Deriving Ternarity*

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0. Introduction

Ternary stress patterns have posed a problem for a parametric metrical theory for some time. In this paper, it is argued that ternary systems can be derived in an explanatory fashion from binary systems. The basic idea is that ternary stress systems can be analyzed as binary stress systems if the theory of extrametricality is enriched. Two specific proposals regarding extrametricality are made. First, extrametricality must be tolerated not just at the edge of morphological and syntactic constituents, but also at the edge of phonological constituents. Second, extrametricality can be lost if adjacent feet are subminimal.

The organization of this paper is as follows. First, the foot typology is briefly reviewed. Then the theory of extrametricality is presented. It is argued that regardless of the analysis of ternary systems, the theory of extrametricality must be enriched as outlined above. Four metrical systems are then considered: Cayuvava, Chugach, Winnebago, and Estonian. Each of these systems provides arguments for deriving ternarity as proposed here.

1. Foot typology

For convenience, the metrical theory proposed by Hayes (1987) is adopted.[1] Hayes maintains that there are three metrical constituents: the syllabic trochee, the iamb, and the moraic trochee.

(1)	syllabic trochee	[[σ]σ]
	iamb	[μ[σ]]
	moraic trochee	[[μ]μ]

The syllabic trochee is a left-headed constituent with syllables as terminals. The iamb is a right-headed foot where the left terminal is monomoraic and the right terminal is a syllable or a mora. The moraic trochee is left-headed and takes morae or monomoraic syllables as terminals.

There are also systems that exhibit superficially ternary iteration. Halle & Vergnaud (1987) deal with these systems by supplementing their foot typology with an amphibrachic foot. This is a foot with three terminals and the head in the middle. It will be shown that such a foot cannot capture the range of ternary iteration and misses central generalizations about ternary systems.[2]

2. Extrametricality

Extrametricality excuses an element from metrification. An element that has been made extrametrical need not be included in the metrical tree to be pronounced and escape stray erasure. This device is constrained by the Peripherality Condition, which stipulates that extrametricality is only available at the edge of a domain (Hayes 1981; 1982; Archangeli 1984-1985).

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* Thanks to Diana Archangeli, Stuart Davis, Bruce Hayes, Mike Kenstowicz, Adrienne Lehrer, James Myers, Pat Perez, and Curt Rice for useful suggestions. All errors of data or analysis are the author's.

[1] See Hammond (1990) for an alternative to this system.

[2] There are also systems where the stresses can fall at potentially unbounded distances from each other. These systems are not discussed here and the reader is referred to Hayes (1981) or Halle and Vergnaud (1987) for a traditional treatment of such systems. See Prince (1985) or Hammond (1990) for another proposal.

English nouns provide an example of extrametricality. Oversimplifying, stress falls on a final long vowel. Else, stress falls on a long or closed penult. Else, stress falls on the antepenult.

(2)

long ultima	light penult	long penult	closed penult
kangaróo	América	aróma	veránda
Tennessée	cínema	balaláika	agénda
tiráde	aspáragus	hiátus	consénsus
repúte	metrópolis	horízon	synópsis
brigadóon	jávelin	thrombósis	amálgam
chimpanzée	vénison	coróna	uténsil

Secondary stresses fall on alternating syllables leftward regardless of syllable weight.

(3)

Mìssissíppi	sèrendípity
Àpalàchicóla	Srìràngapátnam
Cònestóga	hàmamèlidánthemum
dèsignátion	còmpensátion

To account for the basic pattern of stress, the final rhyme is made extrametrical if it is not long. Then a single moraic trochee is built on the right edge of the word followed by syllabic trochees from right to left.[3] Some sample derivations are given below.[4]

(4)

```
                                  x            x  x
x x x x    x x x<x>     x(x x)<x>      (x)(x x)<x>
America -> America   -> Ameri ca   ->   A meri ca

                                     x          x  x
 x  x  x      x  x <x>      x (x)<x>      (x)(x)<x>
consensus -> consensus -> consensus -> consensus

                                   x        x    x
x x  x                    x x (x)       (x x)(x)
anecdote -> em. n/a -> anecdote ->   anecdote
```

Final extrametricality captures the fact that ternarity is exhibited only at the right edge of the word. The moraic trochee captures the fact that only the rightmost stress is sensitive to syllable weight.

The restriction against making a long vowel extrametrical is a natural one. There are a number of languages where heavy syllables of various sorts are immune to extrametricality.[5] The account of ternary footing to be offered below hinges on the fact that extrametricality may be blocked by syllable weight.

The account to be presented here depends on several other properties of extrametricality. First, the domain peripherality refers to can be smaller than the domain footing applies to. Second, extrametricality can be assigned before or during the footing process. Third, extrametricality can be

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[3]There are a number of ways of effecting this differential sensitivity to syllable weight. See, for example, Halle and Vergnaud (1987) and Hammond (1990). Since the precise mechanism used to achieve this effect is irrelevant, a simple analysis, which allows feet to be constructed noniteratively, is given in the text. (See Kager, 1989 for a different view.)

[4]The notation in the text is adopted for typographical convenience. In relevant respects, it is a notational variant of the "lollipop" notation developed in Hammond (1984/1988). See Hammond (1987) for discussion.

[5]See Hayes (1981) and Halle and Vergnaud (1987) for examples.

lost if an adjacent foot is subminimal. Fourth, extrametrical elements are invisible to clash. Each of these points is considered below.

