Rhythm is gradient: evidence from *–ative* and *-ization*[*]

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1 Introduction

- **Commonly assumed**: stress is the manifestation of linguistic rhythm (Liberman & Prince 1977).
- Rhythm implies *alternation*, or the timed succession of weak and strong beats.
  - In English, rhythmic alternation can be found at the phrase level.

    (1) Rhythmic alternation within a phrase (Hayes 1995:28)

    x
    x x x
    x x x x x
    x x x x x x x x x x x
    twenty-seven Mississippi legislators

  - Rhythmic alternation is also found at the word level.

    (2) Rhythmic alternation within a word (Hayes 1995:29)

    x
    x x
    x x x
    x x x x x
    reconciliation

- Alternation implies *distance*: weak and strong beats are separated in time.
- **Question**: how do we measure rhythmic distance?
  - The way in which rhythmic distance is measured differs in foot-based and foot-free approaches to stress.
  - Distance, in recent foot-based approaches to stress (e.g. Kager 1999):
    - ≫ Constraints like PARSESYL requires syllables to be parsed into feet.
    - ≫ Constraints on foot form (e.g. IAMB, TROCHEE) and alignment (e.g. ALLFTLEFT) regulate distance between stresses.
  - Distance, in recent foot-free approaches to stress (e.g. Gordon 2002):
    - ≫ Constraints like *LAPSE and *CLASH directly regulate the distance between stressed and stressless syllables.

      (3) *LAPSE assign one violation for each sequence of two adjacent stressless syllables.

      (4) *CLASH: assign one violation for each sequence of two adjacent stressed syllables.

    - ≫ These constraints are often referred to as *rhythmic* constraints.
- These approaches are superficially different, but share something fundamental: they calculate distance over units of formal structure (syllables and feet).
- **This talk** explores an alternative: rhythm is calculated not over units of formal structure, but over duration, in a more direct way.

Outline

- The evidence for this alternative: suffixal stress in American English *-ative* (Stanton 2019) and *-ization*.
  - In both *-ative* and *-ization*, stress on the inner suffix is variable.
  - **Claim**: this variability is, at least in part, governed by rhythm.
- In both cases, inner suffix stress becomes more likely as its distance from the rightmost stem stress increases.
  - From *-ization*: words like *culturalization* (with a lapse) more likely to bear *-ize* stress than words like *realization* (without one).
  - From *-ative*: words like *legislative* (with a pre-*ate* cluster) more likely to bear *-ate* stress than words like *speculative* (with a pre-*ate* sonorant).
- **Main point**: the metric of distance speakers use references duration in a more direct way than is generally assumed by theories of stress.

[*]Thanks to A. Albright, D. Steriade, and audiences at NYU and AMP 2020 for comments.

2 Stress in *-ization*

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

(5) 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

- It is useful to separate words that end in *-ization* into two domains: the stem (pre-*ization* material) and the suffixal domain (*-ization*).

(6) Division of *–ization* forms into stem and suffixal domains

s o l a r	– i z e - a t e - i o n	f a s c	– i z e - a t e - i o n
stem	*suffixal*	*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$_{\text{-}ize}$.

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

  - Stressing *-ize* and *-ate* violates *CLASH; *-ize* destressing can thus be seen as a clash-avoidance strategy.
    - ⪰ We'll assume that the relevant version of *CLASH is specific to *-ate*.
    - ⪰ Well-known that the verbal *-ate* repels stress; it's a *strong retractor*, in the sense of Liberman & Prince 1977.
  - Preference for *-izátion* (vs. *-ízation*) due to *LAPSER (Gordon 2002).

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

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

(9)

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

2.2 Rhythmic effects in *-ization* stress

- **The question**: can we predict when *-ize* is more or less likely to bear stress?
- Corpus study conducted to see if rhythmic factors are implicated in *-ization* stress (following Stanton 2019:7.2).[1]
  - Corpus: all relevant *-ization* forms in the OED 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 (10) demonstrate a rhythmic effect in *-ization* stress: *-ize* stress is more frequent when it resolves a lapse than when it creates a clash.[2]

(10)

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 (10). Native speaker status and *-ize* stress were determined by ear.

(11)

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

[1] For the OED: a logistic regression finds a significant comparison between *LAPSE vs. *CLASH ($p < .001$) and *LAPSE vs. *EXTLAPSE ($p < .05$). For Forvo: a logistic regression finds a significant comparison between *LAPSE vs. *EXTLAPSE contexts ($p < .01$) but not *LAPSE vs. *CLASH. All models control for the frequency of the *-ization* form as well as the frequency of its *-ize* base.

[2] Numbers in (10) 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 (12), we see that the rate of *-ize* stress varies with the interstress material.[3]

(12)

Interstress seg(s).	Stressed *ize*	Stressless *ize*	% stressed
Sonorant (R)	*xè**n**ìzátion* (n=17)	*rèa**l**izátion* (n=15)	53.1% (17/32)
Obstruent (O)	*stỳlò**p**ìzátion* (n=17)	*fà**sc**izátion* (n=11)	60.7% (17/28)
Cluster (CC)	*bà**pt**ìzátion* (n=20)	*òbjè**ct**izátion* (n=6)	76.9% (20/26)

  - The rate of *-ize* stress does not vary noticeably within the *LAPSE and *EXTLAPSE resolution contexts; the numbers are close to ceiling.

