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# AN OPACITY PROBLEM IN MAYO REDUPLICATION*

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Abstract: The phonological realization of heavy syllable reduplicants in Mayo (Uto-Aztecan) depends on the location of the accent in the unreduplicated form. Because the accent shifts after reduplication this creates an opacity in the determination of the base of reduplication. This paper provides an Optimality Theoretic account of this pattern of reduplication by positing distinct alignment constraints operating over accent placement and base-assignment, thus accounting for this opacity within a non-derivational theoretical framework. The diachronic development of this pattern is also considered.

## 1. Introduction

Mayo, a Southern Uto-Aztecan language of Miller (1984)'s proposed "Sonoran" branch, is spoken in Sonora and Sinaloa, Mexico. Following the work of Hagberg (1993), the Mayo lexicon can be divided into two classes of roughly equal size based on where accent (i.e. high tone or stress) falls: the Accented class, where lexical stress is assigned to the first syllable, and the Unaccented class, where regular default stress falls on the second syllable (by regular rule, in Hagberg 1993's framework).

These two classes pattern differently with respect to reduplication. Mayo reduplication indicates habitual action in verbs and appears in free variation between a light syllable (CV) and heavy syllable (CVC), which I will refer to as RED1 and RED2, respectively. The relevant reduplication data for the two classes are given in (1) and (2) (from Hagberg 1993) (the reduplicant appears in bold throughout):

(1) **Accented Words** (lexical stress on 1st syllable)

| Stem | RED1=$\sigma_{\mu}$ | RED2=$\sigma_{\mu\mu}$ | Unattested | Gloss |
|---|---|---|---|---|
| a. yú.ke | **yú**.yu.ke | **yúy**.yu.ke | ***yúk**.yu.ke | 'rain' |
| b. tí.we | **tí**.ti.we | **tít**.ti.we | ***tíw**.ti.we | 'be ashamed' |
| c. chí.ke | **chí**.chi.ke | **chít**.chi.ke | ***chík**.chi.ke | 'comb' |
| d. wóm.te | **wó**.wom.te | **wóm**.wom.te | ***wów**.wom.te | 'be frightened' |
| e. nók.wa | **nó**.nok.wa | **nók**.nok.wa | ***nón**.nok.wa | 'known language' |
| f. nó.ka | **nó**.no.ka | **nón**.no.ka | ***nók**.no.ka | 'know language' |

(2) **Unaccented Words** (no lexical stress)

| Stem | RED1=$\sigma_\mu$ | RED2=$\sigma_{\mu\mu}$ | Unattested | Gloss |
|---|---|---|---|---|
| a. $b^w$a.ná | **$b^w$a**. $b^w$á.na | **$b^w$an**. $b^w$á.na | ***$b^w$ab**. $b^w$á.na | 'cry' |
| b. $b^w$i.ká | **$b^w$i**. $b^w$í.ka | **$b^w$ik**. $b^w$í.ka | ***$b^w$ib**. $b^w$í.ka | 'sing' |
| c. om.té | **o**.óm.te | **om**.óm.te | ***o'**. 'óm.te | 'hate' |
| d. si.mé | **si**.sí.me | **sim**.sí.me | ***sis**.sí.me | 'go (sg)' |
| e. no.ká | **no**.nó.ka | **nok**.nó.ka | ***non**.nó.ka | 'speak' |

In the first column in each example, light syllable reduplication copies the first CV sequence of the stem. In heavy syllable reduplication in both classes, if there is a coda consonant in the first syllable of the stem (e.g. 1d, 1e and 2c), this coda consonant copies, thus indicating that coda consonants are moraic in Mayo. However, if there is not a coda consonant in the first syllable of the stem, the two classes pattern differently with respect to how they fulfill the heavy syllable requirement on the reduplicant. In the Unaccented cases in (2), the onset of the second syllable of the stem is copied (e.g. ***$b^w$an**.$b^w$á.na*). In the Accented cases in (1), however, only the first syllable of the stem is copied, and the onset of the stem is geminated into coda position of the reduplicant (e.g. ***yuy**.yuke*). (RED2 in 1c shows gemination at the onset of the affricate in the second syllable).

