Experiment Approaches to OT
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What is behind NonFinality?*

1 Introduction

Extrametricality stipulates a prosodic unit set aside before higher levels of prosody are assigned (Liberman & Prince 1977, Hayes 1979, Mohanan 1979, Hayes 1981, Steriade 1980).

(1) Three kinds of extrametricality
   a. Final foot: $< (\sigma\sigma) >$
   b. Final syllable: $< \sigma >$
   c. Final consonant: <C>

Re-thought in OT (Prince & Smolensky 1993) as a prohibition against word-final stress:

(2) NonFinality: No head of PrWd is final in PrWd (1993:52)

But neither is motivated beyond the fact that they allow what would otherwise be an irregularity to be captured under the regular stress pattern of the language.

I propose that extrametricality effects are motivated by the phonetic properties of the right edge, specifically, phonetic final lengthening.[1]

(3) Advantages of proposal over extrametricality/NonFinality
   - •Grounded in phonetic facts
   - •Based on perceptual saliency
   - •Accounts for the left–right asymmetry of extrametricality/NonFinality effects.
   - •Predicts gap of final vowel extrametricality

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[1] Ahn 2000 has also made a connection between final lengthening and stress placement, arguing for stress placement preferences based on contrasts present in a sequence of syllables.

2 History and Issues

Stress systems often behave oddly at or near the right edge.

(4) Final syllable stress avoidance in Right-Aligned stress systems (data from Hayes 1995)

a.	Latin	$\acute{\mu}\mu$	$\breve{\smile}(\acute{\breve{\smile}}\breve{\smile})$–	*$\breve{\smile}\breve{\smile}\breve{\smile}(\acute{\breve{\smile}})$
b.	Hixkaryana	$\mu\acute{\mu}$	/$\breve{\smile}\breve{\smile}\breve{\smile}\breve{\smile}$/ → (–)$\breve{\smile}\breve{\smile}$[2]	*(–)(–)
c.	Delaware	$\mu\acute{\mu}$	(–)($\acute{\breve{\smile}}$)(=)	*(–)(–)(=)

(5) Final syllable excluded from footing in Right-Aligned stress systems (Hayes 1995)

a.	Latin	$\acute{\mu}\mu$	$\breve{\smile}(\acute{\breve{\smile}}\breve{\smile})\breve{\smile}$	*$\breve{\smile}\breve{\smile}(\acute{\breve{\smile}}\breve{\smile})$
b.	Cayuvava	$\acute{\sigma}\sigma$	$\sigma(\acute{\sigma}\sigma)\sigma$	*$\sigma\sigma(\acute{\sigma}\sigma)$
c.	Arabic	$\acute{\mu}\mu$	$(\acute{\breve{\smile}}\breve{\smile})\breve{\smile}\breve{\smile}$	*$\breve{\smile}\breve{\smile}(\acute{\breve{\smile}}\breve{\smile})$

(6) CVC weight asymmetry: CVC is heavy non finally but behaves as light word finally.[3]

Some such languages may still have final stress if superheavy syllables can surface in this position: CV.CV́ː C, CV.CV́CC, but *CV.CV́C (Arabic, Norwegian, Swedish).

2.1 Extrametricality

(7) Final syllable extrametricality

a.	Latin	$\acute{\mu}\mu$	$\breve{\smile}(\acute{\breve{\smile}}\breve{\smile})$<–>
			$\breve{\smile}(\acute{\breve{\smile}}\breve{\smile})$<$\breve{\smile}$>
b.	Hixkaryana	$\mu\acute{\mu}$	/$\breve{\smile}\breve{\smile}\breve{\smile}\breve{\smile}\breve{\smile}$/ → (–)$\breve{\smile}$<$\breve{\smile}$>
c.	Cayuvava	$\acute{\sigma}\sigma$	$\sigma(\acute{\sigma}\sigma)$< σ >

(8) Final foot extrametricality

a.	Delaware	$\mu\acute{\mu}$	(–)($\acute{\breve{\smile}}$)<(=)>
b.	Arabic	$\acute{\mu}\mu$	$(\acute{\breve{\smile}}\breve{\smile})$<$(\breve{\smile}\breve{\smile})$>

(9) Final consonant extrametricality

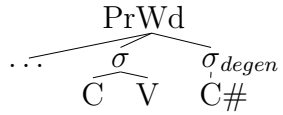
heavy final syllables	CVː<C>
	CVC<C>
	CVV
light final syllable	CV<C>

Such final consonants can be taken to be onsets of degenerate syllables (e.g. Steriade 1982, Rice 1999).