2.3 Hypothesis

- **Hypothesis**: *-ize* stress is sensitive to duration. The longer the distance between the rightmost stem stress and *-ize*, the more likely *-ize* is to be stressed.
- Analytically: *-ize* stress is governed by a gradient version of *CLASH.
  - If this is correct: as the number of syllables between the rightmost stem stress and *-ize* increases, so should the duration (expected given (10-11)).

(13) 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 more duration.
  - ≥ However, Nespor & Vogel (1989:102) hint at the existence of lapse compression in English, so this prediction should be verified.

[3] A logistic regression finds that neither the R vs. O nor the O vs. CC comparisons are significant. In addition, 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.

  - Given (12), we might also expect for clashes with sonorants to be shorter than those with obstruents, which might be shorter than those with clusters.

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

a. V̀ ***R*** -ìzátion (*xe**n**ization*: shortest
   V̀ [***R***] *ìzátion*

b. V̀ ***O*** -ìzátion (*stylo**p**ization*): longer
   V̀ [***O***] *ìzátion*

c. V̀ ***CC*** -ìzátion (*ba**pt**ization*): longest
   V̀ [***CC***] *ìzátion*

- We need to know whether or not trends in the dictionary data correlate with trends in duration, and whether or not speakers' preferences match these trends.

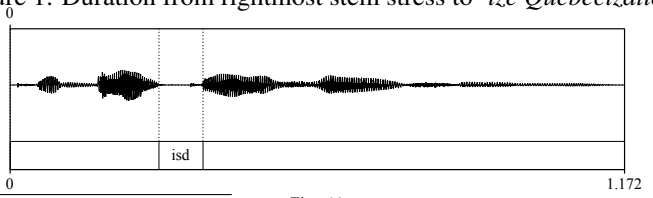
3 Experimental support

- To test the hypothesis, I ran a forced-choice task, asking participants to choose between *-ìzátion* and *-izátion* variants of the same form.
- **Result**: speakers are sensitive to duration! The longer the duration between the rightmost stem stress and *-ize*, the greater the preference for *-ize* stress.
- Analysis of the experimental items supports predictions in (13-14).

3.1 Items and acoustic analysis

- For the experiment, I recorded one speaker producing *-ìzátion* and *-izátion* variants of forms that ended in *-ization*, all placenames or demonyms (Table 1).
  - Ten items where *-ize* stress would violate *CLASH, and ten where *-ize* stress would satisfy *LAPSE, and ten where *-ize* stress would satisfy *EXTLAPSE.
  - Within categories, segmentals following the rightmost stem stress differed.
- Duration between the rightmost stem stress and *-ize* measured as in Fig. 1.[4]

Figure 1: Duration from rightmost stem stress to *-ize Quebècìzátion*



[4] 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]	[ɪ(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], [ɪl], [n]
Bàsqueizátion	*Rùssianizátion*	*Màdisonizátion*
[k]	[ʃ], [n]	[d], [s], [n]
Mìnskizátion	*Ìcelandizátion*	*Ròchesterizátion*
[nsk]	[sl], [nd]	[tʃ], [st], [ɪ]

- Durational properties of these forms are in line with the predictions above.
  - Distance from the rightmost stem stress is shortest in the *CLASH context, longer in *LAPSE, and longest in *EXTLAPSE (Fig. 2).[5]
  - Sonorants between two stresses are shorter than obstruents (though not by much), which are shorter than clusters (Fig. 3).
- First part of the hypothesis is plausible: broad trends discovered in the dictionary study correlate with properties of the productions.

3.2 Experiment 1

3.2.1 Design

- Stimuli were created from the forms in Table 1, 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!*).

