

Layered Feet Laid Bare in Copperbelt Bemba Tone

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1 Introduction

In perhaps the most common conception of metrical structure, pursued in McCarthy & Prince (1986, 1993); Hayes (1995), syllables are parsed according to language-specific preferences into headed binary or unary foot constituents, with binarity defined either on the mora or the syllable. Although the development of these representations was mainly informed by the typology of stress, binary feet have found widespread application in analyses of prosodic morphology, accounting for facts of prosodic minimality, reduplication, locus of infixation, truncation, and templatic and root-and-pattern morphology (Broselow, 1982; McCarthy & Prince, 1986, 1993; Itô, 1990; Mester, 1990, 1994; Poser, 1990; Spring, 1990; Crowhurst, 1991, 1994; Wiese, 2001; Bat-El, 2005; Alderete & MacMillan, 2015). In addition, binary feet are often invoked to describe the domain for a variety of phonological processes (Nespor & Vogel, 1986; Rice, 1992; Hayes, 1995; Bennett, 2012).

A major challenge for binary feet comes from phenomena whose description involves a domain that exceeds the size of the binary template by an additional mora or syllable – a size that we will loosely refer to as “ternary”. We identify three types of ternarity below. Firstly, some languages target the third position from an edge. For example, Standard Macedonian places stress on the third syllable from the right (data from Kager, 2012), as in (1).

- (1) 'pla.ni.na “mountain”
pla.'ni.na.ta “the mountain”

Secondly, Itô & Mester (1992) report Japanese word clippings that sometimes favor a tripartite form, such as the trisyllabic loanwords in (2), which truncate longer source forms.

- (2) a.ni.me “animation”
te.re.bi “television”

Finally, some languages have alternating stress on every third position. One such language is Cayuvava, which places stress on every third syllable counting from the right, as exemplified in (3) (Key 1961, 1967; Levin 1985, data from Torres-Tamarit & Jurgec 2015).

- (3) tʃa.a.di.ro.bo.βu.'ru.ru.tʃe “ninety-nine”

The main response to ternary phenomena in the literature has been to give greater consideration to stray syllables, an approach we will refer to as “Weak Layering”. For third-from-the-edge patterns such as in (1), linguists have typically invoked extrametricality of the edgemoost syllable, so that a binary foot can reach the third position, e.g. as in ('pla.ni).<na>. For the ternary truncation patterns in (2), Itô & Mester (1992) propose, citing McCarthy & Prince (1991a,b), that parsing preferences can yield a so-called Loose Minimal Word, a prosodic word containing a binary foot and, if present, an unparsed light syllable. Finally, Hayes (1995) proposes that ternary iterative stress languages such as in (3) follow a process of Weak Local Parsing, interleaving binary feet with stray syllables.

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In general, then, Weak Layering begets ternarity by minimally allowing unparsed syllables. Consequently, a major problem for Weak Layering, and by extension the binary feet hypothesis, would be the existence of ternary effects in contexts that freely allow unparsed syllables to exist on either side of the ternary domain. The very detection of such a pattern is challenging, since a single stress marking cannot indicate ternarity by itself; the pattern should in some way demarcate both edges of a ternary span. In this paper, we will argue that recent studies by Bickmore & Kula (2013); Kula & Bickmore (2015) have struck upon exactly this type of ternarity in Copperbelt Bemba bounded tone spreading. Because of the tonal nature of the pattern, the domain can be easily read from the surface form. However, we will argue that its definition cannot be purely tonal, but must involve a consideration of syllable weight and, hence, foot structure.

To give an accurate characterization of the spreading domain, we adopt the layered feet framework (Bennett, 2012; Kager, 2012; Martínez-Paricio, 2013). Briefly, the layered feet framework allows a typical binary foot to be parsed into a higher foot layer, which yields nested ternary constituents such as $((\sigma\sigma)\sigma)$. To include cases where tone spread seems to stop in the middle of a heavy syllable, we further propose that parsing in Copperbelt Bemba sometimes allows for syllable integrity violations. With layered feet, a single foot type definition can capture those sequences of heavy and light syllables that can form a spreading domain, to the exclusion of all other such sequences.