[2] There is regular rhythmic lengthening of all iambs in the language. Main stress is apparently assigned independently, based on the intonational structure of the word (Derbyshire 1985 as reported in Hayes 1995).

[3] Arabic (McCarthy 1979), English (Chomsky & Halle 1968), Estonian (Prince 1980), Greek (Steriade 1980), a dialect of Hindi (Hayes 1981, citing Mohanan 1979), Icelandic (Kiparsky 1984), Menomini (Hayes 1995), Norwegian (Kristoffersen 1991), Ponapean (McCarthy & Prince 1986), Romanian (Steriade 1984), Swedish (Riad 1992), and Swiss German (Spaelti 1994).

(10) Final degenerate "syllable"



2.2 NonFinality

Phenomena in (7)–(9) can be viewed as the prohibition of the head foot falling at the right edge of the prosodic word.

(11) NonFinality: The Head Foot is not final in the Prosodic Word (P & S 1993:52)

(12) Rightmost: The right edge of the head foot is aligned with the right edge of the prosodic word[4]

(13) a. NonFinality ≫ Rightmost: Extrametricality effects
b. Rightmost ≫ NonFinality: No extrametricality effects

(14) Example of extrametricality in OT (Latin *ami:kus* 'friend')

	/ami:kus/	NonFinality	Rightmost
☞ a.	a(mí:)kus		σ
b.	ami:(kús)	∗!	

Final consonant extrametricality also captured by NonFinality, given that a language may violate strict prosodic succession (Selkirk 1984, Nespor & Vogel 1986, Ito & Mester 2003/1992, Hyde 2003).

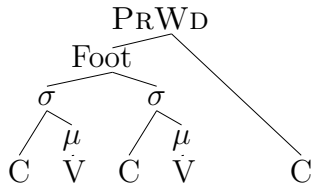
(15) Prosodic hierarchy (Selkirk 1984)

ϕ	phonological phrase
Wd	prosodic word
Ft	foot
σ	syllable
μ	mora

[4]Shown here to be violated gradiently, pace McCarthy (2003), in order to emphasize the tension between NonFinality and Rightmost.

The final consonant in (16) is appended to the prosodic word (Rubach & Booij 1990, Rosenthall & van der Hulst 1999) and therefore violates strict prosodic succession.

(16)



(17) 'construct'

	/kʌnstrʌkt/	Non Finality	Rightmost	*Append-to PrWd
☞ a.	kən.(strʌ́k).t		t	∗
b.	kən.(strʌ́kt)	∗!		
c.	(kʌ́n).strəkt		st!rəkt	

