Ternary rhythm*

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1 The facts

Most languages with iterative stress patterns show a simple rhythmic alternation between stressed and unstressed syllables. But in a few cases, stress appears not on every second syllable, but rather on every third one. Patterns of this nature reveal the phenomenon of ternary rhythm.

Ternary rhythm is most easily seen in a language with a stress system that ignores the internal structure of syllables, i.e. a quantity-insensitive system. The Cayuvava language, currently extinct, but formerly spoken in parts of Bolivia, is a language well-documented in Key's works, e.g. Key (1961) and Key (1967). It is classified as an isolate, with no established genetic relationship to other languages. Key's fieldwork documents ternary rhythm in Cayuvava and no relevant syllable quantity. Stress in this language appears on every third syllable counting from the right edge of the word. To see the pattern first presented schematically, consider the representations in (1). Each number represents a syllable: '0' represents

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a syllable with no stress, '1' represents a syllable with primary stress, and '2' represents secondary stress. The pattern is claimed to emanate from the right edge of the word and the representations here are therefore right-justified. With this schematic representation, the pattern clearly emerges.

(1) *Ternary alternation patterns of Cayuvava*

a. 10
b. 100
c. 0100
d. 00100
e. 200100
f. 0200100
g. 00200100
h. 200200100
i 0200200100

The transcribed data from the literature on Cayuvava, flesh out the schematic patterns. We can see forms ultimately from Key's work in (2), which correspond to the patterns already sketched in (1).

(2) Cayuvava

a. dá.pa	'canoe'
b. tó.mo.ho	'small water container'
c. a.rí.po.ro	'he already turned around'
d. a.ri.pí.ri.to	'already planted'
e. à.ri.hi.hí.be.e	'I have already put the top on'
f. ma.rà.ha.ha.é.i.ki	'their blankets'
g. i.ki.tà.pa.ra.ré.pe.ha	'the-water-is-clean'

To see a more complex instance of ternary rhythm, we turn to Tripura Bangla. Das (2001) describes Tripura Bangla as a dialect of Bangla, resulting from a complicated sociolinguistic situation in the small Indian state of Tripura, where it is a commonly used lingua franca.

One complication in the pattern of Tripura Bangla when compared with Cayuvava is the relevance of syllable structure for stress assignment. Before illustrating this, we can discern the default pattern through a consideration of words consisting only of light syllables. In such strings, we find main stress on the initial syllable and secondary stress emanating rightward in a ternary rhythm. However, a final light syllable cannot bear stress. When the pattern would place stress on a final syllable—e.g. in strings of four or seven syllables—that stress is not realized. This means, for example that a word consisting of exactly four light syllables will only have one stress, namely the main stress on the word-initial syllable.

(3) Tripura Bangla default pattern

a.	rá.za	'king'
b.	gó.ra.li	'ankle'
c.	né.ta	'leader'
d.	boí.ra.gi	'mendicant'
e.	bɛ́.na.ro.ʃi	'Benaras silk'
f.	bí.βɛ.sɔ.na	'consideration'
g.	ʃɔ́.ma.lɔ.sɔ̀.na	'criticism'
h.	ó.nu.kɔ.rò.ni.yɔ	'imitable'
i.	ɔ́.no.nu.dá.βo.ni.yɔ	'unintelligible'
j.	ɔ́.no.nu.kɔ̀.ro.ni.yɔ̀.ta	'inimitability'

These patterns can be perturbed by closed syllables. Closed syllables can under certain circumstances tolerate stress in word-final position and they can also draw stress off of a word-initial open syllable. A simple generalization is that a stressed light syllable cannot be immediately followed by a closed syllable. When this would happen, the closed syllable

instead bears stress.

Further complications assign stress to the third syllable when it is heavy and to a word-final closed syllable, unless immediately preceded by a stressed syllable. Providing analyses at this level of detail is not the aspiration here, but both Das (2001) and Houghton (2006) provide detailed discussion of these patterns. The data in (4) have closd syllables in various positions. In positions where we expect stress anyway, the patterns are as in (3). In other cases, the heavy syllable interrupts the default pattern.

