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)

	σσσσσ	*CLASH	*LAPSE
a.	σσ**σσ**σ	*!	
b	σσσ**σσ**		*!
c.	σσσσσ		

- 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
σ̀ ⓢ ⓢ σ́ σ σ̀ ⓢ ⓢ σ́ σ
both lapses are ⓢⓢ; *LAPSE *penalizes them equally.*

b. Phonetic *LAPSE: content of the lapse should matter
à bracad á bra à bransclad á bra
δ̀ ⓓ$_1$ δ́ δ δ̀ ⓓ$_2$ δ́ δ
ⓓ$_2$ is longer than ⓓ$_1$, so *LAPSE *penalizes ⓓ$_2$ more.*

c. Syllabic *CLASH: content of the clash shouldn't matter
màn.sóon mànsclóon
σ̀ σ́ σ̀ σ́
both clashes are σ̀σ́; *CLASH *penalizes them equally.*

d. Phonetic *CLASH: content of the clash should matter
mà ns óon mà nskl óon
δ̀ ⓓ$_1$ δ́ δ̀ ⓓ$_2$ δ́
ⓓ$_1$ is shorter than ⓓ$_2$, so *CLASH *penalizes ⓓ$_1$ 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 *-ization* and *-ative* (Stanton 2019).
- **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 (*bà**pt**ìzátion*) are more acceptable than clashes across a singleton (*xè**n**ìzátion*).
  - Phonetic *LAPSE: in *-ative*, lapses involving an sonorant (*spécu**l**atìve*) are more acceptable than lapses across an obstruent (*invésti**g**àtive*).
- **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

s o l a r – i z e - a t e - i o n
stem *suffixal*

f a s c – i z e - a t e - i o n
stem *suffixal*

- 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$_{\text{-}ize}$.

(5) STRESS$_{\text{-}ize}$: assign one * if the suffix *-ize* does not bear stress.

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

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

  - *LAPSER ≫ STRESS$_{\text{-}ize}$ explains why it's *-ize* stress that varies.

(7)

	sérial-ize-ate-ion	*LAPSER	*CLASH$_{\text{-}ate}$	STRESS$_{\text{–}ize}$
☞	a. sèrialìzátion		*	
☞	b. sèrializátion			*
	c. sérialìzation	*!		

- **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 *-ize* stress	Stressed *-ize*	Stressless *-ize*	% stressed
*CLASH violation	*còncrètìzátion* (n=59)	*mètronòmizátion* (n=33)	64.1% (59/92)
*LAPSE satisfaction	*chànnelìzátion* (n=529)	*dichòtimizátion* (n=32)	94.3% (529/561)
*EXTLAPSE satisfaction	*fèderalìzátion* (n=202)	*cùlturalizátion* (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 *-ize* stress	Stressed *-ize*	Stressless *-ize*	% stressed
*CLASH violation	*rèalìzátion* (n=4)	*tàblòidizátion* (n=21)	19% (4/25)
*LAPSE satisfaction	*fòssilìzátion* (n=49)	*demòbilizátion* (n=151)	24.5% (49/200)
*EXTLAPSE satisfaction	*àctualìzátion* (n=21)	*lábializátion* (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.

[1] Numbers 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]

(10)

Interstress seg(s).	Stressed *ize*	Stressless *ize*	% stressed
Sonorant (R)	*xè**n**ìzátion* (n=17)	*rèa**l**ízátion* (n=15)	53.1% (17/32)
Obstruent (O)	*yò**t**ìzátion* (n=17)	*stà**t**ízátion* (n=11)	60.7% (17/28)
Cluster (CC)	*bà**pt**ìzátion* (n=20)	*òbjè**ct**ízátion* (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 *EXTLAPSE 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. V̀ C_0 -ìzátion (*fa**sc**ization*) : shortest
   V̀ [***C*₀**] *ìzátion*

b. V̀ C_0V C_0 -ìzátion (*cha**nnel**ization*): longer
   V̀ [***C*₀*V* *C*₀**] *ìzátion*

c. V̀ C_0V C_0V C_0 -ìzátion (***federal**ization*): longest
   V̀ [***C*₀*V* *C*₀*V* *C*₀**] *ìzátion*

  - ⪰ 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.

