

Malagasy /nr/-strengthening within and across prosodic boundaries

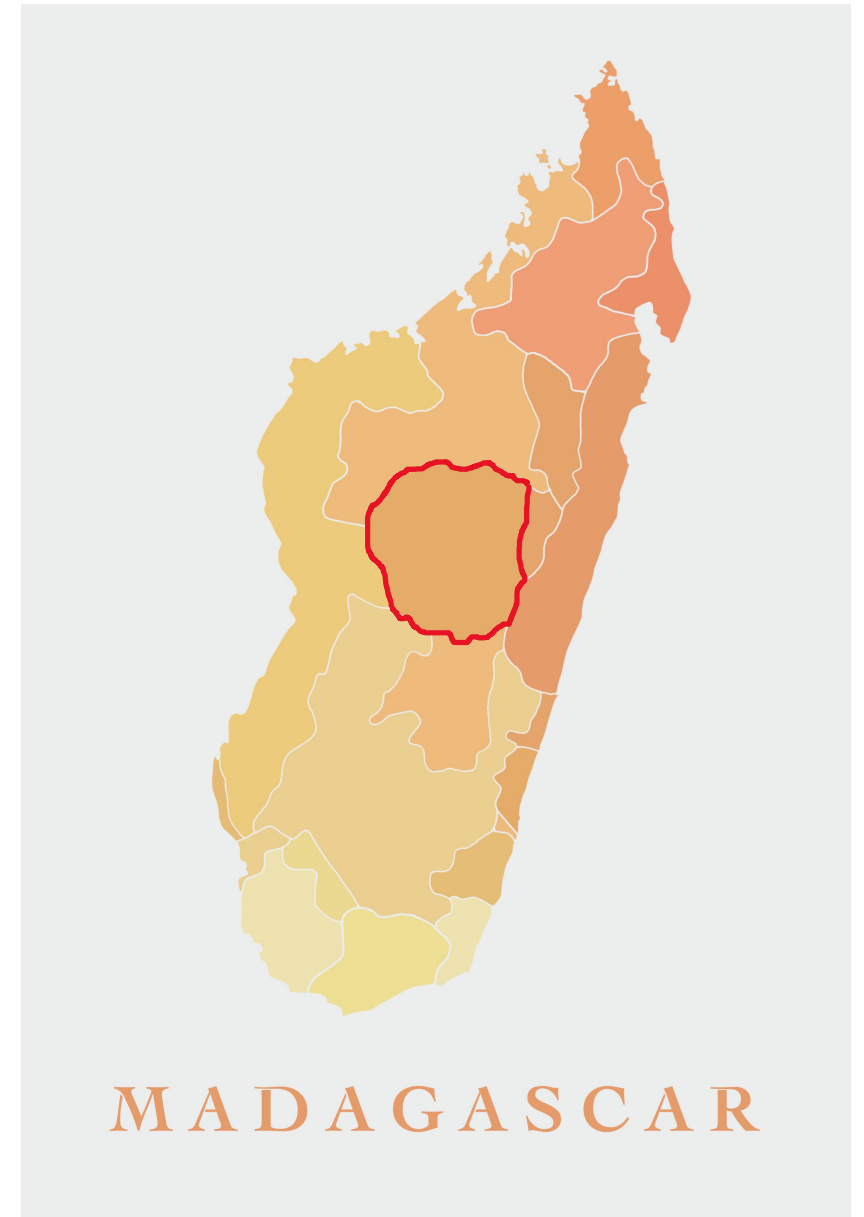
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Background

- Malagasy is a VOS Western Austronesian language spoken in Madagascar and Mayotte by ~25 million speakers
- Dialect under discussion today: Merina Malagasy
- Four monophthongs /a, e, i, o, u/



Strengthening in Malagasy

- Fricatives and liquids are strengthened to a stop or affricate in some morphological constructions, including the genitive (1 and 2) and compounds (3)

(1) /trano -n- soavaly/ → [tʃanuntʃuavali] (Paul, 1996: #9a)
house GEN horse
'house for horses'

(2) /amy -n- rainy/ → [aminɖʒaini] (Paul, 1996: #18a)
to GEN father
'to his father'

(3) /mitso + rano/ → [mitsu-ɖʒanu] (Martin, 2005: #10h)
blow
'bless'

