VOWEL LENGTH IN HAWAIIAN REDUPLICATION

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This paper addresses vowel length alternations in Hawaiian reduplication (Elbert & Pukui 1979) using an Optimality Theoretic analysis, and compares them with alternations in other Oceanic languages. The data and analysis have important implications for theories of reduplication, specifically supporting Correspondence Theory over competing models.

In Hawaiian (Elbert & Pukui 1979, Pukui & Elbert 1986), reduplication indicates repeated action or diminutivity, but these functions are realized with three formal patterns: a syllable prefix, a foot prefix, and a foot suffix. There is no clear semantic distinction among these patterns, and as a result I consider them to be allomorphic variants of the same functional affix. The analysis focuses primarily on the length of vowels in the prefixing patterns.

This paper is organized as follows. In Section 1, I present data illustrating prefixing reduplication, highlighting the ways in which reduplicated forms reflect the root’s properties of vowel length. Section 2 provides a formal analysis of the reduplicative system, addressing aspects of allomorphy, but focusing on length alternations among reduplicative prefixes. In Section 3, I discuss the problems presented by the data for other formal approaches. Section 4 is a discussion of parallels among reduplicative length alternations in other Oceanic languages, including Maori, Samoan, Woleaian, and Ponapean.

1. Data

Vowel length is contrastive in Hawaiian, and the reduplicative syllable prefix contains a short vowel wherever the root’s initial syllable also has a short vowel (1a). If the root’s first vowel is long, it shortens in syllable reduplication: either in the reduplicant (1b), in the base (1c), or in both (1d). In foot prefixing, long vowels always shorten in both the base and reduplicant (1e).
The alternation between (1b) and (1c) is predictable: length shifts to the syllable prefix for disyllabic but not trisyllabic bases length. However, the failure of length to persist in either the base or reduplicant of the syllable prefix forms in (1d) needs to be handled with a lexical workaround, to which I return in Section 4.

(1) Syllable prefixes

a. make ‘death’ ma-make ‘many deaths’
b. mōlio ‘tight’ mo-mōlio ‘REDUP of mōlio’
c. kōhi ‘break off’ kō-kohi ‘break off’
   wāhi
   kōki extremity; don helmet kō-kōki

d. kū.hilo to wander about aimlessly ka-ku.hilo REDUP of kū.hilo
   nā.hili blundering na-na.hili
   pēlu’e

Foot prefixes

e. niele ‘curious’ nur.niele to investigate’
   puahi spry, quick puah.puahi REDUP of puahi
   pō.haka splotch, spot poha.pohaha REDUP of pō.haka
   hala.kau to perch high ha-aha.hala.kau REDUP of halakau
   hau.hili disorderly work hau.hau.hili REDUP of hauhili
   kahana cutting, drawing a line ka.hahana markings, lines
   nī.nau question nina.ninau to question repeatedly

In the following sections, I formalize an account of the alternation between (1b) and (1c), and then show how the foot prefix of (1e) can fit the same model. I then return to the question of (1d), with an appeal to a distinction among lexical representations. I argue that this appeal is formally appropriate and does not run afoul of Richness of the Base (Prince & Smolensky 1993).

2. Analysis

The questions we may ask of the morphophonology of Hawaiian reduplication are as follows: first, how can we predict the size and position of the reduplicant? Second, among prefixing forms, how can we predict the realization of vowel length among base and reduplicant vowels? This paper is focused on the second question, but the first question calls for some discussion. I
address the choice of form for Hawaiian reduplication in the next subsection. The analysis of vowel length in syllable and foot prefixing forms follows.

2.1 Allomorphy

Though Elbert and Pukui (1979) note upwards of seven reduplicative patterns in Hawaiian, this number can be reduced to three: a syllable prefix, a foot prefix, and a foot suffix. The precise manifestation within each subset can be shown to be internally predictable, as this paper is intended to demonstrate, but the choice of which pattern to apply to any particular root is not itself predictable. That is, some roots reduplicate with the syllable prefix, others use the foot prefix, and still others use the foot suffix. Some roots may have several reduplicated derivatives, using several of the available patterns, and with shades of functional or semantic distinction, but the mapping of the three patterns to uniformly consistent functions is not possible. Thus, we are left to attribute the choice of pattern and its semantic or functional interpretation as a subcategorized or lexical property of the root.