It is suggested that the domain of peripherality can also be the foot. That is, extramerical syllables can satisfy peripherality merely by occurring at the appropriate edge of a foot. That the domain of peripherality should differ from the domain of scansion is not a novel proposal. Prince (1985) proposes this in his treatment of English compounding. He suggests that the right sister of each compound constituent should be extrametrical. In the domain of syllabification, Rubach and Booij (1990) have proposed that an extrasyllabic element can satisfy peripherality at the edge of a medial syllable.

Second, the account to be presented here depends on the possibility of assigning extrametricality at various points in the derivation. This too is not a novel proposal. The normal picture, of course, is that extrametricality is constructed on the fly, as feet are built. However, there are a number of systems that have been analyzed with extrametricality assigned before footing, e.g. Yawelmani (Archangeli 1984-1985) and English (Hayes 1981). In both of these cases, lexical extrametricality is presumed to be present in the underlying representation of certain forms.

The third assumption that is critical for this proposal is that extrametricality can be lost if an adjacent foot is subminimal. Prince (1991) argues that just such a process is involved in the Latin phenomenon known as *Brevis Brevians*, whereby in a disyllabic form consisting of a short open syllable followed by a long syllable, the long syllable shortens, e.g. *ego: -> ego*, *cito: -> cito*, etc. Prince argues convincingly that this is a consequence of the loss of final extrametricality and incorporation of the final syllable in a moraic trochee when the foot would otherwise be subminimal.

(5)
```
   x          x
 (x)<x>     (x x)
  e go: ->  ego
```

It will be argued below that analogous processes affect extrametricality when it is assigned at the edge of a foot.

A final property of extrametricality is that syllables are invisible with respect to rules of rhythm and destressing. It will be shown in the following that the English Rhythm Rule is considerably simplified on the assumption that extrametrical material is invisible to rules of rhythm and destressing.

Consider the following facts concerning the English Rhythm Rule. As noted by Hammond (1984/1988), forms like the following readily undergo a shift of stress.

(6)	Tènnessée	Ténnessèe Tím
	Kàngaróo	Kángaròo Cárl

Hayes (1984) notes the following contrast. The forms in (7a) undergo rhythm much more readily than the forms in (7b).

(7)			
	a.	Mìssissíppi	Míssissìppi Mábel
		ànalytic	ánalytic thóught
		Pàssamaquóddy	the Pássamaquòddy vérb
	b.	Mìnneápolis	?Mínneàpolis Míke
		ànalytical	?ánalytical thóught
		Pòtawátomi	?the Pótawàtomi vérb

The contrast falls out automatically given that extrametrical syllables are invisible to metrical structure and that the shift of stress is triggered by clash. Representative input representations to the Rhythm Rule are given in (8) where clashes are marked with hyphens. (A clash exists at some

level n of the representation if columns are adjacent at level n and level n-1.) Notice that the cases where rhythm is more likely are characterized by having more clashes.[6]

(8)

```
        x---x                          x-----x
  (x     x)-(x)                  (x     x)---(x)
  (x  x)(x) (x)                  (x  x)(x)<x>(x)<x>
  Tennessee Tim                  Mississippi Ma bel

                      x--------x
                (x     x  )     (x)
      but:      (x  x)(x x)<x>  (x)
                Minne  apo lis Mike
```

This line of explanation requires the uncontroversial assumption that word-edge extrametricality is not lost when words are concatenated syntactically.

Hayes deals with this by maintaining that the shift of stress is caused by a rule that endeavors to place stresses at four-syllable intervals--"the Quadrisyllabic Rule". Shifting stress in the cases in (6) alters the interval between primary stresses from one to three syllables. In (7a), the interval shifts from two to four syllables. In (7b), however, the interval shifts from three to five syllables bringing it no closer to the desired interval of four syllables. In support of this approach, Hayes cites the following contrasts where rhythm is preferred in (9a), but less likely in (9b).

(9)			
	a.	Alabáma	Alabàma rélatives
		Européan	Europèan hístory
		Oklahóma	Oklahòma cóngressman
	b.	Alabáma	?Alabàma connéctions
		Européan	?Europèan histórian
		Oklahóma	?Oklahòma congréssional dist.

There are three problems with Hayes' proposal. First, there is an alternative analysis available for the dispreference of rhythm in the forms in (9b). These forms have all undergone initial destressing which would presumably leave a stranded 'x' which would interrupt the lower-level clash, which renders the forms in (9b) analogous to the forms in (7b).

(10)

```
        x---------x                    x--------x
  (x     x)       (x)            (x     x  )    (x)
  (x x)(x)<x>  x (x) <x>         (x  x)(x x)<x> (x)
   Ala ba ma  connections        Minne  apo lis Mike
```

The second problem for Hayes is that there is a contrast in the following forms as well. Rhythm is also dispreferred in (11b).

(11)			
	a.	Kàngaróo	Kángaròo Kím
		Tènnessée	Ténnessèe Tím
	b.	Kàngaróo	?Kángaròo connéctions
		Tènnessée	?Ténnessèe congréssional dist.

---

[6]Myers (1987) and Halle and Vergnaud (1987) maintain that the adjectival suffix *-ic* is an exception to extrametricality. This accounts for the fact that the preceding syllable attracts stress and undergoes Trisyllabic Laxing, e.g. *phone/phonic*. If this were so, it would predict that adjectives with *-ic* should pattern like (7b). This does not seem to be the case. Phrases like *phílosòphic Fréd* undergo rhythm readily. There are, however, other analysis of this phenomenon that do not require that *-ic* be an exception to extrametricality, e.g. Yip (1987). Yip proposes that the vowel of *-ic* is underlyingly absent and that shortening with *-ic* is an instance of closed syllable shortening.

