On Reduplication and Its Effects on the Base in Maori*

Miriam Meyerhoff and Bill Reynolds
University of Pennsylvania and University of the Witwatersrand

Maori, an Oceanic language spoken in New Zealand, uses both left-edge and right-edge reduplication to realize a variety of derivational and inflectional categories. This paper focuses on one particular type of Maori reduplication in order to illustrate an aspect of the reduplication process which, to our knowledge, has not been discussed in the literature to date: the idea that reduplication may actually have an effect on the phonological form of the base itself. We present an analysis of Maori reduplication which accounts for both the form of the reduplicant and its effects on the base within the framework of Optimality Theory (ÒOTÓ) (McCarthy and Prince 1993a, b, 1994; Prince and Smolensky 1993).

Most aspects of Maori reduplication can be accounted for straightforwardly under such a theory. However, we will show that in order to account for all the facts of Maori reduplication, the function of the Base-Dependence constraint, which operates in the domain of the reduplicant, must have wider scope than has previously been proposed. We will suggest that the domain of Base-Dependence must include more than segmental material, i.e., suprasegmental features have a role to play in defining the optimal reduplicated form. We then show that, given this expanded role of Base-Dependence, reduplication in Maori may affect not only the form of the reduplicant, but also the form of the base.

In Section 1 we provide an introduction to the various types of Maori reduplication as well as an analysis of Maori stress, which will prove to be of particular importance with regard to those reduplication processes which have an effect on the form of the base. Section 2 summarizes HarlowÕs (1991) templatic analysis of Maori reduplication and offers critical commentary thereon. In Section 3 we offer a review of reduplication in OT, drawing primarily from McCarthy and Prince (1994). Section 4 presents an analysis of bimoraic right-edge reduplication in Maori and shows how an Optimality approach can account for all cases through the proper ranking of constraints within the overall constraint hierarchy. We include here as well an analysis of one type of left-edge reduplication in which the phonological shape of the base also undergoes change. Finally, in Section 5 we offer some concluding remarks.

1. Introduction

Maori has simple, characteristically Polynesian syllable structure, i.e., (C)V(V), with heavy or light open syllables. There are no underlying diphthongs (Williams 1971, p. xxxiii); Harlow (1991, 1994) agrees

---

* This paper has benefited greatly from discussions with a number of people. We would like to thank Alan Prince, Gene Buckley, Laura Downing, Hadass Sheffer, Ray Harlow, Peter Keegan, and Winifred Bauer for their comments and criticisms. An especially warm thank you is extended to Peter Keegan for his assistance with questions regarding usage and stress in various reduplication processes discussed here. None of the aforementioned necessarily agree with the analysis presented here, and are certainly not responsible for any of its flaws.

and argues that surface diphthongs (and even some long vowels) are the result of rules applying late in the derivation, i.e., after reduplication (cf. Poser's 1985 similar analysis of Tongan syllabification and stress). Bauer (1981) argues that the mora rather than the syllable is the salient measure for a number of phonological and morphosyntactic processes in Maori; thus, while surface diphthongs may exist and have an effect on stress in some dialects, they may nonetheless in general be regarded as disyllabic for purposes of reduplication. Except for transliterations of English loan words and derived/compound words, no monomorphemic Maori base ever consists of more than four moras (Williams 1971; Biggs 1976; Winifred Bauer and Ray Harlow *pers. comm.*).

1.1 Stress in Maori

Before looking at the various patterns of reduplication found in Maori, we must first examine the languageÕs stress system, since (as we shall show) stress plays a crucial role in determining the optimal output candidates for all types of Maori reduplication. Like the large majority of Austronesian languages, Maori parses words into quantity-sensitive trochaic feet. Unlike most languages in this family, however, Maori forms such feet from left to right, rather than from the right edge of the word (Harlow 1994). Main stress falls on the head of the leftmost foot in a word, and secondary stress on the head of each following foot (with degenerate feet being disallowed):[1]

(1)	a.	Çi.na.÷a	ÔwhitebaitÕ
	b.	Çma.nuÈhi.ri	ÔvisitorÕ
	c.	ÇpaaÈra.i	Ôscreen; push backÕ
	d.	ÇeeÈta.hi	ÔsomeÕ
	e.	ÇpaaÈkee	Ôrough cloakÕ
	f.	kuÇrii	ÔdogÕ
	g.	aÇpaaÈra÷.i	Ôgroup of noble peopleÕ

An OT approach to stress is, we claim, superior to directional parsing insofar as it considers the suitability of each candidate based on the structural well-formedness of the entire word, rather than by applying rules on a foot-by-foot or syllable-by-syllable basis. Thus it need not rely on repair strategies (such as HayesÕ 1994 Ònonexhaustivity conditionÓ), or indeed on any sort of (arguably) stipulative notions such as extrametricality or degenerate feet. In particular, in the case at hand OT provides us with a principled means for explaining outcomes such as (1f) and (1g) Ñ where quantity sensitivity precludes main stress from falling on the first syllable Ñ without having to propose a parse that must Òlook aheadÓ to discover the weight of the second syllable of a word in order to determine that the first syllable must be skipped over when forming the head foot.

---

[1]Some complexities remain unaccounted for by this description; for example, as noted above, there are dialects in which certain sequences of vowels surface as diphthongs, and hence as heavy syllables (so that, for example, *tinei* ÔextinguishÕ may variably surface as /'ti.ne.i/ or /ti'nei/). Additionally, stress in Maori as it is spoken in New Zealand today shows a number of contact-induced influences from English, particularly in the case of loan words. For purposes of this paper, such regional variation and irregularities will be overlooked.

