi$ are coextensive.

The Arabic broken plural and diminutive present another example of positive prosodic circumscription. In Arabic, the productive plural formation and the diminutive are expressed by imposing a LH iambic foot on the singular noun stem. Singular nouns come in diverse shapes, but this iambic template affects only a portion of the noun. The affected portion of the singular is italicized in the first column of (19), as is the iambic portion of the plural and diminutive in the second and third columns.

(19)

Singular	plural	diminutive	
*ħuk*m	/*ħaka:*m/	*ħukaj*m	'judgment'
*ʕina*b	/*ʕana:*b/	*ʕunaj*b	'grape'
*dʒazi:*r-at	/*dʒaza:*wir/	/*dʒuzaj*wir/	'island'
*ʃa:*ɣil	*ʃawa:*ɣil	*ʃuwaj*ɣil	'engrossing'
*dʒa:*mu:s	*dʒawa:*mi:s	*dʒuwaj*mi:s	'buffalo'
*dʒun*dub	*dʒana:*dib	*dʒunaj*dib	'locust'
*sul*tˤa:n	*sala:*tˤi:n	*sulaj*tˤi:n	'sultan'

Underlying representations are written in virgules for those forms undergoing additional phonological processes that obscure some of the effects of the morphology.

Plural and diminutive morphology have characteristic effects on word shape, vowel quality, and appearance of the glides *w* and *j*. Prosodic circumscription is responsible for the word shape, which is therefore the focus of attention here. Descriptively, plurals and diminutives have both invariant and varying properties of word shape. The invariant is the initial LH sequence, which has been italicized in (19). The varying portion of the plural and diminutive ranges from a single consonant (e.g., the final *m* of *ħukajm*) to a heavy syllable plus a consonant (e.g., the final *miːs* of *dʒuwajmiːs*). The shape of the varying portion is determined by the corresponding singular stem: it matches the unitalicized portion of the singular (e.g., the *m* of *ħukajm* matches the *m* of *ħukm* and the *miːs* of *dʒuwajmiːs* matches the *muːs* of *dʒaːmuːs*).

This division into invariant and varying portions is a consequence of prosodic circumscription. The italicized portion of the singular is the positively circumscribed domain, a trochaic foot, which is also the minimal word 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. Thus, the morphological operation O is mapping to an iambic template, and the circumscriptional function is Φ(MinWd, Left).

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. The negatively circumscribed operation O/Φ(B) – the application of O to the base B minus some edge constituent – is defined in (20).

(20) Negative prosodic circumscription
O/Φ(B) = B:Φ * O(B/Φ)

Except that it is defined in operational terms, this is essentially equivalent to representational extrametricality in metrical phonology. To apply O to B under extrametricality is simply 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.

A common type of infixing reduplication requires negative circumscription of an initial onsetless syllable, one that starts with a vowel rather than a consonant. An example of this comes from Timugon Murut (Austronesian, Malaysia), as shown in (21) (Prentice, 1971).

(21)	bulud	bu-bulud	'hill/ridge'
	limo	li-limo	'five/about five'
	abalan	a-ba-balan	'bathes/often bathes'
	ompodon	om-po-podon	'flatter/always flatter'

The reduplicative template in Timugon Murut is a light syllable. It copies material of the base, minus an initial onsetless syllable, if any. It can therefore be characterized as O/Φ(σ_V, Left), where σ_V is a temporary expedient for referring to onsetless syllables and O stands for the operation of prefixing the reduplicative morpheme. Applied to the final example in (21), this schema yields the result in (22).

(22) O/Φ(ompodon) = ompodon:Φ * O(ompodon/Φ)
= om * O(podon)
= om * σ_μ-podon
= om * po-podon
= ompopodon

The morphological base *ompodon*, minus its initial syllable *om*, functions as the prosodically circumscribed base to which the operation of prefixing a σ_μ template applies. Crucially, it is the residue of circumscription, rather than the kernel, that is the target of the morphological operation. When the initial syllable has an onset, as in *bulud*, the kernel of circumscription is empty, and the entire base *bulud* is the residue to which the reduplicative template is prefixed.

