The phonetics of prosody in Yoloxóchitl Mixtec

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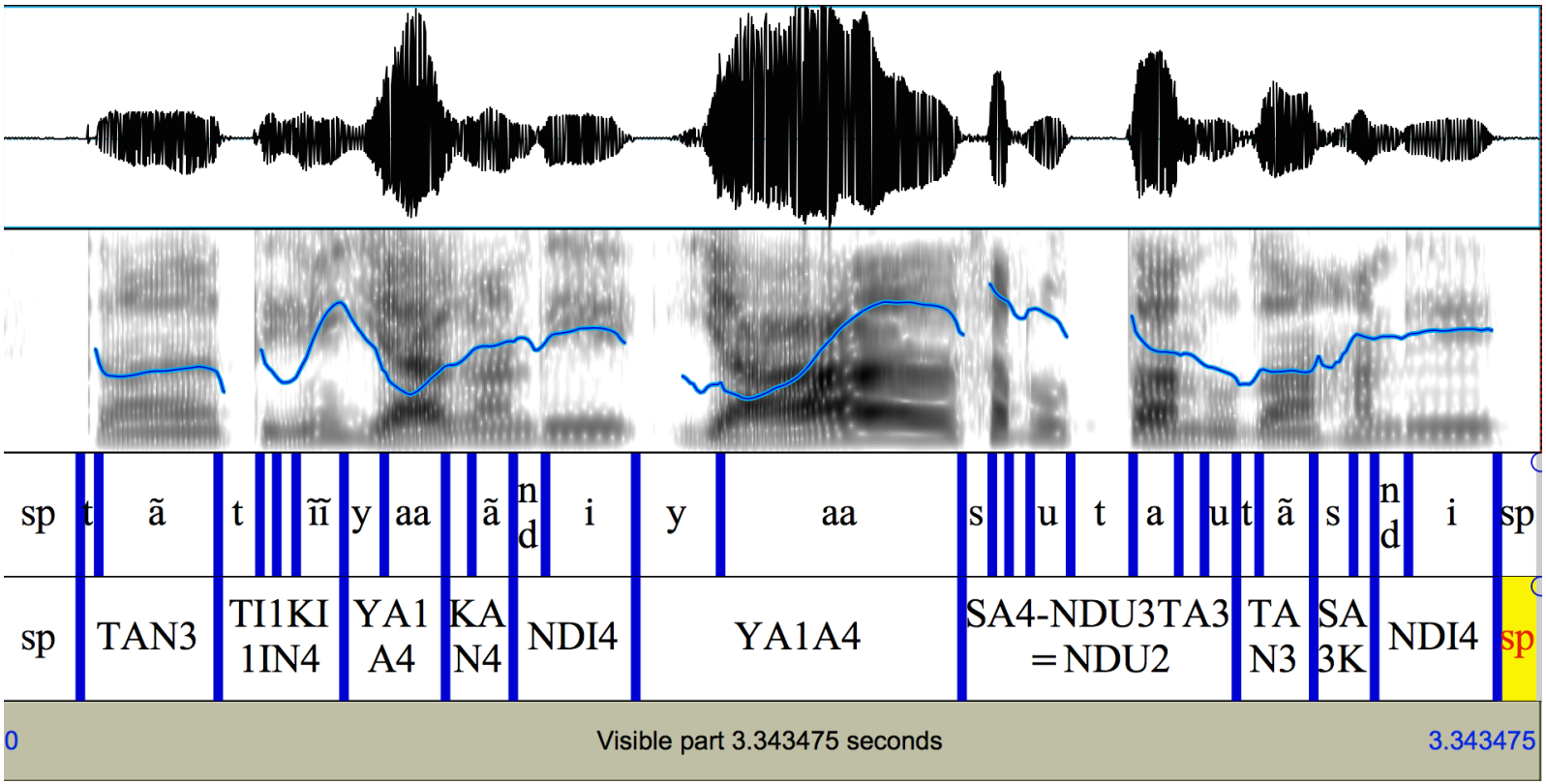
Motivation

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}



How do both instances of /yaa^{14}/ 'ash' differ?

Research questions

Prosody can influence the production of tones in tonal languages.

1. The influence of information structure on tone.

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1. The influence of information structure on tone.
2. Tone production in pre-pausal/connected speech contexts.
3. Tone production and utterance-level intonational patterns.

How is prosodic prominence marked in tone languages?

1. **Phonological**

   Intonational pitch accents or boundary tones can influence tonal contour shapes.

   e.g. Kipare (Herman, 1996), Shekgalagari (Hyman and Monaka, 2011), Thai (Luksaneeyanawin, 1998)

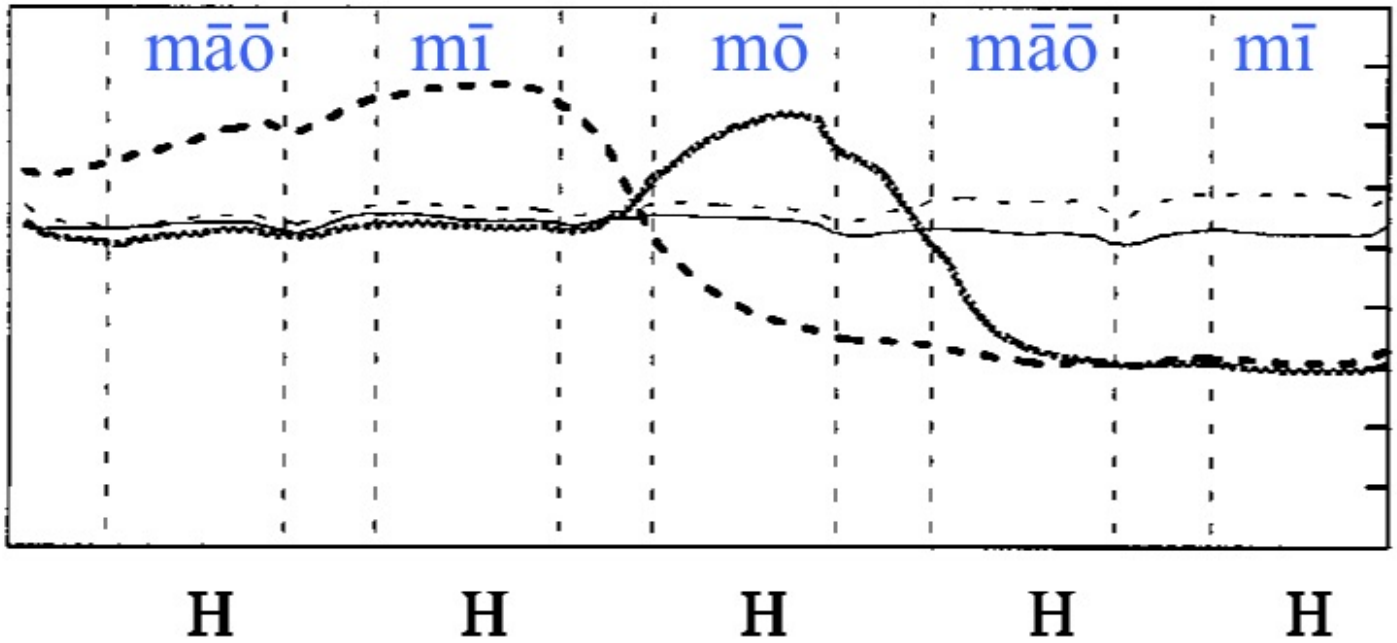
2. **Phonetic**

   Prosodic prominence is marked via phonetic lengthening, register shift, or pitch range expansion.

   e.g. Mandarin (Xu, 1999), Akan (Kügler and Genzel, 2011)

Register shift

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



Phonetic marking of domains

Prominent positions in the prosodic hierarchy undergo processes of phonetic enhancement

- domain-initial strengthening (Fougeron and Keating, 1997; Keating et al., 2000)
- focal F_0 range expansion (Xu, 1999) and gestural hyperarticulation (Mücke and Grice, 2014)
- stress-related hyperarticulation (Byrd and Choi, 2010; de Jong, 1995; Krivokapić and Byrd, 2012)

Prosodic lengthening and strengthening

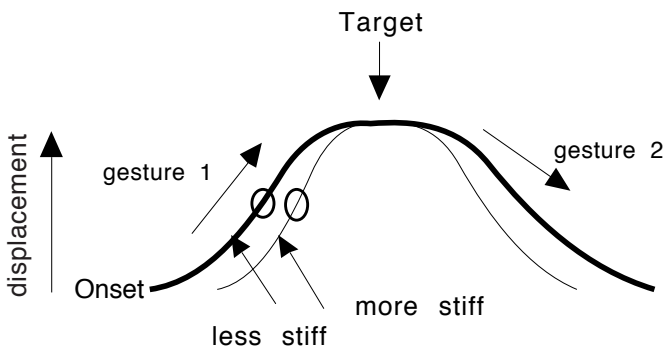
- Stressed syllables undergo greater prosodic lengthening under focus than unstressed syllables do.

  English (Turk and Sawusch, 1997; Turk and White, 1999), Dutch (Cambier-Langeveld and Turk, 1999), Swedish (Heldner and Strangert, 2001)

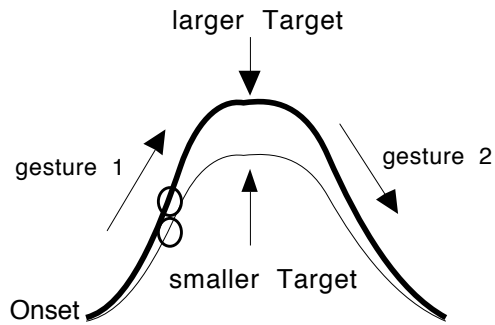
- Intonational pitch accents are aligned with stressed syllables in non-tonal languages (Gussenhoven, 1983). Is focus aligned with stress in tone languages?