The phonological predictability of the reduplicated form emerges once the choice of pattern is known. Thus, while it must be a lexical fact about a root whether it is to receive a syllable prefix or a foot prefix, the precise realization is predictable given knowledge of the phonological form of the root along with whether it is to use a syllable or foot affix.

While it is not the goal of this paper to defend the mechanism for assigning a pattern to a particular root, I follow Kennedy (2008) in using degrees of morphological boundary to model reduplicative allomorphy. In this approach, foot-sized prefixes are considered to be external to the stem, and subject to constraints which ultimately force them to receive their own autonomous feet. Conversely, syllable-sized prefixes are considered to be internal to the stem, and as such
may share foot structure with the root. The phonological component needs only this
morphological information to determine how large to render the reduplicant.

In allomorphic systems such as Hawaiian, the root determines whether its reduplicative
affix is stem-internal or stem-external; thus, there is no need to encode a root’s lexical entry with
details such as the prosodic structure of its reduplicative morpheme. A root need only be
encoded as requiring a stem-external reduplicant, and the size of the affix follows from how the
phonological system handles this purely morpho-syntactic specification.

2.2 The length alternation in syllable prefixes

Other details of the phonological form of reduplicated words can then be modeled within a
uniform phonological account. For example, in this subsection I develop an analysis that
addresses all syllable-prefix forms. The analysis in Section 2.3 will address foot-prefix forms,
but the same formal phonological system will apply; there is no need to posit a distinct set of
formal principles to this other set of forms.

Table (1) shows an alternation in vowel length among syllable-prefixing roots such as
/kōhi/ and /mōlio/. In the former, only the reduplicant maintains vowel length, as in [kō-kohi],
while in the latter, only the base does, as in [mo-mōlio]. Such forms appear to respect a general
constraint of faithfulness to length, ∃-MAX-µ-IO, which is satisfied whether the long vowel is in
the base or the reduplicant. This constraint is an instance of Existential Faithfulness (Struijke
2002): it is satisfied if the underlying element to which it refers is maximized at least once in the
output.

(2) ∃-MAX-µ-IO Underlying length is present in the output.
However, foot-prefix forms such as [nie-niele], present a paradox: such forms appear to respect the constraint \textsc{Weight-Identity-BR}, which requires correspondent base and reduplicant vowels to have equal moraic weight (3). In fact, foot-prefix and syllable-prefix forms motivate opposite rankings of these constraints. For syllable-prefix forms, the appearance of a long vowel only in the prefix motivates a rank of \textsc{Max-μ-IO} over \textsc{Weight-Identity-BR} (4). Conversely, the loss of length in both the reduplicant and base for foot-prefix forms suggests the rank of \textsc{Weight-Identity-BR} over \textsc{∃-Max-μ-IO} (5).

(3) \textsc{Weight-Identity-BR} \quad \text{Base and reduplicant segments in correspondence have equivalent moraic weight.}

(4) \textsc{∃-Max-μ-IO} \rightarrow \textsc{Weight-Identity-BR}:

predicts /kōhi/ → [kō-kohi] but /nīele/ → *[nie-niel]

(5) \textsc{Weight-Identity-BR} \rightarrow \textsc{∃-Max-μ-IO}:

predicts /nīele/ → [nie-niele] but /kōhi/ → *[ko-kohi]

We can resolve this paradox by abandoning the assumption that long vowels occur in prefixes just to satisfy \textsc{∃-Max-μ-IO}. Instead, we will attribute their appearance to constraints on foot and syllable structure. First, in reduplicating [kōhi], full quantitative transfer would produce two adjacent heavy syllables, as in *[kō-kōhi]. This can be ruled out with *HH (Kennedy 2002), which is satisfied if one at least one of the two first syllables is light (6). Note that *HH is also active in Ponapean, generating a pattern of quantitative complementarity in reduplication.

(6) *HH \quad \text{Adjacent heavy syllables are forbidden.}
The account must also ensure that the base-initial syllable is light: the constraint FOOT-BINARITY (7) can do so, as it requires feet to be bimoraic.¹ FOOT-BINARITY is violated by [ko-(kōhi)] but satisfied by the output [(kō)-(kohi)]. This constraint clearly must be placed in a ranking of the Emergence of the Unmarked (McCarthy & Prince 1994), because Hawaiian tolerates such feet outside of reduplication. We must ensure that FOOT-BINARITY does not coarsely affect unreduplicated forms; I return to this issue in Section 2.5.

(7) FOOT-BINARITY Feet are bimoraic.