By the Quadrisyllabic Rule, the shift of stress in (11b) should actually be preferred to the shift in (11a). In (11a), the shift alters the distance from one to three syllables. In (11b), the shift would alter the distance from two to four syllables, the optimal target by the Quadrisyllabic Rule.

Finally, the Quadrisyllabic Rule is to be avoided on theoretical grounds. It has generally been assumed that grammatical principles do not count past two. If there is a reasonable alternative, as has been shown above, the Quadrisyllabic Rule is to be eschewed.

Summarizing, extrametricality is subject to peripherality with respect to a stipulated domain. In addition, it exhibits three other properties. First, it can be blocked from applying to heavy syllables (English right-edge syllable extrametricality). Second, it can be lost to make a minimal foot (Latin). Third, extrametrical elements are invisible with respect to clash (English rhythm).

There is a paradox brewing here in terms of how extrametricality affects the representation. Extrametrical elements must be available for metrification to account for the Latin facts, but extrametrical elements are not available in the computation of what constitutes a clash environment. This problem disappears, however, if a different representation of extrametricality is adopted. Rather than marking it "positively" with angled brackets, assume that it is marked "negatively" by the absence of an 'x' on line 1 of the grid. A word like *Minnesota* is then represented as in (12).

(12) Halle & Vergnaud:

```
 x     x
(x  x)(x)<x>
Minne so ta
```

proposed here:

```
 x     x
(x  x)(x)
 x  x  x x
Minne sota
```

Such a representation provides an account for why extrametrical elements are visible for *Brevis Brevians*, but not visible for English rhythm. Rhythm depends on clash and clash depends on adjacency at two levels of the grid (Liberman & Prince 1977). Extrametrical elements are not represented at a sufficiently high level of the grid to matter for the determination of clash. The new representation of *Mississippi Mabel* is given in (13).

(13)

```
 x     x-----x
(x  x)(x)    (x)
 x  x  x  x  x x
Mississippi Mabel
```

This new representation will be used in the following sections (except when discussing previous work).

Four languages are now considered: Cayuvava, Chugach, Winnebago, and Estonian. It is argued that each of these is more explanatorily treated in terms of foot-edge extrametricality.

3. Cayuvava

The relevance of Cayuvava to metrical theory was first noted by Levin (1988). The data are from Key (1961, 1967). Stress in Cayuvava falls on every third vowel counting from the right end of the word (Levin 1988; p.101-2).

(14) a.

dáru	'hand'
éne	'leaf'
néA	'still'

b.	sákahe	'stomach'
	ríbera	'leg'
	óene	'capywara'
	úhia	'you (sg.) go'
	báau	'Brazil nut'
c.	kihíBere	'I ran'
	takáasi	'old man'
	soísoi	'good spirits'
d.	arikájahi	'he has already fallen'
	Bariékimi	'seed of squash'
	ariúuca	'he came already'
e.	pópohecéBaka	'inside of cow'
	Bádacaóai	'my younger brother'
	ráibirínapu	'dampened manioc flour'
f.	aBárericákaA	'palate (Px)'
	maráhahaéiki	'their blankets'
	hiBújuruéine	'I burn it also again'
g.	ikitáparerépeha	'the water is clean'
	tiBiBíoaíine	'she spank me again'
	iepétiBiBóai	'they not spank me'
h.	cáadiróboBurúruce (caadáirobóirohíine)	'ninety-nine'
	(Bururuce) medárucecéirohíine	'fifteen each'

The most direct way to accommodate these facts would be to build dactylic feet from right to left (Spring 1989). Dactyls are ternary feet where the head falls on the left.

(15)

```
                    x     x
 x x x x x x     (x x x)(x x x)
popoheceBaka -> popohe ceBaka
```

This fails to account for forms with other than 3xn syllables. For example, this analysis would produce the following derivation for a word like *ikitáparerépeha*, incorrectly predicting initial stress.

(16)

```
                       x    x      x
x x x x x x x x x    (x x)(x x x)(x x x)
ikitaparerepeha -> *íki tápare répeha
```

To deal with these, the dactylic analysis needs a special rule to remove nonmaximal feet (feet with less than three terminals) in words with more than one stress.

(17) Dactylic Destressing
Remove a nonmaximal foot in a word with more than one stress.

The derivation in (16) would then continue as in (18).

(18)
```
x    x      x              x      x
(x x)(x x x)(x x x)    x x(x x x)(x x x)
 iki tapare repeha  -> ikitapare repeha
```

Levin (1988) rejects this analysis. She proposes instead that the final syllable is extrametrical and that amphibrachs are constructed from right to left. Halle and Vergnaud (1987) adopt this analysis as well.

(19)
```
                        x    x      x
x x x x x x x x x     (x)(x x x)(x x x)<x>
ikitaparerepeha -> *í kitápa rerépe ha
```

Again, a special rule is needed to remove degenerate feet (feet with only a single terminal) in words with more than one stress.[7]

(20) Amphibrachic Destressing
Remove a degenerate foot in a word with more than one stress.

A problem for both analyses is the unnatural destressing rules (17) and (20) which do not remove clashes. Hammond (1984/1988) argues that all destressing rules remove clashes.

