Situating Blackfoot within a typology of (mobile) boundary tone grammars

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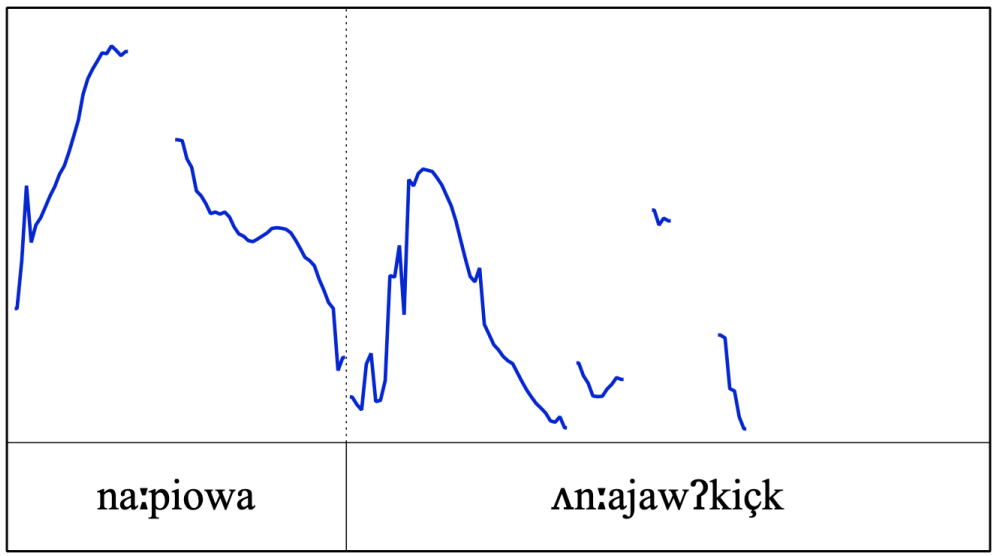
Static vs. mobile boundary tones

What makes a boundary tone a boundary tone?

1. a tone which *anchors to an edge* syllable
2. a tone which *co-occurs* with a prosodic domain boundary
   - potentially dock to a non-edge syllable
   - “mobile boundary tones”

The Blackfoot LHL

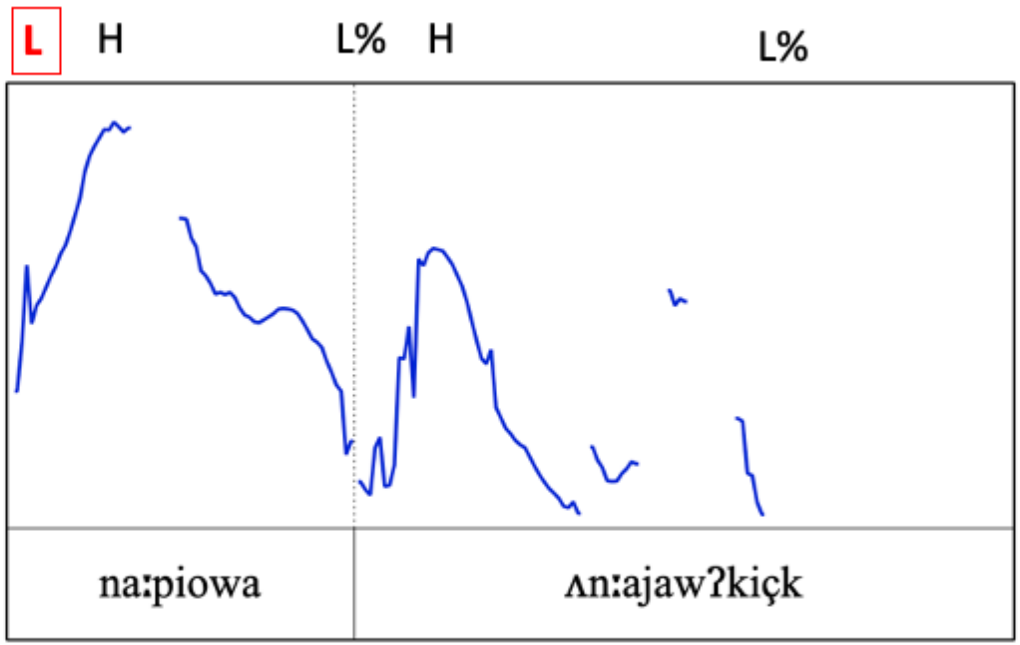
- Pitch contours in Blackfoot (Algonquian; Frantz 2017):
  - rise to a pitch peak on the main stress of a prosodic domain
  - fall to the right edge of prosodic domain