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

Figure 2: Interstress duration by the number of interstress syllables

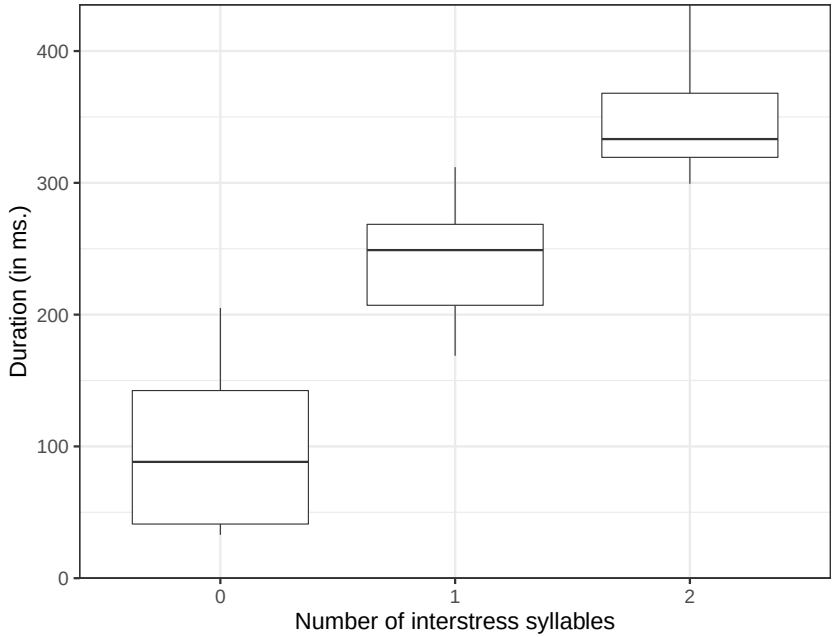
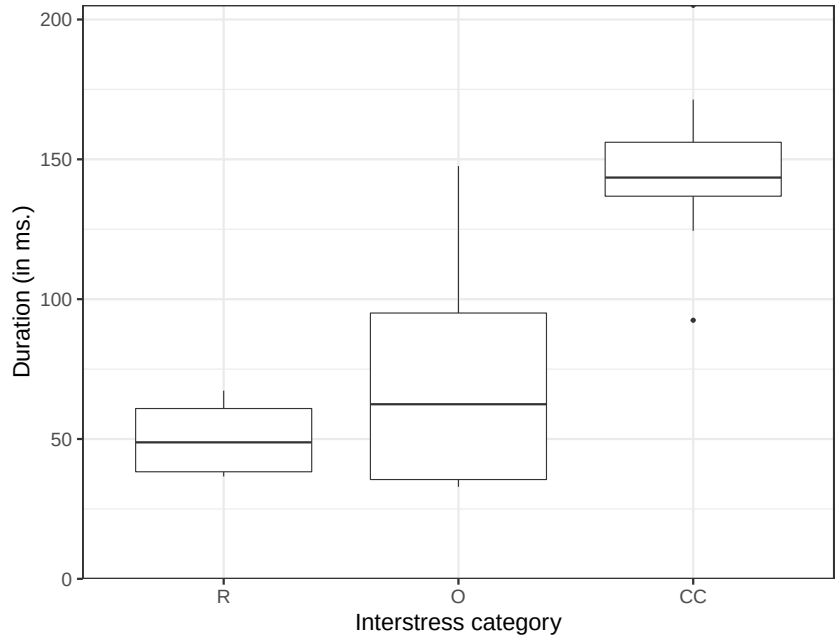


Figure 3: Interstress duration by the type of interstress consonant(s)



- They were asked to choose between two possible pronunciations of the bolded and italicized word, which they could listen to a maximum of twice.[6]

3.2.2 Participants

- Fifty participants recruited using Mechanical Turk. All indicated that they are native speakers of English from the U.S. None 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 (*xè**n**izàtion*), 34.9% prefer *-ize* stress.
    - ≥ For the *LAPSE context (*chà**nnel**ization*), 39.4% prefer *-ize* stress.
    - ≥ For the *EXTLAPSE context (*fè**deral**ization*), 40.2% prefer *-ize* stress.
  - The positive correlation between *-ize* stress and interstress duration is also expected: the worse the clash, the more likely *-ize* destressing (Figure 4).
- Interestingly, the statistics indicate that only duration (and *not* rhythmic category) played a role in participants' responses.
  - A mixed-effects logistic regression finds a significant effect for duration.[7]

(15) Model with duration as fixed effect

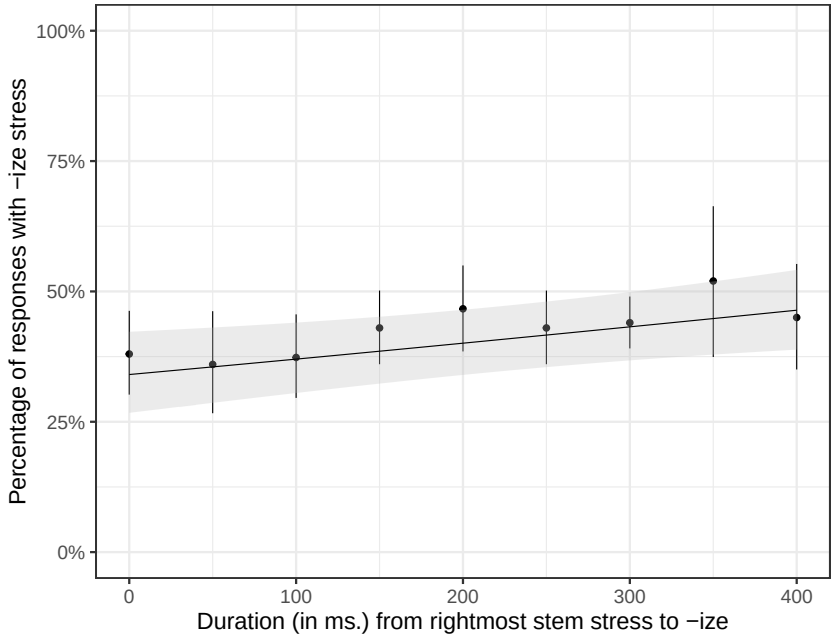
Factor	Coefficient	*z* value	Significant?
(Intercept)	-0.66	–	
Duration	1.29	2.52	Yes ($p < .05$)

  - Adding a predictor for rhythmic category does not improve the fit of the model (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 *duration* 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.

[6] The order of stressed and stressless *-ization* was randomized by item and participant; item order was randomized by participant. Experiments were made with Experigen (Becker & Levine 2013).

[7] All models were fitted using the glmer function of R's lme4 (Bates & Maechler 2011) and include a random intercept for participant,. Significance values are from lmerTest (Kuznetsova et al. 2016).

Figure 4: Preference for *-ize* stress by interstress duration



4 Towards an analysis

- Results from Experiment 1 support the hypothesis. The longer the distance between the rightmost stem stress and *-ize*, the more likely *-ize* is to be stressed.
- Analytically speaking: these results support the addition of a gradient *CLASH constraint, defined over duration, 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): predicts 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 sketch a possible one, based on these results, in Section 4.2.

