The prosody of phrase in Rotuman

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The "phase" alternation in Rotuman is remarkable (and has attracted a good deal of previous attention) for two reasons. First, the shape differences between phases are quite diverse, involving resyllabification, deletion, umlaut, and metathesis. Second, the phase alternation produces prosodic structures that are otherwise unattested in this language, replacing simple (C)V syllables with closed and diphthongal ones. In this article, I argue that Optimality Theory (Prince and Smolensky 1993) helps to make sense of both these observations. I also go on to use these results to support some claims about the nature of templates and prosodic circumscription in the theory of Prosodic Morphology (McCarthy and Prince 1986).

1. INTRODUCTION

Rotuman is a member of the Central Pacific branch of the Austronesian family, closely related to Fijian. The most eye-catching thing about this language is the alternation in "phase" (so named by Churchward 1940). Rotuman words come in two phases, which Churchward calls "complete" and "incomplete". The following examples show the diverse phonological effects of the phase alternation:[1]

(1) Phase Differences in Outline

	Complete	Incomplete	
a. Deletion			
	tokiri	tokir	‘to roll’
	tiʔu	tiʔ	‘big’
	sulu	sul	‘coconut-spathe’
	rako	rak	‘to imitate’
b. Metathesis			
	iʔa	iaʔ	‘fish’
	seseva	seseav	‘erroneous’
	hosa	hoas	‘flower’
	pure	puer	‘to rule’
	parofita	parofiat	‘prophet’

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[1]. The transcriptions abstract away from certain automatic alternations in the vowels which are discussed briefly in section 4.2 and at greater length in McCarthy (1995).

c. Umlaut		
hoti	höt	‘to embark’
mose	mös	‘to sleep’
futi	füt	‘to pull’
d. "Diphthongization"		
pupui	pupu͡i	‘floor’
lelei	lele͡i	‘good’
keu	ke͡u	‘to push’
joseua	joseu͡a	‘Joshua’
e. No Phase Alternation		
rī	rī	‘house’
sikā	sikā	‘cigar’

These complex alternations have attracted considerable attention.[2] They raise many questions at different levels of analysis — descriptive, typological, and theoretical. The goal of this article is to articulate those questions and develop answers to them.

At the descriptive level, there are questions about the mapping between the phases. How are the diverse phase alternations to be united in a single analysis? There are also basic questions about the phonological distinctions involved here. What, for example, is the difference between the phases in the "diphthongization" pattern (1d)? And, of course, something must be said about the contexts or conditions where the phase alternation occurs. Indeed, whether the phase distinction is fundamentally phonological or morphological is controversial.

Similar questions can be asked at the typological level. How is it possible for the complete and incomplete phase to differ so radically in the markedness of the structures they tolerate? Complete-phase words of Rotuman never contain closed or diphthongal syllables, but both configurations are common in the incomplete phase. And how does metathesis, a somewhat unusual process cross-linguistically, fit into this system?

These descriptive and typological questions lead to the theoretical issues lying at the focus of this article. What theory of phonology is best suited to characterizing the differences between the phases and the mapping that produces them? How does Rotuman fit into models of interlinguistic variation in prosodic structure? What are the broader implications of this seemingly idiosyncratic phenomenon in Rotuman?

Below, I will present an analysis of Rotuman framed within Optimality Theory (Prince and Smolensky 1993), and I will argue that OT provides answers to these questions that are always sensible and sometimes compelling. The central thesis of OT is that a grammar is a language-particular ranking of violable, universal faithfulness and markedness constraints. From this thesis, many results can be derived, among which the following are particularly important for Rotuman:

- <u>Homogeneity of target, heterogeneity of process</u>. Between languages and even within a language, diverse processes may be called upon to satisfy a single output target. In OT, the target is a markedness constraint; how it is satisfied depends on the ranking of faithfulness constraints and the specific conditions obtaining in the form under evaluation.

2. Works discussing the phase alternations include Anttila (1989), Besnier (1987), Biggs (1959, 1965), Blevins (1994), Blevins and Garrett (1998), Cairns (1976), Haudricourt (1958ab), Hoeksema and Janda (1988), van der Hulst (1983), Janda (1984), McCarthy (1986, 1989, 1995), Mester (1986), Milner (1971), Odden (1988), and Saito (1981).

- Structural non-uniformity. (This term is due to Prince 1993.) Because constraints are violable, structural requirements are not guaranteed to be uniformly true — for example, codas might be avoided generally in a language, but may nevertheless appear under certain circumstances. A special case of structural non-uniformity is emergence of the unmarked (McCarthy and Prince 1994a), activity of a markedness constraint only under conditions of reduced faithfulness.
- Factorial typology. Because constraint ranking is language-particular but the constraints themselves are universal, any ranking permutation is predicted to be a possible grammar of a human language. Proposals about specific languages must be tested for their typological consequences under permuted ranking.

The analysis of Rotuman presented here illustrates all of these points. The markedness target of the incomplete phase (a word-final stressed syllable) is satisfied in diverse ways depending on the interaction of faithfulness constraints. Interaction among markedness constraints leads to Rotuman's non-uniform prosodic structure, in which heavy syllables are limited to final position in the incomplete phase. The form and conditioning of the phases turn out to have clear precedents in other languages, once the effects of ranking permutation are considered.

This analysis also has consequences for certain specific aspects of OT. The correspondence theory of faithfulness (McCarthy and Prince 1995, 1999) controls the various processes and negotiates the relations between representations. And because the phase alternation is conditioned both prosodically and morphologically, it has implications for the theory of Prosodic Morphology (McCarthy and Prince 1986 et seq.).

This article is organized as follows. Section 2 establishes some key descriptive generalizations about Rotuman prosody and begins developing the OT analysis. Section 3 focuses on the prosodic structure and conditioning of the incomplete phase. The results of this section particularly bear on the non-uniformity thesis and the theory of Prosodic Morphology. Section 4 then turns to the alternation between the phases, which is framed within correspondence theory and which provides an account of the heterogeneous processes that lead to a homogeneous surface shape for the incomplete phase. Throughout sections 2 through 4, typological considerations are prominent as they are used to test the adequacy of any proposed constraints under permuted ranking. Finally, section 5 is a summary.

2. THE PROSODIC STRUCTURE OF ROTUMAN

In this section, I will be arguing for a particular analysis of Rotuman prosodic structure to serve as a basis for studying the phase alternations. The evidence will show that the various examples in (1) have the prosodic structure given in (2–4):

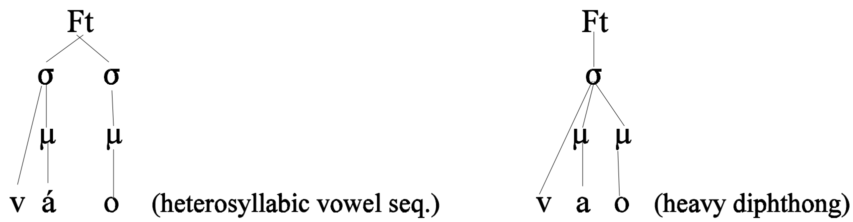
(2) /...VCV/ Words (1a–c)

a. Complete b. Incomplete

(light diphthong (1b) or monophthong (1a, c))

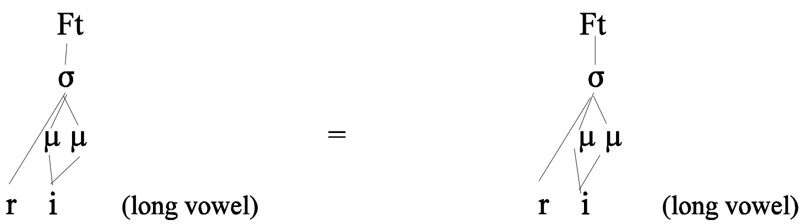
(3) /...VV/ Words (1d)

a. Complete   b. Incomplete



(4) /...Vː/ Words (1e)

a. Complete   b. Incomplete



These representations encode some important claims to be justified below. First, all words end in a bimoraic stress-foot, the moraic trochee of Hayes (1987, 1995) and McCarthy and Prince (1986). Except for stems with final long vowels, the foot consists of two light syllables in the complete phase and a single heavy syllable in the incomplete phase. Second, also excepting final long vowels, only light (C)V syllables are permitted in the complete phase. The final syllable of the incomplete phase is different; it can be closed or contain a diphthong or both. Third, there are two different types of diphthongs, monomoraic (light) diphthongs in closed syllables like seseav or puer, and bimoraic (heavy) diphthongs in open syllables like vao or pupui.

In the remainder of this section I will present evidence in support of these representations and the differences among them. I will begin by analyzing the basic (C)V syllable structure of the complete phase, putting the incomplete phase and the long vowels aside for the moment.

In general, licit syllables of Rotuman all have a (C)V shape. That is, there are no closed syllables and no diphthongs. In Rotuman, as in any other (C)V language, two constraints must be high-ranking: NO-CODA, which rules out closed syllables, and NO-DIPHTHONG, which rules out complex nuclei, including long vowels (Prince and Smolensky 1993, Rosenthall 1994, Sherer 1994). To keep the tableaux simple, I will informally encapsulate both with a single constraint:

(5) SYLL=μ

Syllables are monomoraic.

The constraints abbreviated by SYLL=μ must be ranked high in Rotuman to ensure that (C)V structure is the norm. For one thing, they must dominate ONSET (Ito 1989), so that V-V sequences will be parsed as heterosyllabic:

(6) SYLL=µ >> ONSET

/vao/	SYLL=µ	ONSET
a. ☞ va.o		*
b. va͡o	* !	

Syllable boundaries are indicated by ".", and the ligature is used to emphasize the diphthongal analysis of form (6b) (cf. (1d)). As this tableau shows, hiatus is preferred to a diphthong, one of the hallmarks of a (C)V language. And since obedience to ONSET could be achieved by deleting one of the offending vowels (*va, *vo) or epenthesizing a consonant (*vaʔo), ONSET must also be dominated by the faithfulness constraints MAX and DEP, which militate against deletion and epenthesis, respectively (see (28) and (29) below).

To complete the picture of a (C)V language, we must ensure that any potential coda-producing input will get unfaithful treatment. For instance, an input like /patka/ must surface as something like paka or patika, avoiding a coda by deletion or epenthesis. This means that SYLL=µ dominates some faithfulness constraint, either MAX (if paka is to be optimal) or DEP (if patika is to be optimal). No evidence from alternations supports one option or the other, but loan words point to epenthesis as the usual response to potential codas. On this basis, then, we might say that SYLL=µ dominates DEP.

These rankings — ⟦SYLL=µ, MAX >> DEP >> ONSET⟧ — characterize the (C)V syllable structure of Rotuman as a whole. But the final syllable of incomplete-phase stems can and in fact must be heavy: puer, tokir, mös, and va͡o all end in heavy syllables. Churchward's statements about the syllabificational and accentual properties of the two phases support this. Stress in Rotuman falls on the penult in complete-phase forms like púre, tokíri, móse, and vá.o. But the accentuation of the corresponding incomplete phase is significantly different. Look first at the treatment of /...VCV/ words:

> The general rule in the complete phase is that the accent falls on the penult: taka, hili, mose, fora, hanisi, mamosa, hununuka, ʻatakoa. (Churchward 1940: 75)
>
> [T]he stress seems to be levelled out, so to speak, in the inc. phase. Thus: fora becomes foar, which is pronounced almost, though perhaps not quite, as one syllable, the stress being evenly distributed ... (Churchward 1940: 86)

These observations suggest that foar is a monosyllabic word, with an oa diphthong followed by coda r.