(Miyashita & Weber 2020, Van Der Mark 2003, Weber 2016, 2020)

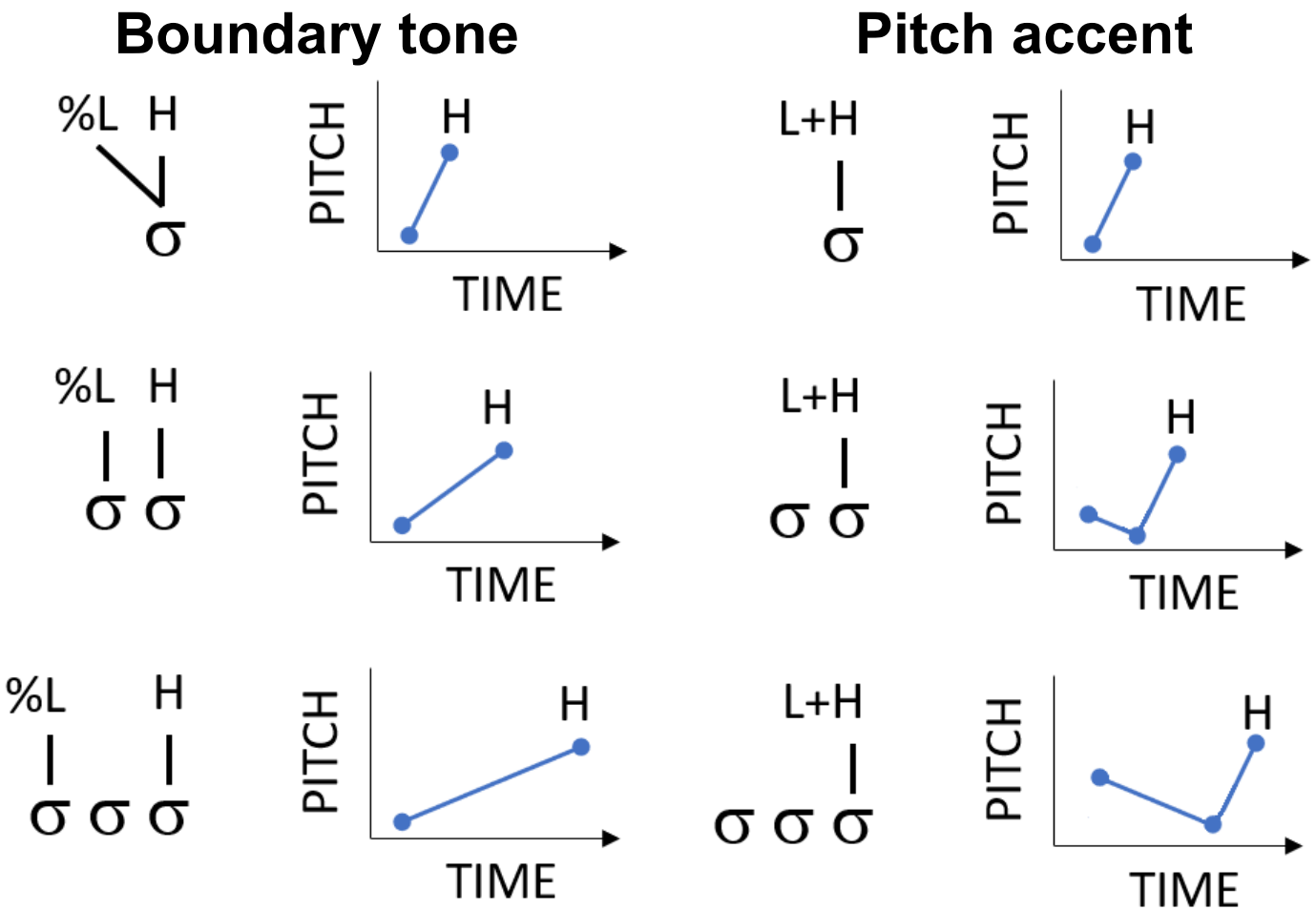
Research question

- Assumptions: the pitch contour is due to a sequence of LHL targets, where
  - the H docks to the stressed syllable