Strengthening in Malagasy

- Strengthening may occur throughout Malagasy phonology more generally
 - Beyond these specific morpho-phonological environments: Pearson (2005) mentions that this is generally a property of word-internal occurrences of /nr/
 - However, Malagasy's restriction on codas and complex onsets prohibits most instances of underlying /nr/, except in the case of the genitive

Vowel Deletion

- However, in recent years Malagasy has been undergoing a sound change involving vowel devoicing/deletion (Pearson 1994, Howe 2019)
- Unstressed high vowels /u/ and /i/ are most prone to deletion; when this occurs, a surface environment can be created in which two consonants are now adjacent
- Impressionistically, strengthening of /r/ appears to occur in underlying /nVr/ environments when the V has deleted

Does Vowel Deletion Feeds Strengthening?

- Feeding rule ordering relationship:

UR:	/mirenireni/	‘wander’
unstressed HVD	mirenreni	
strengthening	mirend ^h zeni	
SR:	[mirend ^h zeni]	

Research Questions

- Through vowel deletion, we can test to see if strengthening is a feature of surface [nr] sequences generally, not just within genitive constructions:
- If it is not bound to the genitive, can it occur in larger domains, such as across prosodic word and/or phonological phrase boundaries?
- If strengthening is non-categorical, what other factors might influence rates of strengthening? How can we model it?

Experimental design

- Recorded 3+ Merina Malagasy speakers reading 27 sentences featuring 30 instances of /nVr/ (90 total tokens):
 1. Within a morpheme
 2. Across a root-affix boundary but within a prosodic word
 3. Across two roots but within the same compound
 4. Across word boundaries but still within the same phonological phrase
 5. Across phonological phrase boundaries

Experimental design

1. Within a morpheme:

Ny lehilahy no mirenireny lava

DET man FOC wander always

‘It is the man who always wanders’

Experimental design

2. Across root-affix boundary:

Ni-taraina	izy	fa	<u>ni</u> -resadresaka	ny	namany
PST-complained	he	COMP	PST-chat	PST	his.friends

‘He complained that his friends were chatting’

Experimental design

3. Across root-root boundary within a compound:

Lafo ny tani-ravo
expensive DET earth-happy (=chalk)
'The chalk is expensive'

Experimental design

4. Across word boundaries, within the same phonological phrase:

Mahatofoka ny ronono ratsy

disgusting DET milk bad

‘The bad milk is disgusting’

Experimental design

5. Across word boundaries, across phonological phrase:

Mino	<u> </u>	Rabe	fa	mamy	ny	ro
thinks		Rabe	COMP	sweet	DET	BROTH

‘Rabe thinks that the broth is sweet’

- In Malagasy, the verb and its subject belong to different phonological phrases (Aziz, 2020)

