Stress is the Trigger of Chamorro Umlaut[*]

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1. Introduction

In Chamorro umlaut, certain prefixes and particles with front vowels cause the fronting of root-initial vowels (Chung, 1983; Topping, 1968). This is shown in (1) with the definite article *i:*[1]

(1) a. nána   'mother'   i nǽna   'the mother'

   b. gúmaʔ   'house'   i gímaʔ   'the house'

   c. cúpa   'cigarettes' i cípa   'the cigarettes'

   d. sóŋsuŋ   'village'   i séŋsuŋ   'the village'

   e. hága   'daughter'   i hǽga   'the daughter'

   f. dáŋkulu   'big one'   i dǽŋkulu 'the big one'

   g. tómo   'knee'   i témo   'the knee'

Umlaut has two intriguing properties that are the focus of this paper. First, it only occurs if, as in each example in (1), the root-initial vowel is stressed. As shown in (2), when the root-initial vowel is unstressed, umlaut is impossible:

(2) a. pulónnun   'trigger fish'   i pulónnun   'the trigger fish'   *(*i pilónnun)*

   b. mundóŋgu   'cow's stomach'   i mundóŋgu   'the cow's stomach'   *(*i mindóŋgu)*

An adequate account of umlaut must explain why unstressed vowels are not viable targets for umlaut, and, alternatively, why umlaut cannot spread through these unstressed vowels to reach the stressed vowel (**i pilénnun, *i mindéŋgu*). The attested behavior is unexpected from the point of view of Positional Faithfulness (Beckman, 1999) because weak (unstressed) positions block spreading while strong (stressed) positions permit it. These data seem to call for "reverse" Positional Faithfulness constraints that preferentially protect unstressed syllables.

Second, umlaut may optionally target a certain kind of secondary stress:

(3) a. mí-pìgas, mí-pùgas   'abounding in uncooked rice'

   b. i gìmaʔníha, i gùmaʔníha   'their house'

   c. i kèbblinmámi, i kòbblinmámi   'our (excl.) cash'

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[1] Diacritics mark stress. The data throughout this paper abstract away from certain alternations in the low vowels. The symbols *a* and *æ* are used for these sounds. See Chung (1983) for relevant discussion.

This paper presents an analysis of umlaut that accounts for these facts. Positional Licensing (Zoll, 1998; Walker, 2001; Kaplan, to appear) produces the contrast between (1) and (2), and Stratal OT (Kiparsky, 2000) is adopted to produce the optional umlaut in (3). These analyses are developed in Sections 2 and 3, respectively.

Umlaut has implications for other important theoretical issues. The data presented above suggest that umlaut is a noniterative process. Based on the ungrammaticality of *i pilénnun and

*i mindéŋgu, one might say that [–back] may spread exactly one syllable to the right, and if the stressed syllable cannot be reached with this operation, then spreading is not permitted. This means that umlaut can shed light on the status of noniterativity in phonology, which is a point on which rule-based theories and Optimality Theory (OT) (Prince and Smolensky, 1993[2004]) differ markedly. In rule-based frameworks, grammars are composed largely of processes (i.e, rules) that apply to produce surface forms. With processes occupying an explicit formal place in grammars, languages can directly regulate how these processes apply. For example, many rule-based theories (e.g, Archangeli and Pulleyblank, 1994) include an iterativity parameter which determines whether a process applies just once, or as many times as possible.

OT, on the other hand, has nothing comparable to an iterativity parameter. Processes in OT are not formal constructs, but instead emerge from constraint interactions. Consequently, OT grammars cannot regulate how a process applies in any direct fashion. For example, constraints like ALIGN, SPREAD, and PARSE, which are often used to produce iterative phenomena like vowel harmony, cannot be made noniterative by switching a parameter. Wholly different constraints are needed for noniterativity. Thus OT does not recognize the close relationship between iterative and noniterative processes that rule-based theories do.

In fact, the difference between these frameworks is greater than this simple conceptual disagreement. In order to determine whether, e.g, a spreading operation has applied exactly once, a constraint that enforces noniterativity would have to compare the extent of a feature's domain in the output candidates to the extent of its domain in the input. If the output domain is one unit larger than the input domain, the spreading operation has applied noniteratively. But since this constraint would have to be a markedness constraint (because spreading is clearly not faithfulness), it is barred from accessing the input: Markedness constraints evaluate candidate forms in isolation. Thus OT constraints cannot require noniterativity, and the theory claims that true noniterativity should not exist in phonological grammars. That is, there should be no phenomenon that has as a defining characteristic the property of occurring exactly once.