The final closed syllables of foar, puer, or seseav contain two moras, constituting a bimoraic foot. As shown in (2b), one mora is assigned to the whole diphthong and the other mora is assigned to the coda. This allocation of the moras is supported by two sources of evidence. Besnier (1987) transcribes forms like the incomplete phase of rito as ryot. Besnier usually writes the lower-sonority vowel as a pre-nuclear high glide, consistent with the claim that this sequence is a light diphthong. Typology provides another argument: cross-linguistically, monomoraic diphthongs are usually limited to vowel sequences of rising sonority (Kaye 1983, Kaye and Lowenstamm 1984, Rosenthall 1994). The diphthongs found in closed syllables of Rotuman do indeed rise in sonority (Churchward 1940: 80):

(7) Metathetic /...VCV/ Cases

iʔa	iaʔ	‘fish’
tiko	tiok	‘flesh’
seseva	seseav	‘erroneous’
hosa	hoas	‘flower’
pure	puer	‘to rule’
luka	luak	‘short’

These are just exactly the vowel sequences of rising sonority (i.e., increasing openness) that are possible within the limits of the Rotuman vowel system. In comparison to these cases, all of which have a metathetic incomplete phase, vowel sequences of equal or falling sonority in /...VCV/ roots follow the deletion or umlaut patterns, as in (1a, c). In other words, metathesis is limited to forms where the resulting vowel sequence is a possible light diphthong because it falls in sonority. Why must it be monomoraic? The coda occupies one mora, under the assumption that non-moraic codas and consonantal appendices are ruled out by undominated constraints. This leaves only one other mora to parse the diphthong, since trimoraic syllables are prohibited categorically in this language. (More about this shortly.)

The /...VV/ roots in (1d) also form diphthongs in the incomplete phase, but they are not limited by any sonority condition:[3]

(8) Phase Alternation in /...VV/ Roots

a. Falling Sonority

čei	če͡i	‘cricket (insect)’
lelei	lele͡i	‘good’
reu	re͡u	‘tail (of bird, fish, snake, etc., but not of horse or cow)’
fai	fa͡i	‘to cut or chop down (a tree or branch)’
tae	ta͡e	‘to touch’
vao	va͡o	‘net, esp. fishing-net’
vau	va͡u	‘bamboo’
ʔoi	ʔo͡i	‘to scrape or grate’
čou	čo͡u	‘bottle’

b. Rising Sonority

fia	fi͡a	‘pouch of a sling’
kamia	kami͡a	‘dog (< come here)’
hio	hi͡o	‘(to perform a) certain kind of maka or action-song’
mea	me͡a	‘the temples’
foa	fo͡a	‘grater’
čua	ču͡a	‘(to have) very serious elephantiasis of the testicles’
joseua	joseu͡a	‘Joshua’
ʔuo	ʔu͡o	‘very bony kind of fish’
ŋarue	ŋaru͡e	‘work’

3. Though Churchward does not usually transcribe the phase distinction in /...VV/ words, we know that all of these words follow the pattern he describes, because they are listed in the dictionary as belonging to the same "declension" as (1d).

c. Equal Sonority

iu	i͡u	‘to change’
meo	me͡o	‘to feel resentment’
fui	fu͡i	‘to pick up (fallen leaves, etc.)’

The only sequences of unlike vowels missing from this list are *ie* and *oe*; they never occur in /...VV/ words anyway (cf. Krupa 1966, Kawasaki 1990). From these facts, it’s clear that there is a significant difference between the vowel sequences in (8) and the light diphthongs in (7).

If the vowel sequences in (8) are not light diphthongs, what are they, then? According to (3), they are heterosyllabic sequences in the complete phase (*če.i*, *fi.a*, *i.u*, etc.), but tautosyllabic heavy diphthongs in the incomplete phase. There are several reasons to think that this is correct. Most striking is the evidence of the permissible vowel sequences. There are no strong universal sonority conditions on heavy diphthongs, so we neither expect nor observe that heavy diphthongs like (3b) would be limited to any particular sonority profile. On top of that, we also have Churchward’s direct testimony about the prosody of these words:

> In dec. 3 [the /...VV/ "declension"], [the stress is] thus: pu*pu*i, pu*pui*; le*le*i, le*lei*. (Churchward 1940: 86)
>
> Most words ending in two or more vowels form their inc. ph. by shortening the penultimate vowel. In the foll. exs. Roman type is used for distinguishing short vowels ... *pupui*, *pup*u*i* floor; *lelei*, *lel*e*i* good; *iria*, *ir*i*a* them (two)... (Churchward 1940: 85)

In the first statement, Churchward uses italics to mark the stressed penult of the complete-phase forms "pu*pu*i" and "le*le*i", but then uses italics for the entire final CVV syllable in the incomplete-phase forms "pu*pui*" and "le*lei*". This is fully consistent with the structures in (3) and the bimoraic foot of Rotuman. Churchward’s remark that the penultimate vowel is shortened in the incomplete phase also supports the proposal in (3): the penultimate vowel is all alone in the stressed syllable of the complete phase (3a), but it shares the stressed syllable (and is therefore somewhat shorter) in the corresponding incomplete phase (3b).

Other phonological considerations also support the proposed prosodic-structural difference between the /...VV/ words in (3b) and the /...VCV/ words in (2b). The incomplete-phase forms *puer* and *va͡o* both respect the familiar bimoraic upper bound on syllable size. Thus, though syllable monomoraicity (i.e., SYLL=μ) is violated by incomplete-phase forms in Rotuman, syllable bimoraicity is not; trimoraic syllables are literally impossible by virtue of an undominated constraint. In *va͡o*, with no final consonant to parse, each vocoid can be assigned to its own mora, yielding the structure (3b). But in *puer*, the final consonant seizes one of the moras, and so both vocoids must be associated with the single remaining mora, yielding (2b). In the latter case, the monomoraicity of the diphthong has an important consequence, already noted: only rising-sonority sequences are possible. Other potential vowel sequences, which cannot be analyzed as light diphthongs, are simplified by deletion or umlaut, both discussed later.

There is one remaining aspect of Rotuman prosody to consider: the analysis of long vowels. Words with final long vowels, whether native or borrowed, have no phase alternation (1e). This is to be expected if, as I have suggested, a constant property of the incomplete phase is a final heavy syllable. A word with a final long vowel "already" ends in a heavy syllable, so it has no need to alternate. The real peculiarity of words with final long vowels is that they contain heavy syllables even in the complete phase, violating SYLL=μ and departing from the consistent (C)V character of the language.

Blevins (1994) observes that long vowels have a highly restricted distribution: they are found only root-finally, in native monovocalic roots (rī, rē) and in some polysyllables, mostly loans (sikā, hanē 'honey'). She proposes that these long vowels are responses to Foot Binarity (FT-BIN — Prince 1980, Broselow 1982, McCarthy and Prince 1986), which requires all feet to be syllabically or moraically binary. A stressed monomoraic root *rí would violate FT-BIN, so the vowel lengthens instead. Words like sikā, Blevins proposes, are represented lexically with an exceptional final stress: /siká /, /hané/. Again, FT-BIN demands bimoraicity. Thus, there is no independent contrast in vowel length, and the restricted distribution of long vowels follows from the restricted distribution of stress.

To formalize Blevins's insight within OT, we first require some background about how contrast is understood. (This background will also be relevant in other contexts later on.) Prince and Smolensky (1993) adopt a hypothesis called "richness of the base":[4] there are no morpheme-structure constraints or other language-particular restrictions on inputs. Instead, all linguistically significant patterns must be derivable from constraints on outputs interacting with faithfulness constraints. There are several reasons for pursuing this claim in OT: it is presupposed by another claim, that all interlinguistic differences are to be derived from constraint ranking; it is possible to obtain the effect of constraints on underlying representation from output constraints; and it is necessary to do so, in order to solve the "duplication problem" (Clayton 1976, Kenstowicz and Kisseberth 1977).

Richness of the base has implications for the analysis of contrast. Absence of contrast is the result of a constraint against the marked member of the potentially contrastive opposition being ranked above any constraint demanding faithfulness to that opposition. In Rotuman, vowel length is non-contrastive, so the markedness constraint SYLL=μ is ranked above faithfulness to underlying quantity (expressed by the constraint MAX-μ):

(9) SYLL=μ >> MAX-μ

/pāta/	SYLL=μ	MAX-μ
a. ☞ pata		*
b. pāta	* !	

This example is hypothetical, since it is drawn from the rich base. It shows that a lexical long vowel does not receive a faithful analysis at the surface, and so length will not contrast independently.

Long vowels are nonetheless possible in two circumstances where they are not independently contrastive (because faith to μ is not decisive). One involves underlying monomoraic roots like /ri/. As usual in such minimal-word situations, satisfaction of FT-BIN forces augmentation of a sub-minimal input:

4. For an important precedent, see Stampe (1972). For further discussion and applications, see Ito and Mester (1995, 1997), Ito, Mester, and Padgett (1995), Kirchner (1997), McCarthy and Prince (1995), and Smolensky (1996).

(10) FT-BIN >> SYLL=μ, DEP-μ

/ri/	FT-BIN	SYLL=μ	DEP-μ
a. ☞ (rī́)		*	*
b. (rí)	* !		

Feet are delimited by parentheses. Form (10b) posits a monomoraic foot, with fatal consequences for well-formedness. Form (10a) achieves bimoraicity by lengthening the vowel, yielding a heavy syllable (violating SYLL=μ) that is unfaithful to the lexical short vowel (violating DEP-μ). A long-voweled input /rī/ would yield the same surface result, emphasizing the irrelevance of underlying vowel length contrasts to the outcome, so long as the moraic faithfulness constraints are low-ranking. This gets one aspect of Blevins's analysis: vowel length occurs in (C)V monosyllables for word-minimality reasons.[5]

I will assume that the exceptional stress of words like sikā is represented by a lexical foot /si(ká)/.[6] If the lexical foot is to be faithfully maintained in the output, then addition of a mora is necessary:

(11) FT-BIN >> SYLL=μ, DEP-μ, with polysyllabic input

/si(ká)/	FT-BIN	SYLL=μ	DEP-μ
a. ☞ si (kā́)		*	*
b. si (ká)	* !		

The candidates compared here are both faithful to this underlying foot. (The responsible faithfulness constraint is a version of HEAD-MATCH (41), which is discussed in section 4. Trochaic FT-FORM is assumed to be undominated.[7]) In (11b), moraic faithfulness is achieved at the expense of FT-BIN, with the expected fatal effect. In (11a), the lexical foot is preserved but made binary through vowel lengthening, violating the two low-ranking constraints.

In summary, we have seen that Rotuman prosody in general follows the (C)V type, with SYLL=μ dominating ONSET and various faithfulness constraints. But at the right edge of an incomplete-phase stem, heavy syllables are not just permitted, but required. Various types of heavy syllables are observed, depending on the segmental material at hand: CVC sequences (tokir), CVVC sequences with light diphthongs (puer), CVV sequences with heavy diphthongs (va͡o), and long vowels (rī). Constraints on prosodic structure and the prosody-morphology interface determine the distribution and form of the incomplete phase. It is to those constraints and their interaction that we now turn.

