Moras are about length not about weight
Cayuga laryngeal metathesis, Chugach Alutiiq degemination and Wolof stress

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Expressing syllable weight by moras leads to two problems. First, there are languages, such as Wolof, with long vowels and geminates, which both make a syllable bimoraic, but where only long vowels, but not geminates, count as heavy for stress. Second, there are languages in which closed syllables are light for stress, but heavy for segmental modifications (laryngeal metathesis in Cayuga and degemination in Chugach Alutiiq). It is argued that a two-layered mora model is not required and that a straightforward Harmonic Serialism is able to directly express that laryngeal metathesis and degemination make an unstressed syllable light.

Keywords: laryngeal metathesis, degemination, syllable weight, geminates and stress

1. Introduction

Since Hayes (1995) it has been custom in metrical theory to describe and represent stress by metrical feet. A foot has two elements, in the most simple case, two syllables. Within the foot the first syllable can be more prominent than the second, as in English (te.le)(vi.sion) [ˌte.le.ˈvi.ʒən] or in Polish (te.le)(wi.zor) [ˌte.le.ˈvi.zɔr] (where , marks secondary stress and ’ marks primary stress). A foot with initial stress is a trochee and one with final stress is an iamb, such as the two feet in Creek (a.pa)(ta.ca) [a.pa.ta.ˈka] ‘pancake’. Feet do not always consist of two syllables. In Hawaiian, (ho.no).(lu.lu) [ˌho.no.ˈlu.lu] ‘a place name’, the two feet each do have two syllables, but in ka.(i.mu).(ki:) [ka.ˌi.mu.ˈkiː] ‘a place name’, the last foot has only one syllable. The last syllable has a long vowel, which is formally represented as a vowel having two moras. As long vowels make a syllable heavy, they typically attract stress and the foot being used is a moraic trochee, where each foot consists of two moras, instead of a syllabic trochee (where each
A syllable can also be heavy if it is closed by a consonant. Compare Spanish \textit{pa.}\textit{pel} ‘paper’ with final stress and Polish \textit{pa.wel} ‘a boy’s name’ with initial stress. The Spanish coda consonant is represented as having a mora (making the final syllable heavy), whereas Polish coda consonant does not have a mora (the syllable stays light).

Expressing syllable weight by moras leads to two problems. First, there are languages in which closed syllables are treated as light, as monomoraic, for stress, but in which at the same time they need to be considered as heavy, as bimoraic, for segmental modifications. Second, there are languages with long vowels and geminates, such as trochaic Wolof (Ka 1988; Bell 2003), where only long vowels, but not geminates, count as heavy for stress. The first case can be illustrated with laryngeal metathesis in Cayuga (Hayes 1995: 300–302; Foster 1982) and with degemination in Chugach Alutiiq.

In order to describe this, Hayes (1995: 300) proposed a two-layered moraic model, where on one level moras for stress are represented, and with moras for duration on another level. This paper argues for an alternative view in which moras are limited to expressing consonantal and vocalic length, but are not used to differentiate between coda consonants that are moraic or not. Adopting a Harmonic Serialism approach (McCarthy 2010) is shown to straightforwardly express the relation between stress and laryngeal metathesis and degemination without any non-motivated theoretical machinery.

This paper is structured as follows. Section 1 discusses laryngeal metathesis in Cayuga and degemination in Chugach Alutiiq. We will show that neither the rule-based metrical theory of Hayes (1995) nor a parallel Optimality Theory (OT) (Prince and Smolensky 1993) approach is able to provide a satisfactory account of laryngeal metathesis and degemination. Section 2 is devoted to Wolof stress and the observation that only long vowels, but not geminates count as heavy for stress. We show that an OT-account can account for these facts, but that in order to do so, the constraint WSP, a heavy syllable must be stressed, needs to be split into two separate constraints. Section 3 argues for a unified solution of the two problems. We motivate the use of two alternative constraints and show that a Harmonic Serialism approach is able to directly describe Cayuga laryngeal metathesis and Chugach Alutiiq degemination as segmental modifications that make unstressed syllables light.
2. Laryngeal metathesis in Cayuga and degemination in Chugach Alutiiq

The Lake Iroquoian language Cayuga is an iambic language where long vowels count as heavy syllables, but where (CVC) closed syllables count as light. In a more traditional rule-based approach to metrical phonology it is analysed by Hayes (1995: 222–226), based on Foster (1982), as a case of left-to-right iambic footing with a final foot being made extrametrical and with the End Rule Right, as in (1).