Last, we must prevent two adjacent light syllables from occurring: this can be accomplished with *REPEAT (Hicks Kennard 2004), which is violated by adjacent identical syllables (8). Since the first two syllables of [(kō)-(kohi)] differ in their weight, the form satisfies *REPEAT. The combined effect of *HH, FOOT-BINARITY, and *REPEAT is summarized in Tableau (9).

(8) *REPEAT Adjacent identical syllables are forbidden.

<table>
<thead>
<tr>
<th></th>
<th>/RED + kōhi/</th>
<th>*HH</th>
<th>*REPEAT</th>
<th>FOOT BINARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>ko-</td>
<td>(kō)-(kohi)</td>
<td></td>
<td>!</td>
<td></td>
</tr>
<tr>
<td>ko-</td>
<td>(kōhi)</td>
<td></td>
<td>!</td>
<td></td>
</tr>
<tr>
<td>ko-</td>
<td>(kōhi)</td>
<td></td>
<td>!</td>
<td></td>
</tr>
<tr>
<td>(kō)-</td>
<td>(kōhi)</td>
<td>!</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

The same constraints predict that the prefix syllable will be light for the reduplicated form of [mōlio]. As before, adjacent light syllables as in *[mo-mo)(lio)] are prevented by *REPEAT, and adjacent heavy syllables as in [(mō)(mō)(lio)] are ruled out by *HH. Thus, either

¹ A constraint that forbids feet comprising one heavy and one light syllable would have a similar effect.
the prefix or the base-initial syllable must be monomoraic, and the other must conversely be heavy. In this case, making the prefix heavy, as in *[(mō-mo)(lio)], will incur a violation of FOOT-BINARITY. These effects are summarized in Tableau (10).

<table>
<thead>
<tr>
<th>(10)</th>
<th>/RED + mōlio/</th>
<th>*HH</th>
<th>*REPEAT</th>
<th>FOOT BINARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mō-(mō)(lio)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(mō-mo)(lio)</td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(mō-mo)(lio)</td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(mō)(mō)(lio)</td>
<td>!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Turning to [kō-koki], we see that *HH must outrank FOOT-BINARITY. This ranking ensures that the prefix rather than the base-initial syllable is heavy. However, the system must also rule out [ko-koki]. We can do this by appealing to an Existentialist Faithfulness constraint, MAX-µ (11). MAX-µ is satisfied as long as there are at least as many moras in the output as in the input; *[ko-kohi] violates it below because it only has three moras – not enough to maximize the underlying four moras. The effects of MAX-µ and *HH are summarized in Tableau (12).

(11) MAX-µ Each underlying mora has a correspondent somewhere in the output.

<table>
<thead>
<tr>
<th>(12)</th>
<th>/RED + kōkī/</th>
<th>MAX-µ</th>
<th>*HH</th>
<th>*REPEAT</th>
<th>FOOT BINARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kō-ko(kī)</td>
<td></td>
<td></td>
<td>!</td>
<td></td>
</tr>
<tr>
<td></td>
<td>kō(kōki)</td>
<td>!</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>kō(kō)(kī)</td>
<td>!</td>
<td>*</td>
<td>!</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ko-(kō)(kī)</td>
<td>!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ko-(koki)</td>
<td>!</td>
<td></td>
<td>!</td>
<td></td>
</tr>
</tbody>
</table>

An alternative is to rank *REPEAT over *HH, but we will see that MAX-µ is independently motivated for the unreduplicated form [kōhi].
In the above analysis, vowel length appears in the prefix in forms such as [(kō)-(kohī)] (9) and [(kō-ko)(kī)] (12) not out of an existential need to maximize underlying length, but to satisfy constraints of prosodic structure and rhythm. Existential Faithfulness has played a role merely in preventing all underlying length from being obliterated, notably in [(kō-ko)(kī)] (12).

In general, then, long vowels are actually emergent in syllable-sized reduplicants, rather than simply being faithful correspondents of underlying long vowels. However, we must not allow length to emerge for stems with underlying short vowels. For example, while *REPEAT is violated by adjacent identical syllables, it must not predict long vowels for reduplication of short-vowel forms such as [ma-make]. A DEP constraint rules out such an option; DEP-µµ is violated wherever long vowels appear as correspondents of underlying short vowels (13).