  - final L is a static boundary tone (Miyashita & Weber 2020)
- Q: what is the phonological status of the initial L target?



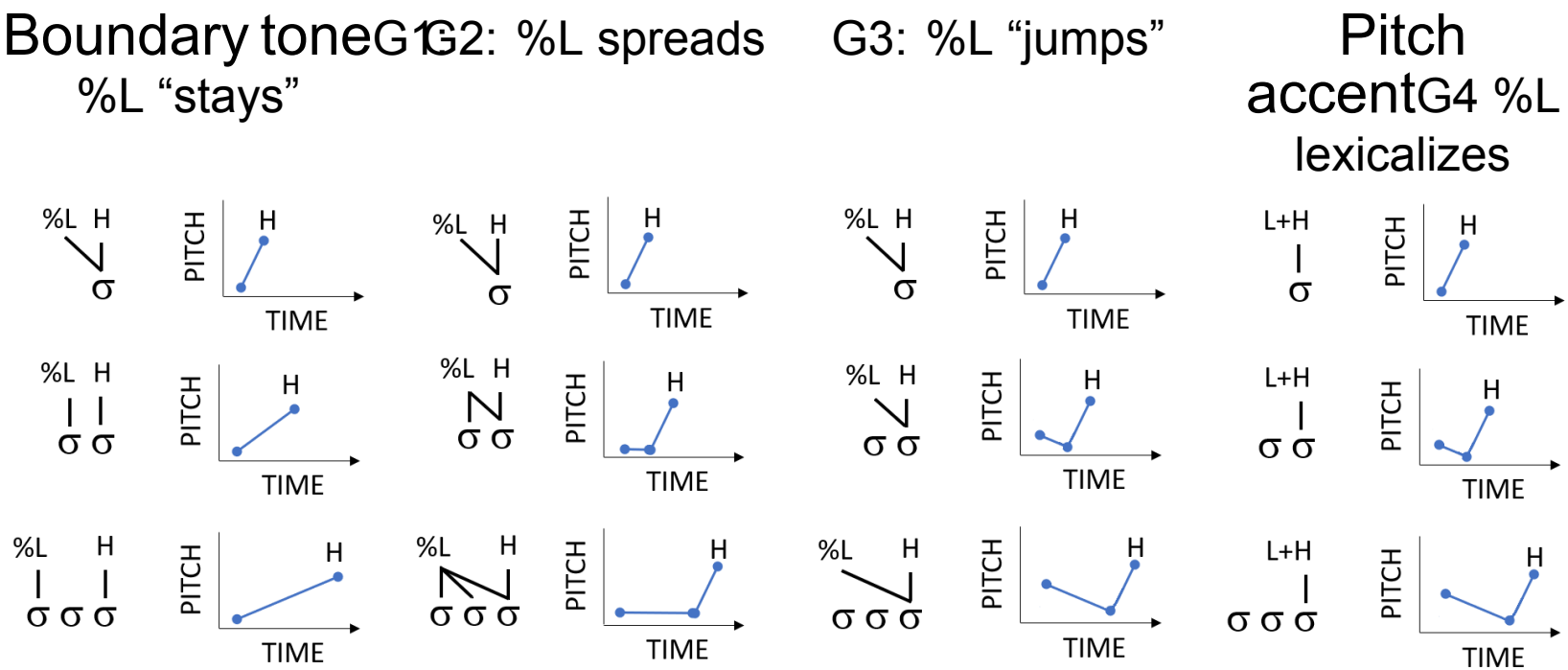
Hypotheses and predictions: static tones

Phonological status of the L dictates variation in: pitch slope and L timing.



