The Lapse Constraint

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In this paper we propose to decompose the traditional constraint of Foot Binarity (a metrical foot is either bimoraic or disyllabic, Hayes 1985, McCarthy & Prince 1986) into two constraints: Min-2, which sets a lower bound on foot size requiring it to be at least two moras or two syllables, and Lapse (Green 1995).

(1)   Ft-Binarity: a metrical foot is either bimoraic or disyllabic.
        Min-2m, Min-2s: a metrical foot contains at least two moras or two syllables.
        Lapse-m, Lapse-s: adjacent unstressed moras or syllables must be separated by a
                foot boundary.

While the idea of a constraint against metrical lapses is not new, the particular formulation in (1) is and has the effects summarized in (2). (We limit our discussion here to Lapse-s.)

(2)   <u>Lapse</u>
        i. too large: ('ss)s   Ã
                                ('sss)   *

        ii. too far apart: ('ss)('ss)   Ã
                                ('ss)s('ss)   Ã
                                ('ss)ss('ss)   *

        iii. too far from edge: ...s('ss)s#   Ã
                                ...('ss)ss#   *

First, it does the work of the traditional Lapse constraint (cf. Selkirk 1984) preventing a metrical foot from becoming too large and hence imposes an upper bound of binarity. Second, it prevents feet from drifting too far apart--at most one unparsed syllable can intervene (a constraint similar to this effect was independently discovered by Kager 1994); finally, another effect of Lapse unique to our formulation is that it prevents a foot from moving too far from the edge of the word: s('ss)s# satisfies the constraint but ('ss)ss# violates it with two successive unparsed syllables. Stated differently, the Lapse constraint ensures that stress is located in a three-syllable window at the edge of the word. In the rest of this paper we show how Lapse elucidates some of the classic data sets in the metrical stress literature including three-syllable window effects from Pirahã and Turkish toponyms, minimal binarity in Maranungku, Banawa, and Passamaquody, and ternary stressing in Chugach Alutiiq, Estonian, and Cayuvava.

1. Three-syllable window

In the Amazonian language Pirahã (Everett & Everett 1984, Everett 1987) stress is located on one of the last three syllables of the word. Within this window it seeks out the "heaviest" syllable, where weight is determined by a combination of factors: length (a long vowel or diphthong is stronger than a short vowel), the presence of an onset (a syllable with an onset is stronger than an onsetless one), and voicing: a voiceless consonant is stronger (and longer?) than a voiced one. Putting these factors together leads to the hierarchy: taa > daa > aa > ta > da (> a ?). If there is a tie with two (or three) syllables of strongest weight inside the window, stress lodges on the rightmost one. In our transcriptions, the stressed syllable is underlined; acute accent denotes high tone.

(3) VV > V: ?o.gi.ái 'big' 108, bií.si 'red' 109, ?í.tii.?i.si 'fish' 108, ?í.si.tai 'feather' 108, si.toi 'egg' 109, toí.sí 'eagle' 108, ?i.gaó 'back' 109, ?i.bí.oí 'liver' 109, ?a.aí.bi 'thin' 109

   onset > no onset: gao.ii proper name 108, gi.ai.baí 'dog' 108

   [-voice] > [+voice]: kaa.gai 'word' 108, bií.sai 'red' 108, ?a.ba.gi 'toucan' 109, pa.hai.bií proper name 108, ?i.baó.saí 'her cloth' 108, pii.gáí.ia 'scissors' 240

   ties: ka.gi.hí 'wasp' 109, ti.po.gi 'sp. of bird' 109, bíi.gió 'underneath'107, kaa.?ai 'macaw' 108, paó.hoa.hai 'anaconda' 213, ba.hóí.ga.toi 'domesticated pig' 107, kaí.tía.bi 'buzzard' 240, ko.?o.pa 'stomach' 239, bíi.gao.baá 'certainly called' 239, ko.po Å koo.po 'cup' 108

   Pirahã presents the following problem for traditional rule-based metrical parsing models that operate with foot binarity: to derive the antepenultimate stress of pii.gáí.ia 'scissors' with an upper bound of binary feet, the final syllable must be extrametrical. But we must "revoke" extrametricality of the final syllable just in case it is the strongest syllable: ?o.gi.ái 'big'. But we can't know whether it is the strongest syllable unless we have compared all the other syllables in weight and have in effect have already computed the stress. Prince & Smolensky's (1993) OT model eludes such paradoxes because it does not assign stress in a step-wise derivation that builds up structure but rather by constraints that compare fully-fledged output candidates for wellformedness--in particular the ranking of Peak-Prominence (evaluating syllables for their capacity to bear the word's stress peak in terms of their inherent weight)[1] >> Rightmost (orienting the stress peak towards the right edge of the word).

(4)   /káo.bii.gá/   Peak-Prom   Rightmost
      $('ss)s   Ã   ss#
       s('ss)   *!   s#

      /?o.gi.ái/
      $s(s's)   Ã   s#

```
        ('ss)s              *!                    ss#
```

However, there is still a problem; as shown by the data in (5), we must prevent a stronger syllable (marked in bold) from luring the stress beyond the antepenult.

