Faithfulness and Prosodic Circumscription[*]

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1. Introduction

Faithfulness constraints have been an essential part of Optimality Theory (OT) since its inception (Prince and Smolensky, 1991, 1993), but the form and function of faithfulness constraints have evolved. McCarthy and Prince (1995a) propose that faithfulness constraints are formalized within a Correspondence Theory of relations between representations. Correspondence Theory permits the statement of constraints demanding faithfulness to diverse linguistic entities, such as features, segments, and prosodic constituents. Furthermore, it generalizes faithfulness from its original role, comparing underlying and surface forms, to similar but distinct linguistic relations, such as comparing a stem to its reduplicative copy.

Here, I will focus on prosodic faithfulness constraints. Studies of lexical stress systems and the like provide abundant evidence for constraints requiring that underlying prosodic structure (such as metrical feet) be faithfully preserved on the surface. The goal of this article is to show how prosodic faithfulness constraints shed light on a different set of phenomena, those that have been attributed to operational prosodic circumscription (McCarthy and Prince, 1990a).

Yidiɲ reduplication, as shown in (1), is a typical case:

(1) Yidiɲ Reduplication (Dixon, 1977; Nash, 1979; Marantz, 1982; McCarthy and Prince, 1990a; Spring, 1990)

Singular	Plural	
$[\text{mula}]_{Ft}$ ri	mula-$[\text{mula}]_{Ft}$ ri	‘initiated man’
$[\text{t}^j\text{ukar}]_{Ft}$ pa	t^jukar-$[\text{t}^j\text{ukar}]_{Ft}$ pa-n	‘unsettled mind’

The choice of how much to reduplicate depends on the foot structure of the base. In the second example but not in the first, r is copied because it is part of the base-initial foot. In the operational circumscription model of McCarthy and Prince (1990a), this dependency is expressed by a succession of derivational steps: the initial foot of the base is parsed out by a circumscription operation, and then the parsed-out constituent, rather than the whole base, undergoes reduplicative copying. Below, I will argue that Yidiɲ is better analyzed in terms of prosodic faithfulness: the foot structure of the reduplicative copy must faithfully match the foot structure of the base. Similar arguments are presented for other phenomena attributed to operational circumscription.

The approach based on prosodic faithfulness enjoys several conceptual advantages over operational circumscription. Most importantly, prosodic faithfulness constraints are independently motivated, but operational circumscription is not. The results obtained here therefore support the reductionist goals of McCarthy and Prince (1994b): to achieve a more explanatory theory of Prosodic Morphology (PM) by eliminating all PM-specific devices like circumscription, templates, or reduplicative copying. There is also significant convergence with the results of other work on PM within OT. A close parallel can be found in Itô, Kitagawa, and Mester's (1996) study of the Japanese zuuja-go secret language, which strongly resembles classic circumscriptional cases like Yidiɲ. Farther afield, these results also converge with the proposal to eliminate other types of circumscription, such as infixation, discussed below in section 2. The overall picture, then, is one in which there is no role for operational prosodic circumscription in linguistic theory, its descriptive effects having been usurped by mechanisms that enjoy strong independent support.

The organization of this article is as follows. In section 2, I introduce the operational circumscription model of McCarthy and Prince (1990a). Section 3 presents and illustrates the premises of Optimality Theory and Correspondence Theory that are essential to the explanation, and sections 4 and 5 apply them to two distinct types of circumscriptional phenomena. Section 6 concludes the article with an overview of the results.

2. Operational Prosodic Circumscription

Operational prosodic circumscription is based on a factoring function Φ(C, E, B) which returns the prosodic constituent C standing at edge E of a base form B (McCarthy and Prince, 1990a).[1] The factors of B given by Φ can be notated as B:Φ for the part that satisfies the (C, E) conditions, called the kernel, and B/Φ for the residue, the complement of B:Φ within B. These terms are combined in the following equation, where "*" gives the relation (normally left- or right-concatenation) that holds between the factors:

(2) Factoring of B by Φ

B = B:Φ * B/Φ

The key idea of operational circumscription is that a morphological operation can target one of the factors in (2) instead of B as a whole. If the kernel, the B:Φ factor, is the target of the morphological operation, then we have positive prosodic circumscription. If the residue, the B/Φ factor, is targeted, then we have negative prosodic circumscription.

The Yidiɲ example in (1) is a typical case of positive prosodic circumscription. The foot standing at the left edge of B is the factor returned by Φ(Ft, Left, B). This foot is subject to a morphological operation of reduplicative copying, so the foot structure of the base determines whether a consonant is copied at the juncture of the second and third syllables.

In general, this means that the result of applying a morphological operation to B under positive prosodic circumscription is the result of applying that operation to just the kernel:

(3) Definition of Operation Applying under Positive Prosodic Circumscription

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

Paraphrastically, to apply O to B under positive prosodic circumscription is to apply O to the kernel, B:Φ, concatenating the result with B/Φ in the same way ("*") that B:Φ concatenates with the residue B/Φ in the base B. In effect, the relation "*" puts the pieces back together, combining the transformed B:Φ factor with the intact B/Φ factor. The following derivations show how the system plays out in Yidiɲ, letting O:Φ stand for the morphological operation of reduplication applied under positive prosodic circumscription:

(4) Application of Positive Prosodic Circumscription to Yidiɲ

a.	i.	O:Φ([múla]$_{Ft}$ ri)	=	O([múla]$_{Ft}$ ri:Φ) * [múla]$_{Ft}$ ri/Φ
	ii.		=	O([múla]$_{Ft}$) * ri
	iii.		=	[múla]$_{Ft}$ [múla]$_{Ft}$ * ri
	iv.		=	[múla]$_{Ft}$ [múla]$_{Ft}$ ri
b.	i.	O:Φ([t^{j}úkar]$_{Ft}$ pan)	=	O([t^{j}úkar]$_{Ft}$ pan:Φ) * [t^{j}úkar]$_{Ft}$ pan/Φ
	ii.		=	O([t^{j}úkar]$_{Ft}$) * pan
	iii.		=	[t^{j}úkar]$_{Ft}$ [t^{j}úkar]$_{Ft}$ * pan
	iv.		=	[t^{j}úkar]$_{Ft}$ [t^{j}úkar]$_{Ft}$ pan

Step (i) shows the basic factoring, with the terms simplified in step (ii). At step (iii), the copy operation O has applied to the Φ-delimited factor, and the terms are reassembled in step (iv).

The main feature of positive prosodic circumscription, then, is that a morphological operation is applied to some prosodic constituent within a base instead of being applied to the whole base. In this way, the morphological operation can show sensitivity to the prosodic structure of its input. This sensitivity is not typical of reduplication (Moravcsik, 1978; Marantz, 1982); compare Lardil parel-pareli, with copying of the l even though it is not part of the initial foot. According to McCarthy and Prince (1990a), Yidiɲ and Lardil differ precisely on this dimension: Yidiɲ reduplicates modulo foot circumscription, while Lardil reduplicates without the intervention of circumscription.

In section 4, I will discuss cases like Yidiɲ that come under the rubric of picking prosodic circumscription.[2] In picking mode, positive prosodic circumscription picks out a prosodic constituent C, such as a foot, that is already present in the simple form. I will argue that a superior account of these systems is available in an Optimality-Theoretic grammar that includes prosodic faithfulness constraints referring to C. These constraints require that certain properties of C be conserved in related forms, leading to a variety of effects that have been wrongly identified with the prosodic circumscription mechanism operating in its picking mode.

In section 5, I analyze an instance of parsing prosodic circumscription, the Arabic broken plural. In operational terms, parsing-mode prosodic circumscription imposes an analysis in terms of a constituent C when no such constituent is already available, because the form being analyzed lacks one (either entirely or at the designated edge). For example, in the McCarthy and Prince (1990a) analysis of Arabic, circumscription parses out an initial trochaic foot from any stem, even a basically iambic one like jaziir(+at). The result is that the prosodic structure of the original form is disregarded, even to the point of splitting a syllable: B:Φ = jazi, B/Φ = ir.

Here I will reject this treatment entirely, showing that a radically different account of these systems is available, based on a proper understanding of faithfulness to moras and autosegmental associations. Details differ, but the core of this proposal recalls some of the insights obtained by Samek-Lodovici (1992, 1993) in analyzing Choctaw. Indeed, the account given here for Arabic generalizes straightforwardly to the Choctaw material.

In the end, these developments lead to the elimination of a special mechanism for positive prosodic circumscription.[3] This follows and extends a result already securely established in the OT literature: the elimination of any special mechanism for negative prosodic circumscription (Prince and Smolensky, 1991, 1993; McCarthy and Prince, 1993ab). In negative prosodic circumscription, a morphological operation targets the residual B/Φ rather than the kernel B:Φ. Thus, negative prosodic circumscription is a kind of extrametricality: a prosodic constituent at some edge is parsed out and the remainder of the word counts as the base for some morphological (or phonological) operation.[4]

Negative prosodic circumscription is often invoked to deal with infixation phenomena like that in Timugon Murut (5):

(5) Infixation in Timugon Murut (Prentice, 1971; McCarthy and Prince, 1993ab)

a. Data

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

b. Circumscriptional Analysis

Φ(Onsetless Syllable, Left), O = Prefix σ_μ (reduplicative prefix)

O/Φ(ompodon)	=	O(ompodon/Φ) * ompodon:Φ
	=	O(podon) * om
	=	popodon * om
	=	ompopodon

The kernel of circumscription is an initial onsetless syllable, if any. It is stripped away, and a reduplicative morpheme is a simple prefix to the residue. From this perspective, infixes are just ordinary prefixes (or suffixes) attached to a base that has been modified by prior negative circumscription.

Though it is surely correct to regard these infixes as basically prefixes, the implementation of this idea in circumscriptional terms is deeply flawed. One problem is that the onsetless syllable must be regarded as a type of prosodic constituent so it can be called on as an argument of Φ. Another, more serious problem is that only reduplicative infixes are located after an initial onsetless syllable (McCarthy and Prince, 1993ab). Circumscription entirely divorces the nature of Φ from the nature of the morphological operation O, and so it cannot explain observed correlations between them. These observations reveal significant failures of the theory of negative circumscription as applied to infixation. They support the investigation of alternatives within OT.

Two key insights underlie the OT approach to infixation developed by Prince and Smolensky and extended by McCarthy and Prince. One, inherited from the circumscriptional treatment, is the idea that infixes are inherently prefixes (or suffixes) which have been minimally displaced from peripheral position by some outside force. Formally, this means that there are constraints of the Alignment family demanding initial (resp. final) placement of prefixes (resp. suffixes). The other factor, the "outside force" demanding non-peripheral affixation, is a higher-ranking constraint of the syllabic markedness family, such as ONSET (Itô, 1989). The following ranking argument shows the crucial constraint interaction.

(6) ONSET >> ALIGN-RED in Timugon Murut

/RED+ulampoy/	ONSET	ALIGN-RED
a. u.u.lam.poy.	** !	
b. ☞ u.la.lam.poy.	*	u

This ranking asserts that the reduplicative affix is located as far to the left as possible (ALIGN-RED), subject to the requirement that it contribute no avoidable onsetless syllables (ONSET).

Obviously, no special PM-specific mechanism of negative circumscription is necessary in such cases. The analysis of Timugon Murut is constructed out of the very stuff of phonological and morphological theory: constraints on syllabic markedness, which are independently needed for language typology; constraints asserting prefixality of these affixes, which any analysis requires in some form or other; and the ranking between the two constraint types, which derives from the notion of factorial typology, central to OT. Furthermore, the role of syllable markedness in forcing infixation provides an explanation for why only reduplicative infixes are placed after an initial onsetless syllable (McCarthy and Prince, 1993a). Operational circumscription offers no illumination of this point, nor can it hope to, since it does nothing more than stipulate the locus of infixation independent of any properties of the form of the infix itself.