(1) Cayuga stress
   a. Foot Construction       Form iambs from left to right
      (/ H / = CV: (C)).
   b. Foot Extrametricality   Foot → <Foot> / –] word
   c. Word Layer Construction End Rule Right

The condition for foot construction in (1a), (/ H / = CV: (C)), guarantees that only syllables containing long vowels are treated as heavy by the stress rules. In (2), some derivations, taken from Hayes (1995: 223), are provided (L stands for light syllables, H for heavy syllables, × for stressed and . for unstressed syllables).

(2) Some Cayuga stress derivations

   /hẽ. na. toː.was/ /e. hẽ. na. toː.wat/ /te. wa. ka. ta. wën. ye/ /ka. nes. taʔ/
   L   L   H   L   L   L   L   H   L   L   L   L   L   L   L   L   L   L
   1a (. x) (x) (. x) (. x) (. x) (. x) (. x) (. x) (. x)
   1b (. x) (x) (. x) (. x) (. x) (. x) (. x) (. x) <(. x)> (. x)
   1c ( x ) ( x ) ( x ) ( x ) ( x )

   [hẽ.ˌna.ˈtoː.was] [e.ˌhẽ.na.ˈtoː.wat] [e.ˌwa. ka.ˈta. wên.ye] [ka.ˈnes.taʔ]

   ‘they are’ ‘they will hunt’ ‘I’m moving about’ ‘board’

   ‘hunting’

In the moraic theory of the syllable, closed syllables may or may not count as heavy depending on whether or not they have a mora. In the derivational stress model of Hayes (1995), this was captured by a language-specific parameter: WBP, weight-by-position. A coda consonant can have its own mora (WBP+) or not (WBP−). Polish and Spanish differ exactly in this respect, with WBP+ in Spanish and WBP− in Polish, as illustrated in (3).

(3) Polish and Spanish as examples of a different WBP setting

   WBP+ Spanish ‘ca sa pa’pel
   μ μ μ μ μ μ
   (x .) (x .)
   ‘house’ ‘paper’
In an OT-account this follows from a constraint ranking in which the constraint \textsc{Parse-σ} (syllables must be parsed in a foot) is ranked higher than the constraints \textsc{Wsp} (a heavy syllable must be stressed) and \textsc{Wbp} (a coda consonant has a mora). The rankings assumed for Spanish and Polish are illustrated in (4), where the stressed syllable is marked with boldface.

\begin{enumerate}
\item Different constraint rankings in Polish and Spanish
\begin{enumerate}
\item Spanish
\begin{tabular}{c|c|c|c}
\hline
\text{Input} & \text{WBP} & \text{Wsp} & \text{Parse-σ} \\
\hline
\text{a. (pa.pel)} & $*$ & & \\
\text{b. (pa.pe.l)} & $*$ & & \\
\text{c. pa.(pe.l)} & $*$ & $*$ & \\
\text{d. (pa.pe.l)} & $*$ & $*$ & \\
\hline
\end{tabular}
\item Polish
\begin{tabular}{c|c|c|c}
\hline
\text{Input} & \text{Parse-σ} & \text{Wsp} & \text{Wbp} \\
\hline
\text{a. (prze.mek)} & & $*$ & \\
\text{b. (prze.me.k)} & $*$ & & \\
\text{c. prze.(me.k)} & $*$ & $*$ & \\
\text{d. prze.(me.k)} & $*$ & $*$ & \\
\hline
\end{tabular}
\end{enumerate}
\end{enumerate}

As (4a) illustrates, the optimal Spanish output form (d) wins over the other output forms by neither violating the constraints \textsc{Wbp} and \textsc{Wsp}, but only violating the low ranked constraint \textsc{Parse-σ}. Given that the constraint \textsc{Parse-σ} is ranked higher in Polish (4b), the choice between output candidates (a) and (b) is decided by the constraint \textsc{Wsp}, which favours (a) over (b).