This contrast can be most clearly illustrated by the minimal pair given in (3), which differ only with respect to which class they belong to (i.e. where the accent falls):

(3) Minimal Pair Showing Different Bases in the Two Classes of Mayo Words:

| | Stem | RED1=$\sigma_\mu$ | RED2=$\sigma_{\mu\mu}$ | Unattested | Gloss |
|---|---|---|---|---|---|
| [1f]. | <u>nó</u>.ka | **nó**.no.ka | **nón**.no.ka | ***nók**.no.ka | 'know language' |
| [2e]. | <u>no.ká</u> | **no**.nó.ka | **nok**.nó.ka | ***non**.no.ka | 'speak' |

Since different amounts of the root are copied in RED2 Hagberg takes this as evidence that there are two different reduplicative bases (which I have marked in the "stem" column with an underscore). In the Accented words, the base is only the first syllable. In Unaccented words, the base is the entire first foot.[1]

The purpose of this paper is to give an account of this pattern in terms of Correspondence Theory (McCarthy and Prince 1995). I will argue that these patterns result from the interaction of a suite of alignment constraints: different alignment constraints operating over both the assignment of the base and the placement of the accent in each of these classes of words.

## 2. A Derivational Account

Working toward a unified account of these two patterns, we observe that there is a phonologically-conditioned environment for the two different bases: the right edge of the base corresponds to the right edge of the stressed syllable in the unreduplicated form. We can provide a very efficient derivational story to unify the two patterns, which is given in (4):

**(4) A Derivational Account of the Mayo reduplication patterns**

A. Assign stress:

| | | |
|---|---|---|
| $noka_A$ | → | nó.ka |
| $noka_U$ | → | no.ká |

B. Align Base to the right edge of the stressed syllable:

| | | |
|---|---|---|
| nó.ka | → | nó.ka |
| no.ká | → | no.ká |

C. Copy: Reduplicate a heavy syllable

| | | |
|---|---|---|
| nó.ka | → | **non**.nó.ka[2] |
| no.ká | → | **nok**.no.ká |

D. Stress-Maintenance: Make sure the accent appears in the original position within the prosodic word (i.e. Re-Apply Rule A).

| | | |
|---|---|---|
| **non**.nó.ka | → | **nón** . no.ka |
| **nok**.no.ká | → | **nok**. nó.ka |

Because of the cognitive salience (i.e. prominence) of stressed syllables, this derivational story is almost assuredly the historical development of these patterns, but defining the base by original stress position and simultaneously moving this stress is impossible on a non-derivational Correspondence Theory account. This is an opacity because the conditions on the assignment of the base are erased in the output.

In contrast, a language such as Malagasy has the reduplicative base transparently aligned to the edge of a stressed syllable. In Malagasy, with suffixal reduplicants, this is the left edge of the syllable with primary stress:

(5) Malagasy Reduplication (Keenan and Polinsky 1998)

| | | | |
|---|---|---|---|
| a. | bé | → | bè. **bé** |
| b. | má.im.bo | → | mà.im.bo.**má.im.bo** |
| c. | in.dráy | → | in.dràin.**dráy** |
| d. | sa.lá.ma | → | sa.là.ma.**lá.ma** |

This transparency in Malagasy leads to a straightforward alignment constraint for base-assignment:

(6) ALIGN (Base, L, $\sigma_{[+stress]}$, L):
The base is aligned to the left edge of a stressed syllable.

This alignment constraint leads to the attested Malagasy reduplication pattern, and high-ranked base-reduplicant faithfulness (i.e. MAX-BR) leads to a full copy of this base. This faithfulness is also reflected in the double location of stress, secondary stress being located on the vowel in the reduplicant corresponding to the vowel with primary stress in the base.

In Mayo, however, the situation is not as straightforward since the underlying stress is shifted under reduplication, and stress even appears on the reduplicant in the accented class of words. This shifting of stress is the opacity problem of Mayo reduplication, and my ultimate solution will involve an assortment of alignment constraints which lead to this apparent opacity in base-assignment.

## 3. An OT Account

I will assume Correspondence Theory and Generalized Alignment (McCarthy and Prince 1995). There are several constraints which are never violated, and are therefore undominated:

(7) EXPONENCE: A morpheme in the input must have some realization in the output.

(8) L-ANCHOR$_{BR}$: The left edge of reduplicant corresponds with the left edge of the base.

