

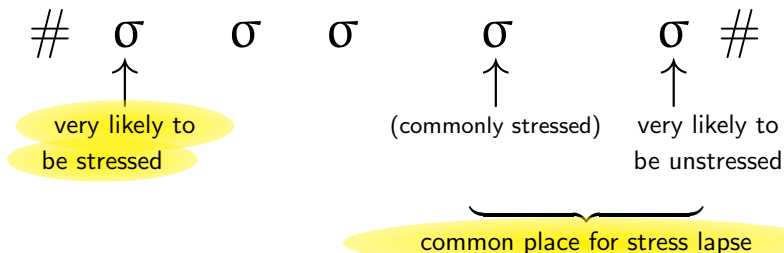
Motivating stress system asymmetries

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August 16, 2014

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Stress tendencies



Reflected in Constraints:

- ▶ INITIALGRIDMARK (Hyde 2001) / INITIALSTRESS (Hyde 2014)
- ▶ NONFINALITY (Prince & Smolensky 1993)
- ▶ LAPSE-AT-END (Kager 2001)

Preference for #ó

Reflected in

- ▶ Pattern “popularity”
 - ▶ Popularity of L→R trochees: 83/172 (StressTyp; Rhythm=Y)
 - ▶ Unpopularity of L→R iambs: 21/172
 - ▶ Likelihood for R→L iambs to have degenerate feet: 8/9 (Gordon 2002 + StressTyp)
- ▶ Adjustments found
 - ▶ Shift to the left, e.g. the *àbracadábra* pattern of English
 - ▶ Preference for even-syllabled words in R→L trochaic language Yidij (via syllable deletion)

Final Lapse

- ▶ Initial lapse can be found (Kager 2012) but there's a clear asymmetry
- ▶ Ignoring extrametricality/Nonfinality, final lapse only potentially arises with Left-to-Right trochees

L→R trochees (σ́σ)(σ́σ)σ / (σ́σ)(σ́σ)(σ́)

L→R iambs (σσ́)(σσ́)σ

R→L trochees σ(σ́σ)(σ́σ)

R→L iambs σ(σσ́)(σσ́)

Prevalence of final lapse tolerance in L→R trochaic systems

$(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)\sigma$ N=34

$(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)(\acute{\sigma})$ N=13

Based on 83 Direction=L and RhythmType=tr in StressTyp, sorted through to exclude non-rhythmic and right-aligned head foot cases

If the prevalence of final lapse in these cases is due to extrametricality/nonfinality, we should find the same tendency in R→L trochees.

$\sigma(\acute{\sigma}\sigma)\sigma$ N=2

$\sigma\sigma(\acute{\sigma}\sigma)$ N=30

Based on 60 Direction=R and RhythmType=tr in StressTyp, sorted through to exclude non-rhythmic and left-aligned head foot cases

Framework, goals

Goal:

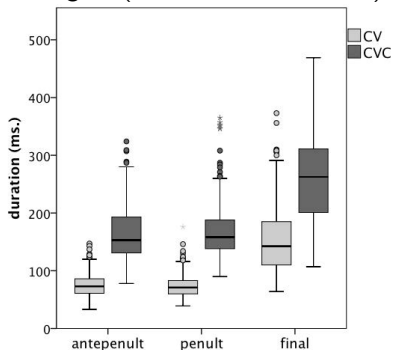
Perceptual motivation for initial stress, final lapse.

- ▶ Foot agnostic (OT accounts employ footless constraints, but this isn't crucial)
1. Reanalysis of final stress lapses, crucially referencing a language's phonetic properties
 - ▶ Case studies of L→R trochaic systems
 - ▶ OT analysis and experimental support
 - ▶ Side note on L→R iambic systems
 2. Cataloging the relevant phonetic properties across languages
 - ▶ Issues and current findings
 3. Expanding on the experimental findings
 - ▶ Additional variables, native language effects
 - ▶ Related perceptual evidence for initial stress

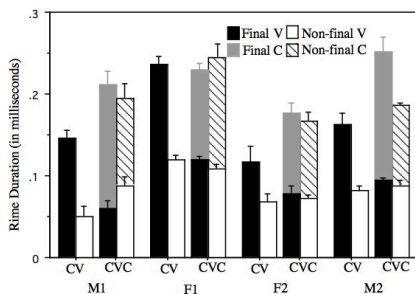
Final lengthening

Final lengthening (FL) is a cross-linguistic force, present to varying degrees in most languages.

