In Favour of Layered Feet. A Response to Golston[*]

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Abstract

In this response we argue that the factorial typology predicted in Martínez-Paricio & Kager (2015), which representationally relies on the existence of internally layered ternary feet, is complete and accurate. We demonstrate it does not suffer from the problematic cases of overgeneration pointed out by Golston (this issue). Additionally, we corroborate the idea that the internally layered ternary foot is a metrical representation that is typologically warranted for stress phenomena as well as for segmental and tonal metrically conditioned distributions. We suggest that Golston's claim that "no stress system requires internally layered ternary feet" appears to be too strong and is not empirically substantiated.

Keywords: stress typology; layered feet; binary and ternary rhythm; Optimality Theory

Resum. *A favor dels peus ternaris amb estructura interna binària. Una resposta a Golston*

En aquest article-resposta argumentem que la tipologia factorial predita a Martínez-Paricio i Kager (2015), basada representacionalment en l'existència de peus ternaris amb estructura interna binaria, és completa i precisa. Demostrem que no prediu els sistemes accentuals assenyalats per Golston (aquest volum) com a problemàtics. A més, corroborem que el peu ternari amb estructura interna binaria és una representació mètrica adequada tipològicament, tant des del punt de vista accentual, com des del punt de vista de les distribucions tonals i segmentals condicionades mètricament. Finalment, suggerim que l'afirmació de Golston «cap sistema accentual requereix peus ternaris» sembla massa forta i no està corroborada empíricament.

Paraules clau: tipologia de l'accent; peus amb estructura interna; ritme ternari i binari; teoria de l'optimitat

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1. Introduction

The optimality theoretical analysis of the typology of quantity-insensitive stress systems put forward in Martínez-Paricio & Kager (2015) (henceforth, MPK) has recently been criticized by Golston (this issue) on two grounds. Firstly, Golston argues that MPK's factorial typology predicts too many stress systems, and hence overgenerates. In particular, Golston claims that it predicts languages with quaternary stress, which are generally assumed to be unattested (Golston this issue: §2). According to Golston (this issue: §4.2), the root of this problem is that MPK's factorial typology is incomplete since a set of crucial rankings is not considered. Golston stated: "A full factorial typology of their constraints would make it clear that ternary feet are never needed." Secondly, concerning metrical representations, Golston claimed that "no stress system requires recursive feet" (e.g. $((\sigma\sigma)_{Ft}\sigma)_{Ft'}$, $(\sigma(\sigma\sigma)_{Ft})_{Ft'}$), which are crucial to MPK's typology of quantity-insensitive stress systems and related work on phonological typology (Kager 2012, Kager & Martínez-Paricio 2019) and metrically related phonological properties in stress and non-stress languages (Martínez-Paricio 2012, 2013; Martínez-Paricio & Kager 2016; Kager & Martínez-Paricio 2018).

The goals of this response are twofold. First, we aim to clarify that the factorial typology predicted by MPK for rhythmic stress systems is both complete and accurate, contrary to Golston's (this issue) criticisms. More specifically, we will first demonstrate that MPK's factorial typology does not suffer from the problematic cases of overgeneration pointed out by Golston. Secondly, we intend to show that Golston's claim that "no stress system requires recursive feet" is too strong and, importantly, it is not empirically substantiated. Solid in-depth analyses of stress and non-stress systems have shown the benefits of adopting internally layered ternary (ILT) feet in metrical representations. Although it is not within the scope of this article to thoroughly review all the phonological (segmental, stress and tonal) and morphophonological evidence in favour of ILT feet, we summarize the main arguments in favour of this structure and demonstrate that, even for the small subset of languages reviewed by Golston, the claim cannot be maintained.

We start by demonstrating that our factorial typology does not predict quaternary stress, nor other alleged problematic stress systems (§2). We continue with an overview of the relevant properties and predictions of a model that allows ILT feet in metrical representations, summarizing the most important sorts of evidence in favour of layered feet, while paying special attention to various layered foot-based analyses criticized by Golston (§3). Finally, in Section 4 we discuss several problems related to Golston's OT analysis and conclude in Section 5.

2. Factorial typology in MPK

According to Golston (this issue), the factorial typology presented in MPK predicts systems with quaternary stress (e.g. $[((σ́σ)σ)σ((σ́σ)σ)σσ]$) and ternary stress systems in which binary feet are separated by one or more unfooted syllables (e.g. $[(σ́σ)σ(σ́σ)σ(σ́σ)σ]$), rendering unnecessary (and problematic, by Occam's razor) the need to resort to layered feet (Golston this issue: §2, §4.2). For ease of comparison, various tableaux in support of Golston's claims are repeated below in (3, 6) and the relevant definitions of MPK's constraints used by Golston (2, 5). The labels "(non)minimal" and "(non)maximal", proposed by Itô & Mester (2009), refer to dominance relations in prosodic configurations. As illustrated in (1), a *minimal* foot is a foot that does not dominate another foot, a *non-minimal* foot is a foot that dominates another foot, a *maximal* foot is a foot that is not dominated by a foot and a *non-maximal* foot is a foot dominated by another foot. Therefore, a traditional maximally bisyllabic foot is minimal and maximal, whereas an ILT foot is maximal and non-minimal.

(1)   Minimal recursive feet in a model of recursive prosodic subcategories
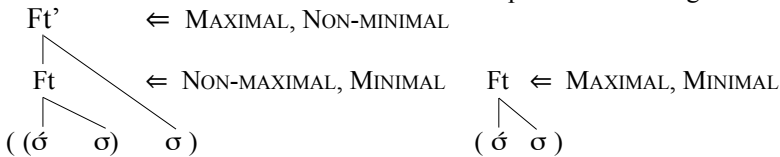
(2)   ALIGN-L/R (Ft$_{min}$]$_ω$, Ft, ω)
      For every foot that is minimal and maximal, assign a violation mark if some foot intervenes between Ft$_{min}$]$_ω$ and the left/right edge of its containing ω.