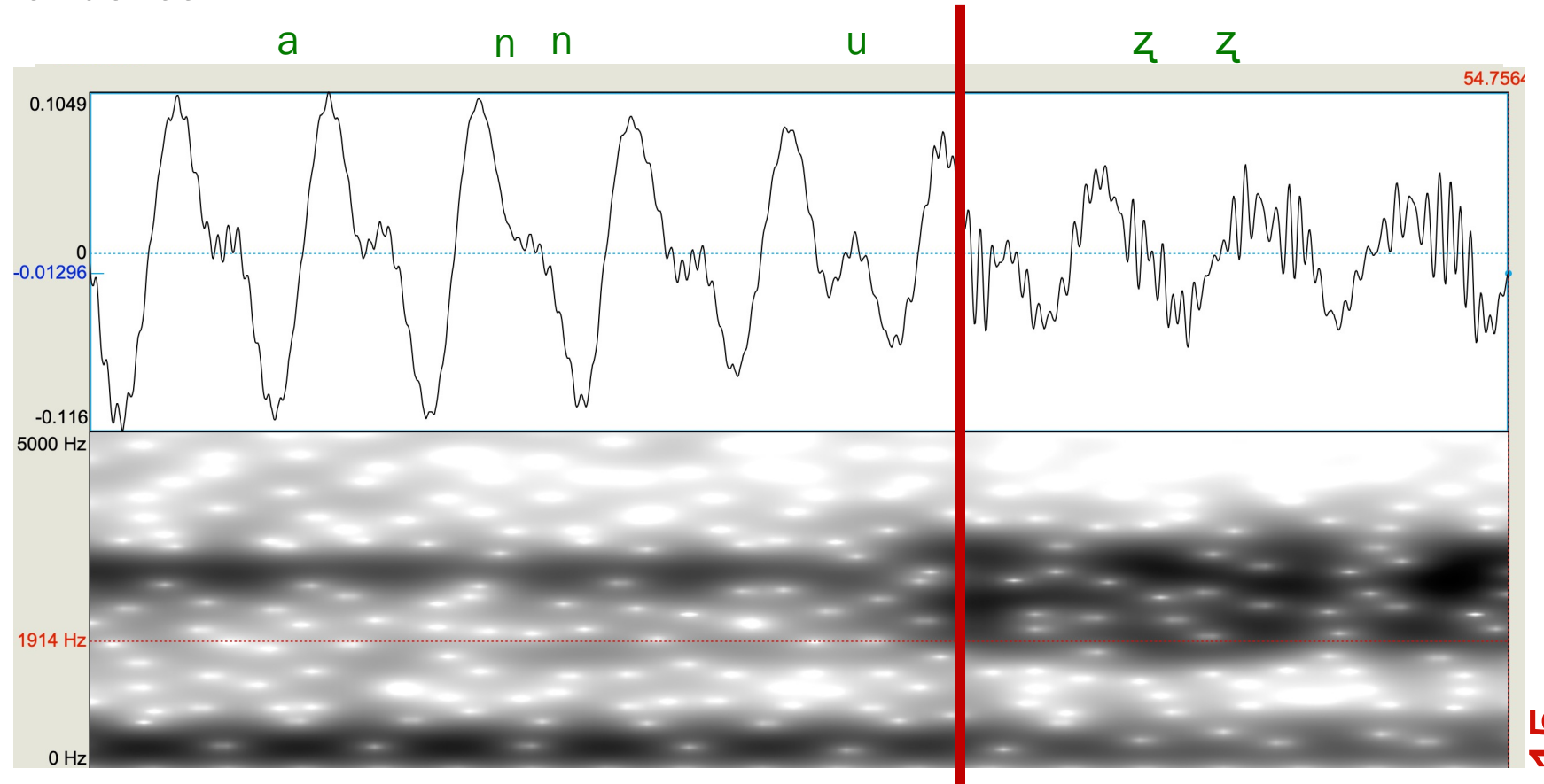
Analysis

1. Identify instances of /nr/ that arise through vowel deletion
2. Identify instances of /nr/-strengthening
3. Model the variation in /nr/-strengthening, accounting for the prosodic factors described

Method: Identifying Vowel Deletion

- We identified tokens where the target vowel was deleted, leaving surface /nr/
 - Auditory-perceptual evidence
 - Phonetic evidence
 - Waveform
 - Spectrogram