2.3 Qualms

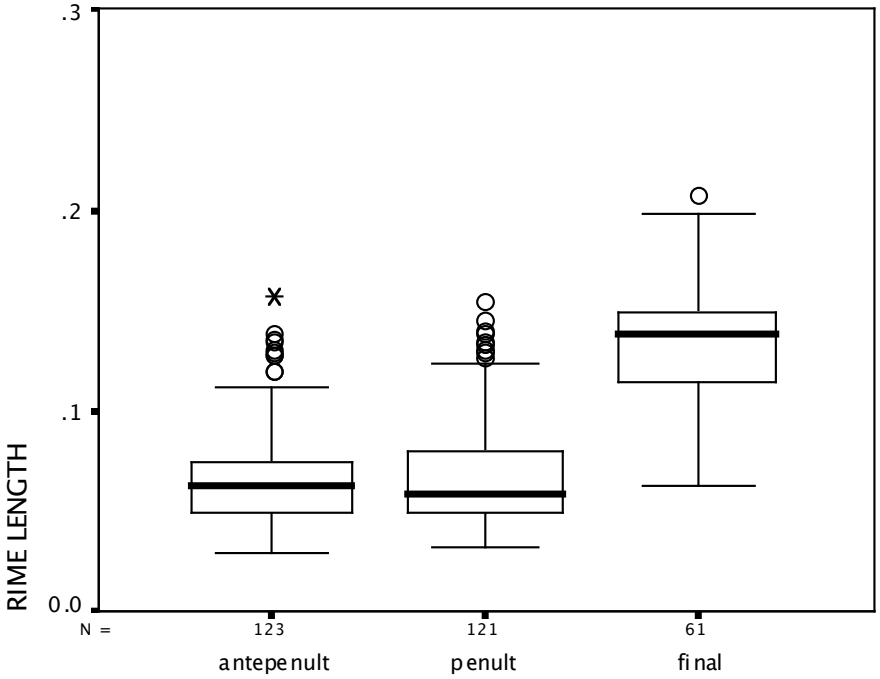
- No clear motivation– still leaves us wondering *why*
- Degenerate σ/C-appendix purely theoretical as final C pronounced as part of the final syllable
- Cannot account for languages like Chickasaw and Klamath which allow CVVC to be stressed word finally but not CVCC (Gordon 2000)

3 A new look at extrametricality/NonFinality effects

Why should final stress be avoided?

Phonetic final lengthening affects segment duration at prosodic boundaries (word, phrase, utterance) (Oller 1973, Lindblom & Rapp 1973, Crystal & House 1990, Horne et al. 1995, et al.).

(18) Norwegian unstressed CV rime length by syllable position



Penult and antepenult CV are not significantly different (p=.861) but CV in final position is significantly different (p<0.0001).

Word-level final lengthening can account for extrametricality/NonFinality effects.

- Final lengthening can throw off trochaic feet
- Final lengthening makes durational cues to stress difficult to perceive
- Final lengthening affects the syllable shape-to-weight relationship

Hayes (1995:100) points to final lengthening as a probable reason for many analyses postulating degenerate feet: that final lengthening might cause the perception of a final secondary stress.

3.1 Foot extrametricality

Languages avoid ($\acute{\sigma}\sigma$)# because given the phonetic length of CV# the durational prominence is more like that of (ĹH).

(19) Palestinian Arabic (Hayes 1995)
- a. (CV́.CV).CV.CV
- b. (CVC).(CV́.CV).CV
- c. (CV.CV).(CV́.CV).CV

Form (19-a) would violate NonFinality if parsed as *(CV.CV).(CV́.CV). But CV́.CV# is a bad trochee, given final lengthening.

(20) Average vowel duration in Jordanian Arabic (Ahn 2000:118)

	Final	Penult	Antepenult
Stressed CV**:**	**173 ms.**	137 ms.	127 ms.
Unstressed CVC	**73 ms.**	51 ms.	46 ms.
Unstressed CV	**81 ms.**	65 ms.	57 ms.

While (ĹH) violates Weight-to-Stress "If heavy then stressed" (Prince 1990) a final CV is only *phonetically* long.

*(CV.CV).(CV́.CV) can be ruled out without stimulation as long as *phonetic* length can be referenced. Perhaps something like (21):

(21) Concide(Prominence, FootHead): Any prominence (weight, duration, pitch) must coincide with the head of the foot.

(22) Palestinian Arabic

	/CVCVCVCV/	All-Feet-Left	Concide(Prom, FtHd)	Rightmost
☞ a.	(CV́CV)CVCV			$\sigma\sigma$
b.	CVCV(CV́CV)		*!	
c.	CV(CV́CV)CV	σ!		σ

Many languages seem to be able to disregard this, however, as penultimate stress is common in trochaic languages, suggesting is not as bad as a true (ĹH) trochee: e.g. Cavineña (Tacanan, Bolivia), Djingili (West Barkly, Northern Territory, Australia), Piro (Arawakan, Eastern Peru), Warao (Pezan, Venezuela). Rightmost ≫ Concide(Prominence, FootHead)

3.2 Syllable extrametricality

Duration is a major cue to stress (Fry 1955, et al.). But increased duration due to stress will not stand out word-finally.