(5)   **poo**.gáí.hi.aí 'banana' 107, ka.**pii**.ga.ií.to.ii 'pencil' 107, **kao**.bi.ga.bai unglossed 236, pia.**hao**.gi.so.ai.pi 'cooking banana' 209, **?ia**.bí.ka.bi.ka.bi proper name 211, káo.bii.gá 'falling' 240, **káo**.bii.gá.há 'certainly falling' 240, hi-**kao**.báí.pá.há 'he died' 215

Our proposal is designed to solve this problem: as shown in the tableau of (6) Lapse >> Peak-Prom keeps the foot housing the peak of the word from moving too far away from the edge--in particular beyond the antepenult.

(6)   /kao.bii.ga.ha/ <u>Lapse</u>   <u>Peak-Prom</u>
```
       $s('ss)s                 Ã                        *
       ('sss)s            *!              Ã
       ('ss)ss            *!              Ã
       ('ssss)            *!*             Ã
```

We assume that main stress is located in the rightmost foot by an undominated constraint in order to rule out the ("ss)('ss) candidate.

One implication of this analysis with high-ranking Lapse is that in longer words such as ?íbo<u>bii</u>hi 'ant' 109, the optimal structure will be ('ss)("ss) with two feet even though just one stress is apparently audible: a ss('ss) structure contains a Lapse violation and will be rejected in favor of the ('ss)("ss) analysis. Consequently we must assume that in the phonetic interpretation of Pirahã metrical structures, only the strongest syllable of the word is assigned an audible prominence. However, there are ample precedents in the literature for the postulation of submerged metrical structure such as Cairene Arabic where binary metrification proceeds left-to-right across the word but only the final foot is marked with an audible stress (McCarthy 1979, Kenstowicz 1980).

Another well-known three-syllable window effect is evident in the Turkish data of (7) (from Sezer 1983, Kaisse 1985, Hayes 1994).

(7)   ...L'LL#   Kenédi, Inégöl, Pitolémi, Papadopúlos, tornavída
       ...L'HL#   Va„sínkton, lokánta, Samuélson, Montazú:ma
       ...'HLL#   _Ankara, „samándÓira 'buoy', „Sévrole
       ...H'HL#   Istánbul, AyzÓinhó:ver, Mendélson

In a certain subset of the vocabulary (comprised largely but not entirely of loanwords) stress is located on the penult unless it is light and the immediately preceding syllable is heavy in which case stress appears on the antepenult instead. As in the case of Pirahã, stress is attracted away from the right edge of the word by a stronger syllable. But as is evident from <u>tornavída</u> 'screwdriver' it cannot drift past the antepenult. The Lapse >> Peak-Prom ranking accounts for this limitation in the stress tropism of the heavy syllable.

The Turkish toponyms differ from Pirahã in that the rightward orientation of the word's stress peak in the case of a tie is blocked from appearing on the final syllable. This indicates that the constraint enforcing left-headed feet dominates Rightmost-"s.

(8)

/tornavida/	Lapse	Head-Left	Peak-Prom	Rightmost-"s
$('ss)("ss)	Ã	Ã	*	s#
('ss)ss	*!*	Ã	Ã	sss#
('ssss)	*!**	Ã	Ã	sss#
('s)("ss)s	Ã	Ã	*	ss#
ss('ss)	*!	Ã	*	s#
('ss)(s"s)	Ã	*!	*	Ã

2. Decomposition of Foot-Binarity

In this section we formulate our second argument for the Lapse constraint--that we must decompose the traditional Foot-Binarity into two separate constraints that prevent the foot from becoming too small--Min-2--and too large--Lapse. The following argument has been made independently by Duanmu (1995) and Everett (1995). It centers on the existence of alternating stress systems with degenerate feet. Consider the well-known paradigm of Maranungku (Hayes 1980 based on Tryon 1970) in (9a), where the final syllable of odd-parity forms is stressed. (The Banawa paradigm (9b) from Buller, Buller & Everett 1993 and Everett 1995 makes the same point).

(9) a. tíralk   'saliva'
      mérepèt   'beard'
      yángarmàta 'the Pleiades'
      lángkaràretì 'prawn'
      wélepènemànta 'kind of duck'

    b. Bádi personal name 287,
      mákarì 'cloth' 282, fúanà 'lost' 282
      tátikùne 'hair' 282, kárabùa 'blowgun' 283, báburùru 'cockroach' 287
      tìasíanì 'acquire' 283, bàduébirì 'species of deer' 287
      tìnarífabùne 'you are going to work' 287

These data suggest that Parse-s dominates Foot-Binarity forcing a ("ss)('ss)('s) analysis for lángkaràretì. However, in order to rule out the candidate ('sssss) that groups every syllable into a single unbounded foot, we must evaluate deviations from binarity in a gradient fashion (10a).

(10) a.