Prosodic circumscription unifies a range of phenomena that are sensitive to phonological subdomains, including operations that target a constituent, as in Ulwa, and those that exclude a constituent, as in Timugon Murut. The theory of PM situates circumscription within broader principles of phonology and morphology, thereby contributing to the explanatory goals of the enterprise. But Timugon Murut also discloses some limits of prosodic circumscription theory. One problem is that the onsetless syllable is not a legitimate prosodic constituent – on the contrary, it is a *defective* prosodic constituent. So its role in Timugon Murut circumscription is inconsistent with principle (1c), which says that only recognized constituents can be employed in circumscription. A more serious problem is that infixes with the same locus of placement as Timugon Murut's are always reduplicative in known cases. Reduplicative infixes that go after an initial onsetless syllable but are otherwise prefixed are not uncommon, yet ordinary, nonreduplicative infixes never have exactly this distribution. Cross-linguistically, then, there is an interactional effect: positioning an affix after an initial onsetless syllable is dependent upon the affix's being templatic and reduplicative rather than segmentally specified. Circumscription theory cannot explain this, because it formally divorces the placement of an affix (which is determined by the arguments of Φ) from the structural nature of the affix (which is determined by the operation O). Research on PM within Optimality Theory has sought to address these and other problems (*see* **Morphology: Optimality Theory**).

Positive and negative circumscription are 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 applies in situations where minimal and supraminimal bases are subject to different morphological operations. For example, in Dyirbal (Pama-Nyungan, Australia) (23), disyllabic and longer bases take different allomorphs of the ergative suffix (Dixon, 1972), while in Axininca Campa (24), bimoraic and longer bases take different allomorphs of the 'possessed' suffix:

(23)

Noun stem	Noun+ergative	
yaɽa	yaɽa-ŋgu	'man'
yamani	yamani-gu	'rainbow'
balagara	balagara-gu	'they'

(24)

mi:	no-mi:-ni
sima	no-sima-ni
ʦʰimi:	no-ʦʰimi:-ti
mana:nawo	no-mana:nawo-ti
mi:	no-mi:-ni
'otter/my otter'	no-mi:-ni
sima	no-sima-ni
'fish/my fish'	

In Dyirbal, the generalization is that the ergative suffix takes the allomorph *-ŋgu* with disyllabic bases (=MinWd), 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 in Arabic, calls on Φ(MinWd), but it puts the result to different use. Specifically, prosodic delimitation partitions the lexicon into those bases where B:Φ, the Φ-circumscribed kernel of B, is identical to B, and those where B:Φ is less than B. This special sense of Φ, designated Φ′, is a partial function defined as in (25).

(25) Delimitation of B by Φ′
Φ′(B) = B if B = Φ(B); otherwise, Φ′(B) is undefined

Under this formalization, suffixation of *-ŋgu* or *-ni* to minimal bases is regarded as the special, prosodically delimited case. Suffixation of *-gu* or *-ti* is regarded as a default, applicable whenever Φ′(B) is undefined (because B is greater than minimal).

The Dyirbal ergative, for example, consists of two morphological operations. One is 'Suffix *-ŋgu*', restricted prosodically by Φ′(MinWd). The other is prosodically unrestricted 'Suffix *-gu*', which is applicable elsewhere. If Φ′ returns a value, in accordance with (25), then *-ŋgu* is suffixed, since the target form is a foot/minimal word. But if Φ′ returns no value at all, then 'Suffix *-ŋgu*' cannot apply, and the default suffix *-gu* is provided instead. In general, a default operation need not be specified; in other languages, the responses to blocking of the prosodically delimited morphological operation are quite diverse, ranging from complete failure (in Kinande (Nandi) noun reduplication (Mutaka and Hyman, 1990) 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.

In summary, three types of prosodic circumscription are 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 (McCarthy, 2000; McCarthy and Prince, 1993a, 1993b). Nonetheless, it seems clear that a notion akin to the prosodic base, common to all types of circumscription, must play a role in the analysis of phenomena such as those discussed here.

See also: Affixation; Arabic as an Introflecting Language; Foot; Metrical Phonology; Morphology: Optimality Theory; Reduplication; Subtraction; Syllable: Phonology; Syntax of Words; Template Morphology.

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Proto-Algonkian Phonology and Morpho-Syntax

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In 1925 Leonard Bloomfield reconstructed the common ancestor of the four best-attested Algonkian languages of the day – Fox (Meskwaki) [Mesquakie], Plains Cree, Menominee [Menomini], and Southern Ojibwa. These four languages, chosen by an accident of history, together retained reflexes of most of the important phonological and morphological distinctions of Proto-Algonkian. After work by Michelson (1935), Voegelin (1941), and Siebert (1941) established this unexpected fact, Bloomfield (1946), still drawing largely on examples taken from Fox, Cree, Menominee, and Ojibwa, sketched a description of Proto-Algonkian phonology and morphosyntax.