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5. Other logically possible candidates are ruled out by high-ranking constraints. Foot-less *ri, for instance, violates HEADEDNESS(PrWd) (see (22)). And candidates with segmental epenthesis to satisfy FT-BIN, such as *riʔ or *ria, violate segmental DEP as well as DEP-μ.

6. For various approaches to lexical stress, see among others Alderete (1999), Buckley (1998), Halle and Vergnaud (1987), Hammond (1995), Hayes (1980), Idsardi (1992), Inkelas (1999), Pater (1994), Rosenthall (1994), and Selkirk (1984).

7. The rich base supplies some lexical feet that will not be treated faithfully, showing that HEAD-MATCH (41) is crucially dominated. Examples include iambic feet, as in /(siká)/, or unaligned feet, as in the hypothetical proparoxytone /(páta)ka/.

3. The Prosody and Prosodic Morphology of Phase

The material in section 2 supports the following descriptive generalization:

(12) The Phase Alternation, Descriptively

The incomplete phase is identical to the complete phase, except that the <u>final</u> <u>foot</u> of the complete phase is realized as a <u>monosyllabic foot</u> in the incomplete phase.

Complete	Incomplete
to(kíri)	to(kír)
se(séva)	se(séav)
(móse)	(mö́s)
le(lé.i)	le(léi)
si(kā́)	si(kā́)

These examples cover all of the relevant word-types. Except for final long vowels, the foot is disyllabic in the complete phase, because of high-ranking SYLL=μ. But in the incomplete phase, the foot is obligatorily monosyllabic, while still bimoraic. So incomplete-phase words all end in a stressed heavy syllable.

This descriptive generalization combines a structural requirement — the incomplete phase must end in monosyllabic foot (which is necessarily a heavy syllable, because of FT-BIN) — with a kind of circumscriptional requirement (cf. McCarthy and Prince 1990a) — the segmental material of the final foot of the complete phase is mapped onto this structure. The form and satisfaction of the structural requirement are dealt with in this section, while the circumscriptional requirement is discussed in section 4.

The unifying generalization about the incomplete phase is the presence of a stress on the final syllable (a formulation suggested by Pater 1996 and two anonymous reviewers). Alignment theory (McCarthy and Prince 1993b) provides the tools for stating the relevant constraint. Constraints on alignment of head constituents are expressed with the "head of" operator H( ): H(PrWd) is the head (i.e., main-stressed) foot of the prosodic word; H(Ft) is the stressed syllable in a foot. Let H′(C) stand for the result of recursively applying the head-of operator to the constituent C, so H′(PrWd) is the main-stressed syllable, which is the head syllable of the head foot.[8] Then the responsible constraint in Rotuman can be defined as follows:

(13) ALIGN-HEAD-σ

Align(H′(PrWd), R, PrWd, R)

The main-stressed syllable is final in every PrWd.

Appropriately ranked, this constraint will ensure that every word ends in a stressed syllable. With FT-BIN and trochaic FT-FORM also active, the effect of ALIGN-HEAD-σ is to require PrWd's to have final heavy syllables, just as observed.[9]

The role of ALIGN-HEAD-σ is easiest to see with examples like <u>(ké.u)</u>/<u>(ke͡u)</u> (1d), where it compels violation of SYLL=μ but has no consequences for faithfulness. The following tableau shows its effects, together with those of the undominated prosodic-structural constraints FT-BIN and FT-FORM:

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8. This is the "designated terminal element" of Liberman and Prince (1977). On alignment of heads, also see Pierrehumbert (1994).

9. An alternative to ALIGN-HEAD-σ is possible. There is a family of markedness constraints favoring various neutralizations of syllabic distinctions word-finally: final light syllables, final heavy syllables, final consonants, and the like (McCarthy 1993, McCarthy and Prince 1990b, 1994a, Piggott 1991). A constraint from this family, demanding a final heavy syllable, could be substituted for ALIGN-HEAD-σ here and subsequently.

(14) ALIGN-HEAD-σ, FT-BIN, FT-FORM(TROCHAIC) >> SYLL=μ (>> ONSET)

/keu/	ALIGN-HEAD-σ	FT-BIN	FT-FORM(TROCHAIC)	SYLL=μ	ONSET
a. ☞ (kéu)				*	
b. (ké.u)	*!				*
c. ke.(ú)		*!			*
d. (ke.ú)			*!		*

Vowel-vowel sequences are normally heterosyllabic in Rotuman, except in the final syllable of the incomplete phase, where they become diphthongs. We now see why: SYLL=μ dominates ONSET, giving the default pattern, but SYLL=μ is itself crucially dominated by ALIGN-HEAD-σ and the other constraints in (14).

These results supply the explanation for the prosodic nonuniformity of Rotuman. In general, only (C)V syllables are permitted. But heavy syllables do occur under two circumstances. First, heavy syllables with long vowels are forced by FT-BIN in situations involving sub-minimal roots or lexical feet (10, 11). Second, heavy syllables are demanded PrWd-finally by ALIGN-HEAD-σ (14). Through crucial domination of SYLL=μ, ALIGN-HEAD-σ accounts for the existence of closed and diphthongal final syllables in a language that basically tolerates only light syllables. Structural nonuniformity like this is an important consequence of Optimality Theory, as Prince (1993) argues. In parametric theories, a language either is or is not limited to (C)V syllables. OT does not demand such typological strictness; it makes perfect sense, as in Rotuman, to say that (C)V syllables are obligate except under particular conditions, which are precisely defined by a higher-ranking constraint. Nonuniformity is a direct consequence of the core OT thesis that a grammar is a hierarchy of violable constraints.

Through ranking permutation, constraints have different activity in different languages, and so typology is a necessary test of proposals framed within OT. In particular, a constraint that is crucially dominated in one language should have undominated force in another. Tübatulabal shows the effect of undominated ALIGN-HEAD-σ: there is fixed word-final stress despite a basically trochaic alternating pattern (Kager 1989, Hayes 1995). But in Rotuman, ALIGN-HEAD-σ is not always satisfied; in fact, failure to satisfy it is the distinguishing characteristic of the complete phase. This brings us, then, to the next step in the argument: accounting for the conditions that determine which phase is used when. This leads to the constraint interaction that explains when and why ALIGN-HEAD-σ is violated in complete-phase forms.

According to Churchward (1940) and most subsequent analysts (including me, in an earlier version of this article (McCarthy 1995)), phase is a basically morphological distinction distributed according to poorly understood syntactic or semantic conditions. But Hale and Kissock (1998), based on a re-examination of Churchward's textual material, argue that the phases are actually distributed according to a morphophonological regularity. Their observations are summarized in the following statement:

> Elements which are followed by monomoraic affixes or clitics show up in the complete phase. All other elements, including those followed by polymoraic affixes or clitics and those followed by <u>no</u> affixes or clitics, show up in the incomplete phase. (Hale and Kissock 1998: 123)

They supply extensive lists of suffixes to document these generalizations. Here are just a few examples:[10]

(15) The Phase Difference and Affix Size

a. Complete Phase with Monomoraic Affixes

puʔa–ŋa	‘to be greedy + nominalizer = greed’
hoʔa-me	‘to take + hither = to bring’
rofi–a	‘to lose one’s head + completive aspect’

b. Incomplete Phase Elsewhere

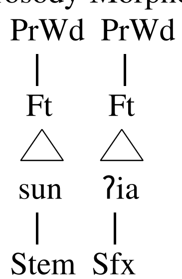
sun–ʔia	‘to be hot + ingressive = to become hot’ (cf. sunu)
al–tia	‘to die + complete aspect = to have died’ (cf. ala)
hiok–hiok	‘soft and springy’ (reduplicated) (cf. hiko)
fion–ŋar	‘will (of a chief)’ (compound) (cf. fino)
ʔeap fol	‘mats three = some three mats’ (phrase) (cf. ʔepa)

My goal now is to provide an explanation for this relationship between affix size and stem phase.

The dichotomy between monomoraic and longer affixes has ample typological precedent. Hewitt (1992) discusses three languages — Yidiɲ, Diyari, and Rotuman’s nearby relative Fijian — where affix size has significant prosodic consequences.[11] The unifying observation is that affixes which constitute footable domains are treated as prosodically independent, but affixes which do not constitute footable domains are prosodically dependent. In Yidiɲ, for example, disyllabic suffixes are demonstrably analyzed as separate PrWd’s, but monosyllabic suffixes are not (Dixon 1977).

FT-BIN is the key to explaining how suffix size has consequences for the prosodic relation between suffix and stem. When the suffix is footable — that is, two or more moras long — then it is prosodically external to the stem. Stem and suffix are in separate PrWd’s in Rotuman, just as in Yidiɲ:

(16) Prosody-Morphology Relation in Stem with Long Suffix

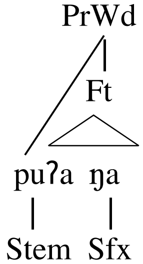


But when the suffix is monomoraic and hence unfootable, then it is prosodically bound to the stem. In this case, stem and suffix are united in a single PrWd:

[10]. Hale and Kissock (1988) also discuss a few suffixes that do not conform to their generalization. Two –Ø suffixes, ‘definite’ and ‘locative’, require a stem in the complete phase: vaka ‘the canoes’, ʔe lopo ‘in the lower part, below’. They propose that these morphemes actually consist of floating moras and thereby follow the pattern of monomoraic suffixes. A third suffix, –ta ‘definite singular’, which takes the incomplete phase, they regard as composite, consisting of –ta ‘singular’ plus the definite suffix, hence effectively bimoraic.

[11]. Paul de Lacy informs me that this relationship between affix size and PrWd-hood is pervasive in the Central Pacific branch of Austroneisan, of which Rotuman is a member. On Maori in particular, see de Lacy (1998, to appear).

(17) Prosody-Morphology Relation in Stem with Short Suffix



I will first show that the difference between (16) and (17) is the source of the phase alternation, and then I will show how that difference comes about.

A stem is prosodically independent when it is followed by a long suffix, as in (16), or when it is part of a compound, or when it has no suffixes at all. A prosodically independent stem is a free-standing PrWd, subject to evaluation by ALIGN-HEAD-σ, which demands stress on the final syllable of any PrWd. Therefore, prosodically independent stems are in the incomplete phase, which is characterized by the presence of a word-final stressed heavy syllable.

A stem is prosodically bound when it is followed by a short suffix, as in (17). A prosodically bound stem is not a free-standing PrWd by itself, because the suffix is also part of the same PrWd as the stem. Because the stem is not coextensive with the PrWd, ALIGN-HEAD-σ, which cares about PrWd's but about stems, is irrelevant to determining its form. The whole PrWd, stem and suffix together, will be in the incomplete phase (as in fereaŋ 'flying', from /fere–ŋa/), but the stem alone will not.

In short, if Rotuman stems are prosodically free, as in (16), except when they are followed by a monomoraic suffix, as in (17), then literally nothing new needs to be said about the conditioning of the phases. Constraints and rankings already discussed — ALIGN-HEAD-σ in particular — are sufficient to account for Hale and Kissock's observation that only stems followed by monomoraic suffixes are in the complete phase. So it only remains to explain why monomoraic suffixes lead to the prosodically bound structure in (17) but longer suffixes do not.