Dynamical parameters (Cho, 2006)

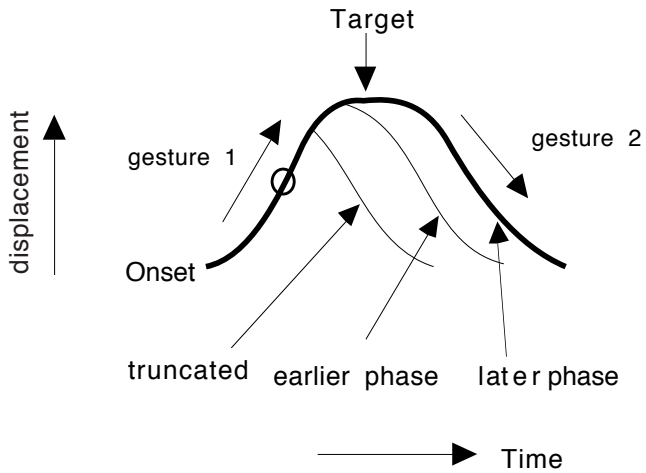
(a) Change in Stiffness



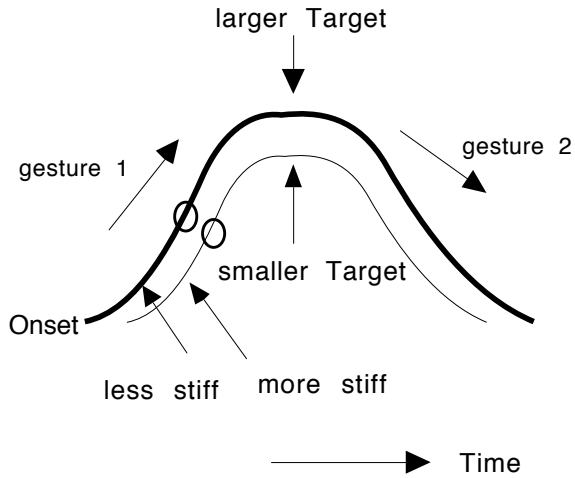
(b) Change in Target



(c) Change in Intergestural Timing



(d) Change by shrinking



1. How do tones change in prosodically weak/strong environments? at boundaries?

2. Is this phonological or phonetic?

Yoloxóchitl Mixtec (YM)

- Otomanguean, spoken in Guerrero, Mexico (∼4000 speakers).
- Phonological/phonetic fieldwork (Castillo García (2007), DiCanio et al. (2014), DiCanio (submitted a, b), 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: /yaʔ^{4}a^{1}/ '*grey*', /saʔ^{3}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 differences in YM?

Methodological issues I

Most work on information structure involves reading.

e.g. in Mandarin (Chen and Gussenhoven, 2008; Xu, 1999), Guaraní (Clopper and Tonhauser, 2013), Arabic (de Jong and Zawaydeh, 2002), German (Mücke and Grice, 2014), Dutch (Peters et al., 2014), etc.

There is no native literacy in YM and many speakers are not functionally literate in Spanish.

Solution I

Corpus linguist/Syntactian's solution: Just mine a corpus for natural examples!

Issue: You are not controlling for tone or word structure.

Methodological issues II

A Q&A paradigm following a short story can naturally elicit NPs of different types (narrow, broad, contrastive focus).

e.g. in Akan (Kügler and Genzel, 2011), Guaraní (Clopper and Tonhauser, 2013)

This works well for contexts of narrow or contrastive focus, but not so well for broad focus.

Why?

1. YM (and other Mixtecan languages) use pronominal clitics for animate entities that have been backgrounded.

2. Mixtecan languages are object-dropping.

3. "Describe what happened." is an odd demand after listening to a text. Speakers attempt to answer it by speculating about the actors' intents in the text.

Solution II

Use a repetition task?

Issue: Speakers might mimic the prompt and this is less natural than a Q&A paradigm.

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.'

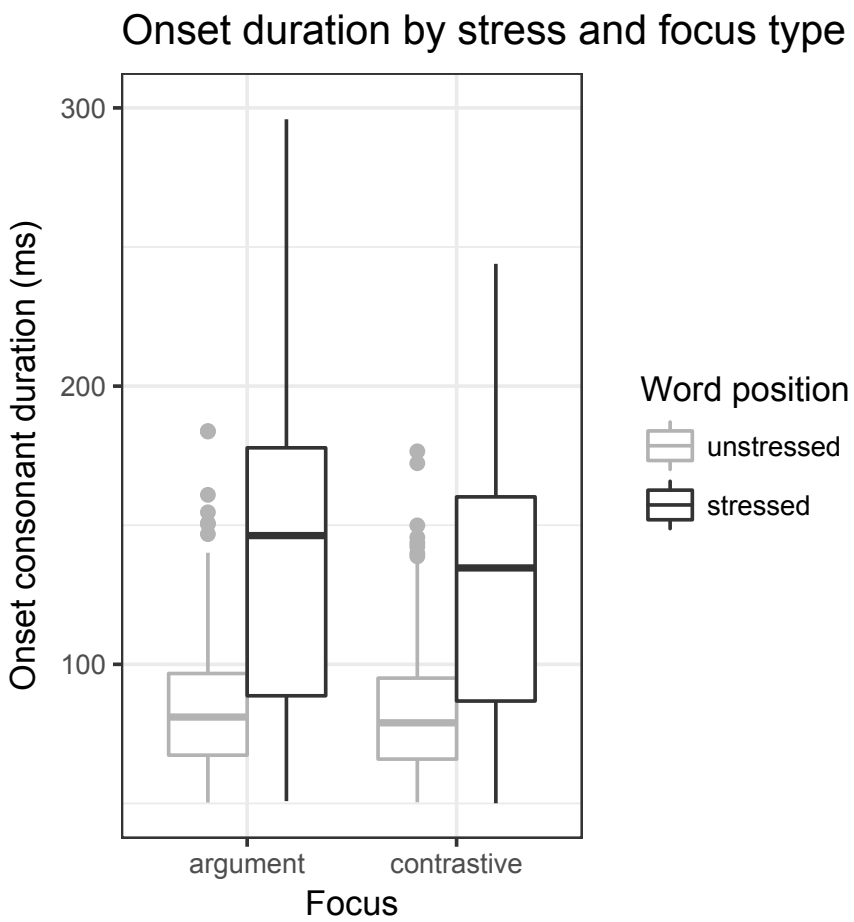
Corrective focus

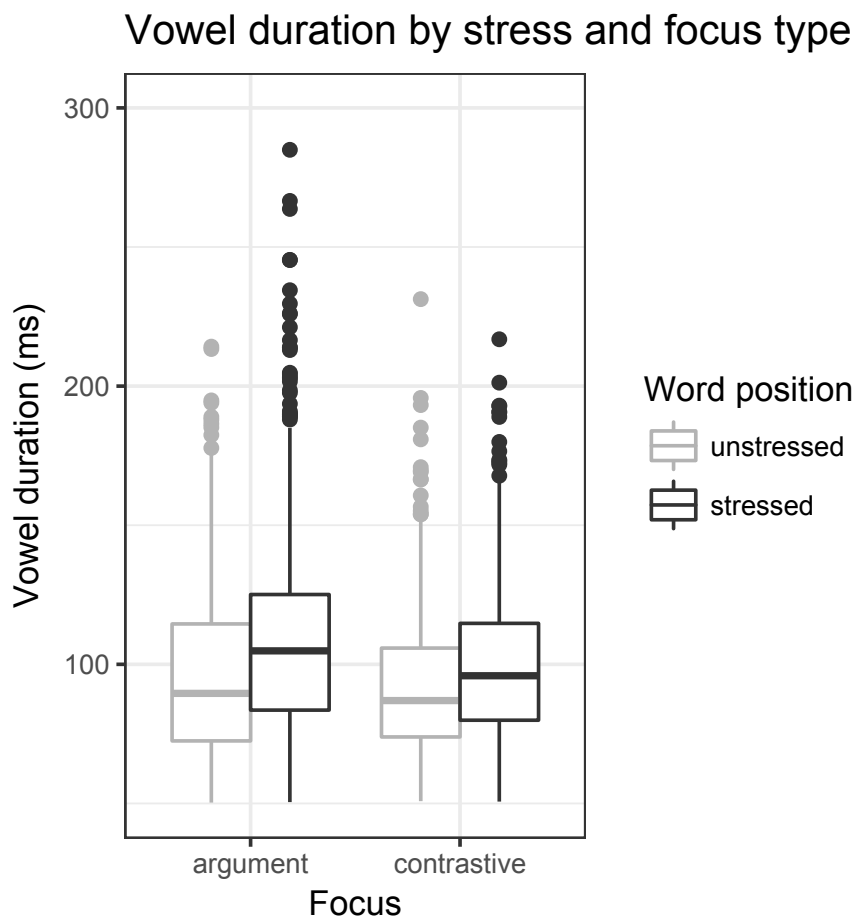
Methods

- 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.
- Ten native speakers participated; a total of 5,040 utterances were analyzed (504/speaker).
- 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., 2013). All reported results are significant.

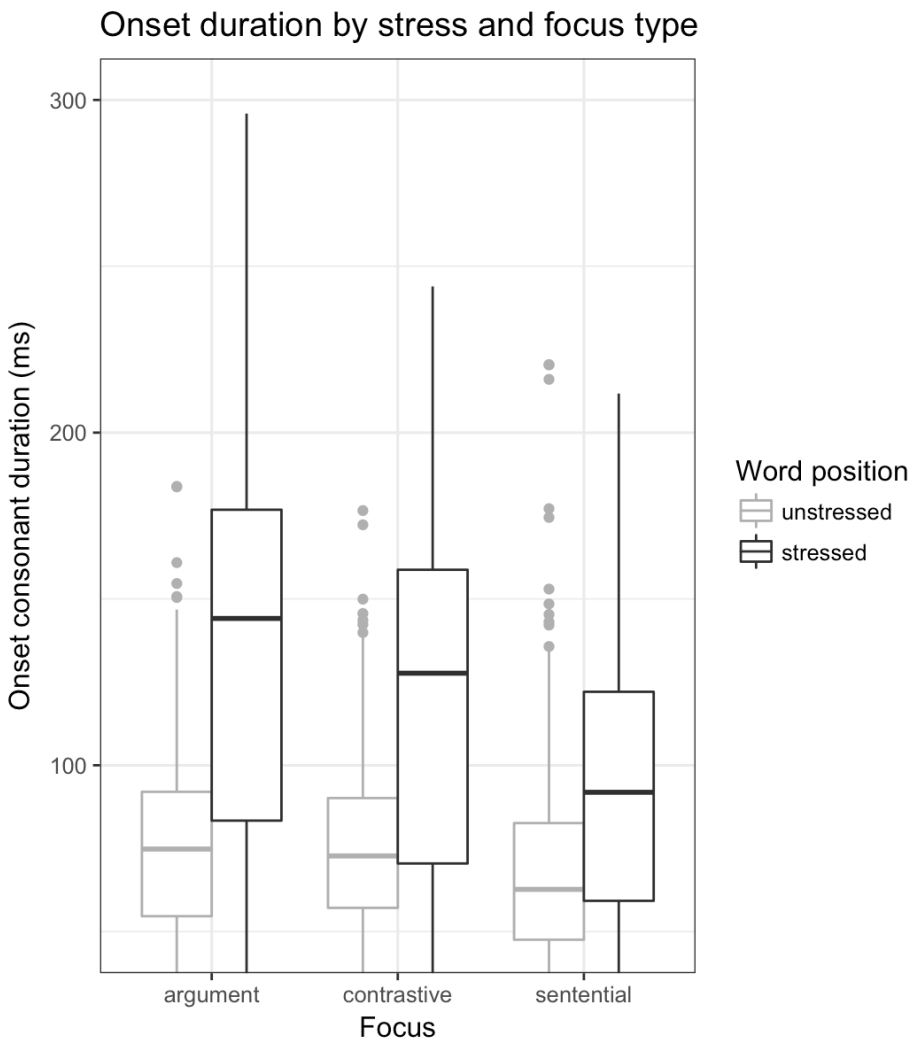
Since we have a mixed design, we will present the contrastive-argument focus comparison first and then compare them both to the sentential focus condition.