[2] There 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 ÝV 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. V̀ ***R*** -ìzátion: shortest
   V̀ [***R***] *ìzátion*

b. V̀ ***O*** -ìzátion: longer
   V̀ [***O***] *ìzátion*

c. V̀ ***CC*** -ìzátion: longest
   V̀ [***CC***] *ìzátion*

  - 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]

[3] All 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)
Pràgueizátion	*Ègyptizátion*	*Pròvidenceizátion*
[g]	[dʒ], [pt]	[v], [d], [ns]
Quebècizátion	*Wyòmingizátion*	*Sènegalizátion*
[k]	[m], [ŋ]	[n], [g], [l]
Chàdizátion	*Cùbanizátion*	*Ìndianàpolisizátion*
[d]	[b], [n]	[n], [p], [l]
Ròmeizátion	*Bròoklynizátion*	*Antàrcticanizátion*
[m]	[kl], [n]	[ɹ(k)t], [k], [n]
Japànizátion	*Àustinizátion*	*Blòomingtonizátion*
[n]	[st], [n]	[m], [ŋt], [n]
Brònxizátion	*Tèxasizátion*	*Mèxicanizátion*
[ŋks]	[ks], [s]	[ks], [k], [n]
Vermòntizátion	*Phòenixizátion*	*Mìchiganizátion*
[nt]	[n], [ks]	[ʃ], [g], [n]
Frànceizátion	*Alàskanizátion*	*Òberlinizátion*
[ns]	[sk], [n]	[b], [ɹl], [n]
Bàsqueizátion	*Rùssianizátion*	*Màdisonizátion*
[k]	[ʃ], [n]	[d], [s], [n]
Mìnskizátion	*Ìcelandizátion*	*Ròchesterizátion*
[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.

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

Figure 1: Interstress duration in *Quebècizátion*

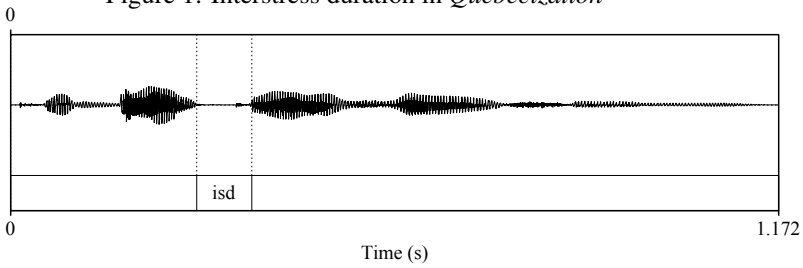
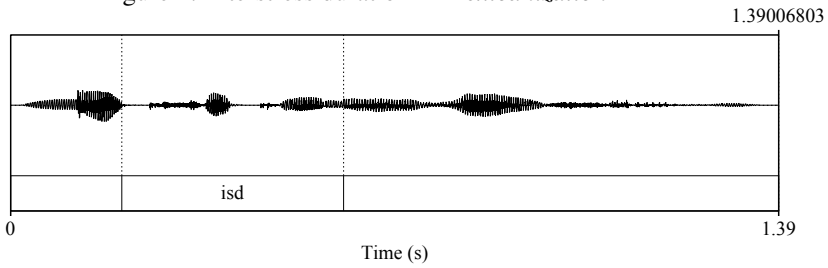


Figure 2: Interstress duration in *Mèxicanizátion*



3.2.1 Study design

- Stimuli: 30 pairs of nonce *-ization* forms, differing only in suffixal stress (examples: *Quebècizátion-Quebècizátion*, *Mèxicanizátion-Mèxicanizátion*).
- 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