Ranking DEP-µµ over *REPEAT ensures that vowels can be long in either the reduplicant or the base only if the root underlyingly has a long vowel. This constraint hierarchy thus presents a unique scenario of the emergence of the unmarked (McCarthy & Prince 1994), in that it portrays the emergence of vowel length as something which occurs in the special circumstance of reduplication, but which is prevented just in case the root has no underlying long vowels.

(13) DEP-µµ Long vowels in the output have long vowels as correspondents.

<table>
<thead>
<tr>
<th>(14)</th>
<th>/ RED + make /</th>
<th>MAX-µ</th>
<th>*HH</th>
<th>DEP-µµ</th>
<th>*REPEAT</th>
<th>FOOT</th>
<th>BINARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ma-(make)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ma-(māke)</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mā)-(make)</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.3 The foot prefix

Now we can turn to the foot prefix form [nie-niele], from the root [nīele]. Before treating the manifestation of vowel length here, let us briefly discuss the foot target of the prefix. I follow
Kennedy (2008) in attributing the larger suffix size here to the presence of a stem boundary occurring between the reduplicative prefix and the base. With such a boundary, forms like [nie-niele] are subject to the Alignment constraint in (15), which requires stem boundaries to occur at foot boundaries. If we assume that the syllable-sized prefixes treated in the previous sections are stem-internal, we safely predict that they are not subject to ALIGN \# FOOT, and they remain monosyllabic.

(15) ALIGN \# FOOT: Stem boundaries occur at foot boundaries.

Since we are now treating the foot-sized prefix, only minimally bimoraic options are closely considered here. Trimoraic prefixes, with a long first vowel and a light second syllable, are ruled out with FOOT-BINARITY. The other remaining prefix options for /nīele/ are a heavy monosyllable, as in *[nī-], and a bimoraic disyllable, as in [nie-]. We must compare possible combinations of these options with two possible base structures: those with initial heavy syllables and those with initial light syllables.

The form *[nīl]-(nīl)(ele)], with adjacent heavy syllables, is ruled out with *HH, leaving three competitors, including the output [nie-niele]. The output has corresponding vowels of the same weight, but competitors such as *[nīl](nīl)(ele)] and *[nie](nīl)(ele)] have one monomoraic and one bimoraic vowel in correspondence. We may thus rule the latter two out with WEIGHT-IDENTITY-BR (3), which this eliminates both *[nie-niele], with a heavy-initial prefix and a light-initial base, and *[nie-niele], with a light-initial prefix and a heavy-initial base. The effects of *HH, FOOT-BINARITY, and WEIGHT-IDNT for [nie-niele] are summarized in Tableau (16).

3 Note that WEIGHT-IDNT-BR is violated by the syllable-prefix forms [kō-kohi] (9) and [mo-mōlio] (10). This is not problematic, because WEIGHT-IDNT-BR can be ranked below *REPEAT and FOOT-BINARITY.
2.4 The third alternant

Recall from (1d) that some roots with long vowels fail to maintain vowel length under syllable reduplication in both their bases and reduplicants. This is problematic for the analysis as developed so far, as the presence of a long vowel in the first syllable of an unreduplicated root predicts that a long vowel will appear somewhere in the reduplicated form. The analysis presented in Sections 2.1-2.2 addresses the choice of which vowel to lengthen: in some cases it is the reduplicant’s vowel, while in others it is the first vowel of the base. But roots such as [kūhilo] appear to contradict this prediction: prosodically, [kūhilo] mirrors [mōlio], and thus we should expect *[ku-kūhilo] rather than the observed [ku-kuhilo].

The analysis cannot stand without addressing this problem. The approach I propose is fairly simple: roots such as [kūhilo] are distinct by the presence of a floating, unassociated underlying mora. Thus, such roots actually have no underlying long vowels, and where they are unreduplicated, the floating mora docks on the first vowel, rendering, for example, [kūhilo]. Under reduplication, the floating mora instead associates to the reduplicant vowel, thereby satisfying MAX-μ. Since the root itself has no underlying long vowels, the presence of a long vowel in the reduplicated form would violate DEP-μμ. Consequently, *[ku-kūhilo] and *[ku-kūhilo] are both ruled out by the rank of DEP-μμ over *REPEAT.
This subset is thus handled with a minor lexical distinction, which preferable to a different constraint ranking or prosodic target. Moreover, the set of underlying representations is not arbitrarily stipulated or restricted, keeping this analysis respectful of Richness of the Base (Prince & Smolensky 1993). Forms with no long vowels and forms with floating moras produce syllable prefixes with short vowels. Forms with underlying long vowels reduplicate with a long vowel appearing somewhere in the output, with its position being predictable.