Hypotheses and predictions: mobile tones

- Static tone grammars are two cells of a typology.
- A tone might *co-occur* with a boundary but *surface* elsewhere.



Summary of predictions

pitch slope from L to H

- varies with stress position — G1 (%L “stays”)
  (greatest in words with 1σ stress;
  smaller in words with stress on a later syllable)
- stable across stress position — G2–G4

timing of initial L target

- consistent across stress position — G1 (%L “stays”) and G2 (%L spreads)
- varies with stress position — G3 (%L “jumps”) and G4 (%L lexicalizes)
  (earliest in words with 1σ stress;
  later in words with stress on a later syllables)

Overview of aims

- **descriptive**: to establish the phonological status of the L pitch minimum via quantitative analysis of f0.
- **typological**: to situate Blackfoot within a typology of intonational grammars that vary in how pitch targets introduced by prosodic domains dock to segmental strings.
- **theoretical**: to argue for the existence of mobile boundary tones.

Outline

Data collection methods

Participants

- Eight native speakers of Blackfoot (four male; four female) between the ages of 50 and 70 at time of recording.
- All participants reside on the Káínai Blackfoot reservation.
- Like most Blackfoot speakers (Genee & Junker 2018), the participants in our study use English in their daily lives, and can be characterized as English-dominant bilinguals.
- Several participants are teachers of the Blackfoot language in a school setting.

Materials

- Six words (three nouns, inflected for singular and plural).
- Two repetitions of each.
- Stems differ in stress position: 1st, 2nd, or 3rd syllable (σ).
  - Independent variable: stress position
  - Dependent variables: pitch slope, L timing

Table: Target singulars and plurals

Stress (σ)	Stem	Gloss	Singular	Plural
1	/ˈmiːn-/	'berry'	[ˈmiː.ni]	[ˈmiː.nists]
2	/maˈminː-/	'wing'	[ma.ˈmɪn.ni]	[ma.ˈmɪn.nists]
3	/napaˈjin-/	'bread'	[na.pa.ˈji.ni]	[na.pa.ˈji.nists]

Procedure

Speakers were asked at the beginning of the study to produce each word in a frame sentence.*

(1) *nitsíini'pa anní ____ matónni*
I.saw.it that(inan) ____ yesterday

'I saw that ____ (inan., sg.) yesterday'

(2) *nitsíini'pi anníistsi ____ matónni*
I.saw.them those(inan) ____ yesterday

'I saw those ____ (inan., pl.) yesterday'

(*Some speakers preferred to create a new sentence for each word.)

Procedure

Pictures prompted either a singular or plural noun.

napayiini ‘bread’

Procedure

The picture prompts for plural nouns simply double the image.