(4) Tripura Bangla quantity effects

a.	mál.ʃa	'big metal bowl'
b.	ɸá.til	'earthen pot'
c.	ʃɔ́r.kar	'government'
d.	ɔ.hɔ́ŋ.kar	'pride'
e.	ʃɔ́ŋ.rɔk.kɔ̀n	'reservation'
f.	o.bíg.ga.ɸɔ̀n	'intimation'
g.	ó.nu.bìk.kɔn	'microscope'
h.	báɸ.zaiʈ.ʈa.mi	'adamancy'
i.	ɔ́.no.nù.kɔ.rɔ̀n	'non-imitation'
j.	ɸɔ́dʒ.dʒa.lɔ.sɔ̀.na	'deliberation'
k.	ʃɔ́ŋ.rɔk.ko.nì.yɔ.ta	'preservability'
l.	ɸá.rɔ.dɔ̀ʃ.ʃi.kɔ.ta	'expertness'

Ternary rhythm is also visible in Chugach Alutiiq, a Yup'ik language spoken by relatively few individuals in Alaska. This language is most extensively documented in a series of important works by Leer, including Leer (1985a,b). These data and Leer's discussion figure prominently in the literature on ternary rhythm, including many of the theoretical works cited in the present article.

Quantity is also relevant for the placement of stress in Chugach Alutiiq, but unlike Tripura

Bangla, a syllable must have a long vowel to perturb the pattern. Closed syllables with short vowels—except when in word-initial position—do not attract stress. Assuming that the default stress pattern is revealed in strings with no relevant quantity distinctions, stress in Chugach appears on the second syllable and then every third syllable thereafter. A word in Chugach Alutiiq with five or six light syllables will have stress on the second and fifth. A word with four, however, will have stress on the second and fourth. Syllables with long vowels always attract stress.

(5) Chugach Alutiiq

a. mu.lú.kan	'if she takes a long time'
b. a.kú.ta.mék	'*akutaq* (a food) abl.sg.'
c. ta.qá.ma.lu.ní	'apparently getting done'
d. a.kú.tar.tu.nír.tuq	'he stopped eating *akutaq*'
e. ma.ŋár.su.qu.tá.qu.ní	'if he (refl.) is going to hunt a porpoise'
f. taá.taá	'her father'
g. taá.ta.qá	'my father'
h. naá.ma.ci.qúq	'it will suffice'
i. naá.qu.ma.lú.ku	'apparently reading it'
j. naá.ma.cí.quá	'I will suffice'
k. mu.ú.kuút	'if you take a long time'
l. u.lú.te.ku.tá.raá	'he's going to watch her'

The three cases presented above are the clearest examples of ternary rhythm that have been uncovered to this point. The languages include some very long words, and even in the quantity-sensitive languages, there are words consisting of long strings of light syllables. The expert field-worker's transcriptions of those strings indicate stressed syllables which are separated by two unstressed syllables. This is the empirical basis for the claim that ternary rhythm is a real phenomenon and that a metrical theory of stress assignment must have

formal tools that can generate such patterns.

While the clearest cases are presented above, there are other languages which have been analyzed as having ternary rhythm, at least in some sub-set of the data. Most familiar among these are Winnebago, Sentani and Munster Irish.

Having established the basis for the claim that ternary rhythm is an empirical fact, we turn now to metrical theory and the major strategies which that literature offers for the analysis of these data.

2 Theory and analysis

The preceding section has established that a plausible theory of metrical structure must offer a strategy for modeling ternary rhythm. We turn now to a brief review of the emergence of this issue in the literature and the general tendencies that can be identified.

Very early in the development of a generative theory of stress assignment, hints about the treatment of ternary rhythm can be found. As [the chapter by Hammond] discusses in detail, early work in generative phonology treated stress as the realization of a phonological feature [stress]. In this way, stress was analyzed with tools parallel to those used in the analysis of place of articulation—e.g. [coronal] or [dorsal]—or manner of articulation—e.g. [voice] or [continuant], cf. Chomsky and Halle (1968).

A breakthrough in the study of stress systems came with Liberman's (1975) proposal that stress should not be characterized as a feature with absolute values, but rather as a relation in which two elements differ in their relative prominence. Along with this proposal came hierarchical representations and the introduction of the metrical foot into the generative literature, further developed in Liberman and Prince (1977). The foot naturally invited a more extensive theory of prosodic structure, incorporating segments into syllables, syllables into feet, and so on, up the prosodic tree to the phrase or utterance, cf. Nespor and Vogel (2007). This is the context today in which any proposed modifications of metrical theory

find themselves.

