The phonetics of prosody in Yoloxóchitl Mixtec

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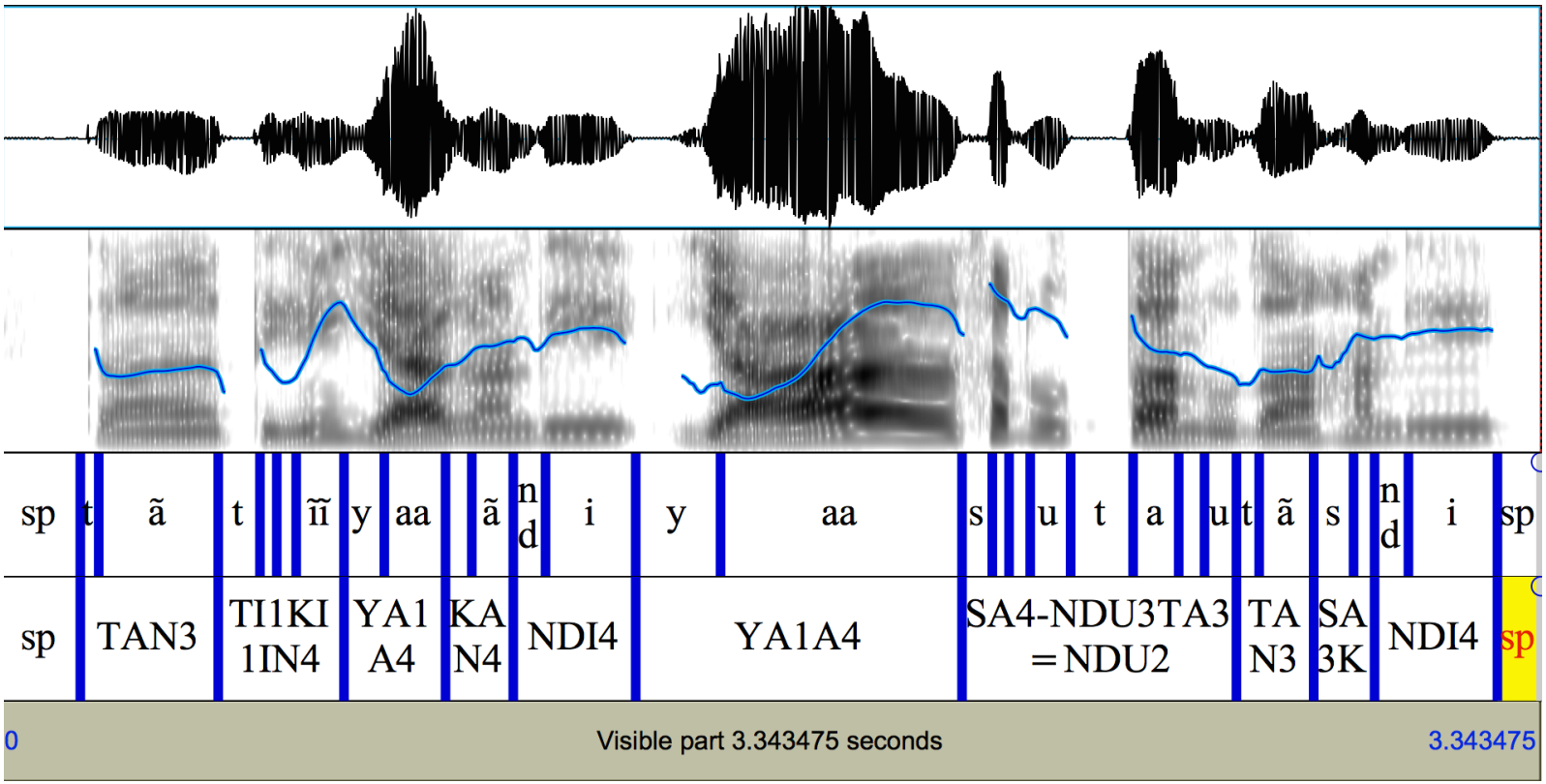
Meta-outline for the lectures

1. The analysis of complex tonal systems: motivations, methods, and analysis
2. Speech perception in the field
3. Creating and working with endangered language corpora
4. **Higher-level prosody and tone**

An example

tã^{3} ti^{1}kĩ^{14} yaa^{14} kã^{4} ndi^{4} yaa^{14} sa^{4}-ndu^{3}ta^{3}=ndu^{2} tã^{4} sa^{3}kã^{4} ndi^{4}



Why do the instances of /yaa^{14}/ 'ash' differ?

Prosody in endangered languages of Mexico

How does higher-level linguistic structure (information structure, intonation, boundaries) influence speech/tone production?

- Parallel speech production studies in the field with speakers of Itunyoso Triqui and Yoloxóchitl Mixtec
- Development of phonologically-annotated corpora in both languages

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Roadmap

1. Background
2. Prosodic marking of focus (DiCanio et al., 2018a)
3. Boundary-adjacent lengthening and tonal effects (DiCanio et al. in prep)
4. Declination effects (DiCanio et al. in prep)
5. Discussion/Conclusion

How might focus be marked in a tone language?

1. **Phonological marking**

   Intonational pitch accents or boundary tones might overlap/influence tonal contour shapes.

   e.g. certain Swedish dialects (Bruce, 2005), Shekgalagari (Hyman and Monaka, 2011), Serbo-Croatian (Godjevac, 2005).

2. **Phonetic marking**

   Marked by phonetic lengthening, register shift, or pitch range expansion.

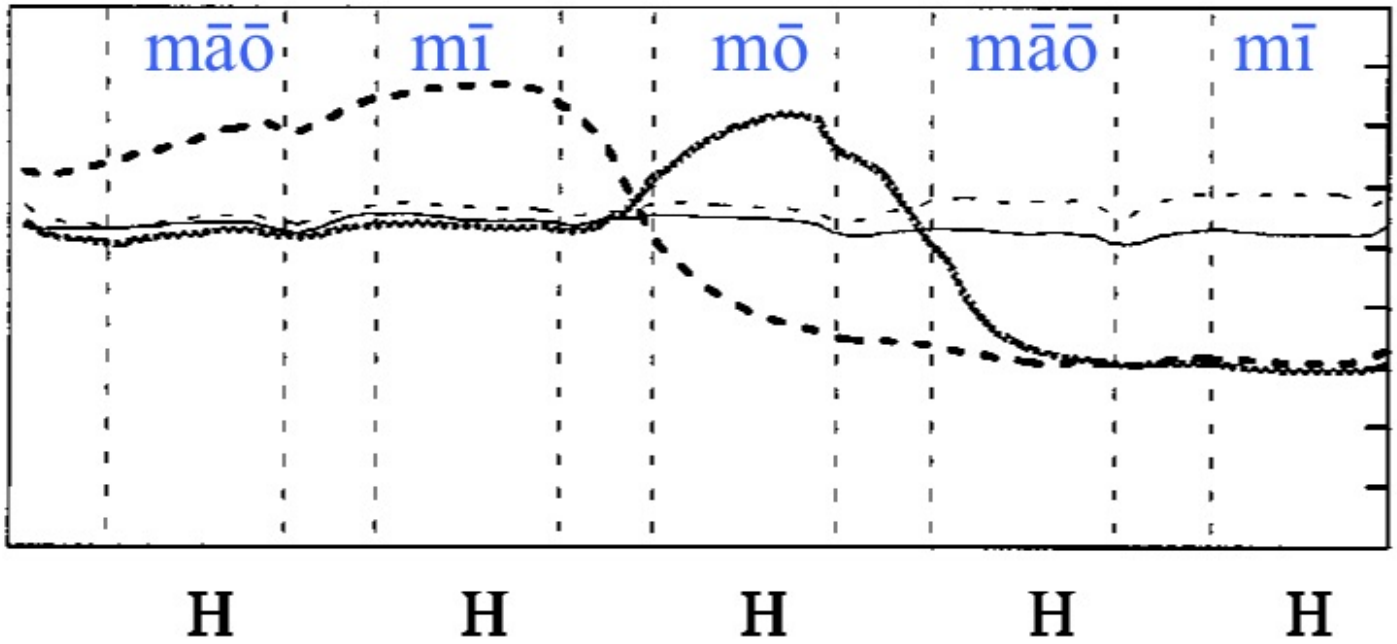
   e.g. Mandarin (Peng, 1997; Xu, 1999; Liu and Xu, 2005), Akan (Kügler and Genzel, 2011), Santa Ana del Valle Zapotec (Esposito, 2010).

3. **Only morphosyntactic marking**

   e.g. Northern Sotho (Zerbian, 2007), Itunyoso Triqui (DiCanio, in progress).

Register shift

High tones in Mandarin undergo raising and F_0 range expansion when in focus (Xu, 1999).



'*The kitty touches the kitty.*'

Phonetic marking of domains

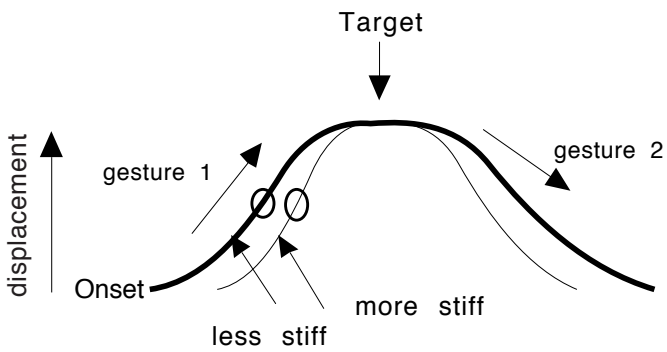
Domain-initial consonants may be lengthened or hyperarticulated
(Fougeron and Keating, 1997; Keating et al., 2000)

The F_0 range may be expanded and articulatory gestures strengthened.
(Mücke and Grice, 2014; Xu, 1999)

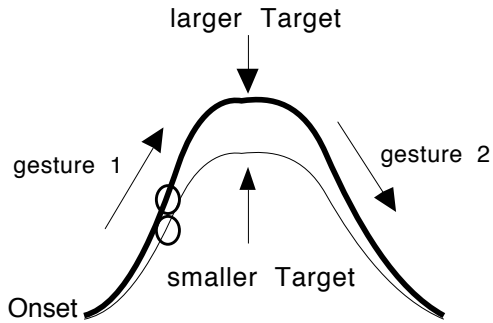
Stressed syllables may be the target of greater phonetic prominence
(Byrd and Choi, 2010; de Jong, 1995; Krivokapić and Byrd, 2012)

Dynamical parameters (Cho, 2006)

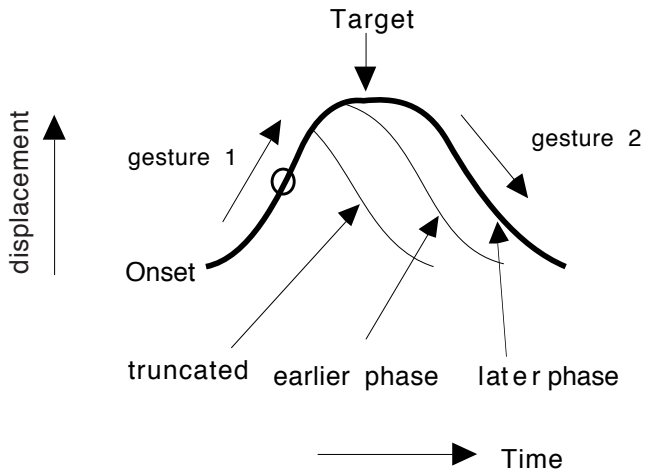
(a) Change in Stiffness



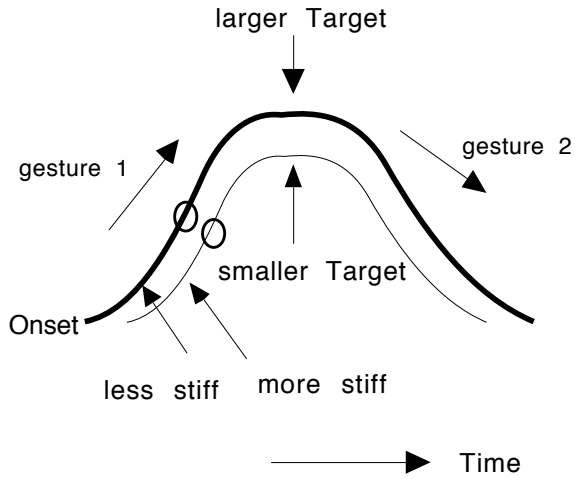
(b) Change in Target



(c) Change in Intergestural Timing



(d) Change by shrinking



Research questions

1. How do tones change in prosodically weak/strong environments (e.g. under different focal conditions)?
2. How do tones change at prosodic boundaries?
3. Are there systematic phonetic differences between different types of prosodic effects (focus vs. boundary-adjacent lengthening)?