Norwegian (data from Lunden 2006)



Egyptian Arabic (Gordon et al 2010)



Final lengthening and stress

Hayes (1995) suggests final lengthening accounts for “stresses” heard on final syllables for what would need to be a degenerate foot (as his theory limits degenerate feet to strong positions).

Potentially some FL prominence mistaken for stress by field linguists but assumption is FL isn't so confusable with *stress*. And if this were a common issue then we wouldn't see the large number of final stress lapse languages that we do.

Prediction

If prominence from FL is “good enough,” languages with duration in their realization of stress and FL can tolerate a final stress lapse.

No prediction that such languages *should* tolerate final lapse.

If stress is right-aligned, there's no benefit:

σσσσ] = Good for Align-R
σσσσ] = Worse(/equal) for Align-R,
albeit fine for Prom-Lapse

But if stress is left-aligned, there is a benefit:

[σσσσ = Good for Align-L, fine for Prom-Lapse
[σσσσ = Worse for Align-L

Question 1

Is *all* final lapse explainable with *PROMINENCE-LAPSE (i.e. it's not really a lapse)?

- ▶ This would be surprising, since internal lapses can be tolerated
- ▶ Expectation is that *PROMINENCE-LAPSE can be violated by winning candidates in some languages (which is what we'd expect of a constraint)

Question 2

Why do some L→R trochaic languages nevertheless avoid final stress lapse?

Strong hypothesis: Such languages either

1. Don't have duration as a stress cue OR
2. Suppress FL to a sufficient degree

⇒ And therefore, *PROMINENCE-LAPSE should replace *LAPSE

Weak hypothesis: Languages can also care specifically about *stress lapse*

⇒ The system needs both *LAPSE and *PROMINENCE-LAPSE

Finnish

In all-light-syllabled words: Stress occurs on the initial syllable, secondary stress on every other syllable following, but never on the final syllable; i.e. $\acute{\sigma}\sigma\grave{\sigma}\sigma$

Suomi & Ylitalo (2002): Found that syllables in stressed positions were longer than those in unstressed positions.

Myers & Hansen (2007) found a significant degree of final lengthening in Finnish

So, arguably, $\acute{\sigma}\sigma\grave{\sigma}\sigma$ doesn't contain a *prominence lapse*.

In formal speech, primary stress is word-initial and secondary stress occurs on every other syllable following; i.e. $\acute{\sigma}\sigma\grave{\sigma}\grave{\sigma}$

Duběda & Votrubec (2005): Used a neural network model indicative of human perception and found that F0 was the best predictor of stress.

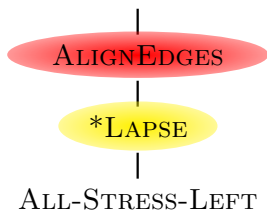
Since stress is not realized with duration in the language, $\acute{\sigma}\sigma\grave{\sigma}\acute{\sigma}$ *would* contain a prominence lapse.

Finnish

	/opettelemanani/ 'as something I have been learning'	*PROM- LAPSE	*CLASH	ALL-STRESS LEFT
☞	a. ó.pet.tè.le.mà.na.ni			6[2]
	b. ó.pet.tè.le.mà.na.nì			12![3]
	c. o.pét.te.lè.ma.nà.ni			9![3]
	d. o.pet.té.le.mà.na.ni	*!		6[2]

cf. Gordon (2002)-type ranking:

NONFIN, *CLASH, PRIMARYSTRESSLEFT



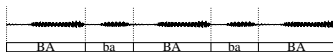
Czech

	filologicky 'philological'	PRIMARY STRESS-LEFT	*PROM- LAPSE	*CLASH	ALL-STRESS LEFT
☞ a.	fí.lo.lò.gi.ckỳ				6[2]
b.	fí.lo.lò.gi.cky		*!		2[1]
c.	fi.ló.lo.gì.cky	*!			4[2]

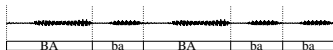
Experimental support

Prediction: If FL-as-prominence hypothesis is correct, a string of alternating syllables ending with a final stress lapse but a FL syllable should be confusable with a string that alternates in stress throughout.

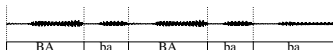
- ▶ Syllables created with the speech synthesizer MBROLA.
- ▶ Praat used to adjust intensity and concatenate into strings.



alternating



final lapse



final stress lapse but FL

Experiment set-up

Participants were users of Amazon's Mechanical Turk.

Subjects were given strings without edge syllables as examples and practice, and instructed to categorize each string as alternating in prominence or failing to.