In Optimality terms, then, the stress system of Maori can be characterized through the appropriate ranking of the following constraints (as defined in Prince & Smolensky 1993, pp. 38ff.):

(2) RHTYPE=T: Feet are trochaic.

RHHARMONY: *(HL).

FTBIN(μ): Feet are binary at some level of analysis (here, moraic).

EDGEMOST(Ft',L): The head of the leftmost foot of a word receives primary stress.

PARSE-σ: Syllables are parsed into feet.

All available evidence indicates that the first three of these constraints are unviolated in Maori: Feet are always trochaic, bimoraic (i.e., heavy-light syllables may not form feet), and quantity sensitive. The constraint FTBIN(μ), however, must crucially be seen to dominate PARSE-σ in order to capture the effect of a general ban on degenerate feet (as can be seen from trimoraic words such as (1a) *Çi.na.÷a*). Furthermore, outcomes such as (1f) *kuÇrii* and (1g) *aÇpaaÈra÷.i* require that RHTYPE=T dominate EDGEMOST(Ft',L). The ordering of this subset of constraints, then, as far as can be determined from the surface forms presented in (1), is as shown in (3):

(3) RHTYPE=T, RHHARMONY, FTBIN(μ) >> EDGEMOST(Ft',L), PARSE-σ

1.2 Reduplication in Maori

Reduplication in Maori takes the form of either one- or two-mora prefixes or suffixes to the base.

(4) a.	mao	ÔdistantÕ	**ma**-mao	ÔdistantÕ
b.	parau	ÔfalseÕ	**para**-parau	Ôspeak falselyÕ
c.	taraha	Ôtrap for hawksÕ	taraha-**ha**	Ôtrap for hawksÕ
d.	matapihi	ÔwindowÕ	matapihi-**pihi**	Ôopen upÕ

Apparent instances of internal reduplication are few and turn out to be ephemeral; in all cases they can be attributed to right- or left-edge reduplication prior to lexical compounding or the affixation of a bound morpheme additional to the reduplicant. Thus:

(5) tonga-**re**-rewa Ôa kind of greenstoneÕ

is derived from reduplication of *rewa* Ômelt, floatÕ and subsequent compounding with *tonga* ÔsouthernÕ (greenstone is found in the South Island of New Zealand).

Both right and left-edge reduplication and one- and two-mora reduplicants realize a variety of semantic features; there is, in other words, no consistent semantic relationship between the base and the derived word for any one kind of reduplicant. The impression to be gained from the data in Williams (1971) is that the only systematic distinction to be made between the various reduplicants is typological: Bimoraic reduplicants seem always to be derivational affixes, whereas monomoraic reduplicants may either be derivational or inflectional. However, this is an area that requires further investigation, particularly since there may be variation in how productive some kinds of reduplication are in modern Maori and since some of the kinds of reduplication found in Williams may no longer be a productive or relevant component of the grammar of modern Maori.[2]

Although a clear semantic distinction between the different reduplicants is lacking, there is a clear correlation between the size of the reduplicant and the edge at which it is affixed. A look at all tokens of reduplication that were found in Williams (1971) shows that right-edge reduplication favours a bimoraic template for the reduplicant, while left-edge reduplication favors a monomoraic reduplicant:

(6)

	1 mora	2 moras	Total
Left-edge	434	77	511
Right-edge	6	603	609
Total	440	680	1120

This table does not include numerous tokens where the domain of reduplication is the whole base, e.g., *kani* Ôrub backwards and forwardsÕ _ *kanikani* ÔdanceÕ; *paku* Ôdry, shrivelÕ _ *pakupaku* ÔdriedÕ. Technically, it is impossible to be certain whether total reduplication of a two-mora base is left or right-edge reduplication; however, in view of the very marked preference for bimoraic reduplicants to occur at the right edge of the base, it seems likely that these would also be analyzed by the learner as reduplication at the right edge of the base.

The particular types of reduplicants which are of interest to us here are right-edge and left-edge bimoraic reduplicants which, under certain conditions, have an effect on the moraic structure of the base. Right-edge reduplication is particularly notable for this effect; nearly half the examples of right-edge reduplicants trigger a lengthening of the vowel in the first syllable of the base:

(7)

a.	kohiko	ÔinterruptÕ	koohiko-**hiko**	Ôdo something irregularlyÕ
b.	mate÷a	ÔdeathÕ	maate÷a-**te÷a**	Ôcramped, numbedÕ
c.	porahu	ÔawkwardÕ	poorahu-**rahu**	Ôawkward, annoyingÕ
d.	kowheta	ÔwriggleÕ	koowheta-**wheta**	ÔwrithingÕ
e.	÷oio	ÔasthmaÕ	÷ooio-**io**	Ôweak, wearyÕ
f.	pahuu	ÔexplodeÕ	paahuu-**huu**	Ôpop, crackleÕ

In fact, with only a very few exceptions, this appears to be the regular form for right-edge bimoraic reduplication in the case of trimoraic bases.[3] This pattern never occurs, however, when the base consists

[2]Work in progress by Peter Keegan, University of Waikato, is specifically directed at answering these sorts of questions about reduplication in Maori.