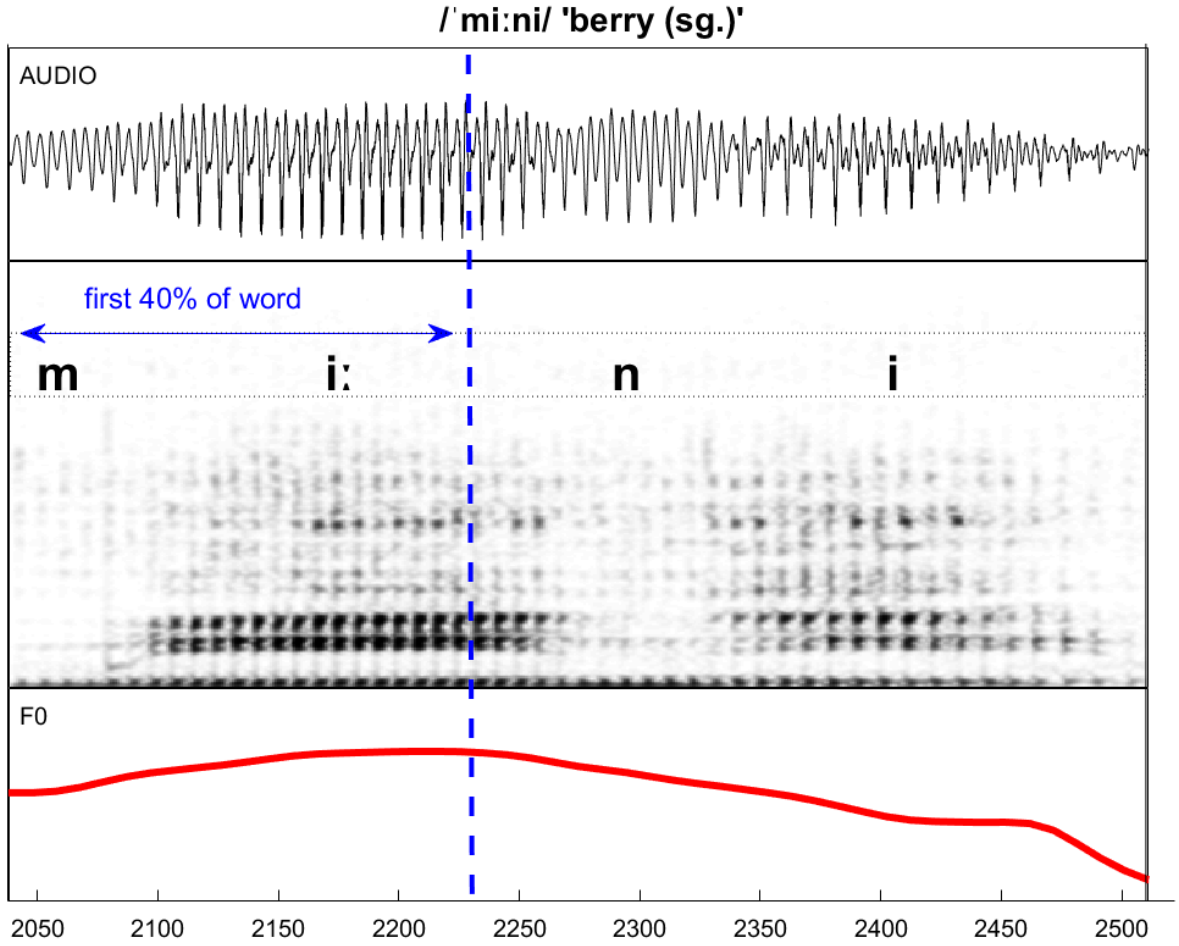
napayiini ‘bread’

Processing and analysis

Pitch tracking

f0 extrema extracted by Praat script (Boersma & Weenink 2021)

- f0 minima in the first 40% of the word, to represent L
- f0 maxima that followed the minima, to represent H



Dependent measures

"Pitch slope = rise magnitude / rise time"

1. Rise time: $\Delta t^{H-L} = H\_time - L\_time$, where
   - Timing of L tone: $L\_time = t^{L}/(t^{e} - t^{s})$
   - Timing of H tone: $H\_time = t^{H}/(t^{e} - t^{s})$
2. Rise magnitude: $\Delta f0^{H-L} = (f0^{H} - f0^{L})$
3. Pitch slope: $P^{\text{slope}} = \Delta f0^{H-L}/\Delta t^{H-L}$

…calculated as a percentage of total word duration, where

- t^{L} is the timestamp in milliseconds of the L tone;
- t^{H} is the timestamp in milliseconds of the H tone;
- t^{s} is the timestamp of the start of the word; and
- t^{e} is the timestamp of the end of the word

The f0 measures were z-score normalized by speaker (Rose 1987) and outliers excluded (5 tokens).