For these and other reasons, the mechanism of negative circumscription no longer has a place in current thinking about Prosodic Morphology or prosody generally.[5] Positive circumscription must stand or fall on its own merits; no crutch of negative circumscription is available to prop it up. Here I will argue that positive circumscription should be eliminated from linguistic theory as well. In its place, the analyses here call on independently motivated constraints demanding faithfulness to prosodic structure or prosodic roles. This new view brings out a range of connections and explanations that are superior to those of the operational model, with its (ultimately misconceived) positive/negative symmetry.

3. Prosodic Faithfulness

In Optimality Theory (Prince and Smolensky, 1991, 1993), each grammar is a ranking of the constraints of Universal Grammar. These include the markedness constraints, which militate against structural elaboration of various kinds, and the antagonistic faithfulness constraints, which demand identity of linguistically related forms.

Faithfulness constraints are formulated under Correspondence Theory (McCarthy and Prince, 1993a, 1995a), which posits the following general relation between linguistic forms:

(7) Correspondence

> Given two linguistic forms S_1 and S_2 standing to one another as input and output, base and reduplicant, etc., correspondence is a relation $\Re$ between any subset of elements of S_1 and S_2. Any element α of S_1 and any element β of S_2 are correspondents of one another if $\alpha\Re\beta$.

Each candidate S_2 comes equipped with a correspondence relation which shows how it is the same as or different from S_1. When full explicitness is necessary in a particular example, the correspondence relation is shown by coindexation of correspondent elements in S_1 and S_2.

In addition to this very general idea, common to all implementations of Correspondence Theory, I also adopt certain additional assumptions, as specific answers to the following questions:

(i) What elements of S_1 and S_2 are related by $\Re$?

(ii) What kinds of linguistic forms stand in correspondence with one another? That is, how are S_1 and S_2 related independently of $\Re$?

(iii) What are the faithfulness constraints?

I will take each of these questions in turn. The responses I give are not intended to be exhaustive, but rather to supply a working framework that is sufficient for present purposes, though not comprehensive.

(i) What elements of S_1 and S_2 are related by $\mathfrak{R}$?

If an element stands in correspondence, then it may receive faithful treatment independent of any other elements of the representation. At a minimum, then, correspondence is a relation between segments. Whether or not features stand in correspondence is a subject of current discussion, irrelevant to our concerns here. Of the various prosodic units, the clearest case can be made for correspondence between moras, to account for the broad class of compensatory lengthening phenomena. Below (section 5) I will also present evidence for moraic correspondence based on the analysis of the parsing type of prosodic circumscription. On the other hand, there appears to be no justification for setting up direct correspondence relations among feet or syllables. Instead, faithfulness to feet and perhaps syllables[6] is indirect, mediated by the edge or head segments that make up those constituents. In this implementation of correspondence, then, moras are reified as segment-like entities, but other aspects of prosodic structure are not.

(ii) What kinds of linguistic forms are related by correspondence?

Correspondence Theory was originally conceived as a relation between the base and its reduplicative copy, called the reduplicant (McCarthy and Prince, 1993a). The many parallels between exactness of base-reduplicant (B-R) matching and faithfulness of input-output matching led McCarthy and Prince (1995a) to extend correspondence to the familiar input-output (I-O) faithfulness relation. Benua (1995, 1997) argues that morphologically related output forms must also stand in a transderivational correspondence relation (dubbed O-O, for output-output), to account for phenomena that have previously been attributed to mechanisms like the cycle or strata.[7] A given candidate form, then, may simultaneously have several distinct correspondence relations — with its underlying input, with some related base word, and between reduplicated parts. Separate, and hence separately rankable, faithfulness constraints on each correspondence relation negotiate the demands of faithfulness in the I-O, B-R, and O-O dimensions, which may compete with each other and with markedness constraints.

(iii) What are the faithfulness constraints?

Various constraints of Universal Grammar demand completeness of correspondence or identity of correspondent elements under various conditions. Among them are the anti-deletion faithfulness constraint MAX-seg and its symmetric anti-epenthesis counterpart DEP-seg.

(8) MAX-seg

Every segment in S_1 has a correspondent in S_2. (S_1 and S_2 stand to one another as in (7) above.)

(9) DEP-seg

Every segment in S_2 has a correspondent in S_1.

Other constraints militate against segment coalescence or splitting, metathesis, and featural change (McCarthy and Prince, 1995a). Names of particular constraints also include the correspondence relation involved, so MAX-seg_{IO} and MAX-seg_{OO} are distinguished.

Of particular importance in the current context are prosodic faithfulness constraints. Three types of prosodic faithfulness constraints will be called upon in the course of this work:

•Constraints demanding the conservation of autosegmental association. There is a faithfulness cost to altering autosegmental associations by spreading or delinking. Universal Grammar must therefore include faithfulness constraints which have the effect of conserving autosegmental association. Thus, there are constraints militating against spreading and delinking, with separate constraints for each pair of associated autosegmental tiers. (For instance, the constraint against tone spreading is different from the constraint against place spreading.) From these considerations, we obtain two families of constraints that, respectively, prohibit gain and loss of autosegmental associations:

(10) NO-SPREAD(τ, ς)

Let τ_i and ς_j stand for elements on distinct autosegmental tiers in two related phonological representations S_1 and S_2, where

τ_1 and ς_1 ε S_1,

τ_2 and ς_2 ε S_2,

$\tau_1 \Re \tau_2$, and

$\varsigma_1 \Re \varsigma_2$,

if τ_2 is associated with ς_2,

then τ_1 is associated with ς_1.

(11) NO-DELINK(τ, ς)

Let τ_i and ς_j stand for elements on distinct autosegmental tiers in two related phonological representations S_1 and S_2, where

τ_1 and ς_1 ε S_1,

τ_2 and ς_2 ε S_2,

$\tau_1 \Re \tau_2$, and

$\varsigma_1 \Re \varsigma_2$,

if τ_1 is associated with ς_1,

then τ_2 is associated with ς_2.

The various antecedent conditions limit the relevance of these constraints to situations where τ and ς are present in both S_1 and S_2. If either τ or ς is added or inserted, I assume, the concomitant changes in association lines do not transgress these constraints. It is an empirical question whether this detail of formulation is correct, but it is a reasonable first guess.

Some relevant examples: the (σ, tone) versions of both these constraints are violated in the Kikuyu tone shift process (Clements and Ford, 1979); the ([aspirated], seg) versions of both are violated in forms undergoing Grassmann's Law in Sanskrit (Whitney 1924). Below, in section 5, which deals with prosodic circumscription of the parsing variety, we will see a role for the (μ, seg) versions.

•Constraints demanding conservation of prosodic constituents per se. As I noted above, phenomena like compensatory lengthening show that moras are subject to faithfulness requirements independent of the segments that sponsor them. This fact justifies including moras in the scope of the correspondence relation ℜ, as is necessary for well-definition of the constraints MAX-μ and DEP-μ:

(12) MAX-μ

Every mora in S_1 has a correspondent in S_2.

(13) DEP-μ

Every mora in S_2 has a correspondent in S_1.

These constraints will be important in section 5, when parsing-mode circumscription is discussed.

•Constraints demanding faithfulness to the edges or heads of prosodic constituents. There is nothing like compensatory lengthening at foot level. That is, there are no effects of conservation of feet independent of the segments that make them up.Yet there are surely foot-faithfulness constraints, as the existence of lexical stress systems and other phenomena prove.[8] The key to the difference is this: foot faithfulness is never direct; it is always mediated by segments bearing head or edge roles in the foot.[9]

Rather than MAX and DEP, then, constraints of the Anchoring family (successors to Alignment) are responsible for foot faithfulness. Details of formalization are treated in the appendix; for present purposes, the following will suffice:

(14) ANCHOR-POS(Foot, Foot, P)

where P is one of {Initial, Final, Head}

If $\varsigma_1 \varepsilon S_1$,

$\varsigma_2 \varepsilon S_2$,

$\varsigma_1 \Re \varsigma_2$, and

ς_1 stands in position P of Foot,

then ς_2 stands in position P of Foot.

By anchoring foot to foot, this constraint demands that the $S_1 \rightarrow S_2$ mapping conserve the prosodic position — foot-initial, foot-final, or foot-head — of any corresponding segment.

Below, I will argue that ANCHOR-POS(Ft, Ft, Initial/Final/Head) goes far toward eliminating the need for operational prosodic circumscription. For example, the pattern of reduplication in Yidiɲ (1) is fixed by undominated ANCHOR-POS$_{BR}$(Ft, Ft, F) — any foot-final segment in the reduplicative base must correspond to a foot-final segment in the reduplicative copy. This constraint makes exactly the right distinction: ANCHOR-POS$_{BR}$(Ft, Ft, F) is satisfied by [$\underline{\text{mula}_4}$]$_{Ft}$-[$\underline{\text{mula}_4}$]$_{Ft}$ $\underline{\text{ri}}$ but not by the failed candidate *[$\underline{\text{mula}_4\text{r}_5}$]$_{Ft}$-[$\underline{\text{mula}_4}$]$_{Ft}$ $\underline{\text{ri}}$. This is clearly a reasonable idea: similarity between base and reduplicant is improved if they have similar foot structure. It is also a simple idea: it is nothing more than a straightforward application of familiar Alignment notions combined with equally familiar faithfulness notions. And it is an idea with ample independent support, since such constraints are also required to enforce faithfulness to lexical prosody in the input→output mapping (Alderete, 1996; Bye, 1996; Inkelas, to appear; Itô, Kitagawa, and Mester, 1996; McCarthy, 1996;

Pater, 1995).[10] Yet, as I will now show, this idea is sufficient to account for a range of prosodic circumscription phenomena of the picking type.

4. Prosodic Circumscription as Prosodic Anchoring

Operational prosodic circumscription in the picking mode locates a prosodic constituent (typically a foot) at one edge of a form and then performs a morphological operation on it, such as reduplication or mapping to a template. Here, I will examine several systems that have been analyzed in these terms. I will show that empirically equivalent and explanatorily superior accounts can be obtained by calling on prosodic faithfulness constraints of the form ANCHOR-POS(Ft, Ft, Initial/Final/Head), as proposed in section 3. The cases I will discuss include reduplication in Yidiɲ and mapping to a template in Rotuman and Cupeño. (Yet another case, reduplication in Makassarese, is addressed in McCarthy and Prince (1994ab) and McCarthy (1997).)[11] I conclude this section by summing up the results and arguing that prosodic faithfulness theory constitutes a conceptual advance over operational circumscription theory.

The most straightforward example comes from reduplication in the Australian language Yidiɲ. Recall the following contrast, which shows that foot structure plays a role in determining the well-formedness of the Yidiɲ reduplicant:

(15) Yidiɲ Reduplication

a. [mula$_4$]-[mula$_4$]ri vs. *[mular$_5$]-[mula$_4$]ri

b. [t^{j}ukar$_5$]-[t^{j}ukar$_5$]pa-n vs. *[t^{j}uka$_4$]-[t^{j}ukar$_5$]pa-n

In (a), the initial foot of the base is mula, and the reduplicant consists of a copy of that foot. Likewise, in (b) the foot t^{j}ukar is copied. No condition on the reduplicant alone can account for this distinction; rather, it is a matter of matching the foot structure of the reduplicant with the foot structure of the base.