In the next section we describe the data, followed in section 3 with a demonstration that Weak Layering offers no means of capturing the tone spreading domain. Section 4 then introduces the layered feet framework and applies it to the Copperbelt Bemba data. In section 5, we consider another means of deriving ternarity with binary feet that fits well with the data, and give reasons why we consider it less desirable than the layered feet account. After that, the paper concludes.

2 Ternarity in Copperbelt Bemba bounded tone spreading

This section is informed by the reports of Bickmore & Kula (2013) and Kula & Bickmore (2015) on Bemba as spoken in the Copperbelt province of Zambia. We refer the reader to these publications for more details on the background of the informants, as well as for a comparison between Copperbelt Bemba (“CB”) and what the authors call “Northern Bemba”, the predominantly studied variant in previous literature.

Our focus is on the facts of CB bounded High tone (“H”) spreading, a process where a tone spreads across a bounded domain that is anchored to the tone’s sponsor, i.e. the tone-bearing unit (“TBU”) that the tone is underlyingly associated to.¹ While the domain for this process is bounded, it exceeds any conception of binary size. In this section we present data to determine the exact nature of the domain, which becomes the target of a theoretical analysis for following sections.

Before describing and analyzing the bounded tone spreading, we go over the general tone facts of the language. CB level tones come in two heights. Following Bickmore & Kula we take H to be the only active element in the phonology, with low level tones being the phonetic implementation of an absence of H. In addition to the level tones, long vowels permit falls, but not rises. Again following Bickmore & Kula, we analyse this by stating that the TBU in CB is the mora, meaning that a falling tone is the realization of a long vowel where only the first mora is associated to a high tone. Finally, the rightmost tone on a phrase-final word undergoes unbounded spreading to the final syllable. Hence, in most of the examples of bounded tone spread that follow, we will ignore the behavior of the rightmost tone.²

2.1 Ternarity and quantity sensitivity Example (4) below shows spreading across a domain containing only light syllables. Tone surfaces on the sponsor, which is indicated with underlining, as well as on the two syllables that follow.

- (4) $\acute{\sigma}_\mu \acute{\sigma}_\mu \acute{\sigma}_\mu$
 a. bá.ká.pá.ta.kó ‘they will hate’
 b. ta.tú.lú.kí.lee.né “we didn’t weave for each other”

¹ The very stipulation of this process is an analytical claim; we believe it is warranted by the fact that spreading takes place across morpheme and word boundaries, and that the proximity of multiple (alleged) sponsors will trigger deviating surface forms.

² The source of the rightmost tone is sometimes a melodic tone pattern, instead of a lexical tone. This has no effect on the generalizations made here.

At first glance, then, CB bounded tone spreading can be described as “ternary”. However CB has underlying and derived long vowels, which complicate the description of the spreading domain. We take syllables with long vowels to carry two moras, and say that CB is sensitive to the presence and position of heavy syllables. Thus, (5) shows the surface tone span when the sponsor syllable is heavy, and (6) when a heavy syllable follows a light sponsor syllable.

- (5) $\underline{\acute{\sigma}_{\mu\mu}\acute{\sigma}_{\mu}}$
 a. tu.ka.léé.tí.la.na.kó ‘we will bring for each other’
 b. tu.léé.mú.shii.ki.la bwii.no ‘we are burying for him well’
- (6) $\underline{\acute{\sigma}_{\mu}\acute{\sigma}_{\mu\mu}\acute{\sigma}_{\mu}}$
 bá.kéé.mbí.la.kó ‘they will dig for’
 bá.lóó.ndó.lo.lé ‘that they introduce’

At this point, we can conclude that a simple counting rule to determine the domain of CB bounded tone spread cannot capture all the facts; tone in the above examples has covered 3/2/3 syllables and 3/3/4 moras, respectively. Before considering other generalizations, we round out our presentation of the data with cases where the spreading domain ends in a heavy syllable.

