

Rhythm is gradient: evidence from *-ative* and *-ization**

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1 Introduction

- In grid-based theories of stress (Prince 1983, Gordon 2002), rhythmic constraints like *CLASH and *LAPSE regulate the distribution of prominences.
- Usually assumed that rhythmic constraints evaluate syllable-sized constituents.
 - *CLASH assigns a violation for each sequence of two adjacent stressed syllables (Prince 1983, Gordon 2002).
 - *LAPSE assigns a violation for each sequence of two adjacent stressless syllables (Green & Kenstowicz 1995, Gordon 2002).
 - Together, these constraints prefer perfect alternation, where stressed and stressless syllables follow one another.

(1)

$\sigma\sigma\sigma\sigma$	*CLASH	*LAPSE
a. $\acute{\sigma}\sigma\acute{\sigma}\acute{\sigma}$	*!	
b. $\acute{\sigma}\sigma\acute{\sigma}\sigma$		*!
c. $\acute{\sigma}\sigma\acute{\sigma}\acute{\sigma}$		

- Possible to conceive of rhythmic constraints differently: as constraints that assess the *total duration of stressless material* and assign violations accordingly.
 - Phonetic *LAPSE: harsher penalties for stresses that are farther apart.
 - Phonetic *CLASH: harsher penalties for stresses that are closer together.
- These differing conceptions of rhythmic constraints make different predictions about whether or not the content of SBUs is relevant to rhythmic phenomena.

(2) Predictions of categorical vs. gradient rhythmic constraints

- a. Syllabic *LAPSE: content of the lapse shouldn't matter
 à.bra.ca.dá.bra à.bran.scla.dá.bra
 $\grave{\sigma} \textcircled{\sigma} \textcircled{\sigma} \acute{\sigma} \sigma$ $\grave{\sigma} \textcircled{\sigma} \textcircled{\sigma} \acute{\sigma} \sigma$
*both lapses are $\textcircled{\sigma}\textcircled{\sigma}$; *LAPSE penalizes them equally.*

- b. Phonetic *LAPSE: content of the lapse should matter
 à bracad á bra à bransclad á bra
 $\grave{\delta} \textcircled{\delta}_1 \acute{\delta} \delta$ $\grave{\delta} \textcircled{\delta}_2 \acute{\delta} \delta$
 *$\textcircled{\delta}_2$ is longer than $\textcircled{\delta}_1$, so *LAPSE penalizes $\textcircled{\delta}_2$ more.*
- c. Syllabic *CLASH: content of the clash shouldn't matter
 mðn.sóon mðnscloón
 $\grave{\sigma} \acute{\sigma}$ $\grave{\sigma} \acute{\sigma}$
*both clashes are $\grave{\sigma}\acute{\sigma}$; *CLASH penalizes them equally.*
- d. Phonetic *CLASH: content of the clash should matter
 mò ns óon mò nskl óon
 $\grave{\delta} \textcircled{\delta}_1 \acute{\delta}$ $\grave{\delta} \textcircled{\delta}_2 \acute{\delta}$
 *$\textcircled{\delta}_1$ is shorter than $\textcircled{\delta}_2$, so *CLASH penalizes $\textcircled{\delta}_1$ more.*

- **Major claim:** phonetic versions of *LAPSE and *CLASH are necessary to account for the full range of rhythmic phenomena in English.

- **This talk:** evidence that phonetic rhythmic constraints are necessary, from American English *-ative* (Stanton 2019) and *-ization*.
- **The evidence:** patterns of clash and lapse resolution indicating that certain kinds of stressless sequences are more acceptable than others.
 - Phonetic *CLASH: in *-ization*, clashes across a cluster (*bàptìzàtion*) are more acceptable than clashes across a singleton (*xènnìzàtion*).
 - Phonetic *LAPSE: in *-ative*, lapses involving an sonorant (*spéculative*) are more acceptable than lapses across an obstruent (*invéstigàtive*).
- **First:** novel evidence for phonetic *CLASH from *-ization*, and a summary of evidence for phonetic *LAPSE from *-ative*.
- **Open questions:** how phonetic *LAPSE and *CLASH are defined; how the analysis presented here relates to the overall analysis of English stress.

*Acknowledgments

2 Stress in -ization

- Our interest: words ending in *-ization* vary in whether or not *-ize-* bears stress.

- (3) Stress on *-ize-* is variable (Data source: OED)
- a. Stressed *-ize-*: *solarization*, *lemmatization*
 - b. Stressless *-ize-*: *fascization*, *functionalization*
 - c. Variable: *relativization*, *serialization*

- Necessary to first review more general properties of stress in *-ization* to answer a few questions: what factors favor/disfavor stress on *-ize-*?

2.1 Background

- For analysis, it will be useful to separate words that end in *-ization* into two domains: the stem (pre-*-ization* material) and the suffixal domain (*-ization*).

- (4) Division of *-ization* forms into stem and suffixal domains
- | | |
|----------------------|----------------------|
| solar-ize-ate-ion | fasc-ize-ate-ion |
| stem <u>suffixal</u> | stem <u>suffixal</u> |

- We need just a few assumptions, for now, to illustrate why *-ization* stress varies.
 - Stress on *-ize* is compelled by a suffix-specific constraint, *STRESS_{-ize}*.

- (5) *STRESS_{-ize}*: assign one * if the suffix *-ize* does not bear stress.

- Stressing *-ize* and *-ate* violates **CLASH_{-ate}* (defined syllabically); *-ize* de-stressing can thus be seen as a clash-avoidance strategy.
- Preference for *-izátion* (vs. *-íization*) due to **LAPSER* (Gordon 2002).

- (6) **LAPSER*: assign one * if neither of the final two syllables is stressed.

- **LAPSER* \gg *STRESS_{-ize}* explains why it's *-ize* stress that varies.

(7)

	sérial-ize-ate-ion	<i>*LAPSER</i>	<i>*CLASH_{-ate}</i>	<i>STRESS_{-ize}</i>
☞ a. sèrializátion			*	
☞ b. sèrializátion				*
c. sérialization		*!		

- **The question:** can we predict when *-ize* is more or less likely to bear stress? (No work that I am aware of addresses this question!)