/sssss/	Parse-s	Ft-Bin	Align-R
$('ss)('ss)('s)	Ã	*	ssss#, ss#, #
('ss)('ss)s	*!	Ã	ssss#, ss#
('sssss)	Ã	**!*	ssss#

b. /sssss/	Parse-s	Ft-Bin	Align-R
('ss)('ss)('s)	Ã	*	ssss#, s!s#, #
('ss)('ss)s	*!	Ã	ssss#, ss#
$*('sssss)	Ã	*	ssss#

Otherwise, ('ss)('ss)('s) and ('sssss) would tie (9b) and the gradient alignment constraint evaluating feet for their distance from the edge of the word would incorrectly choose the ('sssss) candidate. (We follow Green 1993 in measuring alignment violations from the head of the foot rather than from the edge.) But even if Foot-Binarity is evaluated gradiently, the analysis still fails to distinguish the ('ss)('s) and ('sss) candidates for the three-syllable cases.

(11) /sss/	Parse-s	Ft-Bin		Align-R
('sss)	Ã		*	ss#
('ss)('s)	Ã		*	ss#, #

However, if Foot-Binarity is decomposed into Min-2s (minimal binarity) and Lapse (maximal binarity), then the proper distinction can be drawn. ('sss) contains two successive unstressed syllables not separated by a foot boundary and hence violates Lapse. ('ss)('s) contains a monosyllabic foot and hence violates Min-2s. Depending on the ranking of Min-2s and Lapse, either ('sss) or ('ss)('s) emerges as optimal. Maranungku and Banawa reflect a Lapse >> Min-2s ranking.

(12) /sss/	Parse-s	Lapse		Min-2s	Align-R
$('ss)('s)	Ã	Ã		*	ss#, #
('sss)	Ã	*!		Ã	ss#

In his metrical analysis of Shanghai Chinese tone sandhi, Duanmu (1995) argues that ('sss) is chosen over ('ss)('s) and ('ss)s. This analysis implies the Min-2 >> Lapse ranking.

(13) /sss/	Parse-s	Min-2		Lapse		Align-L
$('sss)	Ã	Ã		*		#
('ss)('s)	Ã	*!		Ã		#, #ss

Another case of degenerate feet is to be found in the Algonquian language Passamaquoddy (Hagstrom 1994 based on data and analysis from Lesourd 1993). In Passamaquoddy syllables are grouped into binary left-headed feet. As shown by the paradigm in (13), odd-parity words regularly have a stress clash at their left edge.

(14)   wícohké-m-a-l 'he helps the other' 74
       wícóhke-kémo 'he helps out'
       wícohké-tahá-m-a-l   'he thinks of helping the other'

These data suggest that Passamaqouddy has essentially the same constraint ranking as Maranungku and Banawa except that feet are aligned to the left edge of the word instead of to the right edge (i.e. Align-Ft -L >> Align-Ft-R).

A well-known escape from the problem of apparent degenerate feet in Maranungku has been to appeal to a hidden "catalectic" syllable (Kager 1992 following a proposal by Kiparsky 1991). However, we are unaware of any independent evidence for such a catalectic syllable in Maranungku, Banawa, and Passamaquoddy comparable to the gemination effects found in Italian oxytones such as *città* discussed by Burzio (1987). And even in the latter case the stress retraction reported by Nespor & Vogel (1986: 174) calls the empty syllable into question: (*le cítta nórdiche*). If Nespor and Vogel are correct that stress is retracted in order to avoid a clash, the fact that the hypothetical catalectic syllable does not shield the adjacent stressed syllables from a clash calls its very existence into question.

3. Ternary Rhythm

When Foot-Binarity is decomposed into Lapse and Min-2, Lapse >> Align-Ft becomes the constraint ranking that forces the introduction of additional footing. That is, in order to avoid successive unstressed syllables, additional feet are inserted away from the edge of the word incurring alignment violations. If we take seriously the idea that there is a cost associated with displacing feet from the edge, then we might expect that various patterns will emerge depending on how other constraints are ranked with respect to Align-Ft. In this section we explore several effects of this type that come under the heading of ternary rhythm. We recall from the introduction that the Lapse constraint keeps feet from drifting too far apart. As shown in (15), the effect is to derive the core cases of Hayes' (1994) "weak local parsing": Lapse permits feet to be separated by at most a single unparsed syllable.

	Lapse
(15) ....s)s(s...	Ã
...s)ss(s...	*
...s)sss(s...	**

To illustrate, consider the iambic stress contours of Chugach Alutiiq (Leer 1985, Kager 1993).