(23) The same increase does not have the same perceptual effect (Weber's law)

a. i.  + x

ii. 

b. i.  + x

ii. 

A word-final syllable already has a relatively long duration and so additional duration gets "lost".

Other word-final issues:

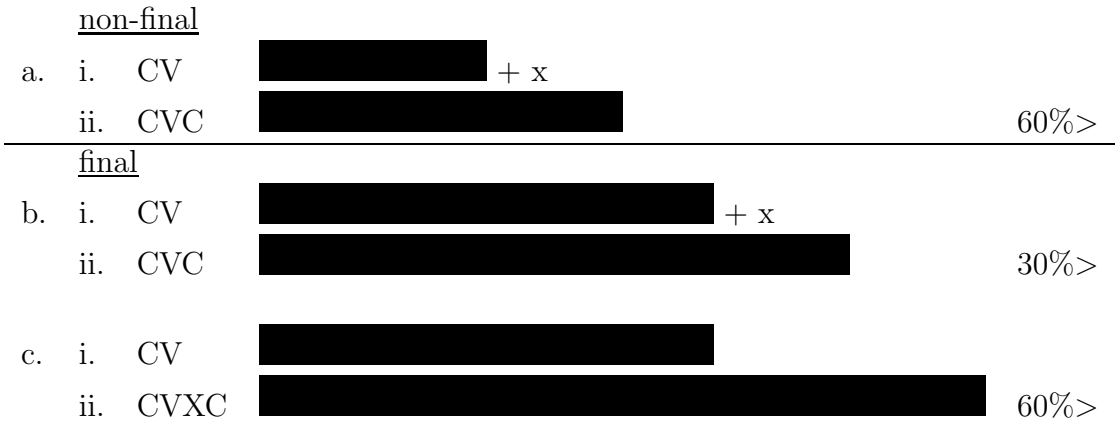
- Pitch is also a stress cue, and boundary tones may interfere with this being well-perceived (Gordon 2000).
- Final devoicing also confounds the perception of word-final syllables (Myers & Hansen in press).

There are languages that allow final stress: e.g. Auca (unclassified, Ecuador), Creek (Muskogean, Oklahoma), Sentani (Sentani family, New Guinea), Maithili (Indo-Aryan, India and Nepal). Cue(s) to stress not at odds with phonetics of final position?

3.3 Consonant extrametricality

Additional length is needed in final position for light/heavy syllables to be perceptively distinct.

(24) Perceptual basis of CVC weight asymmetry



A CVC fails to sufficiently contrast with a CV but a CVXC sets itself apart from a final CV in the same way a CVX syllable does compared to a CV non-finally. Duration of final consonant plays a role, it is not set aside.