2.2 Rhythmic effects in -ization stress

- Corpus study conducted to see if rhythmic factors are implicated in *-ization* stress (following Stanton 2019:7.2).
 - Corpus: all relevant *-ization* forms in the dictionary as of 2/2019 (n=773).
 - Inner suffix counted as “stressed” if *-ize* transcribed as [aɪz].
 - Inner suffix counted as “stressless” if *-ize* transcribed as [ə] or [ɪ].
 - Variable cases are assigned to the “stressed” category (doesn't affect results).
- Results (in (8)) demonstrate a rhythmic effect in *-ization* stress: *-ize* stress is more frequent when it resolves a lapse than when it creates a clash.¹

(8)

Effect of <i>-ize</i> stress	Stressed <i>-ize</i>	Stressless <i>-ize</i>	% stressed
<i>*CLASH</i> violation	<i>còncrètizátion</i> (n=59)	<i>mètronòmizátion</i> (n=33)	64.1% (59/92)
<i>*LAPSE</i> satisfaction	<i>chànnelizátion</i> (n=529)	<i>dichòtimizátion</i> (n=32)	94.3% (529/561)
<i>*EXTLAPSE</i> satisfaction	<i>fèderalizátion</i> (n=202)	<i>cùlturalizátion</i> (n=3)	98.5% (202/205)

- Available evidence suggests that speaker productions mirror the OED trends.
 - Productions are from *forvo.com*, a pronunciation dictionary.
 - Dictionary was searched (in 2/2019) for all *-ization* words in (8).
 - Native speaker status and *-ize* stress were determined by ear.

(9)

Effect of <i>-ize</i> stress	Stressed <i>-ize</i>	Stressless <i>-ize</i>	% stressed
<i>*CLASH</i> violation	<i>rèalizátion</i> (n=4)	<i>tàblòidizátion</i> (n=21)	19% (4/25)
<i>*LAPSE</i> satisfaction	<i>fòssilizátion</i> (n=49)	<i>demòbilizátion</i> (n=151)	24.5% (49/200)
<i>*EXTLAPSE</i> satisfaction	<i>àctualizátion</i> (n=21)	<i>lábializátion</i> (n=51)	29.2% (21/72)

- Are these differences significant?
 - *OED*: **LAPSE* satisfaction more frequent than **CLASH* violation ($p < .001$) and less frequent than **EXTLAPSE* satisfaction ($p < .05$).
 - *Forvo*: **LAPSE* satisfaction less frequent than **EXTLAPSE* satisfaction ($p < .01$). **LAPSE* satisfaction vs. **CLASH* violation not significant.

¹Numbers in (8) adds up to more than 773 because some stems have two stress patterns, e.g. *multimer-ization* can be 202-?10 or 020-?10. In such cases, variants are counted as separate stems.

- A more detailed look at the OED data shows that there is variance within some of these rhythmic categories.

- Focusing on the cases where *-ize* stress results in a *CLASH violation (10), we see that the rate of *-ize* stress varies with the interstress material.²

	Interstress seg(s).	Stressed <i>ize</i>	Stressless <i>ize</i>	% stressed
(10)	Sonorant (R)	<i>xènizátion</i> (n=17)	<i>rèlizátion</i> (n=15)	53.1% (17/32)
	Obstruent (O)	<i>yòtizátion</i> (n=17)	<i>stàtizátion</i> (n=11)	60.7% (17/28)
	Cluster (CC)	<i>bàptizátion</i> (n=20)	<i>òbjèctizátion</i> (n=6)	76.9% (20/26)

- (NB: the comparisons between R vs. O and O vs. CC are not significant.)
- The rate of *-ize* stress does not vary noticeably in the *LAPSE and *EXT-LAPSE resolution contexts; the numbers are close to ceiling.

2.3 Hypothesis

- Hypothesis: the shorter the clash would be were *-ize* stressed, the worse the violation of *CLASH would be, and the more frequent *-ize* destressing is.

- *One corollary*: as the number of syllables between two stressed syllables increases, so does the interstress duration (expected given (8-9)).

(11) Different interstress durations (in black) in *-ization* forms

a. \hat{V} C₀ -izátion (*fascization*): shortest

\hat{V} C₀ izátion

b. \hat{V} C₀V C₀ -izátion (*channelization*): longer

\hat{V} C₀V C₀ izátion

c. \hat{V} C₀V C₀V C₀ -izátion (*federalization*): longest

\hat{V} C₀V C₀V C₀ izátion

- > Seems obvious: more syllables should mean a longer interstress duration.
- > However, Nespor & Vogel (1989:102) hint at the existence of lapse compression in English, so this prediction should be verified.

²There are 6 cases where a vowel-final stem takes *-ization* (e.g. *Maoization*). In 5/6, *-ize* is reported to at least variably bear a stress. Because the number of such forms is small, and it is possible that there are additional constraints on $\hat{V}V$ hiatus, I do not include these forms here.

- *Another corollary*: all else equal, clashes with sonorants are shorter than those with obstruents, which are shorter than those with clusters.

(12) Different clash lengths in *-ization* forms (clash is in black)

a. \hat{V} **R** -izátion: shortest

\hat{V} R izátion

b. \hat{V} **O** -izátion: longer

\hat{V} O izátion

c. \hat{V} **CC** -izátion: longest

\hat{V} CC izátion

- Similar logic applies for lapses: those containing O should be longer than those containing R, and shorter than those containing CC.

- To know if this hypothesis is plausible, we need to know two things:
 - Whether or not the durational facts assumed in (11-12) are correct.
 - Whether or not A. Eng. speakers' preferences correlate with durational facts.

3 Experimental support

- Results of an experiment designed to probe the hypothesis in Section 3 provides support for it in multiple ways.
 - Results from a forced-choice task suggest that speakers are sensitive to differences in clash duration. Rates of *-ize* stress correlate with clash length.
 - An analysis of the items suggests that the cline in (11-12) is correct: rate of *-ize* stress roughly correlates with interstress distance.

3.1 Items and acoustic analysis

- For the experiment, I recorded one speaker saying nonce forms that ended in *-ization*, all based on placenames or their associated demonyms (Table 2).
 - Ten items where *-ize* stress would violate *CLASH, and ten each where *-ize* stress would satisfy *LAPSE or *EXTLAPSE.
 - Each item was recorded twice, with stressed *-ize* and stressless *-ize* variants.
- Interstress duration of each *ize*-stressed item was measured. This ranged from a single consonant (Figure 1) to a much longer string (Figure 2).³

³All acoustic analysis was done in Praat (Boersma & Weenink 2017).