(9) ALIGN (RED, L, Wd, L): The reduplicant is a prefix.
The effects of these constraints are shown in (10):[3]

(10) /RED + omte/ → [om.om.te] 'hate-HAB'

| /RED + omte/ | EXPONENCE | L-ANCHOR$_{BR}$ | ALIGN (RED, L Wd, L) |
|---|---|---|---|
| a. om.te | *! | | |
| b. **te**.om.te | | *! | |
| c. om.te. **om** | | | *! |
| d. ☺ **om**.om.te | | | |

Candidate (10a) has no realization of the reduplicant, and it is dispatched by EXPONENCE. Candidate (10b) is incorrectly anchored to the right edge of the base, and (10c) is suffixed instead of prefixed, and both of these candidates are also rejected. From here on we will not consider candidates which violate these constraints.

We will also need two more constraints at the outset, both of which will play a major role in the account to be developed. These are the Base-Reduplicant faithfulness constraints, defined in (11) and (12):

(11) MAX-BR: All segments in the base appear in the reduplicant.

(12) DEP-BR: All segments in the reduplicant appear in the base.

The effects of these constraints are shown in (13):

(13) /RED + omte/ → [om.om.te] 'hate-HAB'

| /RED + omte/ | MAX-BR | DEP-BR |
|---|---|---|
| a. **om** om.te | t!e | |
| b. ☞ **omte** om.te | | |
| c. **omtem** om.te | | m! |

MAX-BR requires that every segment in the base appears in the reduplicant, which, given no higher-ranked constraint, causes cases of incomplete copying (such as (13a)) to be thrown out. DEP-BR requires that every segment in the reduplicant appear in the base, which causes any candidate (such as (13c)) with extra material to be thrown out. Given no other constraints, full (but not over-)copy reduplication is the only way to satisfy these two constraints.

For the case of Mayo, we will need some way to account for the variant reduplicant sizes for RED1 and RED2. Following recent work in OT (Hendricks 1999, Generalized Alignment, etc.), we will not use a template to force the correct reduplicant size. Reduplicative templates have the effect of two alignment constraints, in that they force both the left edge and the right edge of some morphological unit to be aligned to the left and right edge of some prosodic unit ("$M_{cat} = P_{cat}$", in the terms of McCarthy and Prince 1993).

One fruitful way of accounting for reduplication is the Compression Model, developed by Hendricks (1999). This model uses alignment constraints to force competition between the left-alignment of the base and the left-alignment of the reduplicant to require that the reduplicant be as small as possible. In many cases (such as the "bare-consonant" reduplication which lies at the heart of Hendricks' study), no formal statement needs to be made about the size of the reduplicant at all. The constraints that Hendricks uses are these:

(14) ALIGN (RED L, Wd L): The reduplicant is aligned to the left edge of the word.

(15) ALIGN (Root L, Wd L): The root is aligned to the left edge of the word.

These two constraints must outrank MAX-BR, or else we would see full-copy reduplication, an infelicitous outcome.

These two competing constraints force competition between the base and reduplicant for alignment to the left edge of the prosodic word, as shown in (16) and (17). For the time being, all tableaux mark the stress in its underlying position, and not in its actual output position. We will account for the actual output stress-placement in section 4 below:

(16) ALIGN (Root L, W,L) >> MAX-BR

| /RED + nokấ/ | ALIGN (RED, L,W,L) | ALIGN (Root L, W,L) | MAX-BR |
|---|---|---|---|
| a. ☺ **no** no.ká | | no | ka |
| b. ☹ **nok** no.ká | | nok! | a |
| c. **no.ka** no.ká | | nok!a | |
| d. **non** no.ká | | non! | ka |

(17) ALIGN (Root L,W,L) >> MAX-BR

| /RED + nóka/ | ALIGN (RED,L,W,L) | ALIGN (Root L, W,L) | MAX-BR |
|---|---|---|---|
| a. ☺ **no** no.ka | | no | ka |
| b. **nok** no.ka | | nok! | a |
| c. **noka** no.ka | | nok!a | |
| d. ☹ **non** no.ka | | non! | ka |

On the Compression account, however, we are never able to get heavy syllable reduplication: the minimal reduplicant in Mayo is always a CV. Therefore, we need some formal statement of the two possible prosodic shapes of the reduplicant, which we will generate through the alignment of the left edge of the reduplicant to the left edge of the relevant prosodic unit. These constraints are given in (18) and (19):

(18) ALIGN (RED1, L, $\sigma_{\mu}$, L): The left edge of the reduplicant (RED1) is aligned to the left edge of a light syllable.