2.2 Falling tones When the final syllable of a spreading domain is heavy, the tone span does not line up strictly with syllable boundaries. Instead, Bickmore & Kula report a falling tone on that syllable. Thus, for each of the examples (4-6), there is an analogous case where the last syllable in the domain is heavy instead of light – shown in (7-9).³

- (7) $\underline{\acute{\sigma}_{\mu}\acute{\sigma}_{\mu}\hat{\sigma}_{\mu\mu}}$
 a. bá.ká.shíi.ka.kó ‘they will bury’
 b. bá.ká.lóo.ndo.lo.la.kó ‘they will introduce’
- (8) $\underline{\acute{\sigma}_{\mu\mu}\hat{\sigma}_{\mu\mu}}$
 a. tu.léé.lóo.ndo.lo.la.kó ‘we are introducing’
 b. twaa.léé.mwíi.mbi.la.kó ‘we used to dig for him’

The literature offers only one datum for the sequence light-heavy-heavy, shown in (9). The relevant tone span is the one starting from /tá/. This example also shows tone contact with the span from the preceding tone, starting from initial /ú/, running into that of /tá/. The transition between the two tone spans is signaled by a downstep, indicated here with a superscript exclamation mark. We do not discuss tone contact further in this paper.

- (9) $\underline{\acute{\sigma}_{\mu}\acute{\sigma}_{\mu\mu}\hat{\sigma}_{\mu\mu}}$
 a. ú.kú.[!]tá.láá.ntáa.nta.ku.kú.lú ‘the big stumbling’

2.3 A foot-based generalization Having completed our presentation of the relevant data, we turn to the question of forming a generalization. A shallow descriptive generalization is available, if somewhat convoluted: tone spreads to the next two moras after the sponsor, unless the sponsor syllable is light and the following syllable is heavy, in which case it spreads to the next three moras. While this description is accurate, it does not group the contexts and their respective repairs in any principled way.

A more principled account becomes available when one involves foot structure. That is, rather than being an arbitrary grouping, we note that the domain fits exactly to the template of a quantity-sensitive iamb plus an additional mora. This is demonstrated in (10). Following earlier work, we assume the perspective that feet can be an organizing constituent for tonal distributions, even when no claims about stress are involved (Zec, 1999; De Lacy, 2002; Pearce, 2006; Weidman & Rose, 2006; Shimoji, 2009; Breteler, forthcoming).

³ In (7b), we added a nasal consonant to the stem *loondolol* that was absent in Bickmore & Kula’s (2013) original datum (their 18d), but present in all their other presented instances of this stem.

- (10) $\{ (\sigma_\mu\sigma_\mu), (\sigma_{\mu\mu}), (\sigma_\mu\sigma_{\mu\mu}) \} + \mu$
- | | | |
|-----|---|-------------------------------|
| (4) | (bá.ká).pá.ta.kó | ‘they will hate’ |
| (5) | tu.(léé).mú.shii.ki.la bwii.no | ‘we are burying for him well’ |
| (6) | (bá.kéé).mbí.la.kó | ‘they will dig for’ |
| (7) | (bá.ká).shíi.ka.kó | ‘they will bury’ |
| (8) | tu.(léé).lóo.ndo.lo.la.kó | ‘we are introducing’ |
| (9) | ú.kú. ¹ (tá.láá).ntáa.nta.ku.kú.lú | ‘the big stumbling’ |

We conclude that an account of CB must somehow derive this iamb+mora template. In the next section, we consider the traditional means of deriving ternarity with binary feet, and show that these fall short of meeting the needs of Copperbelt Bemba bounded tone spreading.