Where '3' represents a stressed syllable, '1' represents an unstressed syllable, and '2' represents an unstressed syllable with the phonetic characteristics of the appropriate edge, experiments consisted of

- ▶ 31313 (x2) (fully alternating)
- ▶ 11313 (initial lapse)
- ▶ 21313 (initial lapse with initial strengthening)
- ▶ 31311 (final lapse)
- ▶ 31312 (final lapse with final lengthening)

constructed as three sets, (*ba*, *bi*, *bu*), for a total of 18 stimuli, which were repeated 4 times each.

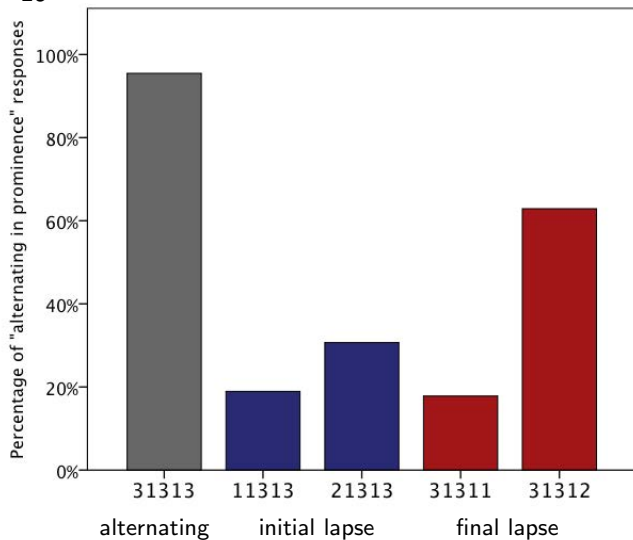
Data weeding

After each experiment iteration was run, results were examined with respect to three exclusion criteria.

1. A significant number of very short response times, indicating that they responded before the syllable string had finished playing.
2. Failure of more than 1 of the 3 test/practice questions
3. Failure to correctly identify more than two-thirds of the alternating test strings

Responses when duration was a cue to stress

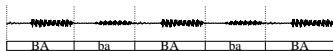
N=19



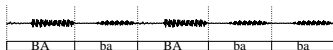
Experiment in which duration was NOT a cue to stress

Same set up, except that stressed syllables in stimuli were louder and higher pitched, but not longer, than unstressed syllables.

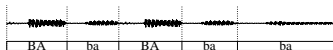
alternating



final lapse

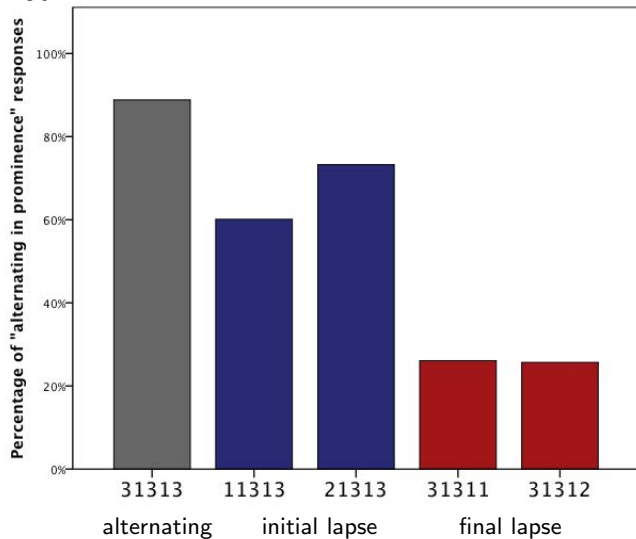


final stress lapse but FL



Responses when duration was NOT a cue to stress

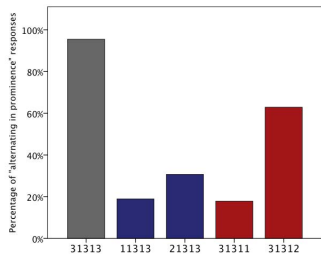
N=30



Violation of *PROM-LAPSE is stress cue dependent

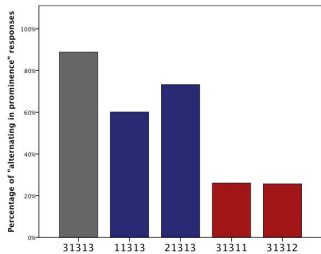
i.e. Finnish

/σσσσσ/	*PROM LAPSE	*CLASH	ALL-STRESS LEFT
☞ óσσσσ			2[1]
óσσσσ			6!2]



i.e. Czech

/σσσσσ/	*PROM LAPSE	*CLASH	ALL-STRESS LEFT
óσσσσ	*!		2[1]
☞ óσσσσ			6!2]



FL-as-prominence hypothesis can also motivate stopping-short patterns

Focus has been on L→R trochees, with a reanalysis that does not need NONFINALITY. However, NONFIN can still be seen to be active.

