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The Rhythmic Foundations of INITIAL GRIDMARK and NONFINALITY

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Two of the principal constraints of metrical stress theory stand out for their asymmetrical formulations.

- INITIAL GRIDMARK 'the initial element in a domain is stressed' (Prince 1983)
- NONFINALITY 'the final element in a domain is stressless' (Prince and Smolensky 1993)
  - NONFINALITY's predecessor, EXTRAMETRICALITY, is also taken to be asymmetrical (see Hayes 1995).

The purpose of this paper

- Demonstrate that the asymmetrical formulations of INITIAL GRIDMARK and NONFINALITY are justified
  - On typological grounds
    - There are numerous attested binary systems where clash or lapse is the result of an initial stress requirement or a final stresslessness requirement.
    - In contrast, binary systems where clash or lapse would be the result of initial stresslessness or final stress are unattested.
  - On rhythmic and phonetic grounds
    - Initial stress is desirable, because stress is compatible with the tempo acceleration at the beginning of words or phrases.
    - Final stresslessness is desirable, because stresslessness is compatible with the tempo deceleration at the end of words or phrases.
- Explain the relative rarity of iambic systems.
  - Iambic footing is marked because it tends to result in initial stresslessness and final stress.

Asymmetrical formulations
Crucially included in the constraint set:

(1) NONFINALITY and INITIAL GRIDMARK (following Hyde 2002, 2003)

Let *GCat* be an entry on a particular level of the metrical grid, *PCat* a prosodic category, and *Cat* a grid entry or prosodic category, then NONFINALITY and INITIAL GRIDMARK can be formulated as follows:

a. NONFIN(*GCat*, *Cat*, *PCat*): No *GCat* occurs over the final *Cat* of *PCat*.

b. INTGRID(*GCat*, *Cat*, *PCat*): A *GCat* occurs over the initial *Cat* of *PCat*.

(2) a. NONFIN(x_F, σ, ω): No foot-level gridmark occurs over the final syllable of a prosodic word.

b. INTGRID(x_F, σ, ω): A foot-level gridmark occurs over the initial syllable of the prosodic word.

Crucially excluded from the constraint set:

(3) NONINITIAL and FINAL GRIDMARK

a. NONINT(*GCat*, *Cat*, *PCat*): No *GCat* occurs over the initial *Cat* of *PCat*.

b. FINGRID(*GCat*, *Cat*, *PCat*): A *GCat* occurs over the final *Cat* of *PCat*.

(4) a. NONINT(x_F, σ, ω): No foot-level gridmark occurs over the initial syllable of a prosodic word.

b. FINGRID(x_F, σ, ω): A foot-level gridmark occurs over the final syllable of the prosodic word.

1 Evidence from the Typology of Binary Stress Patterns

There are four possible patterns that conform to the Perfect Grid (Prince 1983), a grid that contains neither clash nor lapse of gridmark entries.

- Minimal alternation: the fewest stresses possible without a lapse
  - Trochaic version in (5a) and iambic mirror image in (5b)
- Maximal alternation: the most stresses possible without a clash
  - Trochaic version in (5c) and iambic mirror image in (5d).
- All four Perfect Grid patterns are attested

(5) Perfect Grid Patterns

a. Trochaic Minimal Alternation

σ́σσ́σσ́σ

σσ́σσ́σσ́σ

Nengone (Tryon 1967)
Warao (Osborn 1966)

b. Iambic Minimal Alternation

σσ́σσ́σσ́

σσ́σσ́σσ́σ

Araucanian (Echeverria & Contreras 1965)

c. Trochaic Maximal Alternation

σ́σσ́σσ́σ

σ́σσ́σσ́σσ́

Icelandic (Árnason 1980, 1985)
Maranungku (Tryon 1970)

d. Iambic Maximal Alternation

σσ́σσ́σσ́

σ́σσ́σσ́σσ́

Suruwaha (Everett 1996)
Weri (Boxwell & Boxwell 1966)

While the possible Perfect Grid patterns are all attested, the possible departures from the Perfect Grid are not all attested.