OT can of course produce outputs in which some process applies just once. By requiring the target and trigger to be adjacent, constraints can produce spreading to or neutralization of just one segment (as in nasal place assimilation or final devoicing). Foot-constrained phenomena, where spreading occurs from one syllable in the foot to the other, are produced by requiring spreading throughout a foot. Just one spreading operation occurs because there is only one possible target in the foot. Optimal Domains Theory (Cole and Kisseberth, 1994) can produce similar results by building a binary domain and triggering spreading of features or tones throughout the domain. Finally, the construction of just one foot in a word is handled by requiring all feet to be aligned with some word edge. For all these examples, noniterativity *per se* is not required by any part of the formalism; Instead, it results from a confluence of other factors (such as adjacency or binarity) that do not explicitly enforce noniterativity.

This paper argues that Chamorro umlaut also has this property: Its apparent noniterativity is best understood as the product of Positional Licensing constraints that are not concerned with noniterativity. This implies that OT is correct to claim that noniterativity is epiphenomenal.

2. Umlaut as root licensing

2.1. Positional Licensing through prominence hierarchies

More examples of umlaut are given in (4). Glosses for the affixes and particles are: *ni* 'oblique case,' *in-* '1pl. exclusive,' *-in-* 'nominalizer,' *gi-* 'local case,' *en* '2pl.,' *sæn-* 'in the direction of,' and *mi-* 'abounding in.'

(4) a. kátta   'letter'   ni kǽtta   'the letter (obl.)'
     b. húŋuk   'to hear'   in-híŋuk   'we (excl.) heard'
     c. fógon   'stove'   ni fégon   'the stove'
     d. óksoʔ   'hill'   gi éksoʔ   'at the hill'
     e. túŋoʔ   'to know'   en tíŋoʔ   'you (pl.) know'
     f. góde   'to tie'   g-in-éde   'thing tied'
     g. lágu   'north'   sæn lǽgu   'towards north'
     h. ótdot   'ant'   mi-étdot   'lots of ants'

The central claim of this analysis is that umlaut involves spreading [−back] from a weak position to a strong position in order to enhance the feature's salience. Setting aside optional umlaut for the moment, the source of spreading is always a prefix[2] that immediately precedes primary stress (henceforth the term "pretonic" is used for this position specifically).

Pretonic syllables show evidence of weakness in Chamorro. Clash is generally tolerated, but the syllable immediately before primary stress may not itself bear stress (Chung 1983). This fact suggests that, perhaps to enhance the salience of the following primary stress, Chamorro wants weak pretonic syllables. Although careful phonetic work is needed to determine the nature and extent of the pretonic weakness that the clash facts indicate, this sort of weakness is not far-fetched: Other researchers (e.g, Crosswhite, 2001) have identified cases of vowel reduction to the left of stress. We can therefore posit the prominence hierarchy in (5), where '>' means "is more difficult than" along some articulatory, perceptual, or cognitive dimension (see Padgett, 2002).[3]

(5) Pretonic > Pre-Secondary Stress > Non-Pre-Stress > Secondary Stress > Primary Stress

On the other hand, the target of umlaut—the root—is a strong position. Roots are "prominent positions which license more contrasts than other non-prominent positions" (Urbanczyk, 2006:194) such as affixes (see also McCarthy and Prince, 1995; Steriade, 1995; Beckman, 1999; Kaplan, to appear). As phonemic contrasts are keys to correct identification of

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[2] Some sources of umlaut are actually clitics or infixes, but for present purposes they behave phonologically like prefixes. I use the term "prefix" to encompass true prefixes, clitics, and infixes that participate in umlaut.
[3] The universality of this scale is an open question. Many languages differ from Chamorro in the prominence relationships that hold among various syllable types. This suggests that the scale in (5) is not universal, but it is possible that other factors converge to disguise the effects of (5) in these other languages. Of course, an equivalent counterargument can be made: Maybe some other language exhibits the "unfiltered" effects of a universal prosodic prominence scale, and Chamorro is the language in which other factors suppress the scale.

lexemes by hearers, affixes are therefore at a disadvantage compared to roots (Ussishkin and Wedel, 2002). There is also evidence that affixes are psycholinguistically weak (e.g, Jarvella and Meijers, 1983) in that, for example, they do not prime themselves as robustly as roots do. Consequently, we can posit the prominence hierarchy in (6).

(6) Affix > Root

Umlaut thus involves spreading from a *prosodically* weak position (pretonic syllables) to a *morphologically* strong one (the root). Positional Licensing constraints (Zoll, 1998; Walker, 2001; Kaplan, to appear) are well-suited for motivating this sort of spreading. The constraint in (7) is appropriate for Chamorro.