The operative high-ranking constraint here is ANCHOR-POS$_{BR}$(Ft, Ft, Final), which requires that the base→reduplicant mapping preserve a segment's status as foot-final. This matching of prosodic structures is obtained even at the expense of more complete reduplication of the base's segments, as the following ranking argument proves:

(16) Ranking Argument: ANCHOR-POS$_{BR}$(Ft, Ft, Final) >> MAX-seg $_{BR}$

Candidates	ANCHOR-POS$_{BR}$(Ft, Ft, F)	MAX-seg $_{BR}$
a. ☞ [mula$_4$]-[mula$_4$]ri		**
b. [mular$_5$]-[mula$_4$]ri	*!	*

This candidate-comparison shows that prosodic and segmental faithfulness are both relevant factors in base-reduplicant matching — though only segmental faithfulness is widely recognized as such. Candidate (b) achieves more complete copying than (a) does, but it is not optimal, because the foot-to-foot match is imperfect. Here, prosodic faithfulness takes precedence, through ranking, over segmental faithfulness. A special circumscription operation plays no role; rather, the circumscriptional effect is simply a matter of base-reduplicant identity.

An important detail remains: what about the candidate [múla]ri-[múla]ri, which fully satisfies both ANCHOR-POS$_{BR}$(Ft, Ft, F) and MAX-seg $_{BR}$? The ill-formedness of this candidate is a typical templatic effect, independent of circumscription proper: [múla]ri- is too big as a reduplicant, since Yidiɲ limits the reduplicant to a single foot, which is the minimal word of Yidiɲ. Generalized Template Theory (GTT) (McCarthy and Prince, 1994ab, to appear; Urbanczyk, 1995, 1996ab; Itô, Kitagawa, and Mester, 1996; Gafos, 1996, to appear; Downing, 1998, to appear a, b; Spaelti, 1997) asserts that prosodic-morphological templates are not free-standing constraints or entities,[12] but rather are consequences of particular rankings of constraints that are independently motivated. (This conception of templates also furthers the self-annihilatory goal of Prosodic Morphology mentioned in section 1.) The Yidiɲ minimal-word template can be analyzed in the same way as Diyari, discussed by McCarthy and Prince (1994ab). The minimal word is the most harmonic type of prosodic word: it contains a foot which is properly aligned at both edges and it contains no stray syllables. Thus, through domination of MAX-seg $_{BR}$, constraints on foot alignment and syllable parsing ensure the disyllabicity of the Yidiɲ reduplicant and rule out candidates like [múla]ri-[múla]ri.

Yidiɲ is perhaps the best-known example of operational circumscription, and it yields readily to reanalysis in terms of Anchoring. Two other cases of operational positive circumscription involve mapping B:Φ to a template: the formation of the "incomplete phase" (a kind of morphological category) in Rotuman and the habilitative in Cupeño. The Rotuman phenomenon is exemplified in (17):

(17) Phase in Rotuman (Churchward, 1940)

	Complete	Incomplete	
a. Deletion			
	to.ki.ri	to.kir	‘to roll’
	ti.ʔu	tiʔ	‘big’
	mo.se	mös	‘to sleep’
b. Metathesis			
	se.se.va	se.seav	‘erroneous’
	pu.re	puer	‘to rule’
	pa.ro.fi.ta	pa.ro.fiat	‘prophet’
c. Diphthong Formation			
	pu.pu.i	pu.pui	‘floor’
	ke.u	keu	‘to push’
	jo.se.u.a	jo.se.uɑ	‘Joshua’
d. No Formal Distinction of Phase			
	rī	rī	‘house’
	si.kā	si.kā	‘cigar’

In (a), the incomplete phase is formed by dropping the final vowel, leaving a final heavy CVC syllable. (Syllable boundaries are indicated by “.”.) In (b), the result is also a final heavy syllable, achieved in this case by metathesizing the final CV sequence to yield a diphthongal CVVC syllable. Case (c) shows how a final heterosyllabic V.V sequence is syllabified as tautosyllabic in the incomplete phase, producing a final CVV syllable. Finally, case (d) consists of words with final long vowels, which do not alternate in phase. The choice of how to form the incomplete phase is fully determined by the phonological properties of the complete phase; the relevant factors include whether the complete phase ends in VCV or VV, the quality of the vowels involved, and other considerations (Churchward, 1940; McCarthy, 1996).

Stress in Rotuman falls on the penultimate mora, so stress is on the penultimate syllable in pa.ro.fi.ta and on the final heavy syllable in pa.ro.fiat. The foot type in Rotuman is thus the moraic trochee (Hayes, 1987; McCarthy and Prince, 1986), which consists of exactly two moras, grouped into two light syllables or a single heavy syllable: pa.ro.[fi.ta]$_{\text{Ft}}$, pa.ro.[fiat]$_{\text{Ft}}$. Indeed, a consistent finding is that incomplete-phase words end in a monosyllabic foot — a single heavy syllable parsed as a bimoraic trochee. This generalization cross-cuts the differences among (17a-d).

Schematically, the foot structure of corresponding complete and incomplete phase forms is this:

(18)		Complete	Incomplete
	a.	to.[kí.ri]	to.[kír]
		[tí.ʔu]	[tíʔ]
	b.	se.[sé.va]	se.[séav]
		[pú.re]	[púer]
	c.	pu.[pú.i]	pu.[púi]
		[ké.u]	[kéu]
	d.	[rī́]	[rī́]
		si.[kā́]	si.[kā́]

The relevance of prosodic circumscription to Rotuman is now apparent. There is a templatic requirement on the incomplete phase: it must end in a monosyllabic foot (i.e., a heavy syllable).[13] But this template is imposed only on the segments belonging to the corresponding (usually disyllabic) foot of the complete phase. Syllables outside the foot are not involved in the phase alternation.

In terms of the operational theory of circumscription in McCarthy and Prince (1990a), this phenomenon requires circumscription of the final foot by Φ(Ft, Right) followed by an operation O mapping B:Φ onto a monosyllabic foot template:

(19) Operational Circumscription Applied to to.[kí.ri]$_{Ft}$ → to.[kir]$_{Ft}$

i.	O:Φ(to[kíri]$_{Ft}$)	=	O(to[kíri]$_{Ft}$:Φ) * to[kíri]$_{Ft}$/Φ
ii.		=	O([kíri]$_{Ft}$) * to
iii.		=	[kír]$_{Ft}$ * to
iv.		=	to.[kír]$_{Ft}$

At step (iii), the circumscribed foot is mapped onto a heavy-syllable template, in this case transforming it into a CVC syllable by deleting the final vowel. In other cases, there is metathesis, formation of a diphthong, and so on, as was noted above.

These observations readily lend themselves to an analysis in terms of prosodic faithfulness. The foot of the incomplete phase is a transformed version of the foot in the corresponding complete phase, reliably retaining some properties of that foot (its left edge and head) and often altering others (its right edge). Hence, the constraints ANCHOR-POS(Ft, Ft, Initial) and ANCHOR-POS(Ft, Ft, Head) are undominated. In contrast, the constraint ANCHOR-POS(Ft, Ft, Final) is low-ranking; it is violated systematically in deleting and metathesizing cases like (18a, b). These constraints hold over the O-O correspondence relation, the transderivational correspondence relation between the output form of the complete phase and the output form of the incomplete phase, in accordance with the general program of Benua (1995, 1997).[14] Similarity in foot structure between the complete phase and the incomplete phase is a consequence of obedience to these constraints.

The effects of the high-ranking ANCHOR-POS constraints are most apparent in candidates like the following:

(20) Some Plausible But Failed Incomplete Phase Candidates

a. Complete Phase — b. Incomplete Phase

a. Complete Phase	b. Incomplete Phase	
[r$_1$á$_2$.k$_3$o$_4$]	[r$_1$á$_2$k$_3$]	vs. failed candidate *r$_1$a$_2$.[ó$_4$k$_3$]
he.[l$_3$é$_4$.ʔ$_5$u$_6$]	he.[l$_3$é$_4$ʔ$_5$]	vs. failed candidate *he.l$_3$e$_4$.[ú$_6$ʔ$_5$]

Were it not for ANCHOR-POS, the failed candidates in (b) would be more harmonic than the actual output forms. The reason: all other constraints are, for independent reasons discussed in McCarthy (1996), ranked in a way that favors the failed candidates.

- •The form he.[léʔ] violates MAX-seg and obeys ONSET, while *he.le.[úʔ] obeys MAX-seg and violates ONSET. But we can establish independently that MAX-seg >> ONSET because onsetless syllables are abundantly attested in Rotuman.[15]
- •The form he.[léʔ] also obeys LINEARITY (no metathesis), while *he.le.[úʔ] violates LINEARITY. But we can show independently that MAX-seg >> LINEARITY, because metathesis is preferred to deletion in incomplete-phase formation. Deletion occurs only when metathesis is impossible because the resulting diphthong would violate a congeries of undominated constraints requiring that diphthongs in closed syllables be light and that light diphthongs rise in sonority.[16]

Therefore, we cannot appeal to LINEARITY or ONSET to explain the ill-formedness of *he.le.[úʔ].

Rather, what distinguishes the failed candidate *he.le.[úʔ] from the actual output he.[léʔ] is O-O prosodic faithfulness to the related complete-phase form he.[lé.ʔu]. High-ranking ANCHOR-POS$_{OO}$ ensures the required prosodic match:

(21) ANCHOR-POS$_{OO}$(Ft, Ft, Initial) >> MAX-seg$_{OO}$

com. ph. = he.[l$_3$é$_4$.ʔ$_5$u$_6$]	ANCHOR-POS$_{OO}$(Ft, Ft, Initial)	MAX-seg$_{OO}$
a. ☞ he.[l$_3$é$_4$ʔ$_5$]		*
b. he.l$_3$e$_4$.[ú$_6$ʔ$_5$]	*!	

The incomplete phase form in (21a) is more faithful to the prosody of the corresponding complete phase than its competitor in (21b) is, because in (21a) the foot-initial segments of the complete phase and incomplete phase match.[17]

The ranking in (21) is the core of the circumscriptional effect in Rotuman. Like the Yidiɲ ranking in (16), which it closely resembles, (21) prizes prosodic similarity over segmental similarity. No special mechanism of circumscription is needed, since the matching of foot structure is obtained by faithfulness constraints, no different in kind from those that enforce segmental similarity between the phases.

Another case of circumscription with template-mapping comes from the formation of the habilitative verb in the Uto-Aztecan language Cupeño. When the verb root is consonant-final, the habilitative is constructed by a complex pattern of reduplication:[18]

(22) Cupeño Habilitative (Hill, 1970; McCarthy, 1979, 1984; McCarthy and Prince, 1990a; Crowhurst, 1994)

	Simple Stem	Habilitative	
a.	čál	čáʔaʔal	'husk'
	tə́w	tə́ʔəʔəw	'see'
	həl^{y}ə́p	həl^{y}ə́ʔəʔəp	'hiccup'
	kəláw	kəláʔaʔaw	'gather wood'
	ʔatís	ʔatíʔiʔis	'sneeze'
b.	páčik	páčiʔik	'leach acorns'
	čáŋnəw	čáŋnəʔəw	'be angry'
	čəkúk^{w}il^{y}	čəkúk^{w}iʔil^{y}	'joke'
c.	pínəʔwəx	pínəʔwəx	'sing enemy songs'
	xáləyəw	xáləyəw	'fall'

With oxytone (i.e., end-stressed) roots (22a), the habilitative adds two syllables (italicized) to the simple stem. Each added syllable consists of a ʔ onset and a copy of the last vowel. The root-final consonant remains in place, with the reduplicative action occurring to its left. With paroxytone roots (22b), the habilitative adds a single syllable, which likewise has a ʔ onset and a copy of the last vowel. With proparoxytone roots (22c), the habilitative and the simple stem are identical.