The first extensive typological work on stress systems is found in Hayes (1980). Hayes studies the stress systems of many languages and identifies a number of parameters that can be used to characterize the variation shown in these languages. Parameters specify points of variation such as the direction of foot construction, sensitivity to syllable-internal quantitative structure, trochaic or iambic headedness of the feet, whether feet are binary or unbounded, the edge of the word which hosts main stress, and whether or not peripheral material can be excluded from the initial parse through extrametricality. And, indeed, it is precisely the discussion leading up to the proposal of extrametricality that includes the earliest considerations of ternary rhythm. Before turning to the treatment of iterative ternary rhythm in metrical theory and optimality theory, the relevance of extrametricality and its competitor are discussed. For a more thorough overview of metrical theory, see van der Hulst (1999) or Hammond (1995).

3 Extrametricality vs. ternary feet

Extrametricality as a theoretical tool arose in response to apparent ternary rhythm at the edges of words. The stress pattern of English nouns offers a relevant illustration. In sufficiently long words, we can see that English displays alternating, binary stress assignment, in words such as *Apalachicola, Minnesota, candelabra*.

But when we examine the right edges of words more closely, we quickly find that stress is sometimes not found on one of the final two syllables, but rather on the antepenultimate syllable, as in *America, cinema, analysis*.

In this way, we identify a fundamentally binary system which has a ternary component, namely a three-syllable window at the right edge of the word. A model which only constructs binary feet over an entire word would not be able to generate this pattern. Specifically, the construction of feet from right to left in English nouns would always result in penultimate

stress. How can a binary foot 'reach in' far enough to position primary stress on the antepenult?

To model antepenultimate stress, two possible enhancements of the theory were entertained early on. One of these is extrametricality.

Extrametricality is a theoretical tool which does not explicitly entail enhancement of the inventory of feet. Instead, it provides a particular strategy for foot construction, or parsing a string of syllables. In particular, extrametricality excludes a peripheral syllable from the string to be parsed into feet. In the case of English nouns, exclusion of the final syllable, followed by construction of a binary left-headed foot will place stress on the antepenultimate syllable. Extrametricality is also illustrated in [other chapters here. Hammond? others?] As we will see below, some later work on iterative ternary rhythm relativizes the peripherality requirement, such that syllables can be excluded from the string not only when they are word-peripheral but also, for example, when they are foot-peripheral.

A conceptually different approach from extrametricality would be to enhance the model such that it also includes ternary feet. Data of the type described for English nouns would then be modeled by building a ternary foot at the edge, followed by the construction of binary feet iterating leftward.

Since the stress that is found in the three-syllable window is the primary stress, this amounts to a proposal that primary stress can be modeled through the use of one kind of foot while secondary stress requires another. Such proposals can be found for other points of parametric variation for foot construction, as well. For example, primary stress may require the use of a quantity sensitive foot while iterative secondary stress seems to be quantity insensitive (van der Hulst 1999). (add citation to v/d Hulst 84)

One strategy for modeling an edgemost ternary domain — extrametricality — enhances the parsing strategies available in the theory, while the other strategy — a ternary foot — enhances the inventory of feet available in the theory.

4 Modeling iterative ternary rhythm

The parameters of metrical theory specify the nature of feet and control their construction across words in languages. The feet that are constructed are constituents that create a domain for the assignment of relative prominence. Prince (1983) offers an alternative approach without internal constituency, representing relative prominence instead only with a grid, and reconstruing some of Hayes' parameters such that their effects can be replicated without binary constituents. The debate about constituency includes argumentation based on sensitivity of non-stress phenomena to feet, as reviewed in Kenstowicz (1993). This debate is present in much of the subsequent literature, finding one of its most extensive and consequential considerations in Halle and Vergnaud (1987).

Halle and Vergnaud's *constituentized grid* representation integrates grids and feet. Grids are built but the gridmarks are grouped and these groupings represent constituents. The construction process implements parameter settings here, too, also in pursuit of a typology of stress systems. And it is here, in Halle and Vergnaud's opus, that we find the first discussion of iterative ternary stress presented in a major work on stress system typology.

Halle and Vergnaud of course draw on papers and presentations regarding ternarity that were floating about in the immediately preceding years, with some issues nascent already in McCarthy (1979). The discussion of iterative ternary rhythm and its implications for the typologies under consideration in the relevant literature was initiated by Levin (1985), which was ultimately published in a significantly modified form as Levin (1988). Levin's work drew on the data from Cayuvava seen in (2).

Halle and Vergnaud (1987) discuss neither Tripura Bangla nor Chugach Alutiiq. Regarding the latter, Leer's 1985a; 1985b careful and important results would soon influence the details of the constituentized grid theory. Leer's work was picked up on in Rice (1988), where an analysis in the spirit of Halle and Vergnaud (1987) is advanced. This, in turn, influenced subsequent revisions of the theory, as presented in Halle (1990).