Table 1: -ization items, by rhythmic profile and interstress C(s)

*CLASH (n=10)	*LAPSE (n=10)	*EXTLAPSE (n=10)
Interstress C(s)	Interstress C(s)	Interstress C(s)
<i>Pragueizáció</i>	<i>Égyptizáció</i>	<i>Pròvidenceizáció</i>
[g]	[dʒ], [pt]	[v], [d], [ns]
<i>Quebècizáció</i>	<i>Wyòmíngizáció</i>	<i>Sènégalizáció</i>
[k]	[m], [ŋ]	[n], [g], [l]
<i>Chàdizáció</i>	<i>Cùbanizáció</i>	<i>Ìndiànapolisizáció</i>
[d]	[b], [n]	[n], [p], [l]
<i>Ròmeizáció</i>	<i>Bròoklynizáció</i>	<i>Antàrticanizáció</i>
[m]	[kl], [n]	[ɹ(k)t], [k], [n]
<i>Japànizáció</i>	<i>Àustínizáció</i>	<i>Blòomíngtónizáció</i>
[n]	[st], [n]	[m], [ŋt], [n]
<i>Brònxizáció</i>	<i>Tèxasizáció</i>	<i>Mèxicanizáció</i>
[ŋks]	[ks], [s]	[ks], [k], [n]
<i>Vermòntizáció</i>	<i>Phòenixizáció</i>	<i>Mìchiganizáció</i>
[nt]	[n], [ks]	[ʃ], [g], [n]
<i>Frànceizáció</i>	<i>Alàskanizáció</i>	<i>Òberlinizáció</i>
[ns]	[sk], [n]	[b], [ɹl], [n]
<i>Bàsqueizáció</i>	<i>Rùssianizáció</i>	<i>Màdisonizáció</i>
[k]	[ʃ], [n]	[d], [s], [n]
<i>Mìnskizáció</i>	<i>Ìcelandizáció</i>	<i>Ròchesterizáció</i>
[nsk]	[sl], [nd]	[tʃ], [st], [ɹ]

- The acoustic properties of these interstress durations are in line with the predictions detailed in Section 2.3.
 - Interstress duration is short when -ize stress creates a clash, longer when it satisfies *LAPSE, and longest when it satisfies *EXTLAPSE (Fig. 3).⁴
 - Sonorants between two stresses are shorter than obstruents, which are shorter than clusters (Figure 4).
- First part of the hypothesis is plausible: broad trends discovered in the dictionary study are reflected in properties of the productions.

3.2 Forced-choice task

- What needs to be shown: A. Eng. speakers detect small differences in interstress duration, and that these differences affect the preference for -ize stress.
- To investigate: 2-way forced choice, with recordings from Sec. 3.1 as stimuli.

⁴Figure 3 and all other plots were produced with R's ggplot2 (Wickham 2016).

Figure 1: Interstress duration in *Quebècizáció*

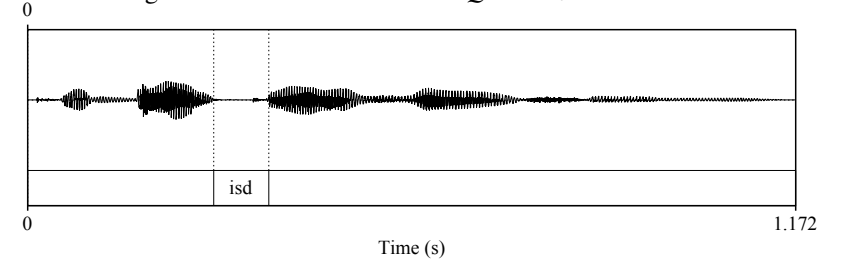
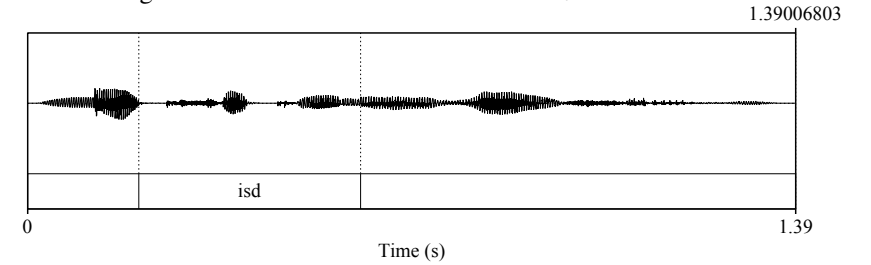


Figure 2: Interstress duration in *Mèxicanizáció*



3.2.1 Study design

- Stimuli: 30 pairs of nonce -ization forms, differing only in suffixal stress (examples: *Quebècizáció-Quebècizáció*, *Mèxicanizáció-Mèxicanizáció*).
- Participants were told they were helping a travel company pronounce words in new slogans (*Prepare for the **Quebecization** of your vacation!*).
- They were asked to choose between two possible pronunciations of the bolded and italicized word. They could listen to a recording a maximum of twice.
 - Ordering of stressed and stressless -ization form randomized by participant.
 - Order of item was randomized by participant.
- Experiments were constructed using Experigen (Becker & Levine 2013).

3.2.2 Participants

- Fifty participants recruited using Amazon's Mechanical Turk.
 - Eligible participants were those with US IP addresses, 500 previously accepted tasks, and an approval rating of 97% or above.
 - Participants were compensated \$1.50 for their time.

Figure 3: Interstress duration by the number of interstress syllables

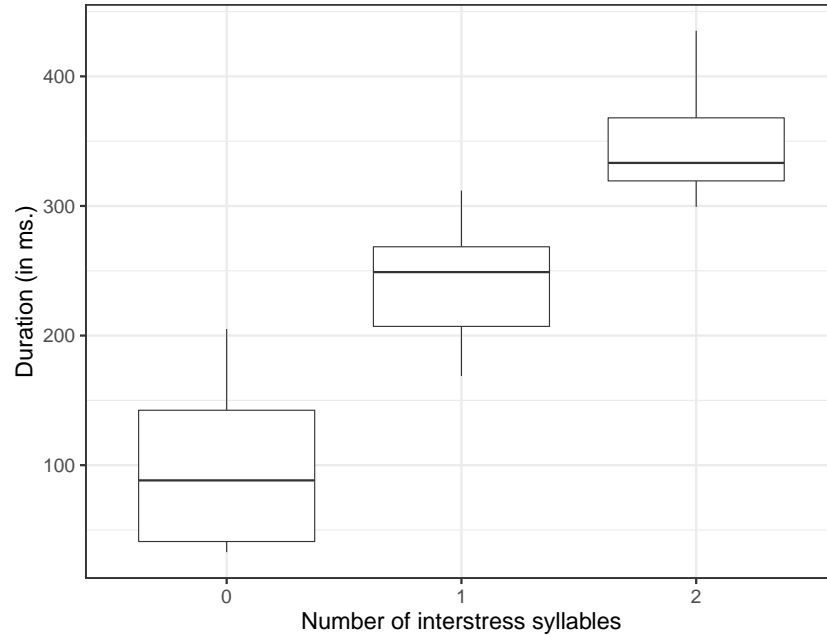


Figure 4: Interstress duration by the type of interstress consonant(s)