Hill (1970) is responsible for the key insight that all subsequent accounts have tried to refine: the habilitative is based on a target of having two post-stress syllables, and this target is achieved by copying the last vowel as many times as necessary. (The ʔ is provided as a default onset, in conformity with a regular pattern of the language.) This core idea has evolved in various ways:

•McCarthy (1979, 1984): mapping to a template with variable and fixed portions. The template is Xσ́σσ. The variable X licenses the pretonic material, if any, and the σ́σσ sequence determines the shape of the rest of the habilitative.

•McCarthy and Prince (1990a): positive prosodic circumscription and mapping to a fixed template. Every stem is assumed to end with a left-headed foot of one to three syllables: $[\underline{\text{čál}}]_{Ft}$, $\underline{\text{ʔa}}[\underline{\text{tís}}]_{Ft}$, $[\underline{\text{páčik}}]_{Ft}$, $[\underline{\text{pínəʔwəx}}]_{Ft}$. This foot is circumscribed by Φ(Ft, Right), and the B:Φ portion is mapped onto a template consisting of the maximal expansion of this foot, a dactyl $[\acute{\sigma}\sigma\sigma]_{Ft}$.

•Crowhurst (1994): negative prosodic circumscription and mapping to a fixed template. Every stem is argued to begin with an iambic foot of one or two syllables (modulo final-consonant extrametricality): $[\underline{\text{čá}}]_{Ft}\underline{\text{l}}$, $[\underline{\text{pá}}]_{Ft}\underline{\text{čik}}$, $[\underline{\text{kəlá}}]_{Ft}\underline{\text{w}}$, $[\underline{\text{čəkú}}]_{Ft}\underline{\text{k}^{w}\text{il}^{y}}$. This foot is circumscribed by Φ(Ft, Left), and the B/Φ portion is mapped onto a template consisting of a binary foot, $[\sigma\sigma]_{Ft}$.

Though they differ in many ways, these previous accounts have one important property in common: they all take special precautions to ensure that the habilitative template affects only the post-tonic portion of the verb. From the stressed vowel leftward, pre-tonically, the habilitative is identical to the simple stem. In the more recent works, this partitioning of the stem into affected and unaffected portions has been obtained circumscriptionally. In McCarthy and Prince's analysis, the pre-tonic string is hors de combat because it is outside the scope of positive circumscription. And in Crowhurst's analysis, the pre-tonic string is segregated out (together with the stressed syllable) by negative circumscription.

In operational theories like these, circumscription is necessary to protect the pretonic string from being affected by the template. But Optimality Theory offers another way of protecting it:

directly, by faithfulness constraints, which have no counterpart in operational theories. If we rely on Crowhurst's well-motivated assumptions about Cupeño prosody,[19] then it is apparent that the habilitative contains a (mostly) faithful reproduction of the initial foot of the basic stem:

(23) Prosodic Faithfulness in the Cupeño Habilitative

	Simple Stem	Habilitative
a.	[$\check{c}_1\acute{a}_2$l]	[$\check{c}_1\acute{a}_2$][ʔaʔal]
	[kə$l_3\acute{a}_4$w]	[kə$l_3\acute{a}_4$][ʔaʔaw]
	[ʔa$t_3\acute{\imath}_4$s]	[ʔa$t_3\acute{\imath}_4$][ʔiʔis]
b.	[$p_1\acute{a}_2$]čik	[$p_1\acute{a}_2$][čiʔik]
	[čə$k_3\acute{u}_4$]k^wil^y	[čə$k_3\acute{u}_4$][k^wiʔil^y]
c.	[$p_1\acute{\imath}_2$]nəʔwəx	[$p_1\acute{\imath}_2$][nəʔwəx]

The left-aligned, mono- or disyllabic foot of the basic stem is preserved unchanged in the habilitative, except for displacement of the stem-final consonant in (a). The habilitative is otherwise dramatically different from the basic stem, since it adds a second, disyllabic foot. By virtue of high-ranking prosodic faithfulness constraints, the disyllabic foot template added in the habilitative is not permitted to disrupt the foot inherited from the basic stem. What circumscription does indirectly, prosodic faithfulness does directly, and it does so without the liabilities that circumscription brings, such as the duplication of effort that will be made apparent below in (26).

This is the essential element of the analysis of Cupeño. It is nothing but a straightforward application of the same ideas called on in Yidiɲ and Rotuman. As the co-indexation of correspondent elements in (23) shows, the segments of the stressed syllable in the simple stem stand in correspondence with segments in the stressed syllable in the habilitative. Thus, ANCHOR-POS(Ft, Ft, Head) is unviolated and undominated.[20]

A particularly striking effect of ANCHOR-POS can be observed from its interaction with the anti-epenthesis constraint DEP-seg. The habilitative [kəl$_3$á$_4$][ʔaʔaw] has a total of two epenthetic syllables containing four epenthetic segments, the two default ʔ's and the two copied a's. Now compare this form to the failed candidate *[kə́][l$_3$a$_4$ʔaw], which avoids epenthesizing an entire syllable by moving stress onto the initial syllable. The problem with this candidate does not lie with prosody per se — compare the prosodically identical form [č$_1$á$_2$][ʔaʔal]. Rather, what's wrong with *[kə́][l$_3$a$_4$ʔaw] is that it is prosodically unfaithful to the simple stem [k$_1$əl$_3$á$_4$w], because the segments of the head syllable in the simple stem do not stand in correspondence with segments in the head syllable of the habilitative. The following tableau completes the argument:

(24) ANCHOR-POS(Ft, Ft, Head) >> DEP-seg

[k$_1$ə$_2$l$_3$á$_4$w]	ANCHOR-POS(Ft, Ft, Head)	DEP-seg[21]
a. ☞ [k$_1$ə$_2$l$_3$á$_4$][ʔaʔaw]		****
b. [k$_1$ə́$_2$][l$_3$a$_4$ʔaw]	*!	**

This ranking argument emphasizes that prosodic faithfulness in the stem→habilitative mapping may be purchased at a cost in segmental faithfulness, such as epenthesis.

We have seen, then, that the segments of the foot-heading or stressed syllable must stand in correspondence in the stem and habilitative. Foot-finally, though, a mismatch is possible. ANCHOR-POS(Ft, Ft, Final) is violated by the habilitative of oxytone stems, as can be seen from (23a). The responsible constraint here is a different kind of Anchoring — one that is more in the nature of classic MCat-PCat alignment effects. Specifically, ANCHOR-POS(Stem, Word, Final) must dominate ANCHOR-POS(Ft, Ft, Final), as the following tableau shows:

(25) ANCHOR-POS(Stem, Word, Final) >> ANCHOR-POS(Ft, Ft, Final)

[č$_1$á$_2$l$_3$]	ANCHOR-POS(Stem, Wd, Final)	ANCHOR-POS(Ft, Ft, Head)
a. ☞ [č$_1$á$_2$] [ʔaʔal$_3$]		*
b. [č$_1$á$_2$l$_3$] [ʔaʔa]	*!	

Hence, absolutely perfect foot-faithfulness is not always achieved — it suffers when it would run afoul of right-edge stem alignment. Effects like this, here attributed to ANCHOR-POS(Stem, Wd, Final), are familiar from the literature on Alignment constraints (and earlier from extrametricality-based approaches like Crowhurst's). For example, the constraints dubbed ALIGN-L and ALIGN-R have very similar edge-preserving consequences in the phonologies of Axininca Campa and Lardil.[22]

To sum up, undominated ANCHOR-POS(Ft, Ft, Head) accounts for the inertia of the stem-initial foot in forming the habilitative. The habilitative template must be satisfied without altering the headedness or segmental contents of the initial foot (except for a stem-final consonant, whose disposition falls to undominated ANCHOR-POS(Stem, Word, Final)).

In Crowhurst's (1994) analysis, by comparison, inertia of the initial foot is a matter of negative circumscription. Here is how she derives the habilitative of some representative oxytone and paroxytone roots:

(26) Negative Circumscription in Cupeño (Simplified from Crowhurst (1994: (17)))

a. Basic Stem

```
Ft                    Ft
|                    / \
σ                   σ   σ
|\                  |\ /|\
pá čik              kə láw
```

b. Final Consonant Extrametricality: B/Φ(C, Right)

```
Ft                    Ft
|                    / \
σ                   σ   σ
|\                  |\ /|
pá či {k}           kə lá {w}
```

c. Negative Prosodic Circumscription of Initial Foot: Φ(Ft, Left)

```
 Ft                    Ft
 |                    / \
 σ                   σ   σ
 |\                  |\ /|
{pá} či {k}         {kə lá} {w}
```

d. Left-to-right Mapping of B/Φ to $[\sigma\sigma]_{Ft}$ Template

```
 Ft    Ft             Ft    Ft
 |      /\           /  \    /\
 σ    σ  σ           σ   σ σ  σ
 |\  /|              |\ /|
{pá} či   {k}       {kə lá}    {w}
```

e. Spreading from B/Φ to Satisfy $[\sigma\sigma]_{Ft}$ Template

```
 Ft    Ft             Ft    Ft
 |      /\           /  \    /\
 σ    σ  σ           σ   σ σ  σ
 |\  /|/             |\ /|
{pá} či   {k}       {kə lá}    {w}
```

f. Restore B:Φ Portion and Proceed Again with Spreading Step (e)

```
Ft   Ft              Ft    Ft
|    /\             /  \   /\
σ   σ  σ            σ   σ σ  σ
|\ /|/              |\ /|/ /
pá či   {k}         kə la    {w}
```

g. Restore Extrametrical Consonant

```
Ft   Ft              Ft    Ft
|    /\             /  \   /\
σ   σ  σ            σ   σ σ  σ
|\ /|/  \           |\ /|/ / \
pá či   k           kə lá     w
```

Inactivity of the initial foot is obtained by negative circumscription at step (c). In this way, the initial foot and its contents are temporarily removed from consideration, leaving template satisfaction to any post-tonic segments in steps (d) and (e).

This is the main idea of the circumscriptional analysis, but it is buttressed by an auxiliary assumption that renders the overall package somewhat less attractive. With oxytones like kəláw, consonant extrametricality and negative circumscription leave no visible segments whatsoever, and so there is nothing to map onto the template at steps (d) and (e). This is the reason for step (f), which attempts vowel spreading again after the negatively circumscribed material has been restored. The problem revealed here is that operational circumscription goes too far; it has a protective effect on the initial foot, as desired, but it also has the undesirable consequence of rendering the contents of the initial foot entirely inaccessible to phonological manipulation. Merely copying the stressed vowel does no violence to the initial foot, but negative circumscription, over-protectively, bans even that. In contrast, the prosodic faithfulness constraints require only that the initial foot be preserved intact; they say nothing about processes, such as vowel copying, that do not and can not affect the initial foot. Hence, a significant complication in the circumscriptional analysis is avoided.

Having sketched an analysis of Cupeño based on prosodic faithfulness and having presented some reasons to prefer it to alternatives, I now need to clear up a few remaining details. The matters to be addressed are these:

(i) The stem→habilitative correspondence relation.

(ii) The nature of the template.

(iii) The choice of epenthetic material.

