1 Extrametricality

Empirical research on stress has revealed a strong tendency for word-final syllables to avoid being (main) stressed. From the perspective of metrical stress theory, this tendency is most relevant for languages with iambic (right-headed) feet, where final stress is expected at least some of the time:¹

(1) Expected final stress in iambic languages
   a. Even-syllable words, either direction: \((σ \, o) \, (σ \, o) \, (σ \, o)\)
   b. Odd-syllable words, right-to-left direction: \(σ \, (σ \, o) \, (σ \, o) \, (σ \, o)\)
   c. Compare odd-syllable words, left-to-right: \((σ \, o) \, (σ \, o) \, (σ \, o) \, (σ)\)

Research specifically within metrical stress theory has revealed a somewhat weaker tendency for word-final syllables to avoid the main stress foot in general, whether or not those word-final syllables are themselves the heads of those feet. This tendency is most relevant for languages with trochaic (left-headed) feet with main stress on the rightmost foot. Consider, for example, Latin stress.

(2) Latin stress: descriptive generalizations
   a. Monosyllabic words are stressed on the one and only syllable.
   b. Bisyllabic words are stressed on the penultimate syllable.
   c. Longer words are stressed on the penult iff it is heavy, else on the antepenult.

Antepenultimate stress is unexpected under the standard assumption that feet are maximally binary: how can the third syllable from an edge be reliably stressed? The solution was to propose that final syllables in Latin are extrametrical, meaning that they are effectively ignored for the purposes of foot construction; a trochaic foot built on the right edge of the remainder yields antepenultimate stress.

(3) Extrametricality in Latin: the ‘standard’ analysis (angled brackets indicate extrametricality)
   a. Longer words: [pa (tri ci) \(\langle a \rangle\)], [ré (fi) \(\langle cit \rangle\)], [re (fé) \(\langle tus \rangle\)], [re (fé:) \(\langle cit \rangle\)]
   b. Bisyllables: [(á) \(\langle qua \rangle\)], [(á) \(\langle mo:\rangle\)]
   c. Monosyllables: ¡ [(ré:) !

How is it that monosyllables are footed (and thus stressed), if final syllables are extrametrical? The answer provided by e.g. Hayes (1995: 58) was the principle of Nonexhaustivity.

(4) Nonexhaustivity: “An extrametricality rule is blocked if it would render the entire domain of the stress rules extrametrical.”

Nonexhaustivity guarantees that every lexical word consists of a prosodic word, which according to the Prosodic Hierarchy must itself consist of at least one foot (its head). But this is just Culminativity: every word must be stressed (which follows from headedness requirement of the Prosodic Hierarchy). Why must Nonexhaustivity be stated as a separate condition to ensure Culminativity? The reason is due to what Prince & Smolensky call Bottom-up Constructionism in pre-OT phonological theory:

1. Extrametricality marking prepares the syllabified but footless input for further processing.
2. Feet are formed above the remaining syllables, determining the location of stressed and unstressed syllables.
3. The prosodic word is formed above the feet, and the location of main stress is determined.

¹ Iambic languages seem to be overwhelmingly left-to-right directional (trochaic languages, with left-headed feet, seem to be more evenly split, directionally speaking). Prince & Smolensky (1993: 58 / 2004: 65, fn. 36) note that (McCarthy & Prince 1993: 162-163 note that) left-to-right iamb successfully avoid word-final stress in odd-syllable forms, as shown in (1c). Kager (2001) proposes to account for this ‘Iambic Asymmetry’ with a constraint against word-initial lapses (see also McCarthy 2003, §6).
This third and final step of prosodic word formation is procedurally remote from the first step of extrametricality marking, and so extrametricality cannot be directly sensitive to the Prosodic Hierarchy analysis of Culminativity. Nonexhaustivity is thus a necessary intermediary.

The correct generalization seems to be that whatever constraint is responsible for extrametricality in Latin is *violable*: specifically, it is forced to be violated whenever the (higher-ranked? possibly universally satisfied?) requirement of Culminativity — due to ALIGN(Stem,Wd,L) — is at stake. Now, what is the constraint responsible for extrametricality? Prince & Smolensky propose *NONFINALITY*.

(5) **NONFINALITY**
   - No head of the prosodic word is final in the prosodic word.

The formulation of this constraint assumes that headship is an inherited property: the head of your head is also your head. So, the head of the head foot — the main stressed syllable — is the absolute worst thing to have in word-final position according to this constraint; two violations are incurred, one by the head foot and one by the head syllable. This would be the violation profile of a word-final iamb or monosyllabic foot. Slightly better than this is for the head foot but not the head syllable to be final; this would be a word-final trochee. Even better than this would be for the final syllable to be left entirely unfooted, or at least not to be footed in the head foot. This is what happens in trisyllabic and longer words in Latin (recall the examples in (3a) above), but it incurs another cost: minimal violation of the alignment constraint that prefers a rightmost main stress foot.

(6) **[[ALIGN(Stem,Wd,L) \gg NONFINALITY \gg ALIGN(Wd,WdHd,R)]]**
   - Stress is rightmost but nonfinal, except when the word would thereby be left unstressed.