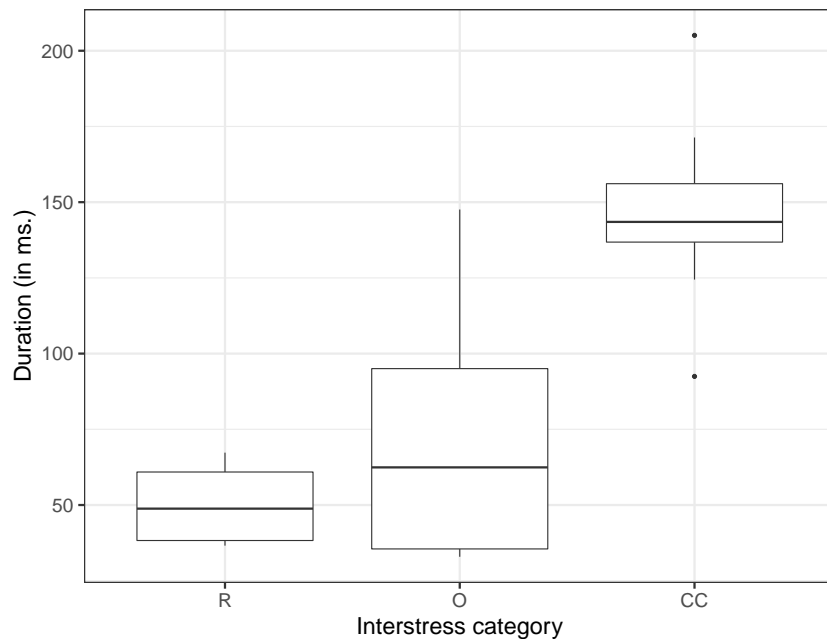
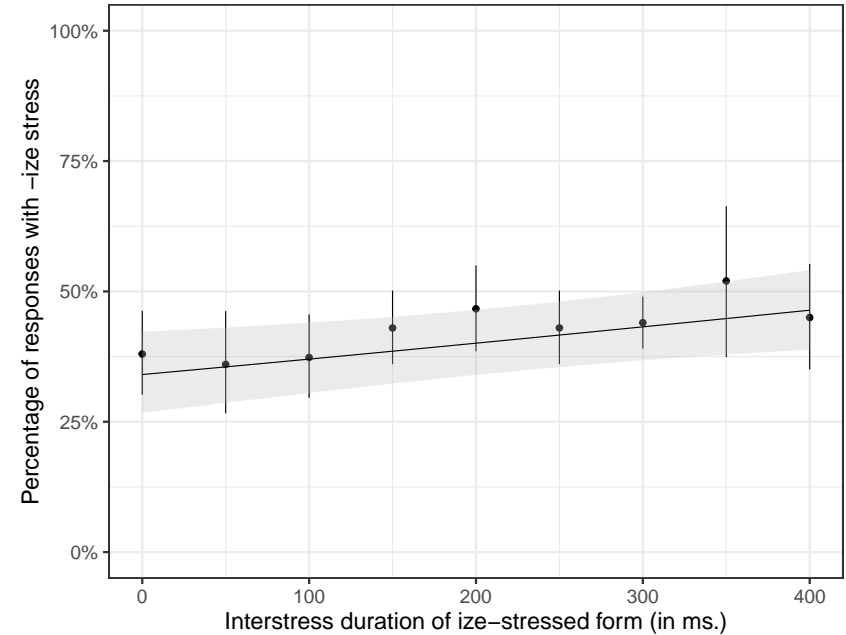


Figure 5: Preference for -ize stress by interstress duration



- All participants indicated that they are native speakers of English from the U.S.
- No participants' responses were excluded from the analysis.

3.2.3 Results

- Patterns in the data suggest that the hypothesis is correct.
 - Distinctions among rhythmic categories are what we would expect, given the dictionary data and acoustic results.
 - For the *CLASH context (*fâscizàtion*), 34.9% prefer -ize stress.
 - For the *LAPSE context (*chànnelizàtion*), 39.4% prefer -ize stress.
 - For the *EXTLAPSE context (*fèderalizàtion*), 40.2% prefer -ize stress.
 - The positive correlation between -ize stress and interstress duration is also expected: the worse the clash, the more frequent -ize destressing (Figure 5).
- Question for a statistical analysis: is rhythmic category a significant predictor of -ize stress? What about interstress duration?

- We answer this by fitting mixed effects logistic regressions to the data that treat rhythmic category and interstress duration as fixed effects.⁵

- Model with rhythmic context as a fixed effect finds no significant effects.
- (Baseline for the fixed effect is the *LAPSE context (e.g. *chànnelizàtion*; comparisons are *LAPSE vs. *CLASH and vs. *EXTLAPSE.)

(13) Model with rhythmic context as fixed effect

Factor	Coefficient	z value	Significant?
Intercept (*LAPSE)	-0.31	–	
*CLASH	-0.22	-1.58	No ($p = .12$)
*EXTLAPSE	0.04	0.27	No ($p = .79$)

- A model with interstress duration (of the *ize*-stressed form) as a fixed effect finds a significant effect; this makes sense, given Figure 5.

(14) Model with interstress duration as fixed effect

Factor	Coefficient	z value	Significant?
(Intercept)	-0.66	–	
Interstress duration	1.29	2.52	Yes ($p < .05$)

- Two pieces of evidence that (14) is the better model of the data:
 - > It scores better on measures of best fit (AIC diff. = 4, BIC diff. = 10)
 - > Adding the rhythm type predictor to (14) does not result in a better fit to the data ($\chi^2(2) = 1.25, p = .53$), nor does adding an interaction.

- What we can take away from these results:

- Gradient rhythmic information plays a role in speakers’ judgments about whether or not to destress *-ize* in *-ization*.
- It’s the *phonetic distance* between the last stem stress and *-ize* that matters. The rhythmic category the form belongs to (*CLASH, *LAPSE, *EXTLAPSE) only matters insofar as these categories are shorthand for duration.

4 Towards an analysis

- Section 2 results support the addition of a phonetic *CLASH constraint to CON.
- But a few things aren’t clear, given the available evidence: how this constraint should be defined, and what kinds of representations it evaluates.