(7) LICENSE-Pretonic: [–back] features that immediately precede primary stress must be linked to root segments.

LICENSE-Pretonic requires each [–back] feature in pretonic position to be linked to the root. It evaluates candidates by scanning the form for pretonic [–back] features, and it assigns a violation if such a feature is not linked to a root segment. This feature may also be linked to other non-root segments, but it crucially requires a link to at least one member of the root. In other words, LICENSE-Pretonic requires a prosodically weak [–back] feature to compensate for this weakness by being in a morphologically strong position.

This constraint can be viewed as part of the fixed hierarchy of constraints in (8). Each constraint requires [–back] features in some prosodic position to be linked to the root, and higher-ranked constraints make this demand of weaker prosodic positions in accordance with (5). While space constraints do not permit a detailed exposition, this constraint subhierarchy can be derived by combining the scales in (5) and (6) according to the method developed by Padgett (2002). See Kaplan (2007) for the details. LICENSE-Pretonic is the only Licensing constraint relevant for now, but we will return to the rest of the hierarchy below.[4]

(8) LICENSE-Pretonic ≫ LICENSE-Pre-Secondary ≫ LICENSE-Non-Pre-Stress ≫ LICENSE-σ̀ ≫ LICENSE-σ́

Since [–back] spreads only from pretonic vowels, IDENT[back], which blocks spreading, must outrank all the constraints in (8) except LICENSE-Pretonic. The Tableau in (9) shows how LICENSE-Pretonic triggers umlaut. The other Licensing constraints are subsumed under LICENSE-Elsewhere for simplicity.

(9)

/i gúmaʔ/	LICENSE-Pretonic	IDENT[back]	LICENSE-Elsewhere
a. i gúmaʔ	*!		
☞ b. i gímaʔ		*	
c. i gímæʔ		**!	

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[4] These constraints can be recast in as a stringency scale in the style of de Lacy (2002), but as this revision is tangential to the current analysis, I will not pursue it here.

The faithful form, candidate (a), fatally violates LICENSE-Pretonic because its pretonic vowel's [–back] feature is not linked to any root segment. Candidate (b) avoids this violation by spreading the prefix's [–back] feature to the root-initial syllable. Now LICENSE-Pretonic is satisfied: The pretonic [–back] feature is linked to a root segment. The last candidate shows that spreading beyond the first root syllable is unproductive. It incurs a fatal superfluous violation of IDENT while doing no better with respect to LICENSE-Pretonic than the winning form.

On the other hand, as (10) shows, when stress is not root-initial, umlaut is not permitted. Since the prefix's [–back] feature is not pretonic, LICENSE-Pretonic is irrelevant. The faithful form instead violates LICENSE-Non-Pre-Stress. But because this constraint is ranked below IDENT, it is powerless to trigger spreading. IDENT eliminates candidates that spread either to the root (candidate (b)) or all the way to the stressed syllable (candidate (c)).

(10)

/i pulónnun/	LICENSE-Pretonic	IDENT[back]	LICENSE-Elsewhere
☞ a. i pulónnun			*
b. i pilónnun		*!	
c. i pilénnun		*!*	

The Positional Licensing analysis claims that umlaut is a response to the weakness of pretonic syllables. Spreading just one syllable rightward to the root is enough to satisfy the constraint that triggers umlaut. Unstressed syllables seem to block umlaut not because of "reverse" Positional Faithfulness, but because they simply do not trigger umlaut. The apparent noniterativity of umlaut falls out from these facts.

This analysis owes much to the analyses of Crosswhite (1996) and Klein (2000), both of whom adopt constraints that motivate spreading the root. But unlike LICENSE-Pretonic, their umlaut-driving constraints do not take stress into account, so those analyses require additional machinery to block spreading in cases like (10). This apparent blocking falls out automatically with LICENSE-Pretonic: Umlaut is not motivated in the first place when stress is not root-initial.

The next section examines the Positional Licensing analysis in more detail.

2.2. Other strategies for satisfying LICENSE-Pretonic

The Positional Licensing constraint used above to motivate umlaut penalizes any non-root-linked pretonic [–back] feature. It does not actually demand spreading of this feature to the root. An alternative way to satisfy this constraint, then, is to eliminate the offending [–back] feature altogether. We must therefore consider a candidate like *u gúmaʔ. To rule out this sort of regressive spreading, IDENT[back] can be split into IDENT[–back] and IDENT[+back] (Hall, 2006). Since [–back] always overwrites [+back], IDENT[–back] must outrank IDENT[+back]:

(11)

/i gúmaʔ/	IDENT[–back]	LICENSE-Pretonic	IDENT[+back]	LICENSE-Else
a. i gúmaʔ		*!		
☞ b. i gímaʔ			*	
c. u gúmaʔ	*!			