(i) The correspondence relation. In Cupeño, many roots have lexical stress, nearly always on the first or second syllable. Except in compounds, the lexical stress of roots emerges faithfully on the surface, by virtue of high-ranking I-O prosodic faithfulness constraints (Alderete, 1996). For instance, surface [kəláw] is derived from underlying /[kəláw]/, with faithful preservation of the underlying foot structure. This leads to a question: in tableaux like (24), is ANCHOR-POS enforcing prosodic faithfulness on the I→O mapping (/[kəláw]/→[kəlá][ʔaʔaw]) or the O→O mapping [kəláw]→[kəlá][ʔaʔaw]? Equivalently, is this a faithfulness effect of the familiar type or a transderivational one of the type studied by Benua (1995, 1997) and exemplified above in Rotuman?

Decisive evidence comes from roots that are underlyingly unaccented. Unaccented roots can be diagnosed by the fact that they are unstressed in the presence of an accented affix; otherwise, accented roots take precedence over accented affixes. (See Alderete (1996) for discussion and analysis.) By this criterion, the root /təw/ 'see' is unaccented, though it receives default initial stress, surfacing as [tə́w] when not in the presence of an accented affix. Significantly, the habilitative of /təw/→[tə́w] is [tə́][ʔəʔəw] — just like the habilitative [čá][ʔaʔal] from the accented root /[čál]/→[čál]. Unaccented and accented roots, which are distinguished in the input and identical in the output, form their habilitatives in exactly the same way. This fact proves that prosodic faithfulness is enforced on an O-O correspondence relation between the output form of the simple stem and the output form of the habilitative, and the constraint involved should properly be called ANCHOR-POS_{OO}(Ft, Ft, Head).

(ii) The template. The habilitative consists of two feet. The first, which is mono- or disyllabic, is faithfully inherited from the simple stem. The second, which is always disyllabic, is added in response to some constraints whose force is limited to the habilitative. Under GTT, we must locate those constraints of Universal Grammar which explain why the added foot is disyllabic and why it is added at all.

The added foot is disyllabic to satisfy FT-BIN, foot binarity (Prince, 1980; McCarthy and Prince, 1986; Hayes, 1995), which demands that all feet be disyllabic (or bimoraic, in quantity-sensitive systems). True, FT-BIN is little honored in Cupeño, since faithful treatment of lexically specified feet takes precedence (Crowhurst, 1994; Alderete, 1996). But the added foot of the habilitative has no faithfulness commitments to honor; it is created ex nihilo. By the logic of emergence of the unmarked (McCarthy and Prince, 1994a), novel structures that have no faithfulness commitments will satisfy markedness constraints that inherited structures, bound by faithfulness, routinely violate. The added foot in the habilitative is binary because binary feet are good, by FT-BIN.

The overall structure of the habilitative is bipodal. This is reminiscent of zuuja-go secret language forms in Japanese. Itô, Kitagawa, and Mester (1996) propose that zuuja-go bipodality is an effect of NON-FINALITY, which requires that the head foot be foot-wise non-final (i.e., that it be followed by another foot). The same idea can be recruited in Cupeño: the head foot, which has an overt stress, is rendered non-final in the habilitative by supplying another foot to follow it. The situation is much like the placement of main stress in English, except that it is limited to a specific morphological category instead of extending to the whole language.

(iii) Epenthesis. The choice of epenthetic material for added syllables in the habilitative is also a consequence of emergence of the unmarked. The onset is the default ʔ, which satisfies markedness constraints that other consonants violate. The nucleus is filled by epenthesizing a root node and spreading a place node from the preceding vowel. Beckman (1995) and Alderete et al. (1997) propose that spreading is favored for markedness reasons, because markedness is evaluated on autosegmental units rather than their individual segmental projections.

In principle, the same result could have been achieved by spreading a consonant and inserting a default vowel, yielding *čáčəčəl, or by spreading both vowel and consonant, yielding *čáčačal. These outcomes seem impossible, not merely in Cupeño but universally. The property that unites them in impossibility is spreading of a consonant across a vowel. Arguably, this is not met with in any language. (For relevant discussion, see Clements and Hume (1995) and Gafos (1996, to appear).)

To sum up, I have argued that inertia of the stem-initial foot in forming the Cupeño habilitative is a consequence of high-ranking prosodic faithfulness constraints. This account is superior to a circumscriptional analysis because the latter goes too far, making the initial foot entirely invisible to the phonology, even though visibility for copying purposes is required. The comparison between prosodic faithfulness and operational circumscription is unusually direct and probative in Cupeño, offering strong support for the overall program pursued here.

In this section, I have shown how ANCHOR-POS constraints, which require forms to match in specific aspects of prosodic constituency, take on much of the descriptive burden of operational prosodic circumscription. From this perspective, circumscriptional phenomena are seen in terms of prosodic faithfulness rather than successive steps of constituent parsing, performing an operation on that constituent, and then putting the pieces back together.

The approach based on Anchoring appears to be at least as successful empirically as the operational circumscription model. As far as explanation goes, it is surely superior, since it accounts without special pleading for the case of Cupeño, which has never been satisfactorily analyzed in operational terms. More broadly, the connection made between circumscriptional phenomena and faithfulness reveals a truth that the operational model obscured: that circumscription is really a matter of ensuring particular kinds of prosodic similarity between reduplicant and base or within partial paradigms. Thus, this account brings with it interesting connections to the theory and practice of faithfulness, connections that the more parochial notion of operational prosodic circumscription cannot provide. In the end, then, these results support the ultimate goal of the theory of Prosodic Morphology, since they lead to the elimination of the PM-specific device for picking-mode prosodic circumscription in favor of faithfulness constraints, which are surely independently necessary in OT.

5. Prosodic Circumscription as Moraic Faithfulness: The Arabic Broken Plural

We turn now to prosodic circumscription in the parsing mode, of which the Arabic broken plural (McCarthy and Prince, 1990a) is the classic exemplar. In the Φ-parsing stage, a foot is extracted from the base even at the expense of disrupting any pre-existing prosodic analysis; in the limit, even individual syllables may be split up. Subsequent events then proceed just as they do in the simpler picking-mode cases. The Arabic plural, like the similar Choctaw phenomenon (Lombardi and McCarthy, 1991; Hung, 1992; Samek-Lodovici, 1992, 1993), calls on the full power of a serial derivation in the operational model, and therefore it presents a particular challenge to the constraint-based approach advocated here. The approach taken here to Arabic is inspired by Samek-Lodovici's work on Choctaw, though of course details are different.

The data of interest, the iambic plural and diminutive pattern, are as follows:

(27) Arabic Iambic Broken Plural and Diminutive

Sg.	Pl.	Dim.	
a. CvCC Singular Nouns			
nafs	nufuus	nufays-at	‘soul’
qidħ	qidaaħ	qudayħ	‘arrow’
ħukm	ʔaħkaam	ħukaym	‘judgment’
b. CvCvC Singular Nouns			
ʔasad	ʔusuud	ʔusayd	‘lion’
rajul	rijaal	rujayl	‘man’
ʕinab	ʔaʕnaab	ʕunayb	‘grape’
c. CvCvvC+at Singular Nouns			
saħaab+at	saħaaʔib	suħayyib	‘cloud’
jaziir+at	jazaaʔir	juzayyir	‘island’
kariim+at	karaaʔim	kurayyim	‘noble’
ħaluub+at	ħalaaʔib	ħulayyib	‘milch-camel’
d. CvvCvC+at Singular Nouns			
faakih+at	fawaakih	fuwaykih	‘fruit’
ʔaanis+at	ʔawaanis	ʔuwaynis	‘cheerful’
e. CvvCv(v)C Singular Nouns			
xaatam	xawaatim	xuwaytim	‘signet-ring’
jaamuus	jawaamiis	juwaymiis	‘buffalo’
f. CvCCv(v)C Singular Nouns			
jundub	janaadib	junaydib	‘locust’
sulṭaan	salaaṭiin	sulayṭiin	‘sultan’

In keeping with the overall aims of this article, I will focus here on the principal motivation for circumscription: the relation between the prosodic structure of the singular noun and its plural or diminutive. There are many details to be considered in a full account; see McCarthy and Prince (1990a).

The core of the operational analysis of Arabic is circumscription of a bimoraic sequence — the foot type known as a moraic trochee — at the left edge of the singular stem. Thus, the circumscriptional operation is $\Phi(\underline{Ft_{\mu\mu}}, \underline{Left})$. Typically, Arabic stems do not begin with such a foot, and sometimes they begin with a light-heavy sequence that cannot be matched with a bimoraic foot. But prosodic circumscription in the parsing mode has no regard for such niceties. Its force may be particularly observed in cases like (28d), where the $\underline{B}$:Φ portion does not even correspond to a whole number of syllables in the singular stem:

(28) Formal Treatment Circumscriptionally

	Sg.	BΦ	B/Φ	Pl.	Dim.
a.	nafs	naf	s	nufuus	nufays-at
	ʔasad	ʔasa	d	ʔusuud	ʔusayd
b.	jundub	jun	dub	janaadib	junaydib
	sulṭaan	sul	ṭaan	salaaṭiin	sulayṭiin
c.	xaatam	xaa	tam	xawaatim	xuwaytim
	jaamuus	jaa	muus	jawaamiis	juwaymiis
d.	saħaab-at	saħa	ab	saħaaʔib	suħayyib
	jaziir-at	jazi	ir	jazaaʔir	juzayyir
e.	kuttaab	kut	taab	kataatiib	kutaytiib
	jilbaab	jil	baab	jalaabiib	julaybiib

Once the <u>B</u>:Φ portion has been extracted, it is mapped onto a light-heavy iambic foot template. The form is then reassembled and adjustments are made in the vocalism (which will not be considered further here).

Operational circumscription lays claim to three principal descriptive results in the analysis of Arabic. First, circumscription protects the <u>B</u>/Φ portion from alteration by the template. That effect is clearest in the contrast between <u>jundub</u>/<u>janaadib</u> and <u>sulṭaan</u>/<u>salaaṭiin</u> (28b) — the weight of the final syllable is preserved in the mapping from singular to plural, despite the havoc the iambic template wreaks on the rest of the form. More subtly, the protected <u>B</u>/Φ factor consists of a syllable fragment like <u>ab</u> in <u>saħaab+at</u> (28d), and this fragment is preserved (with an epenthetic onset) in the corresponding plural <u>saħaaʔib</u>. Second, there is a more abstract effect of circumscription that can be seen from a contrast in the distribution of epenthetic consonants in (28c, d). In <u>xaatam</u>/<u>xawaatim</u>, the circumscribed portion <u>xaa</u> contains just a single root consonant, <u>x</u>, so the templatic portion <u>xawaa</u> is supplied with an epenthetic consonant <u>w</u>.[23] But in <u>saħaab+at</u>/<u>saħaaʔib</u>, the circumscribed portion <u>saħa</u> contains two root consonants, and then the epenthetic consonant appears in the <u>B</u>/Φ portion. Third, circumscription gives a principled account of why plural/diminutive formation conserves spreading of a root consonant, as in (28e) — even to the point of swapping local spreading for long-distance (<u>kuttaab</u> → <u>kataatiib</u>).

Here I will argue that these empirical consequences of operational circumscription can also be obtained from prosodic faithfulness constraints in OT. The preservation of the weight of the final syllable is a typical prosodic faithfulness effect — a consequence of high-ranking MAX-μ and DEP-μ. The contrast in position of the epenthetic consonant — <u>xawaatim</u> versus <u>saħaaʔib</u> — and the conservation of consonantal spreading are also a matter of faithfulness, but in this case it is faithfulness to autosegmental associations. Both are effects of preserving corresponding segment-to-mora linkage — that is, they are anti-spreading, anti-delinking faithfulness effects of the type that are commonplace in tone systems. In this way, the peculiarities of Arabic plural formation are derived from the activity of universal constraints rather than a parochial mechanism of circumscription.