3 Problems for Weak Layering

The previous section established that an account of CB benefits from access to a template consisting of a quantity-sensitive iamb and an additional mora. Here, we show that none of the traditional methods of deriving such ternarity using binary feet can be applied to Copperbelt Bemba.

Firstly, it is not possible for extrametricality to play a role, since the pattern also occurs further away from an edge. Even if the final syllable were extrametrical, there remains far more parsable material than just the ternary span starting from the sponsor; extrametricality does not isolate the ternary span. This is demonstrated in (11)

- (11) (?) tu.(léé).mú.shii.ki.la bwii.<no> ‘we are burying for him well’

Similarly, the concept of the loose minimal word offers no help, because tone spreading also occurs in domains that are not of minimal size. The problem is demonstrated with the form in (12). Although a prosodic word node can etch out a ternary domain for tone spreading, it must also be explained why such a structure would appear here. Itô et al. (1996) suggest that the construction of minimal prosodic words may be related to “Hierarchical Alignment”, the alignment of constituent edges, such as foot edges, with the edges of the categories they are contained in. However, this predicts that minimal prosodic word construction is not necessary when the sponsor is already domain-initial, and that in those cases no ternary spreading is observed. This is contradicted by many of the examples given here and in the original reports on Copperbelt Bemba.

- (12) (?) tu.[(léé).mú]_{P_rW_d}.shii.ki.la bwii.no ‘we are burying for him well’

This leaves the potential application of Weak Local Parsing (WLP, Hayes, 1995). Under WLP, iterative foot placement must be applied such that, where possible, an unparsed light syllable separates two successive feet. Thus, WLP is a mechanism intended for *iterative* ternarity. CB bounded tone spreading is not iterative; it is perfectly grammatical for a form to contain long toneless sequences, or even no tone at all. With some supporting assumptions, WLP can be made more promising for the CB case. Specifically, we could assume that CB does iteratively build feet, which come into play only with tone spreading; tone could be assumed to spread from the start of one foot to the start of the next. This can lead to the correct assignment of ternary spans, such as in (13a). However, even with such assumptions, one design aspect of WLP is problematic for CB: heavy syllables are never skipped. Example (13b) shows that in forms with heavy syllables, the foot structure resulting from WLP fails to line up with the ternary tone span.

- (13) a. (?) (tu.léé).mú.(shii).ki.(la bwii).no ‘we are burying for him well’
 b. (??) (bá.ká).(lóo).ndo.(lo.la).kó ‘they will introduce’

In summary, none of the traditional methods of deriving ternarity are applicable to an account of the new kind of ternarity found in Copperbelt Bemba. In the next section, we introduce layered feet and show how they can accommodate the necessary ternary domain.

4 A layered feet account of Bemba ternarity

4.1 Layered feet The layered feet framework is based on the idea that traditional binary feet can be parsed, along with an unparsed syllable, by a higher foot constituent, to cover a larger domain. Originating in

seminal works in the 1980s, the layered feet framework initially saw only limited uptake (Selkirk, 1980; Prince, 1980; Dresher & Lahiri, 1991; Rice, 1992; Kager, 1994). Recent literature has seen a surge in applications of layered feet, inspired by work on recursive prosody (Ito & Mester, 2007, 2013; Elfner, 2015). Layered feet have been applied to a variety of foot-governed phonotactics and tonotactics (Jensen, 2000; Davis & Cho, 2003; Bennett, 2012; Martínez-Paricio, 2013; Martínez-Paricio & Kager, 2017; Breteler, forthcoming; Kager & Martínez-Paricio, forthcoming); to account for stress windows (Kager, 2012); stress typology (Martínez-Paricio & Kager, 2015); and edge effects typically solved with extrametricality (Buckley, 2014; Kager & Martínez-Paricio, 2017).