(19) ALIGN (RED2, L, $\sigma_{\mu\mu}$, L): The left edge of the reduplicant (RED2) is aligned to the left edge of a heavy syllable.

Hendricks (1999) gives independent motivation for abandoning reduplicative templates in favor of the approach that he takes, but Mayo provides a further reason to take his approach, adopted here, which can be observed in the case of the Mayo Accented words. The constraint requiring that the left edge of the reduplicant be aligned to the left edge of a heavy syllable says nothing at all about the right edge, therefore the constraint is just as satisfied by cases where the right edge of the reduplicant corresponds to the right edge of a heavy syllable, as in ***nok**.no.ka*, or when the right edge of the reduplicant does not, as in ***non**.no.ka*. In the latter case, the geminated coda consonant is not part of the reduplicant at all, yet this form still satisfies the left-edge alignment constraint.

How do we encode free variation between two morphological constraints? Here I will propose a Constraint Disjunction:

(20) [ALIGN (RED1, L, $\sigma_{\mu}$, L) **OR** ALIGN (RED2, L, $\sigma_{\mu\mu}$, L)]

This constraint states that a reduplicant is either aligned to the left edge of a light syllable, *or* it is aligned to the left edge of a heavy syllable. Either result would satisfy the constraint (i.e. make the constraint "true"). The third logical possibility, that a reduplicant is *both* aligned to a light syllable and is aligned to a heavy syllable, would result in two reduplicants for one morpheme, and would be thrown out by the constraint requiring left-alignment of the root (or other possible size-restrictors: ALL-FEET-LEFT, etc.). Thus, this constraint interaction leads to exclusive disjunction, since left-alignment of the root requires the minimal possible reduplicant to satisfy this constraint: either a light syllable or a heavy syllable, but certainly not both.

This disjunction puts this the reduplicant-alignment constraint at the same ranking relative to the rest of the tableau, in undominated position near the top of the hierarchy.

We will now examine the interaction of the constraints thus-far proposed.

<u>3.1. Light Syllable Reduplication.</u> Light Syllable Reduplication is always straightforward, with the alignment of the reduplicant ranked over BR-Identity. (For now I will simply stipulate that the base in the Accented class is the first syllable of the root, and that the base in the Unaccented class is the first foot of the root—this will be formalized below):

(21) <u>Light Syllable Reduplication: Accented</u>

| /RED2 + nóka / | ALIGN (RED1, L, $\sigma_{\mu}$, L) | DEP-BR |
|---|---|---|
| a. ☺ **no** <u>nó</u>.ka | | |
| b. **nok** <u>nó</u>.ka | *! | k |
| c. **no.ka** <u>nó</u>.ka | | k!a |
| d. **non** <u>nó</u>.ka | *! | |

(22) Light Syllable Reduplication: Unaccented

| /RED2 + nokā/ | ALIGN (RED1, L, $\sigma_{\mu}$, L) | MAX-BR |
|---|---|---|
| a. ☹ **no** no.ká | | ka! |
| b. **nok** no.ká | *! | a |
| c. ☛**no.ka** no.ká | | |
| d. **non** no.ká | *! | ka |

Left-edge alignment says nothing about the right edge, so a and c in (21) and (22) are both well-formed by this constraint. In (21), since the base is only the first syllable, DEP-BR dispenses with candidate (21c), which copies more than is contained in the base. In (22), since there is still base material to copy, candidate a is ruled out by MAX-BR.

We still need Root-alignment to force compression in the Unaccented cases:

(23) Final Tableau for Light Syllable Reduplication: Unaccented

| /RED2 + nokā/ | ALIGN (RED1,L,$\sigma_{\mu}$,L) | ALIGN (Root,L,W,L) | MAX-BR |
|---|---|---|---|
| a. ☺ **no** no.ká | | no | ka |
| b. **nok** no.ká | *! | nok | a |
| c. **no.ka** no.ká | | nok!a | |
| d. **non** no.ká | *! | non | ka |

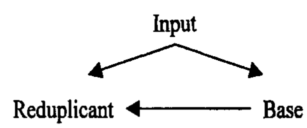
(23) shows another effect of Compression. When two candidates equally satisfy a constraint that aligns a reduplicant to an edge of some prosodic unit, a competing root alignment constraint will force the minimal possible candidate to be the optimal one. This occurs only if the two alignment constraints are ranked above B-R faithfulness, as they are in Mayo. Re-ranking MAX-BR over either one of the alignment constraints would result in full-copy reduplication, thus negating the force of Compression.