Results: Duration I





Results: Duration - comparative



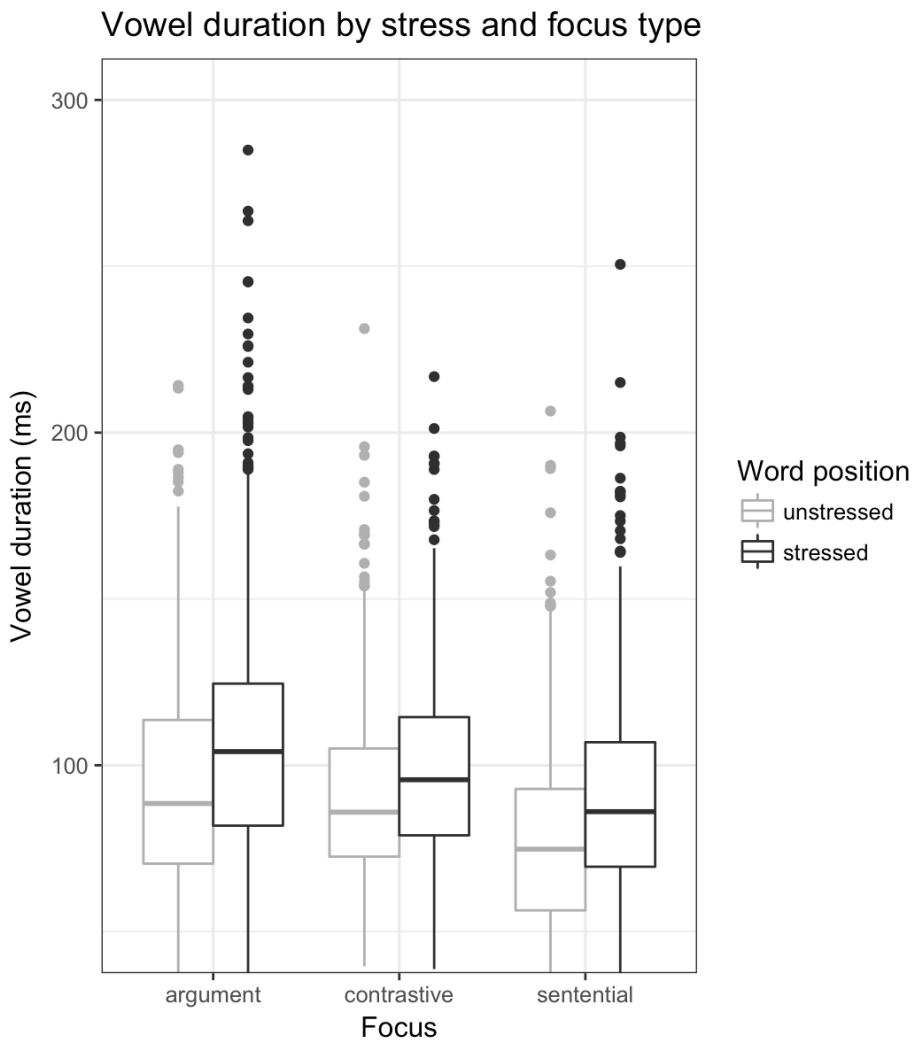
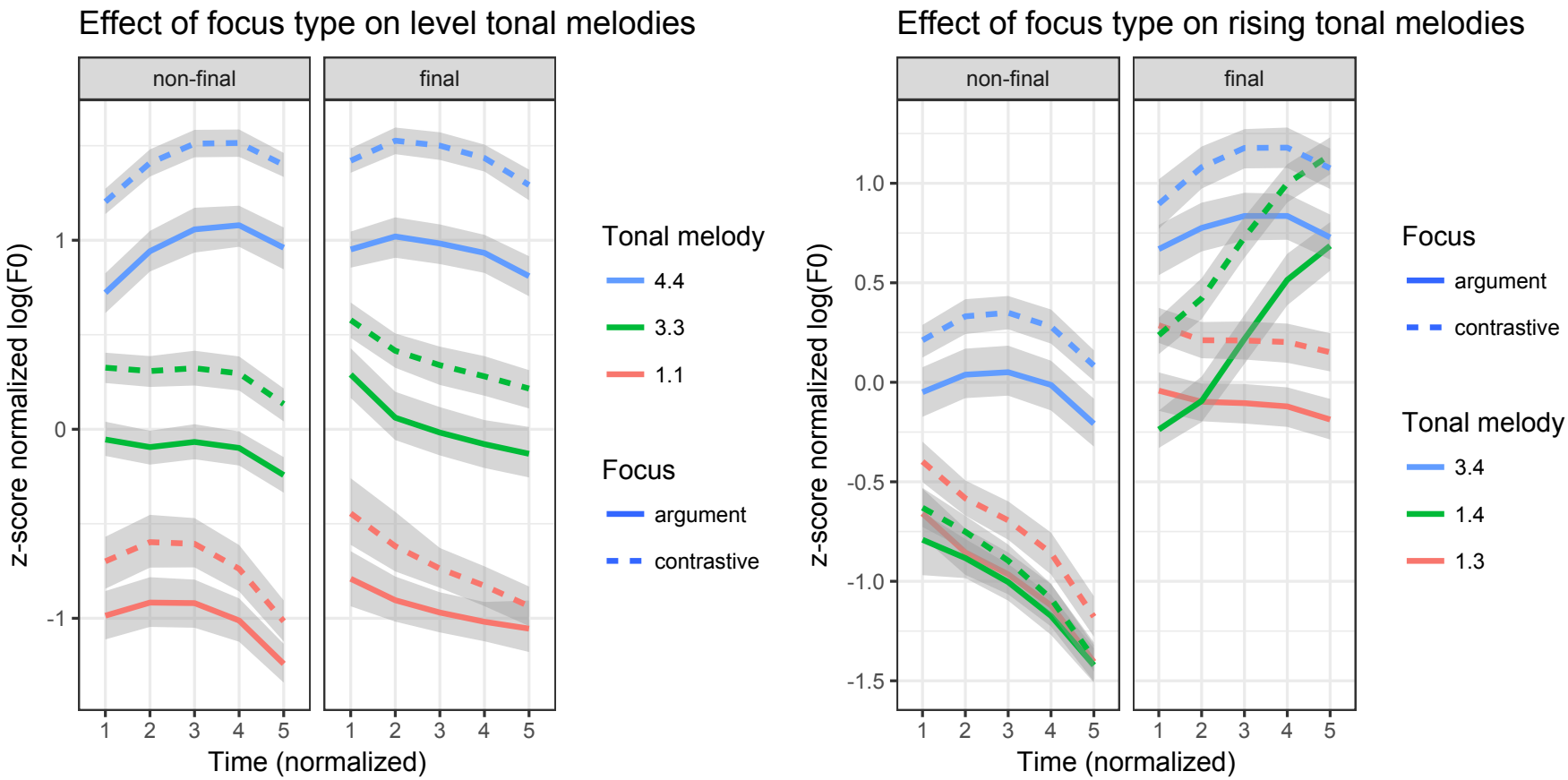


Table: Durational patterns across focus types. Except for ratios and percentages, all numbers are in milliseconds.

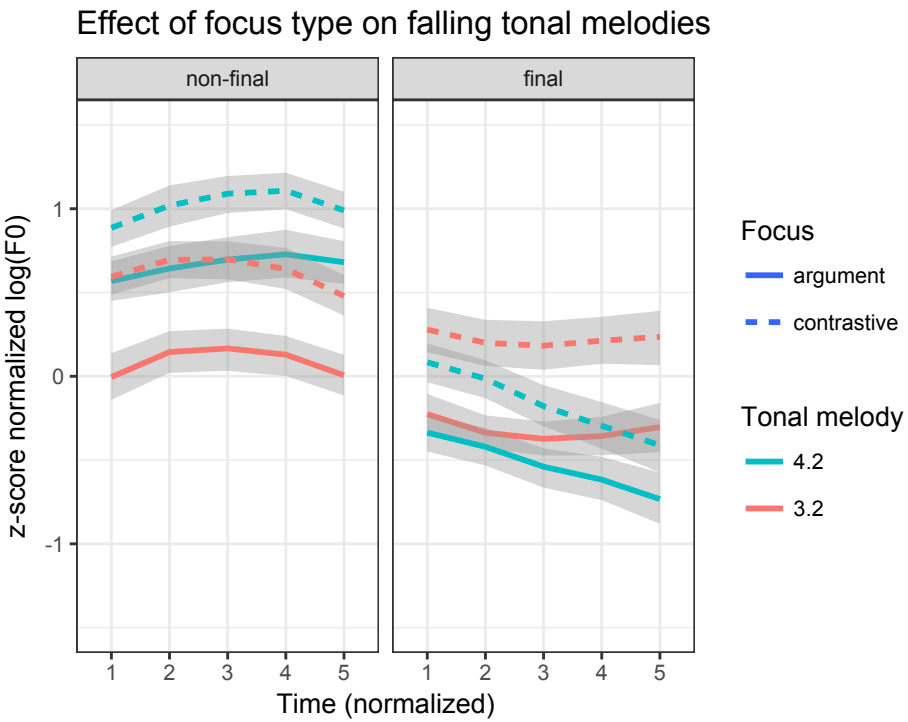
	C_1	V_1	C_2	V_2	σ_1	σ_2	σ-ratio
Sentential focus	70	77	95	90	141	185	1:1.31
Contrastive focus	77	92	120	99	169	219	1:1.30
Argument focus	76	94	136	107	170	242	1:1.42
Maximum Lengthening under focus	10%	22%	43%	19%	21%	31%	

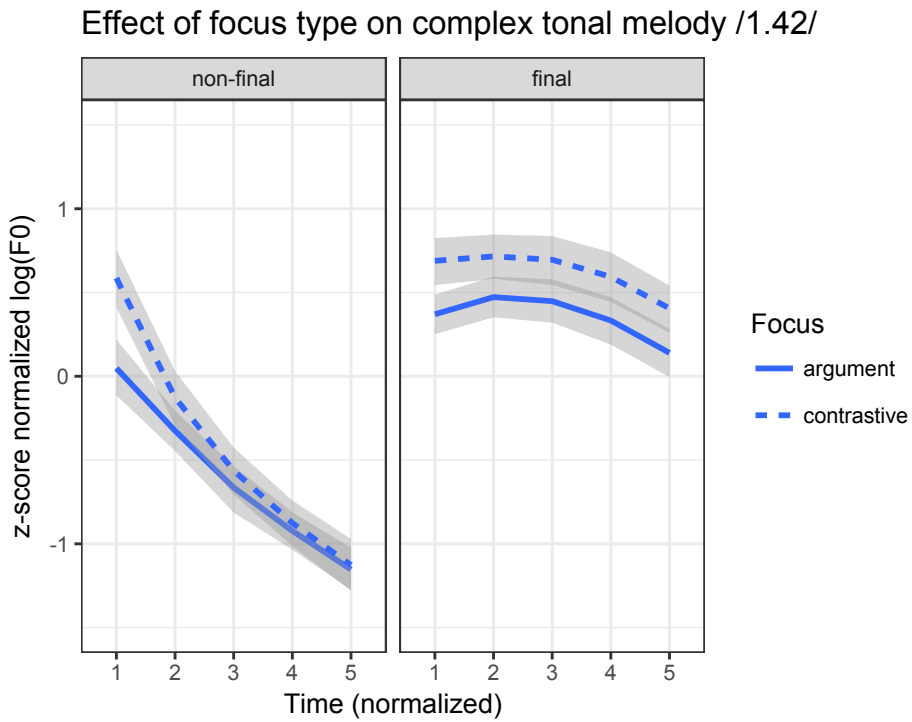
Results: Level and rising melodies

Globally, contrastive focus undergoes raising relative to argument focus.