4 Proportional increase theory of weight

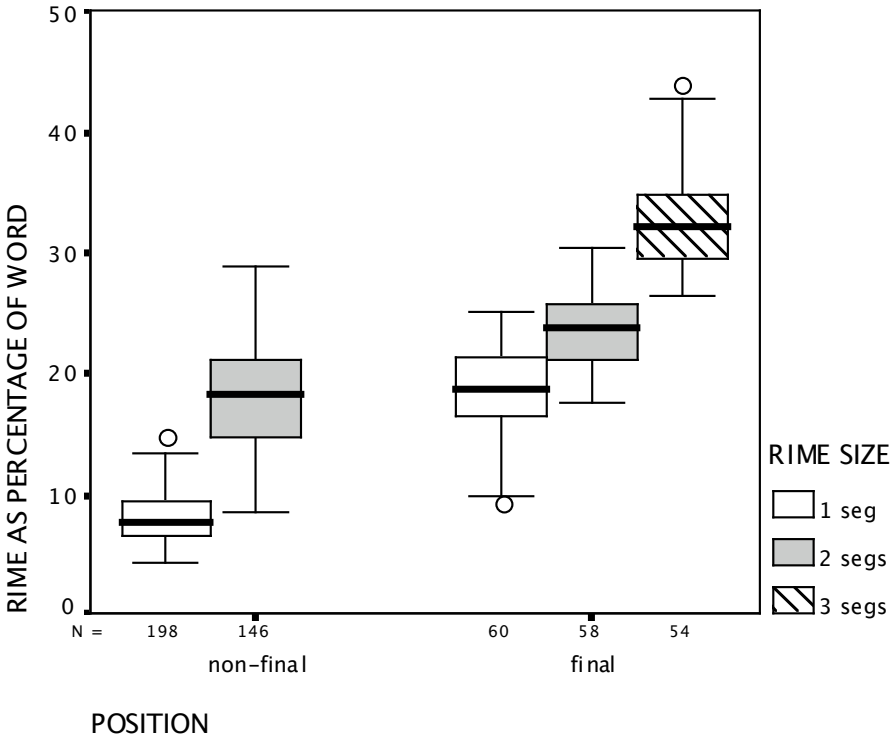
Phonetic length experiment (Lunden 2006):

- Four native Norwegian speakers
- Words of the basic form *katapa* (modified by codas), marked for stress with capital letters (i.e. KAtapa)
- Spoken in carrier phrase *Æ liker* _____ *og smør* ('I like _____ and butter', written in Vest-Agder dialect)
- Each segment duration measured using Praat (Boersma & Weenink 1992–2007)

- Ratio of rime length to word length taken to control for speech rate.

Relation between weight and duration: heavy syllables are significantly longer than light syllables.

(25) Rime/word percentage by syllable position and size



(26)

a. i.  + x

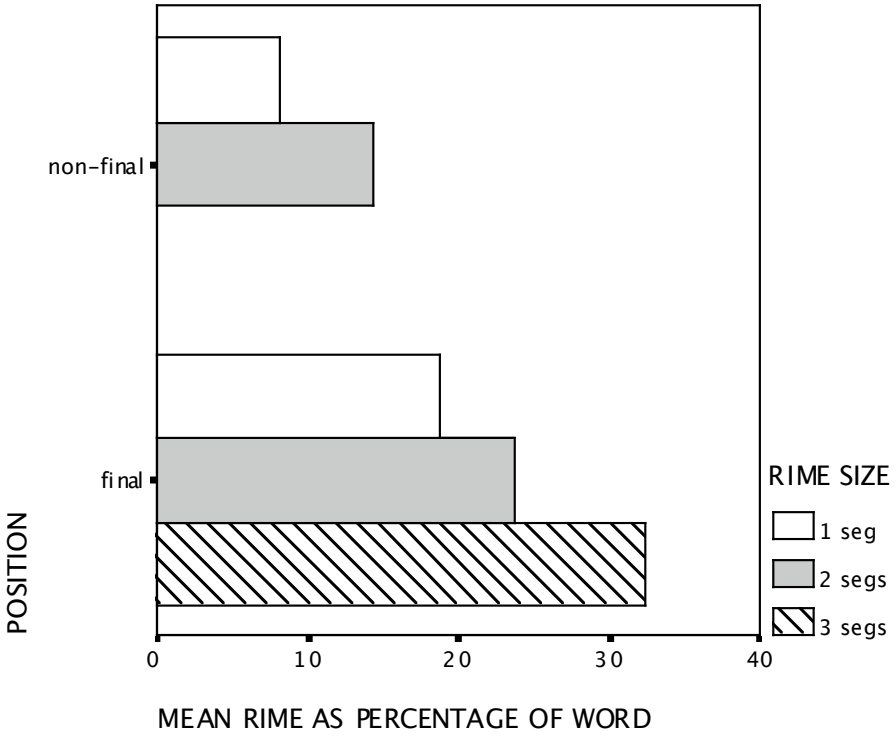
ii.  60% increase

b. i.  + x

ii.  30% increase

iii.  60 % increase

(27) Rime/word percentage by syllable position and size



Taking CV as the baseline since it is light in all positions, what remains constant is the proportional increase threshold.