4.1 Experiment 2

- Experiment 2 used half of the *-ization* items from Experiment 1 (Table 2). 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]
Bròn̄xizátion [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.
  - The first version: both forms were presented at the normal speech rate.
  - The second version: both forms were artificially slowed by 20%, using Praat Vocal Toolkit (Corretge 2012).
- **The prediction:** if phonetic *CLASH is defined in terms of milliseconds, we should find a stronger preference for *-ize* stress in the slowed items.
- The results are clear, and do not support this prediction.
  - First, a sanity check: does the result from Experiment 1 replicate?
    - ≽ Yes: duration is a significant predictor of *-ize* stress (16). Trend is visible in both the normal and slowed forms (Fig. 5).

(16) Model with duration as a fixed effect

Factor	Coefficient	*z* value	Significant?
(Intercept)	-0.66	–	
Duration	0.99	2.26	Yes ($p < .05$)

    - ≽ Adding a rhythmic context factor does not improve fit ($\chi^2(2)$=4.58, p=.1).
  - Item type (slowed vs. not slowed) is not a significant predictor; adding it to the model also 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.

Figure 5: Preference for *-ize* stress by duration (faceted by speech rate)

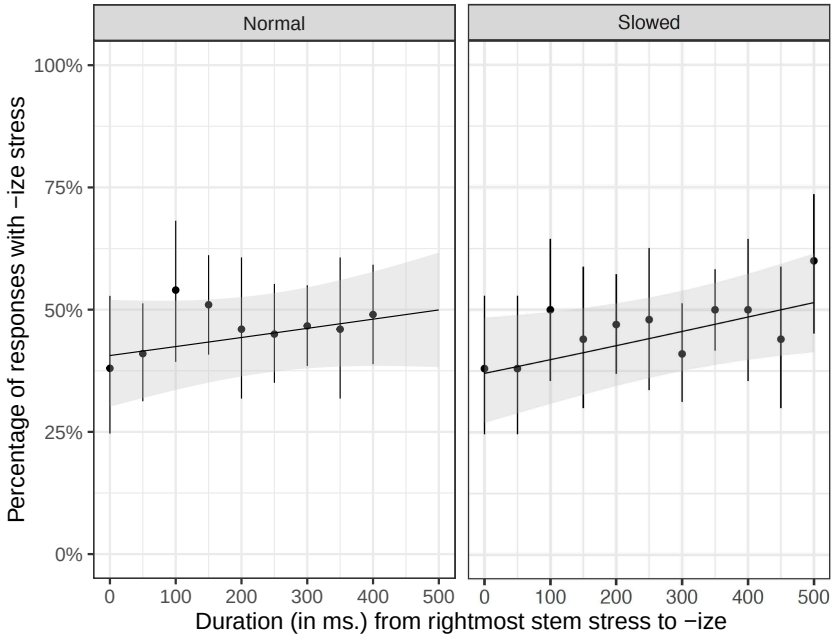
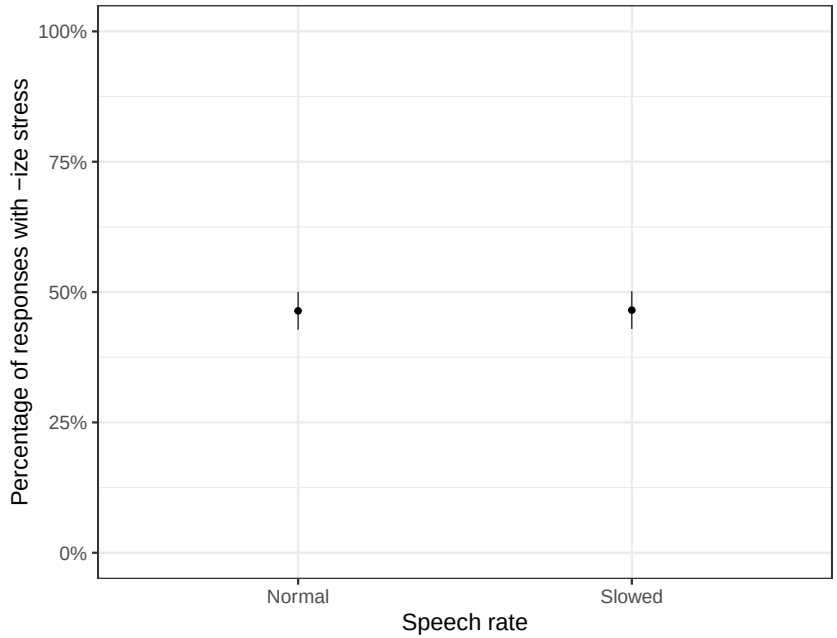


Figure 6: Preference for *-ize* stress by speech rate



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.
  - A possibility: each segment is associated with an idealized duration, stored as milliseconds. Rhythmic constraints reference idealized duration.
  - Another possibility: segments are split up into durational categories. Rhythmic constraints reference durational categories.
- 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.

(17) *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 *Quebècizátion*, violation score is 1/3; for *Tèxasizátion*, it's 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 *Tèxasizátion* vs. *Mèxicanizátion*, possible that the preference for more *-ize* stress on the latter is due to gradient *LAPSE.

(18) *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 *Quebècizátion*, violation score is 3; for *Tèxasizátion*, it's 27.