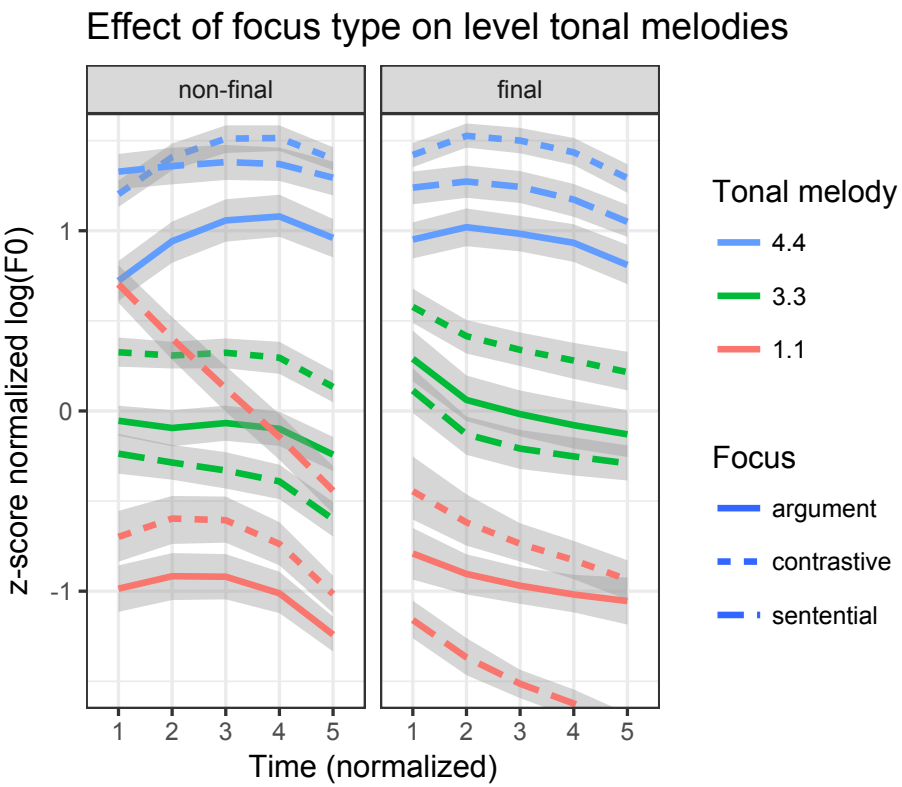
Results: Falling and complex melodies

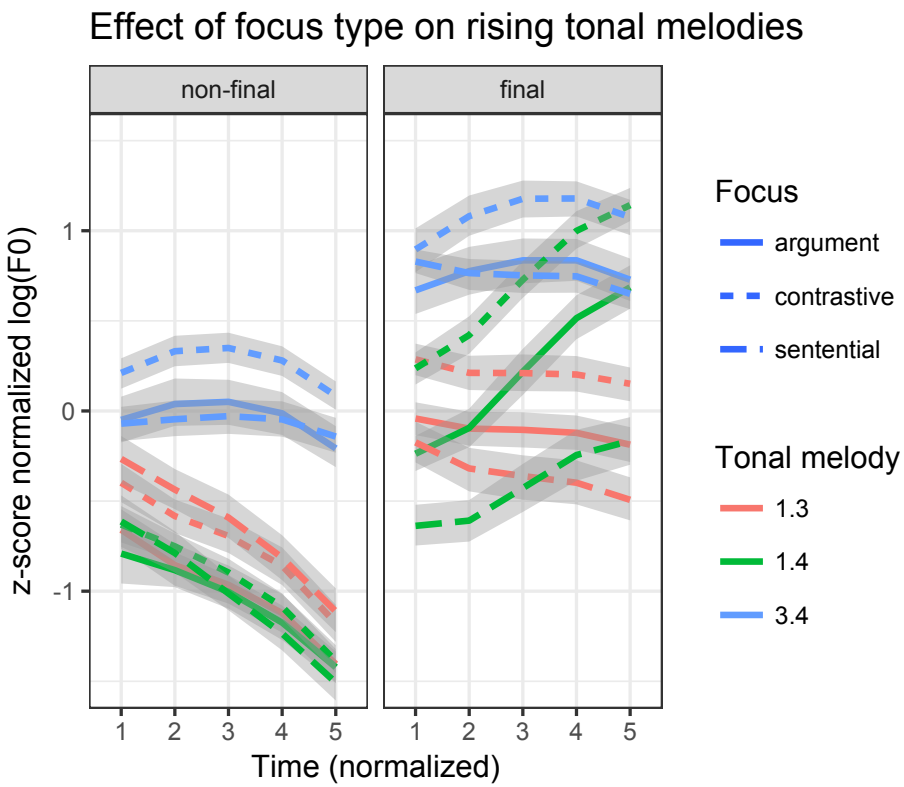




Results: Tone - comparative

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





Discussion: duration and focus

- Focus lengthens the stressed syllable in YM, but more on the onset than on the vowel. Why?
- In Swedish onsets are lengthened when a syllable contains a phonologically short vowel (Heldner and Strangert, 2001).

Given that all vowels in the CVCV disyllables were short, vowel length may have influenced the domain of prosodic lengthening in YM.

Discussion: tone and focus

- Contrastive focus is distinguished from narrow focus by increased F_0 range and raising of tonal melodies.
- Tones in fronted, focal NPs undergo F_0 range expansion and raising relative to tones in sentential focus.

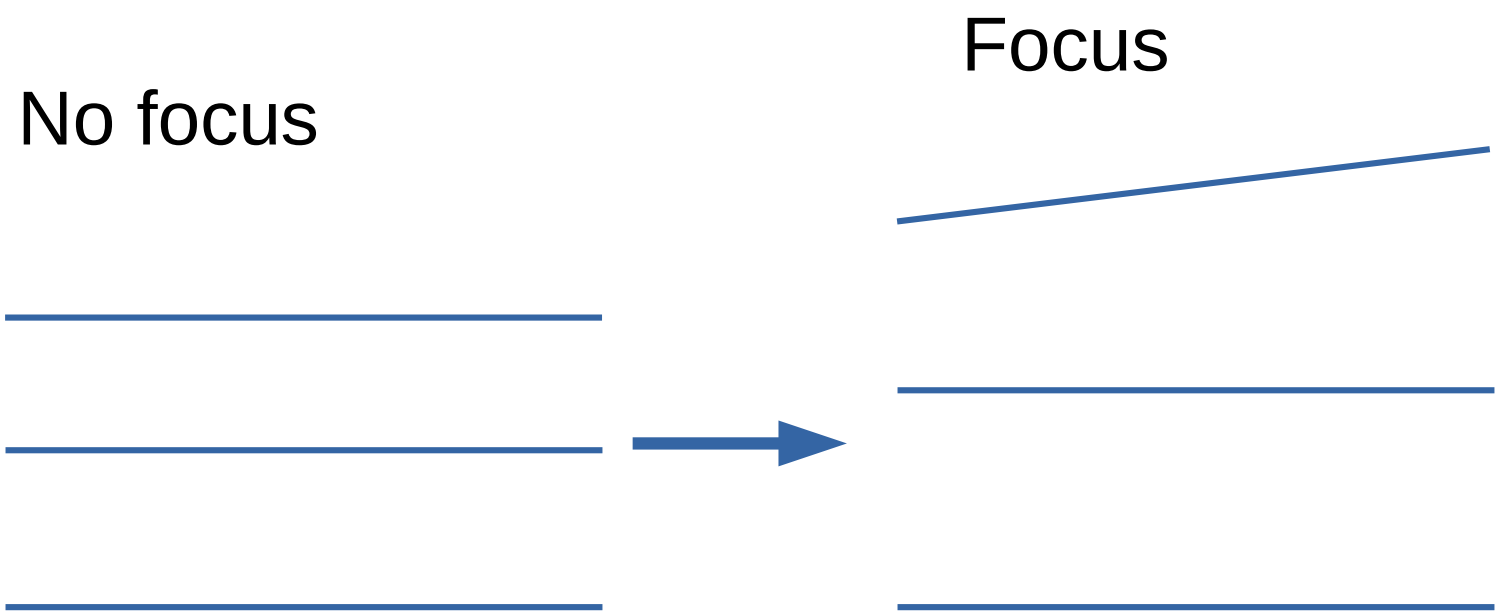
Tonal hyperarticulation, F_0 raising, and range expansion mark focus.

Positional effects

Effect	Tones
Strong focus x position interaction	T1.3, T1.4, T1.42
Weak focus x position interaction	T1.1, T4.4, T4.2, T3.2
No focus x position interaction	T3.3, T3.4

Why initial tone /1/?

- Maintaining the level of /1/ enhances the syntagmatic contrast between it and the following tone.
- The distance between tones in a /1.4/ melody is 2.5x as large under contrastive focus as under sentential focus.
- 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. High vowel displacement functions in a parallel way under different focus conditions (Cho, 2006; Mücke and Grice, 2014).