Analysis

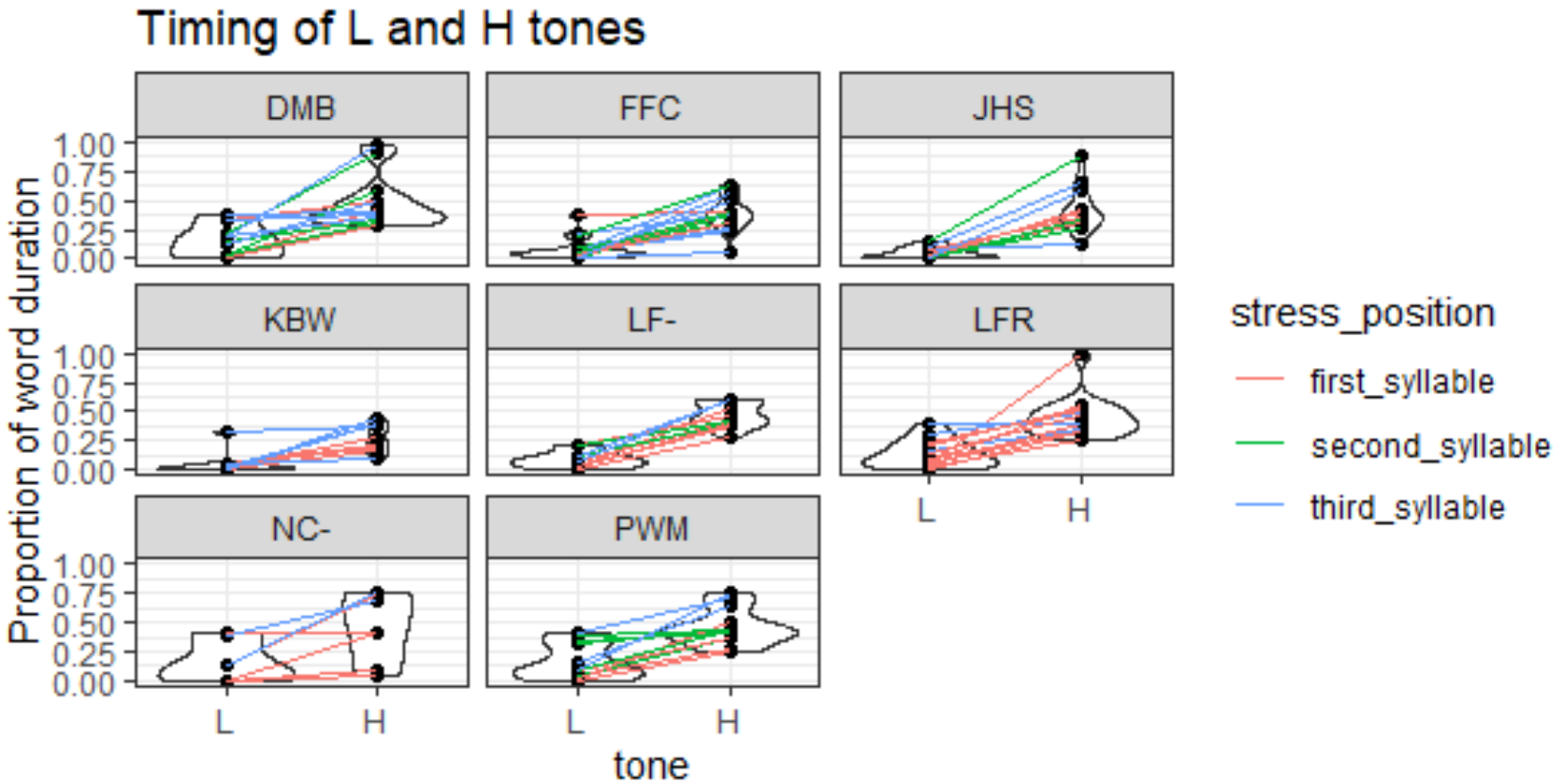
We fit nested linear mixed effects models to statistically assess the effect of stress position on: (1) **pitch slope** (2) **timing of initial L**

- To a baseline model including only a random intercept for speaker, we added the fixed effect of **stress position**.
- determined statistical significance through model comparison via a likelihood ratio test and AIC.
- Stress position was contrast coded, with first syllable stress as the reference level.
- Models fit using LmerTest package (Kuznetsova et al., 2017) in R (version 4.0.3).