Now, given that in Cayuga closed syllables do not count as heavy, the parameter setting for Cayuga is \textsc{Wbp} and coda consonants do not have a mora. Only syllables with long vowels count as heavy. This entails the following OT ranking for iambic Cayuga: \textsc{Wsp} $>>$ \textsc{Parse-σ} $>>$ \textsc{Wbp}, as illustrated for [hēˌnaˌtoː.wa$\emptyset$] in (5).
Let us now turn to laryngeal metathesis which applies in the weak side of an iambic foot. The effects of laryngeal metathesis are illustrated in (6), taken from Hayes (1995:301), who refers to Foster (1982) and Michelson (1988) for why /VɁV/ and /VhV/ sequences are syllabified as /VɁ.V/ and /Vh.V/ in Cayuga.

(6) Cayuga laryngeal metathesis

CVʔ. → CʔV
CVh.C → ChC.C before consonants
CVh.V → CV̥V before vowels

As shown in (6), if the weak syllable of an iambic foot is closed by a glottal stop, the glottal stop is removed from the coda position to the onset of the syllable. If the weak syllable of an iambic foot ends in the laryngeal fricative [h], the laryngeal fricative is moved to the onset if the following syllable starts with a consonant. If it starts with a vowel, the laryngeal fricative [h] merges with the preceding vowel and devoices the vowel. Hayes (1995) does not provide examples, but the following example (Foster 1982:69) is illustrative. The word [(aˌkah).ˈwaɁ.ek] ‘it struck, chimed’ shows no effects of laryngeal metathesis, because the glottal stop and [h] do occur in the strong part of an iambic foot. Habitual aspect is marked by adding the suffix [s], which leads to the dropping of the factual prefix [a] marker, giving underlying /kah.wis.taʔ.eks/. After stressing and laryngeal metathesis, /kah.wis.taʔ.eks/ surfaces as [kḁˌwis.ˈtɁa.ˈes], as illustrated in (7) (final [ks] simplifies to [s]).

(7) Cayuga laryngeal metathesis

Underlying representation /kah. wis. taʔ. eks/
Iambic footing (kahˌwis).(taʔ.eks)
Laryngeal metathesis (kã.ˌwis).(tʔa.ˈeks)
[ks] simplification (kã.ˌwis).(tʔa.ˈes)
Surface representation [kãˌwis. tʔa.ˈes]

The crucial question to be addressed now is the following. The weak part of the iambic foot in (7) is already a perfect iambic foot. This is the first problem for a
metrical theory using a moraic representation of the syllable. How can we understand the fact that closed syllables count as light for stress, but as heavy for foot-based segmental modifications?

Hayes (1995: 300) proposes a two-layered moraic model, where two levels of moraic representation are provided: one for segmental duration and one for stress. As illustrated in (8), this allows for closed syllables to be represented as either in (8c) or in (8d).

(8) A two-layered moraic representation of the syllable

a. \[
\sigma \\
/ \mu \\
/ \mu \\
t \quad a
\]
long vowel

level for stress
level for duration

b. \[
\sigma \\
/ \mu \\
/ \mu \\
t \quad a
\]
short vowel

level for stress
level for duration

c. \[
\sigma \\
/ \mu \\
/ \mu \\
t \quad a \quad t
\]
closed syllable

level for stress
level for duration

d. \[
\sigma \\
/ \mu \\
/ \mu \\
t \quad a \quad t
\]
closed syllable

level for stress
level for duration

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The different representation of closed syllables allows to account for languages, such as Cayuga, where closed syllables are treated as light (monomoraic) for stress, but as heavy (bimoraic) for segmental modifications. If closed syllables in Cayuga are represented as in (8c), Cayuga laryngeal metathesis can then be described as in (9) (cf. Hayes 1995:301).