Part II: Phrase-final phenomena

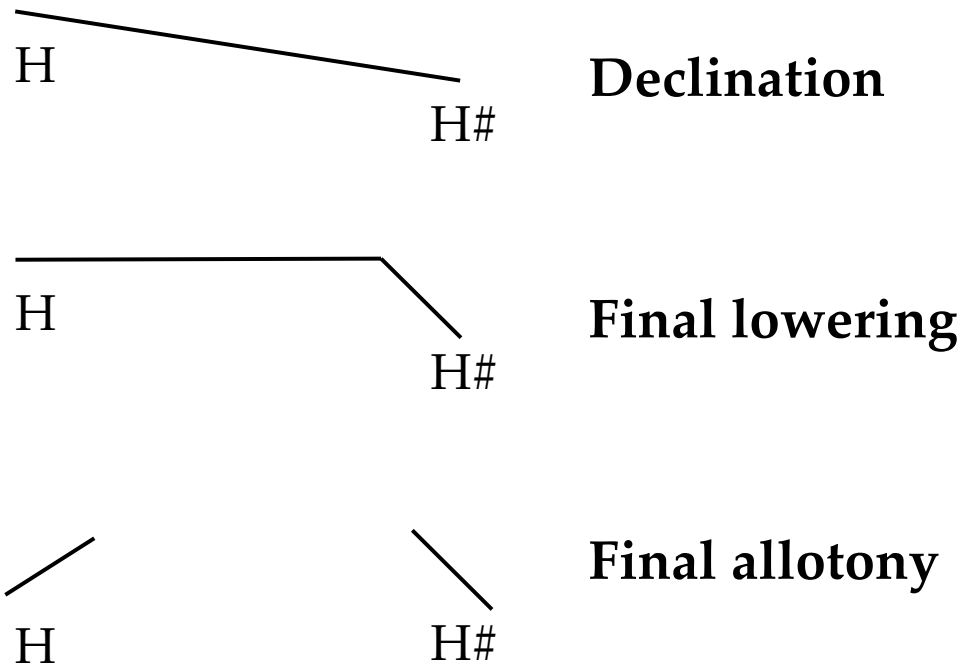
Phrase-final position is a domain of articulatory strengthening (Barnes, 2006; Cho, 2006) and where articulatory gestures may reduce their velocity (Krivokapić and Byrd, 2012).

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

How does one separate domain-final effects from global effects in speech production?

Three possibilities

Impressionistic descriptions of Mixtecan languages mention phrase-final tonal alternations (Pike and Small, 1974; Pike and Wistrand, 1974), but such descriptions do not specify the origin of such effects.



Positional effects

Tone production is sensitive to word and phrasal position.

High > Falling in Diuxi Mixtec (Pike and Oram, 1976)

Low > Low falling in Ayutla Mixtec (Pankratz and Pike, 1967)

In a more complex tonal system, like YM, one anticipates less sensitivity of tone to phrasal position (Connell, 2017).

Declination and final lowering

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).

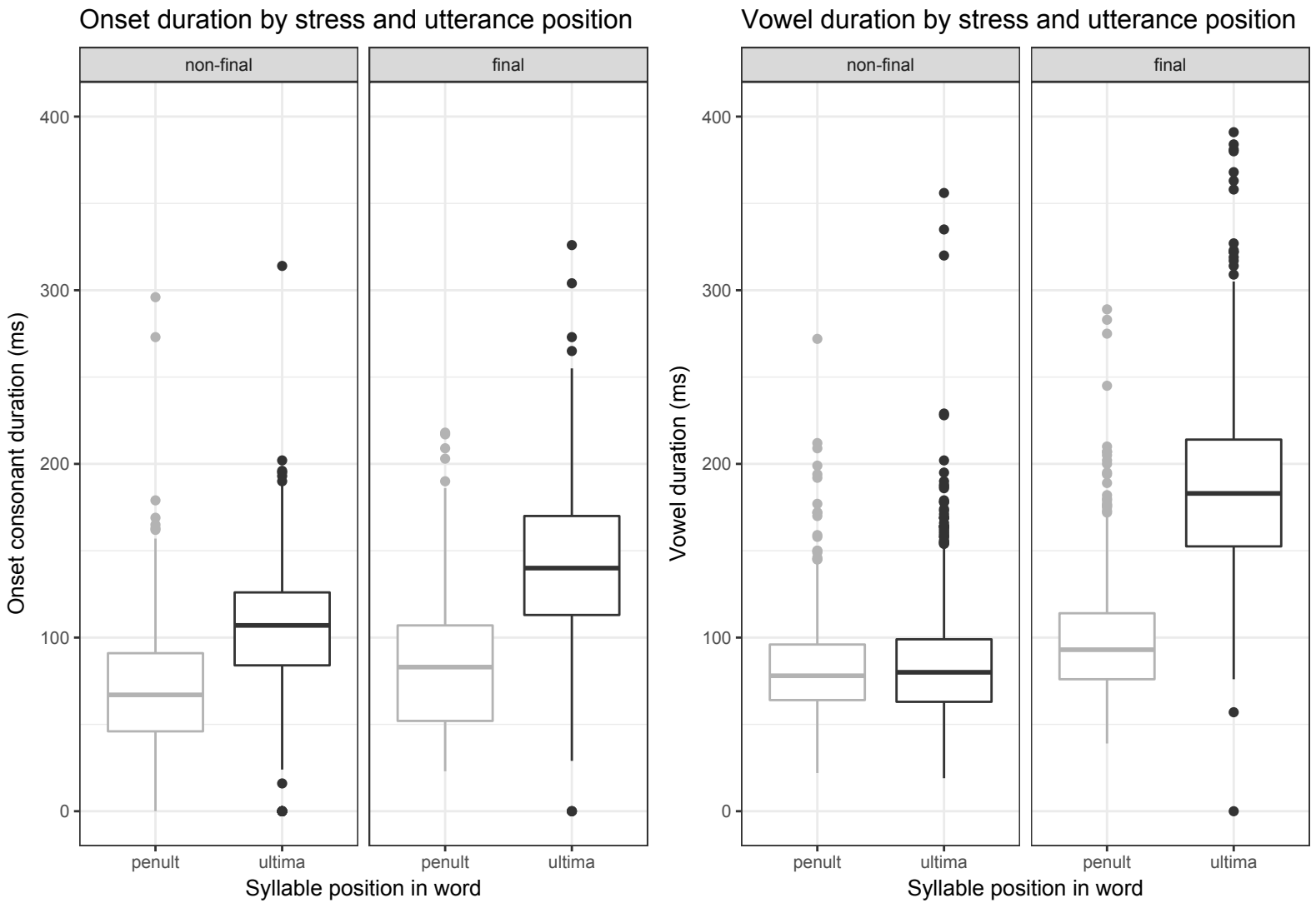
Methods: positional effects on tone

- 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.

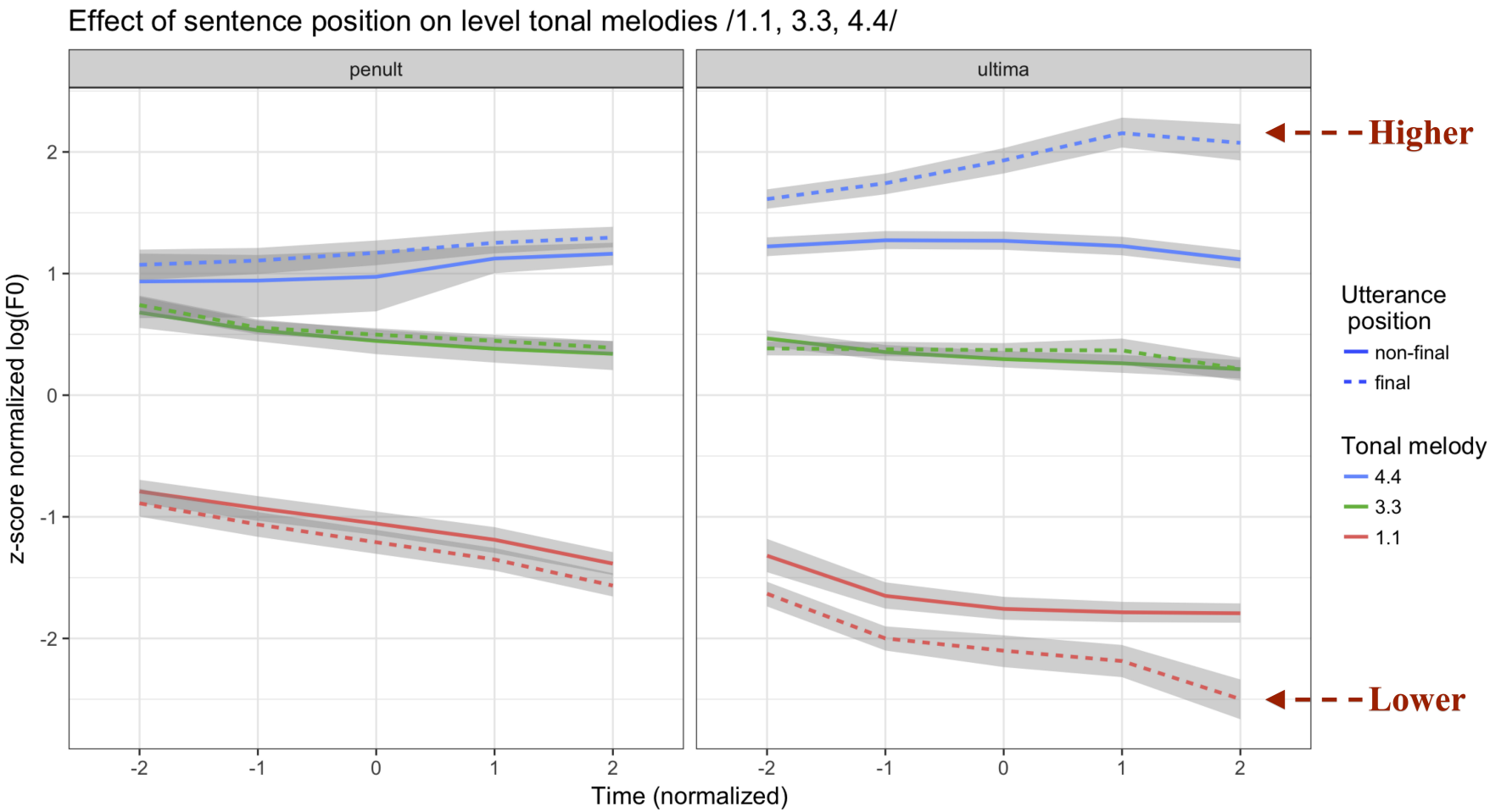
  ʃa^{4}ʃi^{24}=ra^{2} ^{n}di^{3}ʃi^{4} 'He is eating corn.'
  ʃa^{4}ʃi^{24}=ra^{2} ^{n}di^{3}ʃi^{4} βi^{3}tĩ^{3} 'He is eating corn now.'

- 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.