Underlying forms with both long vowels and floating moras need not be formally ruled out; they will behave just like forms with underlying long vowels. Moreover, the presence of a floating mora would not be disruptive to the analysis of foot prefixing: roots will receive foot prefixes with short vowels whether the underlying representation contains a floating mora, a long vowel, or only short vowels.

2.5 Consistency with unreduplicated forms

An important aspect of the account is that the system must tolerate the distribution of light and heavy syllables seen in unreduplicated forms. In particular, it must allow disyllabic feet comprising one heavy and one light syllable. The constraint MAX-µ ensures this result, as shown in Tableau (17).

<table>
<thead>
<tr>
<th>(17)</th>
<th>/kōhi/</th>
<th>MAX-µ</th>
<th>*HH</th>
<th>DEP-µµ</th>
<th>*REPEAT</th>
<th>FOOT</th>
<th>WEIGHT-ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(kōhi)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(kohi)</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Finally, we must show that heavy syllables may indeed be produced in suffixing reduplication, wherever the root has a final heavy syllable. Like the disyllabic prefix, the foot size of the suffix is captured by ALIGN # FOOT (15). Because the suffix is also a foot, we can see that sequences of heavy syllables are forced to occur in such a scenario.
2.6 Interim summary

To predict the distribution of long vowels in Hawaiian reduplication, this account has relied on an interaction between correspondence relations and rhythmic constraints. The constraint \( \text{MAX-} \mu \) demands some degree of faithfulness to underlying moraic structure, though its existential nature allows for remapping of moras at the surface. The constraint \( \text{DEP-} \mu \mu \) is used to prevent overzealous vowel lengthening. The account thus characterizes the vowel lengthening in some syllable prefixes as a consequence of rhythmic concerns, but tolerated only if a long vowel is present underlyingly. Meanwhile, where the rhythmic constraints allow it, moraic balance is also achieved with a third correspondence constraint, \( \text{WEIGHT-IDENT-BR} \).

In other words, the length of a vowel in one morpheme responds to the length of a vowel in another morpheme, and only in the unique situation of reduplication. In formal terms, vowel length is manipulated only where correspondence relationships allow it. Indeed, a theory of reduplication without correspondence cannot adequately handle the distribution of long vowels in the Hawaiian reduplicative system. In the following section, I argue that alternatives to Correspondence lack the power to capture these effects consistently.

3. Competing theories

Among formal mechanisms that capture the copying function in reduplicative phonology, the correspondence model (McCarthy & Prince 1995, 1999) is dominant, but not the only approach. Another Optimality-Theoretic approach is Morphological Doubling Theory (Inkelas & Zoll...
2005), which assigns different morphemes within complex words to different cophonological grammars. Another alternative model is Linear Precedence (Raimy 2000), a derivational model that does not incorporate formal output constraints. Both models purport to address phenomena which Correspondence is incapable of modeling, while avoiding some predictive overgeneralizations their proponents attribute to Correspondence.

While these alternatives present novel overgenerative consequences themselves, this section is intended to test their ability to capture the segment length effects in Hawaiian. Specifically, because these models relinquish base-reduplicant correspondence relations, they deny the phonological component from having the power to adjust the phonological properties of one morpheme in response to properties of another, uniquely in the context of reduplication.

3.1 Linear Precedence

Reduplication in Linear Precedence (Raimy 2000) is formally modeled as a feedback loop in relationships of segmental precedence. As such, reduplication and gemination are products of the same phonological mechanism, distinct from each other by the target of the feedback loop.

The roots of concern in Hawaiian have underlying long vowels, which are represented with feedback loops, as illustrated in figure (19).

(19) Feedback loops for long vowels in Hawaiian roots

\[
\begin{align*}
n &\rightarrow i \rightarrow e \rightarrow l \rightarrow e \\
k &\rightarrow o \rightarrow h \rightarrow i \\
m &\rightarrow o \rightarrow l \rightarrow i \rightarrow o 
\end{align*}
\]
Reduplication adds another feedback loop to these forms. The foot prefix is represented with a feedback loop originating on the second vowel, while the syllable prefix results from a loop originating on the first vowel.

The assignment of the foot-prefix loop must precipitate the deletion of the vowel-length loop; for example, the loop in (20a) produces a foot-sized prefix, and we may presume that the rule which assigns this loop also obliterates the loop which was needed to represent the length of the vowel in the unreduplicated form [nīele].