Similarly, adding MAX to the ranking will eliminate candidates like *gúmaʔ (for the meaning 'the house') that delete the prefix completely.

The definition of LICENSE-Pretonic does not mention prefixes. Why, then, don't we find spreading from all pretonic front vowels, including root-internal ones? For example, the form *mìmantikáɲa* 'more abounding in fat' contains a pretonic front vowel. Why isn't this form *mìmantikǽɲa? The reason is that the pretonic vowel's [–back] feature in this form is already linked to the root, so LICENSE-Pretonic is satisfied without any spreading. As (12) shows, the faithful candidate does not violate LICENSE-Pretonic, so altering the underlying backness specifications is unwarranted (cf. candidate (b)). (This word is morphologically complex, though, so the prefix's [–back] feature violates the low-ranked LICENSE-σ̀. As we saw above, this constraint is ranked too low to trigger umlaut, as candidate (c) shows.)

(12)

/mì-mantiká-ɲa/	IDENT[–back]	LIC-Pretonic	IDENT[+back]	LIC-Else
☞ a. mì-mantiká-ɲa				*
b. mì-mantikǽ-ɲa			*!	*
c. mì-mæntiká-ɲa			*!	

Next, consider suffixes. Umlaut is restricted to prefixes, yet none of the constraints used here distinguishes prefixes from suffixes. But the lack of spreading from suffixes is already predicted by the analysis. All suffixes relocate primary stress to the word-penultimate syllable. (This is the default location for stress in Chamorro, although some roots have exceptional stress and prefixes can move stress leftward.) In order for a suffix vowel to be pretonic, it must be part of a trisyllabic or larger suffix, or a trisyllabic string of suffixes. I have been unable to find any suffixes or suffix combinations that meet this criterion.[5] As (13) shows, the only suffixes I am aware of violate, at worst, one of the low-ranking Licensing constraints, which isn't enough to trigger umlaut. Suffixes are never pretonic, so they cannot violate LICENSE-Pretonic.

(13)

/kwentús-i/ 'to speak to'	IDENT[–back]	LIC-Pretonic	IDENT[+back]	LIC-Else
☞ a. kwentús-i				*
b. kwentís-i			*!	

Of course, if sufficiently long suffixes do exist in Chamorro, it is simple enough to modify the Licensing constraints so that they hold only for prefixes (by requiring [–back] features to be linked to root or suffix segments—perhaps the prosodic word). This would mean making a distinction between prefixes and suffixes in the scale in (6) on which the Licensing constraints are based. There is evidence, e.g, from typology (Hyman, 2002, 2005), that prefixes are more marked than suffixes, so amending (6) would have an independent justification.

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[5] Nor do suffixes ever precede secondary stress, by the same logic. This point is relevant for the discussion of optional umlaut with secondary stress below.

This completes the core of the Positional Licensing analysis of Chamorro umlaut. Umlaut, it is claimed here, is triggered by stress, and the root is the target. The constraint that motivates spreading only penalizes pretonic [–back] features, so when stress is not root-initial, spreading from a prefix is not warranted. This result means that "reverse" Positional Faithfulness is unnecessary: We don't need to explain why weak positions resist assimilation because, under the view advocated here, they instead aren't appropriate triggers.

Furthermore, spreading through unstressed syllables to reach the stressed syllable is unattested because the root, and not the stressed syllable, is the target of umlaut. Consequently, the appearance of noniterativity in umlaut is explained: LICENSE-Pretonic only motivates spreading to the root, so spreading just once to the right from a prefix satisfies this constraint.

3. Optional umlaut

Recall that umlaut optionally occurs with root-initial secondary stress. This section extends the Positional Licensing analysis to account for this.

3.1. Umlaut and cyclic stress

Chamorro has two kinds of secondary stress, and one of these, cyclic stress, optionally triggers umlaut. As mentioned above, affixes can relocate primary stress. When they do, the syllable that hosted primary stress in the unaffixed form receives secondary stress. This is illustrated in (14).