Before these results can be secured, though, it is necessary to develop a fuller picture of the prosodic structure and the correspondence relations in the singular → plural/diminutive mapping. As I noted above (section 3), both moras and segments stand in correspondence. As a notational convenience, superscripted indices will be used for the mora-to-mora correspondence relation and subscripted indices for the segment-to-segment correspondence relation. Thus, the jundub → janaadib mapping can be characterized as follows:[24]

(29) jundub → janaadib Correspondence Relations

Singular Plural

These representations reflects several assumptions I am making to simplify the discussion:

- Onsets are linked to the nuclear mora, forming CV moraic sequences (Hyman, 1985; Itô, 1986, 1989; Zec, 1988; etc.).
- Final consonants are extrametrical, not participating in the prosody of the stem as a whole (as in McCarthy and Prince (1990ab)).
- The "added" mora in janaadib appears at the end of the second syllable. In (29), this mora is shown without a superscript, since it lacks a correspondent in the singular.[25] In the diminutive, this mora has an attached y: juna**y**dib.

•Because vowel melodies are prescribed for the plural and diminutive, the vowels of jundub and janaadib are not in correspondence with one another (and so are shown without subscripts).

These assumptions are not absolutely indispensable, but they (especially the first) greatly simplify the working-out of the proposal.

For compactness, tree structures like (29) can be folded into a single string combining super- and subscripts, with the ligature connecting shared CV moras. In this way, we obtain the following summary of the correspondence relations holding between singulars and plurals:

(30) Singular → Plural Correspondence Relations

a. nafs/nufuus

$$\overset{\frown}{n_1 a^1}\ f_3{}^2\ s_4 \quad \Rightarrow \quad \overset{\frown}{n_1 u^1}\ \overset{\frown}{f_3 u^2}ː\ s_4$$

b. ʔasad/ʔusuud

$$\overset{\frown}{ʔ_1 a^1}\overset{\frown}{s_3 a^2}d_5 \quad \Rightarrow \quad \overset{\frown}{ʔ_1 u^1}\ \overset{\frown}{s_3 u^2}ː\ d_5$$

c. jundub/janaadib

$$\overset{\frown}{j_1 u^1}\ n_3{}^2\ \overset{\frown}{d_4 u^3}\ b_6 \quad \Rightarrow \quad \overset{\frown}{j_1 a^1}\ \overset{\frown}{n_3 a^2}ː\ \overset{\frown}{d_4 i^3}\ b_6$$

d. sulṭaan/salaaṭiin

$$\overset{\frown}{s_1 u^1}\ l_3{}^2\ \overset{\frown}{ṭ_4 a^3}ː^4\ n_6 \quad \Rightarrow \quad \overset{\frown}{s_1 a^1}\ \overset{\frown}{l_3 a^2}ː\ \overset{\frown}{ṭ_4 i^3}ː^4\ n_6$$

e. xaatam/xawaatim

$$\overset{\frown}{x_1 a^1}ː^2\ \overset{\frown}{t_3 a^3}\ m_5 \quad \Rightarrow \quad \overset{\frown}{x_1 a^1}\ \overset{\frown}{w a^2}ː\ \overset{\frown}{t_3 i^3}\ m_5$$

f. jaamuus/jawaamiis

$$\overset{\frown}{j_1 a^1}ː^2\overset{\frown}{m_3 u^3}ː^4 s_5 \quad \Rightarrow \quad \overset{\frown}{j_1 a^1}\ \overset{\frown}{w a^2}ː\ \overset{\frown}{m_3 i^3}ː^4\ s_5$$

g. jaziir(+at)/jazaaʔir

$$\overset{\frown}{j_1 a^1}\ \overset{\frown}{z_3 i^2}ː^3\ r_5 \quad \Rightarrow \quad \overset{\frown}{j_1 a^1}\ \overset{\frown}{z_3 a^2}ː\ \overset{\frown}{ʔ i^3}\ r_5$$

With these preliminaries out of the way, the goal of the analysis can now be described exactly: to characterize the mapping in (30) in terms of a hierarchy of universal constraints, with a focus on faithfulness.

The correspondence relation shown in (30) is of the transderivational or O-O type, since the connection is between output forms of singular and plural, rather than between the output plural and the underlying consonantal root (McCarthy and Prince, 1990a). Two kinds of faithfulness constraints are relevant to this mapping: faithfulness to the elements standing in correspondence (segments and moras), and faithfulness to the autosegmental association relations between these elements. Faithfulness to segments and moras is a matter of obedience to constraints like MAX-seg, DEP-seg, MAX-μ, and DEP-μ. Faithfulness to autosegmental association involves obeying NO-DELINK and NO-SPREAD (see section 3 above). In Arabic, the autosegmental associations of interest are between segments and moras in a representation like (29). The constraints demanding conservation of these associations are therefore NO-DELINK(μ, seg) and NO-SPREAD(μ, seg). These constraints, which must in any case be part of Universal Grammar, are all that we require to explain the main properties of the Arabic plural.

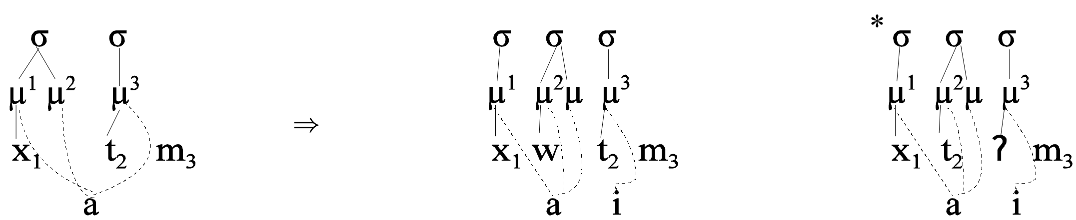
One of the main descriptive results claimed for the operational circumscription model is conservation of the final syllable's weight (see (30c, d, e, f)). From the perspective of OT, this is just faithfulness to moras in the singular→plural mapping. MAX-μ_{OO} is undominated in Arabic; DEP-μ_{OO} is violated only by virtue of the the added mora (an affix) in the plural. In short, failed candidates like *janaadiib (for jundub/janaadib) or *salaaṭin (for sulṭaan/salaaṭiin) present no difficulties; they are straightforward consequences of the high-ranking μ-faithfulness constraints.

Another descriptive result claimed for the operational model is the account of the distribution of epenthetic consonants in the plural. It can be seen by comparing (30e, f) to (30g) — the singulars differ only in the locus of the bimoraic syllable relative to the second root consonant, and this somehow translates into a difference in placement of the epenthetic consonant in the plural. To put the matter in terms of candidate selection, it is necessary to explain why the plural of xaatam is xawaatim and not *xataaʔim and likewise why the plural of jaziir+at is jazaaʔir and not *jawaazir.

The representations in (31) show how this contrast plays out in the singular/plural O-O correspondence relation:

(31) Correspondence Relations in xaatam → xawaatim, *xataaʔim

Singular | Actual Plural | Failed Candidate



xaatam | xawaatim | *xataaʔim

The problem with the failed candidate is that it has undergone a kind of reassociation or "flop" process relative to the singular: correspondence-wise, t_2 of the failed candidate is linked to a different mora than in the singular. This is a violation of NO-DELINK$_{OO}$(μ, seg) and NO-SPREAD$_{OO}$(μ, seg), which militate against loss and gain of association lines, respectively. All of the interesting cases in (30e–g) can be subsumed under the same rubric. Here they are, with the epenthetic consonant indicated by C and the locus of flop italicized:

(32) Role of NO-DELINK$_{OO}$(μ, seg) and/or NO-SPREAD$_{OO}$(μ, seg)

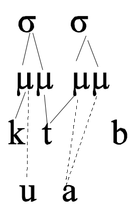
	Singular	Plural	Failed Plural Candidate
e. xaatam/xawaatim			
	$\overset{\frown}{x_1a}{}^1\text{ː}^2\ \overset{\frown}{t_3a}{}^3\ m_5$	$\overset{\frown}{x_1a}{}^1\ \overset{\frown}{Ca}{}^2\text{ː}\ \overset{\frown}{t_3i}{}^3\ m_5$	$*\overset{\frown}{x_1a}{}^1\ \underline{\overset{\frown}{t_3a}{}^2}\text{ː}\ \overset{\frown}{Ci}{}^3\ m_5$
f. jaamuus/jawaamiis			
	$\overset{\frown}{j_1a}{}^1\text{ː}^2\overset{\frown}{m_3u}{}^3\text{ː}^4s_5$	$\overset{\frown}{j_1a}{}^1\ \overset{\frown}{Ca}{}^2\text{ː}\ \overset{\frown}{m_3i}{}^3\text{ː}^4\ s_5$	$*\overset{\frown}{j_1a}{}^1\ \underline{\overset{\frown}{m_3a}{}^2}\text{ː}\ \overset{\frown}{Ci}{}^3\text{ː}^4\ s_5$
g. jaziir(+at)/jazaaʔir			
	$\overset{\frown}{j_1a}{}^1\ \overset{\frown}{z_3i}{}^2\text{ː}^3\ r_5$	$\overset{\frown}{j_1a}{}^1\ \overset{\frown}{z_3a}{}^2\text{ː}\ \overset{\frown}{Ci}{}^3\ r_5$	$*\overset{\frown}{j_1a}{}^1\ \overset{\frown}{Ca}{}^2\text{ː}\ \underline{\overset{\frown}{z_3i}{}^3}\ r_5$

The paired successful and failed candidates in (32) differ only in the placement of the epenthetic consonant; they do not differ in any respect that is relevant to the other constraints, such as moraic or segmental faithfulness. This means that NO-DELINK$_{OO}$(μ, seg) and/or NO-SPREAD$_{OO}$(μ, seg) will settle the matter in favor of the actual output form no matter how they are ranked. In this way, we explain the second main empirical result claimed by the operational model: the complex dependency between the distribution of light and heavy syllables in the singular and the distribution of epenthetic consonants in the plural.