3.2. Heavy Syllable Reduplication. It is in heavy syllable reduplication that the effects of having different bases can be seen, since it is here that the requirement of the heavy syllable alignment constraint is met in two different ways.

One way to derive the correct bases would be to simply mark them in the input. However, as we saw with Malagasy above, stress domains can determine what constitutes a reduplicative base, which we therefore do not need to otherwise stipulate. Additionally, there are several cases cross-linguistically where reduplicative bases correspond to specific prosodic units. These are particularly problematic for theories of reduplication without *any* prosodic units, such as that of Raimy (2000), but if we regard these cases as morphological, then we can refer to the bases with constraints. Some relevant cases are where the base appears as a foot, as in Yidin$^{y}$ (McCarthy and Prince 1986) (e.g. *kintalpa* → ***kin.tal.****kin.tal.pa* (****kin.ta.****kintalpa*) and *mulari* → ***mu.la.****mu.la.ri* (***mular.****mulari*)), and also where the base appears as a syllable, as in the related Uto-Aztecan language Yaqui[4] (Haugen 2003) (*vamse* → ***vam.****vam.se* (****va.****vam.se*) and *vusa* → ***vu.****vu.sa* (****vus.****vu.sa*)). The last case, Yaqui, is particularly relevant to the present discussion since it is related to and largely mutually intelligible with Mayo, and patterns with the Accented class in Mayo, although its accent system is distinct from that of Mayo.[5]

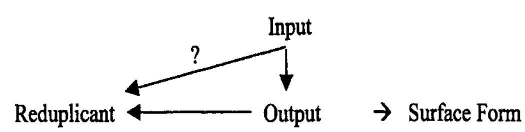
In the full-model of McCarthy and Prince (1995), there was a relation of "Input-Base", as shown in (24):

(24) **The McCarthy and Prince (1995) "Full Model"**




My claim here is that this relation was incorrectly characterized. In fact, there is no relation "Input-Base", but rather Input-Output (which is their characterization of the "basic model"). The evidence from Mayo (among other languages) shows that the "base" can be some sub-string (here, prosodically defined) of the Output.[6] This modification is given in (25):

(25) **The Modified Full Model**




In this modified view of the full model, any input material has correspondence with what I am calling here the capital-O "Output", rather than some category of material which can be somehow neutrally identified as "the base". Rather, the "base" itself is some subset of the "Output", and perhaps the entire "Output" in the unmarked case. I will propose an alignment constraint on the base to deal with the marked cases, as we see in Mayo. By definition, such constraints can only operate over the level of "Output", which, along with the domain of the reduplicant, constitutes the Surface Form.[7]

Following Hagberg's analysis, we will have a default constraint aligning the base to the edge of the leftmost foot of the stem:

(26) ALIGN (Base R, Stem Ft, R): The right edge of the base corresponds to the right

edge of the first (i.e. leftmost) foot in the stem (i.e. in the Output).

We will assume that Foot Binarity is undominated: all feet are binary. Similarly, all stems are minimally composed of at least one foot (i.e. they are disyllabic).

For the Accented class, we will mark the lexical entry with a subscripted A, an arbitrary diacritic marking class membership. We will rank this alignment constraint over the default base alignment constraint, yielding the effects of the Elsewhere Principle through crucial constraint ranking:[8]

(27) ALIGN ($Base_A$, R, Stem σ, R): The right edge of the base (in the accented class) corresponds to the right edge of the first (i.e.leftmost) syllable of the stem (i.e. in the Output).