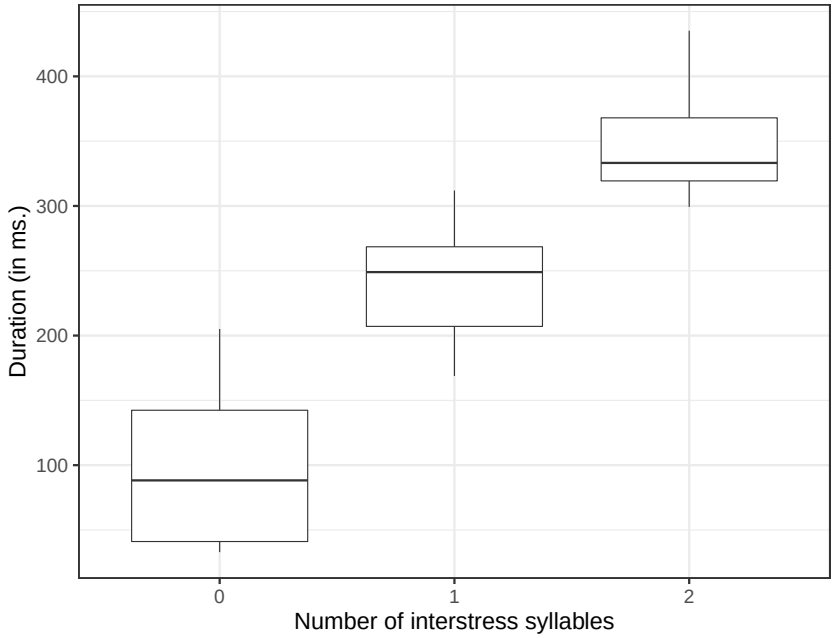


Figure 4: Interstress duration by the type of interstress consonant(s)

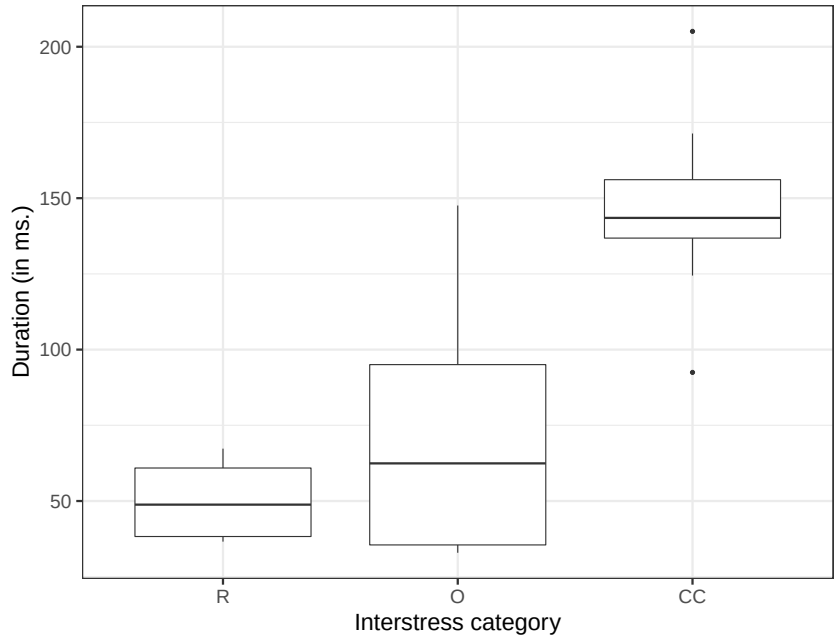
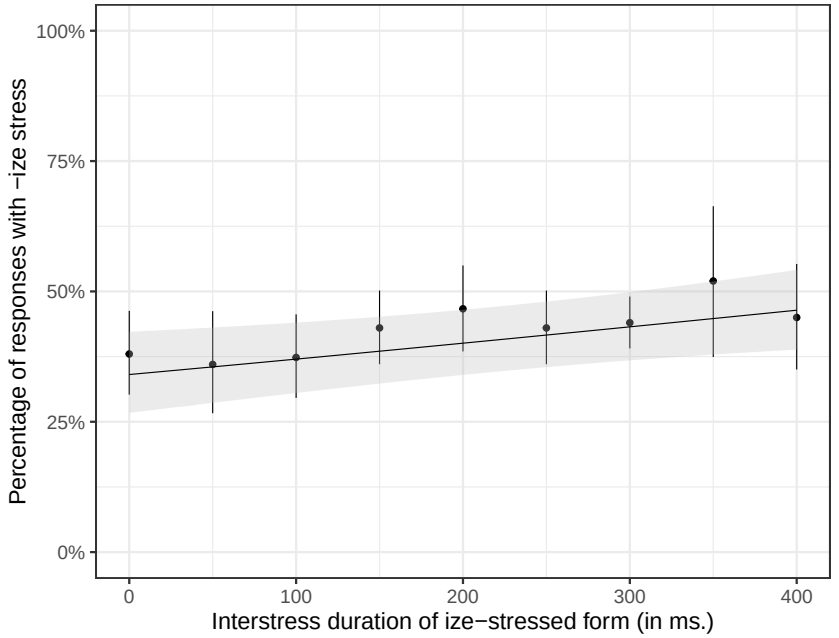