A layered foot is internally asymmetric; it contains the inner foot, and possibly another syllable which we will refer to as the adjunct. Consequently, it is possible to specify the parsing properties of one constituent independently of the other. For Copperbelt Bemba, layered feet allow a specification in line with the observations we made about the pattern back in (10). That is, an inner foot in CB will parse those elements that form a quantity-sensitive iamb; the adjunct will always parse exactly one mora. With this specification, the structure of CB forms falls out as in (14).

- (14) (4) ((bá.ká).pá).ta.kó 'they will hate'
 (5) tu.((l_éé).mú).shii.ki.la bwii.no 'we are burying for him well'
 (6) ((bá.kéé).mbí).la.kó 'they will dig for'
 (7) ((bá.ká).shí).ka.kó 'they will bury'
 (8) tu.((l_éé).ló).o.ndo.lo.la.kó 'we are introducing'
 (9) ú.kú.¹((tá.láá).ntá).a.nta.ku.kú.lú 'the big stumbling'

The layered feet specification fits exactly onto the surface tone spans. The generalization for tone now becomes even simpler: tone associates to all and only footed material (see also Idsardi & Purnell, 1997).

4.2 Syllable integrity violations In contrast to the simpler tone generalization, the complexity of the foot has increased, and must be critically evaluated. Specifically, we have chosen to interpret cases of falling tone as having foot structures that only parse the first mora of a heavy syllable. That is, these forms contain a syllable integrity violation (SIV). An example of this structure is shown in Figure 1. With this footing, the second mora of some heavy syllables remains unfooted, and so high tone will associate only to the first part of such syllables, causing a falling tone.

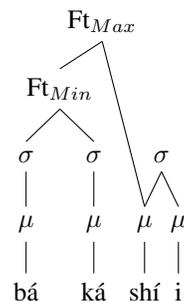


Figure 1: A layered foot parsing only the first mora of a heavy syllable

Syllable integrity is typically held to be inviolable (Hayes, 1995; Hyde, 2007). However, some support for the possibility of SIVs comes from languages where footing is purely moraic. Shimoji's 2009:95 analysis of Irabu Ryukyuan implies that forms such as [á.máir] must be footed (á.má)_{μμ}(ir)_{μμ} to account for the language's tone facts. Blevins & Harrison (1999); Kager & Martínez-Paricio (2017) suggest a trimoraic footing pattern for Gilbertese, where heavy syllables can even be part of two different feet, for example in the form ((ni.ka).ka)((a.e)a) "in search of him". With these cases in mind, we see languages as being on a continuum in terms of SIVs: Some languages are purely moraic, many are purely syllabic, and CB is the first identified instance of a language that blends syllabic and moraic footing, where only the adjunct can break up a syllable. We demonstrate the different structures in the continuum in Figure 2.

Kager & Martínez-Paricio (2017) provide an OT implementation of SIVs with layered feet. They suggest that SIVs arise when moraic foot well-formedness constraints are favored over constraints driving syllabic

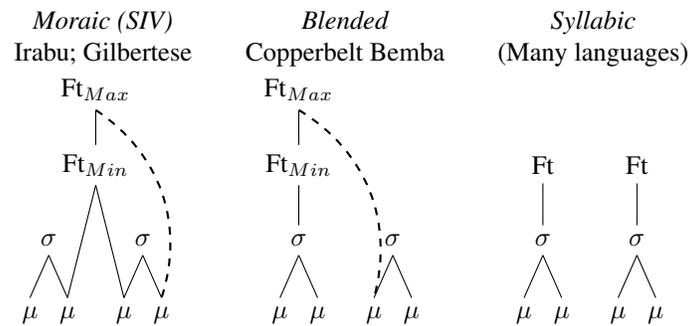


Figure 2: Moraic, blended, and syllabic parsing

parsing preferences. Of particular relevance for CB is their constraint *ADJUNCT- μ* , which drives adjuncts to be monomoraic – regardless of whether that implies breaking up a heavy syllable.