(9) Cayuga laryngeal metathesis in a two-layered moraic model

Laryngeal metathesis converts syllables that are monomoraic only on the higher moraic layer to syllables that are monomoraic on all layers of moraic representation. Hayes remarks (1995:301): “This is an expected outcome for the weak side of an iambic foot: its phonological duration is reduced, following the Iambic/Trochaic Law. But under a single-layered moraic theory, this characterization cannot be formally expressed, since a CVC syllable is represented as monomoraic.”

However, if closed syllables count already as light for stress and weight considerations, why should coda duration, for which there is in terms of stress no evidence, be deleted? Also, by having two layers of moras, the close correlation between length and stress seems to be lost. Moreover, it is impossible to formally express that laryngeal metathesis takes place because the syllable is unstressed. The same critical remarks hold for an OT-analysis. If the OT constraint ranking for Cayuga is WSP >> Parse-σ >> WBP, closed syllables will not have a mora and are light. Of course an additional markedness constraint could be proposed, like NO LARYNGEAL CODA IN THE WEAK PART OF A FOOT, but the close connection between metathesis and stress in terms of syllable weight cannot be straightforwardly expressed. What one would like to formally express is the fact that there is laryngeal metathesis because that makes the unstressed syllable light. Both in the two-layered moraic model and in the OT account sketched above this is impossible. The unstressed syllable already is a light syllable.

A similar problem arises in Pacific Yupik or Alutiiq (Leer 1985; Hayes 1995), and more specifically in Chugach Alutiiq (for a more complete discussion, we refer to Hayes (1995:239–260 and 333-346). In Chugach Alutiiq, syllables closed by a geminate count as light for stress. However, if a geminate ends up in the weak part of an iambic foot, it is degeminated. If it ends up in the strong part of an
iambic foot, it is not. That is, a geminate “may only follow an accented vowel” (Leer 1985: 87). An example is the underlying geminate in the post-base /-nnix/ suffix ‘stop Verb+ing’ in Chugach Alutiiq. We follow Leer (1985) in indicating the geminate as /nn/ instead of /nː/ and Hayes (1995) in not differentiating between main or secondary stress. If the geminate ends up in the strong position of an iambic foot, as in (a.’tu)...(nix.ˈtuq) ‘he stopped singing’, there is no degemination. However, if the geminate ends up in the weak part of an iambic foot, there is degemination, as in [(a.ˈku:)ta.(tu.ˈnix).tuq], ‘he stopped eating akutaq (a food)’. For the relevant foot, (tu.nix) to (tu.ˈnix), this is illustrated in (10).

(10) Chugach Degemination

Hayes (1995: 302) remarks: “on the surface the heavy/light distinction works consistently across both layers of the moraic grid”. The crucial question here is why there would be degemination. The answer cannot be that degemination makes the syllable light, given that a syllable closed by a geminate does not count as heavy for stress. Again, what one wants to say is that there is degemination because that makes the unstressed syllable light. The two-layered mora model does not allow to directly express degemination in terms of syllable weight. For an OT-approach, a first potential problem is the possible existence of underlying long vowels. It is not clear whether all long vowels in Chugach Alutiiq are the result of iambic lengthening or not. If they do exist underlyingly (they do occur in the St. Lawrence dialect of Central Siberian Yupik (cf. Hayes (1995: 240), referring to Kraus 1975, 1985 and Jacobson 1985)), the constraint ranking cannot simply be \textsc{parse-σ} >> \textsc{wsp} >> \textsc{wbp}, as that would predict both long vowels and geminates to count as light for stress. If no underlying long vowels exist, the above ranking will effectively treat syllables closed by a geminate as light, but then again it is hard to formally express that there is degemination because that makes the unstressed syllable light. Here too, one could propose an additional markedness constraint, like \textsc{no geminate in the weak part of a foot}, but the close connection between degemination and stress in terms of syllable weight cannot be straightforwardly expressed.

This section has argued that neither the rule-based approach nor a parallel OT approach is able to directly express that Cayuga laryngeal metathesis and
Chugach Alutiiq degemination are segmental modifications that make unstressed syllables light. In the next section, we turn to the second problem mentioned above: languages with long vowels and geminates, but where only long vowels, not geminates, count as heavy for stress, as in trochaic Wolof.