(14) swéddu   'salary'   swèddunmámi 'your (sg.) salary'

      inéŋŋuluʔ 'peeping'   inèŋŋulóʔɲa   'his peeping'

      néŋkɑnuʔ   'food'   mínèŋkɑnuʔ   'abounding in food'

      ɑdǽhi   'be careful'   gófɑdàhi   'be very careful'

      kwentúsi   'to speak to'   ǽkwentùsi   'to speak to one another'

As the forms in (15) show, root-initial syllables with secondary stress optionally undergo umlaut if those syllables have primary stress in the unaffixed form. That is, root-initial vowels with cyclic secondary stress optionally participate in umlaut.

(15) púgɑs 'uncooked rice'   mí-pìgɑs,   'abounding in uncooked rice'
                              mí-pùgɑs

      gúmɑʔ 'house'   i gìmɑʔníhɑ,   'their house'
                              i gùmɑʔníhɑ

      kóbbli 'cash, money'   i kèbblinmámi,   'our (excl.) cash'
                              i kòbblinmámi

Recall that Chamorro prohibits immediately pretonic syllables from bearing stress. This means that when an affix moves the primary stress one syllable rightward, the syllable that should bear cyclic secondary stress is prevented from doing so because it is now pretonic. Even so, these destressed syllables may undergo optional umlaut:

(16) cúpɑ 'cigarettes'   i cupáɲɑ,   'his cigarettes'

                                i cipáɲɑ

      cóʔuʔ 'work'   i coʔóʔmu,   'your (sg.) work'

                                i ceʔóʔmu

The second kind of secondary stress in Chamorro is rhythmic stress. With some systematic exceptions such as the initial dactyl in (18) below, alternating syllables to the left of primary stress receive secondary stress as illustrated in (17). In the analyses of Flemming (1994) and Klein (2000), these stresses (along with the default penultimate primary stress) reflect trochees. Unlike cyclic stress, rhythmic secondary stress does not trigger umlaut, as (18) shows.

(17) àtmɑygósu   'vegetable sp.'

      kìmɑsón   'to burn'

      mɑgágu   'clothes'   màgɑgúɲɑ   'his clothes'

      bɑpót   'ship'   bàpotníhɑ   S'their ship'

(18) pùtɑmunédɑ 'wallet'   i pùtɑmunédɑ,   'the wallet'

                               *i pìtɑmunédɑ

An analysis of optional umlaut must account for the different behavior of these two kinds of secondary stress. I do so immediately below by adopting a version of Stratal OT (Rubach, 1997; Kiparsky, 2000). Umlaut occurs at a level before rhythmic stress is added and before clash is resolved. When umlaut happens, the only secondary stress available for it to interact with is cyclic, and (soon-to-be) destressed pretonic syllables still bear stress and can condition umlaut.

It is tempting to use Output-Output Faithfulness (Benua, 1997; Crosswhite, 1996) to distinguish rhythmic and cyclic stress. The vowels that undergo umlaut in (15) and (16) correspond to vowels with primary stress in a simpler form, but the root-initial vowel in (18) has no such correspondent. One could invoke an OO-Faith constraint to capture this relationship, as Crosswhite (1996) does. But Klein (2000) points out that viable bases are not always available. For example, *úcan* 'rain,' when prefixed with *mí-* 'lots of,' optionally undergoes umlaut: *mí-ùcan, mí-ìcan* 'lots of rain.' There must be some base that manifests umlaut to which this form can be faithful. The closest such form is *i ícan* 'the rain,' but this form is not wholly contained within *mí-ìcan,* so it is an illicit base according to the architecture of Output-Output Faithfulness. There is no form *ícan* (independent of *i ícan*) that can serve as a base. Consequently, Output-Output Faithfulness is not an adequate theory for an analysis of optional umlaut.

3.2. Stratal OT

In Stratal OT, an output form is produced by a series of Tableaux with each Tableau's output serving as the input for the next one. Rubach (1997) and Kiparsky (2000) have proposed slightly different implementations of Stratal OT, with Kiparsky seeking to tie the strata more closely to

the levels of lexical phonology. I follow Kiparsky's theory of Stratal OT here, except that while he adopts three strata (stem, word, and postlexical), only two strata are needed here. They are probably best thought of as the word and postlexical levels, although I take a neutral position on this point by labeling them Level 1 and Level 2.

The different behavior of cyclic and rhythmic stress with respect to umlaut is captured here by assigning these kinds of stress at different levels. (More accurately, the constraints that produce these kinds of stress receive different rankings in the two levels.) Specifically, at Level 1 (where I assume all affixes are present), primary stress and cyclic stress is assigned. Umlaut also occurs here. Rhythmic stress must wait until Level 2, where clash resolution also occurs. Also at Level 2, promotion of faithfulness constraints prevents any alteration of the umlaut (or lack thereof) inherited from Level 1.