      ALIGN-L (Ft$_{max}$]$_ω$, Ft, ω)
      For every maximal foot Ft$_{max}$, assign a violation mark if some foot intervenes between Ft$_{max}$ and the left edge of its containing ω.

      Quaternary stress via a factorial typology according to Golston (this issue)

(3)

σσ σσ σσ σσσ	ALIGN-L$_{min}$	ALIGN-R$_{min}$	ALIGN-L$_{max}$
☛ a. ((σ́σ)σ) σ ((σ́σ)σ)σσ			*
b. ((σ́σ)σ)((σ́σ)σ)((σ́σ)σ)			**!
c. (σ́σ)(σ́σ)(σ́σ)(σ́σ)σ	*!**	***	***

Importantly, in Golston's tableau (3) crucial candidates that would have emerged as optimal were left out of the evaluation: those with a single foot in the prosodic word (see tableau 4d-e). Note that the non-intervention alignment constraints on minimal (ALIGN-L/R$_{min}$) and maximal feet (ALIGN-L/R$_{max}$) overall have an economizing effect on footing, i.e. they favour the smallest number of feet

per prosodic word. Therefore, this ranking prioritizes parsings with a single foot (4d-e) over those with quaternary rhythm (4a), which are harmonically bounded.

Harmonic bounding of quaternary stress

(4)	σσ σσ σσ σσσ	Align-L$_{min}$	Align-R$_{min}$	Align-L$_{max}$
	a. ((όσ)σ) σ ((όσ)σ)σσ			*
	b. ((όσ)σ)((όσ)σ)((όσ)σ)			**!
	c. (όσ)(όσ)(όσ)(όσ)σ	*!**	***	***
☞	d. (όσ)σσσσσσ			
☞	e. ((όσ)σ)σσσσσ			

One might believe this result was accidental due to the economizing nature of the constraints in tableau (4), and the omission of constraints that promote exhaustive parsing. However, even when constraints are added such as MPK's Chain-Left/Right, quaternary rhythm (candidate a) is never predicted. These constraints have the double effect of (a) banning unfooted syllables, promoting exhaustive parsings, and (b) stacking up unfooted syllables at the edge of the prosodic word, hence *chaining* them. Tableau (6) shows that a candidate with quaternary rhythm like (6a) is harmonically bounded collectively by candidates (6b-6e). That is, (6a) can never win because multiple candidates (6b-6e) collectively prevent it from being the best on any of the proposed constraints (see Samek-Lodovici & Prince 1990 for the notion of collective harmonic bounding).

(5)   Chain-Left/Right
        For every unfooted syllable $(\sigma)_\omega$, assign a violation mark if some foot intervenes between $(\sigma)_\omega$ and the left/right edge of its containing prosodic word.

Collective harmonic bounding of quaternary stress (holding even with Chain-L/R added)

(6)	σσ σσ σσ σσσ	Align-L$_{min}$	Align-R$_{min}$	Align-L$_{max}$	Chain-L	Chain-R
	a. ((όσ)σ) σ ((όσ)σ)σσ			*!	***	*
	b. ((όσ)σ)((όσ)σ)((όσ)σ)			*!*		
	c. (όσ)(όσ)(όσ)(όσ)σ	*!**	***	***	*	
	d. (όσ)σσσσσσ				*******!	
☞	e. ((όσ)σ)σσσσσ				******	

Golston asserts that the reason why syllable-skipping is incorrectly predicted is that "MPK fail to consider grammars where both CHAIN-L and CHAIN-R are dominated by ALIGN-L or ALIGN-R i.e. though such grammars must perforce arise in a factorial typology. These grammars are precisely those that yield syllable-skipping." Tableau (6) shows this claim is incorrect. The weak local parsing candidate (6a) is harmonically bounded collectively – no possible permutation of the ranking of the constraints generates it, since there is always an alternative candidate that performs better than (6a) on the given set of constraints. We explain below that MPK's factorial typology is complete in a technical sense as all logically possible constraint rankings were considered.

Finally, contrary to Golston's claim, MPK do not predict ternary stress systems in which binary feet are separated by one or more unfooted syllables (8a) (cf. Golston this issue: tableau 5, partially adapted here as tableau 8). Golston arrives at this claim by only considering candidates with multiple feet (8a-d). However, analogously to tableau (6), the inclusion of candidates with a single foot in the evaluation indicates that such candidates are optimal (e.g. 8e-f), while the candidate with ternary stress and weak local parsing (8a) is harmonically bounded. In his tableau, Golston uses the left version of the MPK non-intervention constraint ALIGN-R/Lnon-min, defined in (7). Basically, this constraint penalizes ILT feet that are not aligned with a particular edge of the prosodic word.

(7)   ALIGN-L/R$_{\text{non-min}}$
      For every non-minimal foot Ft$_{\text{non-min}}$, assign a violation mark if some foot intervenes between Ft$_{\text{non-min}}$ and the left/right edge of its containing prosodic word.

Harmonic bounding of ternary stress with weak local parsing

(8)	σσ σσ σσ σσσ	ALIGN-L$_{\text{non-min}}$	ALIGN-L$_{\text{min}}$
	a. (όσ)σ(όσ)σ(όσ)σ		*!*
	b. (όσ)(όσ)(όσ)(όσ)σ		*!**
	c. ((όσ)σ)σ((όσ)σ)σσ	*!	
	d. ((όσ)σ)((όσ)σ)((όσ)σ)	*!*	
☞	e. (όσ)σσσσσσ		
☞	f. ((όσ)σ)σσσσσσ		

Note that adding CHAIN-L/R – the pair of constraints that militate against unparsed syllables – to the tableau once more does not affect this conclusion. The weak local parsing candidate with quaternary rhythm (9a) is harmonically bounded collectively by the alternative candidates; that is, (9a) is thwarted by a combination of its competitors since no constraint in (9) favours (9a) over the other candidates.