Prince & Smolensky argue that this interpretation of extrametricality makes sense of four key properties of extrametricality identified in the literature. Identification of these properties was important to the theory of extrametricality (such as it was) because, obviously, a device that allows certain elements to be made invisible to rules must be constrained in some way. However, these properties were always a mystery, so insofar as Prince & Smolensky are right, this is a step in the right direction.

(7) **Property 1. Constituency**
   - Only constituents (e.g., syllables) may be extrametrical.

Since stress is computed over syllables, the type of thing that will be strikingly avoided by stress is a syllable. However, there have been proposals for the extrametricality of other constituents, such as segments, moras, and even feet themselves. The arguments for these proposals need to be reexamined in light of the NONFINALITY theory.

(8) **Property 2. Peripherality**
   - Only edgemost constituents may be extrametrical.

This appears to be because the phenomena for which extrametricality has been invoked involve properties that are themselves edge-oriented, like main stress.

(9) **Property 3. Edge Markedness**
   - The unmarked edge for extrametricality is the right edge.

This turns out to be only true for stress, not for other phenomena for which extrametricality has been invoked (e.g., tone). The explanation must thus lie in the properties of stress itself, not in a theory of the treatment of edges. (But see Spaelti 1994, ROA-18.)

(10) **Property 4. Uniqueness**
    - Only *one* constituent of any type may be extrametrical.

This follows from minimal violation. For example, stress in Latin is rightward-oriented. Being near-final is the best that can be done, given dominant NONFINALITY. (But what about McCarthy 2003?)
2 Word minimality (and syllable maximality)

Apart from enclitic morphemes like -que ‘and’, Latin lacks monomoraic words; e.g., *re.

(11) Latin Monosyllables

a. N mens, cor, mel, re:, spe:, vi: ‘mind, heart, honey-NOM, thing, hope, force-ABL’
b. V do:, sta:, sum, stat ‘I give, I stand, I am, s/he stands’
c. Pro me:, se:, tu:, is, id, quis ‘1sg.-ACC, 3refl.-ACC, 2sg.-NOM, he, it, who-NOM’
d. Conj ne:, si:, cum, sed ‘lest, if, when, but also’
e. Prep a:, e:, pro:, sub, in, ab ‘from, out of, in front of, under, in, from’

This, too, can be made to follow from Culminativity considerations. If every word must contain a foot, and if every foot must be either syllabically or moraically binary, then the smallest allowable word will be a bimoraic monosyllable. So, FTBIN must be at play here:

(12) FOOTBINARITY (FTBIN)

Feet are binary under syllabic or moraic analysis.

Now suppose that FTBIN and ALIGN(Stem,Wd,L) are undominated. How does this explain the lack of monomoraic words? Another way to ask this is: what is the fate of a hypothetical monomoraic input /re/? The answer to this question is not at all trivial. One aspect of it is at least relatively simple to answer: monomoraic inputs cannot be allowed to optimally surface as monomoraic outputs.

Satisfaction of both ALIGN(Stem,Wd,L) and FTBIN can be achieved by boosting monomoraic inputs to bimoraic size. There are three obvious possibilities: vowel lengthening (e.g., /re/ → [re:]), vowel epenthesis (/re/ → [rei]), or consonant epenthesis (/rei/ → [ret]). Which of these is correct depends on further analysis. Ideally, what we want to find is an alternation in the language to give us a clue. Because the processes under consideration (lengthening, epenthesis) are technically triggered by FTBIN, then they should not occur when FTBIN is not at stake. Consider an affixed monosyllabic root:

(13) [re:] NOM, [rem] ACC

This alternation (re: in the unsuffixed NOM, re in the suffixed ACC) suggests that monomoraic inputs are made binary by vowel lengthening. Furthermore, there exist no alternations like the following:

(14) Hypothetical, nonexistent paradigm-types

([reti] NOM, [rem] ACC  ø NOM, [rem] ACC — as per fn. 2)

However, there are apparently no confirmatory nonalternations such as:

(15) Hypothetical and nonexistent paradigm-type

[re:] NOM, [re:m] ACC

The existence of paradigms like (15) would strengthen our case — they would have to be derived from bimoraic roots while paradigms like those in (13) would have to be derived from monomoraic roots, with vowel lengthening in the unaffixed case (to satisfy FTBIN). Since such paradigms do not exist, we must also assume that there is a complementary vowel shortening process in the affixed form (/re:m/ → [rem]). Fortunately for us, there are no long vowels in closed syllables in Latin to contradict such an analysis, and closed-syllable shortening is not an uncommon process. Suppose that lengthening or shortening violates the faithfulness constraint in (16a) and that closed syllables with long vowels violate the markedness constraint in (16b). Then, the ranking in (17) will do the trick.