[3]Williams (1971) provides a very small number of trimoraic bases which do not exhibit initial vowel lengthening in the reduplicated form. Four of these should probably be analyzed as compounds in the base; most of the remainder involve *ha-*, *ma-*, and *ko-* prefixes on bimoraic bases; and Peter Keegan (*pers. comm.*) notes that the only other example (*piaka* Ôyoung shootsÕ _ *piakaaka* Ôrootlets, fibrous rootsÕ) is

of two or four moras (assuming, as noted above, that total reduplication of disyllabic bases is to be regarded as an instance of right-edge bimoraic reduplication):

(8)	a	paku	Ôdry, shrivelÕ	paku-**paku**ÔdriedÕ	
	b.	matapihi	ÔwindowÕ	matapihi-**pihi**	Ôopen upÕ
	c.	tiitaka	ÔunsteadyÕ	tiitaka-**taka**	Ôturn over and overÕ
	d.	aawhio	ÔroundaboutÕ	aawhio-**whio**	ÔwhirlpoolÕ

(As examples (8c) and (8d) illustrate, no change occurs in four-mora bases where the first vowel is already long.)

Conversely, there are a limited number of cases in which left-edge reduplication triggers shortening of a base vowel, as in

(9)	a.	hookai	Ôfar apartÕ	**hoka**-hokai	ÔextendÕ
	b.	paatai	ÔaskÕ	**pata**-patai	Ôask and askÕ
	c.	pootae	ÔencirclingÕ	**pota**-potae	ÔroundaboutÕ

It is our claim that these particular types of Maori reduplication Ñ namely the set of right-edge and left-edge reduplicants that are associated with a change in the form of the base Ñ can best be accounted for by means of a grammar which comprises a series of ranked morphophonemic constraints within the framework of Optimality Theory. Furthermore, we shall show that this effect on the base falls out from the ordering of the constraints themselves Ñ i.e., that these forms, though unusual from a cross-linguistic standpoint, are nevertheless the optimal output candidates in Maori.

2. Maori Reduplication as Prosodic Morphology

To date, the only systematic attempt to account for Maori reduplication is the analysis presented in Harlow (1991). Maori reduplication (like most aspects of Maori phonology) is greatly underdescribed and understudied. Harlow, working within a framework of prosodic morphology, suggests that all tokens of reduplication in Maori might be accounted for by the lexically determined application of a variety of reduplication templates based on the syllable structure of the base. The outputs of the copying process are then presumed to be further modified by the cyclic application of phonological rules, specifically syllabification and consonant dissimilation, to the stems and reduplicated forms (cf. Marantz 1982).

A key factor in Harlow's account is the optional rule that he proposes for consonant dissimilation. Harlow suggests that identical consonants which fall, respectively, three and four moras from the right edge of the word dissimilate in derived forms (such as reduplications) and at the phrasal level of Maori phonology. The dissimilation takes the form of deletion of the consonant in derived environments. For example, the morpheme *motu* ÔislandÕ may variably surface as either *motu* or *mou* when prefixed to a

more generally heard in usage as *piiakaaka*, i.e., with the vowel lengthening canonically found in three-mora bases.

form beginning with *t*: thus, *motu* + *tohora* ÔwhaleÕ _ *Moutohora* ÔWhale IslandÕ, and the form *motutere* ÔislandÕ alternates with *moutere* (1991, p. 117). This process is also common in forms where (generally due to reduplication) four identical consonants (separated only by vowels) surface; thus:

(10)	a.	ma÷u÷u	Ôbroken, chippedÕ	maa÷uu-**÷u÷u**	ÔgrittyÕ
	b.	powhiwhi	ÔtangledÕ	poowhii-**whiwhi** ~ poowhiwhi-**whiwhi**	ÔtangledÕ

Harlow suggests that this rule also accounts for why reduplicated trimoraic forms such as those in (7) and (10) surface with long vowels in the first syllable. As we shall see, however, this argument does not prove persuasive.

To account for the various patterns of reduplication which occur with trimoraic (or trisyllabic) stems in Maori, Harlow proposes four templates, which are reproduced verbatim in (11):

(11)
1. reduplication of the first syllable: $\sigma_1\sigma_1\sigma_2\sigma_3$:
   hohoata < *hoata* both meaning Ôthe moon on the third dayÉÕ;
   a-anini < *anini* both meaning Ôgiddy, aching (of the head)Õ.

2. reduplication of the first two syllables: $\sigma_1\sigma_1\sigma_2\sigma_2\sigma_3$ (with dissimilation of the repeated consonant in $\sigma_1\sigma_1$):
   taÛweweke Ôslow, dilatoryÕ < *taweke* ÔlingerÕ;
   maÛnenei < *manei* Ôreach out toÕ

3. reduplication of the first two syllables: $\sigma_1\sigma_2\sigma_1\sigma_2\sigma_3$:
   takatakai Ôwind round and roundÕ < *takai* Ôwrap upÕ;
   riariaki < *riaki* ÔraiseÕ

4. reduplication of all three syllables: $\sigma_1\sigma_1\sigma_2\sigma_3\sigma_2\sigma_3$ (with dissimilation of the repeated consonant in $\sigma_1\sigma_1$):
   paÛkarukaru Ôbreak in pieces (vtr) < *pakaru* ÔbrokenÕ
   *paÛhuÛhu*Û Ôpop, crackleÕ < *pahu*Û ÔexplodeÕ, i.e., *pa-a-hu-u-hu-u* < *pa-hu-u*[4]

(Harlow 1991, p. 122.) Of these proposed templates, numbers 1 and 3 correspond to the mono- and bimoraic left-edge reduplication patterns presented above in examples (4a) and (4b), respectively; these types of reduplication are quite straightforward and easily accounted for within either a templatic or an

[4]Here, Harlow is assuming BauerÕs (1981) analysis of Maori morphophonological processes as being moraic in nature, i.e., Òthat the underlying syllable structure of Maori is σ = (C)V, and all σÕs are unifromly of one mora (μ) length, the mora inhering in the peak. This is the level at which reduplication rules, among others, operateÓ (Harlow 1991, p. 122).