Hixkaryana is analyzed as iambs from the left with an unstressable final syllable

	/atʃowowo/ 'wind'	STRESS- TO-WEIGHT	*PROM- LAPSE	NON FIN	ALL- STRESS-Rt
☞ a.	a. tʃó: .wo .wo				2[1]
b.	a. tʃó: .wo .wó			*!	2[1]
c.	a. tʃo: .wó .wo		*!		1
d.	á .tʃo: .wó .wo				4![2]

cf. Gordon 2002

lambdas from the left with final lapse isn't a pattern predicted by the constraints of Gordon 2002.

lambdas from the left in Gordon 2002:

	/σσσσσσ/	*LAPSE	*CLASH	ALIGN EDGES	ALL-STRESS RIGHT
☞ a.	σ́σ́σ́σ́σ́			*	6[2]
b.	σ́σ́σ́σ́σ	*!		**	6[2]
c.	σ́σ́σ́σ́σ́			*	9![3]

No constraint in the system can cause (b) to win.

	/σσσσσσ/	NONFIN	*LAPSE	ALL-STRESS RIGHT
a.	σ́σ́σ́σ́σ́	*!		2
b.	σ́σ́σ́σ́σ		*!	6[2]
☞ c.	σ́σ́σ́σ́σ́			9[3]

Can we tell which languages use duration to realize stress?

Evaluation of *PROMINENCE-LAPSE depends on how stress is realized in a language.

Establishment of stress correlates

level 1 General sense from listening

level 2 Acoustic measurement

level 3 Perceptual impact

basically duration	basically pitch	all (duration, pitch, intensity)
Nhanda (lv 1)	Fijian (lv 1)	Walpiri (lv 1)
Finnish (lv 2)	Creek (lv 2)	Arabic (lv 2)
	Czech (lv 3)	English (lv 3)

- ▶ In some cases pitch may be phrase pitch accents docking on stress (English, Arabic)
- ▶ Some languages realize primary and secondary stress through different cues

Duration and stress

Levels of interactions of stress and duration

		(example)
Contrastive	full contrast	Finnish
	positional contrast	Pintupi
Non-contrastive (= cue to stress)	(rhythmic) lengthening	Hixkaryana, Norwegian
	phonetic lengthening	Yimas

Duration and stress questions

1. Can only languages with non-contrastive duration have duration as a stress correlate?
 - ▶ Apparently not, because Finnish and Pintupi are both reported to have duration as a realization of stress
2. Does the use of duration necessitate an iambic foot structure?
 - ▶ It does not seem to –Finnish, Pintupi, Norwegian, and Yimas are analyzed with trochaic feet

Stress correlate database

Reported suprasegmental realizations of stress compiled for binary-stress languages.

Current database has 56 languages from 27 language families.

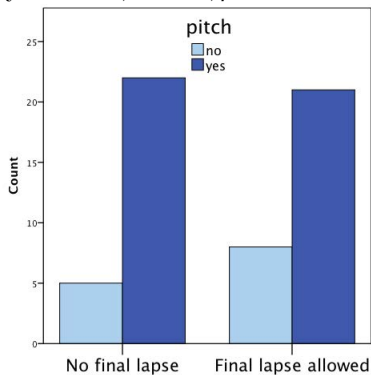
- ▶ Is final lapse tolerated?
- ▶ Is stress realized with duration?
- ▶ Is stress realized with pitch?
- ▶ Is stress realized with intensity?

Predication: If FL contributes to the alternating rhythm in languages in which stress is cued with duration, then we expect to find a correlation between languages that allow a final stress lapse and those that use duration in stress.