Yoloxóchitl Mixtec (YM)

- Otomanguean, spoken in Guerrero, Mexico (∼4000 speakers).
- Phonological/phonetic fieldwork (Castillo García (2007), DiCanio et al. (2014, 2018a), DiCanio et al. (2018b), Palancar et al. (2016)).

Yoloxóchitl, Guerrero

- All roots are minimally composed of bimoraic feet, consisting of either monosyllabic stems with long vowels (CVV) or disyllabic stems with shorter vowels (CVCV) (Castillo García, 2007).

- No codas.

- Glottalization is contrastive: /ya$\text{ʔ}^4\text{a}^1$/ '*grey*', /sa$\text{ʔ}^3\text{ma}^4$/ '*cloth to wrap tortillas*'

- Final syllables are prominent.
  - Nasal vowels only occur on stem-final syllables.
  - Restricted vowel contrasts on non-final syllables.
  - 9 tones on stem-final syllables, but only 5 on non-final syllables.
  - Final syllable lengthening

Tone is lexical and morphological

Twenty-six tonal melodies are possible on a disyllabic word.

Melody	Word	Gloss	Melody	Word	Gloss
1.1	$ta^{1}ma^{1}$	*without appetite*	4.13	$na^{4}ma^{13}$	*is changing*
1.3	$na^{1}ma^{3}$	*to change (intr)*	4.14	$nda^{4}ta^{14}$	*is splitting up*
1.4	$na^{1}ma^{4}$	*soap*	4.24	$ya^{4}ma^{24}$	*Amuzgo person*
1.32	$na^{1}ma^{32}$	*I will change myself*	4.42	$na^{4}ma^{42}$	*I often pile rocks*
1.42	$na^{1}ma^{42}$	*my soap*	13.2	$hi^{13}ni^{2}$	*has seen*
3.2	$na^{3}ma^{2}$	*wall*	13.3	$na^{13}na^{3}$	*has photographed (self)*
3.3	$na^{3}ma^{3}$	*to change (tr)*	13.4	$na^{13}ma^{4}$	*has piled rocks*
3.4	$na^{3}ma^{4}$	*sprout*	14.2	$na^{14}ma^{2}$	*I will not change*
3.42	$na^{3}ma^{42}$	*I will pile rocks*	14.3	$na^{14}ma^{3}$	*to not change*
4.1	$ka^{4}nda^{1}$	*is moving (intr)*	14.4	$na^{14}ma^{4}$	*to not pile rocks*
4.2	$na^{4}ma^{2}$	*I am changing*	14.13	$na^{14}ma^{13}$	*to not change oneself*
4.3	$na^{4}ma^{3}$	*it is changing*	14.14	$nda^{14}ta^{14}$	*to not split up*
4.4	$na^{4}ma^{4}$	*is piling rocks*	14.42	$na^{14}ma^{42}$	*I will not pile rocks*

Morphological tone

Morphology	'to break' (tr)	'hang' (tr)	'to change' (intr)	'to peel' (tr)	'to get wet'
Stem	$ta^{3}ʔβi^{4}$	$tʃi^{3}kũ^{2}$	$na^{1}ma^{3}$	$kwi^{1}i^{4}$	$tʃi^{3}i^{3}$
NEG	$ta^{14}ʔβi^{4}$	$tʃi^{14}kũ^{2}$	$na^{14}ma^{3}$	$kwi^{14}i^{14}$	$tʃi^{14}i^{3}$
COMP	$ta^{13}ʔβi^{4}$	$tʃi^{13}kũ^{2}$	$na^{13}ma^{3}$	$kwi^{1}i^{4}$	$tʃi^{13}i^{3}$
INCOMP	$ta^{4}ʔβi^{4}$	$tʃi^{4}kũ^{2}$	$na^{4}ma^{13}$	$kwi^{4}i^{14}$	$tʃi^{4}i^{4}$
1S	$ta^{3}ʔβi^{42}$	$tʃi^{3}kũ^{2}=ju^{1}$	$na^{1}ma^{32}$	$kwi^{1}i^{42}$	$tʃi^{3}i^{2}$

How do we elicit information structure in YM?

- Illiterate population, so a reading task will not work.
  c.f. studies on Mandarin (Chen and Gussenhoven, 2008; Xu, 1999), Guaraní (Clopper and Tonhauser, 2013), Arabic (de Jong and Zawaydeh, 2002), German (Mücke and Grice, 2014), or Dutch (Peters et al., 2014).

- Mining a corpus for examples does not control for tone or word structure.

- A Q&A paradigm following a short story elicits NPs with different information structure, but this does not work well for broad focus.
  c.f. studies on Akan (Kügler and Genzel, 2011), Guaraní (Clopper and Tonhauser, 2013)),

Stimuli elicitation for focus - a mixed design

- Argument focus (after story)

  Rey: Who arrived?
  Speaker: John arrived.

- Contrastive focus (after story)

  Rey: Did Marcus arrive?
  Speaker: John arrived.

- Sentential focus (repetition)

  Rey: John arrived.
  Speaker: John arrived.

Focus in Yoloxóchitl Mixtec

(1) ni^{1}-ta^{3}ʃi^{3} yu^{3}βa^{4}=õ^{4} kwa^{4}yu^{2} nda^{3}ʔa^{4}=õ^{4}
PERF-give father=2S horse hand=2S
'Your father gave you a horse.'

Sentential focus

(2) yu^{3}βa^{4}=õ^{4} ni^{1}-ta^{3}ʃi^{3}=ɾi^{4} kwa^{4}yu^{2} nda^{3}ʔa^{4}=õ^{4}
father=2S PERF-give=3S horse hand=2S
'Your father gave you a horse.'

Argument focus

(3) yu^{3}βa^{4}=õ^{4} ni^{1}-ta^{3}ʃi^{3}=ɾi^{4} kwa^{4}yu^{2} nda^{3}ʔa^{4}=õ^{4}
father=2S PERF-give=3S horse hand=2S
'Your father gave you a horse.'

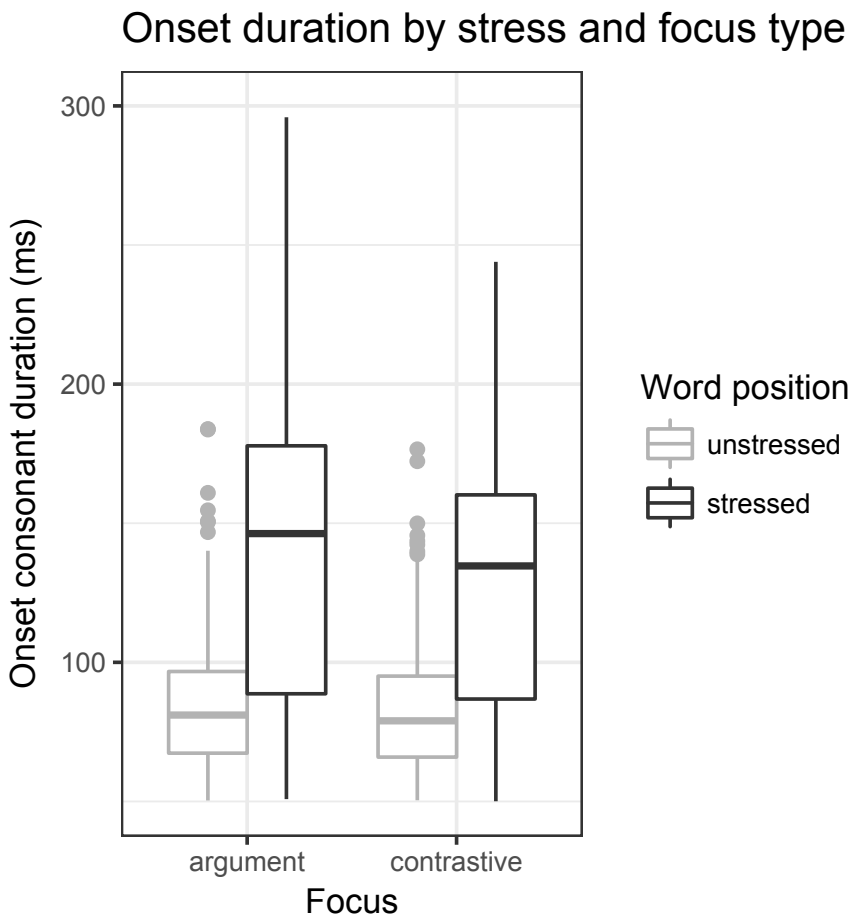
Corrective focus

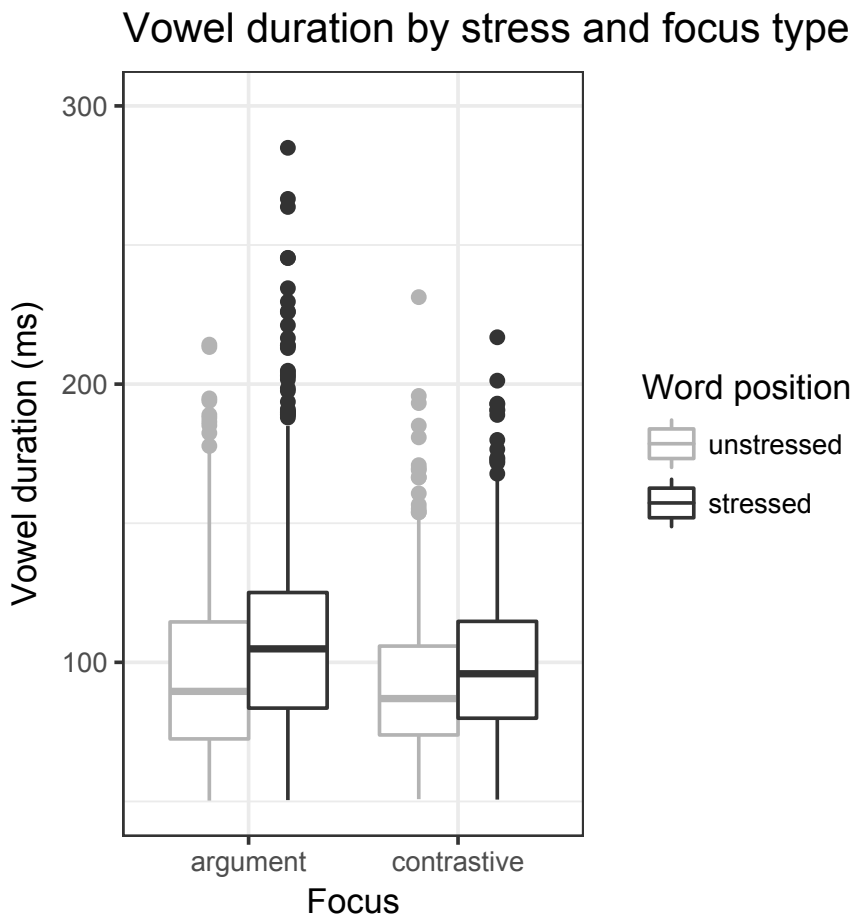
Methods

- Each answer/response was repeated six times by each respondent across two separate recording sessions (3 reps/session).
- Recording took place in San Luis Acatlán, a town near Yoloxóchitl.
- Each condition contained the same 28 target words which possessed nine tonal melodies: 1.1, 1.3, 1.4, 1.42, 3.2, 3.3, 3.4, 4.2, 4.4; all disyllables.
- Ten native speakers participated; a total of 2,595 utterances were analyzed.
- Target words segmented and analyzed using a script written in Praat (Boersma and Weenink, 2016).
- Normalized F_0 trajectories extracted over 5 time points and converted to log-normal values. Onset and vowel duration also extracted.
- Results analyzed using LMMs with lmertest (Kuznetsova et al., 2017). All reported results are significant.