OT framework.[5] HarlowÕs templates 2 and 4, on the other hand, require a good deal of further discussion.

First, we will not here consider template number 2. As Harlow himself notes, ÒPattern 4 is very much the most frequently attested, É while Pattern 2 is rather rareÓ (1991, p. 122). Reduplicated forms such as *taaweweke* and *maanenei*, then, represent a quite limited subset of (and may probably be regarded as lexical exceptions to) the more regular set of forms represented by HarlowÕs fourth template.

Template number 4, then, is of direct concern here, and represents HarlowÕs attempt to explain precisely those reduplicated forms exemplified in (7) above, where lengthening of the first vowel of the stem appears to occur. HarlowÕs claim is that such lengthening is an illusion and actually results from deletion of the onset of the second syllable due to consonant dissimilation. That this argument will not hold water, however, is evident for several reasons. First, if lengthening is due to consonant dissimilation, which is (in all other instances) an optional process, why should deletion of the second consonant in this particular instance be obligatory? Second (and more telling), the template which Harlow is required to utilize to describe the reduplication process for these forms, $\sigma_1\sigma_1\sigma_2\sigma_3\sigma_2\sigma_3$, is quite extraordinary according to any standard templatic account of reduplicative morphology (see, e.g., Marantz 1982; Levin 1985; Prince & McCarthy 1986, 1990). It is either discontinuous or entails simultaneous reduplication at both ends of the word; in either event, it is exquisitely unconstrained in nature (why not, after all, $\sigma_1\sigma_1\sigma_2\sigma_2\sigma_3\sigma_3$, or $\sigma_3\sigma_2\sigma_1\sigma_1\sigma_2\sigma_3$?) and is unattested, as far as we are aware, in any other language. Standard derivational approaches, on the other hand, involve directional mapping to a contiguous template. Yet it is difficult to see how one might account for such a pattern using a more conventional sort of template. Third, while HarlowÕs 1st and 3rd templates are valid for stems of any length, this pattern seems to hold only for stems which are trimoraic in length.

A final problem for HarlowÕs account is that it does not consider (and cannot explain) certain instances of bimoraic left-edge reduplication in which the vowel in the first syllable of the base is not lengthened, but rather shortened Ñ that is, forms such as those listed in (9).

We agree with Harlow that there must be a number of different reduplicants in the Maori grammar. However, we argue that an optional process of consonant dissimilation is not the most effective or constrained way to account for the initial long vowels which surface in one particular type of reduplicated forms. Rather, vowel lengthening must be seen as a systematic consequence of the selection of a particular reduplicant (namely the bimoraic right-edge or left-edge reduplicant) with its associated phonological and morphological constraints, regardless of whether the stem to which this reduplicant attaches contains two, three, or four moras. This, we claim, can only be accomplished by means of a nonderivational approach to reduplication. Additionally, by proposing an account of Maori

[5]Harlow argues that certain template 1 forms lend themselves to optional consonant dissimilation (such as *takai* Ôwrap upÕ _ *ta-takai* _ *taakai* ÔbandageÕ); we would merely note here that various proposals have appeared for handling both dissimilation (see, e.g., Kirchner 1993; Myers 1993) and optionality (see, e.g., Kiparsky 1993, 1994; Reynolds 1994, 1995; Reynolds & Sheffer 1994; Reynolds & Nagy 1994; Nagy & Reynolds 1994) within an OT framework.

reduplication in terms of a series of ranked universal constraints, we think we offer a more insightful basis for the further consideration of Maori grammar as a whole.

3. Reduplication in Optimality Theory

Optimality Theory postulates the existence of two functions basic to all languages that generate and evaluate all possible forms in a grammar. The generation function (GEN) is unconstrained, all possible outputs are created for evaluation, but the evaluation function (EVAL) is a winnowing process which in most cases prevents all but one optimal form from surfacing. In all languages, the evaluation is conducted on the basis of the same set of universal, but violable, constraints. Interlanguage variation is therefore not a product of what the grammars allow to be generated, but is instead a product of how the languages rank a finite set of constraints. An output form is ÒbetterÓ or more optimal than competing possible output forms to the extent that it has fewer violations of certain (generally highly ranked) constraints than any other possible output that is also being evaluated. The optimal form surfacing in the grammar need not, therefore, be perfect; it may (and often does) violate some constraints in the grammar. What is crucial is that the violations it does incur are of less highly ranked constraints than those violated by all other possible forms generated for evaluation. In short, the language-specific ordering of universal constraints determines what constitutes phonological well-formedness in any given language. Only a well-formed string, i.e., the best of all possible strings, will be allowed to surface by the grammar.