Collective harmonic bounding of ternary stress with weak local parsing

(9)

σσ σσ σσ σσσ	ALIGN-L$_{non\text{-}min}$	ALIGN-L$_{min}$	CHAIN-L	CHAIN-R
a. (σ́σ)σ(σ́σ)σ(σ́σ)σ		*!*	***	**
b. (σ́σ)(σ́σ)(σ́σ)(σ́σ)σ		*!**	*	
c. ((σ́σ)σ)σ((σ́σ)σ)σσ	*!		***	*
d. ((σ́σ)σ)((σ́σ)σ)((σ́σ)σ)	*!*			
e. (σ́σ)σσσσσσ			*******!	
☞ f. ((σ́σ)σ)σσσσσσ			******	

In sum, the above set of tableaux clearly shows that MPK constraints are not responsible for predicting quaternary rhythm, nor for generating ternary rhythm via weak local parsing. To close this section, contrary to Golston's criticism (§4.2), the factorial typology in MPK is *complete* (by containing all possible rankings of 16 constraints) and predicts 316 output patterns, for forms of 2–8 syllables in length. MPK:475 group these into 22 abstract patterns, which are known as 'BTU-patterns'. For each BTU-pattern, MPK present the ranking that is responsible for generating it, and an example with foot boundaries indicated. None of the 316 predicted output patterns (which are all integrally available from MPK's online supplementary materials, but apparently not consulted by Golston) exhibits quaternary rhythm, and none displays weak local parsing. Crucially, MPK's factorial typology was corroborated by converging results from two standard computational tools for calculating factorial typologies (OTSoft, Hayes et al. 2003 and OTWorkplace, Prince et al. 2015). To fully understand and appreciate the predictions of MPK's typology, the interested reader is referred to MPK (§3.3, §3.4), where the predicted patterns are discussed at length.

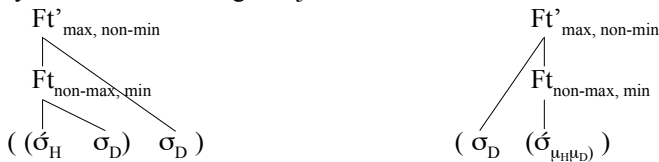## 3. The internally layered ternary foot

In this section, we address Golston's claim that no language requires internally layered ternary (ILT) feet. For this purpose, we first review the basic assumptions of a metrical model that incorporates ILT feet in metrical representations and we summarize the independent evidence in favour of this sort of foot. Additionally, we respond to Golston's criticism that a model with ILT feet predicts too many domains.

An internally layered ternary (ILT) foot is a metrical representation where a foot is minimally expanded via the adjunction of a syllable (or a mora) (10). The ILT foot is not a distinct category from the traditional binary foot since the two projections of the foot are targeted by the same types of distributional evidence from phonological and morphophonological processes: stress assignment, seg-

mental strengthening and weakening phenomena, tonal distributions, instances of stress-dependent vowel harmony, truncation, certain types of metrically conditioned affixation, etc. As depicted in (10), an ILT foot consists of a syllable (or mora), which is the head of two foot projections (indicated with vertical lines), and two foot dependents (syllables or morae, indicated with diagonal lines), one directly dominated by the innermost foot and another one adjoined in a subsequent layer. As noted earlier, the notational labels "maximal/minimal" and "non-maximal/non-minimal" can be derived from the structural dominance relations in a metrical representation. In other words, they do not signal distinct prosodic categories.

(10) Examples of internally layered ternary feet[1]
    a. Bisyllabic foot with a right adjunct   b. Bimoraic foot with a left adjunct

$$\text{Ft'}_{max,\ non\text{-}min}$$
$$\text{Ft}_{non\text{-}max,\ min}$$
$$(\ (\acute{\sigma}_H \quad \sigma_D)\quad \sigma_D\ )$$

$$\text{Ft'}_{max,\ non\text{-}min}$$
$$\text{Ft}_{non\text{-}max,\ min}$$
$$(\ \sigma_D \quad (\acute{\sigma}_{\mu_H \mu_D})\ )$$

The ILT foot has sometimes been described as "minimally recursive", making use of Itô & Mester's theory of *prosodic recursive subcategories* (Itô & Mester 2007, 2009, 2012, 2013) to capture the fact that, in the representations in (10), one foot dominates another foot. Yet, given the rhythmic definition of a foot by which feet have a unique head, feet only allow unbalanced recursion. In other words, a foot cannot dominate two feet $*((\acute{\sigma}_H\sigma)_{Ftmin}\ (\acute{\sigma}_H\sigma)_{Ftmin})_{Ftmax}$, since this would give rise to a foot with two heads, which are prohibited in standard metrical theory. The rhythmic nature of the foot imposes another limitation on recursion. In contrast to supra-feet prosodic categories, which may display unlimited recursion due to their close relation with syntactic categories (which can be recursive), feet only exhibit one layer of recursion. Allowing multiple layers of recursion is rhythmically dispreferred and unmotivated (see Martínez-Paricio 2013 for detailed discussion of this restriction, which limits recursion at foot level, and Bennett 2012 on problems linked to unbounded feet).