(16)	(s's)s	paláyaq	'rectangular skiff'
	(s's)(s's)	akútamék	'a type of food' abl. sg.
	(s's)s(s's)	taqúmaluní	'apparently getting done'
	(s's)s(s's)s	akútartunírtuq	'he stopped eating akutaq'
	(s's)s(s's)(s's)	ma_ársuqutáquní	'if he (refl.) is going to hunt porpoise"

Following previous literature, we assume an undominated constraint requiring the left edge of the Prosodic Word to align with a foot: Align(PW,L,Ft,L) >> Align(Ft,R,PW,R). We depart from previous work, however, by requiring that feet align with the right edge of the Prosodic Word. Under this constraint ranking, Chugach Alutiiq aligns its feet in the manner of Garawa and Indonesian (McCarthy & Prince 1993, Kenstowicz 1994, Cohn & McCarthy 1994). Chugach differs in that its feet are right-headed (iambic) and more importantly it ranks Align-Ft above Parse-s and consequently has sparser footing.

　　　To see how this analysis works, let us first consider the six-syllable *akútartunírtuq*.

(17)　/akutartunirtuq/　Lapse　　　Align-Ft　　　Parse-s
　　　$(s's)s(s's)s　　Ã　　　ssss#, s#　　　**
　　　(s's)ss(s's)　　*!　　　ssss#　　　　　**
　　　(s's)(s's)ss　　*!　　　ssss#, ss#　　　**
　　　(s's)(s's)(s's)　Ã　　　ssss#, ss!#, #　Ã

We limit the discussion to candidates in which the left edge of the Prosodic Word is aligned with a foot. Given that PW alignment is satisfied, the most economical way to avoid a Lapse violation is to plant a binary foot in the middle of the final four syllables: (s's)s(s's)s. Shifting the foot one syllable to the right (s's)ss(s's) or one syllable to the left (s's)(s's)ss introduces a lapse. Finally, the fully parsed (s's)(s's)(s's) candidate also satisfies Lapse. But it is more poorly aligned precisely because it is more densely footed: it has three feet while the winning (s's)s(ss')s candidate (with "weak-local parsing") is better aligned in virtue of having fewer feet. Of course, the price for minimizing alignment violations is paid in more Parse-s violations.

　　　Next consider the seven-syllable structure *ma_ársuqutáquní* .

(18)　/ma_arsuqutaquni/　Lapse　　　Align-Ft　　　　Parse-s
　　　s(s's)s(s's)s　　Ã　　　ssss#, s#　　　　***
　　　(s's)ss(s's)s　　*!　　　sssss#, s#　　　　***
　　　(s's)s(s's)ss　　*!　　　sssss#, ss#　　　***
　　$(s's)s(s's)(s's)　Ã　　　sssss#, ss#, #　　*
　　　(s's)(s's)s(s's)　Ã　　sssss#, sss!#, #*
　　　(s's)(s's)(s's)s　Ã　　sssss#, sss!#, s#　　*

The candidate satisfying Lapse with the smallest number of feet (and hence the minimal alignment violations) is s(s's)s(s's)s. But this candidate violates the overriding requirement that the Prosodic Word start with a foot at its left edge. Consequently, given that first two (light) syllables of a Chugach Alutiiq word must cohabit a foot, two additional feet must be inserted among the remaining five syllables in order to avoid a lapse. And since Chugach orients its noninitial feet to the right, the candidate that places the unparsed syllable as far to the left as possible is the optimal one.

　　　Finally, for an eight-syllable (more generally 3n+2) case we predict the winning candidate to be the one with "weak local parsing", i.e. the one that intersperses its feet with an unparsed syllable.

(19)   /ssssssss/   <u>Lapse</u>   <u>Align-Ft</u>   <u>Parse-s</u>
    $(s's)s(s's)s(s's) Ã   sssss#, sss#   **
       (s's)(s's)(s's)(s's)   Ã   ssssss#, sss!s# Ã
                                                 ss#, #

Once again, s(s's)s('ss)(s's) would be better aligned with the right edge; but it violates the
requirement that the Prosodic Word start with a foot. And the fully parsed
(s's)(s's)(s's)(s's) is assessed more alignment violations in virtue of having an additional
foot. The diagram in (20) summarizes the crucial rankings in our analysis of Chugach.

(20)   Align-PW   Lapse
                      \ |
                    Align-Ft-R
                          |
                    Parse-s

        The stress contours of Estonian exhibit ternary rhythms and hence are prima facie
candidates for the Lapse >> Align-Ft >> Parse-s ranking. For data and analytic insight
we build on Prince 1980, Hayes 1994, and especially Kager 1994 who utilizes the ternary
rhythms of Estonian to propose a constraint with some of the same effects as our Lapse
(see discussion below). These generative analyses have in turn relied on data from Hint
1973. The binary and ternary rhythms of Estonian are described by Hayes as being in
free variation. However, no examples are cited with a switch of rhythm within a word;
nor are words with more than two different stress contours reported. This suggests that
the binary and ternary rhythms reflect two different speech registers and hence two
competing grammars with different constraint rankings. We describe each in turn.
Examples of the binary alternation appear in (21).