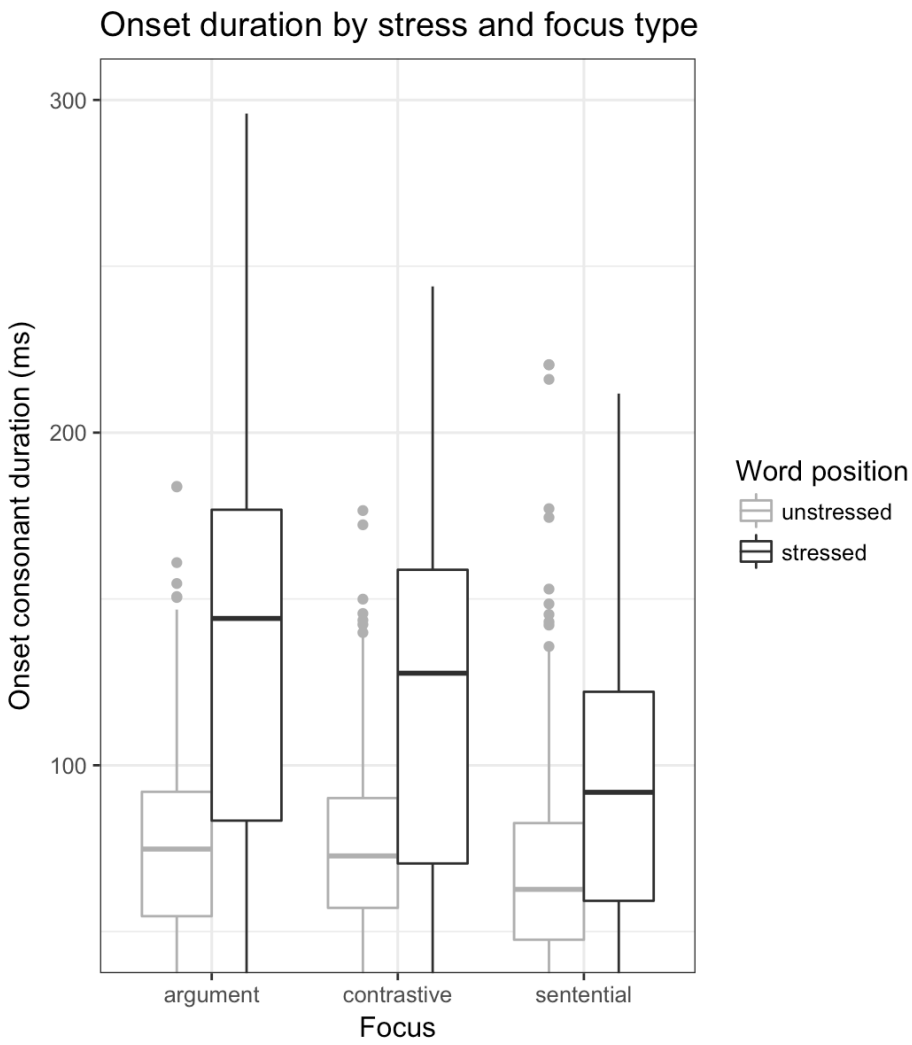
Since we have a mixed design, we will present the contrastive-argument focus comparison first and then compare them both to the sentential focus condition.

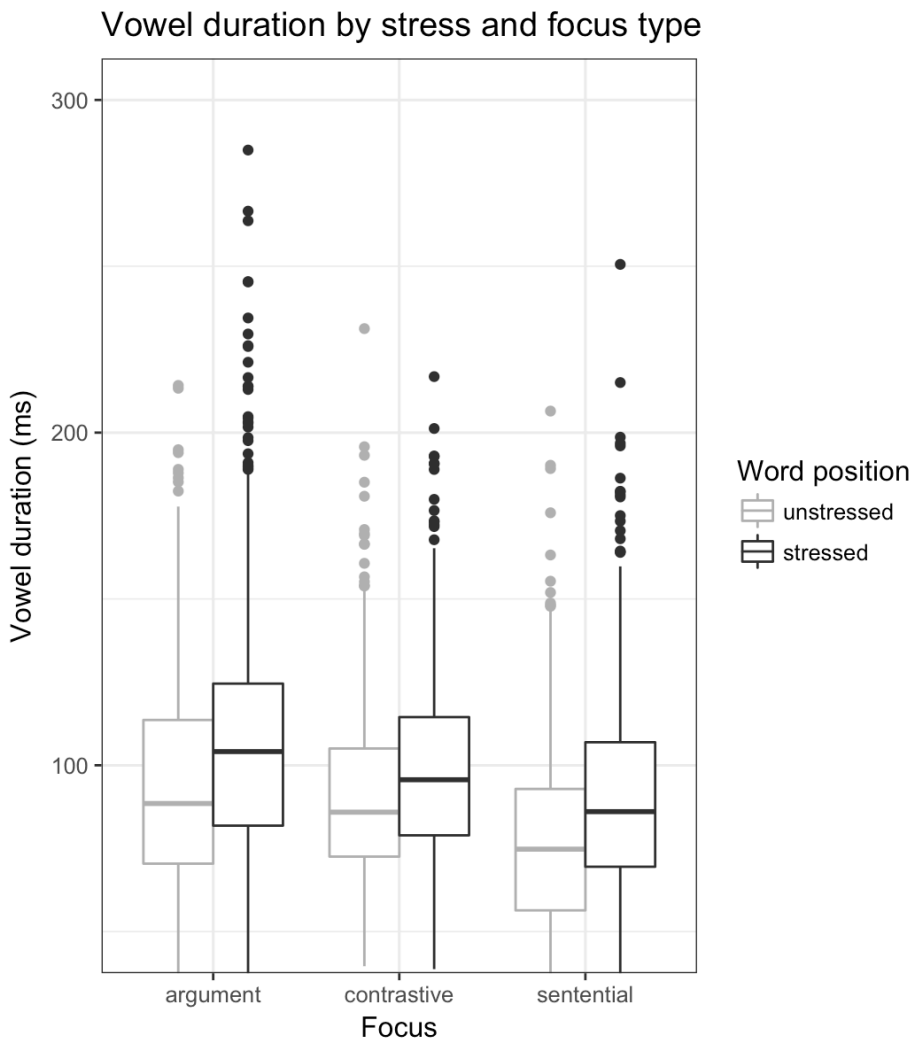
Results: Duration I





Results: Duration - comparative



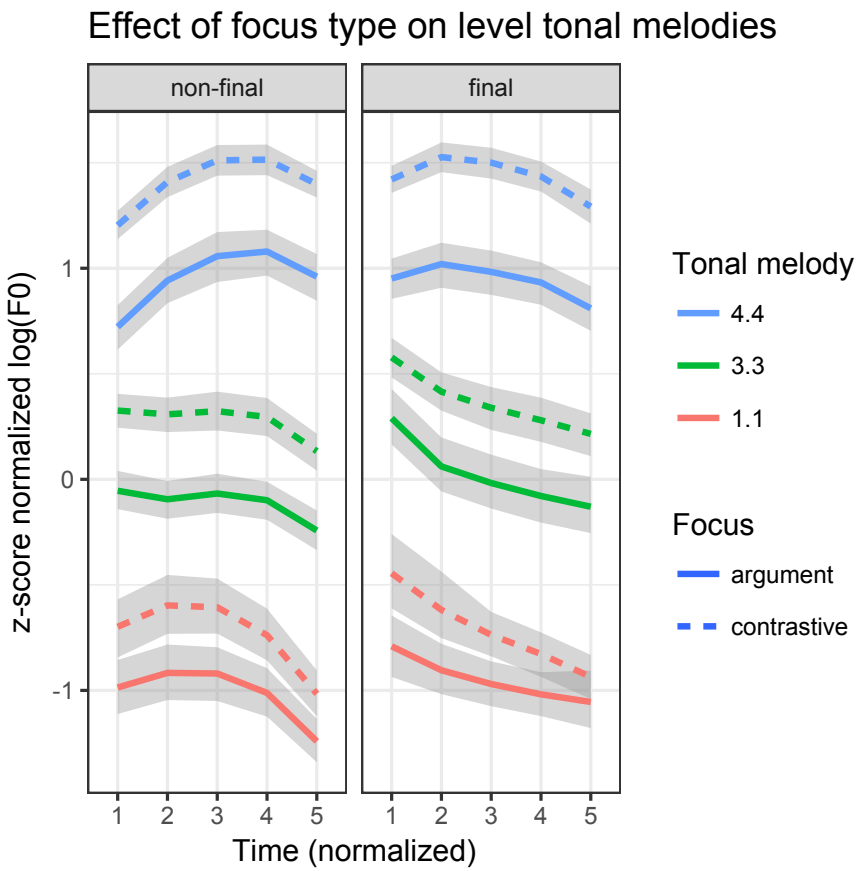


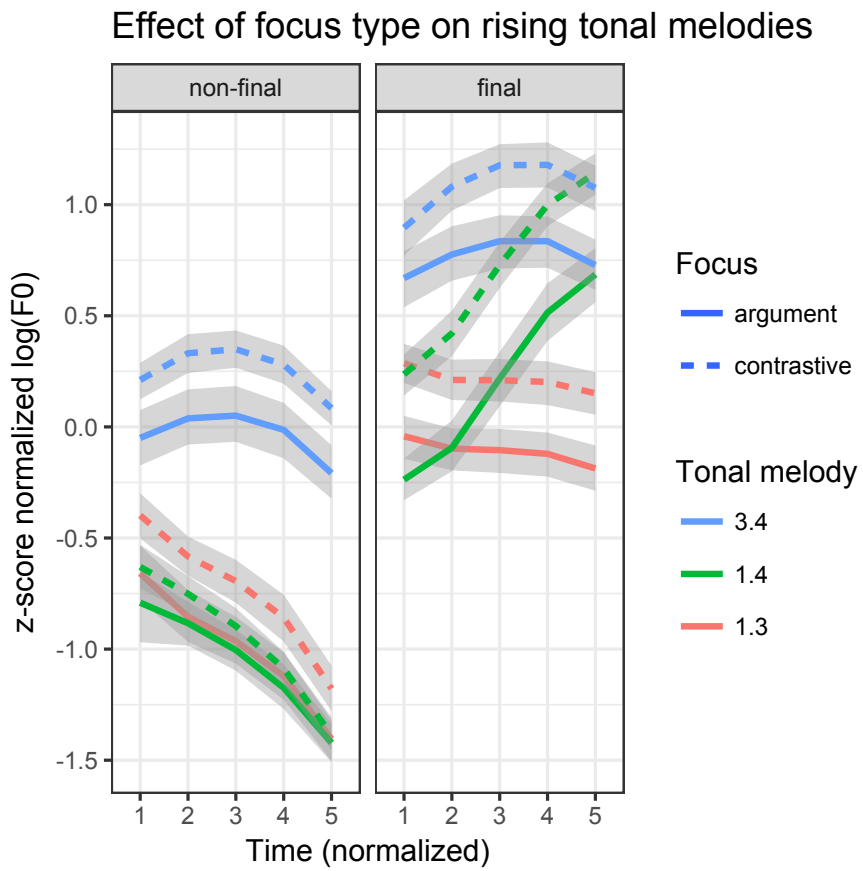
	C_1	V_1	C_2	V_2	σ_1	σ_2	σ-duration ratio
Baseline (sentential)	70	77	95	90	141	185	1:1.31
Contrastive focus	77	92	120	99	169	219	1:1.30
comparison to baseline	10%	19%	**26%**	10%	20%	18%	
Argument focus	76	94	136	107	170	242	1:1.42
comparison to baseline	9%	22%	**43%**	19%	21%	31%	

Final syllables are longer than penults. Under focus, greater lengthening occurs in the onset of the stressed syllable than in the vowel.

Results: Level and rising melodies

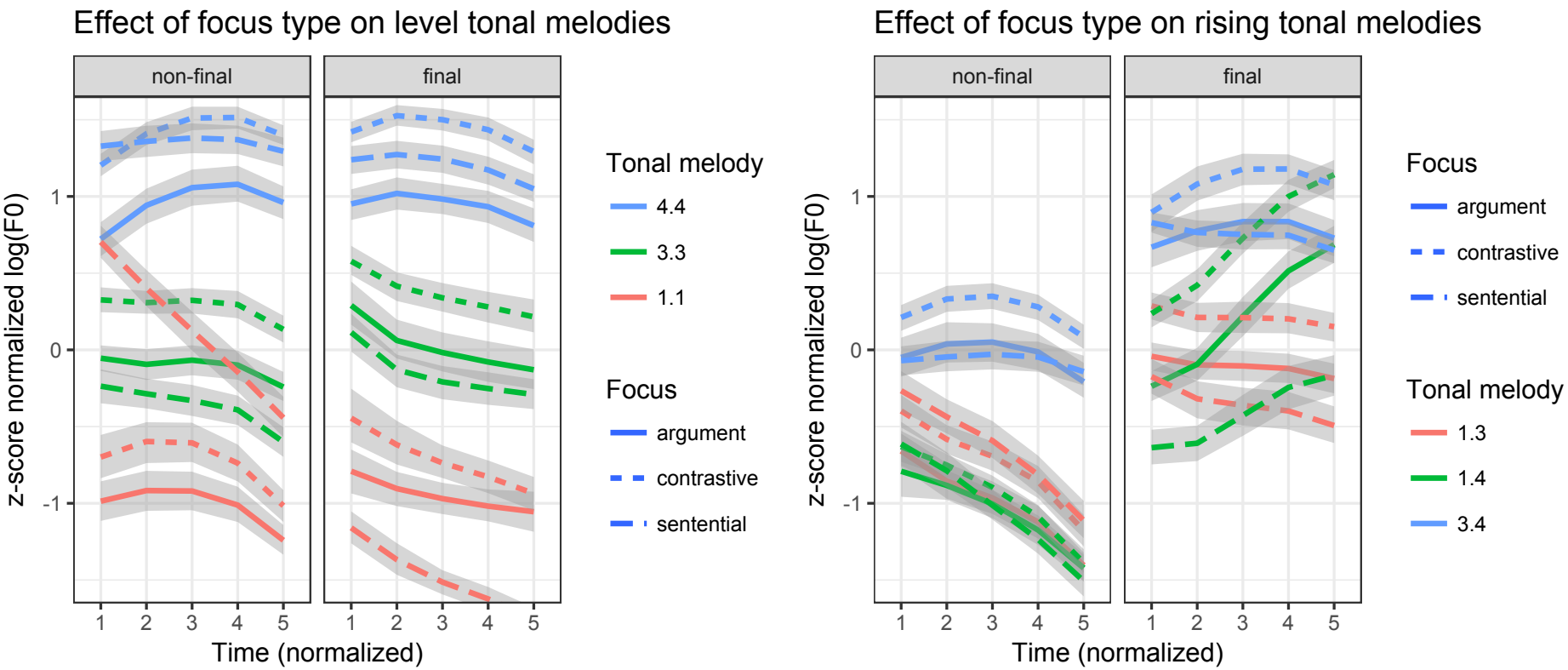
Globally, contrastive focus undergoes raising relative to argument focus.