Pitch, intensity and final lapse

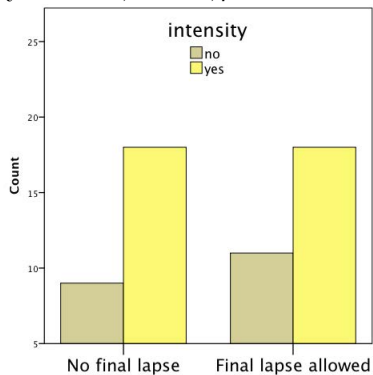
Wald

$$\chi^2 = 0.004, df = 1, p = 0.951$$



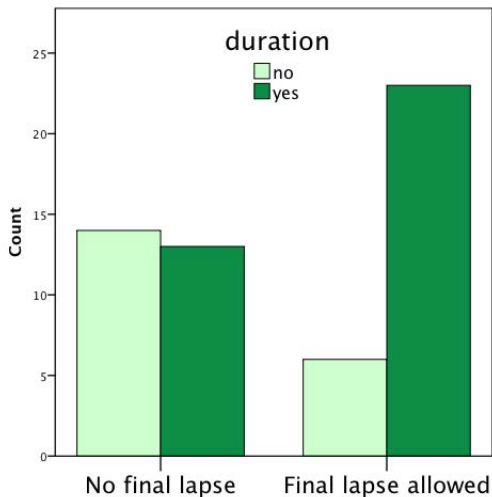
Wald

$$\chi^2 = 0.491, df = 1, p = 0.483$$



Duration and final lapse

Wald $\chi^2 = 5.266$, $df = 1$, $p = 0.022$



Database expansion

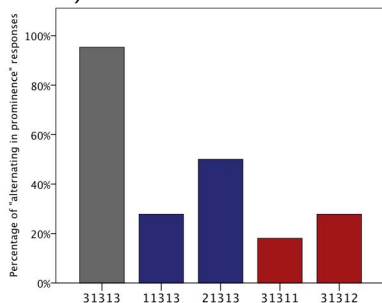
Planned expansions:

- ▶ Use of duration contrastively?
 - ▶ Are languages that use duration contrastively less likely to employ it as a stress correlate?
- ▶ Foot type?
 - ▶ Are languages that use duration as a stress correlate more likely to have an iambic foot structure?
- ▶ Use of vowel quality as a stress correlate?

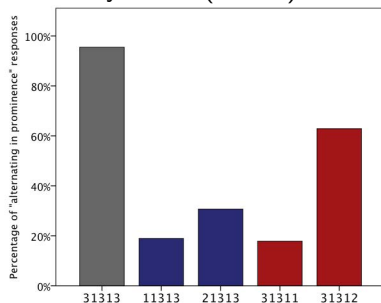
What about vowel quality?

Final lengthening alone insufficient to get alternating effect for English speakers

No vowel quality difference
(N=23)



Reduced vowels in unstressed, nonfinal syllables (N=19)

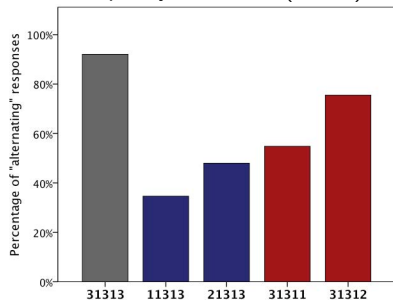


Is vowel quality an integral component of the FL-as-prominence hypothesis, or just a confound for English speakers?

Vowel quality, continued

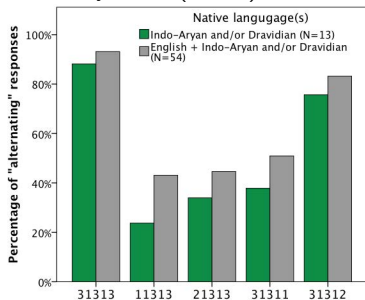
Mechanical Turk studies opened up to non-US Turkers, participants overwhelmingly spoke either an Indo-Aryan (Bengali, Hindi, Konkani) or Dravidian (Kannada, Malayalam, Tamil, Telugu) language.

No vowel quality difference (N=33)



no difference between those who were or weren't bilingual English speakers ($p=0.089$). No interaction with string type ($p=0.520$).

Reduced vowels in unstressed, nonfinal syllables (N=67)

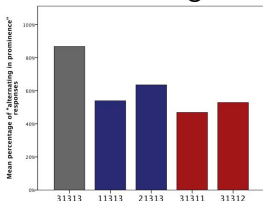


significant difference between those who were or weren't bilingual English speakers ($p<0.001$) but no interaction effect with string type ($p=0.534$).