(21)   pálatt
        pímestav
        kávalàtt
        rételìle
        sóoyemàttel
        téravàmalt
        párimàttelt
        pímestàvale
        pímestàvasse
        pímestàttute
        úlistàvamàit
        óppettàjattèks
        ósavàmalèki
   várasèimattèle
        úsaltàttavàmattèks

These stress contours closely resemble Maranungku: main stress is found on the initial syllable and a secondary stress falls on odd-numbered syllables thereafter. The only difference is that the final syllable of an odd-parity word is stressed only if it is heavy (CVV or CVCC): *pímestàvale* vs. *úlistàvamàit.* The binary rhythm reflects a Parse-s >> Align-Ft ranking (on top of the basic Lapse >> Align-Ft) forcing foot alignment violations in order to parse more syllables. The limitation of final stress to heavy syllables indicates that Min-2m (a foot is minimally bimoraic) dominates Parse-s. Finally, placement of the unparsed light syllable at the right edge of the word suggests that feet are aligned to the left. The tableau in (22) shows how this ranking chooses the correct candidate for *pímestàvale.*

(22) /pimestavale/

	Min-2m	Parse-s	Align-Ft
$("ss)('ss)s	Ã	*	#, #ss
("ss)('ss)('s)	*!	Ã	#, #ss, #ssss
("ss)s('ss)	Ã	*	#, #sss!

Given that feet are aligned to the left in the binary rhythm (i.e.Align-Ft-Left >> Align-Ft-R) along with the fact that a heavy syllable can constitute a foot on its own, *pímestàttute* could incorrectly receive the analysis ("ss)('s)('ss) which is fully parsed and hence beats ("ss)('ss)s. Consequently, some constraint ranked above Parse-s must block this candidate; following Kager (1994), we assume that a clash constraint against stress on adjacent syllables blocks ("ss)('s)('ss).

(23) /pimestattute/

	Clash	Parse-s
$("ss)('ss)s	Ã	*
("ss)('s)('ss)	*!	Ã

The diagram in (24) summarizes the crucial rankings for the binary rhythm in Estonian.

(24)

```
                    Min-mm
                      |
         Clash   Parse-s   Lapse
             \      |      /
               Align-Ft-L
```
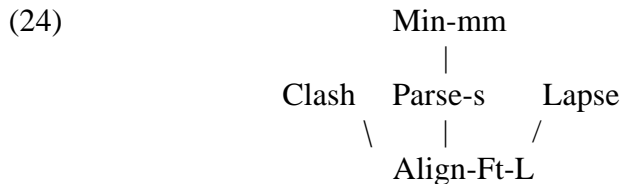
The following data are cited by Hayes (1994) and Kager (1994) as instances of the ternary rhythm in Estonian. The major stress still occupies the first syllable but just in case the third syllable is light the next stress appears on the fourth syllable. Another stress will then follow three syllables to the right provided the preceding syllable is light, and so on.

(25) téravamèlt
 pímestavàle
 pímestavàsse

úlistavàmait
óppettayàtteks
ósavamàleki
válluttayàtteka
érinevàttesse
úsaltàttavamàtteks

Six-syllable words with just two stresses such as *ósavamàleki* betray the sparser footing that arises from the Lapse >> Align-Ft >> Parse-s ranking. To account for the fact that the initial syllable is always stressed we assume that the constraint aligning the left edge of the Prosodic Word with a foot is undominated in Estonian just as in Chugach Alutiiq. Granted the initial foot, the most economical way to avoid a Lapse violation among the remaining syllables is to group the fourth and fifth into a foot: ("ss)s('ss)s. While heavy syllables freely occur in the recessive position in an Estonian foot, when they occupy the third syllable they short-circuit a ternary rhythm and prevent a secondary stress from landing on the fourth syllable. Thus, a six syllable word such as *ópettùstelèki* has just a single stress contour: in particular, **ópettustèleki* is not possible. We may account for this striking contrast if the Parse-s constraint is decomposed into Parse-Heavy and Parse-Light and it is just the Parse-Light portion that slips below the Align-Ft to allow the sparser footing that characterizes ternary rhythm. Stated differently, in Estonian a heavy syllable must be parsed and cannot be skipped. With this constraint ranking the contrast between *ósavamàleki* and *ópettùstelèki* is accounted for. (The tableau in 26 just indicates the number of misaligned feet, pending the determination of the direction of foot aligment).

(26)

/osavamaleki/	Lapse	Parse-H	Align-Ft	Parse-L
$("ss)s('ss)s	Ã	Ã	*	**
("ss)('ss)('ss) Ã		Ã	**	Ã
("ss)ss('ss)	*	Ã	*	Ã

/opettusteleki/	Lapse	Parse-H	Align-Ft	Parse-L
$("ss)('ss)('ss) Ã		Ã	**	Ã
("ss)s('ss)s	Ã	*!	*	*
("ss)('ss)ss	*!	Ã	*	**

Forms such as *pímestavàle* and *pímestavàsse* indicate that feet are aligned to the right in the ternary rhythm, just as in Chugach Alutiiq. More significantly, *téravamàltt* shows that alignment must be measured from the head of the foot (27b). Evaluation from the edge (27c) would tie the ("ss)s('s) and ("ss)('ss) parses and incorrectly allow *téravàmaltt* to emerge as the winner since it parses more syllables.