From a typological perspective, it is actually (16) that is a little unusual. Though there are parallels in Yidiɲ and languages related to Rotuman, it is more typical to find that every PrWd contains within it a lexical or content word (i.e., the "stem" of (16) and (17)):

(18) PRWDCON (after Selkirk 1995)

For any PrWd P there exists some lexical stem S such that the terminals of S are contained in P.

If PRWDCON is obeyed, then functional elements will never have the status of a PrWd. In Yidiɲ or Rotuman, however, PRWDCON is crucially dominated, since some PrWd's (such as the suffix –ʔia in (16)) do not contain a lexical word. Three constraints are responsible for such violations of PRWDCON in Rotuman.

PRWDCON is dominated by the prosody-morphology interface constraint ALIGN-STEM:

(19) ALIGN-STEM (McCarthy and Prince 1993b)[12]

Align(Stem, R, PrWd, R)

"The terminal element which is rightmost in Stem is also rightmost in some PrWd."

[12]. The "stem" of (18) and (19) is a category-of-analysis in the output, rather than the input. This means that ALIGN-STEM is satisfied when the rightmost element of the stem, as it appears in surface structure, is rightmost in some PrWd. Alignment of underlying stems is also possible through the use of ANCHOR constraints (McCarthy and Prince 1995).

This constraint and its left-hand counterpart will be further discussed below. They favor a direct match between morphological and prosodic structure: the stem should end (and begin) neatly on a word-edge. So ALIGN-STEM favors prosodic independence of the stem, forcing externalization of suffixes, as in the following tableau. (The parentheses delimit feet and the braces mark PrWd's.)

(20) ALIGN-STEM >> PRWDCON

/sunu–ʔia/	ALIGN-STEM	PRWDCON
a. ☞ {(sun)} {(ʔia)} (=(16))		*
b. {sun (ʔia)}	* !	

The choice here is between prosodic independence of stem and suffix in (20a) and prosodic fusion in (20b). ALIGN-STEM favors the independent structure, though it means allowing a PrWd that contains only a functional element.

PRWDCON is also ranked below the constraints that define the prosodic hierarchy (Ito and Mester 1992, Selkirk 1995). One, NONREC(PrWd), prohibits recursion of the category PrWd; the other, EXH(PrWd), prohibits "skipping" the PrWd level in the hierarchy by requiring that every element belong to some PrWd. These rankings rule out candidates which subvert the prosodic hierarchy in order to satisfy both ALIGN-STEM and PRWDCON together:

(21) NONREC(PrWd), EXH(PrWd) >> PRWDCON

/sunu–ʔia/	NONREC(PrWd)	EXH(PrWd)	PRWDCON
a. ☞ {(sun)} {(ʔia)} (=(16))			*
b. {{(sun)} (ʔia)}	* !		
c. {(sun)} (ʔia)		* !	

In (21b) and (21c), the stem is prosodically independent, since it is a PrWd on its own. Again (21a) is favored, despite its stem-less PrWd {(ʔia)}. As usual, ranking permutation predicts that the structures disfavored in Rotuman will be good in other languages. And indeed this is the case: (20b) is typical of English level 1 suffixation or Arabic; (21b) is required in Diyari (McCarthy and Prince 1994b); and (21c) is observed in a Serbo-Croatian dialect (Selkirk 1995).

Therefore, long suffixes are independent PrWd's as a side effect of the imperative to analyze the stem as an independent PrWd without recursion. But short suffixes are in a dependent structure (20b) that violates ALIGN-STEM. Four constraints are decisive in this situation. Three come from from the prosodic hierarchy, NONREC(PrWd), EXH(PrWd), and HEADEDNESS(PrWd). We just saw the first two; the last is violated by any PrWd that lacks a main-stressed foot as its head (Selkirk 1995). The third responsible constraint is FT-BIN, which is crucial in segregating the short suffixes from the long ones. The various constraint interactions are summarized in the following tableau:

(22) HEADEDNESS(PrWd), FT-BIN, NONREC(PrWd), EXH(PrWd) >> ALIGN-STEM (>> PRWDCON)

/puʔa−ŋa/	HEAD	FT-BIN	NONREC, EXH	ALIGN-STEM	PRWDCON
a. ☞ {pu (ʔaŋa)} (=(17))				*	
b. {(puaʔ)} {ŋa}	* !				*
c. {(puaʔ)} {(ŋa)}		* !			*
d. {{(puaʔ)} ŋa}			* !		
e. {(puaʔ)} ŋa			* !		

Candidates (22b−e) cover the range of ways to satisfy ALIGN-STEM: positing a footless and consequently headless PrWd (22b), creating a degenerate foot (22c), using recursion (22d), or skipping a level (22e). These candidates all have stems in the incomplete phase, to satisfy ALIGN-HEAD-σ, but none is optimal because of the high-ranking constraints. This tableau, then, explains why monomoraic suffixes are preceded by a complete-phase stem: with a monomoraic suffix, a stem is prosodically bound, as in (22a), and ALIGN-HEAD-σ is irrelevant to evaluating prosodically bound stems.[13, 14]

To sum up, the preferred structure under the ALIGN-STEM regime is one where the stem is isolated in its own PrWd. With NONREC(PrWd) undominated, any suffix must form a PrWd of its own if the stem is to enjoy that isolation. But monomoraic suffixes present problems: they cannot support a PrWd without running afoul of two other undominated constraints, HEADEDNESS(PrWd) or FT-BIN. Consequently, low-ranking ALIGN-STEM suffers before monomoraic suffixes, though it is still decisive with longer suffixes. The echoes of this difference are heard in the phases: a stem with a monomoraic suffix is not an independent PrWd, and so its shape is not determined by ALIGN-HEAD-σ. It is therefore in the complete phase. All other stems — stems with long suffixes, stems in compounds, and stems without suffixes — are independent PrWd's, and ALIGN-HEAD-σ has significant effects on their form.[15]

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13. Another way to satisfy ALIGN-STEM would be to make monomoraic suffixes bimoraic, presumably by vowel lengthening: *{(puaʔ)} {(ŋā)}. Since this is not an option, DEP-μ must dominate ALIGN-STEM.

14. Rotuman has two suffixes with the surface shape −C, -t 'indefinite singular article' and −s 'interrogative', which select for the complete phase (Hale and Kissock 1998): vaka−t 'a canoe', vaka−s 'which canoe?'. The complete phase is expected with these suffixes, since an incomplete phase stem with a −C suffix would have to be parsed as a trimoraic syllable (*vak−s), thereby violating an undominated constraint (see section 2).

15. Hale, Kissock, and Reiss (1998) take a different approach to the interaction of affix size and phase. They propose the following rule:

(i) Phonological Conditions for Clitic Group Incomplete phase

Build RL binary feet within each clitic group. If a vowel is both at the right edge of a foot and a morpheme, that vowel will undergo the effects of Incomplete phase formation.

When stem and suffix (or clitic) are footed together, a stem-final vowel followed by a monormoraic suffix will not be foot-final, as in pu(ʔa−ŋa), so the result is a complete-phase stem.

This analysis and the one in the text both relate the affix-size condition to foot binarity, but the approaches are otherwise quite different. Rule (i) treats the conditioning of phase as rather idiosyncratic. In contrast, the analysis in the text attempts to relate the conditioning of phase to a general theory of morphology/prosody interactions. There are also empirical differences between the two accounts. According to Hale and Kissock (1998, fn. 11), the unique trimoraic

We now have a reasonably complete picture of the prosody of phase in Rotuman. The phase shift itself is primarily a response to phonological requirements, as Hale and Kissock (1998) argue, but the distribution of the two phases is impacted significantly by morphology through the morphology-prosody interface constraint ALIGN-STEM. This stands in contrast to the traditional analysis. As I noted above, analysts since Churchward (1940) have usually understood the phase difference in morphological terms. One idea is that the phases have different CV templates (Besnier 1987, van der Hulst 1983, McCarthy 1986, 1989, Mester 1986, Saito 1981):

(23) The Phase Difference via CV Templates[16]

a. Complete	b. Incomplete
u e	u e
| |	|/
CVCV	CVC
| |	| |
p r	p r

Another idea is that the incomplete phase is subject to a templatic constraint, such as a morphologically-restricted version of ALIGN-HEAD-σ (McCarthy 1995).

Hale and Kissock's generalization shows that these earlier accounts of the phase difference are inadequate empirically, since it doesn't make sense to talk of a phase morpheme or template. My intention now is to show that templatic analyses are also unattainable for theoretical reasons, in the light of more recent developments in the theory of Prosodic Morphology (PM — McCarthy and Prince 1986 et seq.). This leads to a welcome nexus of empirical and theoretical reasoning.

The goal of PM is to explain the interaction of morphology and prosody in terms of general, independently-motivated principles of prosody, morphology, and their interface. The template was an essential component of early work in PM (e.g., McCarthy 1981, Marantz 1982, McCarthy and Prince 1986). A template is a prosodic requirement imposed on stems or their reduplicative copies to express a morphological distinction. The problem with prosodic templates is that they lack independent motivation — they are needed in PM and nowhere else. Thus, an important aim of research on PM in OT has been the elimination of prosodic templates, an aim embodied in the Generalized Template Hypothesis (GTH) of McCarthy and Prince (1994ab, 1999).[17]

According to the GTH, there are no prosodic templates or other morpheme-specific structural constraints. Instead, the descriptive effects of prosodic templates are to be obtained from the following premises, each of which is independently motivated:

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suffix of Rotuman, −teʔisi 'this', also takes the complete phase. This is consistent with the analysis in the text, because a trimoraic suffix is a footable domain, but not with (i). Furthermore, the correct application of (i) depends on assumptions about footing that do not seem to be correct. According to Churchward (1940: 75), there are both stress-neutral and stress-determining monomoraic suffixes: híli−a 'to choose something (tr.)' vs. taká−ŋa 'lying down'. But (i) will work correctly only if all monomoraic suffixes are stress-determining, since a mismatch of foot and morpheme edges is necessary to block the phase shift. The analysis in the text, on the other hand, encounters no such difficulties, since what is crucial for determining phase is the location of prosodic-word edges, not foot edges. (Stress-neutral behavior can then be analyzed as an output-output faithfulness effect, as in Benua's (1997) analysis of English.)

16. Below in section 4.1 I address the segregation of vowels and consonants on separate tiers assumed in (23).

17. Other work contributing to the generalized template program includes Alderete et al. (1999), Carlson (1998), Downing (1994, 1999), Futagi (1999), Gafos (1996, 1998b), Ito, Kitagawa, and Mester (1996), Spaelti (1997), Urbanczyk (1995, 1996ab). See also Shaw (1987), Steriade (1988), and Ito and Mester (1992) for important precursors.

Stem→PrWd homology. The principal, and perhaps only, morphology-prosody interface constraint is ALIGN-STEM and its symmetric counterpart at the left edge.
Markedness constraints. Universal grammar supplies phonological markedness constraints which are not sensitive to morphology.
Correspondence theory (McCarthy and Prince 1993a, 1994a, 1995, 1999). Correspondence theory extends the original OT conception of faithfulness into a general way of relating representations. This allows certain seemingly templatic effects to be obtained from general markedness constraints ranked so as to allow emergence of the unmarked (explained immediately below).