This division of labor—for which we will see additional independent evidence below—has important consequences. Since cyclic but not rhythmic stress is present at the stage in which umlaut occurs, only the former may interact with umlaut. Furthermore, postponing clash resolution until Level 2 means that umlaut occurs without knowledge of whether or not the stress that triggers spreading will survive to the surface.

So far, the constraint ranking developed here produces only umlaut triggered by primary stress. To permit secondary stress to trigger umlaut, LICENSE-Pre-Secondary (which is the second-highest constraint in (8) and requires [−back] features that precede secondary stress to be linked to the root) must be promoted over IDENT[+back]. But since umlaut with secondary stress is only optional, we must also permit IDENT[+back] to outrank LICENSE-Pre-Secondary on some evaluations. Consequently, I adopt a non-crucial ranking between these constraints, and I assume that a ranking between them is chosen at random on each evaluation. This is simply the multiple-grammars theory of variation advocated by Anttila (2006, 2007).

The form *i gimáʔ-ɲa/i gumáʔ-ɲa* 'his house' illustrates the analysis. This form has optional umlaut: The root-initial syllable should bear cyclic secondary stress (cf. *gúmaʔ* 'house'), but it cannot because the following syllable bears primary stress. The Tableau in (19) shows the Level 1 evaluation of this form with LICENSE-Pre-Secondary outranking IDENT[+back]. Following Rubach (1997), I use double slashes to indicate underlying forms and single slashes to indicate intermediate forms. For simplicity, I only consider candidates with correct stress. See Crosswhite (1996) and Klein (2000) for OT analyses of Chamorro stress.

(19)   Level 1, LICENSE-Pre-Secondary ≫ IDENT[+back]

//i gùmáʔ-ɲɑ//	IDENT[−bk]	LIC-Pretonic	LIC-Pre-2nd	IDENT[+bk]	LIC-Else
a. /i gùmáʔ-ɲɑ/			*!		
☞ b. /i gìmáʔ-ɲɑ/				*	

In this Tableau, umlaut is required because of the new higher ranking of LICENSE-Pre-Secondary, even though the umlaut-triggering stress will be deleted in the Level 2 Tableau, which is shown in (20). The same constraint interaction that yielded umlaut on primary stress is at work in (19): The prefix's [−back] feature in the faithful form violates a Licensing constraints that outranks IDENT[+back], so the winning candidate is the one with spreading to the root.

At Level 2, rhythmic stress appears (as enforced below by STRESS-ALT), and clash is resolved (*CLASH). Finally, to prevent further umlaut from occurring, IDENT[+back] is promoted over all the Licensing constraints.

(20)   Level 2: *i gimáʔ-ɲa*

/i gìmáʔ-ɲa/	STRESS-ALT	*CLASH	IDENT[−bk]	IDENT[+bk]	LICENSE
a. i gùmáʔ-ɲa		*!	*!		*
b. i gumáʔ-ɲa			*!		*
c. i gìmáʔ-ɲa		*!			
☞ d. i gimáʔ-ɲa					

The root-initial stress must be eliminated to satisfy *CLASH, so candidates (a) and (c) lose. Consequently, the impetus for umlaut is removed. But the high ranking of the IDENT constraints ensures that the input's backness specifications are retained. This means that since umlaut is present in the input (which is the winner from (19)), it must also be present in the surface form.

The Tableaux in (19) and (20) show how the variant of this form with umlaut is produced. The next two Tableaux show how the other variant is generated. First, at Level 1, the opposite ranking between LICENSE-Pre-Secondary and IDENT[+back] is selected. With the latter outranking the former, only umlaut with primary stress is permitted, just as in Section 2. In contrast with (19), this time the candidate lacking umlaut wins.

(21)   Level 1, IDENT[+back] ≫ LICENSE-Pre-Secondary

//i gùmáʔ-ɲa//	IDENT[−bk]	LIC-Pretonic	IDENT[+bk]	LIC-Pre-2nd	LIC-Else
☞ a. /i gùmáʔ-ɲa/				*	
b. /i gìmáʔ-ɲa/			*!		

Since umlaut is not produced at Level 1, the winner at Level 2 will also lack umlaut. This is shown in (22). As before, *CLASH eliminates candidates that keep the secondary stress, and the IDENT constraints ensure that the backness specification of each vowel is not tampered with. In this case, that means the root initial-vowel must be [+back], and the winner is the second variant for this form.

(22)   Level 2: *i gumáʔ-ɲa*

/i gùmáʔ-ɲa/	STRESS-ALT	*CLASH	IDENT[−bk]	IDENT[+bk]	LICENSE
a. i gùmáʔ-ɲa		*!			*
☞ b. i gumáʔ-ɲa					*
c. i gìmáʔ-ɲa		*!		*!	
d. i gimáʔ-ɲa				*!	