In this paper we apply McCarthy and Prince's (1993a, 1994) work on reduplication within an OT framework to the Maori data and find that, by extending the application of one particular constraint in a minimal way, all forms of two-mora right-edge reduplication can be accounted for Ñ including those which affect the phonological form of the base. This analysis differs from Harlow's proposal in a significant way. His analysis requires copying from a special, ad hoc syllabic template in order to generate the forms in which the base vowel lengthens. Our OT analysis, on the other hand, shows that changes in the form of the base after reduplication fall out systematically and naturally as a consequence of a single set of constraint rankings that apply to *all* right-edge bimoraic reduplicants.

The basic premise of McCarthy and PrinceÕs approach is that the constraints which govern each type of reduplication in a language are both universal and morpheme-specific: That is, they Òfix properties that must be declared for every reduplicative morphemeÓ (1993a, p. 61). To begin, there are two fundamental, definitional constraints on the correspondence relation between the base (ÒBÓ) and the reduplicant (ÒRÓ):

(12) IDENTITY: Correspondents are identical.

LINEARITY: R reflects the precedence structure of B, and vice versa.

The IDENTITY constraint serves to set reduplication apart from ÒnormalÓ (concatenative) affixation; it requires that for every Òelement r of the Reduplicant, rÕs correspondent in the Base must be phonologically identical to itÓ (McCarthy & Prince 1994, p. 7). LINEARITY entails preservation in R of the order relation of the elements in B. IDENTITY and LINEARITY together constitute the definition of reduplicative correspondence and are therefore considered to be part of GEN.

All Òfurther constraints on the reduplicant/base relation are in principle and in fact violable; hence, they are É rankable with respect to the other constraints of UGÓ (1994, p. 8). These consist of three sorts of constraints: universal constraints on the *quality* or structural integrity of the reduplicant; universal constraints on the *quantity* or extent of the correspondence between R and B; and morpheme-specific constraints reflecting templatic or phonological requirements on the size or shape of a particular reduplicant and its position (prefix or suffix) with respect to the base.

The pair of constraints which govern the quality of R are as follows:

(13) ANCHORING: The left (right) peripheral element of R corresponds to the left (right) peripheral element of B, if R is to the left (right) of B.

CONTIGUITY: Correspondence is a function from a contiguous string to a contiguous string.

ANCHORING is a type of alignment constraint whose basic function is the equivalent of requiring edge-in mapping of copied material to a template. CONTIGUITY is a necessary complement to LINEARITY; it ensures the inclusion of all segments in the copied string (though their ordering here is unimportant). On the one hand it forbids skipping of elements in B; on the other, it forbids intrusion of foreign elements inside R.

The pair of constraints governing the quantity of copying into R are:

(14) MAX: Every element of B has a correspondent in R.

BASE-DEPENDENCE: Every element of R has a correspondent in B.

ÒComplete satisfaction of MAX is attained in total reduplicationÓ (McCarthy & Prince 1994, p. 9); violations of this constraint will therefore be common, but they should also be minimal. BASE-DEPENDENCE is satisfied when R exactly copies a substring of B; violations occur Òwhen non-base-correspondent material shows up in RÓ (p. 9).

Constraints governing the size, shape, and position of a particular reduplicant will also be considered universal in nature, though generally speaking only one of each particular subset of such constraints will ever have a chance to be active for a given class of reduplicants. Thus, whether a particular reduplicant will be prefixed or suffixed onto B depends crucially on the ranking of the two constraints R=PFX and R=SFX. Similarly, the size of R will be determined by the relative ranking of MAX with respect to constraints such as R=σσ (the reduplicant is minimally disyllabic), $R=\sigma_{\mu\mu}$, $R=W_{min}$, etc. The highest ranked of these latter constraints (assuming it also outranks MAX) will determine which prosodic constituent will serve as the template for the reduplicant.

4. Constraint Ranking in Maori: Bimoraic Right-Edge Reduplication

As noted above, an ideal account of right-edge bimoraic reduplication in Maori will treat all such reduplicant forms as equivalent, regardless of the length of the base. In presenting an Optimality Theoretic account, then, the lengthening of the initial vowel in trimoraic stems should fall out naturally from the ranking of our constraints. As we shall see, this does indeed prove to be the case.

As we noted in (6), the vast majority of cases of right-edge reduplication in Maori involve two-mora reduplicants; these two moras can, however, be either tauto- or heterosyllabic, as can be seen by comparing the forms in (7a-e) with that in (7f). We can thus express the size and shape of this reduplicant in OT terms by means of two undominated constraints:

(15) R=SFX: R is suffixed onto the right edge of the B.

R=FT$_{\mu\mu}$: R is a bimoraic foot.

Additionally, examination of the forms in (7) and (8) establishes that the constraints ANCHORING and CONTIGUITY are never violated; that is, the right edge of the reduplicant always corresponds to the right edge of the base, and copying is always from a contiguous string to a contiguous string. It is equally clear that MAX is satisfied only by forms such as (8a) *pakupaku*, where the base itself is bimoraic; in all of the other examples in (7) and (8), the base consists of either three or four moras, and MAX is violated accordingly. Finally, at least for two- and four-mora bases such as those listed in (8), it would appear that BASE-DEPENDENCE is also unviolated.