Figure 5: Preference for *-ize* stress by interstress duration



- 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 (*fà**sc**izàtion*), 34.9% prefer *-ize* stress.
    - ⩾ For the *LAPSE context (*chà**nnel**izátion*), 39.4% prefer *-ize* stress.
    - ⩾ For the *EXTLAPSE context (*fè**deral**izátion*), 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. *chànnelizátion*; 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 (χ^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.
  - 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) Interstress C(s)	*LAPSE (n=5) Interstress C(s)	*EXTLAPSE (n=5) Interstress C(s)
Quebècizátion [k]	*Ègyptizátion* [dʒ], [pt]	*Ròchesterizátion* [tʃ], [st], [ɪ]
Chàdizátion [d]	*Cùbanizátion* [b], [n]	*Sènegalizátion* [n], [g], [l]
Ròmeizátion [m]	*Àustinizátion* [st], [n]	*Ìndianàpolisizátion* [n], [p], [l]
Brònxizátion [ŋks]	*Tèxasizátion* [ks], [s]	*Antàrcticanizátion* [ɪ(k)t], [k], [n]
Bàsqueizátion [sk]	*Phòenixizátion* [n], [ks]	*Mèxicanizátion* [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 (Corretge 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 (χ^2 (1) = .72).
- **The takeaway**: gradient *CLASH likely assesses violations at a more abstract level than milliseconds, though more systematic investigation is necessary.

[5] All 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).

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

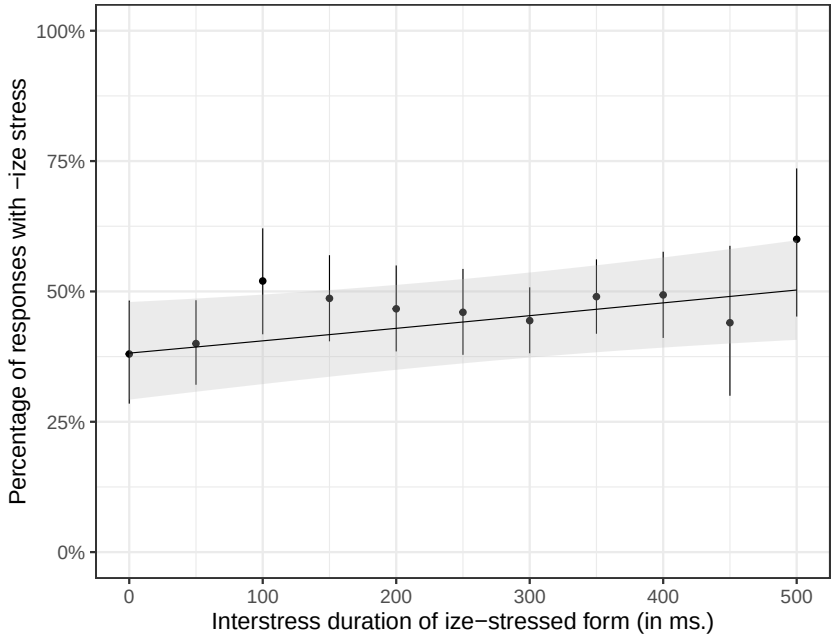
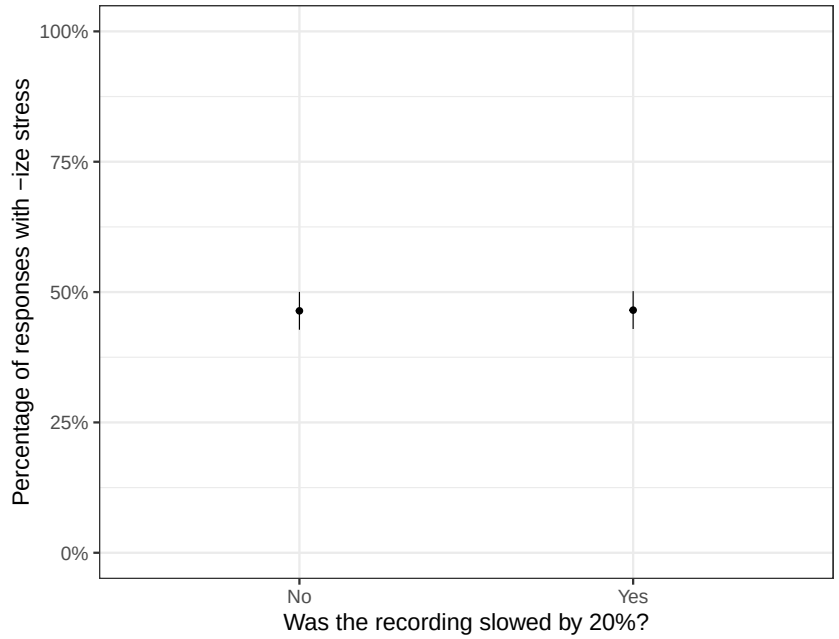