3. Stress, long vowels and long consonants: The case of Wolof

In the preceding section, it was mentioned that a constraint ranking \textit{Parse-}σ >> WSP >> WBP predicts both long vowels and geminates to be light for stress. Such languages do exist. An iambic language exemplifying this property is Osage, a Siouan language (cf. Altshuler 2009).\(^1\)

Some examples are given in (11), using a traditional rule-based fashion.

\begin{align*}
\text{(11) Osage stress insensitive to long vowels} \\
\text{a. Foot Construction} & \quad \text{Form iambs from left to right} \\
\mu \mu & \quad \mu & \mu & \mu & \mu & \mu & \mu \\
/\ddot{a}\. & \quad /w\ddot{a}\. & \quad /l\ddot{a}\. & \quad /x\ddot{y}\. & \quad /\ddot{g}e/ & \quad \text{form rule right} \\
H & \quad L & \quad H & \quad L & \quad H & \quad L & \quad L \\
\text{(11a)} & \quad ( & \quad x) & \quad ( & \quad x) & \quad ( & \quad x) \\
\text{(11b)} & \quad ( & \quad x) & \quad ( & \quad x) & \quad ( & \quad x) \\
\llbracket /\ddot{a}\.\ddot{w}\. /l\ddot{a}\. & 'x\ddot{y}\. & \ddot{g}e \rrbracket & \quad \llbracket /h/pa\ddot{f}. & \text{tse.} & \text{ka} \rrbracket \\
'\text{I crunch up my own (e.g. prey) with teeth}' & \quad '\text{strawberry}'
\end{align*}

The ranking of the constraint \textit{Parse-}σ above WSP and WBP leads to strict binary iambic grouping irrespective of vowel length, as illustrated in (12) (where no distinction is made between main and secondary stress).

(12) Quantity-insensitive iambic stress in Osage

<table>
<thead>
<tr>
<th></th>
<th>/xõː.tso.ðiː.bra/ ‘smoke cedar’</th>
<th>PARSE-σ</th>
<th>WSP</th>
<th>WBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>(xõː.tso).(ðiː.bra) (μμ μ ) (μμ μ )</td>
<td>* *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>(xõː).(tso.ðiː).bra (μμ ) (μ μμ ) μ</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>(xõː.tso).ðiː.bra μμ μ μμ μ μ</td>
<td><em>!</em></td>
<td>* *</td>
<td></td>
</tr>
</tbody>
</table>

Let us now turn to stress in Wolof, an African language belonging to the Niger-Congo family (Ka 1988; Bell 2003; Rialland and Robert 2001), as an example of a language with long vowels and geminates, but where only long vowels count as heavy for stress. Wolof has quantity contrasts for both consonants and vowels, as illustrated in (13).

(13) a. Wolof long and short vowels

<table>
<thead>
<tr>
<th></th>
<th>‘couscous with peanut sauce’</th>
<th>‘cereal’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[baː.si]</td>
<td>[ba.si]</td>
</tr>
<tr>
<td></td>
<td>‘enlighten’</td>
<td>‘man’</td>
</tr>
<tr>
<td></td>
<td>[niːt]</td>
<td>[nit]</td>
</tr>
</tbody>
</table>

b. Wolof long and short consonants

<table>
<thead>
<tr>
<th></th>
<th>‘ear’</th>
<th>‘to love’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[nɔpː]</td>
<td>[nɔp]</td>
</tr>
<tr>
<td></td>
<td>‘understanding’</td>
<td>[ɟi.geːn]</td>
</tr>
<tr>
<td></td>
<td>[dɛgːo]</td>
<td></td>
</tr>
</tbody>
</table>