(28) proportional increase $= \frac{\sigma\ rime/word}{CV in-the-same-position\ rime/word} - 1$

☞A syllable is heavy if (on average) it represents a significant proportional increase over a CV in the same position. The proportional increase threshold seems to be about 60%.

(29) Proportional increase and associated phonological weight

		increase over same-position CV̆	at least 60% increase?	phonological weight
non	CV	0%	no	μ
final	CVː	88%	yes	$\mu\mu$
	CVC	80% (162%)	yes	$\mu\mu$
	CVC.ː	157%	yes	$\mu\mu$
word	CV	0%	no	μ
final	CVC	27%	no	μ
	CVːC	68%	yes	$\mu\mu$
	CVCː	74%	yes	$\mu\mu$
	CVCC	74%	yes	$\mu\mu$

Given the proportional increase threshold, Norwegian speakers learn what shapes in what position have what weight.

This information is encoded as a constraint on GEN.

A syllable in a particular utterance may or may not have the correct duration for its weight but will count as heavy if, on average, such syllables reach the proportional increase threshold.

4.1 Consequences for moraic theory

Binary distinction between light and heavy syllables maintained, but weight is now a property of *syllables*, not *segments*, as assumed under moraic theory (MT) (Hyman 1985, Hayes 1989).

There are problems with the theory of segmentally-associated moras:

- Moras do not always correctly reflect syllable weight: contour tone hosting (Zhang 2002), CVC weight asymmetry
- In MT a geminate is a consonant with an underlying mora, Onset creates the geminate, it is not inherently long (type of underspecification)
- In MT length is a(n assumed) consequence of weight but duration is the primary perceptual distinction between geminates and singletons (Lahiri & Hankamer 1988, Hankamer, Lahiri & Koreman 1989, Abramson 1999).

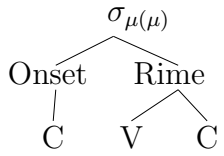
(30) Incorrect prediction: If Onset is ranked low, VC.V syllabification

	/CVC_μV/	MaxLink$_\mu$[5]	*Geminate/*Long	Onset
☞ a.	CVC_μ.V			*!
b.	CV.CV	*!		
c.	CVC_μ.ːV		*	

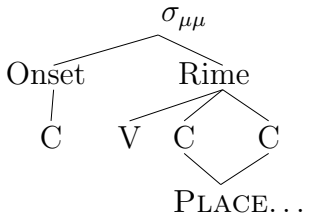
I treat root nodes as timing slots (Selkirk 1990).

(31)

a. CVC



b. CVC:



5 Conclusion

The proportional increase theory of weight is an improvement over extrametricality and NonFinality.

- Motivated by facts of perception (same increase has more effect when original length is shorter).
- Doesn't single out word final position in any way. Word final syllables are held to the same weight standard as all other syllables.
- Borne out by phonetic facts of Norwegian

Appealing to the effects of word-final lengthening

- Explains the initial/final asymmetry of extrametricality/NonFinality effects
- Gives a testable explanation why there is no final-vowel extrametricality effect: vowels are inherently longer than consonants (so CVV#[6]will reach the threshold where CVC# fails to do so)

[5] MaxLink$_\mu$[seg]: For two corresponding segments, if S_1 is associated to a mora, then S_2 is associated to a mora (Morén 1999).

[6] Vowel length is neutralized word-finally in many languages, due to the inherent difficulties of perceiving length contrasts in this position (Myers & Hansen in press). A final long vowel in Norwegian is categorized as light (although it reaches the proportional increase threshold) while a final diphthong is categorized as heavy since the change in vowel quality signals phonological length (Lunden 2006:87).

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