Results: Tone - comparative

For most melodies, tone is lower in sentential focus than argument focus.



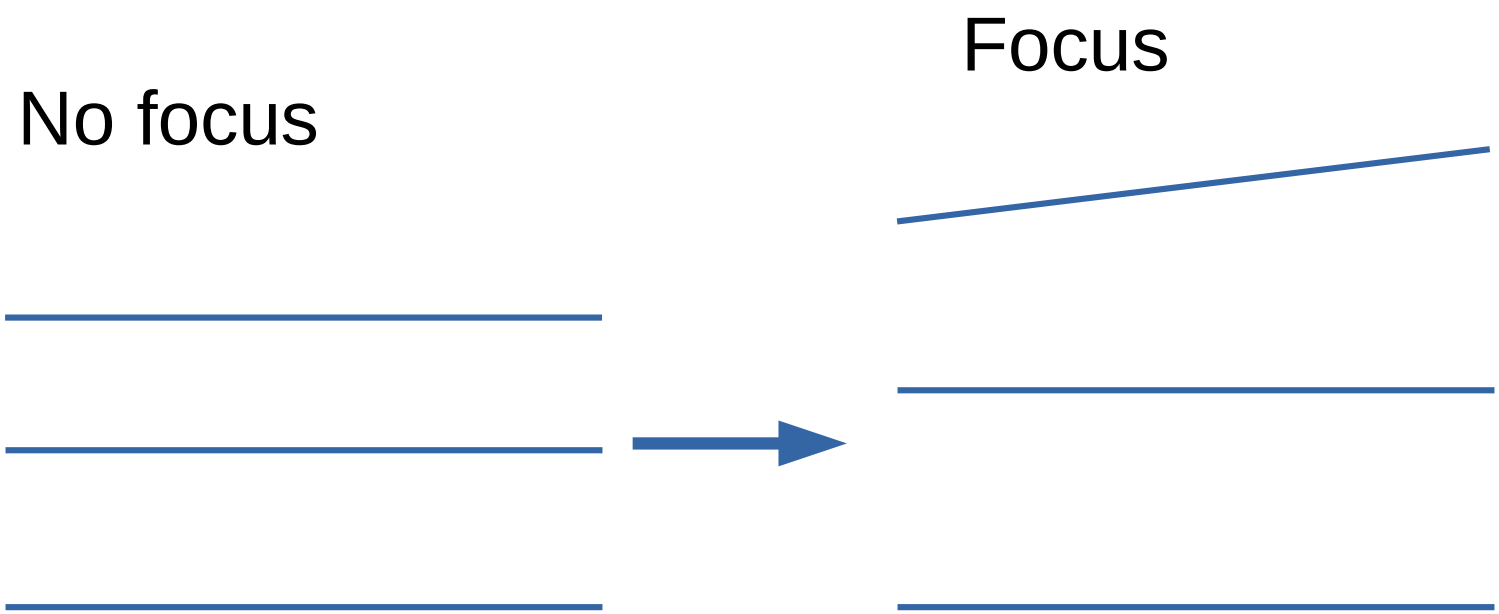
Discussion: duration and focus

Focus lengthens the onset of the stressed syllable more than the vowel. Why?

- In Swedish onsets are lengthened when a syllable contains a phonologically short vowel (Heldner and Strangert, 2001).
- Vowels in the CVCV disyllables were short, so vowel length may have influenced the domain of prosodic lengthening in YM.

Discussion: tone and focus

- Tones in fronted, focal NPs undergo F_0 range expansion and raising relative to tones in sentential focus.
- Contrastive focus has the most raising.
- Tone /1/ is specifically not raised when it is the initial tone in a rising sequence on a disyllable, e.g. 1.4, 1.42, 1.3.
- Focus induces processes of tonal hyperarticulation that enhance syntagmatic contrast on the word.



Asymmetrical expansion occurs because low tones are near the F_0 floor (c.f. high vowel displacement under different focus conditions (Cho, 2006; Mücke and Grice, 2014)).

Phrase-final phenomena

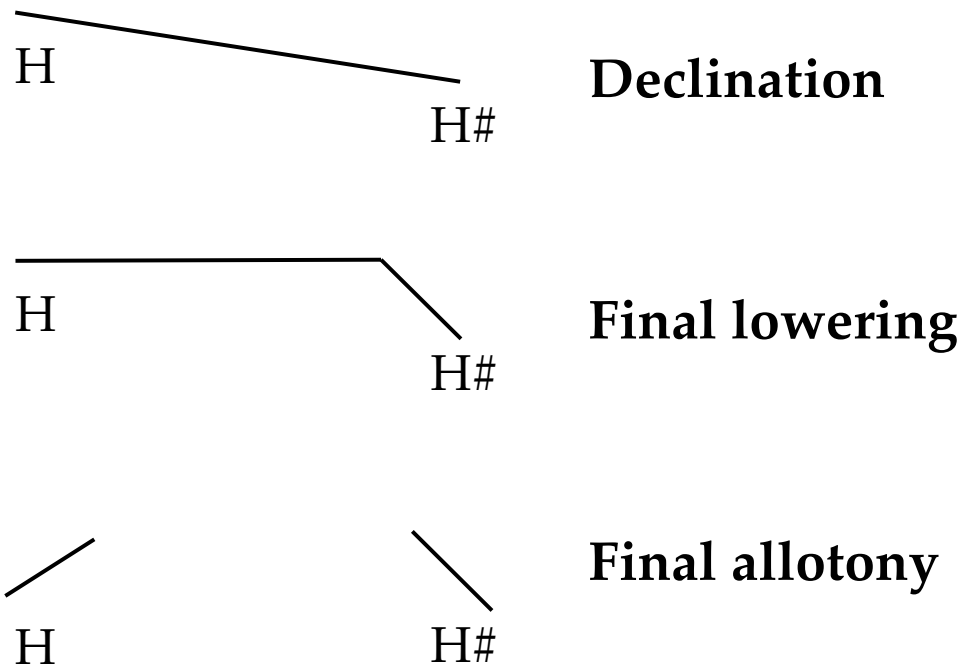
How are tones in YM influenced by phrasal position?

Phrase-final position is a domain of articulatory strengthening and where articulatory gestures may reduce their velocity.
(Barnes, 2006; Cho, 2006; Krivokapić and Byrd, 2012).

Declination is a universal phonetic process but phrase-final tonal alternations may be phonological (Gussenhoven, 2004).

Can we separate domain-final effects from global effects in speech production?

Is it actually just a domain-final effect?



Pike and Small (1974); Pike and Wistrand (1974) provide only impressionistic comments regarding positional differences.

Declination, final lowering, and tone languages

Declination is a universal process in declarative utterances (Gussenhoven, 2004), but there are exceptions in tone languages:

1. It does not occur in a sequence of high tones, e.g. Mandarin (Xu, 1999), Taiwanese (Peng, 1997).
2. It only occurs in a sequence of low tones, e.g. Mambila (Connell, 2017), Yoruba (Laniran and Clements, 2003).
3. It does not occur, e.g. Choguita Rarámuri (Garellek et al., 2015), Embosi (Rialland and Embanga Aborobongui, 2017).

Final lowering occurs in tone languages:

1. It occurs for all tones, e.g. Kipare (Herman, 1996), Moro (Chung et al., 2016), Embosi (Rialland and Embanga Aborobongui, 2017)
2. It only occurs with low and falling tones, e.g. Mambila (Connell, 2017), Taiwanese (Peng, 1997), Akan (Kügler, 2017).

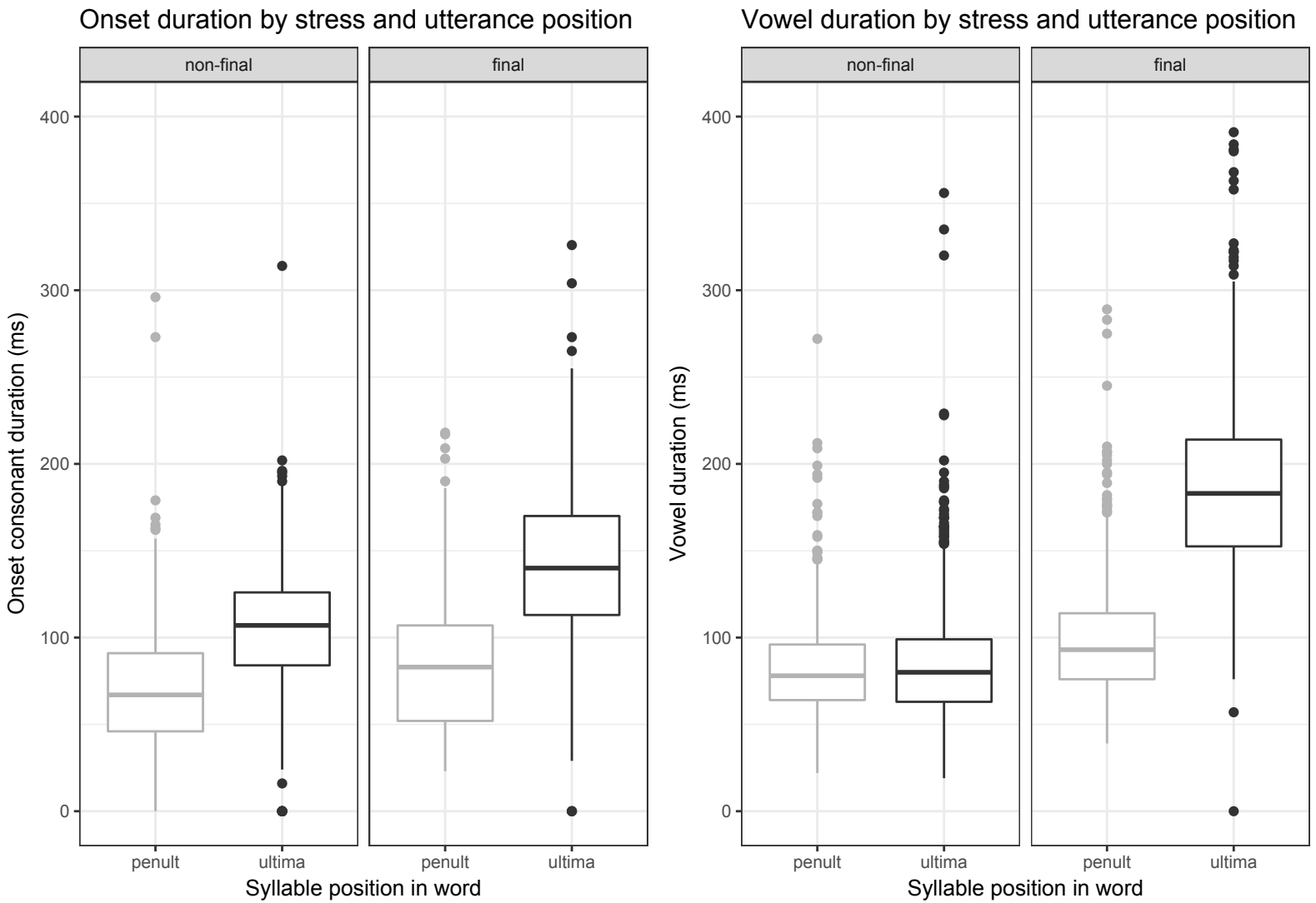
Methods: positional effects on tone

- 20 tonal melodies were analyzed (1.1, 1.3, 1.42...) in disyllabic words in non-final contexts (before a PP/Adv) and utterance-final contexts.