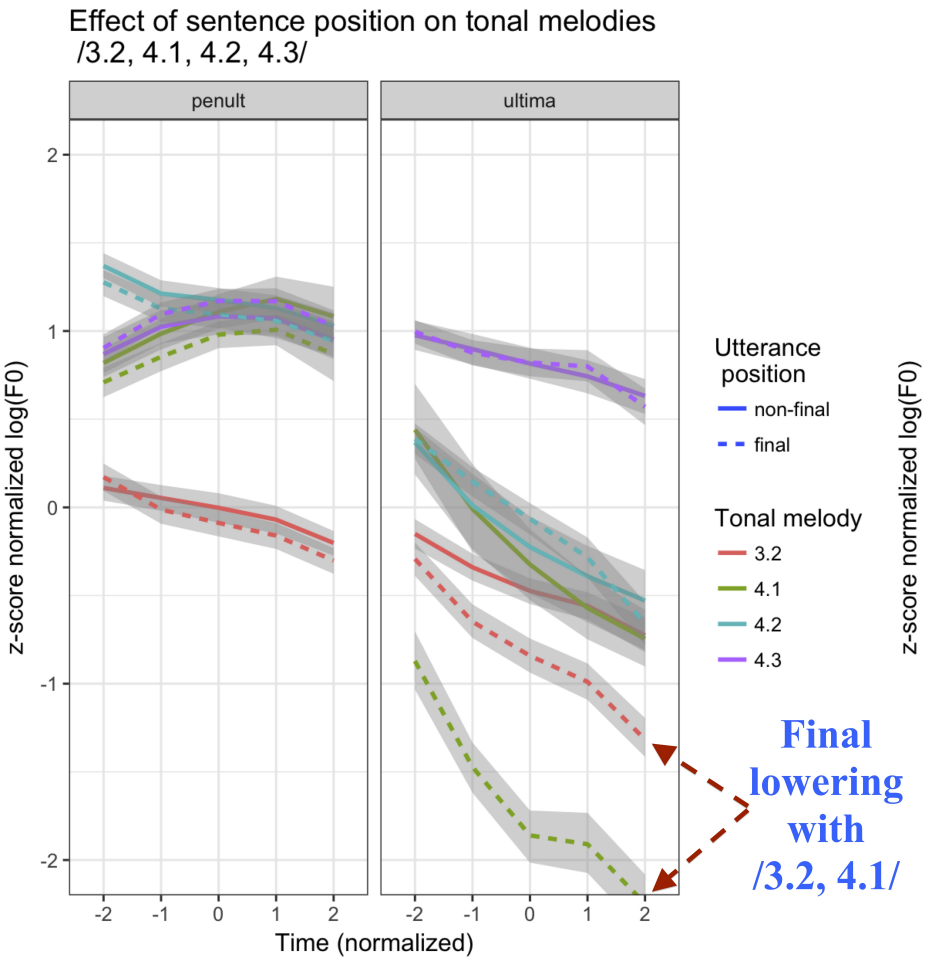
Results II: duration

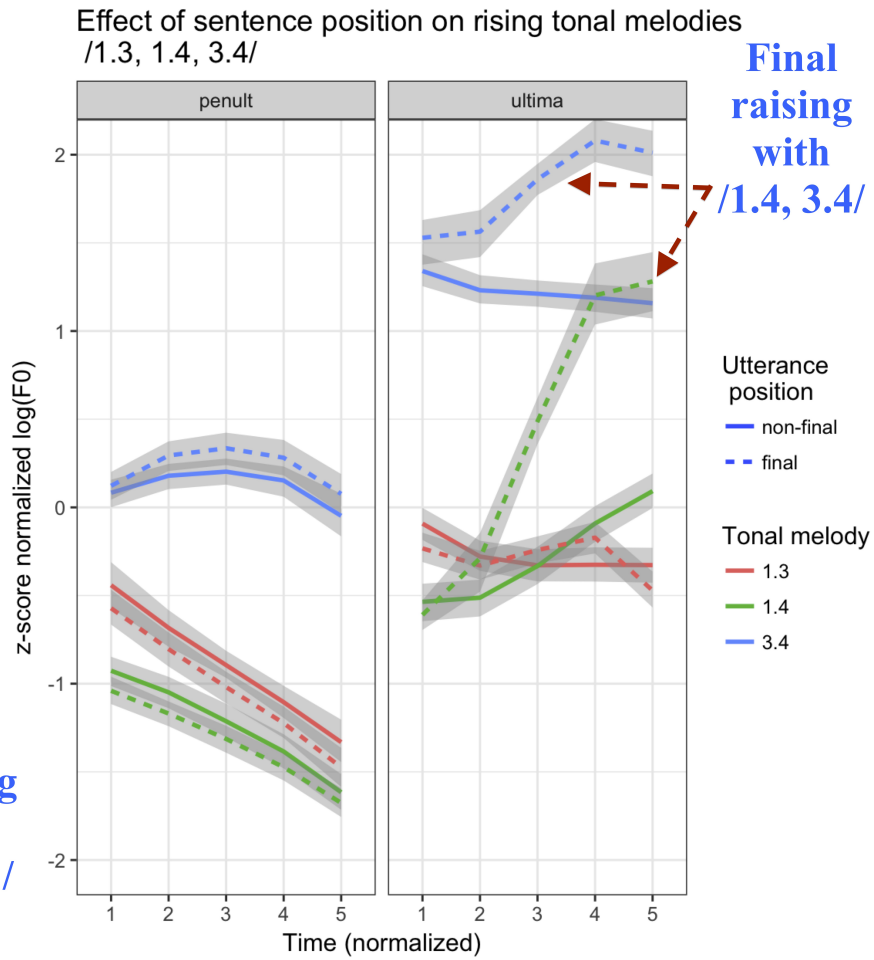


Results II: level tone melodies

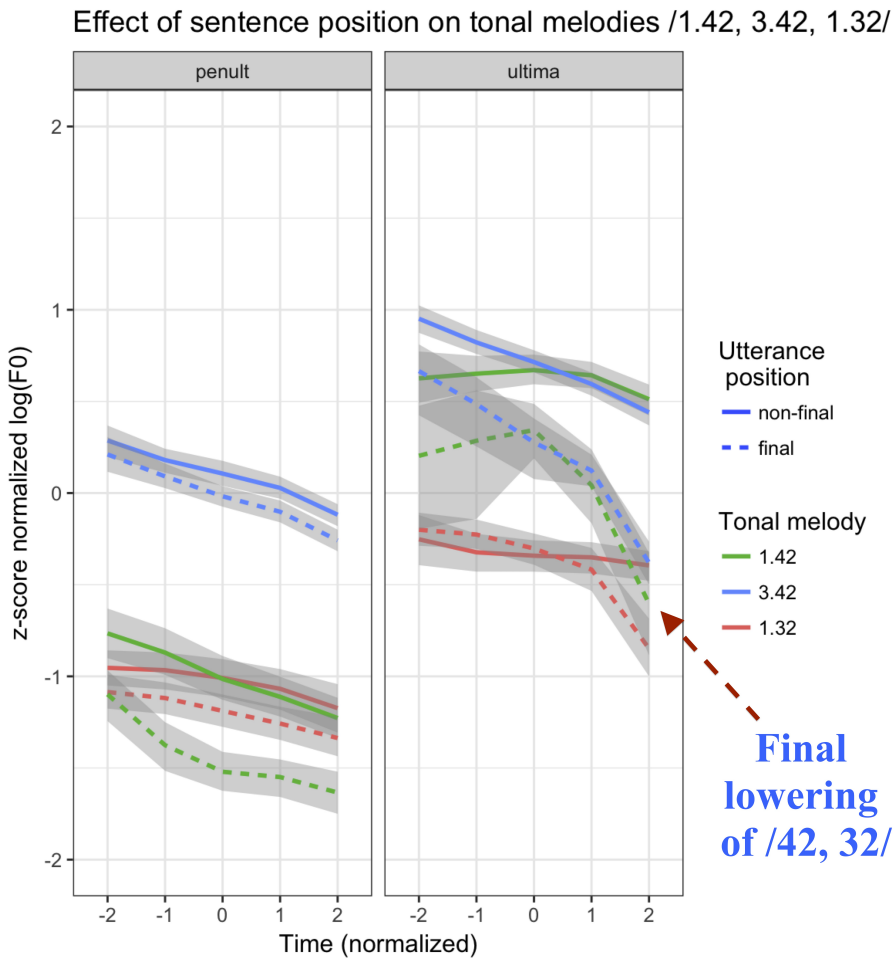


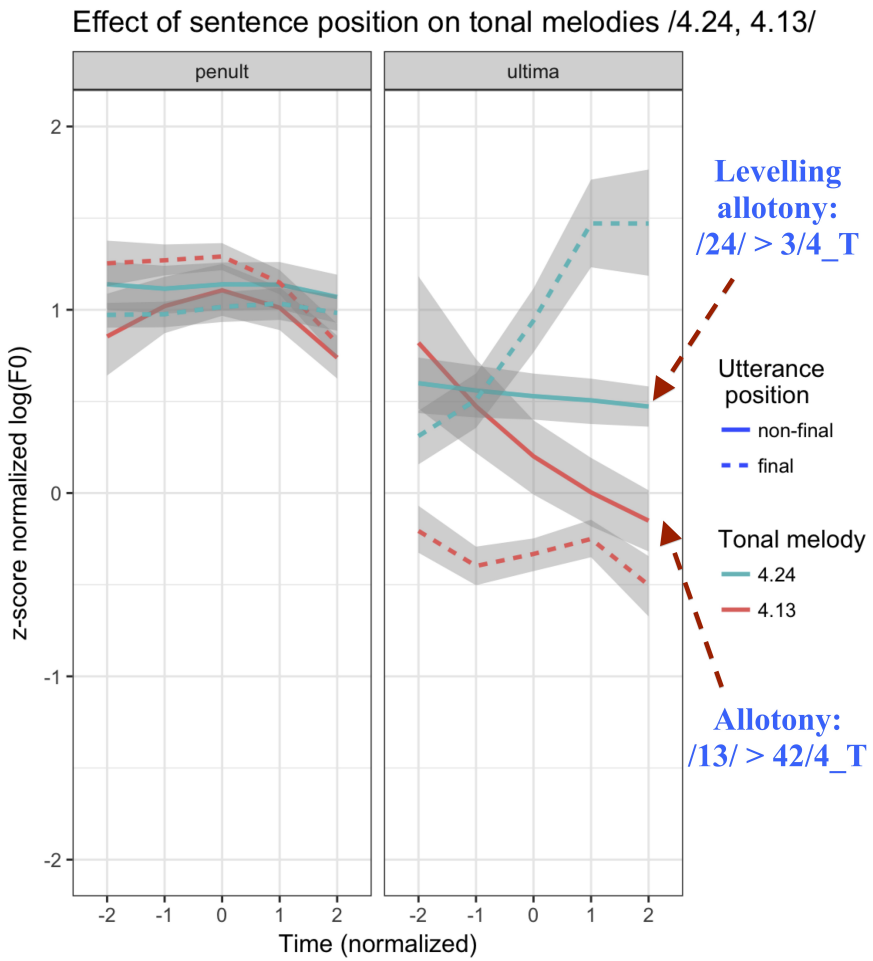
Results II: falling and rising melodies





Results II: melodies with final contours





Discussion - experiment 2

1. Tone /4/ undergoes final raising.

2. Tone /3/ does not change.

3. Final lowering occurs only for lower register tones. Tones /2, 1/ and falling tones /42, 32/ lower in utterance-final position.