- Reasons why a language might depart from the Perfect Grid in odd-parity forms:
    1. It is impossible to have initial stress and final stresslessness without a clash or a lapse.
    2. It is impossible to have final stress and initial stresslessness without a clash or a lapse.
- Only departures from the Perfect Grid required to maintain initial stress and final stresslessness – like the trochaic patterns in (6) – are attested.
- Departures from the Perfect Grid that would be required to maintain final stress and initial stresslessness – like the iambic mirror image patterns in (6) – are unattested.

(6) Clash and Lapse in Odd-Parity Forms

Trochaic Patterns	Iambic Patterns
a. σ́σσ́σσ́σ σ́σ́σσ́σσ́σ Maithili (Jha 1940-1944, 1958) Passamaquoddy (LeSourd 1993)	b. σσ́σσ́σσ́ σσ́σσ́σσ́σ́ *unattested*
c. σ́σσ́σσ́σ σ́σσσ́σσ́σ Garawa (Furby 1974) Spanish (Harris 1983)	d. σσ́σσ́σσ́ σσ́σσ́σσσ́ *unattested*
e. σ́σσ́σσ́σ σ́σσ́σσσ́σ Piro (Matteson 1965) Polish (Rubach and Booij 1985)	f. σσ́σσ́σσ́ σσ́σσσ́σσ́ *unattested*
g. σ́σσ́σσ́σ σ́σσ́σσ́σσ Pintupi (Hansen & Hansen 1969) Wangkumara (McDonald &Wurm 1979)	h. σσ́σσ́σσ́ σσσ́σσ́σσ́ *unattested*

Given a constraint set that includes only NONFINALITY, INITIAL GRIDMARK, and constraints that promote perfect binary alternation

- PERFECT ALTERNATION >> NONFINALITY, INITIAL GRIDMARK produces Perfect Grid patterns
- NONFINALITY, INITIAL GRIDMARK >> PERFECT ALTERNATION produces trochaic departures from the Perfect Grid.
- The unattested iambic departures from the Perfect Grid are harmonically bounded

In the tableaux in (7)

- (a-d) are the attested trochaic departures from the Perfect Grid.
- (g-j) are the unattested iambic mirror image patterns.
- (e,f) are the Perfect Grid Patterns

(7)

σσσσσσσ	NONFIN	INTGRID	PERFALT
☞ a. σ́σ́σσ́σσ́σ			*
☞ b. σ́σσσ́σσ́σ			*
☞ c. σ́σσ́σσσ́σ			*
☞ d. σ́σσ́σσ́σσ			*
e. σσ́σσ́σσ́σ		*!	
f. σ́σσ́σσ́σσ́	*!		
g. σσ́σσ́σσ́σ́	*!	*!	*
h. σσ́σσ́σσσ́	*!	*!	*
i. σσ́σσσ́σσ́	*!	*!	*
j. σσσ́σσ́σσ́	*!	*!	*

In (8), when NONINTIAL and FINAL GRIDMARK are added to the constraint set

- The iambic departures are no longer harmonically bounded.
- They emerge under NONINITIAL, FINAL GRIDMARK >> PERFECT ALTERNATION, NONFINALITY, INITIAL GRIDMARK.