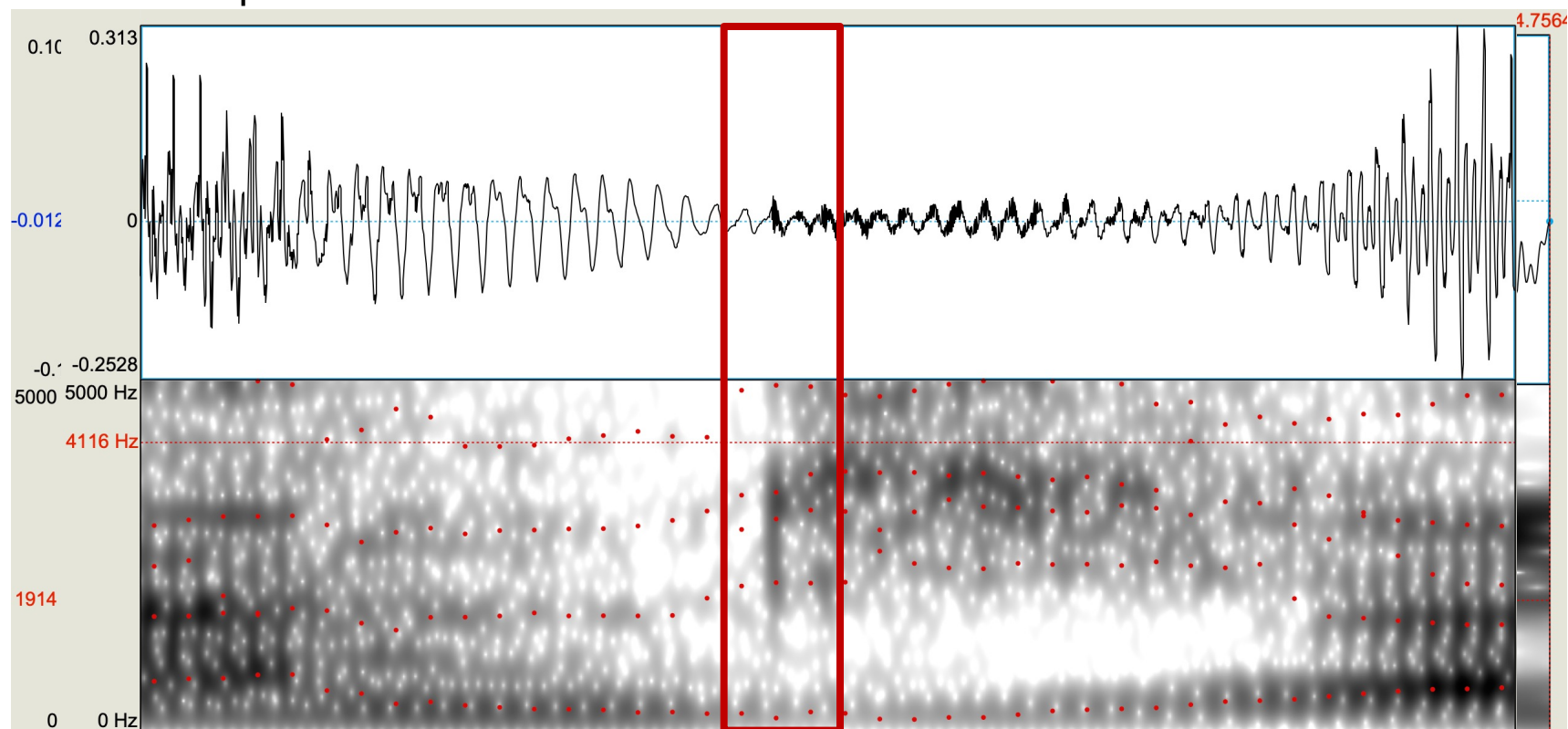
Deleted /i/ in
many a show, pickt at'



Method: Identifying /nr/-Strengthening

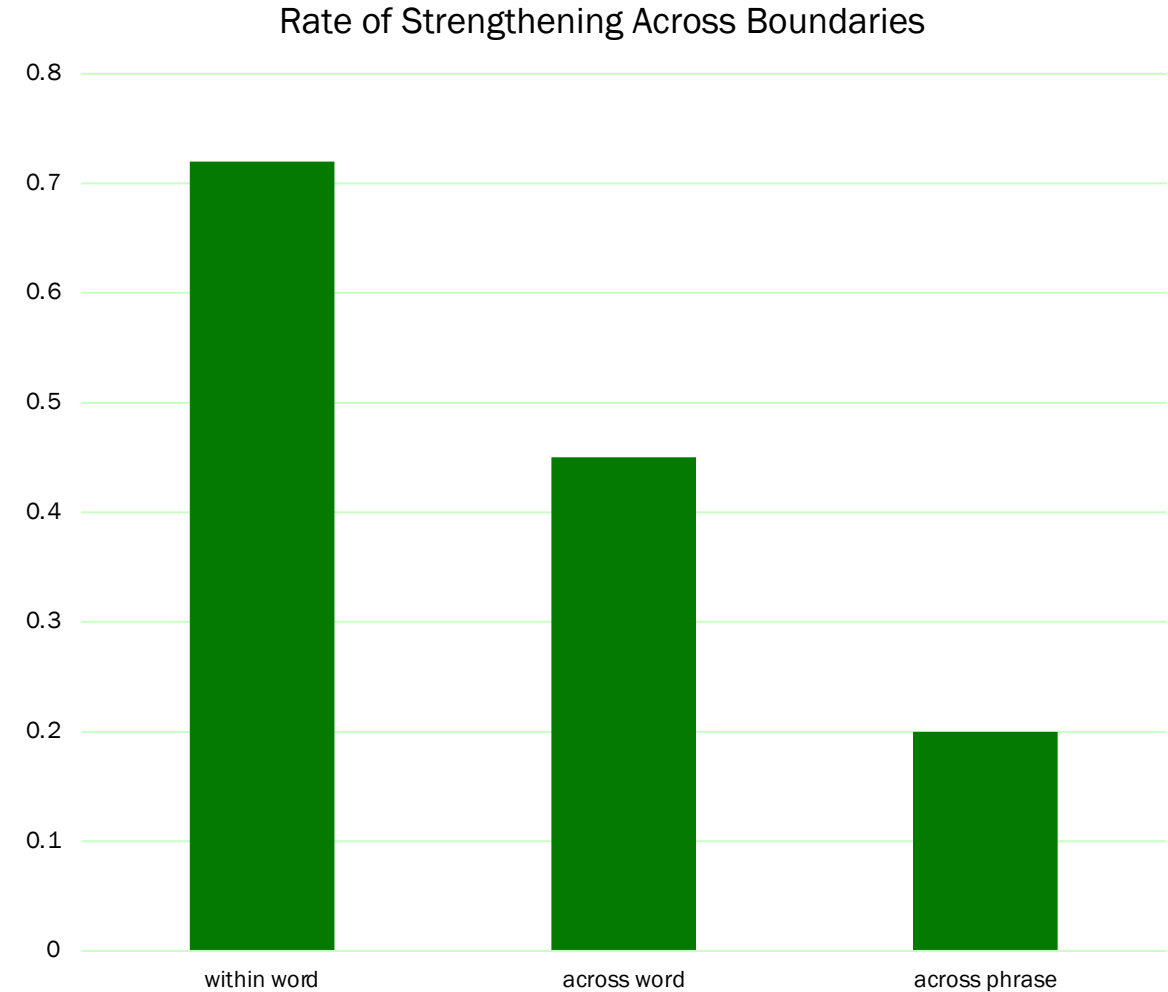
- We identified instances where surface /nr/ was strengthened, either to the affricate [ndʒ] or [ndr]
 - Phonetic evidence: look for stop "burst"
 - Waveform
 - Spectrogram