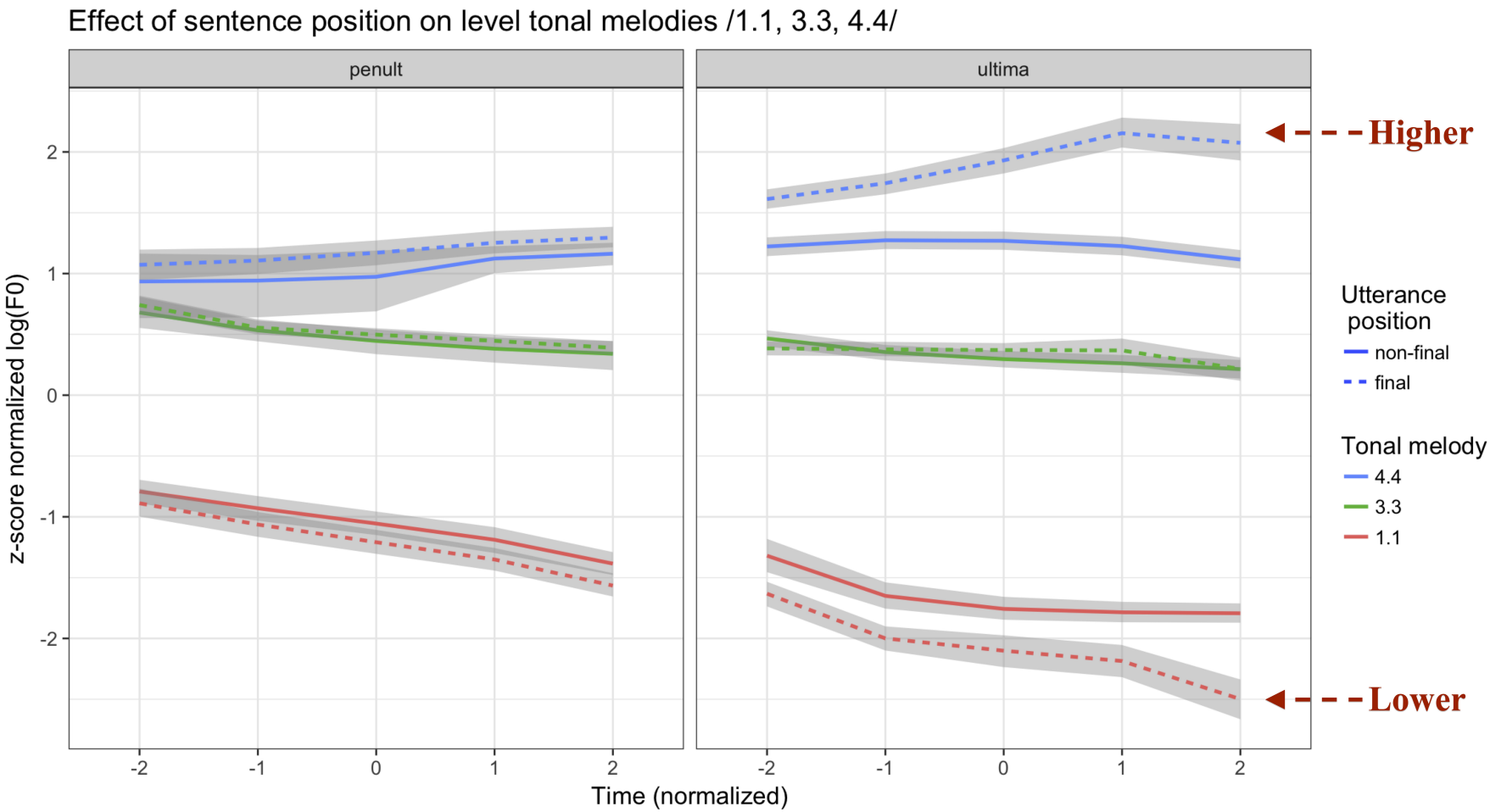
  ʃa^{4}ʃi^{24}=ra^{2} ^{n}di^{3}ʃi^{4} 'He is eating corn.'
  ʃa^{4}ʃi^{24}=ra^{2} ^{n}di^{3}ʃi^{4} βi^{3}tĩ^{3} 'He is eating corn now.'

- The post-target word always had tone /3/.
- 288 repetitions for each speaker (36 words x 2 conditions x 4 repetitions); 9 speakers.
- Initial transcription in ELAN and segmentation in Praat. We used a script to analyze F_0 dynamics and duration.
- F_0 was normalized and all data was analyzed using the same methods as experiment 1.