Next, consider *i pùtamunéda* 'the wallet.' This form has initial rhythmic secondary stress, and umlaut is impossible. The Level 1 Tableau for this form is given in (23). This time, the ranking between LICENSE-Pre-Secondary and IDENT[+back] is inconsequential: With no secondary stress on the root-initial syllable (because rhythmic stress is assigned later), LICENSE-Pre-Secondary is not violated by the faithful form. Umlaut is never motivated under either possible ranking, and IDENT[+back] is free to select the fully faithful candidate.

(23)   Level 1: *i pùtamunéda*

//i putamunéda//	IDENT[−bk]	LIC-Pretonic	LIC-Pre-2nd	IDENT[+bk]	LIC-Else
☞ a. /i putamunéda/					*
b. /i pitamunéda/				*!	

Both rankings send the faithful candidate to Level 2. With only one winner at Level 1, there is only one possible outcome at Level 2. As before, the promotion of IDENT[+back] at this level means that umlaut at Level 2 is not permitted, even though a new secondary stress is added:

(24)   Level 2: *i pùtamunéda*

/i putamunéda/	STRESS-ALT	*CLASH	IDENT[−bk]	IDENT[+bk]	LICENSE
a. i putamunéda	*!				*
☞ b. i pùtamunéda					*
c. i pitamunéda	*!			*!	
d. i pìtamunéda				*!	

STRESS-ALT requires initial secondary stress and eliminates candidates (a) and (c). Despite candidates (b) and (d) exhibiting what is ostensibly the right context for optional umlaut, the high ranking of the faithfulness constraints precludes adding umlaut at this level. This form missed its chance: It did not have initial secondary stress when the door was open for umlaut.

Stratal OT permits an explanation for why only cyclic stress triggers optional umlaut, and the non-crucial ranking between LICENSE-Pre-Secondary and IDENT[+back] produces the optionality. A very similar and equally successful approach (which is taken by Kiparsky (1986) in a derivational theory) is one in which all forms of umlaut are optional at Level 1, and umlaut with primary stress is required at Level 2. This would require a revision of the current analysis so that IDENT[+back] is non-crucially ranked with respect to both LICENSE-Pretonic and LICENSE-Pre-Secondary at Level 1, and LICENSE-Pretonic outranks IDENT[+back] at Level 2. This seems just as adequate as the approach taken here, and I see no way to decide between these alternatives.

Chung (1983) rejects a cyclic rule-based account of optional umlaut similar to the Stratal OT analysis proposed here in favor of one that foreshadows Output-Output Faithfulness. Her argument against a cyclic analysis is this: The rule that produces umlaut must be optional, otherwise there is no way of producing the optionality seen with secondary stress. But if the rule is optional, we cannot ensure that it always applies at least once in each derivation to produce umlaut with primary stress, which does not show the variability discussed in this section.

The Positional Licensing analysis escapes this confound. The difference between obligatory and optional umlaut is a by-product of the different relationships between IDENT[+back] and constraints at various points in the Licensing hierarchy from (8). With LICENSE-Pretonic always outranking IDENT, umlaut on primary stress always occurs. But since LICENSE-Pre-Secondary only sometimes outranks IDENT, it triggers umlaut on secondary stress only part of the time.

3.3. Other evidence for Stratal OT

There is independent evidence for the order of events posited in the Stratal OT analysis of optional umlaut. According to this analysis, cyclic and rhythmic stress are assigned at different stages and should interact with other processes in ways similar to the way each interacts with umlaut. There are two phenomena, gemination and vowel lowering (both analyzed by Chung (1983) and Crosswhite (1996)), that bear out this prediction.

Gemination targets CV suffixes in words that meet the following conditions: (i) the syllable immediately before the suffix must be open, and (ii) there must be a closed stressed (or formerly stressed) syllable elsewhere in the word. Compare the words in (25), which meet these conditions, with (26), where the stressed syllable in the bare form is not heavy. In all three forms, the original stresses are eliminated in the suffixed forms because they are pretonic.

(25)   kánta   'song'   kantákku   'my song'

         maléffa   'forgetting'   maleffámmu 'your forgetting'

(26)   dúda   'doubting'   dudámu   'your doubting'   *(*dudámmu)*

Chung (1983) points out that gemination maintains the weight of the stressed syllable across cycles or related output forms. If the stressed syllable in the unaffixed word is heavy, the stressed syllable created by suffixation must also be heavy. Since suffixes relocate stress to the penultimate syllable, gemination of the suffix-initial consonant provides a coda for the new stressed syllable. (Crosswhite's (1996) analysis of gemination follows this description closely.)