This constraint is also covered by the other alignment constraint, because feet are composed of syllables, but as we saw above for the light-syllable reduplication patterns of RED1, Align Root-L will compress the base to the smallest possible unit: a single syllable (or single foot in the default case). This is illustrated in the tableau in (28):

(28) Accented Words with Base Alignment

| /RED2 + nóka / | ALIGN (Red2,L,$\sigma_{\mu\mu}$,L) | ALIGN ($Base_A$ R,σ,R) | ALIGN (Root,L,Wd,L) | DEP-BR | MAX-BR |
|---|---|---|---|---|---|
| a. **no** nóka | *! | | no | | |
| a'. **no** nóka | *! | | no | | ka |
| b. **nok** nóka | | | nok | k! | |
| b'. **nok** nóka | | | nok | | a! |
| c. **no.ka** nóka | *! | | noka | | ka |
| c'. **no.ka** nóka | *! | | noka | | |
| d. ☺ **non** nóka | | | non | | |
| d'. **non** nóka | | | non | | k!a |
| e. **nok** nóka | | *! | nok | | |

These candidates are separated into lettered and letter-primed candidates. In the lettered candidates, the base for reduplication is the first syllable of the root. In the primed candidates, the base is the entire first foot of the root. The (a) and (c) candidates are ruled out because they fatally fail to align their reduplicants to the left edge of a heavy syllable. The (e) candidate fails to align its base to the right edge of a syllable, also a fatal violation. The (b) and (d) candidates are both correctly aligned to a heavy syllable, and their bases (b and b' and d and d') are all aligned to the right edge of a syllable. However, these candidates can be distinguished by their varying faithfulnesses between the reduplicants and the bases. In (b') and (d'), the base is the entire stem: (b') incurs a violation of MAX-BR (for failing to copy a segment of the stem), and (d') incurs two violations for the same reason. In b and d, the base is only the first syllable, and (b) incurs a violation of DEP-BR for copying material which is not included in the base, while (d) only copies the base, and is thus completely faithful and is the winning candidate. The gemination of the onset of the stem into the coda position of the syllable containing the reduplicant is not a violation of B-R faithfulness, since it is not a part of the reduplicant. We will motivate this gemination (as opposed to vowel lengthening or epenthesis of an unmarked consonant) in section 4.1.

It should be noted here that there is no crucial constraint ranking between DEP-BR and MAX-BR to choose between (b), (b'), (d) and (d'). The two permutations are given in (29) and (30), and the winning candidate passes through both rankings unscathed:

(29) Accented: base = first syllable

| RED + nóka | ALIGN Root L | DEP-BR | MAX-BR |
|---|---|---|---|
| b. **nok** nóka | nok | k! | |
| b'. **nok** nóka | nok | | a! |
| d.☺**non** nóka | non | | |
| d'. **non** nóka | non | | k!a |

(30) Accented: base = first syllable

| RED + nóka | ALIGN Root L | MAX-BR | DEP-BR |
|---|---|---|---|
| b. **nok** nóka | nok | | k! |
| b'. **nok** nóka | nok | a! | |
| d.☺**non** nóka | non | | |
| d'. **non** nóka | non | k!a | |

I should also note that I am assuming that the gemination of the onset of the root does not get the root "closer" on the root-alignment constraint, otherwise we would *always* get gemination, since ALIGN Root L >> MAX-BR. Thus, the Accented words would also receive gemination of the root if this was not the case. Instead, the root alignment constraints refers to the actual morpheme (the root), rather than the segmental material which fills up that morpheme (i.e. the spread of the onset consonant into coda position of the reduplicative morpheme).

Tableau (31) gives the correct analysis for the Unaccented class:

(31) Unaccented Words with Base Alignment

| /RED2 + noká / | ALIGN (Red2,L,$\sigma_{\mu\mu}$,L) | ALIGN (Base R, Ft, R) | ALIGN (Root, L, Wd,L) | DEP-BR | MAX-BR |
|---|---|---|---|---|---|
| a. **no** noká | *! | * | no | | |
| a'. **no** noká | *! | | no | | ka |
| b. **nok** noká | | *! | nok | k | k |
| b'. ☺ **nok** noká | | | nok | | a |
| c. **no.ka** noká | *! | * | noka | ka | ka |
| c'. **no.ka** noká | *! | | noka | | |
| d. **non** noká | | *! | non | | |
| d'. **non** noká | | | non | | ka! |
| e. **nok** noká | | *! | nok | | |

(31) shows the identical candidate set to (28). The only difference here lies in the base-alignment constraint. Since the base-alignment constraint for the Unaccented class requires alignment to the right edge of the first foot in the Output, only the prime candidates satisfy this constraint. Once again, (a') and (c') are removed from contention for failing to correctly align the reduplicant to the left edge of a heavy syllable. Both (b') and (d') have B-R faithfulness violations, since neither shows full copy reduplication, but (b') copies more of the base than (d'), and is thus correctly the winning candidate.