Unlike the foot-prefix loop, the syllable-prefix loop must allow the vowel-length loop to remain intact (20bc). This itself is not problematic, as it is not inconsistent to allow the two reduplicative loop assignment rules to have different effects. However, the representations for [kō-kohi] and [mo-mōlio] are paradoxical. In linearizing [kō-kohi] (20b), the vowel-length loop must apply before the reduplication loop, while in [mo-mōlio] (20c), the reduplication loop must apply first.

(20) Feedback loops for reduplicative prefixes in Hawaiian

a. \[ n \rightarrow i \rightarrow e \rightarrow l \rightarrow e \]  
   \[ n \rightarrow i \rightarrow e \rightarrow l \rightarrow e \]

b. \[ k \rightarrow o \rightarrow h \rightarrow i \]
   \[ k \rightarrow o \rightarrow h \rightarrow i \]

c. \[ m \rightarrow o \rightarrow l \rightarrow i \rightarrow o \]
   \[ m \rightarrow o \rightarrow l \rightarrow i \rightarrow o \]

3.2 Morphological Doubling Theory

Morphological Doubling Theory (MDT, Inkelas and Zoll 2005) assigns different morphemes within complex words to different cophonological grammars. Additionally, the model eschews the labeling of morphemes as base and reduplicant; instead, it characterizes reduplication as the doubling of morphemes. Differences between what we traditionally call the
base and the reduplicant are captured by sending each of the doublets to a different grammar. In partial reduplication, the reduced morpheme is the product of a truncation grammar.

Under these terms, the morphemes we have been calling prefixes in Hawaiian are sent to a truncation grammar $\phi_a$, which takes the root as an input and produces a single syllable or a single foot (21). The other doublet goes to a different grammar $\phi_b$, which may or may not shorten long vowels present in its input. The outputs of these grammars are then concatenated and sent to a third grammar $\phi_c$, which generates the surface form.

(21) \[
\begin{array}{c}
\text{/ kohi /} \\
\downarrow \phi_a \\
\text{/ kō } + \text{ kohi /} \\
\downarrow \phi_c \\
\text{[kōkohi]}
\end{array}
\]

The same question applies here as anywhere: why shorten the prefix vowel in [mo-mōlio] but the base vowel in [kō-kohi]? The answer to this question, under MDT, requires us to identify the intermediate forms – those that serve as the output to the first layer of cophonologies $\phi_a$ and $\phi_a$ and the input to the second layer $\phi_c$.

As I understand MDT, the prefixes must have their length set before going through the final layer of constraints $\phi_c$, because this layer is to be the same constraint set that evaluates any combination of morphemes. The reasoning is as follows: first, for [kō-kohi], suppose the final (second) cophonology were configured to take intermediate forms with long vowels and shorten the base vowel. That is, it takes /kō-kōhi/ and produces [kō-kohi]. Were this the case, the cophonology would presumably shorten any HL root after a heavy-syllable prefix. Since such
shortening does not occur generally in Hawaiian, we are led to conclude that either (a) the cophonology $\varphi_c$ is distinct from other post-concatenative cophonologies, or (b) that shortening of the root vowel is a consequence of the first layer. The former choice entails that cophonology $\varphi_c$ is unique to reduplication, thereby rendering the model moot. To keep working within MDT, we must follow the latter option; thus, the first layer includes a cophonology $\varphi_a$ that truncates the initial /kōhi/ to [kö] and a cophonology $\varphi_b$ that realizes the second /kōhi/ as [kohi] (22a).

The same line of argumentation applies to [mo-mōlio]: the length of its vowels must be determined by the first layer of cophonologies. Consequently, the first layer includes a cophonology $\varphi_a$ that truncates the initial /mōlio/ to [mo] and a cophonology $\varphi_b$ that leaves the second /mōlio/ as [mōlio] (22b). This means we need to formalize one cophonology $\varphi_a$ that generates [kö] from /kōhi/ but [mo] from /mōlio/, and a separate cophonology $\varphi_b$ that generates [kohi] from /kōhi/ but [mōlio] from /mōlio/.