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2 Prince & Smolensky consider a fourth possibility, the Null Parse, the idea being that absolute deletion could be the best of all possible worlds; see Orgun & Sprouse 1997/1999 (ROA-224/Phonology 16), Raffelsiefen 2004 (Phonology 21), McCarthy & Wolf 2005 (ROA-722). Epenthesis of an entire syllable (e.g., /re/ → [rei]) is also possible — think about how it could win.
Additional constraints and a ranking

a. IDENT(μ): A segment linked to x number of moras in the input corresponds with a segment linked to x number of moras in the output.}\(^3\)

b. BIMORA: Syllables are maximally bimoraic.

Recall the contrast among \([ \text{ré fi} \langle \text{cit} \rangle ], \ [ \text{re (fé:) } \langle \text{cit} \rangle ], \text{ and } [ \text{re (fèc) } \langle \text{tus} \rangle ]. \) The WSP (Weight-to-Stress Principle) forces less than exhaustive footing when the penult is heavy:

\[ \text{NONFINALITY forces the unparsed final syllable common to all of these candidates. An alternative to underparsing of the initial syllable is iambic footing: } [ \text{ré fi} \langle \text{cit} \rangle ], \] FTBD-L must dominates PARSE-σ to prevent this, but this requires a further ranking of IDENT(μ) above PARSE-σ, as shown in (19):

This may seem to lead us full circle to the conclusion that monomoraic inputs should simply remain unfooted, since that only violates lowest-ranked PARSE-σ while lengthening as in (17) further above violates higher-ranked IDENT(μ). But recall that ALIGN(Stem,Wd,L) (= ALIGN-L) is the undominated constraint effectively requiring at least one foot per word, independent of PARSE-σ. In fact, ALIGN-L is effectively a more specific (in the lingo, less stringent) version of PARSE-σ: ALIGN-L demands that at least one syllable be parsed, while PARSE-σ demands that all syllables be parsed. PARSE-σ is thus violated by any candidate that violates ALIGN-L, but PARSE-σ is also violated by other candidates.

\(^3\) There are a number of ways to formulate this constraint; I’ve made it maximally general to penalize not only vowel lengthening and shortening but also, e.g., consonant lengthening or shortening (gemination or degemination). You’ll find constraints in the literature with roughly this formulation called things like IDENT-WEIGHT or IDENT-LENGTH. Alternatively, this constraint has also been proposed to be split into its component parts, MAX-μ (to penalize shortening) and DEP-μ (to penalize lengthening).
4 Back to bisyllables

The analysis of word minimality raises a similar problem with an implicit part of the analysis of extrametricality. Assuming that there is extrametricality in all forms other than monosyllables, bisyllabic forms with an initial light syllable should be [(á) (qua)] and [(á) (mo:)]. The one foot is of course required by undominated ALIGN-L. However, the prediction so far is that this one foot should be boosted to bimoraic size due to the already-established [FTBIN ≫ IDENT(μ)] ranking. However, now that we are working with violable constraints, we are no longer committed to the assumption that all final (but noninitial) syllables are extrametrical. If both FTBIN and IDENT(μ) dominate NONFINALITY, then the optimal candidate is [(á qua)], not [(á) (qua)] or [(á:) (qua)].

(20) [FTBIN ≫ IDENT(μ) ≫ NONFINALITY]

<table>
<thead>
<tr>
<th>/aquə/</th>
<th>FTBIN</th>
<th>IDENT(μ)</th>
<th>NONFIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>[(á qua)] ~ [(á) (qua)]</td>
<td>W</td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>[(á qua)] ~ [(á:) (qua)]</td>
<td></td>
<td></td>
<td>L</td>
</tr>
</tbody>
</table>

In the case of a light-heavy sequence like ámo:, the necessary violation of WSP can be forced by ranking it below NONFINALITY. Note that the ranking of IDENT(μ) above WSP, necessary by transitivity through NONFINALITY, also serves to explain why the final syllable is not simply shortened.

(21) [FTBIN ≫ IDENT(μ) ≫ NONFINALITY ≫ WSP]

<table>
<thead>
<tr>
<th>/amo:/</th>
<th>FTBIN</th>
<th>IDENT(μ)</th>
<th>NONFIN</th>
<th>WSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>[(á mo:)] ~ [á (mó:)]</td>
<td></td>
<td></td>
<td>W</td>
<td>L</td>
</tr>
<tr>
<td>[(á mo:)] ~ [(á) (mo:)]</td>
<td>W</td>
<td></td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>[(á mo:)] ~ [(á:) (mo:)]</td>
<td>W</td>
<td></td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>[(á mo:)] ~ [(á mo)]</td>
<td>W</td>
<td></td>
<td>L</td>
<td></td>
</tr>
</tbody>
</table>

Interestingly: in pre-classical Latin, words like these were (optionally) scanned as light-light. *Mutatis mutandis*, Prince & Smolensky claim that this ‘iambic shortening’ is the result of WSP and PARSE-σ being ranked above IDENT(μ). (Quick: what consequence does this have for the scanning of réfецit?)

5 Summary ranking

ALIGN-L  FTBIN  BIMORA

(17)

(6)

IDENT(μ)

(20)

NONFINALITY

(6)

WDHD-R  WSP

(18)

PARSE-σ