Stress is on the first syllable as in [ˈpe.tax] ‘pigeon’ or [‘wo.ne. wu] ‘to show off’. If the first syllable contains a short vowel and the second syllable a long vowel, stress is on the second syllable, as in [wo.ˈjaː.na.ti] ‘to beg once more’. This means that in Wolof, the constraint WSP must be ranked above PARSE-σ and the constraints F/L, every foot should be left-aligned with the word, and F/R, every foot must be right-aligned with the word. This produces an initial quantity-sensitive trochee, as illustrated in (14) for [wo.ˈjaː.na.ti] and [‘wo.ne.wu].
A quantity-sensitive initial trochee in Wolof

\[
\begin{array}{|c|c|c|c|c|}
\hline
\text{WSP} & \text{F/L} & \text{F/R} & \text{PARSE-}\sigma & \text{WBP} \\
\hline
\text{a.} & \mu \mu \mu & \sigma & \sigma & ** \\
\text{b.} & \mu \mu \mu & \sigma, \sigma!\sigma & * & \\
\text{c.} & \mu \mu \mu & *! & \sigma \sigma & * \\
\text{d.} & \mu \mu \mu & *! & \sigma \sigma & \\
\hline
\end{array}
\]

In (14a), candidates (c) and (d) are ruled out because they violate WSP, leaving the choice between output candidates (a) and (b). The first foot in (a) and (b) is separated by one syllable from the left word-edge. The second foot in (b) is separated by two syllables from the left word-edge, hence the two additional syllable violation marks, which makes (a) the optimal output candidate. Finally, (14b) shows that an initial foot is preferred over a final one.

A coda consonant does not make a syllable heavy, as illustrated by initial stress in [ˈpɛ.tax] 'bird', not *[pɛ.ˈtax]. This means that, like in Polish, the constraint PARSE-σ must dominate the constraint WBP, as illustrated for [ˈpɛ.tax] in (15).
The constraint Parse-$\sigma$ above the constraint WBP in Wolof:

<table>
<thead>
<tr>
<th>/pɛ.tax/</th>
<th>WSP</th>
<th>Parse-$\sigma$</th>
<th>WBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>(pɛ.ta $\mu$ $\mu$)</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>(pɛ.ta $\mu$ $\mu$)</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>pɛ.(ta $\mu$)</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>d.</td>
<td>pɛ.(ta $\mu$ $\mu$)</td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

Bell (2003: 8) observes that syllables closed by a glide also count as light, given that there are no diphthongs in Wolof, as illustrated by [sɛj.ˈlɛːn] ‘get married’. He further observes that two adjacent syllables cannot be stressed, as illustrated by [ˈxaː.raː.ˌnaːt] ‘to show up again unannounced’ (examples taken from Bell 2003: 8). We follow Bell (2003) in assuming a constraint against stress-clash, *Clash, no adjacent stressed syllables, in Wolof.

That coda consonants are not moraic in Wolof is supported by distributional phonotactic facts. Word-internal and word-final coda consonants may occur after a short vowel as in [ɟar.goɲ] ‘spider’ after a long vowel as in [naːr.ga] ‘area’ or [ga.naː] ‘chicken’, but a long consonant may never follow a long vowel. Words like [niːt] or [nit] are fine, but words like *[niːtː] or *[deːgːo] are not. A Wolof syllable is maximally bimoraic (Bell 2003). A long consonant has a mora, but a coda consonant does not. Given that the OT ranking for Wolof is WSP $>$ Parse-$\sigma$ $>$ WBP, a singleton consonant ending a syllable will be light, as in (15). Given that syllables ending in a geminate consonant are bimoraic, they are predicted to attract stress in Wolof. However, a crucial case falsifying this prediction is given in (16).

(16) The moraic representation of Wolof [deːgːoː]

\[
\begin{array}{cccc}
\sigma & \mu & \mu & \sigma \\
\mu & & & \\
d & e & g & o
\end{array}
\]

The underlying form /degːoː/, containing a geminate in the first syllable and a long vowel in the second syllable, is stressed on the second syllable not on the first, [degː'oː] not *[degːoː]. But how can the initial bimoraic syllable (cf. words like [ˈcoː.ba.re] ‘will’ or [ˈmiː.neːl] ‘familiarity’) be skipped by stress assignment? As illustrated in (17), the constraint ranking assumed in (14) above, fails to produce the correct outcome [degː'oː], but produces initially stressed *[degːoː] as optimal output form.
Why the Wolof constraint ranking fails for [degːˈoː].