3.1. Beyond ternary stress

The evidence for ILT feet does not come solely from languages with ternary stress, as claimed by Golston (this issue). In contrast, MPK propose that this metrical representation constitutes a parsing mechanism often used in quantity-insensitive binary rhythmic stress systems to ensure exhaustivity. For example, an ILT foot can act as a last resort device to parse a syllable that would otherwise be left unfooted, e.g. $(\sigma\acute{\sigma})_{Ft}(\sigma\acute{\sigma})_{Ft}((\sigma\acute{\sigma})_{Ft}\underline{\sigma})_{Ft}$ (see also van der Hulst 2010 and Bennett 2012 for this idea). Evidence supporting the presence of ILT feet in binary systems has been discovered in several Australian languages (namely, in Wargamay and Yidiɲ), where

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1.   The innermost foot in these examples is a trochee, but similar structures are possible with iambs.

vowel lengthening targets exclusively a specific syllable in odd-parity forms, in particular, the penultimate syllable in the prosodic word in Yidiɲ and the peninitial syllable in Wargamany. These crucially coincide with the head of an ILT foot (e.g. (σ(σ́σ))(σ́σ)(σ́σ), (σσ́)(σσ́)((σσ́)σ)). Such representations allow a straightforward interpretation of lengthening as a strengthening effect targeting syllables with a *double foot-headed* status (Martínez-Paricio 2012, 2013). Without reference to an ILT foot, there is no transparent way to locate the vowel to undergo lengthening, nor to capture its motivation. Similar strengthening phenomena that affect only the syllable that is the head of an ILT foot have been documented in unrelated languages like Brazilian Portuguese, where syllables with a double foot-headed status favour the emergence of certain vowels with higher sonority (for details, see Nevins & Costa 2019; Martínez-Paricio & Vigário 2019 based on Wetzels 1992).

Furthermore, the postulation of ILT feet enables a restrictive account of the maximal size of stress and accentual windows, which never spans more than three syllables (see Kager 2012). Furthermore, in Kager & Martínez-Paricio (2019) the set of constraints proposed in MPK (2015) is minimally expanded so that ILT feet can be used in modelling accentual phenomena in quantity-sensitive languages.

Beyond the typology of stress patterns, ILT feet have been shown to facilitate a simple, unified account of several puzzling cases of foot-conditioned phonotactics and tonal distributions in languages from different linguistic families. First, metrically governed segmental strengthening and weakening effects (e.g. specific cases of vowel reduction, vowel lengthening, strengthening and weaking of consonants) have been shown to benefit from a layered foot analysis (Jensen 2000; Davis & Cho 2003; Bennett 2012, 2013; Harris 2013; Martínez-Paricio 2013; Kager & Martínez-Paricio 2018, 2019 *inter alia*). In particular, it has been shown that the number of foot projections that dominate a syllable and/or its particular position within the foot (e.g. initial *vs.* non-initial; head *vs.* non-head), can be responsible for subtle phonological differences among stressed and unstressed syllables, which cannot be captured in a framework with standard (non-layered) feet. Second, it has been shown that the ILT foot provides a natural way of defining the bounding domain for ternary tone phenomena such as tonal spreading (Breteler 2018, Breteler & Kager 2018, to appear) and other specific tone and tonal accent distributions (Morén-Duolljá 2013, Martínez-Paricio 2013, Iosad 2016).

On the morphological side, reference to an ILT foot facilitates a unified account of minimality conditions in languages that involve some sort of ternarity in truncation processes (for Italian, see Krämer 2018; for Spanish, see Martínez-Paricio & Torres-Tamarit 2019; for Sardinian, see Cabré, Torres-Tamarit & Vanrell 2021) or impose a minimal trimoraic restriction on the minimal form of lexical items (Harrison & Blevins 1999 and §3.3). Moreover, the ILT foot has been claimed to regulate the position of certain infixes in English (McCarthy 1982, Yu 2004) and the emergence of certain interfixes in Catalan (Mascaró 2021).

Finally, Torres-Tamarit (2021a,b) has recently demonstrated that a variety of segmental stress-related typological predictions are better formalized when it is possible to refer to minimal and maximal feet, i.e. when layered feet are allowed (see Torres-Tamarit 2021a on the distribution of contrastive vowel length in stressed

syllables in Italo-Romance varieties, including monophthongs/diphthongs and lax/ tense vowels; and Torres-Tamarit 2021b on stress-dependent vowel harmony in Italo-Romance proparoxytones).

In sum, an ILT foot not only accounts for ternary stress distributions, but its predictive power extends to explaining a range of phonological and morphophonological phenomena, which are not always dependent on stress. In the next sections, we respond to Golston's critique by which a model with ILT feet predicts too many domains (§3.2) and we briefly review some specific evidence for ILT feet in various ternary stress languages (§3.3).

3.2. Too many domains?

Golston (this issue) considers that prosodic recursion and, more specifically, a model with ILT feet, "predicts too many domains":

> ILT feet provide about four times the number of domains as a theory with only binary feet, *ceteris paribus*: e.g. foot-initial is one domain if we only have one kind of foot, but four if we have max, min, non-max and non-min kinds of feet: $(\sigma\acute{\sigma})_{max, \, min}$, $((\sigma\acute{\sigma})_{min, \, non-max}\sigma)_{max, \, non-min}$ (p. 17)[2]

Authors like Vogel (2009a,b) have rejected prosodic recursion because it (wrongly, according to her) predicts that each recursive level should be associated with the same phonological phenomena, given that recursive projections constitute instances of a single prosodic category. For example, every foot dependent in (10) should be the target of the same phonological process. However, studies in ILT have argued for a different view, by showing, for instance, that syllables in the weak branch of a foot may behave differently with respect to a particular phonological process precisely because of the different type of metrical configuration they belong to (a minimal foot, a non-minimal foot, etc.) (e.g. Martínez-Paricio 2013, Kager & Martínez-Paricio 2018). According to Vogel and Golston, if different projections trigger different processes, this necessarily entails that these projections are in fact different categories.