In summary, we have shown in this section that the shape of the CB tone spreading domain falls within the predictions of the layered feet framework, drastically simplifying the generalization on tone distribution. We have made the provision that layered feet must be able to violate syllable integrity for falling tone cases, but we point to other evidence that representational theory is well-served with this addition. In the next section, we discuss a counterargument to SIVs, and a counteranalysis of CB using binary feet.

5 Discussion

5.1 An objection to syllable integrity violations One objection leveled against allowing SIVs comes from Hyde (2007:241), stating that SIVs “open the door to syllable-internal stress distinctions [e.g.] multimoraic syllables that have stress on more than one mora.” We agree with Hyde that we have no reason to expect such a language to be attested. However, our proposal on SIVs does allow its representation. We see it as an open research problem how to rhyme these two facts. One possibly relevant observation is that most of the data used to argue in favor of SIVs contains a tonal aspect, whereas most of the objections to it come from stress languages (Kager & Martínez-Paricio, 2017). Consequently, in addition to expanding the typological investigation of SIVs, we feel that our results warrant further research into differences between tone and stress, for example in their acquisition, processing, or diachrony.

5.2 Boundary hopping Our analysis above started from the intention of defining the entire tone domain at once. However, there is also the option of having the domain be the result of multiple processes – especially since the domain is only partly quantity-sensitive. This option is attractive if one wishes to restrict foot representations to the traditional binary form. Thus, we consider an analysis of “boundary hopping”, where the grammar establishes an iambic, binary domain, and adds a spreading effect that hops just past the foot boundary. A sample derivation is outlined in (15) below.

- (15)
1. $(\acute{\sigma}_{\mu}\sigma_{\mu})\sigma_{\mu}\sigma_{\mu}\dots$
Build binary, iambic feet over sponsors
 2. $(\acute{\sigma}_{\mu}\acute{\sigma}_{\mu})\sigma_{\mu}\sigma_{\mu}\dots$
Spread tone through the foot
 3. $(\acute{\sigma}_{\mu}\acute{\sigma}_{\mu})\acute{\sigma}_{\mu}\sigma_{\mu}\dots$
Spread tone to the first mora following the foot

The boundary hopping approach is descriptively adequate; it always builds tone spans of exactly iamb-plus-mora size. In this sense, then, it is equivalent to the layered feet approach. However, we question the position of the boundary hopping analysis within a typological context. In search of a general linguistic principle that boundary hopping reflects, we suggest that it could be an instance of misalignment. However, to our knowledge, only one previous study (Bickmore, 1996) has suggested that misalignment is a preference that languages can display. Moreover, if a preference for misalignment is indeed a propensity of languages that can show up in typology, it is predicted that languages will not just display overspreading, as suggested here

for CB, but also underspreading. Moreover, some languages should mix both effects in order to achieve misalignment in different contexts – something which to our knowledge is not attested.

Consequently, we argue that introducing this misalignment effect comes at a larger theoretical cost than applying the layered feet framework. Not only does the latter enjoy better support in the literature, but it also has a wider scope of application. Whereas a boundary hopping mechanic is relevant solely to reassociation processes, the application of layered feet extends to all facets of prosodic analysis.

6 Conclusion

In conclusion, Copperbelt Bemba presents a new kind of ternary domain which can arise in a context rife with unparsed syllables. As such, traditional binary Weak Layering approaches cannot derive it. On the other hand, a recently emerging strand of linguistic theory already meets the needs of the CB data; layered feet provide both the size and flexibility needed to define the ternary domain. The case of Copperbelt Bemba also provides further support for allowing syllable-integrity violations in representational theory. Future research is needed to understand the source of restrictions on such violations.

In general, we look forward to seeing the contributions that the case of Copperbelt Bemba bounded tone spreading can make to future debates about metrical theory – and the impetus that the theoretical debate can give to fortifying our understanding of the Copperbelt Bemba facts.

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