The following constraint ranking, then, is sufficient to determine the optimal output form for bases such as (8a) *paku* and (8b) *matapihi*:

(16) R=SFX, R=FT$_{\mu\mu}$, ANCHORING, CONTIGUITY, BASE-DEPENDENCE >> MAX

This is relatively unproblematic and is demonstrated in the tableau in (17):

(17) *matapihi*

Candidates	R=SFX	R=FT$_{\mu\mu}$	ANCH	CONTIG	BASE-DEP	MAX
F matapihi-pihi						*
mata-matapihi	*!					*
matapihi-matapihi		*!				
matapihi-tapi			*!			*
matapihi-pii				*!		*
matapihi-pi𝕋hi		*!		*!	*!	*

The final candidate, with an epenthetic coda consonant, is given an exclamation mark as a fatal violation of three different constraints, since we do not know at this point how these constraints are ranked with respect to one another; it should be pointed out, however, that it also fails on the constraint NO-CODA, which, as we mentioned earlier, is never violated in Maori.

This partial constraint ranking does not, however, rule out the candidate *matapihi-ihi*; to do so, we must invoke the constraint ONSET. We already know that onsetless syllables are permissible in Maori, so this is not an undominated constraint; and in fact, if we consider the possible output candidates for form (8d) *aawhio*, it becomes evident that ONSET must in fact be ranked lower than CONTIGUITY or BASE-DEPENDENCE (though its ranking relative to MAX cannot be determined):

(18) *aawhio*

	Candidates	CONTIG	BASE-DEP	ONSET	MAX
F	aawhio-whio			***	*
	aawhio-whiTo	*!	*!	**	*

(It could be claimed, of course, that ONSET falls *between* CONTIGUITY and BASE-DEPENDENCE, as opposed to below both of them. That it *must*, however, be ranked lower than BASE-DEPENDENCE can be seen by the fact that the winning candidate for (7e) *÷oio* is *÷ooio-io* rather than *÷ooio-Tio*, an outcome which violates BASE-DEPENDENCE but not CONTIGUITY.)

What, then, of the vowel-lengthening in trimoraic-based forms like those listed in (7)? As we have already noted, with only a handful of (readily-explainable; see footnote 3, *supra*) exceptions, in all cases of right-edge reduplication with trimoraic bases, the initial vowel in the base lengthens in the output. We propose, unlike Harlow, that the lengthened vowel is not in any sense a part of the reduplicant itself; rather, it is an effect of the reduplicant upon the base. Furthermore, we argue that this effect follows directly from the ranking of constraints already established for bimoraic right-edge reduplicants, with the addition of a single further constraint, FILL**.** In order to get this result, however, we must take a broader view of the domain in which BASE-DEPENDENCE applies, allowing it to be sensitive to suprasegemental features such as stress.

We should note that the idea of BASE-DEPENDENCE referring to prosodic as well as segmental material is not entirely without precedent. In discussing the quantitative counterpart of BASE-DEPENDENCE, MAX, McCarthy and Prince make the following observation:

> Violations of MAX and related constraints must be reckoned in terms of phonological elements of some specific type. The well-known *quantitative transfer* phenomenonÉ, in which Base vowel length is copied in the Reduplicant, shows that the Base and Reduplicant cannot always be regarded as strings of **segments**, since the segmental level alone does not encode quantitative oppositions.É We shall not aspire to settle the complicated issue of transfer here. Rather, we will make the assumption, sufficient for our purposes, that *MAX evaluates candidate Reduplicants as strings of segments together with their prosodic affiliations (such as moras)*.É

(McCarthy & Prince 1993a, p. 64; final emphasis added.) Furthermore, two recent works on reduplication in Indonesian, Cohn and McCarthy (1994) and Kenstowicz (1994), have dealt with issues of differing stress between base and reduplicant; Cohn and McCarthy, for example, make the observation that Òif the base and the reduplicant have different stress patterns, MAX is violated.ÉÓ (1994, p. 54). If this is the case for MAX, then it seems clear that it must also hold true for BASE-DEPENDENCE.

To see how our OT analysis works, let us consider example (7a), *kohiko*. Recall that the stress system in Maori requires, where possible, that the head of the leftmost foot of a word receive primary stress Ñ in other words, satisfaction of the constraint EDGEMOST(Ft',L). In the case of *kohiko*, this means that primary stress falls on the first syllable. Additionally, the final syllable is not parsed into a foot at all, since the hierarchy presented in (3) specifies crucially that FTBIN dominates PARSE-σ. Thus the prosodic representation of *kohiko* is as shown in (19):

(19) [[Çko.hi]$_{Ft}$ ko]$_{PrWd}$

Yet the ÒfootÓ which is copied as the reduplicant is not *kohi*, but rather *hiko*.

Our claim, then, is that the constraint BASE-DEPENDENCE Ñ which states that every element of R has a correspondent in B Ñ requires not only that the *segmental* content of the reduplicant have a correspondent in the base but also that the *suprasegmental* or *prosodic* content of the reduplicant be present in the base. Thus the surface form *kohiko-hiko* (in which the reduplicant *hiko* is, by virtue of the un-dominated constraints RHTYPE=T and R=FT$_{\mu\mu}$, necessarily a trochaic foot) is in violation of BASE-DEPENDENCE. Lengthening of the first vowel in the base, however, will alleviate this violation, at the expense of the addition of an additional mora in violation of the constraint FILL. Thus, we claim that BASE-DEPENDENCE must crucially outrank FILL in the Maori constraint hierarchy. This is demonstrated in the tableau in (21), assuming the revised ranking hierarchy presented in (20):

(20) RHTYPE=T, RHHARMONY, FTBIN(μ), R=SFX, R=FT$_{\mu\mu}$, ANCHORING, CONTIGUITY, NO-CODA, BASE-DEPENDENCE >> EDGEMOST(Ft',L), PARSE-σ, >> FILL, ONSET, MAX

That EDGEMOST(Ft',L) must dominate FILL, is made clear in Tableau (21) (where feet are enclosed in parentheses), although the precise location of PARSE-σ is open to debate. We have not conclusively demonstrated, either, that BASE-DEPENDENCE must dominate EDGEMOST(Ft',L); however, such a situation is strongly indicated by the fact that the former constraint is unviolated in Maori while the latter is known to be dominated by at least one other constraint (RHTYPE=T). In any event, it is only the domination of FILL by EDGEMOST(Ft',L) that is crucial to our analysis here.