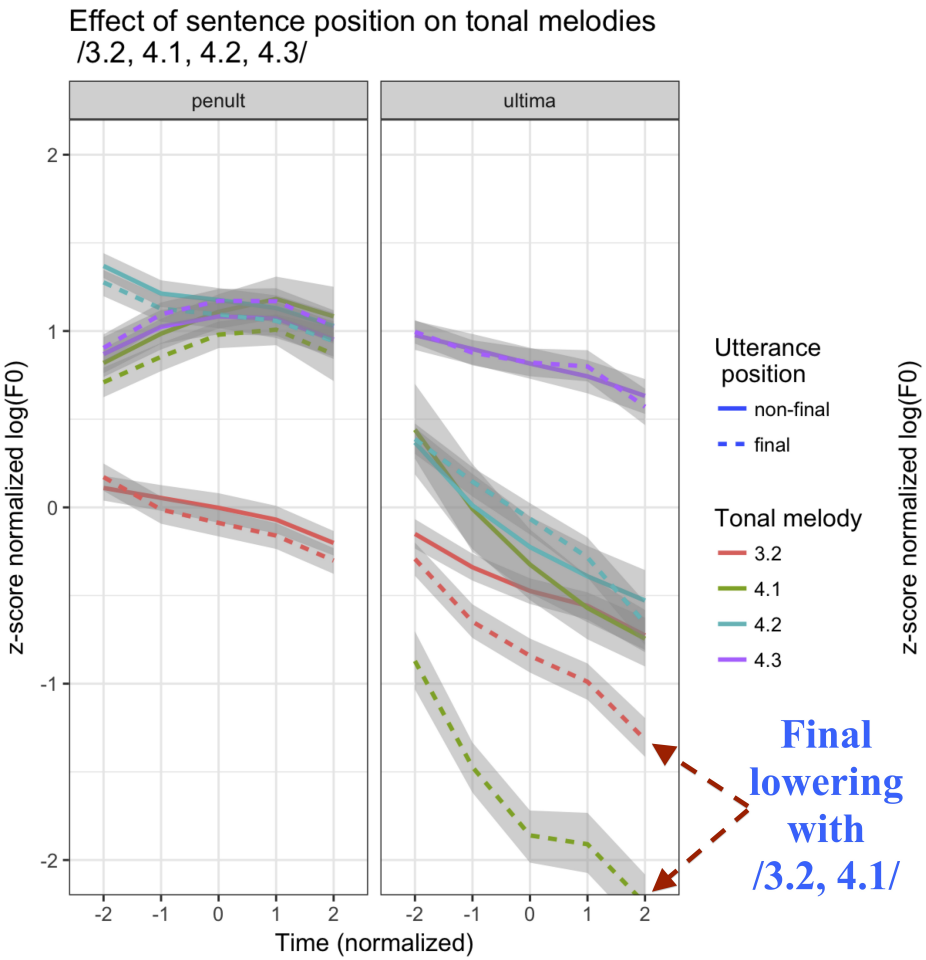
Results II: duration

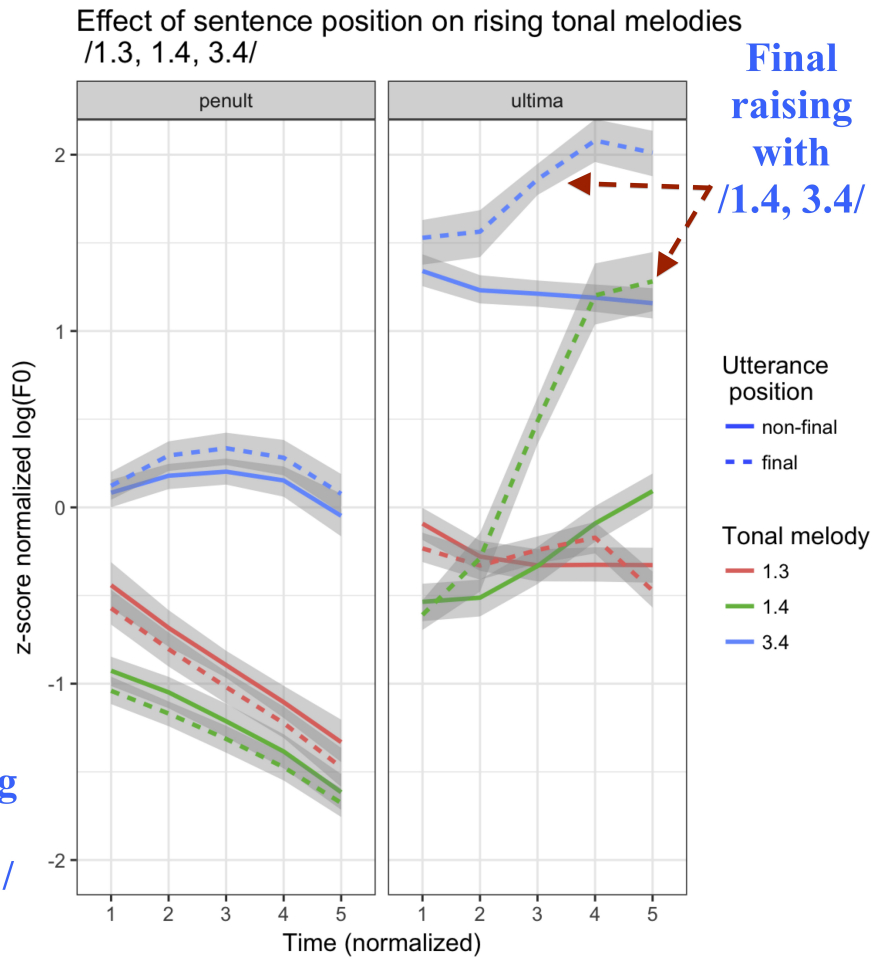


Results II: level tone melodies

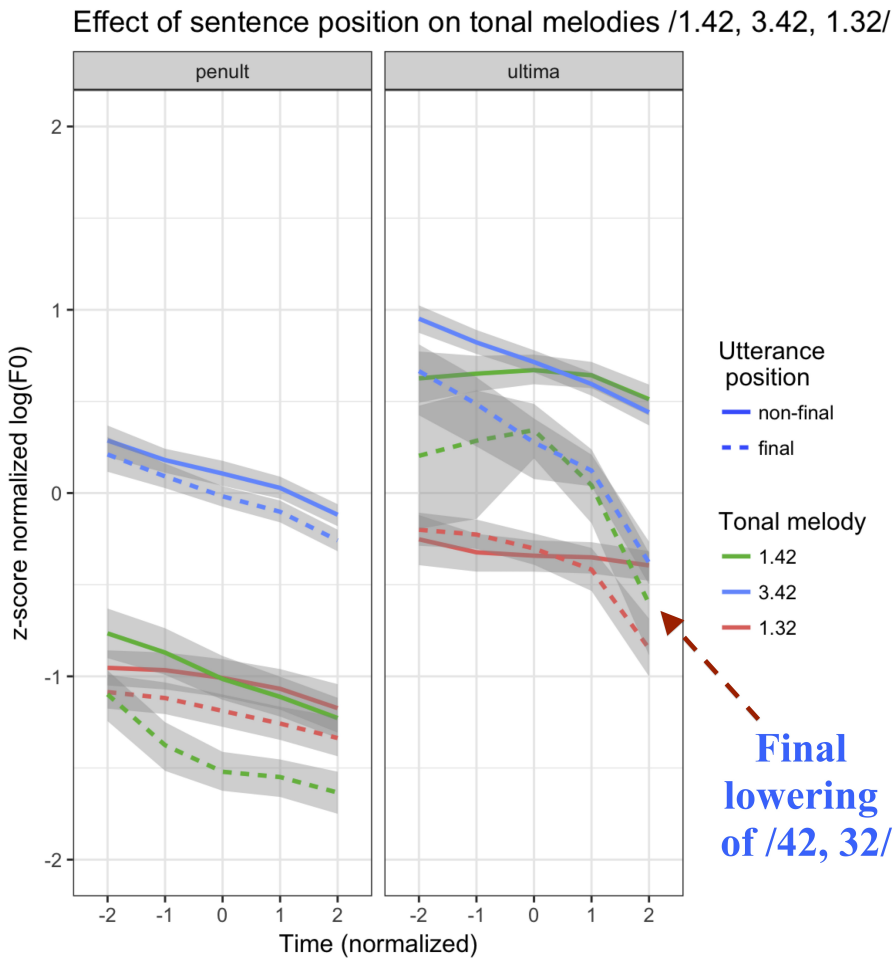


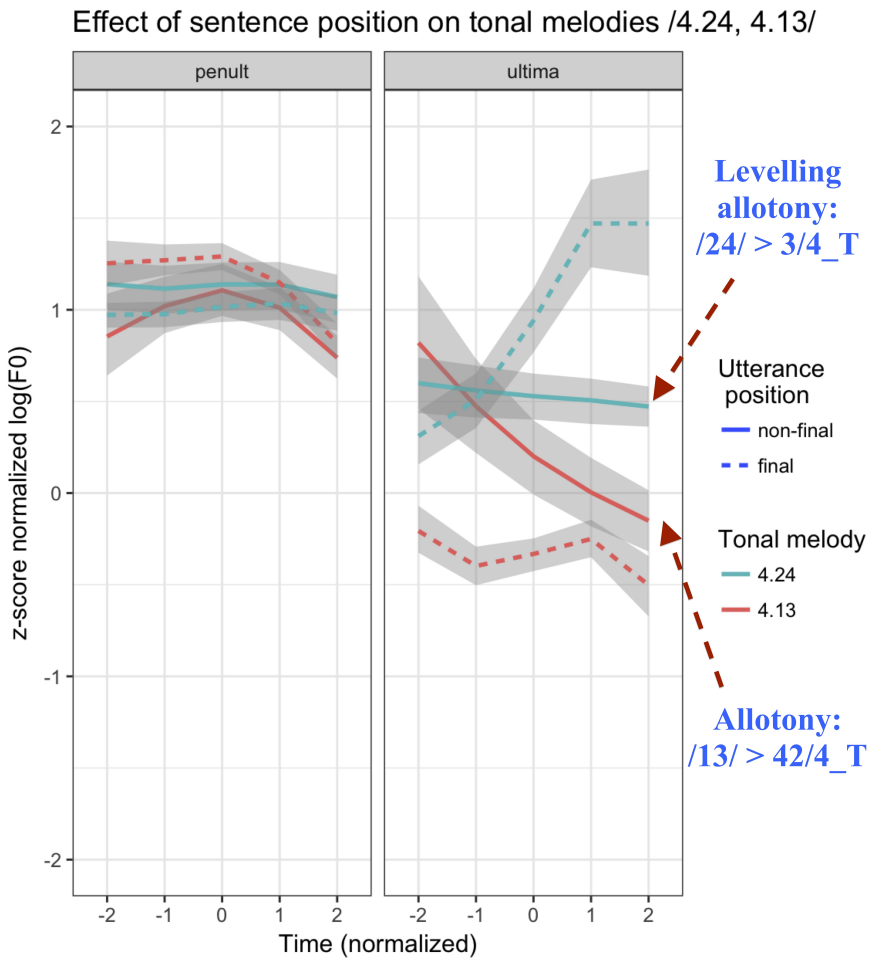
Results II: falling and rising melodies





Results II: melodies with final contours





Discussion

1. Vowels are lengthened in phrase-final position.
2. Tonal effects occur only in the boundary-adjacent syllable.
3. Phrase-final position is marked by F_0 range expansion. The highest tone /4/ raises and lower/falling tones (/2, 1, 42, 32/) lower. Tone /3/ does not change.
4. Rising tones (/13, 24/) have distinct allotones in non-utterance-final position.

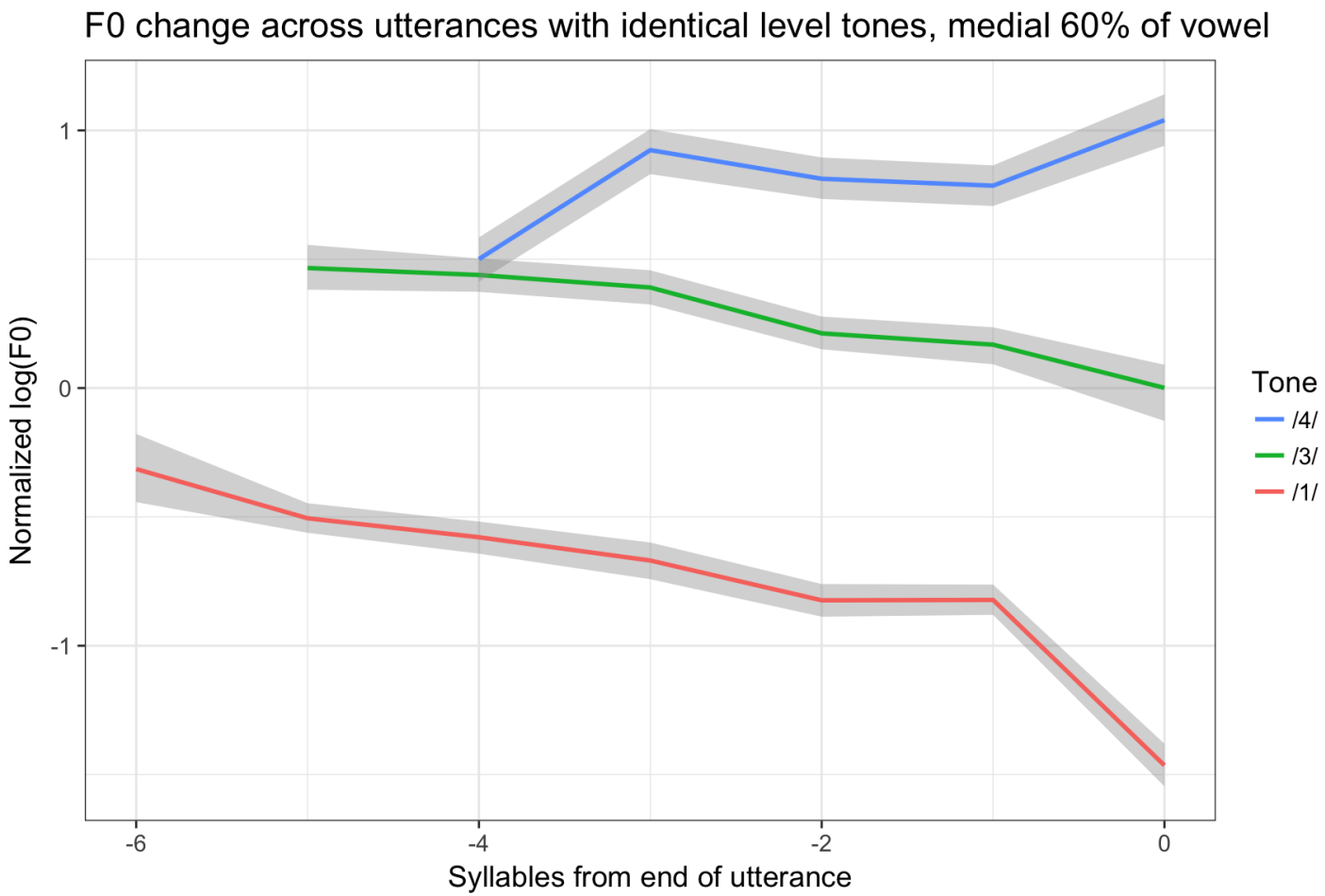
Are processes in final position related to utterance-level declination or raising?

Methods: Declination

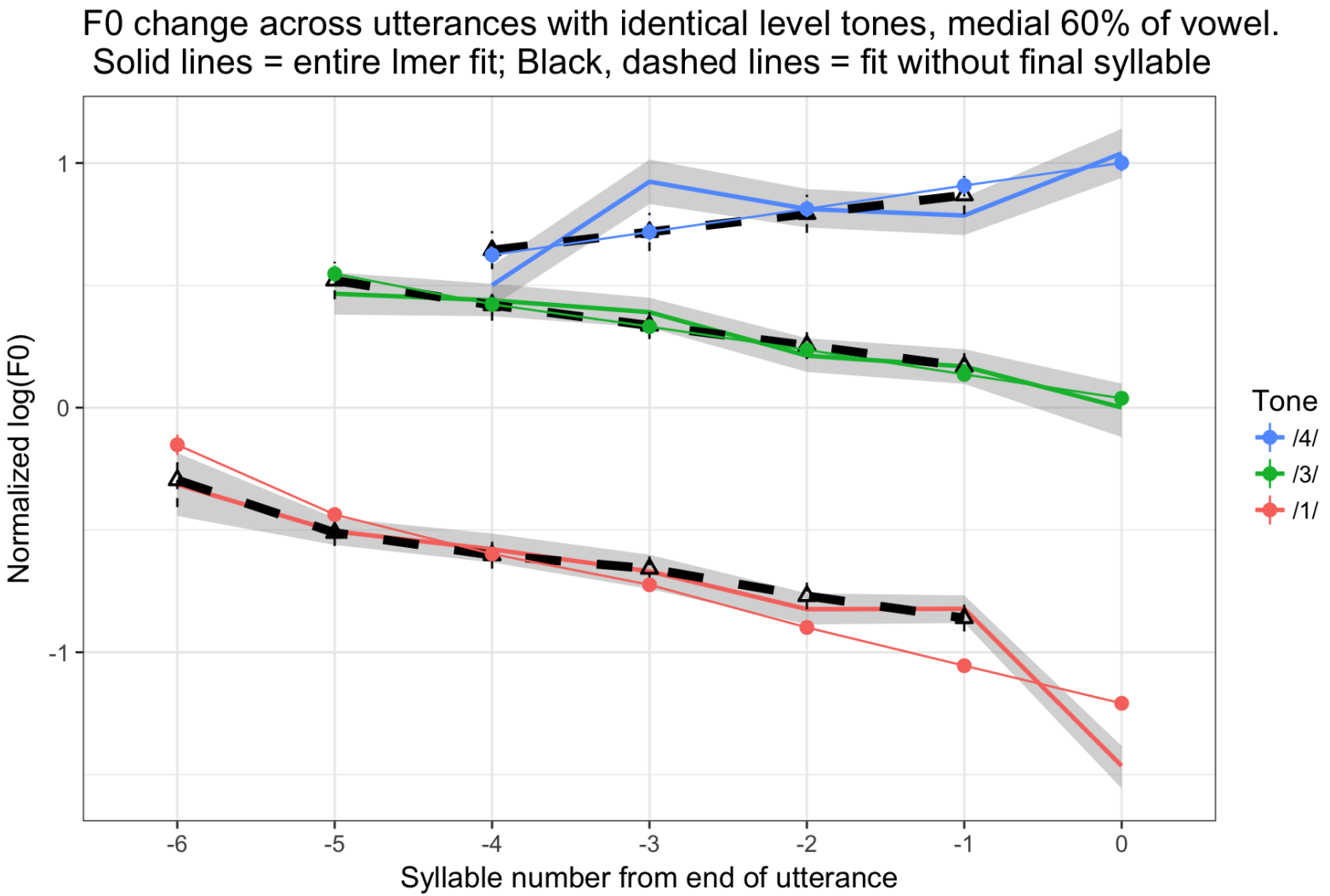
- We analyzed sentences that consisted of only level tone sequences.
- 10 sentences between 4-7 syllables in length; 2 with tone /4/, 4 with tone /3/, 4 with tone /1/.
- 10 sentences x 4 repetitions; 9 speakers.
- Initial transcription in ELAN and segmentation in Praat. We used a script to analyze F_0 dynamics and duration.
- F_0 was normalized and all data was analyzed using the same methods as experiment 1.
- Two statistical methods to disambiguate declination from final lowering: trajectory modelling with and without utterance-final syllable.

Results - declination

Occurs in sequences of tone /1/ and /3/, but not with tone /4/.

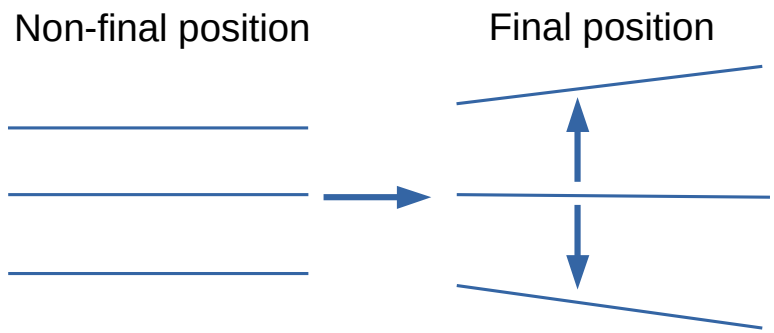


Results - declination modelling



Processes affecting final tones

- Final raising of highest tone and lowering of lowest tone reflect distinct processes from utterance-level effects.
- Utterance-level declination occurs with non-high tones but not with the highest tone (/4/).
- Are these boundary tones? No. If they were to exist, we would have to stipulate that they be extensions of the same preceding tones, i.e. H% only after /4/.