⁵All models were fitted using the glmer function of R’s lme4 package (Bates & Maechler 2011) and include a random intercept for participant, in addition to the fixed effects discussed in the text. Significance values are from the lmerTest package (Kuznetsova et al. 2016).

- Constraint could be defined in terms of milliseconds (as in Stanton 2019): predict sensitivity to speech rate, length of intervening segments.
- Constraint could be defined in more abstract terms; predicts no sensitivity to speech rate, length of intervening segments, etc.
- Results from a second judgment task suggest that an abstract definition is more appropriate; I propose one in Section 4.2.

4.1 Experiment 2

- Experiment 2 used a subset of the *-ization* items from Experiment 1. It was in all other ways identical to Experiment 1.

Table 2: Experiment 1 items, by rhythmic profile and interstress C(s)

*CLASH (n=5)	*LAPSE (n=5)	*EXTLAPSE (n=5)
Interstress C(s)	Interstress C(s)	Interstress C(s)
<i>Quebècizàtion</i>	<i>Ègyptizàtion</i>	<i>Ròchesterizàtion</i>
[k]	[dʒ], [pt]	[tʃ], [st], [ɹ]
<i>Chàdizàtion</i>	<i>Cùbanizàtion</i>	<i>Sènegalizàtion</i>
[d]	[b], [n]	[n], [g], [l]
<i>Ròmeizàtion</i>	<i>Àustinizàtion</i>	<i>Ìndianàpolisizàtion</i>
[m]	[st], [n]	[n], [p], [l]
<i>Brònxizàtion</i>	<i>Tèxasizàtion</i>	<i>Antàrticanizàtion</i>
[ŋks]	[ks], [s]	[ɹ(k)t], [k], [n]
<i>Bàsqueizàtion</i>	<i>Phòenixizàtion</i>	<i>Mèxicanizàtion</i>
[sk]	[n], [ks]	[ks], [k], [n]

- For this experiment, two versions of each item were used.
 - For the first version, both forms were identical to that used in Experiment 1.
 - For the second version, both forms were artificially slowed by 20%, using Praat Vocal Toolkit (Corrette 2012).
- **The prediction:** if gradient *CLASH is defined in terms of milliseconds, we should find a greater preference for *-ize* stress in the slowed items.
- The results are clear, from Figures 6-7:
 - Interstress duration is a significant predictor of *ize*-stress ($p < .05$).
 - Item type (slowed vs. not slowed) is not a significant predictor; adding it to the model does not improve fit ($\chi^2(1) = .72$).
- **The takeaway:** gradient *CLASH likely assesses violations at a more abstract level than milliseconds, though more systematic investigation is necessary.

Figure 6: Preference for *-ize* stress by rhythmic category

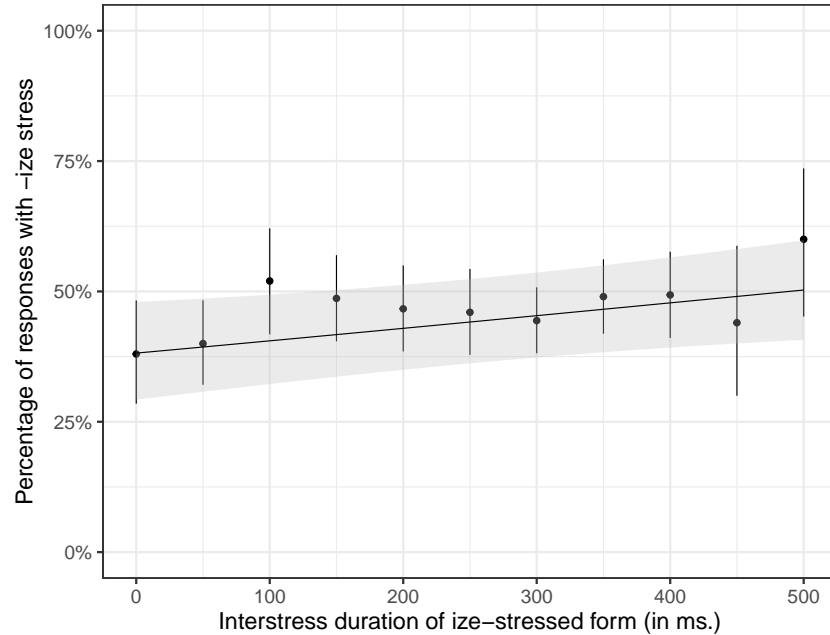
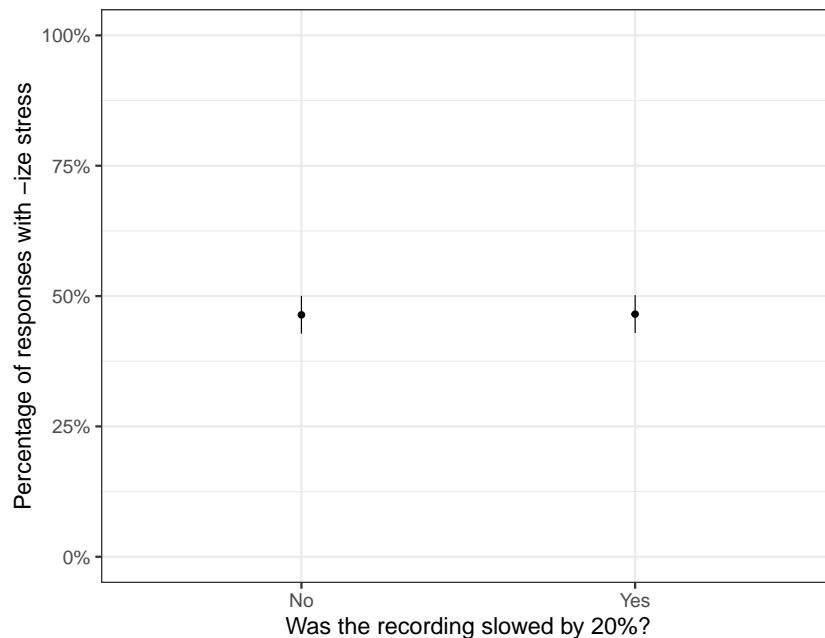


Figure 7: Preference for *-ize* stress by interstress duration



4.2 Defining gradient rhythmic constraints

- Results of the above experiment limit the hypothesis space as to how gradient *CLASH is defined, but the hypothesis space is still large.
 - One possibility: each phoneme (or maybe allophone) is associated with an idealized duration, stored as milliseconds in the speaker's mind.
 - Another possibility: each durational category is associated with a violation score (though what these categories would be is unclear).
- Further work is required to further narrow down this hypothesis space!
- For the purposes of this talk, I'll define gradient *CLASH as the following.