(11) Minimal recursive feet in a model of recursive prosodic subcategories

      Ft'   ⇐ Maximal, Non-minimal

      Ft   ⇐ Non-maximal, Minimal   Ft ⇐ Maximal, Minimal

    ((σ́   σ)   σ)   (σ́   σ)

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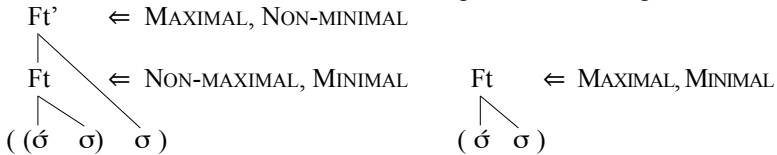
2.   In this specific representation, this is not even the case since the foot-initial syllable in the maximal foot $(\sigma_1\acute{\sigma}_2)$ coincides with the foot-initial syllable in the non-maximal and non-minimal feet provided in the example, $((\sigma_1\acute{\sigma}_2)_{min, \, non-max}\sigma_3)_{max, \, non-min}$. However, Golston is right in pointing out the foot-initial syllable would not necessarily be the same syllable in a language with maximal feet like $(\sigma_1\sigma_2)$ and $((\sigma_3 \, (\sigma_1\acute{\sigma}_2))$.

Examining the arguments against prosodic recursion, Bennett (2018: 22) points out that we seem to be forced to the (apparently incoherent) conclusion that projections of recursive prosodic structures can condition the same phonotactic (or tonotactic) patterns, yet they can also condition different patterns, given that different projections (minimal, maximal, etc.) of one particular category are structurally unique. However, as Bennett (2018) shows in his research on recursive prosodic words, this conclusion is not contradictory: "different levels of recursive structure can be distinguished by their dominance relations (cf. 11)". This is in fact what we see in languages that treat a particular foot subconstituent (e.g. a foot head, a foot dependent), depending on the specific projection that it directly belongs to (e.g. a [non] minimal foot, a [non]maximal foot). For instance, we saw that in some Australian languages, only syllables that are in a head of a non-minimal foot (i.e. syllables that are dominated by two foot projections) are the target of vowel lengthening. This is also the case in Chugach Alutiiq (§3.4). Likewise, there are languages that distinguish between types of foot-dependents according to their dominance relations. For instance, Bennett (2012, 2013) demonstrates that epenthesis of [h] occurs at the foot-initial domain in Huariapano, but only when the foot is maximal (e.g. $(\acute{\sigma}_h\sigma)_{max}$, $(\sigma_h\,(\acute{\sigma}\sigma))_{max}$ *vs.* *$(\sigma_h\,(\acute{\sigma}_h\sigma)_{non\text{-}max})$). However, as pointed out by Bennett (2018) and MPK, there are also languages where recursive projections of a particular prosodic category all behave similarly, conditioning the same phonological phenomenon, based on the fact that all recursive layers of a particular category are instances of the same prosodic category. This is the case, for instance, in the American English varieties described in Davis (1999, 2005) and Davis & Cho (2003), where aspirated consonants surface in every foot-initial position, no matter the specific dominance relations of the foot, e.g. *potato* [(pʰə(tʰéɪɹo))], *Mediterranean* [(mɛdɪ)(tʰə(réɪni))ən]. For this particular case, Golston presents as a possible alternative parsing to the one proposed here for *potato*, two adjacent feet, where the first foot is stressless and is built over the first syllable, e.g. [(pʰə)(tʰéɪɹo))]. However, such an account runs into problems since it cannot determine why some feet are stressless in English while others are stressed, and since it fails to explain why the vowel in the initial syllable is reduced despite being in a foot head. Even though there is variation with respect to vowel reduction in English, foot heads do not tend to exhibit reduction. By contrast, if the first syllable in *potato* is in a *foot dependent* position, its weak properties (e.g. reduction, lack of stress) can be related to its position in the weak branch of a foot. However, its strong properties (like aspiration) can be related to its *initial* position in the foot (see Bennett 2013 for discussion of other strengthening phenomena in unstressed syllables in a foot-initial position).

To sum up, data analysed in a variety of languages (see references in §3.1) show there are systems for which reference to different projections of a foot are in fact needed to account for some specific phonological process, whereas in others, a particular process targets equally all foot projections. Only a model that allows minimally recursive feet is compatible with the two types of data reported in languages. As pointed out by Bennett (personal communication, 2021), strong support in favour of the recursive subcategories model would come from a language where recursive subcategories of a particular domain (e.g. prosodic word,

foot, etc.) exhibit mixed behaviour "with all instances of category π behaving the same for some process P, but behaving different for some (other) process." With respect to the category of the foot, this would entail documenting a language with a phonological process that needs to refer to a particular projection of the foot, whereas other process in this same language needs to refer to all foot projections. Future research in the phonology and morphology of languages with ILT feet is needed to test this prediction.

Finally, Golston states that a model with ILT feet predicts 26 domains. However, some of these domains have been strongly motivated, as explained in this section. With respect to those that are predicted but have not yet been instantiated, these make valuable and testable predictions for future studies. Finally, it is important to specify that the 26 domains are not independent but mutually related: several of these domains always occur in combination with others (for instance, a foot-dependent in a trochee is always foot final; a foot-head in an iamb is foot-final, etc.). Hence, the domain typology is in fact much smaller than the 26 domains claimed by Golston.

3.3. Ternary stress languages require ILT feet

One of the ternary languages that Golston claims does not require ILT feet is Chugach Alutiiq. Golston builds on Leer's data (1993/1994), which goes into greater detail than his often-quoted previous study, Leer (1985a, b, c). However, descriptively, the two studies do not substantially differ. The main differences lie in their interpretation of the facts. For instance, Leer (1993/1994) reinterprets the three degrees of stress posited in Leer (1985) in terms of pitch, but this idea was already made explicit in Rice's (1992) dissertation and is fully compatible with a layered foot-based analysis as shown in Martínez-Paricio & Kager (2016). Specifically, the ILT foot can account for the distribution of high (H), superhigh (¡H) and low (L) tones in Chugach Alutiiq in a straightforward way by referring to different constituents in the metrical foot (based on de Lacy 2002).[3] On the one hand, the dual behaviour of unstressed syllables (only a subset of which target a L) can be explained by referring to the structural difference between syllables (or morae) located in the dependent of a minimal foot (Ft_{min}) and syllables (or morae) located in the adjunct of an ILT foot (i.e. dependent of a Ft_{Nonmin}). High tones dock to foot heads, whereas low tones dock to foot dependents that are located in an adjunct position, as illustrated in (12a). The tonal data are equally compatible with a weak local parsing account, where low tones would be said to dock to unfooted syllables instead (12b). With respect to the distribution of H and H!, both the layered (12a) and non-layered metrical analyses (12b) perform equally well in their account since the emergence of superhigh tones is seen in both as an OCP effect. To understand