In sum, we have the following crucial constraint rankings:

(32) [ALIGN (RED, L, $\sigma_{\mu}$, L) **OR** ALIGN (RED, L, $\sigma_{\mu\mu}$, L)] >> everything else

(33) The more specific ALIGN BASE$_A$ >> ALIGN BASE (unmarked).

(34) ALIGN BASE >> ALIGN ROOT-L >> DEP-BR, MAX-BR.

In this section we have used alignment constraints to successfully account for the two bipartite reduplication patterns in Mayo: alignment of the reduplicant to either a light or heavy syllable (for each of the classes), and alignment of the base to either a syllable or a foot (in the Accented and Unaccented classes, respectively).

In the next section, we will account for the gemination in RED2 in the Accented class, and solve the lingering problem of the opacity with respect to the assignment of stress with which we began. We will also discuss what might be construed as a stipulation: the two various bases for these two classes.

## 4. Residual Issues

In this section we will address the remaining issues in our account of reduplication in Mayo.

4.1. Why gemination? Gemination is accounted for in Mayo via the emergence of the unmarked: i.e. through the interaction of markedness and faithfulness constraints. The three relevant constraints are given in (35), (36), and (37):

(35) *LONG-V: Vowels may not be long.

(36) *LONG-C: Consonants may not be long.

(37) DEP-IO: Segments in the Output have correspondents in the Input.

In Mayo, the constraint *LONG-V outranks *LONG-C. A tableau for the accented class is given in (38), assuming that the base is the first syllable and that the reduplicant is aligned to the left edge of a heavy syllable, by the constraints motivated above:

(38) *LONG-V >> *LONG-C

| /RED + nóka/ | DEP-IO | DEP-BR | *LONG-V | *LONG-C |
|---|---|---|---|---|
| a. **noh** nó.ka | *! | | | |
| b. **nok** nó.ka | | k! | | |
| c. **noo** nó.ka | | | *! | |
| d.☺ **non** nó.ka | | | | * |
| e. **noo** nó.ka | (*?) | | *! | |

(38a) epenthesizes a consonant to realize a heavy syllable, and incurs a fatal violation of DEP-IO. (38b) copies more than is allowed by the base, and is ruled out by DEP-BR. Both (38c) and (38e) have long vowels, and are ruled out by *LONG-V (and this is true whether they are reduplicative or not—(38e), where there is apparently an epenthetic non-reduplicative vowel, also violates DEP-IO). Finally, although (38d) does violate *LONG-C, this is the lowest-ranked constraint and (d) is the most optimal candidate.

Interestingly, further evidence for this ranking of markedness constraints comes from the related Uto-Aztecan language Guarijío (also in the Taracahitan sub-branch), which has the opposite ranking: cases of compensatory lengthening result in epenthesis of glottal stop (or [h]) or vowel-lengthening, and there is no gemination anywhere in the language (Miller 1996). This situation strongly suggests a re-ranking of markedness constraints between these two languages (see Barragan and Haugen 2002 and Haugen 2002 for further discussion of reduplication patterns across Uto-Aztecan). In Mayo, long vowels do violate *LONG-V, but they are attested due to higher-ranked Input-Output faithfulness.

4.2. How do we get the correct stress placement? We began this paper by observing an opacity in reduplicative base-assignment in Mayo: the reduplicative base corresponds to the right edge of a stressed syllable in the unreduplicated form. Cases of transparent base-assignment to a stressed syllable, such as Malagasy, can be handled with one alignment constraint. The Mayo situation is different, and we have already seen that a series of alignment constraints were necessary to account for other aspects of Mayo reduplication.

In this section I will propose a similar scenario for the assignment of accent. Following Hagberg (2000), I will propose two contradictory alignment constraints which hold over the different lexical items marked by class:

(39) $ALIGN_A$-Hi, Σ, L: High tone appears at the left edge of a foot.
[for the Accented class words]

(40) ALIGN-Hi, Σ, R: High tone appears at the right edge of a foot.
[default]

As demonstrated by the data in (1) and (2), these constraints require this stress placement under reduplication, and also under other cases of prefixation (see Hagberg 1993 for further discussion). Therefore, as a constraint on the surface form, they equally constrain non-reduplicated and reduplicated forms (this is what motivated the "stress maintenance rule" from (4) above).