The theory developed by Halle and Vergnaud models ternary rhythm through the con-

struction of ternary feet, extending to the problem of iterative ternary rhythm the spirit of the approach discussed above in the context of word-final three-syllable stress windows.

A competing approach also reflects that earlier debate. This competitor maintains a size limit such that feet are maximally binary. Ternary rhythm is achieved with a parsing strategy that leaves occasional syllables unincorporated into feet, extending the basic notion of extrametricality, cf. Hammond (1990); Hayes (1995).

These two general approaches, to be illustrated presently, form the heart of the theoretical debate occasioned by ternary stress patterns. As we will see in the discussion of ternary rhythm and Optimality Theory below, the debate persists there, too. We turn now to the chronologically first approach, namely an analysis of ternary rhythm using ternary feet.

5 Ternary feet

5.1 Amphibrachs

At first glance, the Cayuvava stress patterns in (1) and (2) suggest an analysis with dactylic feet (strong-weak-weak), built from right to left. If we maintain a parametric strategy for constructing feet, then the independently established presence in the theory of a parameter placing heads at the left or right edge of the foot means that the admission of dactyls to the inventory of derivable feet would imply the introduction of anapests (weak-weak-strong) as well. Allowing a ternary foot with its head at the left edge implies via the relevant parameter the possibility of constructing a ternary foot with its head at the right edge. With Cayuvava as the only known case of iterative ternary rhythm at the time of this theoretical work, generating dactyls would lead to the phenomenon of overgeneration, i.e. being able with the tools of the theory to generate patterns unknown to exist.

In pursuit of a restrictive theory, Levin (1988) therefore takes a different tack, relaxing metrical theory just enough to allow for exactly one type of metrical foot, instead of two; dactyls and anapests are disallowed, but the theory now permits amphibrachs, i.e. ternary

feet with prominence on the middle syllable, employing a strategy described below.

When combined with final extrametricality—which can be overridden when necessary to build at least one foot on the (minimal) disyllabic words—the construction of amphibrachs will yield a footing of the schematic patterns in (1) which correctly locates stress, as seen in (6). Parentheses indicate feet and angled brackets mark extrametricality. In longer words, initial lone syllables are left unfooted, by stipulation.

(6) *Ternary alternations parsed into amphibrachs*

a. (10)

b. (10)⟨0⟩

c. (010)⟨0⟩

d. 0(010)⟨0⟩

e. (20)(010)⟨0⟩

f. (020)(010)⟨0⟩

g. 0(020)(010)⟨0⟩

h. (20)(020)(010)⟨0⟩

i (020)(020)(010)⟨0⟩

Halle and Vergnaud (1987) adopt Levin's strategy and also limit UG to this one type of ternary foot. They parameterize the requirement that the head of a constituent be at its edge. When this parameter is set such that the head is not required to be at the edge of a constituent, the only ternary foot that can emerge is an amphibrach, cf. Rice (1988) and Rice (1990) for related discussion. The approach developed by Levin and widely published by Halle and Vergnaud effectively views iterative ternary rhythm as evidence for expanding the inventory of feet. Constituents may have one head, but as many as two non-heads. For them, there is no hierarchical structure within the foot, such that this approach generates flat ternary feet.

Another main thrust of the literature also sees a proposal with ternary feet, but now with

internal hierarchical structure. Early proponents of this include Dresher and Lahiri (1991) and Rice (1992), building on Rice (1990). Leer's (1985b) article offers the leading idea, namely identifying the quantitative equivalence of two lights syllables with a single heavy syllable, allowing either of those configurations to be the head of a foot. Taking into account a non-head consisting of a light syllable, a foot might consist of three light syllables, two of which are themselves a subconstituent. Hence, ternary feet become an option.

In the foot typology of Hayes (1980), some languages were identified in which the heads of feet must be heavy, a foot typed dubbed the *obligatory branching* foot. Rice (1992) in particular draws a parallel between Hayes' OB feet and the analysis of ternarity under consideration, since the head consisting of one heavy syllable or two light ones could be construed as obligatory branching. That analysis is also relevant to the contrast between (2e) and (2d): in the former case, two word-initial syllables concluding the right-to-left parse are sufficient for a foot, while the single syllable in the latter case is not. The analysis in Rice (1992) suggests that degenerate feet must have a head, and in the case of the ternary feet constructed for Cayuvava, two lights are required to constitute a head, hence the minimal foot (and word) is binary. In the approach with flat ternary feet, it is unclear why a minimum of two syllables is necessary for a degenerate foot. Additional discussion related to this approach can be found in Everett (1988); Hewitt (1992); Rice (1993); van der Hulst (1999); Blevins and Harrison (1999); Rifkin (2003) and other references mentioned below.