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3. Leer (1993/1994: 102) uses a scale of numbers (3 > 2 > 1) to describe the relative highness/strength of syllables with different pitch patterns, where 3 represents the highest pitch and 1 the lowest. Likewise, he sometimes refers to a high (3), mid-high (2) and a low pitch (1), which are what we call here superhigh (H!), high (H) and low (L).

the parsings provided in (11), it is important to recall that in Chugach Alutiiq there are two types of heavy bimoraic syllables: (i) syllables with long vowels and diph-thongs (CVV) and (ii) word-initial closed syllables (CVC), which is why all words in (12) build a foot on their initial syllable.

(12) Metrical accounts for the dual behaviour of unstressed syllables

    a. Layered foot analysis   b. Weak local parsing analysis

      ((án^H) ci^L) (quá^H)   (án^H) ci^L (quá^H)   'I'll go out' (Leer 1985a)

      (taá^H) (ta. qá^{iH})   (taá^H) (ta. qá^{iH})   'my father' (Leer 1985a)

Besides the tonal distributions, the fortition of consonants in foot initial posi-tion, and the mixed binary-ternary stress patterns reported in Chugach Alutiiq pro-vide further support for a metrical account of the facts, whether with or without ILT feet. However, Leer (1993/4) presents an additional generalization, only formalized as a personal impression in Leer (1985c), which tilts the balance in favour of a layered foot-based analysis.

Leer (1993/4: 112-116) deepens his documentation of vowel lengthening in open strong syllables and claims that Chugach Alutiiq displays a clear dichotomy. Vowels in open stressed syllables that are transcribed with a raised dot are char-acterized as "semi-lengthened", while vowels transcribed with a colon are said to be "fully lengthened". The latter are claimed to be "twice or three times as long" as the former (p. 112-113). In (13) it can be observed that allowing ILT feet in metrical representations facilitates a straightforward account of the lengthening facts: vowels that are semi-lengthened are located in the head of a single foot (i.e. a minimal foot, 13a-b, f) whereas those that are fully lengthened are simultaneously dominated by two foot projections (i.e. a non-minimal foot, 13d-e). Hence, their double-foot headed status predicts not only the context of lengthening but also provides its motivation. This account does not come as an ad hoc stipulation, but it can be derived from the prosodic hierarchy and the headedness relations.

(13) New lengthening data in Leer (1993/4: 112-113, 1985c: 164)

    a. (nu.ná·)   land

    b. (nu.ná·) (qaá)   land? (yes/no question)

    c. (nu.nám)   on the land

    d. ((nu.**na**:) mi)   how about the land?

    e. ((a.**ku**:) taq)   an item of food

    f. (a.kú·)(ta.mék)   kind of food (ABL. SG)

Golston posits that extra lengthening can be claimed to be "inhibited before fortis consonants (Hayes 1995) or before another foot", but this statement is not entirely accurate. In (13a) the lengthened vowel is not followed by a fortis conso-nant nor by a foot, yet extra lengthening does not take place. Even if in a weak local parsing account extra lengthening could be proposed to be precluded word-finally, such an account would still miss formalizing in a unified way both the locus and motivation for extra lengthening as in an ILT foot account.

A second language that is claimed to not require ternary feet is Gilbertese (Blevins & Harrison 1999) despite the fact that Blevins and Harrison provide various sorts of evidence for Gilbertese trimoraic feet, which Golston (this issue) omits. High pitch falls on the antepenultimate mora and on every third mora preceding it. Stress, described as "an intensity or loudness peak", falls on the penultimate mora and on every previous third mora (Blevins & Harrison 1999: 217). In terms of ILT feet, stress can be interpreted as the phonetic realization of a foot head, while insertion of a high tone can be interpreted as a foot-initial strengthening effect, e.g. ((a^H.**rá**).na) 'his/her name' (for details, see Martínez-Paricio 2013 and Kager & Martínez-Paricio 2019). In addition to the distribution of stress and tone, further support for the ternary foot in this language comes from a minimality restriction by which all words must contain three morae. This is seen to be active in the borrowing of two morae proper names which are lengthened in Gilbertese (14a), as well as bare plural nouns (14b) and verbal imperatives (14c), which lengthen their vowels to meet the trimoraic requirement.

(14) Lengthening (all data taken from Blevins & Harrison 1999: 213-216)

    a. Borrowed proper names

ta$^\mu$a$^\mu$m$^\mu$	'Sam'
ti $^\mu$i$^\mu$me$^\mu$	'Jimmy'
bi$^\mu$i$^\mu$ti$^\mu$	'Fiji'

    b. Bare plural nouns   Noun phrases

bwa$^\mu$a$^\mu$ta$^\mu$	'the/some huts'	cf.	te$^\mu$ bwa$^\mu$ta$^\mu$	'the/a hut'
o$^\mu$o$^\mu$n$^\mu$	'the/some turtles'	cf.	te$^\mu$ o$^\mu$n$^\mu$	'the/a turtle'
ba$^\mu$a$^\mu$i$^\mu$	'the/some arms'	cf.	ba$^\mu$i$^\mu$-u$^\mu$	'my arms'

    c. Imperative verbal forms   Verbs+subject marker

bi$^\mu$i$^\mu$ri$^\mu$!	'run!'	cf.	e$^\mu$ bi$^\mu$ri$^\mu$	's/he ran'
ni$^\mu$i$^\mu$m$^\mu$!	'drink them!'	cf.	i$^\mu$ ni$^\mu$m$^\mu$	'I drank them'
a$^\mu$mw$^\mu$ara$^\mu$ke$^\mu$!	'eat!'	cf.	i$^\mu$ a$^\mu$mwa$^\mu$ra$^\mu$ke$^\mu$	'I ate'

The only exceptions to lengthening in words that do not satisfy the trimoraic minimality requirement occur in environments in which lengthening would have introduced an extra-long vowel, which are illicit in Gilbertese (15a, b), or a geminate nasal in preconsonantal position, which are also illicit in prevocalic position (15c, d) (Blevins & Harrison 1999: 215).