Not strengthening of /nr/ to [ndʒ]



Preliminary findings

- We find that strengthening of /nr/ occurs often, even when not part of the genitive construction
- Strengthening is not categorical: all speakers affricated to an extent, but certain speakers did so in different positions
- Deletion of underlying /i/ and /u/ are both able to trigger affrication



Modelling

- We aim to model the frequency of strengthening across speakers, and identify prosodic factors that significantly affect strengthening rates
- As surface [nr] is gradiently repaired by speakers, and appears to be variably conditioned by a number of factors, we turned to Maximum Entropy Harmonic Grammar (MaxEnt; Smolensky 1986, Goldwater & Johnson 2003) to model speakers' productions

MaxEnt

MaxEnt is an Optimality Theory-based framework where probability distributions are calculated over candidates

- Constraints are weighted rather than ranked; a candidate's probability is determined by its violation profile
- The probability of a candidate's being outputted by the grammar is inversely proportionate to the probabilities of its competitors

Constraints can be introduced to the grammar to test for significance (similar to significant effects in a logistic regression)

MaxEnt modelling: constraint set

- Since we find that strengthening of /nr/ occurs even when not part of the genitive construction, we assume that Malagasy penalizes instances of the surface sequence [nr] via some markedness constraint, say *NR
 - Either an optimal syllable contact constraint (the coda must be more sonorous than the following onset) or *CC
- This will conflict with a faithfulness constraint IDENT[son], which is violated when the value of the feature [sonorant] of /r/ changes when strengthened

MaxEnt modelling: constraint set

As boundary may also play a role, we introduced increasing boundary strength in four additional positional markedness constraints (Hsu & Jesney 2016)