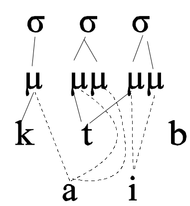
The third main descriptive result that the operational model obtains in Arabic involves the conservation of consonantal spreading. Formation of the plural and diminutive preserves consonantal spreading from the singular, even when original geminates must become long-distance linked structures:

(33) Effect of Consonantal Spreading in Operational Circumscription

Singular   B:Φ   B/Φ   Plural



⇒ kut   taab ⇒

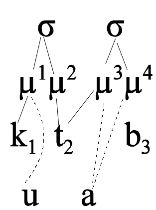


kuttaab   kataatiib

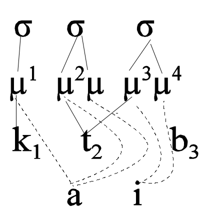
In these spreading configurations, a single consonant occupies more than one syllabic position, either locally or long-distance. Since segmental correspondence is a relation between root-nodes, there is just one root-node t̲ in the singular in (33) standing in correspondence with just one root-node t̲ in the plural:

(34) O-O Correspondence Relations in Spreading Configurations

Singular   Plural



⇒



Or more compactly:

(35) Principal Cases of Spreading in Singular/Plural Pairs

Singular	Plural
a. baSS/buSuus (common, productive, N > 100)	
$\overset{\frown}{b_1a}{}^1\ S_3{}^2\ S_3$	$\overset{\frown}{b_1u}{}^1\ \overset{\frown}{S_3u}{}^2\text{ː}\ S_3$
b. jilbaab/jalaabiib (uncommon, N < 30)	
$\overset{\frown}{j_1i}{}^1\ l_3{}^2\ \overset{\frown}{b_4a}{}^3\text{ː}^4\ b_4$	$\overset{\frown}{j_1a}{}^1\ \overset{\frown}{l_3a}{}^2\text{ː}\ \overset{\frown}{b_4i}{}^3\text{ː}^4\ b_4$
c. kuttaab/kataatiib (common, productive, N > 100)	
$\overset{\frown}{k_1u}{}^1\ t_3{}^2\ \overset{\frown}{t_3a}{}^3\text{ː}^4\ b_5$	$\overset{\frown}{k_1a}{}^1\ \overset{\frown}{t_3a}{}^2\text{ː}\ \overset{\frown}{t_3i}{}^3\text{ː}^4\ b_5$
d. tinniin/tanaaniin (rare, N < 5)	
$\overset{\frown}{t_1i}{}^1\ n_3{}^2\ \overset{\frown}{n_3i}{}^3\text{ː}^4\ n_3$	$\overset{\frown}{t_1a}{}^1\ \overset{\frown}{n_3a}{}^2\text{ː}\ \overset{\frown}{n_3i}{}^3\text{ː}^4\ n_3$

This conservation of autosegmental spreading in the singular→plural mapping follows from the μ-faithfulness constraints NO-DELINK$_{OO}$(μ, seg) and NO-SPREAD$_{OO}$(μ, seg). The former ensures that spreading in the singular is maintained in the plural. The latter, by dominating DEP-seg$_{OO}$, accounts for the fact that spreading is not normally an option in onset-filling situations.[26] Compare:

(36) Spreading in Singular ⇒ Spreading — Not Epenthesis — in Plural

kuttaab	kataatiib	
$k_1\ u^1\ t_3{}^2\ t_3\ a^3\text{ː}^4\ b_5$	$k_1\ a^1\ \underline{t_3}\ \underline{a^2\text{ː}}\ t_3\ i^3\text{ː}^4\ b_5$	(with preservation of spread t)
	$*k_1\ a^1\ \underline{t_3}\ \underline{a^2\text{ː}}\ \underline{ʔ}\ i^3\text{ː}^4\ b_5$	(with epenthetic ʔ)

(37) No Spreading in Singular ⇒ Epenthesis — Not Spreading — in Plural

a. xaatam	xawaatim	
$x_1\ a^1\text{ː}^2\ t_3\ a^3\ m_5$	$x_1\ a^1\ \underline{w}\ \underline{a^2\text{ː}}\ \underline{t_3}\ i^3\ m_5$	(with epenthetic w)
	$*x_1\ a^1\ \underline{t_3}\ \underline{a^2\text{ː}}\ \underline{t_3}\ i^3\ m_5$	(with spreading of root-medial t)
	$*x_1\ a^1\ t_3\ a^2\text{ː}\ \underline{m_5}\ \underline{i^3}\ \underline{m_5}$	(with spreading of root-final m)

b. <u>jaziir(+at)</u> <u>jazaaʔir</u>

$j_1\ a^1\ z_3\ i^{2}\text{ː}^{3}\ r_5$	$j_1\ a^1\ \underline{z}_3\ \underline{a^2\text{ː}}\ \underline{\text{ʔ}}\ i^3\ r_5$	(with epenthetic $\underline{\text{ʔ}}$)
	$*j_1\ a^1\ \underline{z}_3\ \underline{a^2\text{ː}}\ \underline{z}_3\ i^3\ r_5$	(with spreading of root-medial $\underline{z}$)
	$*j_1\ a^1\ z_3\ a^2\text{ː}\ \underline{r}_5\ \underline{i^3}\ \underline{r}_5$	(with spreading of root-final $\underline{r}$)

The competition between the actual output and any of the failed candidates in (37) is sufficient to prove that NO-SPREAD$_{OO}$(μ, <u>seg</u>) >> DEP-<u>seg</u>$_{OO}$. This ranking ensures that spreading is dispreferred in onset-filling situations. But when spreading is already present in the basic form, it is preserved in the plural, because of NO-DELINK$_{OO}$(μ, <u>seg</u>).

I began this section by pointing out three main analytic results obtained by applying operational circumscription to Arabic: conservation of the weight of the final syllable in certain singular→plural/diminutive mappings; the complex relation between the weight of syllables in the singular and the position of epenthetic consonants in the plural/diminutive; and the conservation of consonantal spreading in all singular→plural/diminutive mappings. I have argued that each of these phenomena can be equally well understood within a correspondence-based approach to prosodic faithfulness. Conservation of weight is simply a matter of satisfying DEP-μ and MAX-μ; the other two results follow from the associational faithfulness constraints NO-DELINK$_{OO}$(μ, <u>seg</u>) and NO-SPREAD$_{OO}$(μ, <u>seg</u>). Unlike parsing-mode prosodic circumscription, which appears to have no applicability beyond a narrow range of cases like Arabic, all of these constraints are independently motivated. Indeed, they are absolutely essential aspects of phonological theory, with obvious ties to other types of faithfulness constraints.

I have not offered a complete account of the Arabic plural and diminutive in this brief sketch, but I have disposed of the principal arguments for operational circumscription. Before concluding, though, I should say something about the templatic morphology of the plural and diminutive. In the operational approach, the template is an iambic (light-heavy) foot to which B:Φ is mapped. In contrast, I have proceeded under the assumption that a mora (with a y in the diminutive) is infixed into a particular position in the stem. The locus of infixation can be seen in the following list or in (30) above:

(38) Locus of Added Mora (and y) in Plural and Diminutive

	Singular	Plural	Diminutive
a.	nafs	nufuus	nufays
b.	ʔasad	ʔusuud	ʔusayd
c.	jundub	janaadib	junaydib
d.	sulṭaan	salaaṭiin	sulayṭiin
e.	xaatam	xawaatim	xuwaytim
f.	jaamuus	jawaamiis	juwaymiis
g.	jaziir(+at)	jazaaʔir	juzayyir

The added mora appears in a consistent position: at the end of the second syllable.

The logic of infixation in OT (see section 2) is that infixes are normal (peripheral) affixes forced to non-peripheral position by high-ranking constraints. Here, I propose that the responsible constraints are members of the positional faithfulness family identified by Beckman (1995, 1997). The theory of positional faithfulness asserts that some positions are privileged to receive special faithfulness treatment. Among the positions so privileged are stem-initial and stem-final syllables. If faithfulness to stem-initial and stem-final syllables is high-ranking, then the μ-affix, though formally a suffix, will be forced into into a stem-medial syllable. With disyllabic stems, there is no medial syllable, of course;[27] in that case, faithfulness to the stem-initial syllable takes precedence over faithfulness to the stem-final syllable, following a pattern that is widely observed cross-linguistically. The point, then, is that there is a plausible affixational analysis to replace the templatic one of the operational theory.

6. Conclusion

The theory of Prosodic Morphology is concerned with explaining the properties of phenomena like template-mapping, infixation, and reduplication. In Prosodic Morphology and in linguistics generally, the goal of explanation is advanced when local stipulations and parochial mechanisms are replaced by principles of broad applicability. This article pursues that goal in relation to phenomena coming under the purview of operational prosodic circumscription.

Though it has achieved some significant descriptive and analytic successes, operational prosodic circumscription includes much that is local and parochial and therefore incompatible with explanation. Research in Optimality Theory, however, has already led to significant improvements in our understanding of one circumscriptional phenomenon, infixation. Infixation (section 2) is now understood in a much more revealing way as a consequence of the interaction of syllable-structure constraints with affixal alignment constraints. Both of these constraint types have ample support outside the narrow domain of infixation, and so they supply the kind of independent support that is essential to further development of any theory. These results in the study of infixation show what can be achieved by re-casting the central idea of Prosodic Morphology — to understand morphological phenomena in terms of independently motivated principles of prosody — within the OT framework.

This article continues that research program by addressing a different body of cases that had also been analyzed in terms of operational circumscription. These include morphological processes of foot reduplication and circumscriptional template-mapping. I have argued that all can be better understood as effects of prosodic faithfulness constraints, which demand preservation of the location of foot or syllable edges or heads, of moras, or of mora-segment associations. Prosodic faithfulness is by no means peculiar or special; rather, it is part of the very stuff of phonology in OT, essential to dealing with facts as diverse as lexical stress, compensatory lengthening, and tone shift. To the extent that they are correct, then, these results carry us further toward the ultimate aim of Prosodic Morphology: to explain all relevant data in terms of the interaction of independently motivated constraints of prosody, morphology, and their interface.

Appendix: Anchoring Constraints

The original Alignment constraints were defined within the PARSE/FILL/Containment-based model of Prince and Smolensky (1991, 1993), which posits a single output representation containing information about underlying morphological structure and surface prosodic structure. They require coincidence of the edges of prosodic and/or morphological constituents within the output structure:

(39) Generalized Alignment (McCarthy and Prince, 1993b)

Align(Cat1, Edge1, Cat2, Edge2) $=_{def}$

$\forall$ Cat1 $\exists$ Cat2 such that Edge1 of Cat1 and Edge2 of Cat2 coincide.

Where

Cat1, Cat2 ε PCat $\cup$ GCat

Edge1, Edge2 ε {Right, Left}.

In Correspondence Theory, which allows direct reference to the input (or other related representation), Anchoring replaces Alignment in some applications:[28]

(40) {RIGHT, LEFT}-ANCHOR(S_1, S_2) (McCarthy and Prince, 1995a: 372)

Any element at the designated periphery of S_1 has a correspondent at the designated periphery of S_2.

Let Edge(X, {R, L}) = the element standing at the Edge = {R, L} of X.

RIGHT-ANCHOR . If x = Edge(S_1, R) and y = Edge(S_2, R) then x$\Re$y.

LEFT-ANCHOR. Likewise, mutatis mutandis.

Starting from the basic schema in (40), I will present several refinements here based on more recent developments.[29]

First, in accordance with a standard move in the Alignment literature (McCarthy and Prince, 1993b; Pierrehumbert, 1994), Anchoring is extended to include identity of constituent heads as well as edges. This is important in section 4, where it is shown that circumscriptional effects can involve faithfulness to foot-head position.

Second, following Benua (1997) and Gafos (1997), I assume the existence of distinct but symmetric Anchoring constraints from S_1 to S_2 and from S_2 to S_1. This move parallels an established symmetry in Correspondence Theory: e.g., between MAX and DEP or between I-CONTIG "no skipping (maintain contiguity of input string)" and O-CONTIG "no intrusion (maintain contiguity of output string)". The Anchoring constraints distinguished in this way can be referred to as I-ANCHOR and O-ANCHOR.

Third, also following a proposal by Benua (1997) (which is itself based on positional faithfulness and allied notions in Beckman (1995, 1997) and Alderete (to appear)), I assume a distinction between two senses of Anchoring:

- ANCHOR-POS is satisfied when a segment's position as constituent-initial, -final, or -head is conserved under correspondence;
- ANCHOR-SEG is positional faithfulness per se, conserving the segment itself standing in the designated position.

As Benua points out, the Alignment theory fuses these two notions into a single constraint-type, but the richer Correspondence framework allows them to be treated separately, and, she argues, they must be.