(27) a.

/pimestavale/	Align-Ft-R	Align-Ft-L
$("ss)s('ss)	ssss#, s#	#, #sss
("ss)('ss)s	#ssss, ss!#	#, #ss

b. /teravamallt/   <u>Align-Ft-R</u>   <u>Parse-L</u>

   ("ss)s('s)   sss#, #   *

   ("ss)('ss)   sss#, s!#   Ã

c. /teravamallt/   <u>Align-Ft-R</u>   <u>Parse-L</u>

   ("ss)s('s)   ss#, #   *!

$*("ss)('ss)   ss#, #   Ã

The diagram in (28) summarizes our analysis of the Estonian ternary rhythm[2].

(28)   Align-PW   Lapse   Parse-H

                 \ | /

               Align-Ft-R

                 |

               Parse-L
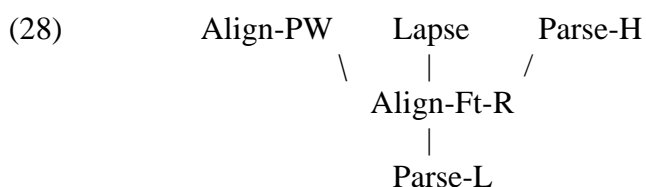
       In (29) we reproduce the ternary stress pattern of Cayuvava introduced into the metrical stress literature by Hayes (1980) based on data from (Key 1961, 1967). This paradigm presents a considerable challenge to Optimality Theory since previous derivational parsing analyses have had to invoke defooting rules (Halle & Vergnaud '88, Levin 1988, Dresher & Lahiri 1991) that alter the structure constructed by the basic parsing mechanism. We are able to generate these stress contours on a single level but see the intervention of another constraint which has not been active in our earlier analyses.

(29)   'ss   éñe   'tail' K 144

      'sss   sákahe   'stomach' K 144

      s'sss   kihíbere   'I ran' K 144

      ss'sss   ariúuca   'he came already' K 144

      'sss'sss   jíhiraríama   'I must do' M 71

      s'sss'sss   maràhahaéiki   'their blankets' K 150

      ss'sss'sss   ikitàparerépeha   'the water is clean' K 149

      'sss'sss'sss   càadiròbo¦urúruce   'ninety-nine' (first digit) M 60

      s'sss'sss'sss   medàrucecèirohíiñe   'fifteen each' (second digit) M 61

      ss'sss'sss'sss   caadàirobòirohíiñe   'ninety-nine' (second digit) M 60

 other examples: kapakírue 'your fingernail' K 150, yahuhámiño 'small peto bee' K 149

       The antepenultimate stress, the ternary alternation, and the initial sequence of two unstressed syllables all suggest that the Lapse >> Align-Ft >> Parse-s constraint ranking is active in Cayuvava. In a five-syllable span the most economical way footwise to avoid a Lapse violation would be to insert an amphibrach s(s'ss)s in which the head lies in the middle of the metrical foot. This structure satisfies Lapse because the two syllables lying at either edge are separated from their neighbor by a foot boundary; and although the foot encompasses three syllables, the medial location of the head prevents a foot-internal lapse. Given low-ranking Parse-s, the nine-syllable 'sss'sss"sss is particularly informative.

The failure of the double amphibrach candidate s(s'ss)s(s"ss)s in the face of ('ss)s('ss)s("ss)s indicates that some constraint other than Lapse must dominate Align-Ft in order to force the insertion of additional feet. Yet it cannot be Parse-s because then a binary alternation of stress is expected. The most obvious culprit is a preference for left-headed feet (Head-L). This is shown in tableau (30). (We anticipate later discussion and measure alignment violations from the right edge.)

(30) /sssssssss/   Lapse   Head-L   Align-Ft
      $('ss)s('ss)s("ss)s   Ã   Ã   sssssssss#, sssss#, ss#
        s(s'ss)s(s"ss)s Ã   *!*   sssssss#, ss#

But if Head-L dominates foot alignment, we must reconsider the five-syllable s(s'ss)s case. What blocks binary trochees in this case? Both ('ss)("ss)s and ('ss)s("ss) are left-headed. They are worse by foot alignment but the failure of s(s'ss)s(s"ss)s in the nine-syllable case tells us that economizing on foot alignment with amphibrachs cannot be the whole story. We may block ('ss)("ss)s if we invoke a constraint against adjacent feet: *s)(s. This constraint also produces weak-local parsing effects by forcing a stray syllable between feet; but it cannot subsume the work of Lapse that we saw operative in Pirahã and Turkish in producing a three-syllable window at the right edge. More generally, *s)(s is related to Lapse in a fashion that parallels Min-2. As we have seen, Lapse and Min-2 set upper and lower bounds on the size of a metrical constituent converging on a foot with two positions. Similarly, Lapse and *s)(s set upper and lower bounds on the size of the interval between feet and converge on a length of one. (A constraint of this form is also suggested by independently by Cassimjee 1994 and Kager 1994). As shown in (31), *s)(s blocks ('ss)("ss)s; but it still fails to rule out ('ss)s("ss).