This problem for the dactylic and amphibrachic analyses of Cayuvava is solved if it is assumed that superficial dactylic feet are derived via foot-edge extrametricality. Cayuvava actually involves trochaic footing, but a stray syllable is licensed at the right edge of each foot. (Extrametrical elements must be at the right periphery of a foot.) In (21), a sample derivation is given that can be compared with (16) and (19) above.

(21)
```
                       x     x
                      (x x) (x x)
 x x x x x x           x x x x x x
popoheceBaka ->  popoheceBaka
```

This approach to ternarity solves the destressing problem above. The destressing rule can now be treated as a straightforward rule of destressing under clash. An initial binary foot under the primitive dactyl analysis is an initial monosyllabic foot in a clash environment under the derived dactyl analysis presented here. A sample partial derivation is given in (22).

(22)
```
                        x---x     x
                       (x)  (x x) (x x)
x x x x x x x x x       x x x x x x x x
ikitaparerepeha ->  ikitaparerepeha
```

Cayuvava is thus best analyzed in terms of trochaic feet plus extrametricality, where peripherality is relativized to the foot. This accounts for destressing in a natural way. While this analysis requires a weakening of the traditional Peripherality Condition, it is in conformity with the general principle that extrametrical elements, relativized or not, are invisible to operations sensitive to clash.[8]

Notice that if foot-edge extrametricality is assigned on the fly in Cayuvava, then relativized peripherality is not satisfied until the next foot to the left is constructed. This is a general property

[7]Levin proposes a special rule; Halle & Vergnaud propose their recoverability condition.

[8]Suggestive support for this analysis comes from the prosodic morphology of Cayuvava where there is support for a disyllabic foot. First, the minimal word is disyllabic. Second, Key (1967) cites instances of disyllabic reduplication, but no cases of trisyllabic reduplication have been found anywhere in the data.

of extrametricality, however, and not specific to this extension of peripherality. Compare the analyses of English adjectival suffixes (Hayes 1981) and the Yawelmani suffix *-xoo* (Archangeli 1984-1985). In both cases, extrametricality is in place early in the derivation, but peripherality is not checked until later in the derivation.

4. Chugach

Let us now consider the complex facts of Chugach, a dialect of Eskimo. The data are from Leer (1985). There are recent metrical descriptions by Rice (1988, 1990a), and Halle (1989). Word-initial closed syllables and all syllables containing long vowels count as heavy. In a word with all light syllables, stress falls on the second syllable from the left and every third syllable thereafter. Rice (1988) cites the following forms.

(23)	pa.lá.yaq	'rectangular skiff'
	qe.ná.wik	'hospital'
	qa.yá.kun	'by boat'
	a.tún.'ir.túq	'he stopped singing'
	ta.qú.ma.lu.ní	'apparently getting done'
	qa.ngá.te.ra.mék	'from a porcupine'
	a.kú.tar.tu.nír.tuq	'he stopped eating akutaq'
	sa.rá.ni.wa.kár.tuq	'he is too sleepy'

Heavy syllables interrupt this pattern in two ways. First, heavy syllables always receive stress. In (24) are examples of long vowels receiving stress; in (25) are some examples of initial closed syllables receiving stress. Noninitial closed syllables do not count as heavy. In the following examples, heavy syllables are underlined.

(24)	taá.ta.qá	'my father'
	taá.taá	'her father'
	mu.lúk.'uút	'milks' (noun plural)
	naá.'uq	'it's burning'
	naá.qu.ma.lú.ku	'apparently reading it'
	mu.lú.kuút	'if you take a long time'
	pa.lát.kaáq	'tent'
	pi.lú.liá.qa	'the fish pie I'm making'
(25)	úl.'uq	'it flooded'
	úl.luá	'its tongue'
	án.ci.quá	'I'll go out'
	án.ci.qu.kút	'we'll go out'
	íq.llu.nir.túq	'he stopped lying'
	qáy.yaá.kun	'by his boat'
	úm.yuár.te.qu.té.ka.qá	'I am thinking about it'

Second, a light syllable following a light syllable and preceding a heavy syllable receives stress. (The relevant syllables are marked with double underlining.)

(26)	naá.ma.cí.quá	'I will suffice'
	ág.ku.tár.tuá.nga	'I'm going to go'
	ág.nguá.qu.tár.tuá.nga	'I'm going to dance'

This pattern is accounted for directly on the analysis presented here. First, following Hayes (in progress), the fact that only word-initial closed syllables count as heavy is accounted for by

restricting Weight-by-Position (Hayes 1989) to word-initial syllables. Noninitial closed syllables are treated as light by the stress system because Weight-by-Position does not apply to these syllables. Second, iambs are built left to right. Third, each iamb licenses a (relativized) extrametrical light syllable to its right.

The analysis is given in (27).

(27) a. Word-initial Weight-by-Position;
b. Build iambs left to right;
c. Foot-edge extrametricality of a light syllable on the right.

Some sample derivations are given below. Derivation (28) is of a word containing all light syllables.

(28)

```
                                  x         x
                               (x   x)   (x  x)
 x   x  x  x  x       x   x  x  x  x
qa.ngá.te.ra.mék -> qa.ngá.te.ra.mék
```

Derivation (29) contains medial heavy syllables.

(29)

```
                                    x    x          x     x
                                   (x)  (x)     (x  x)   (x)
x    x   x  x  x  x  x      x    x   x  x  x  x  x
úm.yuár.te.qu.té.ka.qá -> úm.yuár.te.qu.té.ka.qá
```

Derivation (30) shows how the light syllable effect illustrated in (26) requires some additional machinery.