- Where is the evidence that we need to define these constraints with reference to the identity of segments, rather than just the number of segments?
  - Sporadic evidence that R vs. O matters: in the *LAPSE context, for example, *Texasization* has a higher rate of *-ize* stress (48%) than *Austinization* (40%).
  - Evidence is more consistent for *-ative*, where the segmentals of experimental stimuli were more tightly controlled. We'll come back to this.
- What's important here is the idea: the strength of violation is correlated with the distance between two stresses. These precise formulations can be revised.

4.3 Analysis

- To demonstrate how an analysis of these data might work, I consider four items: *Quebècizátion*, *Fràn ceizátion*, *Tèxasizátion*, and *Mèxicanizátion*.
- For an analysis of these results, I include the following constraints:

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

(20) STRESS$_{\text{-}ize}$: assign one * if the suffix *-ize* doesn't bear stress.

(21) *LAPSE, *CLASH: as in (17, 18).

- 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. *Quebècizátion*		1	1/3	3
b. *Quebècizátion*	1		1/9	9
c. *Fràn ceizátion*		1	1/6	6
d. *Fràn ceizátion*	1		1/18	18
e. *Tèxasizátion*		1	1/27	27
f. *Tèxasizátion*	1		1/81	81
g. *Mèxicanizátion*		1	1/54	54
h. *Mèxicanizátion*	1		1/162	162

- The tool finds the weights in (22), and makes the predictions in (23).

(22)

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

(23)

Form	Rate of *-ize* stress	
	Predicted	Observed
Quebècizátion	30%	30%
Fràn ceizátion	38%	40%
Tèxasizátion	50%	48%
Mèxicanizátion	59%	60%

- **The main takeaway**: phonetic, gradient versions of *CLASH and *LAPSE play a role in judgments of *-ize* stress. Rhythm drives variation.

5 A parallel from *-ative*

- The suffix *-ative* behaves like *-ization*, in that 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 (24), *-ate* stress is dispreferred under clash (data in this section from Stanton 2019).

(24)

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	*améliòràtive* (n=9)	*detérioratìve* (n=1)	90.0% (9/10)

- To understand why this is, it's useful to assume that *CLASH$_{\text{-}ate}$ is active.
- 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 (25).[8]

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

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

(26) *-ate* 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	*!*		

[8] It's possible that *-ive* is not stressed in your dialect. With some modification, the analysis proposed here works for dialects where *-ive* is stressless. See Stanton (2019) for more.

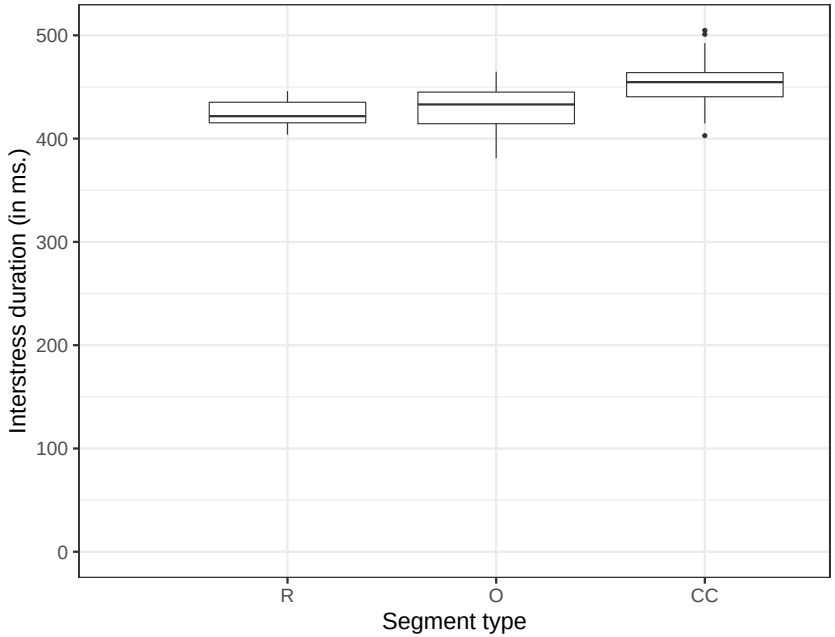
- **Question**: can we predict when *-ate* is more or less likely to bear stress?
- **Answer** (Stanton 2019): The longer the lapse that would result were *-ate* not stressed, the higher the likelihood that *-ate* will bear stress.
  - Observation (due to Nanni 1977): *-ate* stress depends on content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

(27)

Interstress seg(s).	Stressed *-ate*	Stressless *-ate*	% 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)

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

Figure 7: Lapse length by category of the pre-*ate* consonant(s) (Stanton 2019)



5.2 Experimental evidence

- Evidence that speakers are sensitive to lapse duration: there is a positive correlation between lapse duration and a preference for *-ate* stress (Stanton 2019[9]).
- Unlike *-ization*: for *-ative*, *CLASH has a categorical effect. This may be 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; recruitment was also identical, though one participant's data was excluded.

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 8), but not for the iambic stems (Figure 9).
- A mixed-effects logistic regression (with random intercepts for item, participant) confirms an interaction between stem type and interstress duration.[10]

(28)

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)

[9]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.