(31)   /sssss/   Lapse   *s)(s   Head-L
       s(s'ss)s Ã   Ã   *
       ('ss)("ss)s   Ã   *!   Ã
       ('ss)s("ss)   Ã   Ã   Ã
       ss('ss)s *!   Ã   Ã

In order to generate the consistent antepenultimate stress seen in paradigm (29), we must ensure that the final foot is displaced one-syllable from the right edge of the word. One possibility is to invoke a version of Non-Finality (erstwhile "extrametricality") that prevents the final syllable from being footed (cf. Prince & Smolensky 1993): *s)# However, we would like to preserve Hung's (1994) reduction of Nonfinality effects to "Rhythm"--a constraint requiring a stressed syllable to be followed by an unstressed one whose primary effect is to retract stress from the final syllable in an otherwise iambic system. Another possibility is to say that feet are aligned to the left; but this implies that the left edge of the word should consistently start with a foot, which is obviously untrue for Cayuvava. We have one option left. As the OT literature has made clear, constraints orienting the main stress towards one edge of the word independent of the subordinate footing platform are required and justified (Kenstowicz '94, Cohn & McCarthy '94)--a kind of "top-down" effect that we invoked in our analysis of Pirahã

peak prominence. Our suggestion is that the final foot in Cayuvava is special in that it is the strongest foot of the word and hence projects the major peak in the Prosodic Word; see Levin 1988 for evidence from the intonational and segmental phonology for the prominence of the final foot. We postulate a constraint aligning the peak of the Prosodic Word with the left edge: Align-L(Peak-PW, PW). We refer to this constraint informally as Main-Left. As shown by the tableau in (32), if Main-Left dominates Head-L then the amphibrach analysis s(s"ss)s is favored over the ('ss)s("ss) candidate with trochees at the right and left edge. Shifting the main stress further towards the left edge as s('sss)s or s('ss)ss creates a foot-internal or foot-external lapse.

(32)

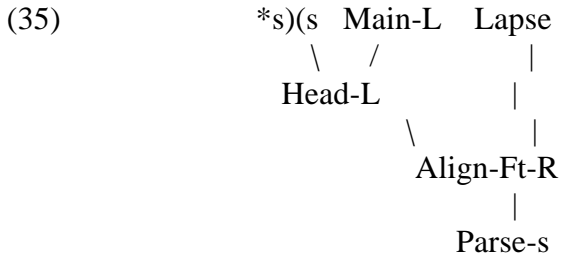| /sssss/	Lapse	*s)(s	Main-L	Head-L
☞ s(s'ss)s	✓	✓	#ss	*
('ss)("ss)s	✓	*!	#ss	✓
('ss)s("ss)	✓	✓	#sss!	✓
s('sss)s	*!	✓	#s	✓
s('ss)ss	*!	✓	#s	✓

The eight-syllable ss'sss"sss with the initial double upbeat tells us that (nonfinal) feet are aligned to the right. To show this we consider candidates which satisfy Lapse and *s)(s. With eight syllables and two stresses and hence two feet, in order to avoid a Lapse violation, one of the feet must be an amphibrach; two binary feet necessarily leave a lapse (underlined) no matter where they are placed: s('ss)ss("ss)s, ('ss)s("ss)sss, sss('ss)s("ss). As demonstrated in tableau (33), rightward alignment correctly selects the candidate that stresses the third syllable: s(s'ss)s("ss)s; leftward alignment would erroneously choose candidates that stress the second syllable. Hence, Align-Ft-R >> Align-Ft-L.

(33)

/ssssssss/	Head-L	Align-FT-R	Align-FT-L
$ s(s'ss)s("ss)s	*	sssss#, ss#	#ss, #sssss
s('ss)s(s"ss)s	*	ssssss#, ss!#	#s, #sssss
(s'ss)s(s"ss)s	**!	sssss#, ss#	#s, #sssss

The seven-syllable form shows that Main-Left aligning the peak of the prosodic word must measure the distance to the left edge from the syllable bearing the main stress--not from the left edge of the foot. If we evaluated in terms of the left edge of the foot, the amphibrach candidate ('ss)s(s"ss)s would incorrectly win since its left edge is closer to the beginning of the word.

(34)

/sssssss/	*s)(s	Main-L	Head-L
$ s('ss)s("ss)s	✓	#ssss	✓
(s'ss)s("ss)s	✓	#ssss	*!
('ss)s(s"ss)s	✓	#ssss	*!

The diagram in (35) summarizes the crucial rankings in our analysis of Cayuvava.

(35)   *s)(s Main-L   Lapse
                          \   / |
                      Head-L |
                          \ |
                       Align-Ft-R
                             |
                        Parse-s

       As in Estonian and Chugach Alutiiq, Cayuvava has the Lapse >> Align-Ft >> Parse-s ranking that generates the ternary rhythm. These three languages also align their feet to the right edge of the word. They differ in that Estonian and Chugach require the left edge of the word to align with a foot which, at least in the case of Estonian, happens to also house the main stress. In Estonian one can see the prosodic word as subject to two forces that tug the feet in opposite directions: the initial foot housing the main stress is pulled to the left while the remaining feet are pulled to the right. In Cayuvava the feet are also tugged in opposite directions but across one another: main stress is at the right edge but is pulled leftward while the remaining feet are pulled to the right.