5.2 Weak local parsing

The appearance of iterative ternary stress patterns in the literature on metrical phonology triggered, as noted above, a second strategy. Instead of increasing the set of possible feet, this second strategy increased the set of possible parsing strategies. This approach is developed in Hayes (1995), drawing on earlier work by Hammond (1990). In Hayes' approach, universal grammar allows only three kinds of feet, as in (7).

(7) *The Hayesian foot typology*

a. Syllabic trochee (x .)
σ σ

b. Moraic trochee (x .) or (x)
L L H

c. Iamb (. x) or (x)
L σ H

No exhaustive parsing of a string with any of these feet will give an iterative ternary pattern. But non-exhaustive parsing can do that.

Hayes proposed that UG include a *weak local parsing* parameter which creates the possibility of leaving an unparsed syllable between each foot. The unparsed syllable can by stipulation only be a light one. Having an unparsed light syllable between each foot yields a ternary pattern using only binary feet, as in (8).

(8) *Ternary alternations parsed into nonexhaustive binary feet*

a. (10)

b. (10)⟨0⟩

c. 0(10)⟨0⟩

d. 00(10)⟨0⟩

e. (20)0(10)⟨0⟩

f. 0(20)0(10)⟨0⟩

g. 00(20)0(10)⟨0⟩

h. (20)0(20)0(10)⟨0⟩

i 0(20)0(20)0(10)⟨0⟩

For the Cayuvava pattern, trochees are constructed from right to left; whether they are moraic or syllabic trochees is irrelevant since there is no quantity distinction in this language. The parsing also uses final extrametricality and, of course, weak local parsing. The final syllable in (8c) is extrametrical and the initial syllable is unfooted because it is too little to be a foot, since no degenerate feet are allowed. In (8d) the influence of weak local parsing is seen; in this form, there is in fact sufficient material at the left edge of the word to form a foot. Since doing so would result in adjacent feet—which is not allowed by with weak local parsing—no foot can be formed. Not until we have six syllables, as in (8e), is there sufficient space to build two non-adjacent—i.e. weakly local parsed—feet. A detail beyond the scope of this article is that adjacency can be tolerated in the case of adjacent heavy syllables—as in Chugach—suggesting that the requirement to incorporate heavy syllables into feet has priority over the prohibition on adjacent feet under weak local parsing.

5.3 Summary

At the level of analysis, we have seen that there are two primary strategies for constructing constituents across strings when the goal is to achieve iterative ternary alternations. One strategy is to expand the inventory of constituents and here there are also two approaches. In the approach developed by Levin (1988) and Halle and Vergnaud (1987), flat ternary feet are allowed. Any non-head in a foot must be adjacent to its head. This allows exactly one kind of ternary foot, namely an amphibrach, where the head is not found at the edge of the foot, but rather is flanked by two non-heads. The second inventory-expanding approach as seen primarily in Dresher and Lahiri (1991) and Rice (1992), relaxes the requirement that the head of a foot can span only one syllable. Feet that require heavy heads can draw their material either from one heavy syllable or from two light ones.

The alternative to expanding the foot inventory is expanding the strategies available for constructing binary feet, where the primary representative of this approach is Hayes (1995). In this approach, binary feet are constructed in a new way. There are two necessary properties

to the weak local parsing of a string: feet must be non-adjacent and they must be minimally non-adjacent. These requirements lead to iterative construction of feet which are separated by one light syllable.

There was, as noted, an early debate in the metrical literature regarding the need for constituency; perhaps stress systems can be modeled simply with a theory of prominence as represented with a grid, and feet are superfluous. This debate has not shown itself in the context of ternary rhythm, insofar as the literature lacks a grid-only analysis of iterative ternary rhythm.

6 Ternary rhythm in Optimality Theory

The typological enterprise in generative grammar has enjoyed enhanced prominence in the era of Optimality Theory (Prince and Smolensky 1993; McCarthy and Prince 1993). One of the core foci in the OT literature is typology (Archangeli and Langendoen 1997; Roca 1997; Kager 1999). Classic OT achieves typological insights by having a universally fixed set of constraints. Variation is modeled with constraint reranking. The factorial typology of constraint rankings defines the range of possible grammars.