(15) Bimoraic prosodic words (Blevins & Harrison 1999: 215)

    Bare plural nouns

ni$^\mu$i$^\mu$	'some coconut trees'	(cf. SG.: te nii)
ba$^\mu$a$^\mu$	'some leaves'	(cf. SG.: te baa)
nn$^\mu$e$^\mu$	'some spots'	(cf. SG: te nne)
nn$^\mu$a$^\mu$	'some fleets'	(cf. SG: te nna)

From these data, it is clear that both the minimality condition and the distribution of pitch and stress benefit from an analysis by a ternary foot, whether this is layered or not.

With respect to Tripura Bangla and other languages more briefly analysed in Golston's article, such as Sentani, Winnebago and Estonian, none of these are incompatible with a layered foot analysis. Hence, they do not stand as arguments against ILT feet. The fact that Estonian displays two optional patterns does not rule out the fact that one of these makes use of ILT feet. As for the other languages, although very few data are presented, they are all equally compatible with an ILT foot-based account. Likewise, Tripura Bangla stress patterns and weakening of consonants in certain positions is compatible with a binary foot representation, but also with an ILT foot approach. In the former, weakening targets foot-medial positions, in the latter, weakening can be said to target the dependent of a minimal foot, i.e. (ká.$\underline{ha}$)$_{Ftmin}$, ((zɔ.$\underline{βa}$)$_{Ftmin}$ bi) (where underlined consonants are weakened).

4. Comparison with Golston's alternative OT analysis

Golston does not provide a factorial typology of the set of constraints included in his study. Hence, it is not possible to compare the predictive power of his proposal against MPK's. Complete rankings for the few languages he analyses in greater detail are not provided. Therefore, sometimes it is not clear how a particular ranking derives stress in all length forms. This is the case, for instance, in Cayuvava $3n+2$ words. The proposed ranking PARSE-2, NONFINAL >> ALIGN-R cannot single out the correct candidate in such forms. This is illustrated in (17); the constraints used by Golston are defined in (16). Golston assumes Cayuvava displays the metrical representation illustrated by candidate (17a), but it is not clear how this candidate can be selected as optimal, given the undominance of PARSE-2.

(16) Constraints used in Golston's account of radical ternarity in Cayuvava
   a. PARSE-2: one of two adjacent stress units must be parsed by a foot (based on Kager 1994)

   b. NONFINAL: assign a violation mark for every foot that is final in the prosodic word

   c. ALIGN-R: for every (maximal) foot assign a violation mark if some foot intervenes between Ft$_{max}$ and the right edge of the prosodic word

(17) The proposed ranking cannot single out the correct candidate in $3n+2$ forms

σσσσσσσσ	PARSE-2	NONFINAL	ALIGN-R
a. σσ (óσ) σ (óσ) σ	*!		*
☛ b. (óσ) (óσ) σ (óσ) σ			**
☛ c. (óσ) σ (óσ) (óσ) σ			**
☛ d. σ (óσ) (óσ) (óσ) σ			**
e. (óσ) (óσ) (óσ) (óσ)		*!	

The classical challenge of deriving the initial stressless sequence in 3*n*+2 words (e.g. Halle & Vergnaud 1987, Elenbaas & Kager 1999) is not adequately met by Golston.

Finally, Golston's typology is at times descriptively inadequate. For instance, Golston oversimplifies the complex stress pattern of Choguita Raramuri, a language described as having an initial three-syllable window. Golston reports the language as having stress on the second syllable, but Caballero (2011: 749) describes stress as resulting from "a complex interaction between lexically prespecified stress, two systematic subpatterns (second and third syllable stress), a stress rule specific to noun incorporation constructions, and an initial three-syllable window, a highly unusual typological pattern." Caballero convincingly argues for the need of a left-aligned layered foot in Choguita to account for these regular patterns of stress and their inter-action with morphology. Further evidence for the ILT foot in Choguita is provided in Caballero & Carroll's (2013: 766) analysis of loanword adaptation in this language. Interestingly, loans from Spanish are truncated to avoid a violation of the three syl-lable window restriction. In other words, if a form in Spanish has stress further away than three syllables from the left-edge of the prosodic word, segmental material is deleted to respect the three-syllable window (18c-e). Stress marks need not appear in the orthography; the truncated portion from the original base is underlined.

(18) Choguita Raramuri loanwords from Spanish (Caballero & Carroll 2013: 1, 8)

Loans		*Spanish original source*
ma.sá.na	'apple'	manzána
me.ho.rá.ra	'acetaminophen'	mejorál
nau.gu.rár̺.po	'inaugurate-Fᴜᴛ Pʟ'	i̲n̲a̲u̲gurár
se.r̺a.dé.ro.t͡ʃi	'log house- t͡ʃi'	a̲s̲erradéro
ki.r̺i.sáan.te	'fertilizer'	f̲e̲r̲tilisánte

5. Conclusion

We hope to have clarified that the factorial typology of the set of constraints pre-sented in MPK predicts neither systems with quaternary stress (e.g. *[((σ́σ)σ) σ((σ́σ)σ)σσ]), nor systems with ternary stress that combine disyllabic feet with skipped syllables (e.g. *[(σ́σ)σ(σ́σ)σ(σ́σ)σ]. Hence, MPK's factorial typology does not suffer from the problematic cases of overgeneration pointed out by Golston. To fully evaluate the predictive power of our typology, the interested reader is referred to MPK (2015: §3.3, §3.4), where the systems predicted by our model are discussed at length. Contrary to Golston's criticism (§4.2), our factorial typology is complete, as demonstrated by means of two standard computational tools (OTSoft, Hayes *et al*. 2003; OTWorkplace, Prince *et al*. 2015).