[10]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 8: Preference for *-ate* stress by lapse duration (trochaic subset)

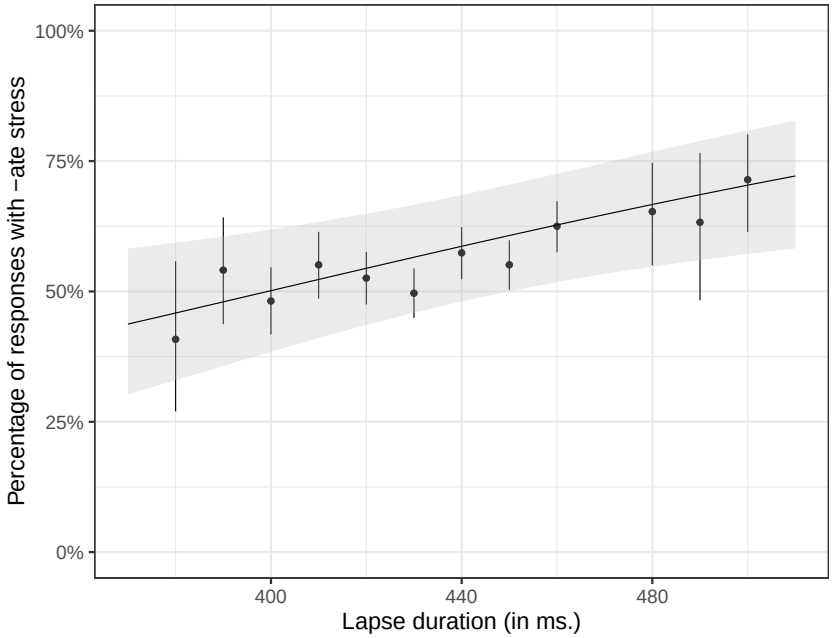
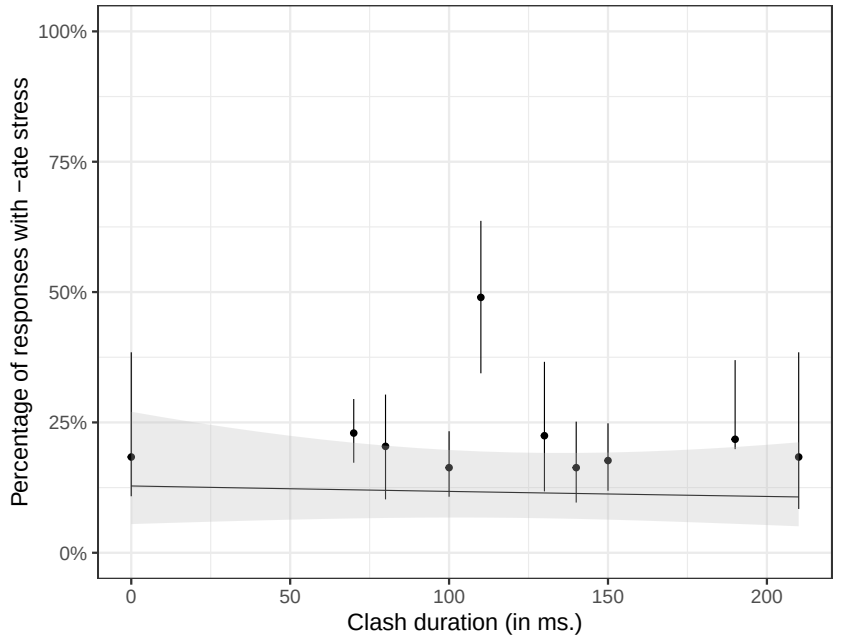


Figure 9: Preference for *-ate* stress by clash duration (iambic subset)



- **Takeaway**: gradient *LAPSE influences speakers' judgments about *-ate* stress. Gradient *CLASH does not; this may be because clash with *-ate* is dispreferred.

5.3 Analysis

- To demonstrate how an analysis of these data might work, I consider four items: *sidjópative*, *sidjósprative*, *bádjapative*, and *bádjasprative*.
- For an analysis of these results, I include the following constraints: STRESS$_{\text{-}ive}$, *CLASH$_{\text{-}ate}$, *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$_{\text{-}ive}$	*CLASH$_{\text{-}ate}$	*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 (29), and makes the predictions in (30).

(29)

Constraint	Weight
*CLASH$_{\text{-}ate}$	1.443
*LAPSE	0.004
STRESS$_{\text{-}ive}$	0.000
*CLASH	0.000

(30)

Form	Rate of *-ate* stress	
	Predicted	Observed
sidjósàtive	19%	24%
sidjóspràtive	21%	18%
bádjapàtive	52%	61%
bádjaspràtive	70%	69%

- Picking up on a loose thread: there's evidence that talking about segment identity, and not just segment count, is necessary to accurately model these results.
  - Participants preferred *-ate* stress on -R*ative* items 47.6% of the time.
  - By comparison: *-ate* stress on -O*ative* items preferred 56.9% of the time.
  - Any proposed definition of *LAPSE that counts segments, ignoring their quality, would entirely miss this distinction.
- **Takeaway**: phonetic *LAPSE plays a role in *-ative* stress. Categorical *CLASH prevents us from seeing any effects of phonetic *CLASH.