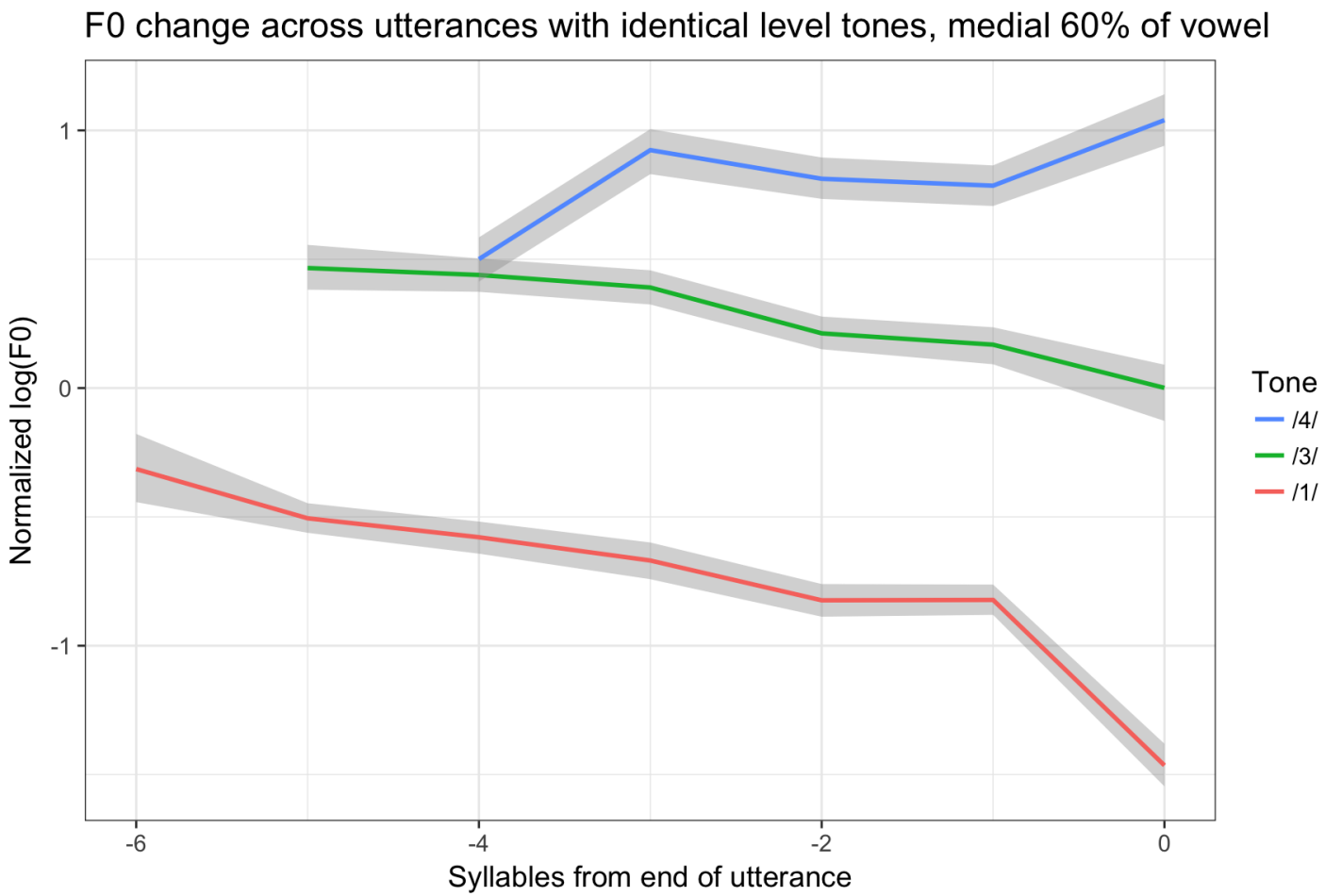
4. Rising tones ((/13, 24/) have distinct allotones in non-utterance-final position.

Methods: Declination

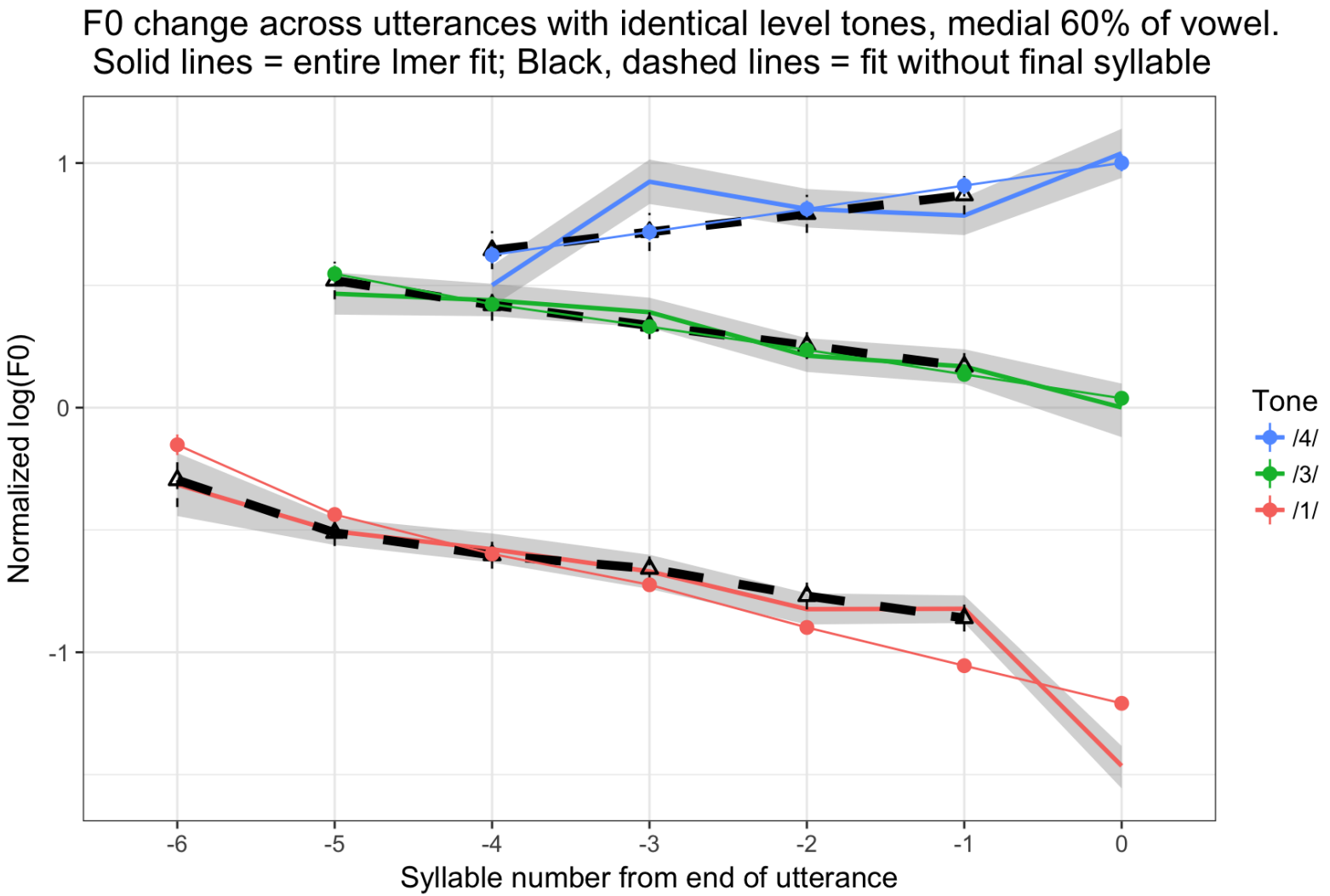
- We analyzed sentences that consisted of only level tone sequences.
- 10 sentences between 4-7 syllables in length; 2 with tone /4/, 4 with tone /3/, 4 with tone /1/.
- 10 sentences x 4 repetitions; 9 speakers.
- Initial transcription in ELAN and segmentation in Praat. We used a script to analyze F_0 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/.



Resultados - declination modelling

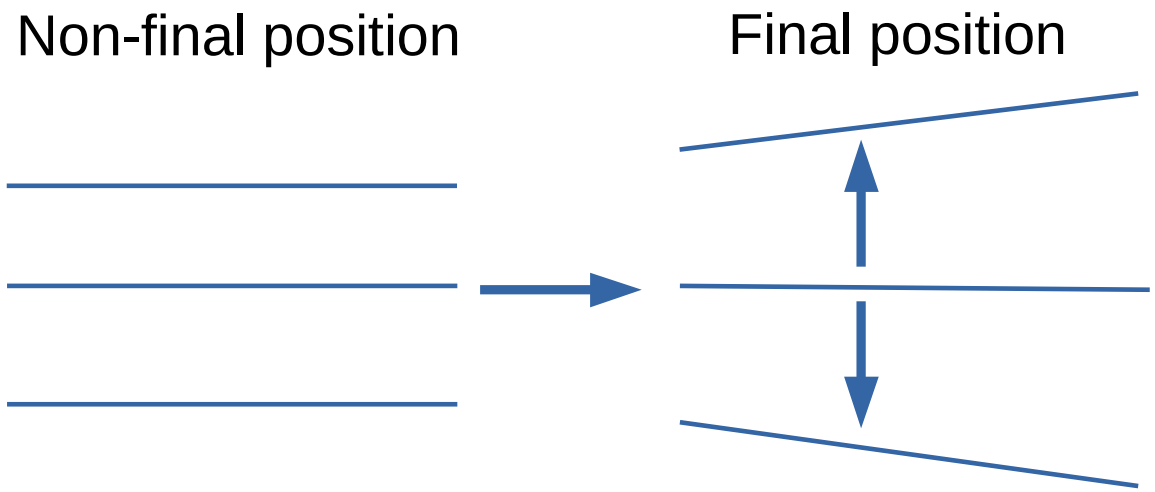


Declination, final lowering, or allotony?

- All of them occur in YM!
- Final raising occurs with tone /4/, final lowering occurs with lower register tones; declination occurs with tones /3/ and /1/; and positional allotony occurs with rising tones /13, 24/.
- Declination is a distinct phenomenon from final lowering.

Are there 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/.

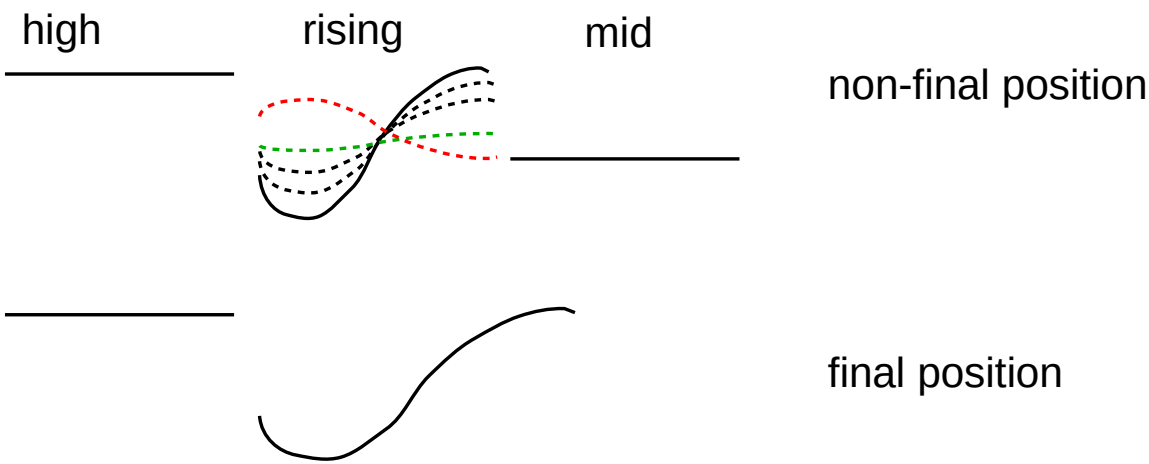


Tonal changes in utterance-final position result from tonal hyperarticulation which expands the tonal range (Krivokapić and Byrd, 2012).