Secondary stress in a heavy syllable can also trigger gemination:

(27)   a.   míbàtku   'abounding in ships'

              mìbatkóŋŋa   'more abounding in ships'

         b.   mícòdda   'abounding in green bananas'

              mìcoddáŋŋa   'more abounding in green bananas'

But this only holds if the secondary stress is cyclic. Rhythmic secondary stress does not trigger gemination. Although all the suffixed words in (28) have heavy stressed syllables, gemination is not possible because these syllables have rhythmic stress.

(28)   a.   sitbésa   'beer'   sìtbesá   'his beer'

         b.   iskwéla   'school'   ìskweláŋa 'his school'

         c.   cincúlu   'fishing net'   cìnculúmu 'your fishing net'

These patterns are expected if gemination occurs at Level 1 and rhythmic stress appears at Level 2. When gemination occurs, the heavy syllables in (28) don't have stress, so gemination fails in these forms.

Vowel lowering in Chamorro is a process whereby "[n]on-low vowels surface as mid in stressed closed syllables, and as high elsewhere" (Chung 1983:46). The forms in (29) illustrate this: Stress alternations yield changes in vowel height.

(29) a. lápis   'pencil'   lapéssu   'my pencils'

      b. malǽguʔ   'wanting'   malæ̀góʔmu   'your (sg.) wanting'

      b. hugándu   'playing'   hùgandóŋŋa 'his playing'

Like gemination, vowel lowering obligatorily targets syllables with cyclic secondary stress:

(30) a. éttigu   'short'   èttigóŋŋa   'shorter'

      b. inéŋŋuluʔ 'peeping'   inèŋŋulóʔhu   'my peeping'

      c. óttimu   'end'   òttimóŋŋa   'her end'

      d. sénsin   'flesh'   mísènsin   'fleshy'

But (unlike gemination) it only optionally affects syllables with rhythmic secondary stress:

(31) a. tintáguʔ   'messenger'

          tìntagóʔta, tèntagóʔta   'our (incl.) messenger'

      b. mundóŋgu   'cow's stomach'

          mùnduŋgóŋŋa, mònduŋgóŋŋa   'its stomach'

      c. ispéyus   'mirror'

          ìspiyósɲa, èspiyósɲa   'his mirror'

If vowel lowering is obligatory at Level 1 but optional at Level 2, these facts are accounted for. Cyclic stress is assigned at Level 1, so vowels with cyclic stress must lower. But rhythmic stress is assigned at Level 2, so vowels in syllables with rhythmic stress optionally lower.

Like umlaut, gemination and vowel lowering discriminate between Chamorro's two kinds of secondary stress. Analyses of these phenomena must recognize a formal dichotomy between cyclic and rhythmic stress. Stratal OT provides a simple way to make the necessary distinction.

4. Conclusion

Positional Licensing is an ideal tool for an analysis of umlaut because it permits the umlaut-inducing constraints to be formulated in a way that motivates spreading just when stress is root initial. The analysis developed here therefore avoids the theoretical awkwardness (i.e, "reverse" Positional Faithfulness) that accompanies an attempt to treat unstressed syllables as genuine, formal blockers. Since umlaut treats cyclic and rhythmic secondary stresses differently, an

analysis of umlaut must provide some formal distinction between these two kinds of stress. I argued here that Stratal OT provides an easy way to make such a distinction.

Many interesting questions remain. I argued above for the weakness of pretonic syllables in Chamorro based on patterns of clash resolution, but verification of this weakness through a phonetic study is desirable. It is also worth asking why only [–back] participates in umlaut: Are there functional or cognitive reasons that this feature is singled out by umlaut?

Finally, I have shown that umlaut in Chamorro can be accounted for without assuming that the spreading involved is necessarily noniterative in nature. When the stressed syllable is not adjacent to the prefix/particle from which [–back] might spread, umlaut fails not because the target of spreading is too far away, but because the form fails to meet the conditions that trigger umlaut. This analysis therefore supports the claim that true noniterativity is absent from phonological systems. Other research (Kaplan, to appear) draws similar conclusions for another potential case of noniterativity, vowel harmony in Lango. If these results are indicative, we are led to the conclusion that genuine noniterativity is not attested in phonological grammars, and therefore OT's approach to processes is superior to the rule-based approach. Since noniterativity is epiphenomenal, there is no need to embed it within phonological theory.

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