Perception of rhythm and native language

Evidence that they are independent:

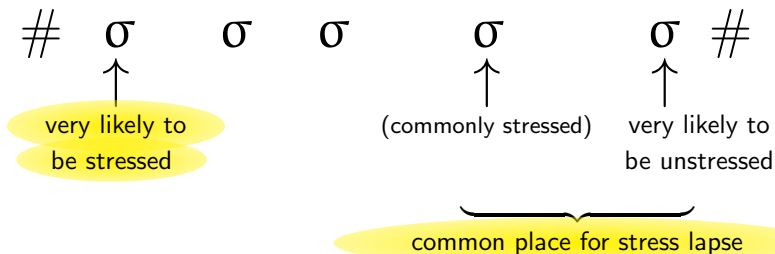
- ▶ Speakers respond based on whether the stimuli contain duration as a cue to stress
- ▶ Saw this for English speakers, also true of foreign Turks:



Evidence that they are interdependent:

- ▶ English speakers only have a notable effect of FL-as-prominence when vowel qualities differs

Stress tendencies, again

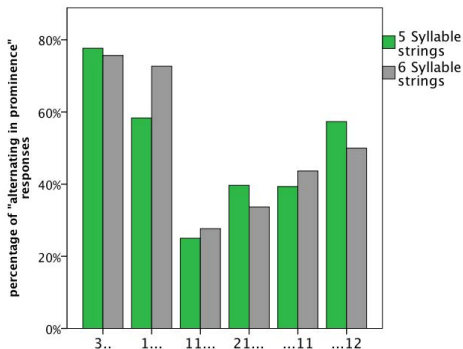


Reflected in Constraints:

- ▶ INITIALGRIDMARK (Hyde 2001) / INITIALSTRESS (Hyde 2014)
- ▶ NONFINALITY (Prince & Smolensky 1993)
- ▶ LAPSE-AT-END (Kager 2001)

Differences among alternating strings

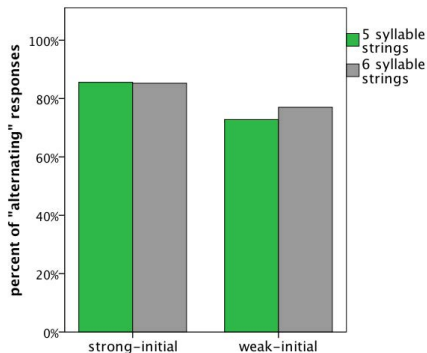
- ▶ Undergraduates at the College of William & Mary (N=20)
- ▶ No vowel quality difference in strings



- ▶ Weak-initial alternating strings more likely to be mis-identified.
- ▶ In 5-syllable strings ($p < 0.001$), but not in 6-syllable strings ($p = 0.371$)
 - ▶ Misperception of rhythm in weak-initial always more likely?
 - ▶ Or more likely when there are an unequal number of strong and weak syllables?

Strong vs. weak start alternating strings

- ▶ Mechanical Turk study with vowel-quality difference strings
- ▶ No strings with edge-syllables, only alternating and true lapse
- ▶ Opened to US and foreign Turkers (N=58)



- ▶ Significant difference found between both initial-strong and initial-weak ($p < 0.001$)
- ▶ No effect of syllable-number ($p = 0.392$) or interaction effect ($p = 0.259$)

Perceptual motivations for stress asymmetries

We have seen evidence for a perceptual motivation for two asymmetries

1. Rhythm is better perceived when the alternating sequence starts with a strong syllable
 - ▶ Not clear whether this is only/particularly true when there are an unequal number of strong and weak syllables
2. The perception of a rhythmic alternation is not always interrupted by a final stress lapse
 - ▶ Evidence suggests that it is not specifically when stress is realized with duration and when final lengthening occurs
 - ▶ It is not known whether/how the effect changes when duration is only realized in either primary or secondary stressed syllables

We can therefore better understand at least some stress system tendencies as having a perceptual grounding.

Thanks to

Collaborators:

- ▶ Nick Kalivoda, UC Santa Cruz (stress correlate database co-author)
- ▶ Marissa Messner, College of William & Mary (assistance with Mechanical Turk studies)
- ▶ Jeremy Ross, College of William & Mary (assistance with possible effects of *PROMINENCE-LAPSE)

Database contributors:

- ▶ Lindsay Baldwin, College of William & Mary
- ▶ Sara Carter, University of Georgia
- ▶ Rachel Nabulsi, University of Georgia

Thanks to a summer WISE grant from William and Mary for the funding to conduct the Mechanical Turk studies.

Additional thanks to Ann Bungler and Jeffrey Ngare

The idea for a perceptual motivation of final lapse was originally developed with Nick Deschenes, College of William & Mary

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