(30)

```
                                    x     x          x
                                   (x)   (x)   (x    x)
x     x  x  x    x   x      x     x  x  x    x   x
ág.nguá.qu.tár.tuá.nga -> *ág.nguá.qu.tár.tuá.nga
```

To complete such derivations correctly, it is proposed that an extrametrical syllable is adjoined to a following foot, subject to the condition that the resulting feet must be bimoraic.

(31) Adjunction

```
      (x  ->  (x x)
   x   x       x x
```

The restriction that feet be bimoraic produces the correct results. There are basically four situations to consider, diagrammed in (32). (Heavy syllables are marked with an underposed hat.)

(32) a.

```
       x         x  x
   (x x)  ->  (x x)(x)
  x x x       x x  x
      ^           ^
```

b.

```
       x         x  x
   (x x)  -> *(x x)(x)
  x x x       x x  x
```

```
c.      x          x
       (x)  ->  *(x x)
      x x         x x
        ^           ^

d.      x          x
       (x)  ->  (x x)
      x x         x x
```

Adjunction succeeds only in (32a) and (32d) because only in these cases can it produce bimoraic feet. Adjunction in (32b) and (32c) would result in non-bimoraic feet. In (32d), adjunction has no effect on the stress pattern; in (32a), it results in an additional stress on the medial syllable. Additional cases are cited below where adjunction results in an automatic shift of stress.

Adjunction can be taken as an argument for deriving ternarity as proposed here. Superficial ternarity is eliminated just in case well-formed bimoraic feet can be created. On the analysis presented here, binary feet are part of the basic stress assignment procedure. If ternary feet were basic in Chugach, the appearance of binary feet via adjunction would be completely mysterious.

With rule (31), the derivation in (30) continues as follows, exemplifying case (32a).

(33)

```
                                        x     x         x
                                       (x)   (x)   (x    x)
x     x  x  x    x   x      x     x  x  x    x   x
áq.nguá.qu.tár.tuá.nga ->  áq.nguá.qu.tár.tuá.nga

   x     x     x    x
  (x)   (x)(x   x)  (x)
   x     x  x  x    x   x
-> áq.nguá.qu.tár.tuá.nga
```

Rule (31) has additional consequences as well. Derivations like (29), with a monomoraic foot on the right edge, undergo (31) vacuously, illustrating case (32d).

(34)

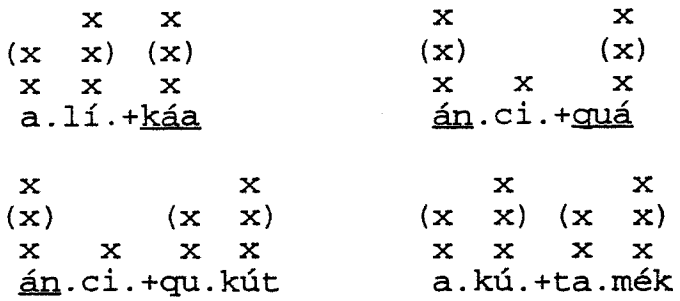
```
 x    x         x     x     x    x         x     x
(x)  (x)     (x  x)   (x)  (x)  (x)     (x  x)(x  x)
 x    x   x  x  x  x  x    x    x   x  x  x  x  x
 úm.yuár.te.qu.té.ka.qá  -> úm.yuár.te.qu.té.ka.qá
```

Support for this analysis comes from fortition, a process whereby certain consonants become fortis (Leer 1985). Fortition applies to the onset of a medial long syllable or a medial light syllable immediately preceding a stressed light syllable. Fortis consonants are marked with a prefixed '+' in (35).

(35)	a.lí.+káa	'she is afraid of it'
	án.ci.+quá	'I'll go out'
	án.ci.+qu.kút	'we'll go out'
	a.kú.+ta.mék	'a food'

Under the analysis presented here, these are precisely the medial foot-initial consonants.

(36)



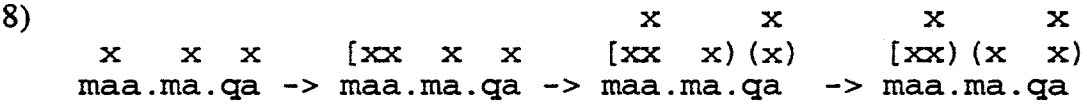
Under previous approaches, ad hoc readjustment rules were required so as to alter the feet required for stress to produce appropriate foot structure for fortition. On the analysis presented here, no such machinery is required. The pattern of fortition is an automatic consequence of the feet constructed, the distribution of relativized extrametricality, and the independently required adjunction process.

Basic amphibrachic feet would fail on a number of fronts. Halle (1990) proposes an analysis of Chugach that includes amphibrachic feet and the following machinery. First, heavy syllables must be marked so that they occur at the left edge of a foot (a left square bracket). Second, heavy syllables must be treated as bipositional so that the head of the amphibrach falls on the heavy syllable (two asterisks at line 0). Finally, there is a special rule that readjusts foot boundaries to get fortition to work out correctly:

(37) line 0: x x)(x) -> x)(x x)

A sample derivation is given below.