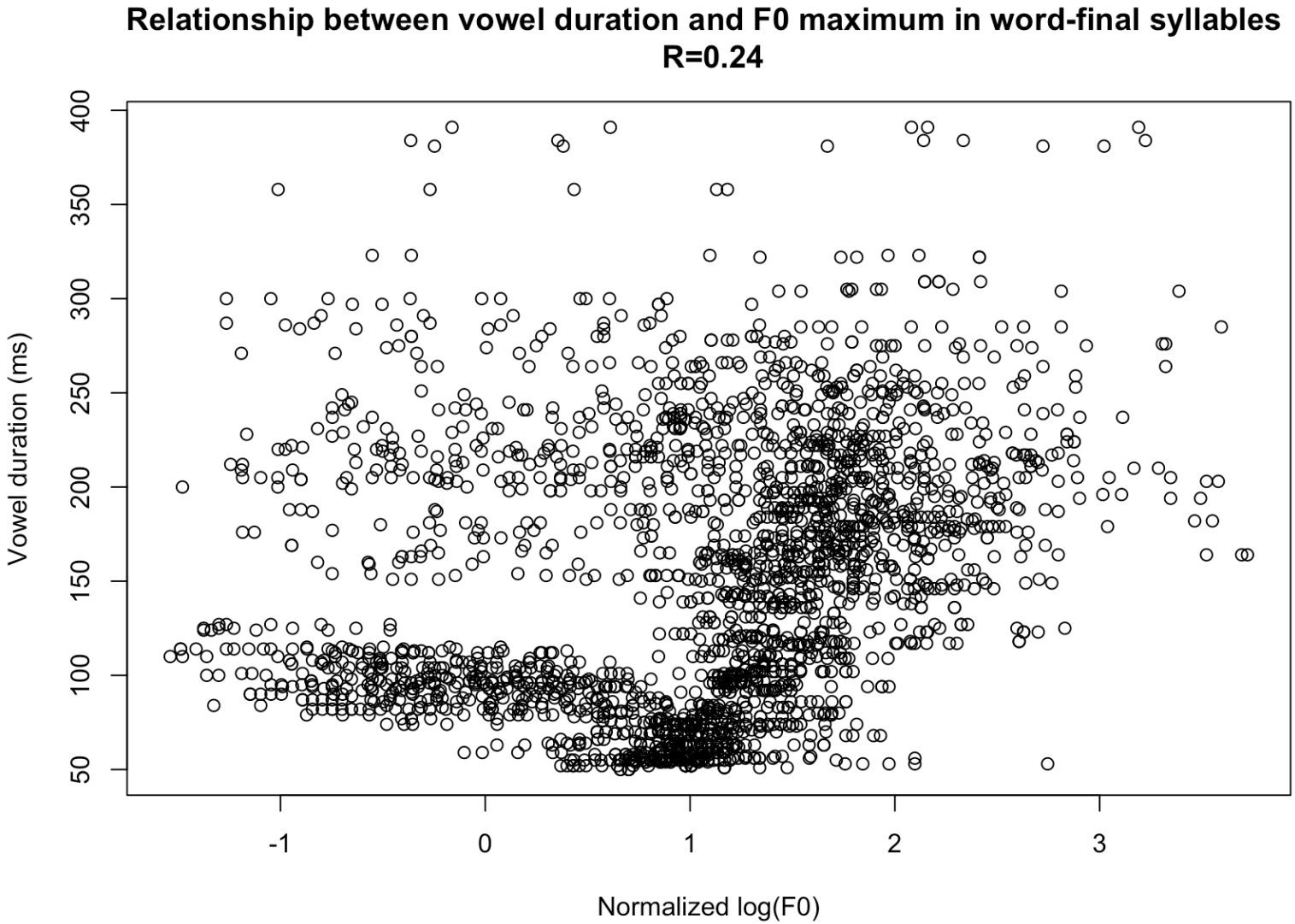
Conclusions: multiple prosodic mechanisms

The type of F_0 range expansion and durational changes observed on initial focused constituents are distinct from those observed in phrase-final position.

Prosodic marking of focus in YM is distinct from boundary-related prosodic effects.

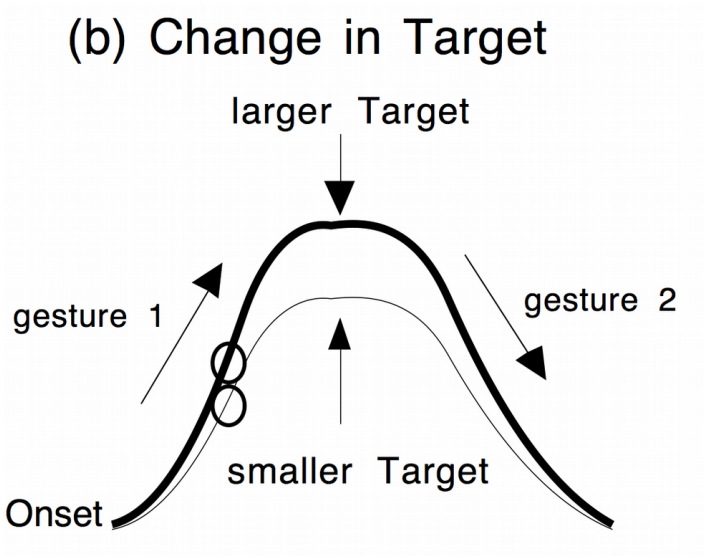
Tonal changes in utterance-final position result from tonal hyperarticulation which expands the tonal range (Krivokapić and Byrd, 2012).

Duration and F_0 raising on tone /4/ is correlated, but it is not a strong relationship.

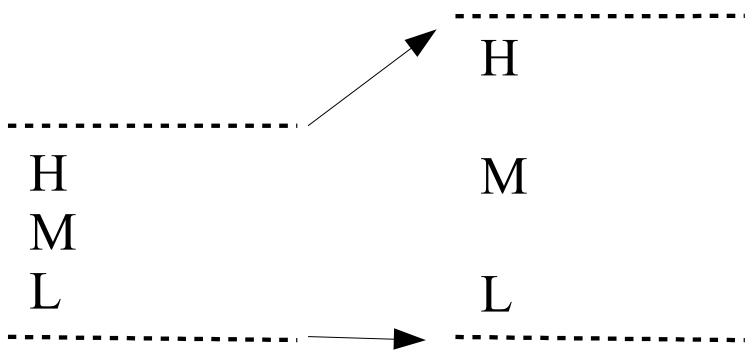


Conclusions: mechanisms

Prosody in YM is marked primarily by adjustments to F_0 range and hyper/hypoarticulation (de Jong, 1995; de Jong and Zawaydeh, 2002).



Change in range = postural target adjustment?



Future plans

1. Parallel research on Itunyoso Triqui (IT) prosody.
2. Tone production in the YM and IT corpora.
3. EMA research in the UB Phonlab on the supralaryngeal articulation of information structure in English and Korean.

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- Commentary from audiences at CILLA VIII and UC Santa Cruz.

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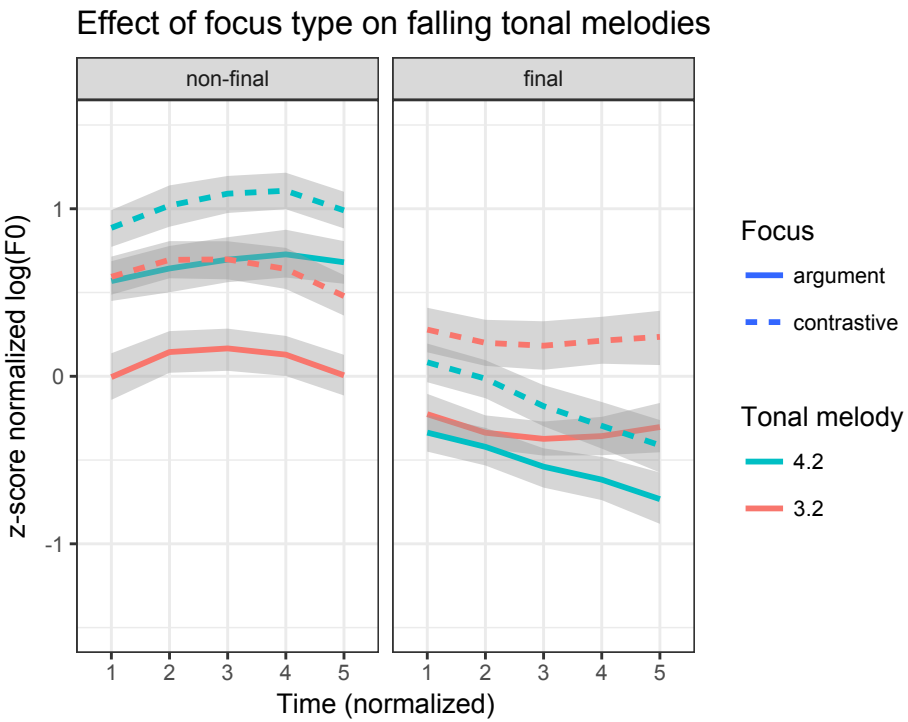
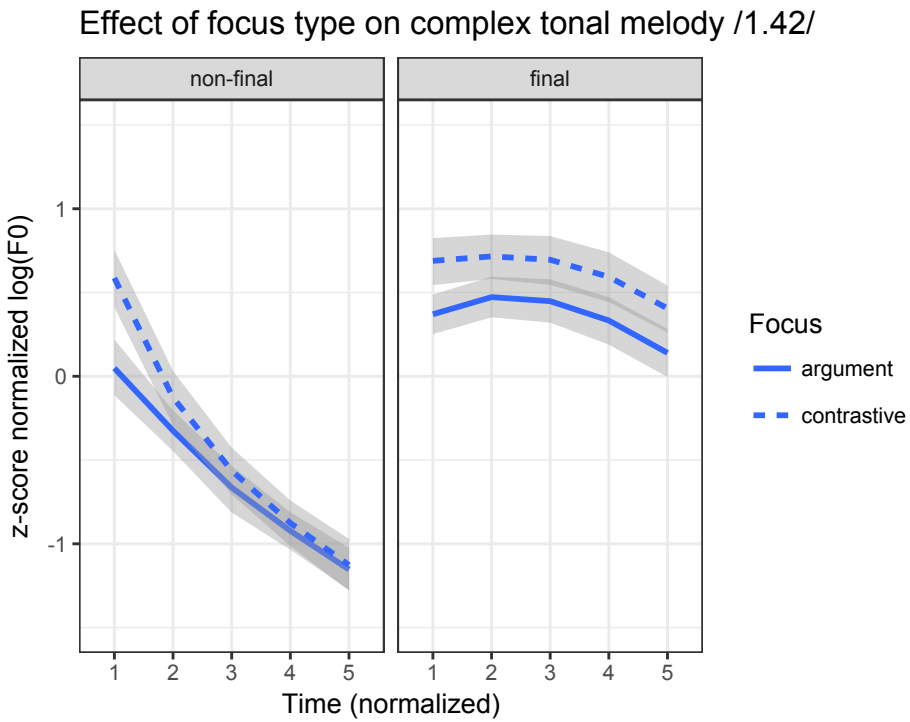
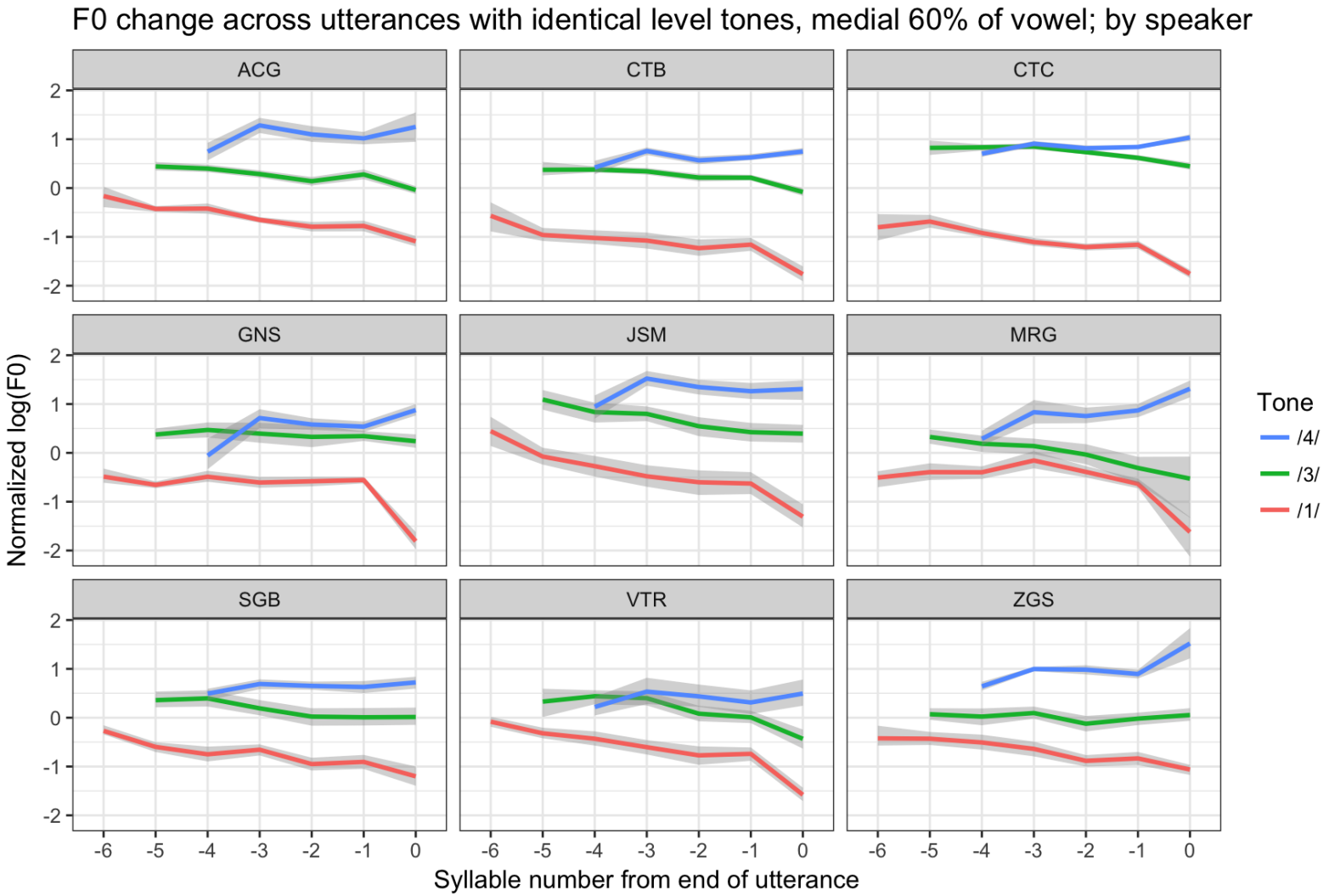
Results: Falling and complex melodies