Results

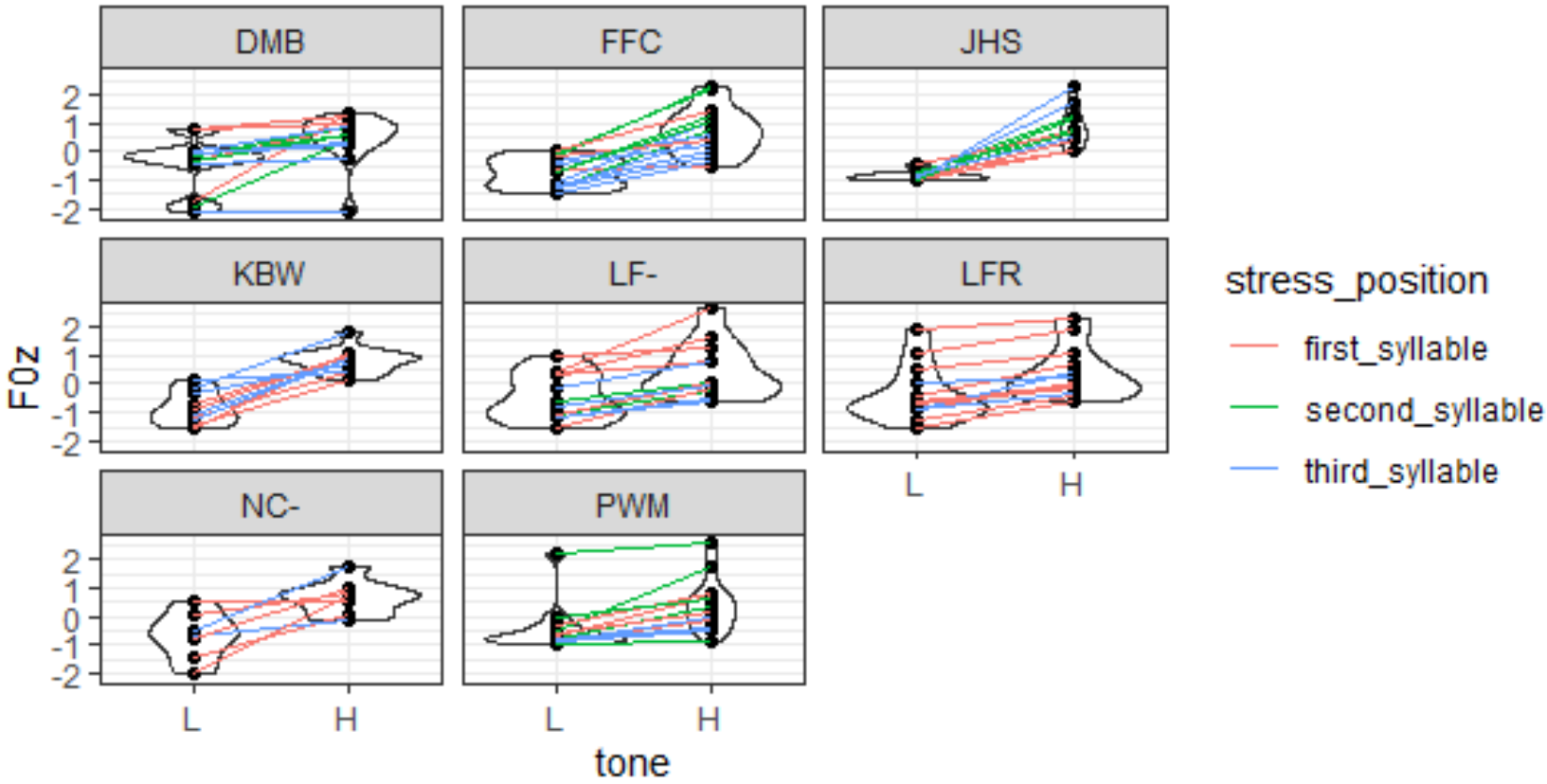
Rise time

Data check: a pitch maximum follows each pitch minimum.