(38)



This analysis is undesirable for a number of reasons. First, it requires a number of supplementary devices to get stress in the correct place. The derived ternarity analysis requires only adjunction (31), which is analogous to machinery independently required in Latin. The amphibrach analysis requires idiosyncratic boundaries and bipositionality, which are otherwise unnecessary. Halle cites Cairene Arabic, but as shown by Hayes (1987), no such device is necessary if moraic trochees are adopted. Moreover, enriching the theory by including bipositionality and idiosyncratic boundaries predicts that the two devices should be able to operate independently of each other, yet no cases of this sort occur. Including these two devices in the theory would also predict that they should be able to cooccur with the more orthodox accent rules of Halle and Vergnaud (1987). Again, they do not.

Second, the amphibrach analysis requires the rule (37) solely to get the fortition facts to work out. On the analysis presented here, the fortition facts follow automatically. Finally, the amphibrach analysis fails to account for the fundamental binary aspect of the Chugach system. The representation of heavy syllables is enriched because they must attract the heads of ternary constituents. Rule (37) is also required because the constituents are ternary. As argued above, with basic binary constituents, far less machinery is required.

Notice that Chugach makes the distribution of relativized extrametricality more symmetric in two respects. First, while relativized extrametricality in Cayuvava occurs at the right edge of a foot built from right to left, in Chugach, relativized extrametricality occurs at the right edge of a foot built from left to right. Foot-edge extrametricality does not correlate with the direction of iteration. Moreover, while the feet in Cayuvava are syllabic trochees, the feet in Chugach are iambs.

5. Winnebago

Winnebago (Hale and White Eagle 1980) provides an example of foot-edge extrametricality at the left edge of the foot. Main stress in Winnebago falls on the third syllable from the left. Secondary stresses fall on alternating syllables to the right of the primary stress.

(39)

wajé	'dress'
wijúk	'cat'
hochichínik	'boy'
hakirújikshàna	'he pulls it taut'
haakítujìk	'I pull it taut'(plain)
haakítujìkshanà	I pull it taut'(decl.)

This system requires word-initial extrametricality and iterative iambic footing. A sample derivation of the analysis so far is given below.

(40)

```
                              x x x   x x
x x x x   x x          x x x x   x x
hakirujikshana -> hakirujikshana ->

          x       x  x
       (x x)(x    x)(x)
     x x x  x    x  x
-> hakiru jiksha na
```

Winnebago is also subject to a rule of destressing which removes the final degenerate foot in a stress clash.

Winnebago exhibits a process of epenthesis which has long posed a problem for metrical theorists. In fact, under the derived ternarity analysis to be presented here, the facts of epenthesis in Winnebago require nothing special. Rather, they confirm the analysis presented so far. The epenthesis rule breaks up obstruant-sonorant clusters by inserting a copy of the immediately following vowel. Halle and Vergnaud (1987; p.31) formalize the rule as in (41).

(41) $[\text{-son}]\ \begin{bmatrix}\text{-syl}\\ \text{+son}\end{bmatrix}\ \text{V}$

1 2 3 -> 1 3 2 3

In the following forms, epenthetic vowels are underlined.

(42)

hosha̲wazhá	'you are ill'
harakíshu̲rujìksha̲nà	'you pull taut'
maashárach	'you promise'
waki̲ripá̲ras	'flat bug'
hirakórohò	'you dress, prepare'
waki̲ripóropò̲ro	'spherical bug'

What is crucial here is the effect epenthesis has on metrical structure. Sometimes the epenthetic vowel behaves as if it were inserted before stress assignment, as in [hirako̲roho], and sometimes it behaves as if it were inserted after stress assignment, as in [hosha̲wazhá]. This apparent paradox prompted Halle and Vergnaud to posit an otherwise unmotivated principle to account for these facts: the Domino Condition. The Domino Condition is global in that it requires the metrical structure of the entire string to be rebuilt under specified circumstances. In contrast, the analysis below relies only on independently required machinery.

Let us assume simply that epenthesis precedes stress assignment and that epenthetic vowels are marked as foot-extrametrical (i.e. subject to relativized peripherality).[9] As such, they are invisible to footing and must ultimately occur at the (left) periphery of feet. If, in the course of footing, epenthetic vowels end up in the right place, nothing happens. If, on the other hand, an epenthetic vowel should end up in an illegitimate position, then extrametricality marking on the relevant syllable is not interpreted.[10]

Here are some sample derivations showing how this works. In (43), epenthesis applies inserting vowels marked as extrametrical. Next, initial extrametricality applies removing the first syllable from the domain of the scansion. Iambs are then built.

(43)

```
                                x x x    x x     x
          x x x   x x    x      x x x  x x x   x x
harakishrujikshna -> harakishurujikshana ->

                               x      x     x
          x x    x x     x       (x x)  (x x)   (x)
       x x x  x x x   x x      x x x  x x x   x x
-> harakishurujikshana -> harakishurujikshana
```

Notice that unlike in Cayuvava, a relativized extrametrical syllable does not seem to be transparent for the determination of clash. To get this result without stipulating that extrametricality is only occasionally invisible, it is proposed that destressing is preceded by Left-Adjunction.

(44) Left-Adjunction

```
(x)  ->  (x x)
x x      x x
```

Notice that (44) has no direct effect on the distribution of stresses. Additional support for (44) comes from a process of Right-Adjunction to be motivated below.

The derivation in (43) is then completed as follows.

(45)

```
      x      x     x          x      x     x
   (x x)  (x x)   (x)      (x x)  (x x) (x x)
 x x x  x x x   x x      x x x  x x x   x x
harakishurujikshana  -> harakishurujikshana
```

The derivation in (46) shows that there must be an additional adjunction.