(8)

σσσσσσσ	NONINT	FINGRID	PERFALT	NONFIN	INTGRID
a. σ́σ́σσ́σσ́σ	*!	*!	*		
b. σ́σσσ́σσ́σ	*!	*!	*		
c. σ́σσ́σσσ́σ	*!	*!	*		
d. σ́σσ́σσ́σσ	*!	*!	*		
e. σσ́σσ́σσ́σ		*!			*
f. σ́σσ́σσ́σσ́	*!			*	
☞ g. σσ́σσ́σσ́σ́			*	*	*
☞ h. σσ́σσ́σσσ́			*	*	*
☞ i. σσ́σσσ́σσ́			*	*	*
☞ j. σσσ́σσ́σσ́			*	*	*

Iambic-trochaic asymmetries

- Traditionally described as directional parsing asymmetries (Kager 1993, McCarthy and Prince 1993, and Hayes 1995)
- Actually due to the asymmetrical formulations of INITIAL GRIDMARK and NONFINALITY.

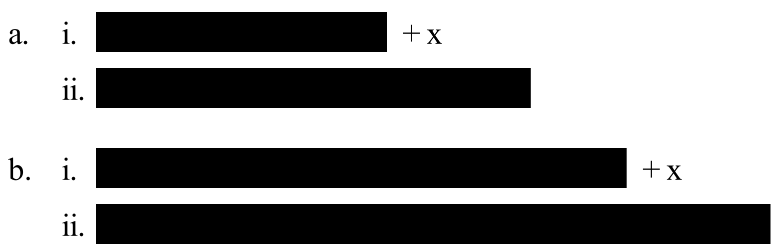
The preference for initial stress and final stresslessness explains the markedness and relative rarity of iambic systems.

2 Rhythmic and Phonetic Evidence

In Lunden's (2006, 2007) account, the crucial insight is that final stress avoidance is connected to phonetic final lengthening.

- Duration is an important cue for stress (Fry 1955, among others)
- Duration due to stress stands out better when added to shorter syllables and less well when added to longer syllables. See (9) below.
- A word-final syllable already has a long duration due to phonetic final lengthening, so additional duration is harder to notice.
- Word-final syllables are poor candidates, from a perceptual standpoint, for stress.

(9) The same increase does not have the same perceptual effect (connection to Weber's Law)



The problem is the focus on simple length: the longer a syllable is, the less stressable it should be, because the additional length should be more difficult to perceive.

- Does not account for positional asymmetry
  - Variation in syllable length not restricted to final position.
- Cross-linguistically greater length attracts stress. It does not repel stress.
  - There do not appear to be languages where stress avoids heavy syllables in favor of light syllables.

The nature of the lengthening appears to be the key

- It is well known that lengthening occurs in both initial and final syllables
- It is also well known that initial lengthening and final lengthening have different characteristics
    - (Variable) characteristics of final lengthening (Oller 1973, Wightman et al. 1992, among others)
        - Typically affects all rhyme segments to some degree
        - Often associated with decline in amplitude and devoicing
        - Often cumulative when multiple boundaries coincide
    - (Variable) characteristics of initial lengthening (Oller 1973, Keating et al. 2003, among others)
        - Typically limited to initial segment
        - Often associated with longer voice onset time and aspiration
        - Less typically cumulative when multiple boundaries coincide

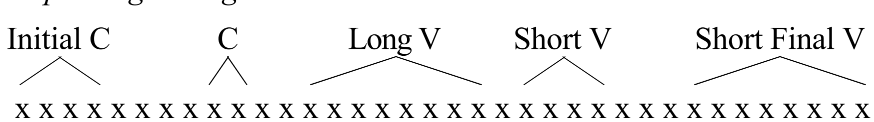
(Variable) characteristics of stressed syllables (Lieberman 1960, Beckman 1986, Gordon 2002, 2005, Smith 2003, and numerous others)

- Increased duration of rhyme
- Increased intensity
- Fortition/lengthening/aspiration of onset

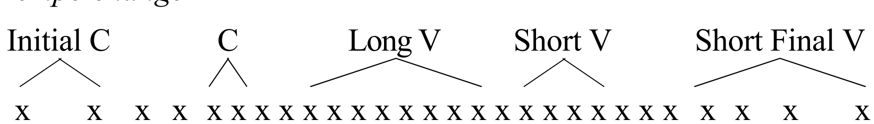
Two interpretations of initial and final lengthening