(21) *kohiko*

	Candidates	NO-CODA	BASE-DEP	EDGEMOST	FILL	ONSET
	(Çko.hi)ko-(Èhi.ko)		*!			
F	(Çko𝕆)(Èhi.ko)-(Èhi.ko)				*	
	(Çko.𝔸)(Èhi.ko)-(Èhi.ko)				*	*!
	(Çko𝕋)(Èhi.ko)-(Èhi.ko)	*!				
	ko(Çhi.ko)-(Èhi.ko)			*!		

The undominated constraints RHTYPE=T and R=FT$_{\mu\mu}$, we should note, also rule out any possible outcome in which the reduplicant is made to satisfy BASE-DEPENDENCE by virtue of iambic or non-bimoraic footing of some sort.

A small proportion of the three-mora bases found in Williams (1971) cannot be accounted for solely by reliance on our expanded definition of BASE-DEPENDENCE. These seeming exceptions involve trimoraic, disyllabic bases such as (7f) *pahuu* which contain long vowels in the final syllable and are thus (thanks to the dominance of EDGEMOST(Ft',L) by RHTYPE=T) stressed on the final syllable, with the first syllable remaining unparsed by a foot. Yet these forms nevertheless do undergo lengthening of the vowel in the first syllable as a result of bimoraic right-edge reduplication:

(22) a. [pa[Çhuu]$_{Ft}$]$_{PrWd}$ ÔexplodeÕ paahuu-**huu** Ôpop, crackleÕ
b. [ho[Çpuu]$_{Ft}$]$_{PrWd}$ Ôbe swollenÕ hoopuu-**puu** ÔblisteredÕ

It appears at first glance that vowel lengthening in such forms is not only unnecessary but should in fact be ruled out by the constraint ordering in (20): that is, the possible (but nonoccurring) output candidates *pahuu-huu* and *hopuu-puu* do not violate BASE-DEPENDENCE, yet the actual surface forms *do* violate FILL. However, as we see in the tableau in (23), the constraint ordering which we have already established does yield the correct result, due to the fact that FILL is dominated by EDGEMOST(Ft',L):

(23) *pahuu*

	Candidates	BASE-DEP	EDGEMOST	FILL
	pa(Çhuu)-(Èhuu)		*!	
F	(Çpa𝔸)(Èhuu)-(Èhuu)			*

Finally, we return to the question of bimoraic left-edge reduplication. Recall that there are two major types of left-edge reduplication: one in which the reduplicant is a syllable, and one in which the reduplicant is a foot. As shown in (6), the former is vastly more common than the latter. And among the seventy-seven bimoraic forms, the majority simply copy the first foot of the base:

(24)	a.	aroaa	Ôbe understoodÕ	**aro**-aroaa	Ôlonely (for absent friends)Õ
	b.	ruuwai	Ôof no accountÕ	**ruu**-ruuwai	Ôfoolish; sillyÕ
	c.	kairau	ÔwhoreÕ	**kai**-kairau	Ôcommit adulteryÕ

However, a small number of bimoraic left-edge reduplicants exhibit a more interesting pattern. All of these are shown in (25):

(25)	a.	haapai	ÔliftÕ	**hapa**-hapai	Ôlift (frequentative)Õ
	b.	hookai	Ôfar apartÕ	**hoka**-hokai	ÔextendÕ
	c.	mookai	Ôslave; petÕ	**moka**-mokai	Ôtame bird/animalÕ
	d.	paatai	ÔaskÕ	**pata**-patai	Ôask (frequentative)Õ
	e.	pookai	ÔballÕ	**poka**-pokai	Ôroll upÕ
	f.	pootae	ÔencirclingÕ	**pota**-potae	ÔroundaboutÕ

In these forms, we again have an instance of the phonological form of the base being affected by reduplication; this time, however, the initial vowel of the base is shortened rather than lengthened. Although the class itself is small, the words concerned are fairly high-frequency items of vocabulary.

What distinguishes this class from the remaining seventy-one left-edge bimoraic reduplicants is that they appear to require not simply two moras but a disyllabic shape. That is, rather than R=FT$_{\mu\mu}$, these reduplicants are subject to an undominated constraint of the form shown in (26):

(26) R=FT$_{\sigma\sigma}$: R is a disyllabic foot.

(The constraints RHTYPE=T and RHHARMONY will ensure that this foot is also trochaic as well as bimoraic, i.e., that each syllable contains exactly one mora.)

If, then, our constraint hierarchy for this reduplicant is modified from one shown in (20) to include the constraint R=FT$_{\sigma\sigma}$ instead of R=FT$_{\mu\mu}$ (as well as changing R=SFX to R=PFX), and in addition we specify that FILL must dominate the constraint PARSE, we should obtain the correct results for these forms. This is illustrated in the tableau in (26):

(26) *haapai*

	Candidates	R=FT$_{\sigma\sigma}$	BASE-DEP	FILL	PARSE
	ha-hapai	*!			
	(Çhaa)-(Èhaa)(Èpa.i)	*!			
	(Çha.pa)-(Èhaa)(Èpa.i)		*!		
F	(Çha.pa)-(Èha<>.pa)i				*
	(Çha.pa)-(Èha.ℙa)(Èpa.i)			*!	