Figure 7: Preference for *-ize* stress by interstress duration



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 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 $\acute{V}_1$ and $\acute{V}_2$, assign a base violation score of 1. For each segment between $\acute{V}_1$ and $\acute{V}_2$, multiply the violation score by $1/x$, where x is valued according to (a-b).
   a. Sonorant consonants = 2
   b. Obstruent consonants = 3

  - For *Quebècìzátion*, violation score is 1/3.
  - For *Tèxasìzátion*, 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 *chànnelizátion* vs. *fèderalizátion*, possible that the preference for more *-ize* stress on the latter is due to gradient *LAPSE.

(16) *LAPSE: for each pair of stressed vowels $\acute{V}_1$ and $\acute{V}_2$, assign a base violation score of 1. For each segment between $\acute{V}_1$ and $\acute{V}_2$, multiply the violation score by x, where x is valued according to (a-b).
   a. Sonorant consonants = 2
   b. Obstruent consonants = 3

  - For *Quebècìzátion*, violation score is 3.
  - For *Tèxasìzátion*, 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: *Quebècizátion*, *Fránceizátion*, *Tèxasizátion*, and *Mèxicanizátion*.
- For an analysis of these results, I include the following constraints[6]:

(17) CLASH$_{\text{-}ate}$: assign one * for each sequence of two adjacent stressed syllables that includes the verbal suffix *-ate*.

(18) STRESS$_{\text{-}ize}$: 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$_{\text{-}ate}$	*CLASH	*LAPSE
a. *Quebècìzátion*		1	1/3	3
b. *Quebècizátion*	1		1/9	9
c. *Fránceìzátion*		1	1/6	6
d. *Fránceizátion*	1		1/18	18
e. *Tèxasìzátion*		1	1/27	27
f. *Tèxasizátion*	1		1/81	81
g. *Mèxicanìzátion*		1	1/54	54
h. *Mèxicanizátion*	1		1/162	162

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

(20)

Constraint	Weight
*CLASH	2.553
CLASH$_{\text{-}ate}$	0.280
*LAPSE	0.006
STRESS$_{\text{-}ize}$	0.000

(21)

Form	Rate of *-ize* stress	
	Predicted	Observed
Quebècìzátion	30%	30%
Fránceìzátion	38%	40%
Tèxasìzátion	50%	48%
Mèxicanìzátion	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$_{\text{-}ize}$ 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 *Quebècízation*.

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 *mollificative*.
- **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).