Stress patterns and metrical theory have played an important role in the construction and exploration of optimality theoretic approaches to modeling grammar. Indeed, one of the important early discussions of the power of violable constraints was built around the pursuit of a parallelist strategy for achieving the effects of directionality. The insight in this discussion is that minimal violation of a requirement that all feet be at one edge of the word (All-Foot-Left or All-Foot-Right) when combined with the force of a requirement that all syllables be parsed into feet (Parse-σ), will yield as optimal a parse identical with serial foot construction from one edge of a string to the other.

Less present in the OT literature, however, has been a discussion of ternary rhythm. There has been almost no debate about the contrast between analyses using ternary feet and

those using non-exhaustive parsing with binary feet. Indeed, Rice (2007) is to the best of my knowledge the only publication in which the issue is even mentioned, although Hyde (2002) also offers relevant perspectives on the nature of ternary parsing.

The most prominent discussions of ternary rhythm in OT mimics the weak local parsing approach, as in Ishii (1996) and Elenbaas and Kager (1999). Elenbaas and Kager take an important principled position on methodology. In particular, Elenbaas and Kager articulate and adopt the goal of deriving iterative ternary rhythm with tools which are already necessary to account for other phenomena. This laudable position of theirs contrasts with the too frequent practice in OT analyses of positing new constraints to give new analyses. That practice has substantial implications, in light of the methodology of the factorial typology noted above; introducing a new constraint introduces many new grammars, and the restricted typological enterprise as construed in classic OT is substantially challenged with every new constraint that is introduced.

The analysis of ternary rhythm in OT based on under-parsing has two crucial components. First, PARSE-σ—which requires that syllables be incorporated into feet—must be relatively low ranked. This will be important to allow optimization of an incomplete parse along the lines seen in (8). But simply ranking PARSE below a requirement that all feet align with the right edge of the word will yield a parse with only one foot. Note that ALLFTR awards a violation for every syllable intervening between the right edge of a foot and the right edge of the word, for each foot.

(9) *Underparsing with low ranked* PARSE

	$\sigma\sigma\sigma\sigma\sigma\sigma$	ALLFTR	PARSE
	a. $(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)$	*!*****	
	b. $\sigma(\acute{\sigma}\sigma)\sigma(\acute{\sigma}\sigma)$	*!**	**
☞	c. $\sigma\sigma\sigma\sigma(\acute{\sigma}\sigma)$		****

This brings us to the second crucial component. To counter the pressure of AllFtR, parsing of at least some of the other syllables must be rewarded. The solution offered builds on well-established insights that lapses in long parses should be avoided, cf. Selkirk (1984). Various *Lapse constraints are in the literature, e.g. Kager (1994); Green (1995); Gordon (2002), where the leading idea is that a string of more than two unstressed syllables is disfavored. With *Lapse ranked above AllFtR, the optimal parse will show only as much parsing as is necessary to minimize violations of *Lapse, and will favor options in which the feet are relatively towards the right.

(10) *Ternary rhythm with* *Lapse

	$\sigma\sigma\sigma\sigma\sigma\sigma$	*Lapse	All-Ft-R	Parse
	a. $(\sigma\acute{\sigma})(\sigma\acute{\sigma})(\sigma\acute{\sigma})$		******!	
	b. $(\sigma\acute{\sigma})\sigma(\sigma\acute{\sigma})\sigma$		****!*	**
☞	c. $\sigma(\sigma\acute{\sigma})\sigma(\sigma\acute{\sigma})$		***	**
	d. $\sigma\sigma(\sigma\acute{\sigma})(\sigma\acute{\sigma})$	*!	**	**

The OT analysis of ternary stress requires consideration of many more details and much more discussion, which is to be found in the cited works. For the present purposes, it is sufficient to note that an analysis akin to Hayes' weak local parsing strategy is achieved through the interaction of *Lapse and AllFtR. Although the methodology of pursuing an analysis built simply on the reranking of independently motivated constraints is commendable, that goal has not yet been achieved. For example, careful study reveals that multiple versions of *Lapse will be necessary, one of which is specifically designed for the ternary cases; this is made laudably explicit in Houghton (2006). While the use of ternary-specific tools is not an *a priori* flaw with these analyses, it nonetheless keeps those analyses from clearing the high bar set in pursuit of an analysis by pure reranking of constraints which are not ternary-specific.

In addition to facilitating an illustration of the strategy that has been most thoroughly

pursued in providing an analysis of ternary rhythm within OT, the patterns under consideration here also raise another important methodological point. Future work in OT which considers the relative merits of the two main types of analyses illustrated above—ternary feet or under-parsing—must consider related issues about the division of labor among the modules of the theory. Consider, for example, the possibility that a particular analysis intends to optimize a parse which does not use flat ternary feet, or amphibrachs. How will such feet and their optimization be avoided?