Unfortunately, this same rigid computational test cannot be performed with respect to the set of constraints put forward in Golston (this issue), since his article does not provide a factorial typology. Furthermore, for some systems, it is not even clear how the specific ranking presented in the paper can correctly derive stress in all length forms (see, for instance, our discussion in §3.3 on Cayuvava).

In a more general vein, we have tried to argue that Golston's representational claim "no stress system requires ILT feet" besides being too strong, is neither substantiated nor empirically demonstrated. First, Golston only discusses a subset of the stress languages for which an ILT foot has been posited. Nothing is stated about an increasing number of languages that were recently analysed with ILT feet. Moreover, Golston ignores the fact that ILT feet were reintroduced in metrical representations not only to account for ternary stress distributions, but also to provide a unified account of binary (and mixed binary-ternary) rhythmic stress, as well as to explain a wide array of segmental, tonal and morphophonological phenomena in stress and non-stress languages (see references in §3). Given that the motivation (and evidence) for rehabilitating ILT feet in metrical representations is not solely based on ternary stress, it is empirically and analytically inadequate to ignore the additional evidence.

Second, even in languages with ternary stress like Chugach Alutiiq, Gilbertese and Choguita, we have argued that an ILT foot account allows a better, more unified explanation of the accentual and non-accentual facts than Golston's weak local parsing account. For other languages like Tripura Bangla, Golston is nevertheless right in pointing out that the segmental facts can indeed be analysed resorting to maximally disyllabic feet and weak local parsing. Still, the ILT foot account is neither incompatible with the stress facts, nor with the segmental phenomena. Hence, importantly, our approach has not been falsified.

In conclusion, an ILT foot is a metrical representation that is typologically warranted for stress phenomena as well as for metrically conditioned distributions of segmental and tonal phenomena in a large range of languages. We believe that the study of metrical representations immensely benefits from developing an integrated approach to metrical stress distributions and metrically conditioned segmental/tonal phenomena. Analyses of stress for particular languages should be maximally informed by non-stress distributional evidence, and vice-versa. We should not forget the major insight (e.g. Selkirk 1980) that the foot is a prosodic category that unifies a wide range of metrically-conditioned phenomena.

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Summary

Articles

A recursive foot is one in which a foot is embedded inside another foot of the same type: e.g., iambic ($_{ia}\sigma(_{ia}\sigma\acute{\sigma})$) or trochaic ($_{tr}(_{tr}\acute{\sigma}\sigma)\sigma$). Recent work has used such feet to model stress systems with full or partial ternary rhythm, in which stress falls on every third syllable or mora. I show here that no stress system requires recursive feet, that phonological processes in such languages likely don't either, and that the notion of recursive foot is theoretically suspect.

Keywords: recursive feet; stress; ternary rhythm

In this response we argue that the factorial typology predicted in Martínez-Paricio & Kager (2015), which representationally relies on the existence of internally layered ternary feet, is complete and accurate. We demonstrate it does not suffer from the problematic cases of overgeneration pointed out by Golston (this issue). Additionally, we corroborate the idea that the internally layered ternary foot is a metrical representation that is typologically warranted

for stress phenomena as well as for segmental and tonal metrically conditioned distributions. We suggest that Golston's claim that "no stress system requires internally layered ternary feet" appears to be too strong and is not empirically substantiated.

Keywords: stress typology; layered feet; binary and ternary rhythm; Optimality Theory

57-75   **Revithiadou, Anthi** (Aristotle University of Thessaloniki)**; Markopoulos, Giorgos** (University of the Aegean)
A Gradient Harmonic Grammar Account of Nasals in Extended Phonological Words. *Catalan Journal of Linguistics*, 2021, vol. 20, pp. 57-75.

The article aims at contributing to the long-standing research on the prosodic organization of linguistic elements and the criteria used for identifying prosodic structures. Our focus is on final coronal nasals in function words in Greek and the variability in their patterns of realization before lexical words. Certain nasals coalesce before stops and delete before fricatives, whereas others do not. We propose that this split in the behavior of nasals does not pertain to item-specific prosody because the relevant strings are uniformly prosodified into an *extended phonological word* (Itô & Mester 2007, 2009). It rather stems from the contrastive *activity level* of nasals in underlying forms in the spirit of Smolensky & Goldrick's (2016) *Gradient Symbolic Representations*; nasals with lower activity coalesce and delete in the respective phonological environments, whereas those with higher activity do not. We show that the proposed analysis captures certain gradient effects that alternative analyses cannot account for.

Keywords: Gradient Symbolic Representations; Gradient Harmonic Grammar; Greek; extended / maximal phonological word; nasal coalescence; post-nasal voicing

77-114   **Yu, Kristine M.** (University of Massachusetts Amherst)
Computational Perspectives on Phonological Constituency and Recursion. *Catalan Journal of Linguistics*, 2021, vol. 20, pp. 77-114.

Whether or not phonology has recursion is often conflated with whether or not phonology has strings or trees as data structures. Taking a computational perspective from formal language theory and focusing on how phonological strings and trees are built, we disentangle these issues. We show that even considering the boundedness of words and utterances in physical realization and the lack of observable examples of potential recursive embedding of phonological constituents beyond a few layers, recursion is a natural consequence of expressing generalization in phonological grammars for strings and trees. While prosodically-conditioned phonological patterns can be represented using grammars for strings, e.g., with bracketed string representations, we show how grammars for trees provide a natural way to express these patterns and provide insight into the kinds of analyses that phonologists have proposed for them.

Keywords: prosody; recursion; computational phonology; tree transducers