Relevant tableaux are provided in (41) and (42):

(41) Accented

| / RED + $nó.ka_A$/ | $ALIGN_A$-Hi, Σ, L | ALIGN($Base_A$ R, σ, R) |
|---|---|---|
| a. [ **no**.nó]. ka | *! | |
| b. ❽ [ **nó.ka**].nó.ka | | |
| c. ☺ [ **nó**.no].ka | | |
| d. [ **nók**.no].ka | | *! |

(42) Unaccented

| / RED + noká / | ALIGN-Hi, Σ, R | ALIGN(Base R, Σ, R) |
|---|---|---|
| a. [ **nó**. no]ka | *! | |
| b. ❽ [**no.ká**]. noká | | |
| c. ☺ [ **no**. nó]ká | | |
| d. [**nok**.nó].ka | | *! |

With just these two constraints we are unable to select the correct candidates, although only candidates with the correct tone-alignment and base-alignment will pass through these constraints successfully. The attested surface forms will be selected by other mechanisms that we have argued for in this paper: alignment of the reduplicant to one of two prosodic shapes; the left alignment of the root to force Compression in both the reduplicant and the base; etc.

What is crucial here is that the alignment of high tone be distinct from the alignment of the base. It is this grammaticalized distinction between tone-alignment and base-alignment which leads to the apparent opacity in Mayo reduplication. While the account presented here may appear to be merely stipulative in that separate alignment constraints are proposed for each aspect of apparently related phenomena, I think that these alignment constraints are justified when we view the development of these patterns from a diachronic perspective. Given the prominence of stressed syllables, and the maintenance of stress placement within the word even after affixation (true for Mayo as well as some other Uto-Aztecan languages), the "derivational" account given in (4) is the most plausible explanation of the historical development of these Mayo reduplication patterns. Using separate alignment constraints is just the most perspicuous way to account for this historical trajectory in a parallelistic synchronic grammar.

## 5. Conclusions

In this paper I have accounted for Mayo reduplication by using three pairs of alignment constraints:

i. Base-alignment: (Accented vs. Unaccented)

ii. High-tone alignment: (Accented vs. Unaccented)

iii. Reduplicant-alignment (Light-syllable vs. Heavy-syllable)

I have claimed that the distinction between (i) and (ii) leads to an apparent opacity in base-assignment. For (iii), I have introduced a (morphological) constraint disjunction to account for free variation among reduplicative morphemes.

Beyond accounting for the Mayo data, I have also shown that reduplicative bases are not the same thing as the string of segments faithful to the input, but can be a (prosodic or morphological) subset of that string, and I have crucially claimed that these can be referred to with constraints. Finally, I have extended the device of Compression (Hendricks 1999) to force the minimal possible base in reduplication.

## NOTES

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[1] All of the examples provided by Hagberg happen to have roots which are composed of a disyllabic foot. Mayo does contain a few roots with a longer form, but Hagberg (1993) does not give any contrasting reduplication patterns for these.

[2] We will ignore for now why we get gemination in the accented class; we take this issue up in section 4.1.

[3] *Symbol Key*: ☺ = Correctly chosen candidate;
☹ = Attested output, but not chosen by a tableau;
☻ = Incorrectly chosen candidate.

[4] The Yaqui language is also referred to as Hiaki and Yoeme.

[5] In Yaqui the regular high tone assignment is to the first syllable (Demers, Escalante and Jelinek 1999), and the majority of words follow this pattern, whereas in Mayo the words are roughly evenly divided between the two classes: first or second syllable accent. See Haugen (2003) for further discussion of the phonology of the Yaqui reduplication patterns.

[6] The other possible base domain which comes readily to mind would be some morphological unit.

[7] At this point I will remain agnostic about the relation I-R, although approaches to reduplication which require violations of "INTEGRITY" to force minimal reduplicants (e.g. Riggle 2001) lead me to suspect that we would be better off without such a relation. The full argumentation on this point is beyond the scope of the present paper.

[8] It would also be possible to form a constraint disjunction among the two classes, if we marked them both. This is not relevant here; my preference is to only mark the exceptional members, and leaving a default (a la Panini), which would have to be the lowest-ranked constraint in a constraint-based system such as OT.

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