4. Conclusion

       Four constraints have been at the forefront of our discussion: Lapse, Min-2, Align-Ft, and Parse-s. Lapse prohibits a sequence of two unstressed syllables not separated by a foot boundary and forces the insertion of feet. It is thus in tension with Align-Ft which penalizes feet displaced from the edge of the word. Languages with a single foot aligned at an edge display the Align-Ft >> Lapse ranking. Multiple footing arises from ranking Lapse above Align-Ft and comes in two varieties: binary and ternary rhythm. Among the binary languages we distinguished three subtypes found in Pintupi (Hayes 1994), Maranungku, and Shanghai Chinese depending on the ranking of Parse-s and Min-2 with respect to each other or with Lapse. Finally, ternary rhythm arises from downgrading syllable parsing below foot alignment (Lapse >> Align-Ft >> Parse-s) to create the sparser footing that we have seen in Chugach Alutiiq, Estonian, and Cayuvava.

(36)   a. Align-Ft >> Lapse   ('sssss) ('sssssss)   Cheremis
         b. Lapse >> Align-Ft
            Min-2s >> Parse-s   ('ss)('ss)s   ('ss)('ss)('ss)   Pintupi
            Parse-s >> Min-2s   ('ss)('ss)('s) ('ss)('ss)('ss)   Maranungku
            Min-2s, Parse-s >> ('ss)('sss)   ('ss)('ss)('ss)   Shanghai
              Lapse

         c. Lapse >> Align-Ft >> ('ss)s('ss)   ('ss)s('ss)s   Chugach
            Parse-s   Estonian
                                               Cayuvava

Notes

[1]The prominence hierarchy can be broken down into a sorting for weight (taa, daa, aa vs. ta, da, a), then for a consonant (necessarily an onset in this CV language: taa, daa, vs. aa vs. ta, da, vs. a), and finally for voicing (inherent duration: taa vs. daa, vs. aa vs. ta vs. da vs. a).

[2]In his penetrating discussion of Estonian stress Kager (1994:9) proposes a constraint that is similar to our Lapse in its ability to model weak-local parsing--Parse-2: one of two adjacent stress units must be parsed by a foot. Parse-2 is violated if two or more syllables intervene between feet. By interpreting "stress unit" to include "mora" as well as "syllable", Kager intends for Parse-2 to account for fact that Estonian ternary rhythm cannot skip a heavy syllable. Given that Parse-2 restricts the size of the gap between feet to a single mora, Kager treats the difference between the Estonian binary and ternary rhythms as the ranking of foot alignment and a constraint against adjacent feet: binary rhythm arises from Parse-2 >> Align-Ft-L >> *FtFt while the ternary rhythm reflects the Parse-2 >> *FtFt >> Align-Ft-L ranking. Due to space limitations, we restrict our discussion of Kager's analysis to a couple of brief points; see Green (1995, to appear) for further discussion. In order for his analysis to work, Kager must depart from McCarthy & Prince's (1993) assumption that alignment violations are evaluated cumulatively and independently and instead proposes that they are carried out on a foot-by-foot basis. Foot-by-foot evaluation is crucial for otherwise ('ss)s('ss)s would beat ('ss)('ss)('ss) in the binary register because its second foot incurs a violation of three syllables (#sss) while ('ss)('ss)('ss) is assessed a total of six violations (#, #ss, #ssss) and should therefore lose. Under the foot-by--foot evaluation ('ss)('ss)('ss) bests ('ss)s('ss)s at the second foot and this must suffice to terminate any further evaluation for alignment of later feet. Foot-by-foot evaluation strikes us as conceptually unwelcome. Either it requires imposing a special mode of constraint evaluation that is otherwise unnecessary or it requires postulating an unlimited series of separately rankable constraints: Align-Ft-1, Align-Ft-2, Align-Ft-3, etc. Secondly, in Kager's analysis both the binary and ternary rhythms of Estonian evaluate alignment with respect to the left edge of the word while our analysis of the ternary rhythm aligns feet to the right. The two analyses predict different parses for words of the structure ssLsLss (L = light syllable): ours ("ss)L('sL)('ss), Kager's ("ss)('Ls)L('ss). The reason is that given ("ss)LsLss, two feet must be inserted to avoid a Parse-2 violation and one of them must necessarily abut another foot in violation of *FtFt. Other things being equal, leftward alignment should then choose the ("ss)('Ls)L('ss) candidate. Unfortunately, the available data lacks a word of this structure; but given the general characterization of the Estonian ternary rhythm as skipping the third syllable if light, the ("ss)('Ls)L('ss) parse predicted by Kager's analysis seems dubious.

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