(22)  a.  / kōhi /  / kōhi /  / mōlio /  / mōlio /  / nīele /  / nīele /  
      ↓ $\varphi_a$  ↓ $\varphi_b$  ↓ $\varphi_a$  ↓ $\varphi_b$  ↓ $\varphi_d$  ↓ $\varphi_b$  
      / kö + kōhi /  / mo + mōlio /  / nie + nīele /  
      ↓ $\varphi_c$  ↓ $\varphi_c$  ↓ $\varphi_c$  
      [kōkōhi]  [momōlio]  [nieniele]  

The task for the syllable prefix grammar $\varphi_a$ appears to be insurmountable. This cophonology must truncate its input to a single syllable, but is stuck on whether to make this syllable heavy or light. The principle that identifies the target weight would need to be overruled.
to allow the opposite weight in specific circumstances. Suppose, for example, the morph’s target
is a light syllable, and /mōlio/ → [mo] satisfies this. Some set of principles must be responsible
for ensuring the maintenance of length in /kōhi/ → [kō] and in /kōkī/ → [kō]. Meanwhile, the
other cophonology cophonology \( \varphi_b \) must shorten a vowel in /kōhi/ → [kohi] but not /mōlio/ →
[mōlio]. In this case, it might appear that even parity of moras is idealized, but then we are still
left without fitting /kōkī/ → [kokī] to the model.

Moreover, we need also to consider the foot-prefix forms such as [nie-niele]; we can
safely presume that a distinct cophonology \( \varphi_d \) produces a foot sized initial doublet. However,
these forms shorten the vowel of their second morph, even though they are prosodically identical
to unshortened morphs such as [mōlio]. This implies that the root cophonology for foot-prefix
forms is distinct from the root cophonology of syllable prefix forms. Because of these predictive
difficulties of the model, it seems to be the case that MDT, without base-reduplicant
correspondence, is unable to model the length alternations of Hawaiian reduplication.

4. **Length effects in other reduplicative systems.**

This account deals with alternations in vowel length in reduplicative affixes, and attributes the
monomoraic or bimoraic quantity of particular vowels to constraints that emerge in the
reduplicative context. Nevertheless, the means by which length appears is never a function of
reduplicant specific constraints such as \( \text{RED} = \text{CV} \) or \( \text{RED} = \text{CV} \). Likewise, length is not
realized to satisfy emergent constraints that deal directly with the length of individual vowels
such as \( *\text{SHORTVOWEL} \) or \( *\text{LONGVOWEL} \). Instead, length is a function of (a) what kinds of
syllables may be adjacent, (b) what kinds of feet are acceptable, or (c) whether length is present
underlyingly.
This appears to be true generally of length alternations that occur in reduplication. That is, although segments may lengthen under particular circumstances of reduplication, it does not appear to be the case that reduplication ever specifically requires long segments, nor can length be analyzed as an emergent property that appears in reduplicated structures.

To explore this, we may look to segment length effects in other Oceanic languages, such as long vowel prefixes in Maori (Bauer 1993, de Lacy 1999, Harlow 2007), base-vowel lengthening in Samoan (Mosel & Hovdhaugen 1992), vowel length effects in Ponapean (Rehg 1981), and consonant gemination in Woleaian (Sohn 1976).

Maori has a variety of reduplicative patterns, including a light syllable prefix (23a), a foot prefix (23b), and a third form which at first glance is a prefix distinct by having a long vowel (23c). This third prefix appears to contradict the above claim that length is never a specific target for reduplicative morphemes.

(23) Maori prefixing reduplication patterns

a. pepeke ‘hasten’
   pipirau ‘decayed’

b. pekepeke ‘quick’
   tapatapahi ‘cut to pieces’

c. pe:peke ‘draw up limbs’
   ka:kanapa ‘gleaming’

Nevertheless, this third prefix is easily analyzable as a sequence of two light syllables: the second of consecutive identical consonants is deleted in Maori if it occurs in the ante-penultimate or earlier syllable, even if it is in a reduplicant-base relationship. The passive form of some reduplicated forms illustrates this: the second consonant in [pupuhi] ‘shoot’ and [tatari]
‘wait’ occurs in the penultimate syllable, but when the passive suffix is added, deletion applies, yielding [puuhia] and [taaria].

Double reduplication of light syllables occurs elsewhere in Oceanic languages, including Hawaiian. In Maori, surface forms like [pepepeke] are missing, but if we added two light reduplicants to /peke/, the deletion process is predicted to apply to the second /p/ of the structure /pe+pe+peke/, producing [peepeke]. Consequently, we need not posit an explicit requirement of a long vowel for this third reduplicative form in Maori; instead, we can attribute vowel length to the application of an independently observed consonant deletion process applying to instances of double light-syllable reduplication.