If it is possible that prosodic structure is present in inputs—a possibility required by *the richness of the base* methodology—then amphibrachs are possibly present in inputs. One way in which these can be prevented from being selected as optimal is with a constraint that rules them out. Introducing an anti-amphibrach constraint, however, implictly raises the possibility that it could be ranked relatively low, which in turn could open the door to the optimization of such structures. If one's position is that amphibrachs are never optimal, then it is unfortunate to achieve this universal exclusion with a constraint. The alternative is to provide structure to Gen, such that the output of Gen cannot include amphibrachs. The tension between these possibilities is the focus of Rice (2007) and it is one of the general theoretical issues raised in OT by the study of ternary rhythm.

7 Implications and directions for future research

As noted earlier, one strategy for modeling an edgemost ternary domain—extrametricality—enhances the parsing strategies available in the theory, while the other strategy—a ternary foot—enhances the inventory of feet available in the theory. On what basis can a theoretician select the model to be pursued? Are these two options really different from one another in some meaningful sense? Does one approach allow for the description of some kind of situation that the other one does not?

If the approaches do not make different predictions, are there other strategies available

for selecting among them? One possibility would be to appeal to general principles of theory construction or to findings in other realms of cognitive science. Such principles or findings may have implications for selecting among competing theories of phonology.

To see one example of argumentation for selecting among competing theories, we can turn to Hayes' 1980 argumentation for extrametricality over ternary feet. This argument is based primarily on identifying differences in the types of systems the competing theories predict. In the cited work, Hayes compares his foot inventory at that point with a proposal made by Morris Halle, attributed to 'class notes' (Hayes 1980: 114ff.). Halle had introduced ternary feet into his version of the theory, while Hayes had developed the approach using extrametricality.

Hayes begins his argument against Halle's inventory by stating the following: "I know of no languages whose stress patterns could simply be described using feet of the [ternary] form" (Hayes 1980: 115). He suggests with this quote that a gap in the typology—namely the absence of languages with iterative ternary rhythm—can be used as an argument against a theory that could in fact model that.

Again at the conclusion of the section, we are encouraged to adopt an inventory with binary feet and peripheral extrametricality in part because it provides "an explanation for why feet which have [ternary] surface forms ... are never assigned iteratively ..." (Hayes 1980: 122).

This example from the early literature on ternary rhythm illustrates an argument based on overgeneration. The theories are evaluated, and the one which generates a pattern not known to exist is dispreferred on those grounds. Gaps in the typology become a criterion for theory selection. However, as we now know from the sections above, this gap was soon revealed to be accidental.

This is not the only example in the generative literature of argumentation based on gaps in the empirical record. We might use this occasion to ask if such experiences are relevant as we hone our methodology for identifying the properties of Universal Grammar. The following

paragraphs present some of the broader implications that may be explored on the basis of our discussion of ternary rhythm.

The typological enterprise as widely practiced in generative phonology aspires to model grammatical variation through simple formal manipulations of various components of the theory: reranking of constraints, different rules or rule orders, or the setting of parameters to different values.

Generative linguists often see themselves as doing work grounded in a reliable typology of the structures found in natural languages. Our goal, cf. Odden (To appear), is to identify the limits of the human linguistic capacity and to model that knowledge: What is a possible grammar, and what is not? What cognitive structures must be posited to restrict the outcome of the language acquisition process to possible grammars, thereby rendering unattainable the impossible ones? And regarding the case at hand, what does the fact of ternary rhythm force us to posit in our theory?

These questions are sometimes studied from 'above.' Researchers could take as their starting point a theory of cognitive capacity and build a model of linguistic knowledge within the context of that theory. Demonstrated incompatibility of a conceivable linguistic structure with a known fact about our cognitive system would be an argument for genuine universal ungrammaticality, cf. Odden (2008); Reiss (2008).

Alternatively, one could develop a theory from 'below.' In this case, one would approach the matter through a deep study of one language, or one family of languages, or through a carefully selected set of unrelated languages. Regardless of the starting point one adopts, any predictive model of linguistic knowledge will be held accountable to facts about natural languages.

We work to enhance the empirical foundation for developing theories of grammars by studying individual languages. The very act of documenting, describing and analyzing the multifarious properties and subsystems that are found in natural language, entails engagement in a typological enterprise, cf. Newmeyer (2005); Hyman (2009). A model of linguistic

knowledge that allows the construction of a particular grammar gains credibility vis-à-vis its competitors when a specific language is identified that requires precisely that grammar.