In correspondence theory, the faithfulness constraints demand completeness of correspondence, identity of correspondent elements, preservation of linear order under correspondence, and so on (see section 4.2). The representations related by correspondence may be the underlying form and its surface counterpart (IO, for input-output, correspondence), base and reduplicant (BR correspondence), or other pairs, such as a simple word and its morphological derivative (OO correspondence).[18] There are different but parallel faithfulness constraints on each of these correspondence relations; for example, there are distinct MAX constraints for IO and BR correspondence (McCarthy and Prince 1994b, 1995; Urbanczyk 1995, 1996a; Benua 1997).

These different dimensions of faithfulness are the key to allowing emergence of the unmarked. Suppose $\mathbb{C}$ is some universal markedness constraint, such as NO-CODA. Under the ranking in (24), and disregarding other faithfulness constraints, $\mathbb{C}$ is obeyed in the reduplicant, by virtue of incomplete reduplication (violating MAX_{BR}), but violated in the language as a whole (satisfying MAX_{IO}):

(24) A Ranking for Emergence of the Unmarked

$\text{MAX}_{IO} >> \mathbb{C} >> \text{MAX}_{BR}$

In this way, though $\mathbb{C}$ is a markedness constraint of complete generality, unable to mention the reduplicant or other morphological entity, its activity emerges only in reduplicants because it is crucially dominated by MAX_{IO}. If the GTH is right, then the descriptive effects of all putative prosodic templates will be derivable from a simple, independently motivated interface theory (ALIGN-STEM) and independently motivated markedness constraints deployed in rankings like (24).

GTH is a restrictive theory of templates. Indeed, it is so restrictive that it could not account for the Rotuman phases even if, contrary to fact, it were desirable to do so on other grounds. To show this, I will pursue an analysis based on (24) until it goes wrong.

To apply (24) to Rotuman would require two dimensions of correspondence. One is IO correspondence, relating the underlying form to the surface complete phase. The other is OO correspondence, which relates the output form of the complete phase directly to the incomplete phase:

[18]. For OO correspondence and related approaches, see among others Buckley (to appear), Benua (1995, 1997), Burzio (1994, 1997), Kager (to appear), Kenstowicz (1995, 1996), Kraska-Szlenk (1995), Orgun (1994, 1996), and Pater (1995).

(25) One View of Correspondence in the Phase Relation

Input:	/rako/		
	⇓		
Output:	ráko	⇒	rák
	Complete		Incomplete

This architecture follows Benua's (1995) treatment of truncation and Burzio's (1997) treatment of affixation. It presupposes that the incomplete phase is derived morphologically from the complete phase.[19] Under (25), there are two distinct systems of faithfulness, Faith_{IO} and Faith_{OO}. The idea is to deploy the markedness constraint ALIGN-HEAD-σ between these two faithfulness systems, substituting it for ℂ in (24):

(26) A Putative Ranking for Emergence of the Unmarked in Rotuman

Faith_{IO} >> ALIGN-HEAD-σ >> Faith_{OO}

For instance, substituting MAX for Faith, we get the example in (25): underlying /rako/ is mapped faithfully in the IO dimension, respecting MAX_{IO}, but ALIGN-HEAD-σ takes over in the OO dimension, with consequent violation of MAX_{OO}.

Although this analysis looks superficially plausible, it is not a workable account of the phase alternation. The problem is that the two phases differ not just in faithfulness, as in (26), but also in markedness. Recall the argument made in (14): the ranking of ALIGN-HEAD above SYLL=μ gives Rotuman its non-uniform prosodic structure, with heavy syllables required finally in incomplete-phase words and prohibited everywhere else. But the ranking in (26) describes a different — and wrong — situation: heavy syllables are required finally in incomplete-phase words, permitted finally in complete-phase words, and prohibited non-finally. The hierarchy (26) wrongly entails that complete phase words can end in heavy syllables because an input like /rak/, drawn from the rich base, would perfectly satisfy top-ranked Faith_{IO}. In somewhat more general terms, the problem is that Rotuman has non-overlapping structural possibilities in the two phases: only final light syllables in the complete phase, but only final heavy syllables in the incomplete phase. Emergence of the unmarked through rankings like (26) is suited to describing a different situation, involving partial overlap: generally the structures A and B are permitted, but in some restricted morphological domain only the less marked A is allowed.

In sum, the Rotuman phase alternation cannot be analyzed morphologically in a way that is compatible with the GTH. Hale and Kissock's (1998) conclusion that phase is not a primarily morphological phenomenon, which is derived from empirical considerations, finds top-down support from the theory of Prosodic Morphology: if the most restrictive theory of templates is correct, then the phase alternation simply could not be analyzed templatically in any case.

There is a sense, however, in which the Rotuman phases actually do have a templatic basis. ALIGN-STEM is really a template; templates in general express morphology→prosody homologies, and ALIGN-STEM expresses the Stem→PrWd homology. But ALIGN-STEM is not a morphological template imposed on just one of the phases. Instead, it checks every single stem for a homologous PrWd. And ALIGN-STEM is crucially dominated. The prosodic constraints that dominate it force ALIGN-STEM to be violated with monomoraic suffixes, and the unaligned stem is in the complete phase, for reasons I went into above. The overall picture is typical of non-uniformity effects in the sense of Prince (1993); here the template itself is non-uniform, with striking consequences for the morphology→prosody mapping and the resulting prosodic structure.

[19]. In a phonological analysis, like the one proposed here or the one in Hale and Kissock (1998) and Hale, Kissock, and Reiss (1998), both phases are derived directly from the input, as I have tacitly assumed throughout.

4. SEGMENTAL AND PROSODIC FAITHFULNESS

In sections 2 and 3 I focused mainly on markedness constraints and the morphology-prosody interface. Faithfulness is the other component of an OT grammar. Section 4.1 briefly reviews the correspondence theory of faithfulness and then applies it to the various phase alternations — metathesis, deletion, and umlaut. Section 4.2 looks at a prosodic faithfulness effect in the phase alternation, relating it to some topics in correspondence theory and Prosodic Morphology.

4.1. Faithfulness and the Phase Alternations

We've now dealt with the elements of Rotuman prosody. We also have a comprehensive account of the phase alternation in words where it has no faithfulness effects, /...VV/ words (1d) and (vacuously) /...Vː/ words (1e). But nothing has been said yet about the choice among metathesis, deletion, and umlaut in the incomplete phase of /...VCV/ stems (1a–c). ALIGN-HEAD-σ entails that stems in the incomplete phase end in a heavy syllable, and this leads inevitably to an unfaithful analysis of underlying /...VCV/ stems like /pure/, /rako/, or /mose/. By itself, though, ALIGN-HEAD-σ cannot determine the type of unfaithfulness that ensues; there are many ways to make a final heavy syllable, and it is up to the ranked faithfulness constraints to determine the optimal one. At this point, correspondence theory becomes especially important as a means of negotiating among the various options.

Correspondence is defined as follows:

(27) Correspondence (McCarthy and Prince 1995, 1999)

Given two strings S_1 and S_2 standing to one another as input to output, base to reduplicant, simple form to derived form, etc., correspondence is a relation $\Re$ from the elements of S_1 to those of S_2. Elements $\alpha \in S_1$ and $\beta \in S_2$ are referred to as correspondents of one another when $\alpha \Re \beta$.

A fully characterized candidate includes a phonological form and some relation $\Re$ between it and its input. Candidates and their correspondence relations are evaluated by faithfulness constraints, of which the following will be most important here:

(28) MAX ("No deletion")

Every element of S_1 has a correspondent in S_2.

(29) DEP ("No epenthesis")

Every element of S_2 has a correspondent in S_1.

(30) LINEARITY ("No metathesis")

S_1 is consistent with the precedence structure of S_2, and vice versa.

Let $x, y \in S_1$ and $x', y' \in S_2$.

If $x \Re x'$ and $y \Re y'$, then

$x < y$ iff $\neg (y' < x')$.

(31) UNIFORMITY ("No coalescence")

No element of S_2 has multiple correspondents in S_1.

For $x,y \in S_1$ and $z \in S_2$, if $x \Re z$ and $y \Re z$, then $x=y$.

When applied to the IO correspondence relation, MAX and DEP prohibit deletion and epenthesis, respectively. LINEARITY prohibits metathesis, by requiring that correspondence preserve linear-order relations (see also Gnanadesikan 1995 and Hume 1995, 1998). And the similar UNIFORMITY constraint militates against segmental coalescence, by prohibiting mappings of multiple input segments onto a single output segment (see also Gnanadesikan 1995, Keer to appear, Lamontagne and Rice 1995, and Pater 1999). Additional constraints are defined in

McCarthy and Prince (1995, 1999), and a few of them will be presented as they are needed below. In particular, constraints demanding that correspondent elements have the same prosodic role are introduced and discussed later.

Even prior to extensive analysis, it is possible to discern a rough pattern of ranking in the realization of the incomplete phase of /...VCV/ words:

(i) The metathesis pattern (1b) is preferred. It occurs whenever the resulting vowel sequence rises in sonority and so is a possible light diphthong.

(ii) The umlaut pattern (1c) is dispreferred relative to metathesis. Umlaut affects back+front vowel sequences, but only when metathesis is impossible because the vowels do not rise in sonority. So <u>mose</u> and <u>futi</u> umlaut to <u>mös</u> and <u>füt</u>, but <u>pure</u> metathesizes to <u>puer</u>.

(iii) The deletion pattern (1a) is least preferred. Deletion occurs only when metathesis is impossible because the vowels do not rise in sonority and umlaut is impossible because the vowels do not constitute a back+front sequence.

From an OT perspective, (i)–(iii) represent conditions of decreasing faithfulness to the input, relative to a language-particular constraint hierarchy: deletion is least faithful, umlaut more so, and complete preservation (through metathesis) most of all. Unfaithfulness of any ilk is demanded by ALIGN-HEAD-σ, which (indirectly) requires a final heavy syllable.

Metathesis is the most faithful mapping of a /...VCV/ input that still satisfies ALIGN-HEAD-σ. It violates the faithfulness constraint LINEARITY, which demands that linear precedence relations among segments be preserved under correspondence. In Rotuman, this violation of LINEARITY is compelled by ALIGN-HEAD-σ, of course, and also by MAX. The ranking between these two faithfulness constraints expresses the preference for metathesis over deletion:

(32) Metathesis from MAX >> LINEARITY

$/pur_1e_2/$	MAX	LINEARITY
a. ☞ (pue_2r_1)		*
b. (pur_1)	* !	

(The subscripted indices are just a convenient way to keep track of correspondent elements.) In the input, the order of segments is <u>r</u> > <u>e</u>. The output correspondents of those elements occur in the reverse order in form (32a), violating LINEARITY. The failed candidate (32b) spares this violation, but at the expense of violating MAX by positing no correspondent at all for input <u>e.</u> Since (32a) is optimal, MAX must dominate LINEARITY.

Metathesis occurs only in /...VCV/ words, and then only when the two vowels are in the appropriate sonority relation to form a light diphthong. In /...VV/ words, there is no need for metathesis, because ALIGN-HEAD-σ is obeyed without further ado, simply by positing a final heavy syllable (see (14)). The same goes for /...Vː/ words.