- *Simple lengthening*, illustrated in (10)
    - Short initial consonants and final vowels take up more metrical space (more beats) than short medial consonants and vowels.
    - Short initial consonants and final vowels are similar to long medial consonants and vowels.
- *Tempo change*, illustrated in (11)
    - Initial consonants and final vowels take up the same metrical space as medial consonants and vowels, but the time between beats is longer.
    - Despite their length, short initial consonants and final vowels differ from long medial consonants and vowels.
        - Initial consonants are part of an initial acceleration
        - Final vowels are part of a final deceleration.

(10) *Simple lengthening*



(11) *Tempo change*



A parallel in music suggests a tempo change

- Early and late half measures in a musical phrase have a slower tempo than medial half measures (Gabrielsson 1987, 1993)
  - Acceleration to medial tempo occurs during early half measures
  - Deceleration from medial tempo occurs during late half measures
- The tempo change in late half measures
  - Is much more pronounced
  - Appears to be cumulative when multiple boundaries coincide

In final syllables, stress is avoided because

- Dwindling intensity of deceleration may confound perception of final stress.
- Intensity of final stress may make it more difficult to decelerate.

In initial syllables, stresslessness is avoided because

- The intensity of an acceleration may confound perception of initial stresslessness.
- Lack of intensity of initial stresslessness may make it more difficult to accelerate.

3 Other NONFINALITY and INITIAL GRIDMARK constraints

Some of the additional INITIAL GRIDMARK and NONFINALITY constraints can be motivated on grounds similar to those discussed above.

- Some of the constraints discourage iambic footing
- Iambic footing typically leaves the initial syllable stressless and stresses the final syllable
- Initial stresslessness and final stress are marked

Some of the additional INITIAL GRIDMARK and NONFINALITY constraints must be motivated on different grounds.

3.1 Motivated by iamb markedness

(12) a. NONFIN(x_F, σ, F): No foot-level gridmark occurs over the final syllable of a foot.

b. INTGRID(x_F, σ, F): A foot-level gridmark occurs over the initial syllable of the foot.

- As indicated in (13), NONFIN(x_F, σ, F) prefers trochees to iambs and monosyllables
- As indicated in (14), INTGRID(x_F, σ, F) prefers trochees and monosyllables to iambs
- By discouraging iambic footing, NONFIN(x_F, σ, F) and INTGRID(x_F, σ, F) both promote initial stress and final stresslessness.

(13) Preferences of NONFIN(x_F, σ, F)

(σ́σ) ≻≻ (σσ́),(σ́)

(14) Preferences of INTGRID(x_F, σ, F)

(σ́σ),(σ́) ≻≻ (σσ́)

3.2 Partially motivated by iamb markedness

3.2.1 Moraic NONFINALITY in the foot

(15) NONFIN(x_F, μ, F): No foot-level gridmark occurs over the final mora of a foot.

As indicated in (16), NONFIN(x_F, μ, F) prefers LL trochees over LL iambs

- By discouraging iambic footing, NONFIN(x_F, μ, F) promotes initial stress and final stresslessness.

NONFIN(x_F, μ, F) also prefers LH iambs over LL iambs

- Does not discourage iambic footing
- Motivated by Iambic-Trochaic Law in (17).

(16) Preferences of NONFIN(x_F, μ, F)
(μ́.μ), (μ.μ́μ) ≻≻ (μ.μ́)

(17) Iambic-Trochaic Law (Hayes 1995)
a. Elements contrasting in intensity naturally form groupings with initial prominence.
b. Elements contrasting in duration naturally form groupings with final prominence.

3.2.1 Podal NONFINALITY in the Prosodic Word

(18) NONFIN(x_ω, F, ω): No prosodic word-level gridmark occurs over the final foot of a prosodic word.