Some forms in Maori also appear to have a base-vowel lengthening effect that occurs where the form receives a foot suffix. We could treat these cases as having a morphological restructure that requires double exponence of the reduplicative morpheme in the guise of one light syllable prefix and one foot suffix, not unlike the above forms that call for two light syllable prefixes. Thus, /ko + kopuu + puu / would lose its second /k/, yielding [koopuu-puu]. Likewise, /ma + marara + rara / would lose both its second /m/ and second /r/, yielding [maaraa-rara].

(24) Maori double exponence

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>kopuu</td>
<td>blistered</td>
<td>koopuu-puu</td>
<td>having blistered skin</td>
</tr>
<tr>
<td>mohua</td>
<td>yellowhead</td>
<td>moohuahua</td>
<td>id</td>
</tr>
<tr>
<td>marara</td>
<td>scattered</td>
<td>maaraarara</td>
<td>rather scattered</td>
</tr>
<tr>
<td>matoru</td>
<td>benumbed</td>
<td>maatorutoru</td>
<td>benumbed</td>
</tr>
</tbody>
</table>

Though it is speculative, we may wonder whether a parallel effect of double exponence plus deletion is historically the source of the lengthening of the initial vowel in Samoan infixing forms like /alofa/ → [ā-lo-lofa] and Hawaiian suffixed forms like /aloha/ → [āloha-loha]
Vowel length alternations also appear in Ponapean prefixing reduplication (Rehg 1981), but only under very particular circumstances. The Ponapean reduplicative prefix is analyzable as a foot target, and some vowels lengthen to satisfy this target, as in [(paa)-(pa)] ‘weave’ and (lii)(liaan) ‘outgoing’. Some vowels conversely shorten because of *HH, e.g. [(tu)(tuup)] ‘bathe’. Reduplicants only manipulate vowel length when consonant weight, the default strategy for achieving bimoraic feet, is unavailable, as forms such as (pam)(pap) ‘swim’ and (ʧepi-ʧep) ‘begin’ show. Thus, vowel length is not a direct or explicit function of the reduplicative target in Ponapean.

An example of consonant length appearing in reduplication is observed in Woleaian (Sohn 1976): root-initial consonants lengthen to fill out a foot target for the reduplicative prefix, as in /misi/ → [(mim)(misi)] ‘fool’. However, only geminates may serve as medial codas and provide consonant weight in Woleaian. Consequently, we may conclude that the reduplicative prefix is required to be a foot, but restricted to a single syllable, in which case it must be heavy; in turn, the language uses consonant germination in this context to yield bimoraic syllable weight. Thus, consonant length is not a direct, explicit requirement of the reduplicative target.

5. Summary

This paper has addressed alternations of vowel length that are observed in Hawaiian reduplication. Although Hawaiian calls for some amount of morphological conditioning in reduplication, especially with respect to the choice of the reduplicative pattern as a foot prefix, a syllable prefix, or a foot suffix, the length alternations themselves do not require any morphological conditioning. The length of vowels in the reduplicated forms of roots which themselves have long vowels is predictable given a slate of constraints on rhythm, foot structure, and correspondence. Long vowels appear in reduplication only if the moraic structure of the root
allows it, only to satisfy emergent constraints on foot structure and rhythm, and only if the root contains no long vowels. Moreover, this constraint system is held consistent across each reduplicative pattern.

Vowel length is never an explicit target of any of the reduplicative forms in Hawaiian. Thus, while the model of allomorphy discussed in 2.1 allows the root to choose its reduplicative pattern, it does not need to make a choice between, say, a syllable with a short vowel and a syllable with a long vowel. The root only chooses whether its reduplicant is stem internal or external, and facts about the length of vowels can be derived in a uniformly principled from this morphological information.

Meanwhile, the account supports notions like existential faithfulness, correspondence over moraic elements, and rhythmic constraints such as *REPEAT and *HH. It also presents a fairly unique instantiation of the Emergence of the Unmarked, in that reduplicative forms satisfy emergent rhythmic and prosodic constraints, but DEP constraints prevent these constraints from applying across the board to all reduplicative substrings. Each of these principles is motivated elsewhere in the phonological literature, but the crucial component of this analysis is the ability of a phonological derivation to evaluate the correspondence relationships between the base and reduplicant. The length of vowels in reduplicative prefixes responds to the length of vowels in the root and in the base, which can only be encoded using correspondence constraints.

References