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: stress in English words ending in *-ative* and *-ization*.
  - Why have we focused on this small slice of the lexicon?
    - ⩾ Words ending in *-ative* and *-ization* are perhaps the two corners of the English lexicon where evidence for gradient rhythm is most easily available.
    - ⩾ Clashes and lapses are in principle allowed in these forms: *-ative* and *-ization* are largely stress-preserving (Stanton & Steriade in prep).
    - ⩾ Both of the inner suffixes, *-ate* and *-ize*, have stressed and stressless forms. Their realization can depend on rhythmic context.
- Words in *-ative* and *-ization* are infrequent; must be the case that evidence for gradient rhythm is more widespread in English than we've seen here.

6.1 More potential evidence: post-tonic syncope

- In English, post-tonic schwas are often deleted. This is conditioned to some extent by segmental factors (not discussed here; see Hooper 1978).

(31) English post-tonic syncope (Hooper 1978:192)
  a. obstruent + *r*: *separate, temperature, every, dangerous*
  b. obstruent + *l*: *pedaling, awfully, javelin, especially*
  c. sonorant + *r, l*: *camera, general, family, Emily*

- Post-tonic syncope is also rhythmically conditioned (Hooper 1978, Polgárdi 2015), in a way familiar from the *-ization* and *-ative* cases discussed above.
  - Post-tonic syncope is blocked when it would create a clash.

(32)
  a. *degéneràte*, v. (cf. *degénerate*, adj.)
  b. *imágninàry* (cf. *imágining*)
  c. *mémorìze* (cf. *mémory*)

  - We can thus see post-tonic syncope as a lapse resolution strategy (Polgárdi 2015): it serves to reduce the amount of stressless material.
- **Hypothesis:** post-tonic syncope is conditioned by the *overall duration of the stressless material*. The longer its duration, the more likely syncope is.
- A small pilot study I ran in 2015 suggests that this hypothesis might be correct, though the data are not as clear as they are for *-ization* and *-ative*.

6.2 Methods and design

- To probe speakers' intuitions regarding post-tonic syncope, I created a set of 75 forms with four different metrical configurations (Table 5).

Table 5: Items for post-tonic syncope task

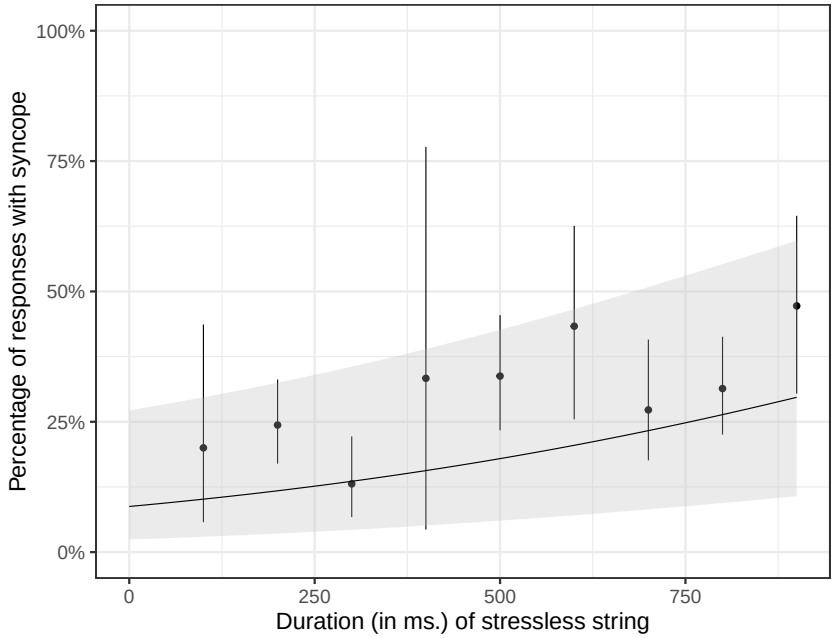
Context	Form (n=75)	Examples
*CLASH	*-áte* (n=9)	*delíberàte*, *séparàte*
	-ósity (n=9)	*glàmorósity*, *slúmberòsity*
*LAPSE	*-ate* (n=9)	*séparate*, *delíberate*
	-ous (n=9)	*glámorous*, *slúmberous*
*EXTLAPSE	*-able* (n=12)	*génerable*, *óperable*
	-ousness (n=9)	*glámorousness*, *slúmberousness*
	-ousness (n=9)	*séparateness*, *delíberateness*
*EXTEXTLAPSE	*-ableness* (n=9)	*génerableness*, *óperableness*

- Items consisted of two versions of each form, recorded by a native American English speaker. One version had schwa deletion and the other did not.
- Order of items was randomized. Order of forms within items was not: approximately half were deletion-first, the others in the reverse order.
- 7 participants (all native speakers of Am. English, recruited through personal contacts) were played the recordings and chose which form they preferred.

6.3 Results

- Patterns in the data suggest that the hypothesis is correct.
  - Distinctions among rhythmic categories are what we would expect, given the hypothesis and what we already know about post-tonic syncope.
    - ⪰ For the *CLASH context (*séparàte*), 19.4% prefer syncope.
    - ⪰ For the *LAPSE context (*séparate*), 23.3% prefer syncope.
    - ⪰ For the *EXTLAPSE context (*génerable*), 30.6% prefer syncope.
    - ⪰ For the *EXTEXTLAPSE context (*génerableness*), 47.2% prefer syncope.
  - Positive correlation between stressless duration and syncope is expected: the longer the potential lapse, the more preferred syncope is (Figure 10).
- Unlike the earlier cases, the statistics indicate that rhythmic category may have played a larger role than stressless duration in participants' responses.