(15) *CLASH: for each pair of stressed vowels \hat{V}_1 and \hat{V}_2 , assign a base violation score of 1. For each segment between \hat{V}_1 and \hat{V}_2 , multiply the violation score by $1/x$, where x is valued according to (a-b).

 - Sonorant consonants = 2
 - Obstruent consonants = 3
 - For *Quebècizàtion*, violation score is $1/3$.
 - For *Tèxasizàtion*, violation score is $1/27$.
- In addition to gradient *CLASH, we should also consider the possibility that gradient *LAPSE plays a role in speakers' judgments.
 - Argued in Stanton (2019) that phonetic *LAPSE is active in English.
 - For *chànnelizàtion* vs. *fèderalizàtion*, possible that the preference for more *-ize* stress on the latter is due to gradient *LAPSE.

(16) *LAPSE: for each pair of stressed vowels \hat{V}_1 and \hat{V}_2 , assign a base violation score of 1. For each segment between \hat{V}_1 and \hat{V}_2 , multiply the violation score by x , where x is valued according to (a-b).

 - Sonorant consonants = 2
 - Obstruent consonants = 3
 - For *Quebècizàtion*, violation score is 3.
 - For *Tèxasizàtion*, violation score is 27.
- What's important here is the idea behind the constraints, not the formulation.
 - Strength of violation is correlated with the distance between two stresses.
 - Unlike categorical rhythmic constraints, the gradient constraints do not "turn off": they assign violations no matter how close or distant the stresses.

4.3 Analysis

- To demonstrate how an analysis of these data might work, I consider four items: *Quebècizàtion*, *Frànçeizàtion*, *Tèxasizàtion*, and *Mèxicanizàtion*.
- For an analysis of these results, I include the following constraints⁶:
 - (17) **CLASH_{-ate}**: assign one * for each sequence of two adjacent stressed syllables that includes the verbal suffix *-ate*.
 - (18) **STRESS_{-ize}**: assign one * if the suffix *-ize* doesn't bear stress.
 - (19) ***LAPSE**, ***CLASH**: as in (15, 16).
- I used the Maxent grammar tool (Hayes et al. 2009) to find weights for the above constraints, given the candidates and violation scores in Table 3.

Table 3: Candidates and violations fed to the Maxent grammar tool

	STRESS _{-ize}	*CLASH _{-ate}	*CLASH	*LAPSE
a. <i>Quebècizàtion</i>		1	1/3	3
b. <i>Quebècizàtion</i>	1		1/9	9
c. <i>Frànçeizàtion</i>		1	1/6	6
d. <i>Frànçeizàtion</i>	1		1/18	18
e. <i>Tèxasizàtion</i>		1	1/27	27
f. <i>Tèxasizàtion</i>	1		1/81	81
g. <i>Mèxicanizàtion</i>		1	1/54	54
h. <i>Mèxicanizàtion</i>	1		1/162	162

- The tool finds the weights in (20), and makes the predictions in (21).

(20)	Constraint	Weight	(21)	Form	Rate of <i>-ize</i> stress	
					Predicted	Observed
	*CLASH	2.553		<i>Quebècizàtion</i>	30%	30%
	CLASH _{-ate}	0.280		<i>Frànçeizàtion</i>	38%	40%
	*LAPSE	0.006		<i>Tèxasizàtion</i>	50%	48%
	STRESS _{-ize}	0.000		<i>Mèxicanizàtion</i>	59%	60%

- A few important takeaways from this analysis:
 - Gradient *CLASH and *LAPSE both play a role in judgments of *-ize* stress.
 - The tool assigns STRESS_{-ize} no weight; this suggests that rhythmic considerations may be entirely responsible for the varying rates of *-ize* stress.

⁶*LAPSER is not included here as participants were not presented with forms like *Quebècizàtion*.

5 A parallel from *-ative*

- The suffix *-ative* behaves like *-ization*; stress on the inner suffix varies.
 - The OED lists *-ate* as stressed in *motivative* and stressless in *communicative*
 - It also lists some *-ative* forms as having variable stress, like *molificative*.
- **Crucial:** I assume that the morphological composition of these forms is *X-ate-ive*, and that the *-ate* in *-ative* is the same verbal *-ate* that is in *-ization*.

5.1 Background

- Unlike *-ization*, there are rhythmic limitations on *-ate* stress. As shown in (22), *-ate* stress is dispreferred under clash (data in this section from Stanton 2019).

	Effect of <i>-ate</i> stress	Stressed <i>-ate</i>	Stressless <i>-ate</i>	% stressed
(22)	*CLASH violation	<i>òrnàtíve</i> (n=15)	<i>quòtative</i> (n=216)	6.4% (15/231)
	*LAPSE satisfaction	<i>législàtive</i> (n=229)	<i>spéculative</i> (n=105)	68.6% (229/334)
	*EXTLAPSE satisfaction	<i>amélioràtive</i> (n=9)	<i>detériorative</i> (n=1)	90.0% (9/10)

- To analyze this, useful to import an earlier assumption: *CLASH_{-ate} is active.
 - *Support*: if the stem is stress-final, *-ate* generally doesn't bear stress.
 - *More support*: either *-ate* or *-ive* is stressed; never both.
- To analyze the fact that stress varies within the suffixal domain, I assume for now that the suffix *-ive* prefers to bear stress when possible (23).

(23) STRESS_{-ive}: assign one * if the suffix *-ive* does not bear stress.

- Variation: STRESS_{-ive} conflicts with *LAPSE (evaluated syllabically, for now).