(22)

Effect of *-ate* stress	Stressed *-ate*	Stressless *-ate*	% stressed
*CLASH violation	*òrnàtíve* (n=15)	*quótatìve* (n=216)	6.4% (15/231)
*LAPSE satisfaction	*législàtive* (n=229)	*spéculatìve* (n=105)	68.6% (229/334)
*EXTLAPSE satisfaction	*amélioràtive* (n=9)	*detérioratìve* (n=1)	90.0% (9/10)

- To analyze this, useful to import an earlier assumption: *CLASH$_{\text{-}ate}$ 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$_{\text{-}ive}$: assign one * if the suffix *-ive* does not bear stress.

- Variation: STRESS$_{\text{-}ive}$ conflicts with *LAPSE (evaluated syllabically, for now).

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

	investigative	*CLASH$_{\text{-}ate}$	*LAPSE	STRESS$_{\text{-}ive}$
☞	a. invéstigàtive			*
☞	b. invéstigatìve		*	
	c. invéstigàtìve	*!		
	quotative			
	d. quótàtive	*!		*
☞	e. quótatìve			
	f. quótàtìve	*!*		

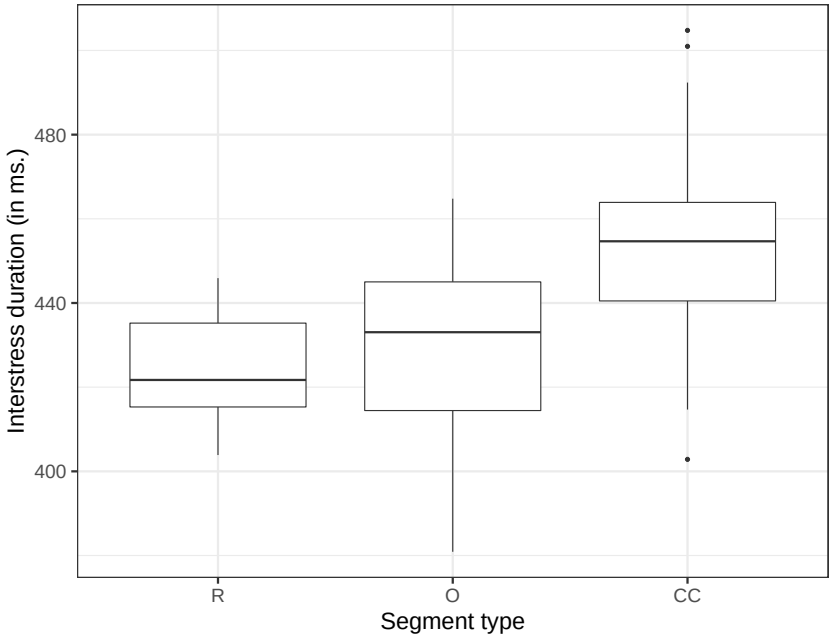
- The question: can we predict when *–at-* is more or less likely to bear stress?
- Stanton (2019): The longer the lapse that would result were *-ate* not stressed, the higher the likelihood that *-ate* will bear stress.
  - Observation: *-ate* stress depends on content of the lapse (Nanni 1977).
  - 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.

(25)

Interstress seg(s).	Stressed *-ize*	Stressless *-ize*	% stressed
Sonorant (R)	*muti**l**ative* (n=85)	*specu**l**ative* (n=65)	57% (85/150)
Obstruent (O)	*depre**c**ative* (n=91)	*dubi**t**ative* (n=19)	83% (91/110)
Cluster (CC)	*legi**sl**ative* (n=27)	*ade**qu**ative* (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-bádjaspatìve, sidjólatìve-sidjólàtive*).
  - 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 (*sidjólatìve-sidjólàtive*), 20.6% preferred *-ate* stress.
  - For trochaic forms (*bádjaspàtive-bádjaspatìve*), 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]

(26)

Factor	Coefficient	z value	Significant?
(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)

[7] Stanton (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.