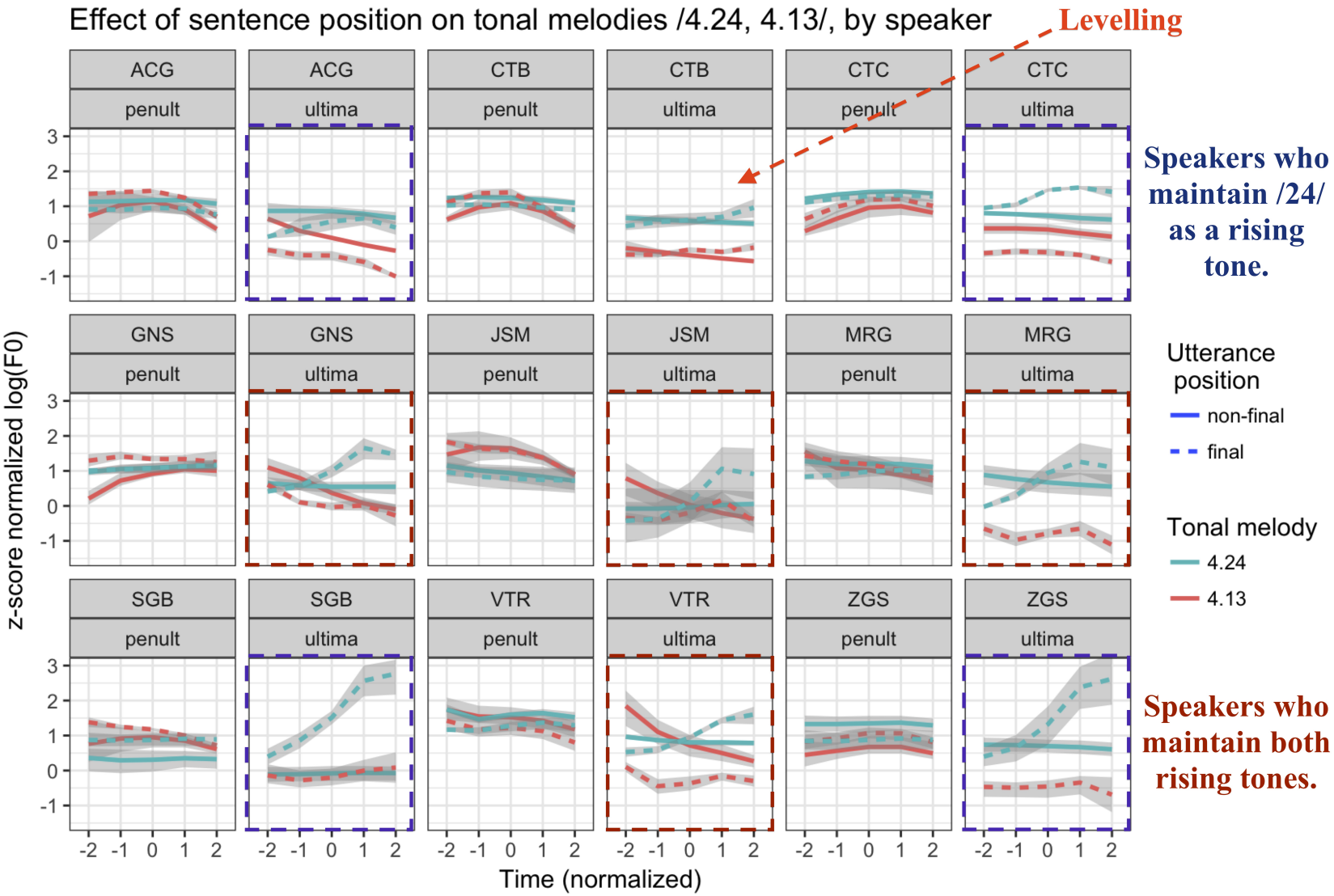




Results - declination by speaker



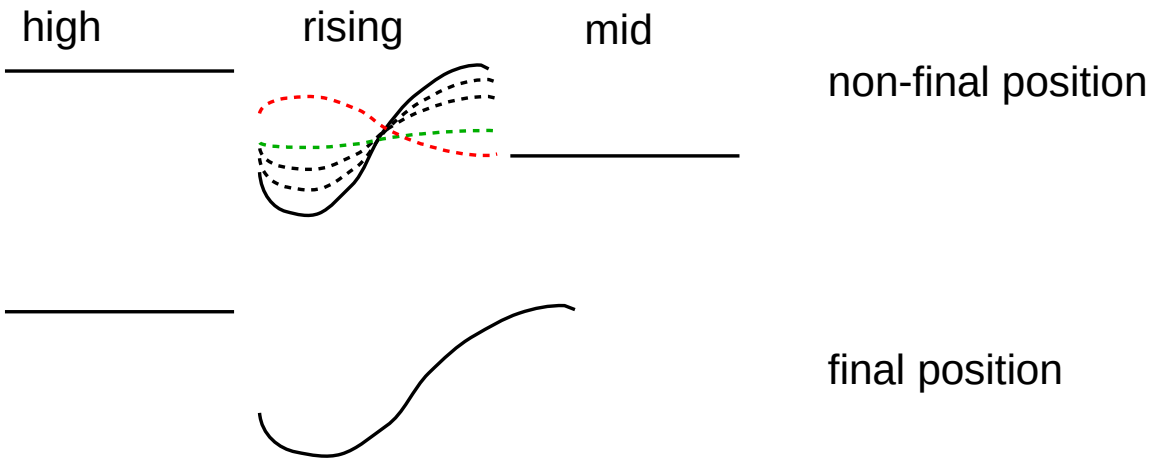
Variation in the production of rising tones



Final allotony

F_0 rises require more time than level or falling trajectories, thus we might expect that they be limited to contexts with longer phonetic duration, e.g. phrase-final position (Sundberg, 1979; Zhang, 2004).

Allotony results from durationally-induced F_0 levelling. Levelling is induced via articulatory undershoot (Parrell, 2014; Mücke and Grice, 2014).



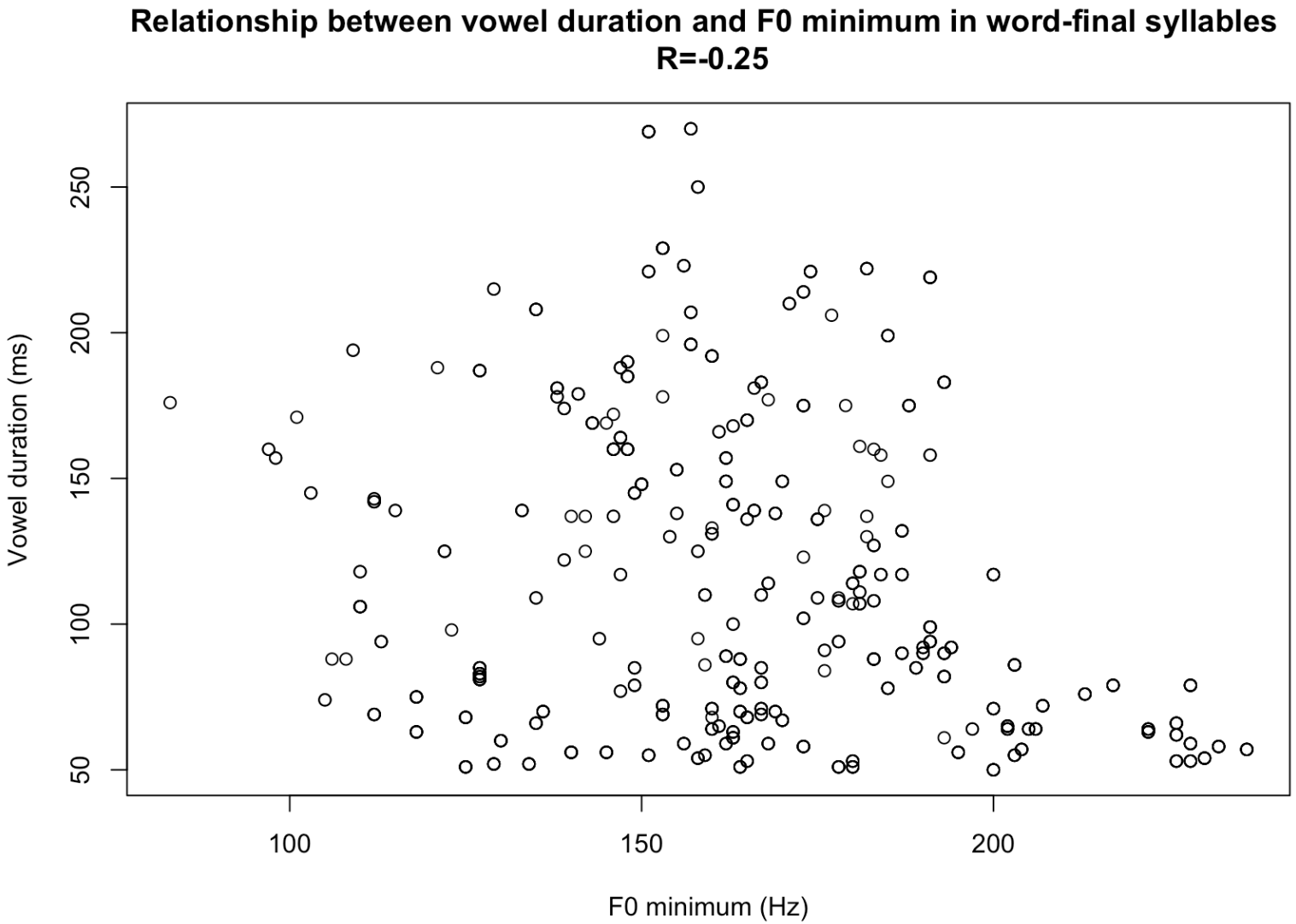
Prosodic marking

Accentual marking of heads/edges – intonational pitch accents are attracted to prominent positions in the prosodic hierarchy or on constituents with narrow focus (Gussenhoven, 2004; Pierrehumbert and Beckman, 1988).

Non-accentual phonological marking of domains – prominent positions in the prosodic hierarchy license the application of specific phonological processes, e.g. tone spreading domains (Hsu and Jun, 1996; Hyman, 1990; Hyman and Monaka, 2011; Lee, 2014), positional neutralization (Barnes, 2006).

Phonetic marking of domains – prominent positions in the prosodic hierarchy undergo processes of phonetic enhancement, e.g. domain-initial strengthening (Fougeron and Keating, 1997; Keating et al., 2000), focal F_0 range expansion (Xu, 1999), stress-related hyperarticulation (Byrd and Choi, 2010; de Jong, 1995; Krivokapić and Byrd, 2012).

Duration and F_0 lowering on tone /1/ are negatively correlated, but this is a weak effect.



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