(24) *-at-* stressing as *LAPSE resolution

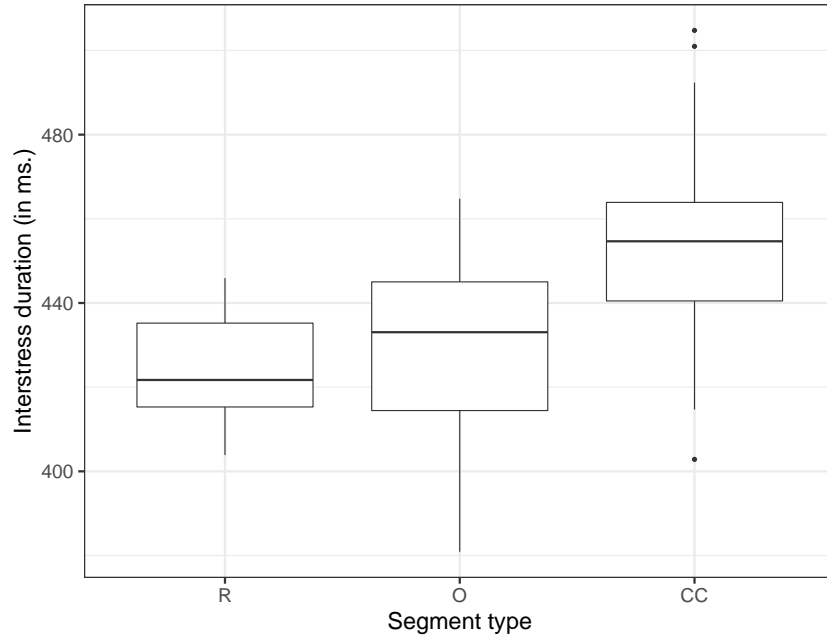
	investigative	*CLASH _{-ate}	*LAPSE	STRESS _{-ive}
☞ a. <i>investigative</i>				*
☞ b. <i>investigative</i>			*	
c. <i>investigative</i>		*!		
quotative				
d. <i>quotative</i>		*!		*
☞ e. <i>quotative</i>				
f. <i>quotative</i>		*!*		

- The question: can we predict when *-at-* is more or less likely to bear stress?
- Stanton (2019): The longer the lapse that would result were *-ate* not stressed, the higher the likelihood that *-ate* will bear stress.
 - Observation: *-ate* stress depends on content of the lapse (Nanni 1977).
 - Note a similarity to how clash works in the *-ization* corpus: the rate of *-ate* stress increases as we go from sonorant to obstruent to cluster.

	Interstress seg(s).	Stressed <i>-ize</i>	Stressless <i>-ize</i>	% stressed
(25)	Sonorant (R)	<i>mutilative</i> (n=85)	<i>speculative</i> (n=65)	57% (85/150)
	Obstruent (O)	<i>deprecatative</i> (n=91)	<i>dubitative</i> (n=19)	83% (91/110)
	Cluster (CC)	<i>legislative</i> (n=27)	<i>adequative</i> (n=1)	96% (27/28)

- A small production study suggests that this cline reflects duration: categories associated with higher rates of *-ate* stress are associated with longer lapses.

Figure 8: Lapse length by category of the pre-*ate* consonant(s)



5.2 Experimental evidence

- Stanton (2019) reports a judgment study documenting a positive correlation between lapse duration and *-ate* stress.⁷
- Unlike *-ization*: for *-ative*, *CLASH has a categorical effect. I claim this is due to differences in morphological composition between the two classes of forms.

5.2.1 Design and participants

- Stimuli: 80 pairs of nonce *-ative* forms, differing only in suffixal stress (examples: *bádjaspàtive*-*bádjaspative*, *sidjólàtive*-*sidjólative*).
 - Forms varied in two ways: the pre-*ative* material (e.g. *r* vs. *s* vs. *sp*) and the rhythmic profile of the stem (iambic, *bádja-* or trochaic, *sidjó-*).
 - There were three times as many trochaic as iambic stems; my interest in this task was on forms with lapses, or the trochaic forms.
- Design and presentation was identical to the *-ization* tasks in all relevant ways.
- Participant recruitment was identical to that for the *-ization* tasks; here, though, one participant's data was excluded for an exceptionless ordering effect.

5.2.2 Results

- Results demonstrate a clear distinction between the iambic and trochaic stems.
 - For iambic forms (*sidjólàtive*-*sidjólative*), 20.6% preferred *-ate* stress.
 - For trochaic forms (*bádjaspàtive*-*bádjaspative*), 54.3% preferred *-ate* stress.
- Interstress duration has a clear effect for the trochaic stems (Figure 9), but not for the iambic stems (Figure 10).
- A mixed-effects logistic regression (with random intercepts for item, participant) confirms an interaction between stem type and interstress duration.⁸

	Factor	Coefficient	z value	Significant?
(26)	(Intercept)	-1.58	–	–
	RhType (Trochee)	-0.11	-0.40	No ($p = .69$)
	Interstress dur.	2.68	1.86	Almost ($p = .06$)
	RhType*Interstress dur.	-3.83	-2.65	Yes ($p < .01$)

⁷Stanton (2019) actually reports two judgment studies; I focus on the first (the study described in that paper's Section 5.3). The two tasks have equivalent results for the present purposes.

⁸The RhType factor is sum-coded. The model is a better fit to the data than one that does not include an interaction ($\chi^2(1) = 6.74, p < .01$).

Figure 9: Preference for *-ate* stress by interstress duration (trochaic subset)

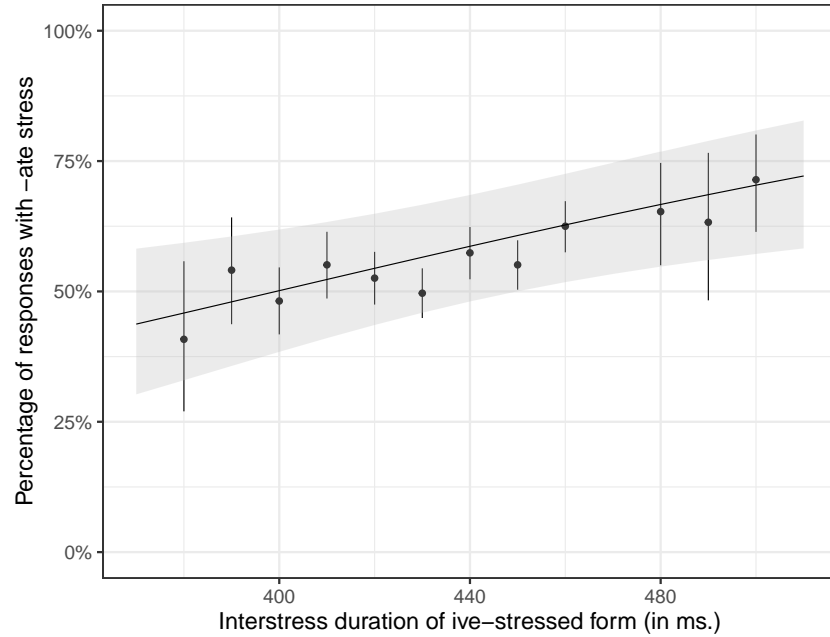
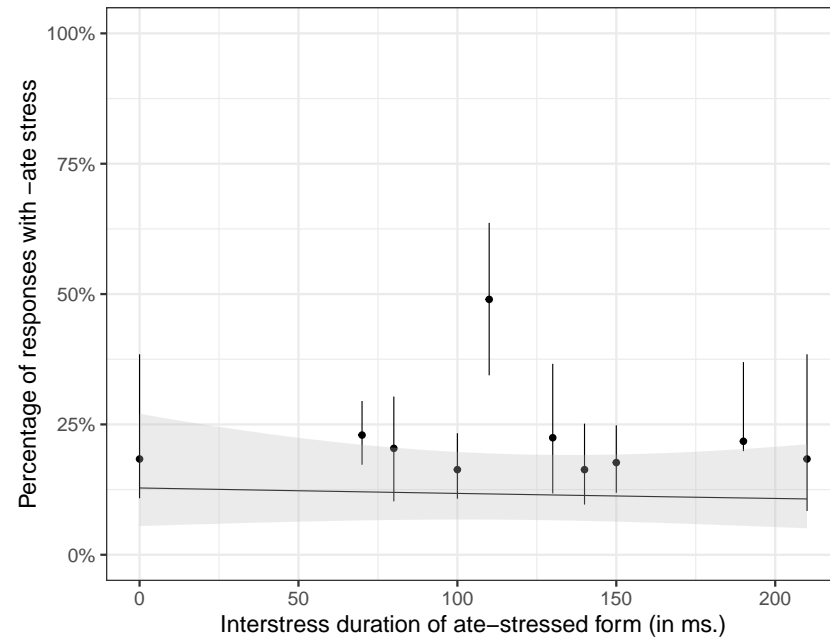