Although metathesis takes precedence over deletion, deletion does occur when the metathetic option is barred by high-ranking constraints. Following Kaye (1983) and Kaye and Lowenstamm (1984), Rosenthall (1994) posits a constraint, LIGHT-DIPH, which demands that light diphthongs rise in sonority (cf. (7)). It crucially dominates MAX in Rotuman, as shown by the following tableau:

(33) Deletion from LIGHT-DIPH >> MAX

/rak$_1$o$_2$/	LIGHT-DIPH	MAX
a. ☞ (rak$_1$)		*
b. (rao$_2$k$_1$)	* !	

Both of these candidates obey ALIGN-HEAD-σ, because they end in stressed (heavy) syllables. Form (33b) has a monomoraic diphthong followed by a moraic coda, like puer in (2b), but since the diphthong falls in sonority, LIGHT-DIPH is fatally violated. The alternative is to delete the o, thereby violating MAX.

Thus far, I have motivated the following ranking:

(34) Interim Ranking

LIGHT-DIPH, ALIGN-HEAD-σ >> MAX >> LINEARITY

The two top-ranked constraints can compel violation of MAX, but metathesis (a LINEARITY violation) is preferred to outright deletion. The following summary tableaux put the system to the test:

(35) Summary Tableaux

a. Metathesis Case

/pur$_1$e$_2$/	LIGHT-DIPH	ALIGN-HEAD-σ	MAX	LINEARITY
a. ☞ (pue$_2$r$_1$)				*
b. (pur$_1$)			* !	
c. (pú.r$_1$e$_2$)		* !		

b. Deletion Case

/rak$_1$o$_2$/	LIGHT-DIPH	ALIGN-HEAD-σ	MAX	LINEARITY
a. ☞ (rak$_1$)			*	
b. (rao$_2$k$_1$)	* !			*
c. (rá.k$_1$o$_2$)		* !		
d. (ro$_2$k$_1$)			*	* !

The only new candidate introduced here is rok (35b.d), which combines metathesis and deletion. Since a candidate with deletion only is available in rak (35b.a), rok is harmonically bound and so it can never be optimal.

Other candidates naturally come to mind. Some, such as trimoraic *raok with a heavy diphthong, are ruled out by undominated constraints discussed in section 2. Candidates like *ra.ók, with stress "shift" (cf. ráko), raise additional issues that are addressed below in section 4.2. The other candidates bring out certain details of faithfulness theory. For instance, the candidate *$\widehat{\text{rao}}$ ought to tie with rak, since both violate MAX equally. This shows, not unexpectedly, that deletion of a consonant and deletion of a vowel have a very different status, and that constraints regulating them are ranked differently in Rotuman. Concretely, it will suffice to differentiate consonant- and vowel-specific versions of MAX, with the ranking ⟦MAX-C >> MAX-V⟧ to select rak over *ra͡o. Another candidate is *roak, in which o metathesizes past both k and a to produce a licit light diphthong. This form experiences multiple violation of LINEARITY, but that is not decisive, because low-ranking LINEARITY must always be superseded by MAX, no matter how many times it is violated (see Prince and Smolensky 1993 on "the strictness of strict domination"). Rather, the difference here is categorical, not quantitative: *roak has V-V metathesis, while puer has V-C metathesis. While V-C metathesis is not uncommon, to my knowledge processes of V-V metathesis have been proposed on just three occasions, in Kasem (Chomsky and Halle 1968), Latvian (Halle and Zeps 1973), and Old English (Keyser 1975). All three involve very abstract analyses, in which the underlying representations and/or the consequences of metathesis are by no means apparent; in fact, Kasem and Old English have been reanalyzed in ways that do not involve V-V metathesis at all (de Haas 1988, Kiparsky and O'Neil 1976). It therefore seems reasonable to prohibit V-V metathesis outright (cf. Ultan 1978). The deeper reasons for this universal prohibition may lie in a fuller understanding of C-V metathesis, perhaps along the lines of Steriade (1990).[20]

Metathesis also takes precedence over umlaut, which itself takes precedence over deletion. Umlaut is observed only in cases where metathesis is ruled out by high-ranking LIGHT-DIPH; hence, it is only possible with vowel sequences of equal or falling sonority. Umlaut is also limited to vowel sequences with the order back+front, such as these:[21]

(36) Umlaut in the Incomplete Phase

	Underlying	Complete	Incomplete	Gloss
a.	/...oCe/	mose	mös	‘to sleep’
b.	/...uCi/	futi	füt	‘to pull’

These words are all of the form $CV_{Back}CV_{Front}$ in the complete phase, but $CV_{Front}C$ in the incomplete phase. The penultimate vowel retains all of its other properties — rounding and height — while taking on the fronting of the missing final vowel.

In the view of many analysts (Besnier 1987, van der Hulst 1983, McCarthy 1986, Mester 1986, Saito 1981), Rotuman umlaut is a coalescence process.[22] The final vowel is not literally deleted, but rather is combined with the preceding vowel. There is more than one way of understanding coalescence in correspondence theory (Causley 1997, Gnanadesikan 1995, 1997, Lamontagne and Rice 1995, McCarthy and Prince 1995, Pater 1999), depending on whether segments or features are seen as the primary objects of combination. For concreteness I will

[20]. Another difference between *roak and puer is that the former has metathesis of non-adjacent segments. This too may be universally prohibited, as proposed by Poser (1982). Yet another possibility, afforded by Smolensky's (1995) proposed local constraint conjunction, is to construct a power hierarchy of a suitable LINEARITY constraint, with the ranking ⟦LINEARITY^3 >> LINEARITY^2 >> MAX >> LINEARITY^1⟧. Then only local metathesis would be permitted in Rotuman to avoid MAX violation

[21]. Inputs of the form /...aCi/ also undergo umlaut; see McCarthy (1995) for the details.

[22]. Cairns (1976) considers and rejects a coalescence analysis of Rotuman. His grounds: his survey of coalescence processes yielded no other cases in which front rounded vowels are the result of coalescence (p. 281). Hoeksema and Janda (1988: 228–9) cite this finding as evidence against later incarnations of the coalescence analysis (such as those in Saito 1981 and McCarthy 1986). It is difficult to know what to make of this typological claim, since it is not embedded in an actual theory of coalescence. In any case, the claim does not seem to be true; according to Sohn (1987), Korean has a process of vowel coalescence that produces front rounded vowels in free variation with vocoid sequences.

adopt the segmental approach here, though nothing depends on that choice. (See McCarthy 1995 for a featural approach.)

Under a segmentally-based view of coalescence, Rotuman umlaut satisfies MAX, because every input segment has a correspondent in the output. But it does so at the expense of violating UNIFORMITY, which prohibits two or more input segments from sharing an output correspondent. Moreover, coalescent forms also violate LINEARITY in Rotuman, since the two vowels that join are not adjacent in the corresponding complete phase: compare complete-phase $\underline{fu_1t_2i_3}$ with incomplete-phase $\underline{\text{fü}_{1,3}t_2}$. The umlauted vowel has dual allegiances — it strives to be faithful to the featural composition of both its input correspondents. The result is coalescence, a merger of the features of both correspondent vowels, taking [−back] from the second of them.

Since coalescence spares a MAX violation, we require the ranking in (37); part of it is new (MAX >> UNIFORMITY) and part of it confirms a result previously established (MAX >> LINEARITY — see (32)):

(37) MAX >> UNIFORMITY, LINEARITY

/$fu_1t_2i_3$/	MAX	UNIFORMITY	LINEARITY
a. ☞ $\text{fü}_{1,3}t_2$		*	*
b. fu_1t_2	* !		

With MAX standing at the top of this hierarchy, deletion is the least favored option. Ranked below MAX are the two constraints violated in Rotuman coalescence, the anti-coalescence constraint itself and LINEARITY. This tableau shows that, because of the particular circumstances obtaining in Rotuman, coalescence is really a special case of metathesis, since all instances of coalescence also involve CV→VC reordering. This means that UNIFORMITY and LINEARITY can't be ranked with respect to one another in the grammar of Rotuman; apart from transitivity of ranking, the basis of ranking is conflict, and no conflict is possible when violation of one constraint happens to entail violation of the other.

Coalescence is only possible with combinations V_1CV_2 in which V_1 is back and V_2 is front. The resulting vowel $V_{1,2}$ is identical to V_1 except that it takes on the frontness of V_2. Accounting for these observations requires an apparatus of ranked IDENT constraints, which select among the conflicting featural allegiances of the coalescent segments or block coalescence entirely when the conflicts are irresolvable under ranking. Predominant faithfulness to V_1 is a consequence of its status as prosodic head, since it is the locus of stress (Alderete to appear, Beckman 1998); only preservation of V_2's frontness takes precedence. I will not develop these final details here, because there are ample precedents in the literature on coalescence under correspondence theory.[23] But I will say more about faithfulness to prosodic heads in the next section, and in the last paragraphs of this section I will focus on a more central theme of this article, homogeneity of target and heterogeneity of process under OT.

The ranking in (37) is a core element of Rotuman phonology. A markedness constraint, ALIGN-HEAD-σ, characterizes the output target of the incomplete-phase stem, and (37) says how that constraint is to be satisfied. Metathesis incurs the least bad violations under (37): only low-ranking LINEARITY is violated by metathetic candidates. But metathesis is sometimes excluded

[23]. See Gnanadesikan (1997: 139ff.) on how coalescence can be, in effect, non-structure-preserving, yielding a vowel that is not otherwise permitted. This is of obvious relevance to the problem of umlauted vowels in Rotuman.

for structural reasons, because the resulting vowel sequence would breach LIGHT-DIPH or other undominated prosodic constraints. And if metathesis is excluded, then the candidate ranked next in faithfulness is one with coalescence, which violates both of the low-ranking constraints in (37). Finally, if coalescence is ruled out for the reasons just given, then the only remaining option is to violate the higher-ranking faithfulness constraint in (37), MAX.

This means that (37), embedded in a ranking that includes the other constraints discussed here, provides a formal account of the diverse processes that produce incomplete-phase stems in Rotuman. The target ALIGN-HEAD-σ underdetermines the outcome; there are many ways to form a final stressed, heavy syllable. With /...VV/ stems like ʔo.i/ʔo͡i, the target conditions can be met simply by changing the prosodic analysis, without being unfaithful to the input. With /...Vː/ stems like sikā/sikā, no change at all is necessary. But with /...VCV/ words, there is an observed hierarchy of preferences, and (37) instantiates that hierarchy: metathesis is best, because it is most faithful; next comes coalescence; last is deletion, which is least faithful because MAX is top-ranked in (37). This analysis emphasizes the significance of constraint ranking in defining grammars within OT, and it shows how ranked faithfulness constraints negotiate the heterogeneous processes that may be called on to satisfy a single output target.

Previous accounts of Rotuman do not fare as well in dealing with the diverse phase alternations. They can be divided into two general approaches: pure rule-based analyses, and pre-OT accounts based on satisfying a templatic target. I will discuss each in turn.

Advocates of rule-based analyses of Rotuman include Cairns (1976), Hoeksema and Janda (1988), Janda (1984), and Odden (1988). The proposed rules, when they are worked out at all, do not seem to generalize beyond the first-order descriptive categories. Every way in which the phase alternation is realized requires a separate rule. For instance, Hoeksema and Janda posit the metathesis rule in (38), which applies to just one phonologically-defined subset of Rotuman words:

(38) Rotuman Metathesis in Hoeksema and Janda (1988) (morphological conditions omitted)

$$/\,\underset{1}{X}\ \underset{2}{\begin{bmatrix} V \\ \underline{m}\ \text{high} \end{bmatrix}}\ \underset{3}{C}\ \underset{4}{\begin{bmatrix} V \\ \underline{n}\ \text{high} \end{bmatrix}}\ / \rightarrow /1\ 2\ 4\ 3/, \text{ where } \underline{m} > \underline{n}$$

The condition that the affected vowels must fall in height is stipulated in the morphological process itself. Because it is merely stipulated in the context of a morphological rule, this condition cannot be related to known typological regularities, such as the form of light diphthongs and the bimoraic upper-bound on syllable size. Other rules, each with their own stipulations, will be required for the other alternations. No greater generality is attempted nor, it would seem, even possible.