<table>
<thead>
<tr>
<th>/ degː oː /</th>
<th>*CLASH</th>
<th>WSP</th>
<th>F/L</th>
<th>F/R</th>
<th>PARSE-σ</th>
<th>WBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>μμ μμ 'understanding'</td>
<td>*</td>
<td>σ</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. ex</td>
<td>(deg): o: (μμ) μμ [degːoː]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. deg: (o:) μμ (μμ) [degːoː]</td>
<td>*</td>
<td>σ!</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. (deg): (o:) (μμ) (μμ) [degːoː]</td>
<td>*!</td>
<td>σ</td>
<td>σ</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bell (2003: 32) states: “The only segments that affect stress assignment are both moraic and [−consonantal]” and in this way makes a difference between long consonants [+consonantal] and long vowels [−consonantal]. The problem with his solution is that the feature [+−consonantal] is specified at the root node (McCarthy 1988), and one might expect stress rules to be sensitive to other features specified at the root node, like [+−sonorant]. Stress in general, however, is not sensitive to featural content.

Two obvious strategies come to mind. From a rule-based perspective, we could use a two-layered moraic model with Wolof geminates as heavy for duration, but as light for stress. From an OT-perspective, we could split up the constraint WSP, a heavy syllable must be stressed, into two separate constraints: WSP-vowel(EL), a syllable with a long vowel must be stressed, and, WSP-geminate, a syllable ending in a geminate must be stressed or, alternatively, assume a constraint WSP-vowel next to the original constraint WSP. The differential footing of words with a long vowel in the first syllable, such as [ˈcoː.ba.re] ‘will’ and words with a geminate in the first syllable, like [degːˈoː], can then be accounted for as in (18).

---

2. For similar cases, Ryan (2020) proposed a similar constraint, VV-TO-STRESS, which favours stress on a long vowel. Ryan (2020) is mainly concerned with the typology of stress patterns and not so much with the differential behaviour of coda consonants or geminates with respect to segmental modifications.
This section has discussed Wolof where long vowels count as heavy for stress, but where long consonants do not. Although splitting up the constraint WSP into two separate constraints, WSP-vowel and WSP-geminate, works technically, this solution is not helpful in understanding the fact that there are languages where coda consonants or geminates count as light for stress, but heavy for segmental modifications. In the next section, we propose a unified solution to both problems.
4. A unified Harmonic Serialism solution

Instead of splitting up the constraint WSP (a heavy syllable must be stressed) into two separate constraints, WSP-Vowel and WSP-Geminate, we would like instead to propose the two constraints in (19).

(19) Instead of splitting up WSP in two sub-constraints two different constraints

   NUCLEUS: A branching nucleus may not be in the weak position of a foot
   RHyme: A branching rhyme may not be in the weak position of a foot

Both a syllable with a branching nucleus as well as one with a branching rhyme are considered to be heavy syllables. Languages where long vowels and geminates or coda consonants count as heavy for stress, such as trochaic Latin or iambic Hixkaryana (Hayes 1995: 205–208), can be described by the ranking NUCLEUS >> RHyme >> PARSE-σ. Languages where only long vowels count as heavy for stress, but not coda consonants, such as iambic Cayuga, and also languages where only long vowels count as heavy for stress, but not coda consonants or geminates, such as trochaic Wolof, can be described by the constraint ranking NUCLEUS >> PARSE-σ >> RHyme. Finally, languages such as iambic Osage, where long vowels do not count as heavy for stress, can be described by the ranking PARSE-σ >> NUCLEUS >> RHyme. The two proposed constraints also allow us to express Cayuga laryngeal metathesis and Chugach Alutiiq degemination as segmental modifications that make syllables light, as we will show next.

In Harmonic Serialism (McCarthy 2010), an input is subject to the constraint grammar and may undergo one single modification, if that makes the form more harmonic. The constraint ranking determines what the best first modification is. The modified input is then subject again to the same constraint grammar and so forth until no further harmonic improvement is possible.