(46)

```
               x x   x x       x   x x
 x x  x x      x x x x x     x x x x x
hirakroho -> hirakoroho -> hirakoroho ->

        x     x
     (x x) (x x)
      x x x x x
-> *hirakoroho
```

This is termed Right-Adjunction and precedes Left-Adjunction (44).

---

[9]This idea can be implemented by assuming that the rule responsible for epenthetic vowels inserts vowels specifically marked as extrametrical or that epenthesis is followed by a rule marking empty morae as foot-edge extrametrical.

[10]Cf. the interpretation of extrametricality in Yawelmani (Archangeli, 1984-1985).

(47) Right-Adjunction

```
(x)   -> (x x)
 x x      x x
```

Since feet are right-headed, (47) does shift stress to the right.

Derivation (48) shows a complex case involving multiple instances of Right-Adjunction and destressing in clash.

(48)

```
                  x   x   x   x          x   x   x
 x  x  x  x     x x x x x x x     x x x x x x x
wakripropro -> wakiriporoporo -> wakiriporoporo ->

          x   x   x            x    x  x
         (x) (x) (x)         (x x)(x x)(x)
    x x x x x x x      x x x x  x x  x
-> wakiriporoporo -> wakiripo ropo ro ->

           x    x
         (x x)(x x)x
    x x x x  x x x
-> wakiripo roporo
```

This analysis needs no new mechanisms. It requires only that extrametricality be marked before footing. Left-Adjunction and Right-Adjunction are of a form that has been seen in the analyses of Latin and Chugach already. In contrast to Halle and Vergnaud's analysis, no global reapplication of footing must take place halfway through the derivation.

Halle and Vergnaud formalize the Domino Condition as follows.

(49) Domino Condition
The introduction of an additional position inside a bounded constituent destroys that constituent and all constituents to its right if the Constituent Construction rule applied from left to right, and all constituents to its left if the Constituent Construction rule applied from right to left. Constituent structure is reimposed on the affected substring by a subsequent reapplication of the Constituent Construction rule.

This produces derivations as follows. Derivation (50) shows what happens when epenthesis does not intrude in a foot.

(50)

```
                        x              x
 x   x  x     <x> (x  x)    <x> x(x  x)
hoshwazha -> hoshwazha -> hosh_awazha
```

Derivation (51) shows what happens when epenthesis does intrude in a foot.

(51)

```
                        x              x
 x  x  x      <x>(x  x)     <x>x(x x x)
wakripras -> wakripras -> wak_iripa_aras ->

                              x  x             x
   <x>x(x x x      <x>x(x x)(x)     <x>x(x x)x
-> wak_iripa_aras -> wak_iripa ras -> wak_iripa_aras
```

There are two problems with this analysis. First, it is devastatingly global. Intrusion into a foot entails the destruction of that foot and all feet to the right. In addition, feet must be subsequently reassigned.[11]

A second problem with the Domino Condition is that it is empirically inadequate. Miner (1990) cites data showing that epenthesis applies in initial syllables as well. This epenthesis does not interrupt a foot, but must apparently trigger the Domino Condition.

(52)		
	shawazhókji	'you mash hard'
	kerejúsep	'Black Hawk'
	paragúchge	'in formation'
	xorojíke	'hollow'

A sample derivation showing how the Domino Condition fails is given in (53).

(53)

```
          x                   x
    <x>(x  x)          x x (x  x)
shwazhokji  -> *shawazhokjí
```

Under the analysis presented here, these cases are straightforward. The epenthetic vowel is inserted and marked as extrametrical. Word-edge extrametricality applies vacuously (since the leftmost syllable is already extrametrical), feet are built, and adjunction is inapplicable.

(54)

```
                                          x  x
                    x  x  x          (x  x) (x)
   x  x  x       x x  x  x       x x  x  x
shwazhokji -> shawazhokji -> shawazhokji
```

Thus the analysis in terms of derived ternarity is preferred to the analysis incorporating the Domino Condition.

6. Estonian

Finally, consider stress in Estonian. Estonian further instantiates the system of derived ternarity developed here. The analysis to be presented here basically recasts the analysis of Prince (1980) into the terms of this framework. Main stress falls on the first syllable of the word. Secondary stresses fall on every second or third syllable thereafter. Prince (1980; p. 518) cites the following data.

[11]Rice (1990b) proposes an analysis in which the Domino Condition is argued to follow from other principles. This analysis too is subject to the same objection of globality, however.

(55) a.

kínnast	'glove' part. sg.
pálatt	'piece' part. sg.
pímestav	'blinding'
kávalátt	'cunning' part. sg.
páhemáit	'worse' part. sg.
rételíle	'ladder' all. sg.
pímestávale-pímestavále	'blinding' ill. sg.
pímestávasse-pímestavásse	'blinding' ill. sg.
hílisémattéle-hílisemáttele	'later' all. pl.

b.

áa:s:tátt	'year' part. sg.
káu:kéle-káu:kele	'far away'
júl:késse	'bold' ill. sg.
jǎl:kétest-jǎl:ketést	'track' el. pl.
tőö:s:tústesse-tőö:s:tustésse	'industry' ill. pl.
téo:t:táttuttéltt	'supporter' abl. pl.

The stress pattern of Estonian is intimately tied up with quantity. There are three degrees of quantity in Estonian: Q1, Q2, and Q3. Prince schematizes them as follows.