Crossing the I-ANCHOR/O-ANCHOR distinction with the ANCHOR-POS/ANCHOR-SEG distinction gives four main types of Anchoring constraints, . Within each constraint type, a particular constraint token must also specify the constituents involved, the type of correspondence relation between them (I-O, B-R, O-O), and the position P anchored to (initial, final, head).

The ANCHOR-POS constraints produce the kinds of prosodic faithfulness effects that replace operational prosodic circumscription:

(41) Anchoring as Alignment and Prosodic Faithfulness: ANCHOR-POS

a. I-ANCHOR-POS(Cat_1, Cat_2, P)

If ς_1, Cat_1 ε S_1,

ς_2, Cat_2 ε S_2,

$\varsigma_1 \Re \varsigma_2$, and

ς_1 stands in position P of Cat_1,

then ς_2 stands in position P of Cat_2.

b. O-ANCHOR-POS(Cat_1, Cat_2, P)

If ς_1, Cat_1 ε S_1,

ς_2, Cat_2 ε S_2,

$\varsigma_1 \Re \varsigma_2$, and

ς_2 stands in position P of Cat_2,

then ς_1 stands in position P of Cat_1.

When $Cat_1 = Cat_2$, we have prosodic faithfulness per se: for instance, I-ANCHOR-POS_{IO}(Ft, Ft, Head) says that the locus of stress must not change in the input→output mapping. Constraints of this type are important in lexical stress systems and in the analysis of prosodic circumscription. When Cat_1 = Base and Cat_2 = Reduplicant, we have a typical Base-Reduplicant Anchoring effect of the type explored in McCarthy and Prince (1993b: Chapt. 5), Alderete et al. (1997), and Gafos (1997). When Cat_1 = Stem and Cat_2 = σ, I-ANCHOR-POS subsumes the effects of classic (MCat, PCat) alignment, demanding that every stem-edge coincide with a syllable-edge.

The ANCHOR-POS constraints, because of the antecedent conditions in (41), are irrelevant when a segment is deleted or inserted at the designated edge. But deletion or insertion at edges — that is, positional faithfulness in Beckman's (1997) sense — is regulated by Anchoring constraints of the other type, ANCHOR-SEG. I-ANCHOR-SEG is a position-specific MAX constraint; O-ANCHOR-SEG is a position-specific DEP constraint:[30]

(42) Anchoring as Positional Faithfulness: ANCHOR-SEG

a. I-ANCHOR-SEG(Cat, P)

If ς_1, Cat ε S_1,

ς_2 ε S_2, and

ς_1 stands in position P of Cat,

then there exists ς_2 such that $\varsigma_1 \Re \varsigma_2$.

b. O-ANCHOR-SEG(Cat, P)

If ς_1 ε S_1,

ς_2, Cat ε S_2, and

ς_2 stands in position P of Cat,

then there exists ς_1 such that $\varsigma_1 \Re \varsigma_2$.

When Cat is a prosodic category, these are prosodically-sensitive faithfulness constraints. When Cat is a morphological category, they express resistance of, say, stem-edges to epenthesis or deletion. In this way, ANCHOR-SEG and ANCHOR-POS separate the faithfulness and parsing consequences of (MCat, PCat) alignment, in a way that Correspondence Theory permits but its Containment-based predecessor did not.

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1 Other work on operational circumscription includes Broselow and McCarthy (1983), Crowhurst (1994), Itô, Kitagawa, and Mester (1992), Lombardi and McCarthy (1991), McCarthy and Prince (1990a), and Mester (1990). For a comprehensive list of references, McCarthy and Prince (1995b).

2 The parsing/picking classification and terminology come from McCarthy and Prince (1991).

3 A third type of positive prosodic circumscription is not considered here because it has already been addressed in the OT literature. This is prosodic subcategorization, where a morpheme is prefixed or suffixed to a prosodic constituent (typically the foot, as in Ulwa and Samoan). These subcategorizational effects are attributed to alignment constraints by McCarthy and Prince (1993a: Chapt. 7; 1993b), building on Broselow and McCarthy (1983).

4 McCarthy and Prince (1990a) also discuss a third type of prosodic circumscription, in which the Φ function is used to select only those bases meeting a particular prosodic criterion. See Kager (1996) and Hargus and Tuttle (1997) for recent discussion from an OT perspective.

5 In prosody generally, the notion of extrametricality, which is another type of negative circumscription, has been much transformed in OT works like Prince and Smolensky (1993) and Hung (1994).

6 Syllabic faithfulness presents significant difficulties. If there are input-output syllabic faithfulness constraints, then some languages would be expected to contrast monomorphemic pa.ta with pat.a, by ranking syllabic faithfulness above ONSET and NO-CODA. Notoriously, such contrasts are never observed. Likewise, a base-reduplicant syllabic faithfulness constraint, through domination of MAX_{BR}, would be capable of enforcing syllable-copying reduplication, a pattern that is also unknown (Moravcsik, 1978; Marantz, 1982; McCarthy and Prince, 1986, 1990a). On the other hand, syllabic faithfulness is surely necessary in output-output relations, to account for such well-known contrasts as night-rate/nitrate or lightening/lightning. Clearly, there is an interesting research problem here.

7 For further discussion of O-O correspondence and related approaches, see Archangeli (1996), Buckley (to appear), Burzio (1994ab, 1996, 1997), Bybee (1985), Crosswhite (1996), Kager (to appear), Kenstowicz (1996), Kraska-Szlenk (1995), Orgun (1994, 1996), and Pater (1995).

8 Works discussing prosodic faithfulness include Alderete (1996, to appear), Beckman (1997), Burzio (1994ab), Bye (1996), Inkelas (to appear), Itô, Kitagawa, and Mester (1996), Kenstowicz (1994, 1996), McCarthy (1996), and Pater (1995).

9 In this respect, foot faithfulness is analogous to featural faithfulness in the IDENT sense, rather than the MAX sense. (On this distinction, see McCarthy and Prince (1995a).)

10 The idea that prosodic structure may be present in underlying representations is a frequent cause of anxiety, because it seems to run afoul of the underspecificational assumption that only unpredictable information can be present lexically. This assumption, though, plays no role in OT, which instead relies on the axiom of richness of the base (Prince and Smolensky, 1993): there are

no language-particular restrictions on underlying forms. (Richness of the base is essential to OT's solution for conspiracies or the duplication problem (Kisseberth, 1970; Kenstowicz and Kisseberth, 1977).) The predictability of prosodic structure in some language is an indication of low-ranking prosodic faithfulness constraints, not underspecification.

11 Other studies of circumscriptional phenomena within OT include Avery and Lamontagne (1995), Benua (1995), Crowhurst (1997), de Lacy (1996), Downing (1998, to appear a), Hung (1992), Itô, Kitagawa, and Mester (1996), Kager (1996), McCarthy (1996), Prince and Smolensky (1991, 1993), and Samek-Lodovici (1992, 1993)

12 The impossibility of positing a templatic morpheme consisting of a free-standing foot follows from the assumption made in section 3 that feet (and syllables) do not stand in correspondence, so foot-faithfulness is always mediated by segments. An underlying foot with no segments is invisible to the faithfulness theory, and so by the logic of Stampean occultation (Prince and Smolensky, 1993) it plays no useful role in the lexicon. Effectively, it does not exist.

13 Under GTT, the requirement that the Rotuman incomplete phase end in a monosyllabic foot must be understood in terms of some independently necessary constraint of universal grammar. There are two likely possibilities. One is that the templatic requirement of Rotuman is enforced by the same constraint that is responsible for neutralization of weight distinctions word-finally in many languages (McCarthy, 1996). Another is a constraint demanding word-final stress, also a common typological option (Pater, 1996).

14 Segmental evidence for the O-O relation in Rotuman is presented by McCarthy (1996).

15 Epenthesis is out of the picture because DEP-seg is undominated.

16 For this reason, we need not concern ourselves with candidates like *he.[leuʔ]. Though they achieve satisfactory prosodic faithfulness, they violate undominated constraints by including a falling

sonority diphthong in a closed syllable.

17 The constraint ANCHOR-POS$_{OO}$(Ft, Ft, Head) could also have been adduced in (21), with identical results.

Forms like he.[lé.uʔ] or he.[lé].uʔ might be expected to fare better than either candidate considered in (21), since they violate neither ANCHOR-POS nor MAX-seg. But they do so by positing metrical structures that are never attested in Rotuman: a light-heavy trochee in he.[lé.uʔ] and an unaligned foot in he.[lé].uʔ. Undominated constraints foreclose both options.

18 I am indebted to John Alderete for his detailed comments on the Cupeño material.

19 Crowhurst observes that Cupeño roots are regularly stressed on the first or second syllable — the choice is lexically determined. She therefore proposes that roots are provided lexically with a left-aligned mono- or disyllabic iambic foot. (See Alderete (1996) for a detailed discussion of the system in OT terms.) This analysis supports the idea that the native foot type is binary and iambic, just as in Crowhurst's assumed simple stem forms and habilitative template.

20 Equivalently, starting from the observation that the foot-initial segment in the simple stem stands in correspondence with a foot-initial segment in the habilitative, we could assert that ANCHOR-POS(Ft, Ft, Initial) is undominated.

21 The violation marks for DEP-seg are here presented under the assumption that the added vowels in e.g. kəláʔaʔaw have epenthetic root nodes (though their Place nodes are supplied by autosegmental spreading). Alternative assumptions are possible and certainly compatible with the argument made here. (I am indebted to Ania Łubowicz for a question on this point.)

22 Caroline Jones points out that the candidate *[čal$_3$]ʔaʔal$_3$, with doubling of the l, is anchored in both dimensions simultaneously. Candidates like this, with long-distance consonant gemination, are not just less harmonic but in all likelihood impossible. For relevant discussion, see Clements and

Hume (1995) and Gafos (1996, to appear).

23 The choice between epenthetic ʔ in saħaaʔib and epenthetic w in xawaatim is made on phonological grounds — see McCarthy and Prince (1990a).

24 In order to maintain the closest possible parallel to the McCarthy and Prince (1990a) analysis, I continue to assume that Arabic has CV tier segregation. But compare note 22.

25 If the added mora of the plural is an affix though, as suggested below, it does have a correspondent in the input.

26 A few nouns — about 10, all of them CiiCaaC — show onset-filling spreading in the singular→plural mapping: diinaar → danaaniir 'dinar (unit of currency)'.

27 This then raises the possibility of singular→plural mappings like nafs → *nafaʔis, to force the affixal mora into medial position. In general, though, Arabic prohibits stem-forms consisting of three light syllables (McCarthy and Prince, 1990b).

28 Alignment in the sense of McCarthy and Prince (1993b) and Anchoring in the sense of McCarthy and Prince (1995a) differ in two respects. First, Alignment can have a subcategorizational effect, by demanding coincidence of different edges of the two constituents. The Anchoring schema does not include that possibility — a defect, since cases of this type exist (e.g., SFX-TO-PRWD in McCarthy and Prince (1993a)). Second, Alignment can demand the coincidence of edges of two constituents which are present only in the output, such as ALIGN(Ft, L, PrWd, L). Anchoring does not generalize to these cases unless we assume that the correspondence relation is reflexive.

29 Another refinement: Zoll (1996) and Gafos (1997) develop a distinction between categorical and gradient senses of Anchoring/Alignment. This distinction does not appear to be relevant to the analysis of prosodic circumscription and so I will not address it here.

30 A full account of positional faithfulness will also require IDENT-like constraints that militate

against featural alteration in edges or heads. See Beckman (1997).