We might call this the *positive typological enterprise*: Certain structures are attested in the set of well-studied natural languages, and any theory of grammar must sanction the generation of such structures.

But there is also a *negative typological enterprise*. Work on this side of the program aspires to model the absence of unattested structures. If we imagine competing models of linguistic knowledge, all of which satisfy the positive side of the enterprise insofar as all of them generate those structures that are known to exist, then we need some criterion for choosing among them. Proposed models of linguistic knowledge are therefore routinely criticized from the negative side, i.e. for allowing the construction of a grammar which is not known to be instantiated by any natural language; this is the state of overgeneration, of which we saw an example above.

A model that overgenerates is in principle inferior to one which does not. A model that completely fails to overgenerate matches the systems that it cannot generate with those that are unattested.

While this seems at first glance to be an important goal, the danger we must guard against when attempting to eliminate aspects of a theory that overgenerate, is the equation of *unattested* with *impossible*. How can we know whether a structure which is absent from the empirical database is merely unattested—as was the case with iterative ternary rhythm—or genuinely beyond the grasp of universal grammar?

Finding an answer to this question seems insurmountably foreboding when we realize that distinguishing the merely unattested from the cognitiviely impossible would be no easier if all languages were thoroughly documented, studied and analyzed. Those activities, of course, may fill gaps in our knowledge and they will certainly generate a richer base for our research enterprise, thereby contributing to a deeper understanding of our cognitive capacity. But even if all languages were deeply understood, any linguist would still be able to posit

conceivable albeit unattested structures, and all theories that overgenerate would make this challenge easy. Such conceivable but unattested structures, can be assumed to be universally ungrammatical only if we assume that all possible structures in fact do appear somewhere in the set of human languages. This assumption, alas, is no more plausible than an assumption that all possible structures for eyes, for example, are attested somewhere in the animal kingdom.

This realization presents a significant confrontation to the bottom up approach to linguistic theory construction. Building theories on the basis of what is attested and unattested tends to confuse *does not exist* with *cannot exist*. The work of linguists is not to explain linguistic structures that do exist, but rather to explain linguistic structures that can exist. While the starting point may be the empirical record, that cannot be the ending point. The empirical record does not and cannot show us the limits of human linguistic capacity. The empirical record cannot reveal what is necessarily beyond the realm of our grammatical competence, cf. Isac and Reiss (2008).

7.1 Conclusions

Although it is not the purpose of this article to go deeply into methodological issues, it is essential nonetheless to highlight the importance of doing so. The study of ternary rhythm and the history of analyses of this phenomenon in the generative literature, raise issues of the kind presented here. The remaining challenge is to take these discussions further, not only in this context, but whenever we enter into discussions arguing for the selection of one theoretical model over another.

There is more work to do in metrical theory and on ternary rhythm. This must address several issues, both in the context of a specific analysis and with respect to the theory with which that analysis is built. Naturally, any analysis has to satisfy the positive typological enterprise by allowing the generation of those patterns which are attested. An analysis must take a position on the kind of constituents which are constructed. Are they binary or ternary?

If there are ternary feet, i.e. feet with three terminals, is there any internal structure to those constituents, or are they flat ternary structures? If there are not ternary feet, how are binary feet constructed with iterative non-exhaustivity, i.e. periodic non-parsing as with the earlier theory of weak local parsing? What is the fate of those syllables that are left unparsed? How are they incorporated into the prosodic structure of the word, and what implications does this have for a theory of layering in prosodic structure (Selkirk 1984)?

Beyond the basic matter of developing an analysis, future work on this topic also should address the role of typological evidence in the theory being offered, specifically the extent to which patterns absent from the empirical record are considered to be not merely unattested but unattestable. In this way, the typological enterprise will remain an important topic of discussion, and the languages showing ternary rhythm will play their significant role in future refinements of metrical theory and the methodologies of research in generative linguistics.[1]

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[1]Works relevant to the study of ternary rhythm that have not been mentioned in this article, but which students of this topic should consult include the following: Idsardi (1992); Crowhurst (1992); Kager (1993); Green and Kenstowicz (1995); Rowicka (1996); van de Vijver (1998); Elenbaas (1999); Hyde (2001); Gordon (2002); McCartney (2003); Karttunen (2006); Buckley (2007).

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ROA=Rutgers Optimality Archive, http://roa.rutgers.edu

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