Templatic accounts of Rotuman have been much more successful than the rule-based approaches. The idea, as in (23), is to see the phase difference in terms of two CV templates differing in the presence or absence of a final V-slot or equivalent (Besnier 1987, van der Hulst 1983, McCarthy 1986, 1989, Mester 1986, Saito 1981). The key to making this work is C/V tier segregation, the assumption that Rotuman vowels and consonants are arrayed on separate tiers (cf. McCarthy 1979, 1981). Because of C/V tier segregation, metathesis can be integrated into a system of "automatic" repairs for stranded vowel melodemes, as in (23).

With tier segregation, the possibility of metathesis is hard-wired into every phonological representation — in essence, it's a stipulated regularity of the Rotuman lexicon which has overt consequences in the incomplete phase. In OT, though, there is a rich base — regularities must emerge from constraints on output forms interacting with faithfulness, without any language-particular assumptions about inputs. For this reason, it is not possible in OT to hard-wire the possibility of metathesis into the lexical entries of specific languages; all interlinguistic differences come from the ranking of constraints, and metathesis in Rotuman is a consequence of the ranking ⟦MAX >> LINEARITY⟧. More broadly, OT takes much of the burden of explanation off of representations (e.g., tier segregation) and places it on constraints (e.g., LINEARITY), which are violable under domination. Thus, consonant-vowel tier segregation is superfluous in an OT analysis of Rotuman, and, if language-particular, is antithetical to fundamental premises of OT.[24]

Suppose, though, that we put these premises of OT aside and, as an intellectual exercise, pursue the idea that Rotuman has tier segregation within an OT analysis. The idea, then, is that the Rotuman lexicon consists of tier-segregated forms like /{p_1r_2, u_ae_b}/,[25] which Gen is free to improvise on. Given this as input, SYLL=μ (5) and ONSET will force the syllabically most harmonic output $\underline{p_1u_ar_2e_b}$. When ALIGN-HEAD-σ is relevant, though, the same input will be analyzed as $\underline{p_1u_ae_br_2}$. In this analysis there is no technical violation of LINEARITY, and so there is no literal metathesis. An assumption about the form of the lexicon seems to do the work of LINEARITY-violation. So LINEARITY could undergo a kind of apotheosis, becoming a "hard" constraint. (Moreover, there is now a structural rather than substantive account of the non-optimality of doubly metathetic forms like <u>*roak</u> for <u>rak</u> from /{rk, ao}/ — V-V metathesis is impossible because all vowels are on the same tier.)

However attractive this metathesis-less account may appear on superficial inspection, it is fatally flawed. For one thing, it cannot represent the lexical contrast between /CVV/ and /VCV/. Words like <u>usi</u> 'bush sp.' and <u>sui</u> 'bone' (and 27 other minimal pairs among the disyllables) will receive identical lexical representations as /{s, ui}/. For another, this analysis cannot deal in a sensible way with the deletion alternations like <u>rako</u>/<u>rak</u>. Since consonants and vowels are unordered in the input, why precisely is the incomplete-phase form <u>rak</u> and not the equally faithful *<u>rok</u>? One might appeal to some constraint other than faithfulness — for instance, left-to-right association of vowels — to favor <u>rak</u> over *<u>rok</u>, but then it is an accident that the vowel preserved in <u>rak</u> happens to be the same vowel that occurs between <u>r</u> and <u>k</u> in the corresponding complete phase <u>rako</u>. No superficial technical fix is appropriate, because the problem derives directly from the core assumption of tier segregation theory.

Perhaps a way to rescue tier segregation would be to combine it with underlying specification of the skeleton (so (23a) would be a typical underlying representation). This analytic move solves the problem of representing the contrast between /CVV/ and /VCV/. It also solves the problem of <u>rak</u> versus *<u>rok</u>. In the lexical entry for <u>rako</u>, the <u>a</u> is linked to a V slot between <u>r</u> and <u>k</u>. Because it preserves that linkage, <u>rak</u> is more faithful to the lexical form than *<u>rok</u> is. But what is this faithfulness constraint, which favors the output in which the order of linked elements is the same as in the input? It's nothing but a version of LINEARITY, though it is disguised by the more complex representational assumptions. So tier segregation has not eliminated the need for a LINEARITY constraint or for violation of LINEARITY in metathetic forms. I conclude, then, that tier segregation is superfluous.

More broadly, the failure of tier segregation in Rotuman accords with the Optimality-Theoretic imperative to derive linguistic properties from output constraints rather than

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24. For other criticisms of C/V tier segregation, see Gafos (1996, 1998b).

25. Recall that the numerical values of the indices play no role in the theory; they're just a convenient way of keeping track of input-output correspondent pairs.

restrictions on the input. Analogously, it supports the diminished role for underspecification in OT analyses (Prince and Smolensky 1993: Chapt.9, Smolensky 1993, Ito, Mester, and Padgett 1995). Tier segregation in Rotuman is a type of underspecification; it is underspecification of predictable linear-order relations between consonants and vowels (McCarthy 1989). The problem with the underspecified input /{pr, ue}/ is that it requires the lexicon to account for something that is properly in the purview of output constraints interacting with faithfulness. Rather than some peculiarity of the input, it is the ranking ⟦MAX >> LINEARITY⟧ that is responsible for the metathetic alternations.

4.2. Prosodic Faithfulness

4.2.1. The Phenomenon and Basic Analysis

There remains a class of candidates that respect the unviolated prosodic canons and that are consistent with the faithfulness hierarchy (37). Some of these candidates are listed below, with their foot structure shown as usual by parentheses:

(39) Some Seemingly Plausible Incomplete-Phase Candidates from /rakoˀ/ and /heleʔu/

actual		(rak)	he (leʔ)
failed	a.	ra (kō)	hele (ʔū)
	b.	ra (koʔ)	hele (ʔuʔ)
	c.	a (rok)	he.e (luʔ)
	d.	ra (ok)	hele (uʔ)

The forms in (39a) and (39b) satisfy ALIGN-HEAD-σ by adding weight to the final syllable, either by lengthening the final vowel or by consonantal epenthesis. The lengthening is particularly troubling, since we know that vowel lengthening is permitted under other conditions (see section 2). The forms in (39c) avoid deletion (and vowel-vowel metathesis) by double vowel-consonant metathesis, in a kind of domino effect. Only low-ranking LINEARITY and ONSET are violated. Most serious of all is case (39d) — it has metathesis and a hiatal sequence, both of which the language tolerates freely, and it spares all other complications. It seems clear that *ra.(ok) and *hele.(uʔ) ought to be optimal, as the following tableau shows:

(40) Potentially Problematic Evaluation of (rak) vs. *ra.(ok)

$/rak_1o_2/$	MAX	LINEARITY	ONSET
a. $ra.(o_2k_1)$		*	*
b. (rak_1)	* !		

Explaining why *ra.ok is impossible departs slightly from the main line of analysis, but leads to some further insights (and questions) about how faithfulness functions in the Rotuman phase system.

Most of the faithfulness constraints discussed so far have involved preserving segments or segmental strings. But there are also constraints demanding faithfulness to aspects of prosodic structure, such as DEP-μ and MAX-μ from section 2. In Rotuman, faithfulness to metrical feet is also an important element of the phonology. It can be observed in two circumstances: in the mapping from input to output, where it accounts for the restricted distribution of long vowels (see (11) in section 2); and in the relation between the two phases, where it yields an effect akin to prosodic circumscription in rule-based phonology. More broadly, prosodic faithfulness constraints lead to a general cross-linguistic theory of circumscriptional effects, pursued in

McCarthy (to appear a) and Ito, Kitagawa, and Mester (1996), and to a general theory of lexical stress and accent, pursued in Alderete (1999) and Pater (1995).

First there are details of formulation to consider. Following an implementational decision by McCarthy and Prince (1995), I assume that correspondence is a relation from segment to segment, so prosodic faithfulness is mediated by segments bearing specific prosodic roles, as in the following constraint:

(41) HEAD-MATCH

If α is in H′(PrWd) and $\alpha\Re\beta$, then β is in H′(PrWd).

Thus, two forms will satisfy HEAD-MATCH if their main-stressed vowels are in correspondence.

The idea is that HEAD-MATCH selects (rák) over *ra.(ók) by comparing them to the complete-phase form (ráko). Since the vowel a occupies the stressed nucleus in complete-phase (rá$_2$ko$_4$), only the actual output form (rá$_2$k) satisfies HEAD-MATCH. The same goes for the other failed candidates in (39):

(42) Violations of HEAD-MATCH in Failed Candidates from (39)

a. *ra$_2$.(ó$_4$k)

b. *ra$_2$(kǒ́$_4$)

c. *ra$_2$(kó$_4$ʔ)

d. *a$_2$(ró$_4$k)

All of these forms have the required final stress of an incomplete-phase stem, but they have "shifted" the stress from the correspondent of a$_2$ to the correspondent of o$_4$. The following tableau completes the argument, showing that HEAD-MATCH must dominate MAX if it is to favor (rák) over *ra.(ók):

(43) HEAD-MATCH >> MAX

(rá$_2$ko$_4$) he (lé$_4$ʔu$_6$)	HEAD-MATCH	MAX
a. ☞ (rá$_2$k) ☞ he (lé$_4$ʔ)		*
b. ra$_2$.(ó$_4$k) hele$_4$ (ú$_6$ʔ)	* !	

The forms in (43a) have the required relation between the prosody of the complete phase and the prosody of the incomplete phase: the correspondent of the prosodic head is also a prosodic head. In the failed candidates, by contrast, headship is skewed between different correspondent segments. The preference for (43a), then, is a faithfulness effect, but it differs from more familiar faithfulness effects in two respects: it is faithfulness to the related complete-phase form, rather than faithfulness to the input lexical representation; and it is faithfulness to an aspect of prosodic structure rather than segmentism. I will discuss each of these properties in turn.

4.2.2. Details I: Faithfulness to What?

According to (43), HEAD-MATCH compares the incomplete phase with the output form of the complete phase — not with the input. Could we avoid the need for comparison of output forms by insisting that the input is already supplied with prosodic structure, as various readers have suggested to me? Since some underlying foot structure is needed in Rotuman to account for exceptional vowel length (see section 2), why not assume that all words have lexical feet, deriving both (ráko) and (rák) directly from underlying /(ráko)/?

The standard pre-OT objection to this line of analysis is that predictable prosodic structure, like other non-contrastive properties, is not specified underlyingly. In OT, the objection has to be put differently, since contrastiveness is a consequence of the interaction between faithfulness and phonological markedness, rather than a stipulation about the lexicon (see the discussion in section 2 of richness of the base). A predictable property is one that can be consistently and correctly derived from inputs with the right structure, inputs with the wrong structure, and inputs with no structure at all. In short, predictable prosodic structure is not reliably present in the input, so one cannot presuppose that all underlying forms will have conveniently correct foot structure like /(ráko)/. (For example, an input with an unaligned foot like /(tóki)ri/ will not receive a faithful analysis in Rotuman.) There's no way around it: the incomplete phase is faithful to derived, not underlying, foot structure.