Cayuga has the ranking NUCLEUS >> PARSE-σ >> RHyme. This means that after footing underlying / cvʔ.cvʔ/ from (9) above as iambic (cvʔ.cvʔ), as a first step, the footed form (cvʔ.cvʔ) will be further inspected for possible harmonic improvement. If we suppose that the constraint RHyme dominates the constraint LINEARITY (no metathesis), i.e. if it is more important to avoid having a branching rhyme in the weak part of a foot than to avoid metathesis, the iambic foot can

3. A full scale factorial typology motivating the possible constraint rankings of the three constraints assumed is beyond the scope of this paper. As far as we know, there are no languages where geminates do, but long vowels do not count as heavy for stress. Also, as pointed out by Ryan (2020), there seem to be no languages where closed syllables are, but long vowels are not, treated as heavy for stress. This means that the rhyme must be considered to be branching also if it dominates a branching nucleus. If NUCLEUS and RHyme dominate PARSE-σ or are dominated by PARSE-σ, they might well be unordered.
be modified by laryngeal metathesis at the next step: (cvʔ.cv) is then turned into (cʔv.cv). Metathesis can thus be seen as harmonic improvement, given that the higher ranked constraint \textit{Rhyme} is no longer violated. In this way, the relation between metathesis and stress can straightforwardly be expressed. There is metathesis because the foot is improved. A similar account holds for degemination in Chugach Alutiiq. If the constraint \textit{Rhyme} is ranked above \textit{Max-µ} (Do not delete moras), degemination after footing can in the same way be considered as harmonic foot improvement, as illustrated in (20) and (21) for the relevant foot involved.\footnote{A model of the syllable, with a nucleus containing the vocalic material and a rhyme containing the nucleus and the coda with consonantal material, also allows the use of moras to express phonological length only: long vowels have two moras and long consonants have one mora. This allows also for initial (Swiss German (Kraehenmann 2001)) and final geminates (Wolof (12) above), which can both be represented as being moraic as well.}

(20) A Harmonic Serialism account of Chugach Alutiiq degemination

\begin{center}
\begin{tabular}{|c|c|c|c|c|}
\hline
& HEAD & NUCLEUS & PARSE-σ & RHyme & MAX-µ \\
\hline
a. & tun.nix & *! & & & \\
\hline
b. & (tun.nix) & & * & & \\
\hline
c. & tun.(nix) & & *! & & \\
\hline
d. & (tun).nix & & *! & & \\
\hline
\end{tabular}
\end{center}

The constraint \textit{Head} in (20) requires that a word has a prosodic head and therefore footing is the first modification. The grammar in (20) decides on output form (20b), (tun.nix), as the optimal output form. The footed form (tun.nix) is then inspected for further possible harmonic improvement in (21).
Please observe that the constraint \textsc{Rhyme} is crucial. If for Chugach Alutiiq, the constraint \textsc{WBP} were used, the foot (\texttt{tun.'nix}), resulting after the first step in the derivation from underlying /a.\texttt{ku:}:.\texttt{ta.}tun.nix.tuq/ to surface [(a.'\texttt{ku:}:)\texttt{ta.}tun.'nix].tuq] could not be further harmonically improved given that (tun.'nix) does not violate \textsc{WBP}. Violating the constraint \textsc{Max-µ} would then not be a harmonic improvement. The foot (tun.'nix) with a heavy unstressed syllable does violate the constraint \textsc{Rhyme} and, therefore, harmonic improvement is possible, changing (tun.'nix) into (tu.'nix), with no longer a branching rhyme, as in (21c).

5. Conclusion

This paper has discussed two problems with expressing syllable weight with moras. On the one hand, there are languages in which closed syllables are treated as light, but at the same time treated as heavy for segmental modifications. On the other hand, there are languages with long vowels and geminates, where only long vowels, but not geminates, count as heavy for stress. We have argued that neither the rule-based approach nor a parallel OT approach is able to directly express that both Cayuga laryngeal metathesis and Chugach Alutiiq degemination are modifications that make unstressed syllables light.

Instead of two separate \textsc{WSP} constraints and the constraint \textsc{WBP}, we proposed two different constraints, \textsc{Nucleus} and \textsc{Rhyme} and argued that a Harmonic Serialism approach can then straightforwardly describe Cayuga laryngeal metathesis and Chugach Alutiiq degemination as segmental modifications that make unstressed syllables light.
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