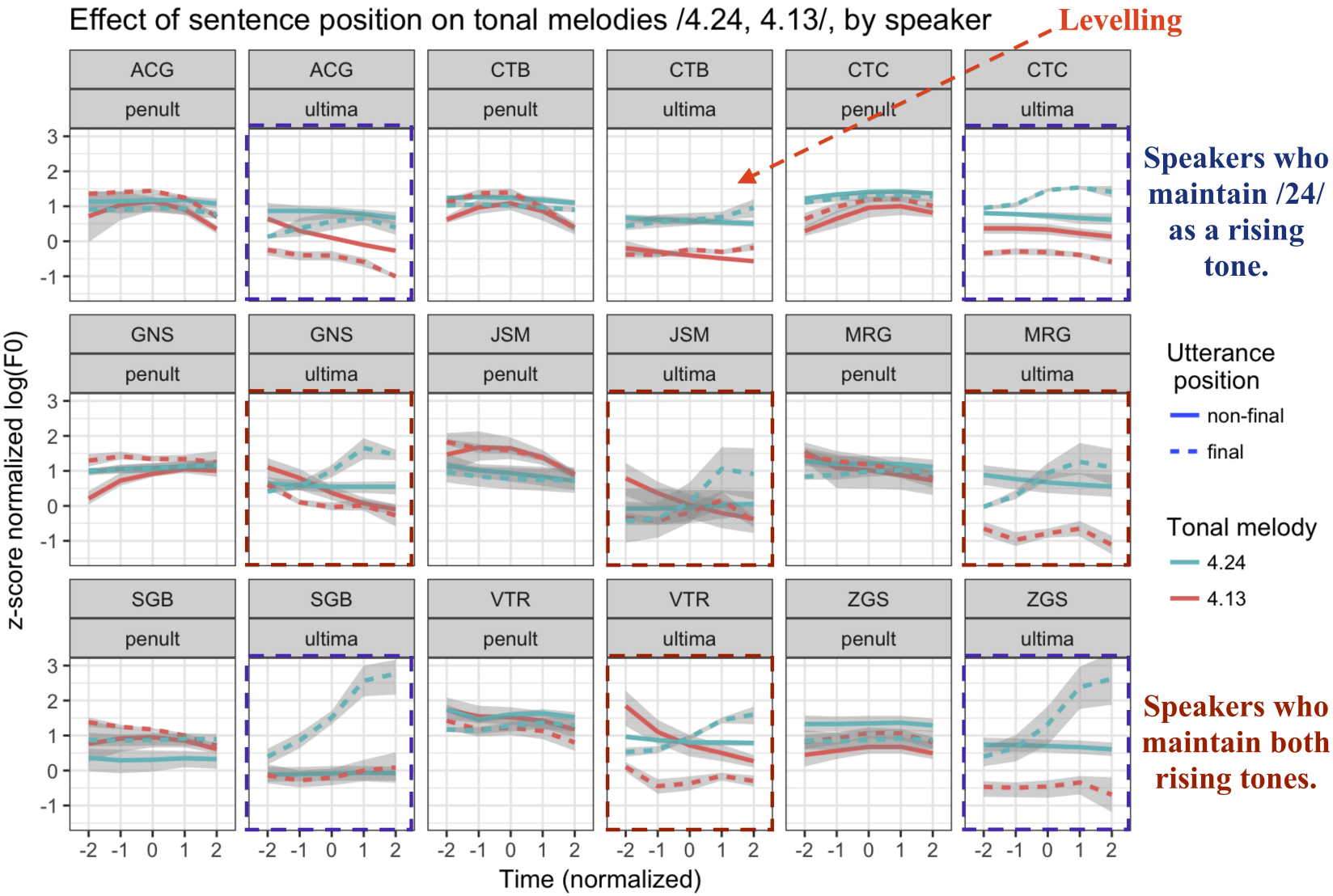
Final allotony

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).



Variation in the production of rising tones



Conclusions I

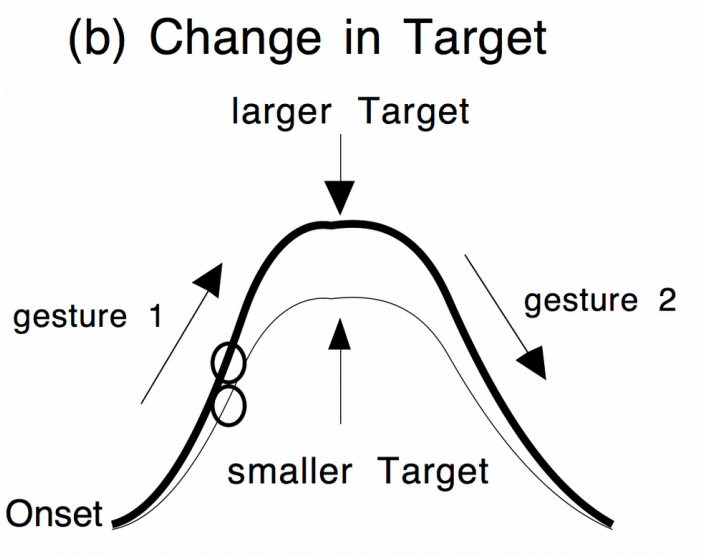
Both narrow focus (at utterance-initial position) and utterance-final position involve tonal range expansion and hyperarticulation.

The *type* of range adjustment differs with respect to low tones. Final lowering occurs with low or falling tones in utterance-final position, but no active lowering occurs for low tones under focus.

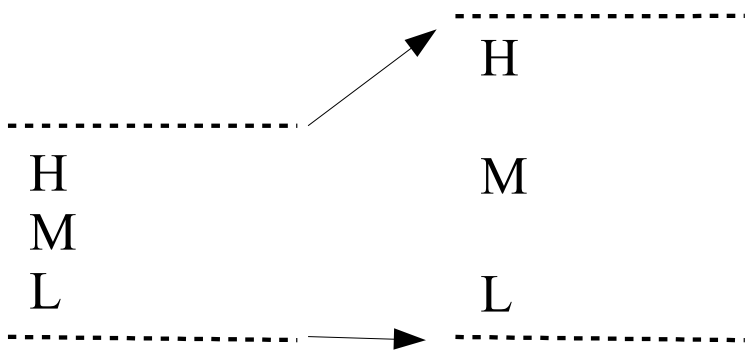
Phrase-final effects occur in addition to range expansion.

Conclusions II

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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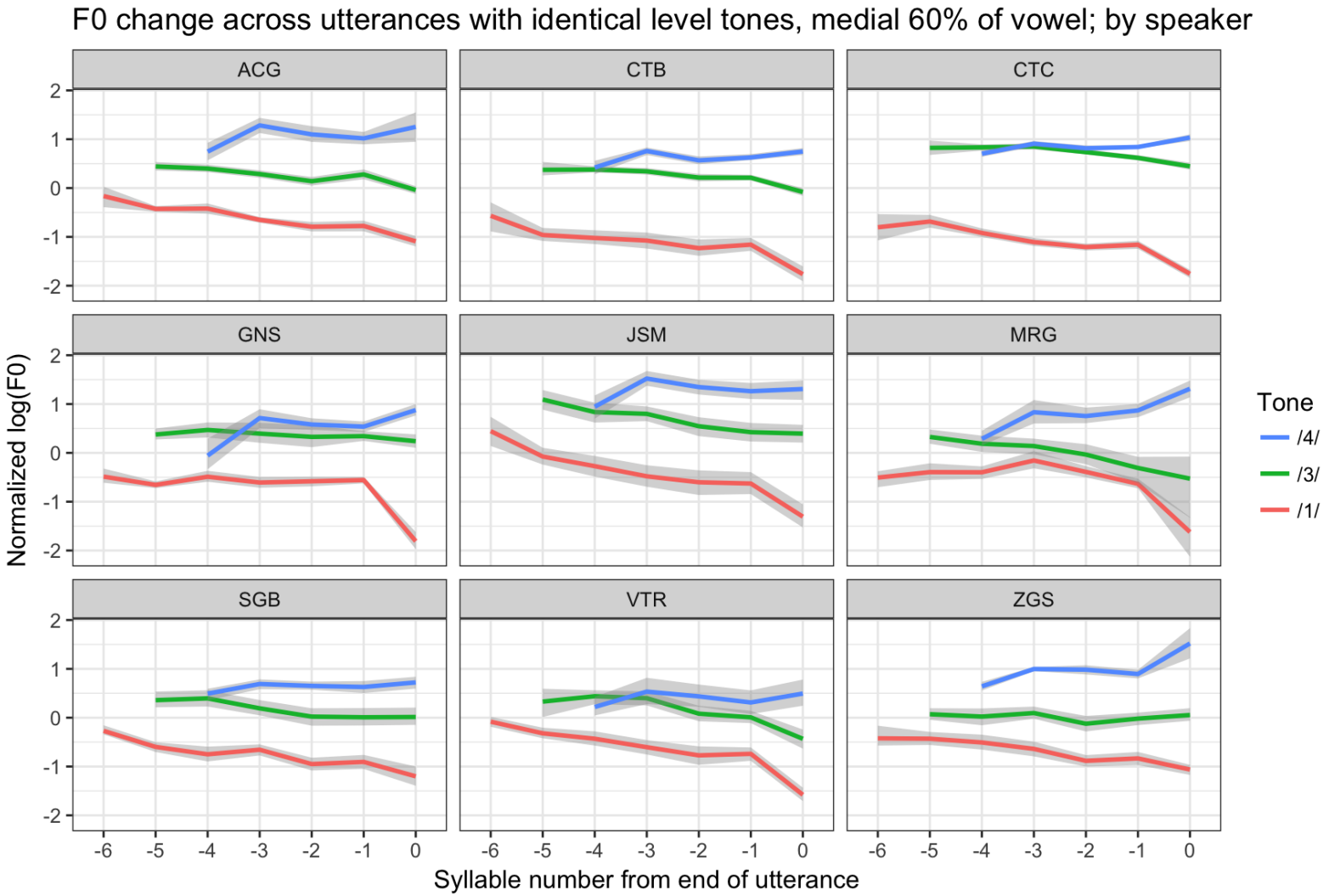
WHERE DISCOVERIES BEGIN

Results - declination by speaker



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).

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