Figure 10: Preference for syncope by total stressless duration



  - A mixed-effects logistic regression finds a significant effect for duration.[11] (It also finds a significant effect for order; order of presentation mattered.)

(33) Model with duration and order as fixed effects

Factor	Coefficient	*z* value	Significant?
(Intercept)	-2.74	–	
Duration	1.65	3.24	Yes ($p < .01$)
Order	0.78	2.93	Yes ($p < .01$)

  - A separate mixed-effects logistic regression finds a significant effect for rhythmic context (treated as a continuous predictor) and order.

(34) Model with duration and order as fixed effects

Factor	Coefficient	*z* value	Significant?
(Intercept)	-2.54	–	
Context	0.53	3.96	Yes ($p < .001$)
Order	0.70	2.72	Yes ($p < .01$)

[11] This model includes random intercepts for participant and form.

  - Best-fit statistics suggest that ((34); AIC = 540.9, BIC = 562.4) is a better fit to the data than ((33); AIC = 545.7, BIC = 567.2).

- What to make of this? I'm not sure; the next step in this project is to run a new version of the study with more participants and see what replicates.

- In any case, the overall result is clear: longer lapses mean more syncope.

- What's at issue in this particular case is whether length should be counted in terms of syllables or normalized duration.

6.4 Conclusion

- These results add to a growing base of evidence that rhythmic constraints pay greater attention to duration than is commonly assumed. A couple of examples:
  - Secondary stress in Russian compounds
    - ⪰ Gouskova & Roon (2013): the further away the secondary stress from the primary stress (counting by syllables), the more acceptable the compound.
    - ⪰ Additional work (done by me in 2018) found that replacing the number of syllables with the duration of the interstress interval improves model fit.
  - Secondary stress in Finnish
    - ⪰ Karvonen (2008): for long odd-parity words, secondary stress on antepenult if words ends in *-ia* (*érgonòmia*), penult otherwise (*kólesteròli*).
    - ⪰ Potentially understandable as an effect of gradient *LAPSER: maybe stress wants to be a consistent distance from the edge, and *-ia* is short.

- All work discussed here is consistent with a broader view in which stress placement is directly informed by phonetics (e.g. Lunden 2013, 2014; Ryan 2014).

References

Bates, Douglas & Martin Maechler (2011). Package 'lme4'. R.

Becker, Michael & Jonathan Levine (2013). Experigen – an online experiment platform. Available at http://becker.phonologist.org/experigen.

Boersma, Paul & David Weenink (2017). Praat: doing phonetics by computer [computer program]. version 6.0.31. http://www.praat.org.

Corretge, Ramon (2012). Praat Vocal Toolkit. http://www.praatvocaltoolkit.com/index.html.

Gordon, Matt (2002). A factorial typology of quantity insensitive stress. Natural Language and Linguistic Theory 20, 491–552.

Gouskova, Maria & Kevin Roon (2013). Gradient clash, faithfulness, and sonority sequencing effects in Russian compound stress. Laboratory Phonology 4, 383–434.

Hayes, Bruce (1995). Metrical Stress Theory: Principles and Case Studies. The University of Chicago Press, Chicago/London.

Hayes, Bruce, Colin Wilson & Ben George (2009). Maxent grammar tool. Software package Software tool (`https://linguistics.ucla.edu/people/hayes/MaxentGrammarTool/`).

Hooper, Joan B. (1978). Constraints on Schwa-Deletion in English. Fisiak, Jacek (ed.), Recent Developments in Historical Phonology, De Gruyter, Berlin, 183–207.

Kager, René (1999). Optimality Theory. Cambridge University Press, Cambridge.

Karvonen, Daniel (2008). Explaining Nonfinality: Evidence from Finnish. Chang, Charles B. & Hannah J. Haynie (eds.), Proceedings of the 26th West Coast Conference on Formal Linguistics, Cascadilla Proceedings Project, Somerville, MA, 306–314.

Kuznetsova, Alexandra, Per Bruun Brockhoff & Rune Haubo Bojesen Christensen (2016). Package 'lmertest'. R.

Liberman, Mark & Alan Prince (1977). On Stress and Linguistic Rhythm. Linguistic Inquiry 8, 249–336.

Lunden, Anya (2013). A proportional theory of weight. The Journal of Comparative Germanic Linguistics 16, 1–31.

Lunden, Anya (2014). Motivating stress system asymmetries. Invited talk at the Conference on Stress and Accent, University of Leiden.

Nanni, Debbie L. (1977). Stressing Words in -Ative. Linguistic Inquiry 8, 752–763.

Nespor, Marina & Irene Vogel (1989). On Clashes and Lapses. Phonology 6, 69–116.

Polgárdi, Krisztina (2015). Syncope, syllabic consonant formation, and the distribution of stressed vowels in English. Journal of Linguistics 51, 383–423.

Ryan, Kevin M. (2014). Onsets contribute to syllable weight: statistical evidence from stress and meter. Language 90, 309–341.

Stanton, Juliet (2019). Phonetic lapse in American English *-ative*. Glossa: A Journal of General Linguistics 4, p. 55.

Stanton, Juliet & Donca Steriade (in prep). English stress and the cycle. Ms., NYU and MIT.

Wickham, H. (2016). ggplot2: Elegant Graphics for Data Analysis. Spring-Verlag, New York.