The incomplete phase also shares some derived segmental properties with the complete phase. Several phonological processes affect the penultimate vowel under the influence of the final vowel. (For further discussion of these processes and transcriptional details, see McCarthy 1995.) In the incomplete phase, the triggering final vowel might be deleted, but the penultimate vowel still shows the effects of these processes, as in the following examples (given here in IPA transcription based on Churchward's descriptions):

(44) Segmental Alternations (Churchward 1940: 72ff.)

a. /e/ and /o/ raise before a high vowel:

	Com. Ph.	Inc. Ph.	
/...eCi/	fe̝pi	fe̝p	'to be slow'
/...eCu/	se̝ru	se̝r	'to comb'
/...oCu/	lo̝ʔu	lo̝ʔ	'to bend at an angle'

b. /ɑ/ becomes ɒ before a high vowel:

/...ɑCu/	hɒŋu	hɒŋ	'to awaken'

c. /ɑ/ fronts to æ before e:

/...ɑCe/	læče	læč	'coral'

d. /ɑ/ is backed before ʔ or h followed by o:

/...ɑʔo/	fɑ̠ʔo	fɑ̠ʔ	'nail'
/...ɑho/	mɑ̠ho	mɑ̠h	'to become cold'

In all four situations, the vowel of the incomplete phase undergoes the same alternation as the corresponding complete-phase vowel, even though the triggering context (the final vowel) is absent in the incomplete phase. In short, these processes are opaque in the sense of Kiparsky (1973).

So some derived prosodic (43) and segmental (44) properties of the complete phase are reproduced in the incomplete phase. But the two phases are not identical, prosodically or segmentally — they can differ in syllabic structure, vowel fronting (as a result of umlaut), and vowel height (as a result of the "version" alternation discussed by Hale and Kissock 1998). There are, then, both shared and unshared properties.

There are several different ways of addressing these observations. Hale and Kissock (1998) and Hale, Kissock, and Reiss (1998) propose a serial OT architecture for Rotuman, in which the shared properties are derived lexically and the unshared properties are derived postlexically. The literature contains much discussion of serial implementations of OT (e.g., Black 1994, Blevins 1997, Booij 1997, Cohn and McCarthy 1994, Clements 1997, Kenstowicz 1995, Kiparsky 1997, McCarthy and Prince 1993a: Appendix, Potter 1994); a typical approach, which I will call "Stratal OT", involves linking several distinct OT grammars like the strata of Lexical Phonology (Kiparsky 1982) or Harmonic Phonology (Goldsmith 1993). Grammars at different strata are distinct, which means that they have different rankings of the same universal constraints, and the output of one grammar serves as input to the next. Applying Stratal OT to (43) would involve ranking HEAD-MATCH top-most in the postlexical phonology, but lower in the lexical phonology. To account for (44), there would be similar differences in the ranking of constraints on faithfulness to vowel features.

Though Stratal OT is certainly consistent with the facts of Rotuman, it has been criticized on the grounds that the strata required to analyze other cases of opacity are not always independently motivated (see Noyer 1997: 515, Paradis 1997: 542, Roca 1997: 14ff., Rubach 1997: 578). There is also an issue of restrictiveness: classic Lexical Phonology limits between-stratum differences with the Strong Domain Hypothesis (Borowsky 1986, Kiparsky 1984), but nothing comparable is available in Stratal OT (Benua 1997, McCarthy 1999). Indeed, there are important questions about the relationship between Stratal OT and classic Lexical Phonology, since familiar notions like structure preservation do not seem to carry over (McCarthy 1999).

Taking a rather different tack, one might pursue an account of Rotuman that analogizes to other opaque alternations. Sympathy theory is an approach to opacity based on the idea of faithfulness to another member of the candidate set, called the sympathetic candidate (McCarthy 1999, to appear b). Applied to (43), this approach would treat HEAD-MATCH as a sympathy constraint, requiring faithfulness to a sympathetic candidate that is much like the complete-phase form.

The problem with using sympathy in Rotuman is the selection of the right sympathetic candidate. In general, the sympathetic candidate is the most harmonic member of the set of candidates obeying a specific faithfulness constraint, called the selector. But because the phase alternations are so inhomogeneous, involving violation of diverse faithfulness constraints (see section 4.1), there is no single faithfulness constraint which, by acting as selector, could choose those candidates that resemble the complete phase. For example, if MAX-V were the selector, it would select *ra.ók* as the sympathetic candidate relative to *rák* — and so, obviously, this would not help to explain why *ra.ók* is not the incomplete phase of /rako/ (cf. (43)).

A final possibility which seems most promising but is also least developed is to build on the OO faithfulness idea of Benua (1995, 1997) and others. Standardly, two forms are related by OO correspondence if one is derived morphologically from the other. Suppose, however, that some form of OO correspondence is projected onto phonological alternants of whole phonological words, such as the contextual, pausal, and citation forms that are found in some languages. Then OO correspondence would relate the various realizations of a word that depend on its phonosyntactic context. An approach like this has the potential of accounting for Rotuman and also for addressing the lexical/postlexical ordering paradoxes that have been attributed to precompilation theory (Hayes 1990; cf. Odden 1990, 1996).

4.2.3. Details II: Prosodic Faithfulness and Prosodic Circumscription

Faithfulness to prosodic structure reproduces certain effects of positive prosodic circumscription (PPC — McCarthy and Prince 1990a). PPC is one of the key elements of a rule-based approach to Prosodic Morphology. PPC is built around the idea of a parsing function Φ(C, E, B) which returns the prosodic constituent C that sits at the edge E of the base B. The function Φ induces a factoring on the base B, dividing it into two parts: one is the kernel $B{:}\Phi$, the part that satisfies the constraint (C,E); the other is the residue B/Φ, the complement of the kernel within B. Assuming an operator "*" that gives the relation holding between the two factors (normally left- or right-concatenation), the following identity holds:

(45) Factoring of B by Φ

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

In PPC, the $B{:}\Phi$ factor serves as the input to some phonological or morphological operation (such as stress assignment or reduplication), referred to here as O:

(46) Definition of Operation Applying under Positive Prosodic Circumscription

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

That is, to apply O to B under PPC is to apply O to $B{:}\Phi$, concatenating the result with B/Φ in the same way ("*") that the kernel $B{:}\Phi$ concatenates with the residue B/Φ in the base B. In this way, the operation $O{:}\Phi$ inherits everything that linguistic theory tells us about O, except its domain of application.

In an analysis of Rotuman based on PPC, the final foot of the complete phase would be circumscribed and mapped onto a monosyllabic template:

(47) PPC in Rotuman

a. Underlying Form /seseva/
b. Pass through phonology, yielding se(sé.va).
c. Prosodic circumscription by O:Φ(Ft, Right), where O = "map to monosyllable"

i.	O:Φ(se(sé.va))	=	O(se(sé.va):Φ) * se(sé.va)/Φ
ii.		=	O((sé.va)) * se
iii.		=	(seav) * se
iv.		=	se(seav)

In (46c.i–ii), we see the separation of the base into the Φ-delimited portion seva and the residue se. The Φ-delimited string is mapped onto a monosyllabic foot template (46c.iii), and the form is re-assembled (46c.iv) by attaching the residue in the position where it originated.

PPC has always stood uneasily in relation to the overall goals of the theory of Prosodic Morphology. The problem is that PPC enjoys no direct support outside a relatively narrow range of infixational and templatic phenomena. Indeed, the most compelling argument for PPC may be the (now doubtful) existence of its symmetric counterpart, negative prosodic circumscription (NPC):

(48) Definition of Operation Applying Under Negative Prosodic Circumscription

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

NPC has also been applied to infixation, but its main use and most compelling independent support is as a formalization of extrametricality. To apply O to B under extrametricality of the Φ-named constituent is just to apply O to B/Φ, concatenating the result with $B{:}\Phi$ in the same way that the residue B/Φ concatenates with the kernel $B{:}\Phi$ in the original base B.

Research on infixation and extrametricality in Optimality Theory has cast considerable doubt on NPC. Processes of infixation via NPC, such as –um– infixation in Tagalog or reduplicative infixation in Timugon Murut, are better understood in terms of the interaction of affixal alignment constraints with the prosodic constraints ONSET and NO-CODA (Prince and Smolensky 1991, 1993; McCarthy and Prince 1993ab). This approach has yielded new typological insights about infixation that cannot be obtained with negative circumscription.

Likewise, work in stress theory has largely dispensed with extrametricality in favor of constraints barring final prominences (see Prince and Smolensky 1993, Hung 1994).

With NPC moribund, PPC has lost its independent support. In contrast, the treatment of circumscriptional phenomena via prosodic faithfulness constraints is strongly connected, through correspondence theory, with the fundamental linguistic notion of faithfulness. The same constraint HEAD-MATCH that produces circumscriptional effects in Rotuman is also responsible for lexical accent phenomena and the treatment of exceptional stress. So prosodic faithfulness makes good sense at every level: theoretical, typological, and descriptive.

5. CONCLUSION

There has been a good deal of research on the Rotuman phase alternations over the years. Though a problem that has already received so much attention would seem to have little left to offer, sometimes it makes sense to revisit well-studied (and seemingly well-understood) topics in the light of more recent theoretical developments.

Optimality Theory has a lot to contribute to our understanding of Rotuman. The various phase alternations seem almost bafflingly diverse, but OT provides a framework for stating a single output target and negotiating among the various processes mapping forms onto that target. OT can do this because of one of its fundamental theses: a grammar is a ranking of markedness and faithfulness constraints, the former expressing output targets and the latter regulating the application of processes. Another problem is that the phase alternation produces significant non-uniformity in prosodic structure, literally requiring heavy syllables, which are otherwise prohibited. And affix-length effects on the distribution of the two phases reflect non-uniformity in the morphology→prosody mapping. Such regions of non-uniformity are typical consequences of OT grammars, because constraints are violable. A final problem is that the phase alternations have often been seen as bizarre and isolated from the phonology of other languages. But OT brings with it a commitment to the universality of constraints and the typological consequences of permuted ranking; indeed, it is precisely because ranking is permutable that the constraints can be universal. From this perspective, as I have argued throughout, Rotuman is not so strange after all: ALIGN-HEAD-σ is also active in Tübatulabal; ALIGN-STEM has the same effect in Yidiɲ and in languages related to Rotuman; HEAD-MATCH is involved in lexical accent systems; and so on.

The results here are also relevant to the theory of Prosodic Morphology, particularly as it has developed within OT. The thesis of constraint universality and the goal of explanation call into question the traditional notion of a prosodic template, leading to the Generalized Template Hypothesis, which limits prosodic templates to certain independently motivated constraints like ALIGN-STEM. The Rotuman phase alternations, I argued, support this hypothesis. And a kind of circumscriptive effect, I showed, could be attributed to the prosodic faithfulness constraint HEAD-MATCH, supporting other work that has developed superior accounts of other circumscriptive phenomena within OT. These results, and other topics raised in the text, suggest that Rotuman still has plenty to offer.

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