Figure 10: Preference for *-ate* stress by interstress duration (iambic subset)



- What we can take away from these results:

- Gradient **LAPSE* plays a role in speakers' judgments about *-ate* stress: as the potential lapse duration increases, so does the likelihood of *-ate* stress.
- There's not evidence that gradient **CLASH* is active; presumably it is masked by categorical **CLASH.ate*,

5.3 Analysis

- To demonstrate how an analysis of these data might work, I consider four items: *sidjópàtive*, *sidjòsklative*, *bádjapàtive*, and *bádjaspràtive*.
- For an analysis of these results, I include the following constraints: *STRESS.ive*, **CLASH.ate*, **LAPSE*, and **CLASH*.
- As before, I used the Maxent grammar tool (Hayes et al. 2009) to find weights for these constraints, given the candidates and violation scores in Table 4.

Table 4: Candidates and violations fed to the Maxent grammar tool

	<i>STRESS.ive</i>	<i>*CLASH.ate</i>	<i>*LAPSE</i>	<i>*CLASH</i>
a. <i>sidjópàtive</i>	1	1	3	1/3
b. <i>sidjópative</i>			9	1/9
c. <i>sidjòsklàtive</i>	1	1	18	1/18
d. <i>sidjòsklative</i>			54	1/54
e. <i>bádjapàtive</i>	1		9	1/9
f. <i>bádjapative</i>			27	1/27
g. <i>bádjaspràtive</i>	1		108	1/108
h. <i>bádjasprative</i>			324	1/324

- The tool finds the weights in (27), and makes the predictions in (28).

(27)	Constraint	Weight	(28)	Form	Rate of <i>-ate</i> stress	
					Predicted	Observed
	<i>*CLASH.ate</i>	1.443		<i>sidjòsàtive</i>	19%	24%
	<i>*LAPSE</i>	0.004		<i>sidjòspràtive</i>	21%	18%
	<i>STRESS.ive</i>	0.000		<i>bádjapàtive</i>	52%	61%
	<i>*CLASH</i>	0.000		<i>bádjaspràtive</i>	70%	69%

- A few important takeaways from this analysis:
 - It is not necessary to reference *STRESS.ive* in this analysis; rhythm determines whether *-ate* or *-ive* bears stress.
 - The activity of categorical **CLASH.ate* prevents us from seeing activity of gradient **CLASH* in the clash context.

6 Discussion

- **In short:** gradient, phonetically informed versions of *LAPSE and *CLASH are necessary to account for the full range of rhythmic effects in English.
- Supporting evidence comes from English words ending in *-ization* and *-ative*.
- This work, and these results, raise a number of questions.
- **Question 1:** Why this focus on *-ative* and *-ization*?
 - They are perhaps the two corners of the English lexicon where evidence for gradient *CLASH and *LAPSE is most easily available.
 - They are classes of forms where clashes and lapses are in principle allowed: *-ative* and *-ization* are largely stress-preserving.
 - Both of the inner suffixes, *-ate* and *-ize*, have stressed and stressless forms. They exhibit variation between the two forms.
- **Question 2:** What do we make of these results?
 - One possibility: they are just task effects and do not tell us anything about the participants' grammars.
 - I think this is unlikely, given the other information available to us.
 - Forvo results for *-ization* suggest that the rhythmic effect observed in the OED is present in speakers' productions as well.
 - Nanni's (1977) work on *-ative* suggests that the distinction among types of lapses is accessible to speaker intuition.
 - To confirm this, necessary to do more work using different types of task.
 - Another possibility: they are effects peculiar to *-ization* and *-ative*.
 - I think this is also unlikely; how would a child acquire these patterns?
 - Words ending in *-ization* and *-ative* are not all that frequent. In the OED, they have an average frequency bin of 2 (< .01 per million words).
 - No *-ative* forms in the CHILDES Parental Corpus; have not been able to check for *-ization* (MacWhinney 2000, Li & Shirai 2000).
 - Speaker knowledge of gradient rhythmic effects probably not from *-ative* and *-ization* alone.
 - A third possibility: gradient *LAPSE and *CLASH are language-specific constraints, and English is the only language they are active in.
 - Unlikely; there are hints of gradient rhythmic effects in other languages.
 - Karvonen (2008): in odd-parity Finnish words of 5+ syllables, secondary stress is antepenultimate if the word ends in *-ia* (*érگونòmia*) but penultimate otherwise (*kòlesteròli*). Perhaps *-ia* is short.

- Gouskova & Roon (2013): in Russian compounds, the further away the secondary stress from the primary, the more acceptable the compound.
- Distance was measured in terms of syllables, but replacing syllables with the duration of the interstress interval improves model fit.
- Burroni (2020): results from a production experiment suggest that Italian speakers ameliorate clashes by lengthening the first stressed syllable.
- I suspect gradient *LAPSE and *CLASH are universal. They coexist with, and are perhaps usually overpowered by, their categorical relatives.
- **Future work:** expand the base of evidence for gradient rhythmic effects in English, and broaden the search to other languages.

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