(56)

Q1	Q2	Q3
CV	CVV	CVV:
	CVVC	CVV:C:
	CVC	CVC:

If word-final consonants are extrametrical, the distribution of stress with respect to quantity can be characterized as follows. Column (57a) shows the distribution of quantity when stresses fall three syllables apart. ('X' stands for a syllable of any weight.) Notice how while the first two syllables can be either Q1 or Q2, the third syllable must be Q1. Column (57b) shows what happens when the two stresses are two syllables apart. Here there are basically two cases. The first four possibilities are a mirror of the first four possibilities of (57a) for the first two syllables. The last two cases involve Q3 on the first syllable and Q1 or Q2 or the second. Column (57c) only gives one possibility with Q3.

(57)

a.	b.	c.
x x x x x x	x x x x x	x x x x ....
Q1 Q1 Q1 X Q2 Q1 Q1 X Q1 Q2 Q1 X Q2 Q2 Q1 X	Q1 Q1 X Q2 Q1 X Q1 Q2 X Q2 Q2 X Q3 Q1 X Q3 Q2 X	Q3 X

This analysis is conceptually close to Prince's, but is cast in terms of the theory developed here. Word-final consonants are extrametrical. Left-headed binary feet are built from left to right. That stress recurs on every second or third syllable is captured by allowing any foot to be either a syllabic or moraic trochee. A light syllable is optionally licensed as extrametrical at the right edge of the foot. Q3 results in a nonfinal degenerate foot. Some sample derivations are given below.

(58) a.

```
                    x
                  x   x       (x   x)
                  x   x        x   x
          Q2 Q2   kinnast -> kínnast
```

b.

```
                              x   x
                  x   x       (x) (x)
                  x   x        x   x
          Q2 Q2   aastatt -> aastatt -> áa:s:tátt
```

c.

```
                               x
                  x x   x     (x x)
                  x x   x      x x   x
          Q1 Q1 Q1 pimestav -> pímestav
```

d.

```
                              x   x
                  x   x x     (x) (x x)
                  x   x x      x   x x
          Q2 Q1 Q1 kaukele -> kaukele -> káu:kéle
```

e.

```
                                          x     x
                        x x   x x   x     (x x) (x x)
                        x x   x x   x      x x   x x   x
          Q1 Q2 Q1 Q2 Q1 pimestavasse -> pímestávasse
```

f.

```
                                          x       x
                        x x   x x   x     (x x)   (x   x)
                        x x   x x   x      x x   x x   x
          Q1 Q2 Q1 Q2 Q1 pimestavasse -> pimestavasse
```

There is an additional glitch involving heavy syllables after Q3 medially. In contrast to the normal case, a heavy Q2 syllable can occur after a Q3 syllable if it is medial.

(59)	tőö:s:tustésse	'industry' ill. pl.
	áu:sattéle	'honest' all. pl.
	vät:mettéka	'key' com. pl.
	tőö:k:kailéki	'hardworking' all. pl.

This can be accounted for if it is assumed that Q3 can optionally be assigned in a medial binary foot.

(60) x -> Q3 /__ x)(

Estonian provides an argument for the system proposed here because the restrictions on the relativized extrametrical syllable are different from the restrictions on the weak position in the trochaic foot (57). If Estonian were analyzed with a dactylic or amphibrachic foot, this fact would be much more difficult to account for. If the foot imposed no requirements on the weight of the first two syllables, then it should impose no requirements on the weight of the third syllable. This is not true as is apparent from (57a).

7. Summary

To summarize, analyses of four systems exhibiting superficial ternary iteration have been presented: Cayuvava, Chugach, Winnebago, and Estonian. All four of these were shown to be more perspicuously analyzed in terms of foot-edge extrametricality.

A theory of extrametricality emerges which includes the following criterial properties. First, extrametricality can occur at the edge of a word-medial foot. Second, extrametrical elements are invisible to rhythm and destressing rules. Third, extrametricality may be lost to augment feet.

8. Appendix: Weak Local Parsing

Hayes (in progress) develops a system that is similar in some senses to the system proposed here. He suggests that languages can stipulate whether iteratively constructed feet are adjacent or are separated by a greater distance. These options are Local Parsing and Weak Local Parsing. For a language like Cayuvava, syllabic trochees would be constructed weak-locally.

(61)

```
                        x   x     x
x x x x x x x x x     (x)x(x x)x(x x)x
ikitaparerepeha -> *íkitáparerépeha
```

Notice that this allows a straightforward treatment of the destressing problem in Cayuvava.

While it is difficult to consider in detail work that it is still in progress, it is perhaps appropriate to indicate how the approach presented here differs from the Weak Local Parsing idea.

First, relativized extrametricality, as argued by Rubach and Booij (1990), is independently required to treat syllabification. Weak Local Parsing is not independently required.

Second, relativized extrametricality can appear at either end of a foot. For example, in Cayuvava and Winnebago, the extrametrical syllable appears closer to the origin of iteration, while in Chugach and Estonian, the extrametrical syllable appears on the far side of the foot from the origin of iteration. The latter is not a possibility for Weak Local Parsing.

Third, Weak Local Parsing is a property of the scansion, not a property of syllables. Hence the analysis of Winnebago presented here would not be possible because relativized extrametricality is marked on syllables before the scansion.

Thus, it appears that relativized extrametricality is distinct from Weak Local Parsing and superior to it in explanatory and descriptive terms.

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