As indicated in (19), NONFIN(x_ω, F, ω) prefers primary stress to fall on a nonfinal foot, regardless of whether the final foot is iambic, trochaic, or monosyllabic.

(19) Preferences of NONFIN(x_ω, F, ω)
a. …(σ́σ)(σ̀σ) ≻≻ …(σ̀σ)(σ́σ)
b. …(σ́σ)(σ̀) ≻≻ …(σ̀σ)(σ́)
c. …(σσ́)(σσ̀) ≻≻ …(σσ̀)(σσ́)

The avoidance of each of these final foot types can be seen in Paumari and Banawá.

- In Paumari, (20), final feet are always iambic.
- In Banawá, (21), final feet can be trochaic, iambic, or monosyllabic.

(20) Paumari primary stress (Everett 2003)

a.	(kabá)(hakì)	'to get rained on'
b.	(à)(haká)(barà)	'dew'
c.	(athà)(nará)(rikì)	'sticky consistency'
d.	(bikà)(nathà)(rará)(vinì)	'to cave in, to fall apart quickly'

(21) Banawá primary stress (Buller, Buller, and Everett 1993; Everett 1996, 1997)

a. (abá)(rikò) 'moon'

b. (mètu)(wási)(mà) 'find them'

c. (tìna)(rífa)(bùne) 'you are going to work'

When NONFIN(x_ω, F, ω) prevents primary stress on a final iamb or monosyllable

- Prevents an especially prominent stress from occurring on the final syllable.

The same justification not available when primary stress avoids a final trochee

- A final trochee with primary stress does not position stress on the final syllable.
- The idea that final trochees are marked because phonetic final lengthening creates something too much like an LH trochee (Lunden 2006, 2007) is not especially plausible.
  - Why? Final trochees are very common.
- Is motivation in every context necessary to ground a constraint?
- Can the trochee case piggyback on the iamb and monosyllable cases?

3.3 Not motivated by iamb markedness

(22) a. NONFIN(x_F, μ, σ): No foot-level gridmark occurs over the final mora of a syllable.

b. INTGRID(x_F, μ, σ): A foot-level gridmark occurs over the initial mora of the syllable.

As indicated in (23), NONFIN(x_F, μ, σ) prefers stressed heavy syllables to stressed light syllables (see Hyde 2006, 2007b).

- PEAK PROMINENCE (Prince and Smolensky 1993), STRESS-TO-WEIGHT (Hammond and Dupoux 1996 and numerous others)
- Stress on heavy syllables motivated by their perceptual prominence (Gordon 2002, 2005)

As indicated in (23) and (24), in heavy syllables, NONFIN(x_F, μ, σ) and INTGRID(x_F, μ, σ) both position stress over the most prominent part of the rhyme

- Discourage stressed codas in closed syllables.
- Discourage stress on less sonorous vowel in diphthongs.
- Beginning of the rhyme (after a consonant) is perceptually prominent (Smith 2003, Gordon 2005)
- See Hyde 2007a for discussion of INTGRID(x_F, μ, σ) or FIRSTMORA

(23) Preferences of NONFIN(x_F, μ, σ)

CV́V, CV́C ≻≻ CV́, CVV́, CVĆ

(24) Preferences of INTGRID(x_F, μ, σ)

CV́V, CV́C ≻≻ CVV́, CVĆ

4 Conclusions and questions for future research

Conclusions

- Asymmetrical formulations of INITIAL GRIDMARK and NONFINALITY justified by their typological predictions.
- Asymmetrical formulation of many INITIAL GRIDMARK and NONFINALITY constraints also justified on rhythmic and/or phonetic grounds.

Questions about the relationship between phonetics and phonology

- Is it necessary for all of the specific constraints arising from a general formulation to be phonetically grounded?
- Is grounding of some of the specific constraints reason enough to expect to see the effects of others that are not grounded?
- Is it necessary for all of the specific constraints arising from a general formulation to be grounded in the same way?

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