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

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

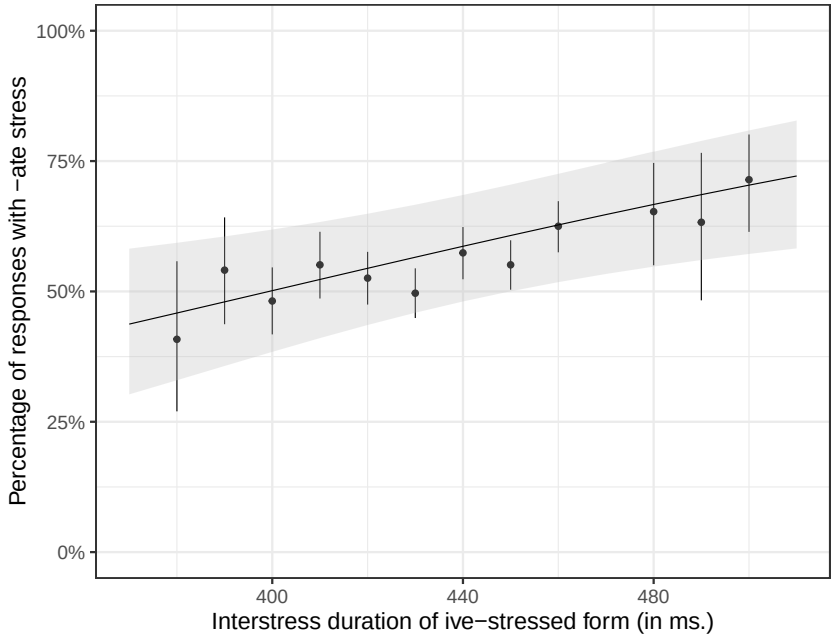
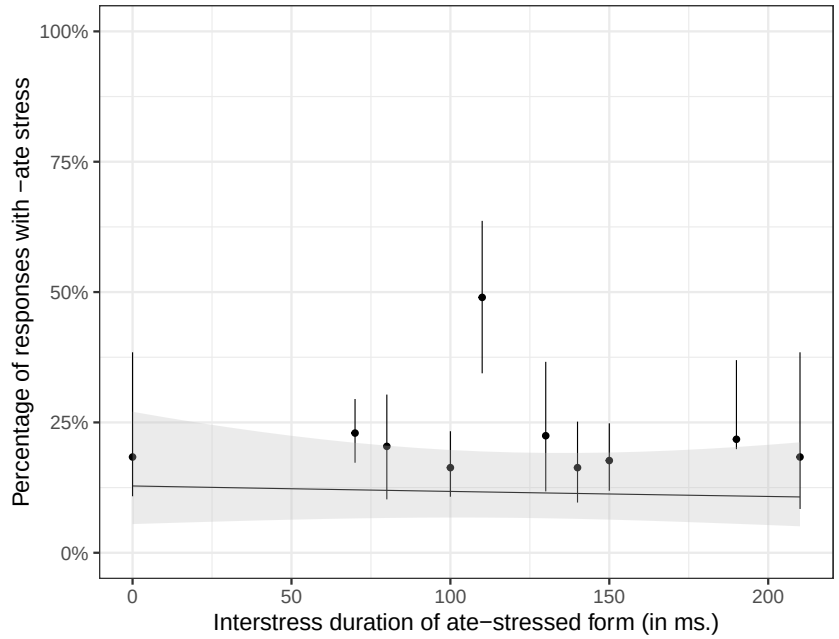


Figure 10: Preference for *-ate* stress by interstress duration (iambic subset)



- 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: *sidjópative*, *sidjósklative*, *bádjapative*, and *bádjasprative*.
- 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

	STRESS-*ive*	*CLASH-*ate*	*LAPSE	*CLASH
a. *sidjópàtive*	1	1	3	1/3
b. *sidjópatìve*			9	1/9
c. *sidjósklàtive*	1	1	18	1/18
d. *sidjósklatìve*			54	1/54
e. *bádjapàtive*	1		9	1/9
f. *bádjapatìve*			27	1/27
g. *bádjaspràtive*	1		108	1/108
h. *bádjaspratìve*			324	1/324

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

(27)

Constraint	Weight
*CLASH-*ate*	1.443
*LAPSE	0.004
STRESS-*ive*	0.000
*CLASH	0.000

(28)

Form	Rate of *-ate* stress	
	Predicted	Observed
sidjósàtive	19%	24%
sidjóspràtive	21%	18%
bádjapàtive	52%	61%
bádjaspràtive	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* (*érgonòmia*) but penultimate otherwise (*kólesteròli*). 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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