1. *N-MORPH[-R

Violated if unstrengthened [nr] straddles a morpheme boundary

2. *N-COMP[-R

Violated if unstrengthened [nr] straddles a compound boundary

3. *N-PRWD[-R

Violated if unstrengthened [nr] straddles a prosodic word boundary

4. *N-PHR[-R

Violated if unstrengthened [nr] straddles a phonological phrase boundary

MaxEnt modelling: methods

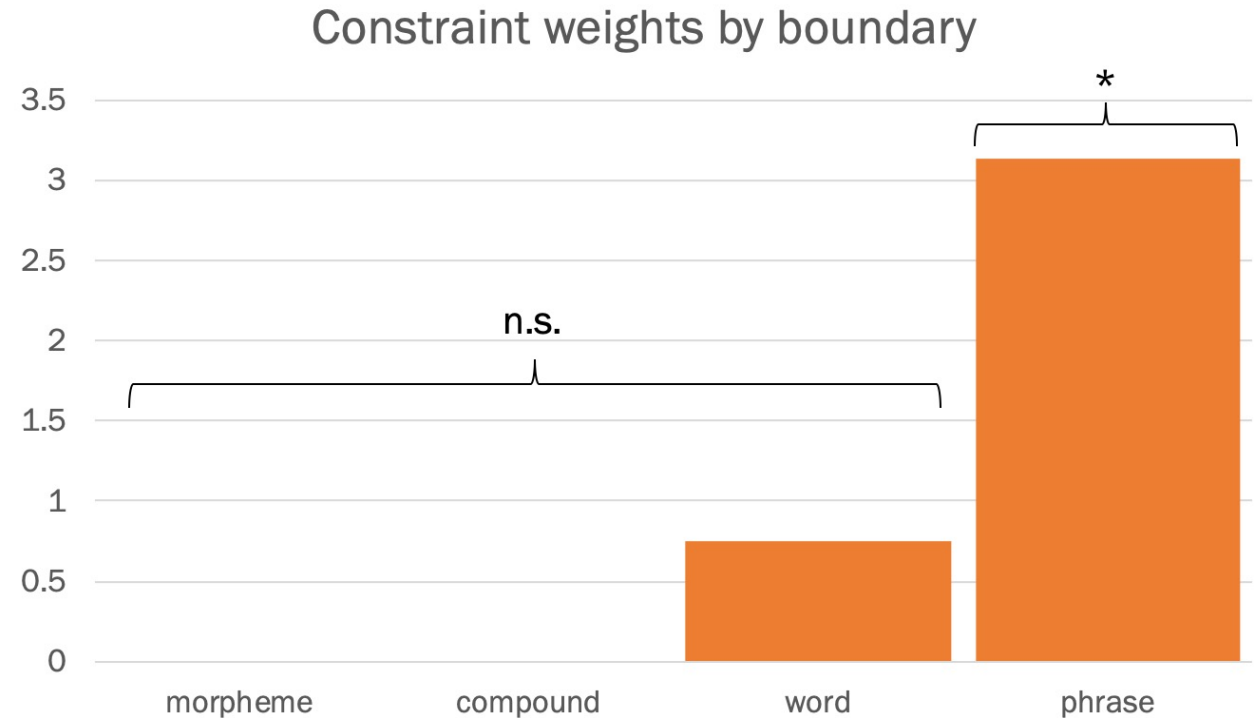
- GEN consisted of strengthened and unstrengthened candidates corresponding to potential outputs of our test materials
 - Each candidate's probability calculated based on their violation profiles of the constraints compared to their competitors
- Model fit assessed via the maximum likelihood criterion
 - Best-fit constraint weights achieved using Excel's solver function (Fylstra et al. 1998)
- Each positional markedness constraint was added to the model one at a time to test for significance, using likelihood ratio tests
 - The addition of a constraint is considered "significant" if it significantly increases overall log likelihood ($p \leq 0.05$), thus improving model fit

MaxEnt modelling: Results

- Three positional markedness constraints had no significant effect on log likelihood
 - *N-M O R P H [-R ($p = 0.99$)
 - *N-C O M P [-R ($p = 0.99$)
 - *N-P R W D [-R ($p = 0.96$)
- Only *N-P H R [-R was found to significantly improve model fit ($p = 0.04$)

MaxEnt modelling: Results

- Although strengthening is gradiently sensitive to any boundary, there is an inverse relationship between boundary strength and likelihood of affrication of /r/



Discussion

In a previous description of Malagasy /nr/ strengthening, Pearson (2005) describes the process as sensitive to *word* boundaries, indicating that strengthening is a word-internal process

- Our findings suggest that it is most sensitive not to word-boundaries, but to *phrase* boundaries

Discussion

Strengthening as a *phrase*-internal process may serve as a non-intonational cue to prosodic phrasing in Malagasy

- Phonological phrases are often clearly demarcated by right-aligned pitch accents (Aziz, 2020)
- Lack of strengthening/faithfulness is a novel, segmental, diagnostic of prosodic phrasing in Malagasy

Discussion

Preliminary findings situate Malagasy with other languages/processes which find boundary strength scales the application of gradient processes

- Greater boundary reduces likelihood of final t/d deletion in spontaneous British English (Tanner, et al. 2017)
- Larger prosodic phrase boundary reduces rates of high vowel deletion in Tokyo Japanese (Kilbourn-Ceron & Sonderegger, 2017)

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