(Note that here the winning candidate does not violate the constraint BASE-DEPENDENCE, since stress and footing are the same in both the reduplicant and the base.) Once again, MaoriÕs unusual propensity for allowing reduplication to change the shape of the base itself is seen to fall out from the ranking of universal constraints in Optimality Theory.

4. Conclusion

In this paper, we have argued that an OT analysis of Maori reduplication is at least as descriptively adequate as one formulated solely in terms of the copying of prosodic constituents, as well as that an OT analysis is preferrable because it is based on differences in the ordering of a finite set of universal constraints on the phonology and morphology of both the base and the reduplicant. But more importantly, we have shown that for Maori, OT allows us to account in a constrained and consistent manner for both vowel lengthening and vowel shortening in the base of certain reduplicated forms Ñ an effect which a traditional templatic approach simply cannot handle.

In addition, we have made the following points:

(a) Reduplication processes may affect more than just the form of the reduplicant; reduplication may alter the phonological form of the base, as well;

(b) Such changes in the form of the base follow naturally from permutations in the ranking of established OT constraints on reduplicants; and

(c) BASE-DEPENDENCE, an OT constraint on the relationship between material in the reduplicant and the base, must take into account not merely segmental but also suprasegmental or prosodic features, such as stress and footing.

References

Bauer, Winifred (1981). ÒHae.re vs ha.e.re: A NoteÓ in *Te Reo* 24, 31-36.

Biggs, Bruce (1976). *Let's Learn Maori* (Wellington).

Cohn, Abigail C. and John J. McCarthy (1994). ÒAlignment and Parallelism in Indonesian PhonologyÓ (manuscript, Cornell University and University of Massachusetts, Amherst).

Harlow, Ray (1991). ÒConsonant Dissimilation in Maori,Ó in Robert Blust, ed., *Currents in Pacific Linguistics: Papers on Austronesian Languages and Ethnolinguistics in Honour of George W. Grace*, *Pacific Linguistics* C-117, 117-128 (Canberra: The Australian National University).

ÑÑÑ (1994). ÒSyllabification in Maori PhonologyÓ (manuscript, University of Waikato).

Kenstowicz, Michael (1994). ÒCyclic vs. Noncyclic Constraint Evaluation,Ó in *MIT Working Papers in Linguistics* 21.

Kiparsky, Paul (1993). ÒVariable RulesÓ (paper presented at ROW-1, Rutgers University).

ÑÑÑ (1994). ÒAn OT Perspective on Phonological VariationÓ (paper presented at NWAV 23, Stanford University).

Kirchner, Robert (1993). ÒTurkish Vowel Harmony and Disharmony: An Optimality-Theoretic AccountÓ (manuscript, University of California, Los Angeles).

Levin, Juliette (1985). *A Metrical Theory of Syllabicity* (Ph.D. dissertation, Massachusetts Institute of Technology).

Marantz, Alec (1982). ÒRe Reduplication,Ó in *Linguistic Inquiry* 13, 435-482.

McCarthy, John J. and Alan S. Prince (1986). *Prosodic Morphology* (manuscript).

ÑÑÑ (1990). ÒFoot and Word in Prosodic Morphology: The Arabic Broken Plurals,Ó in *Natural Language and Linguistic Theory* 8, 209-282.

ÑÑÑ (1993a). *Prosodic Morphology I: Constraint Interaction and Satisfaction* (manuscript, University of Massachusetts, Amherst and Rutgers University).

ÑÑÑ (1993b). ÒGeneralized Alignment,Ó in G. Booij and J. van Marle, eds., *Yearbook of Morphology 1993*, 79-153.

ÑÑÑ (1994). ÒThe Emergence of the Unmarked: Optimality in Prosodic MorphologyÓ (manuscript, University of Massachusetts, Amherst and Rutgers University).

Myers, Scott (1993). ÒOCP Effects in Optimality TheoryÓ (manuscript, University of Texas, Austin).

Nagy, Naomi and Bill Reynolds (1994). ÒAccounting for Variable Word-Final Deletion within Optimality TheoryÓ (paper presented at NWAV 23, Stanford University).

Poser, William (1985). ÒCliticization to NP and Lexical Phonology,Ó in *WCCFL* 4, 262-272.

Prince, Alan and Paul Smolensky (1993). *Optimality Theory: Constraint Interaction in Generative Grammar* (manuscript, Rutgers University and University of Colorado at Boulder.

Reynolds, Bill (1994). *Variation and Phonological Theory* (Ph.D. dissertation, University of Pennsylvania).

ÑÑÑ (1995). ÒVariation in Optimality Theory: The Floating ConstraintÓ (paper presented at the Annual Meeting of the Linguistic Society of America, New Orleans).

Reynolds, Bill and Naomi Nagy (1994). ÒPhonological Variation in Faetar: An Optimality Account,Ó in *CLS* 30:2.

Reynolds, Bill and Hadass Sheffer (1994). ÒVariation and Optimality,Ó in *Penn Working Papers in Linguistics* 1, 103-110.

Williams, H. W. (1971). *A Dictionary of the Maori Language*, 7th edition (Wellington: Government Printing Office).