Rise magnitude

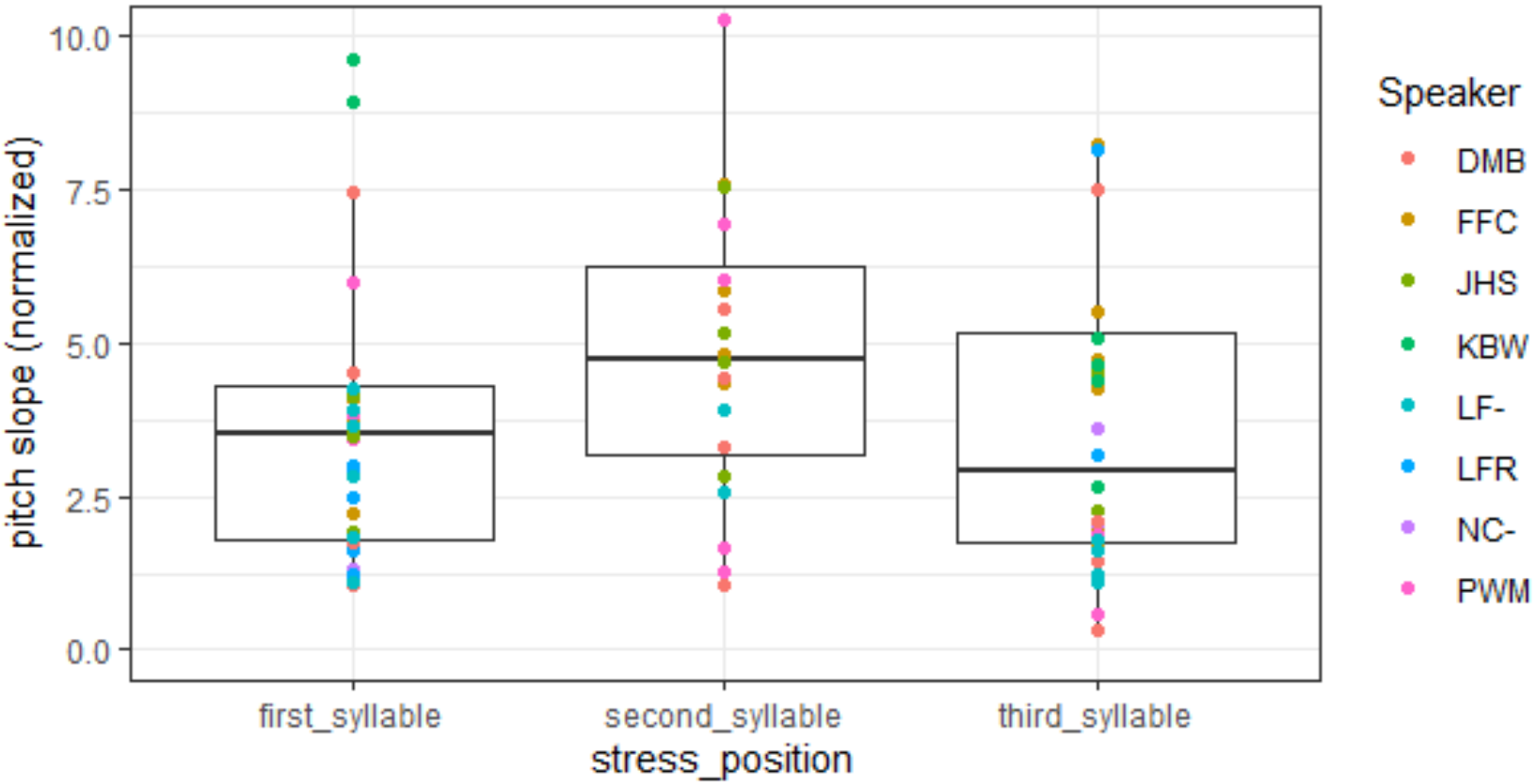
Data check: L tends to fall in low pitch range; H in high range.



*Our interest is in the relation between the rise time and rise magnitude (**pitch slope**) as stress position varies.*

Pitch slope

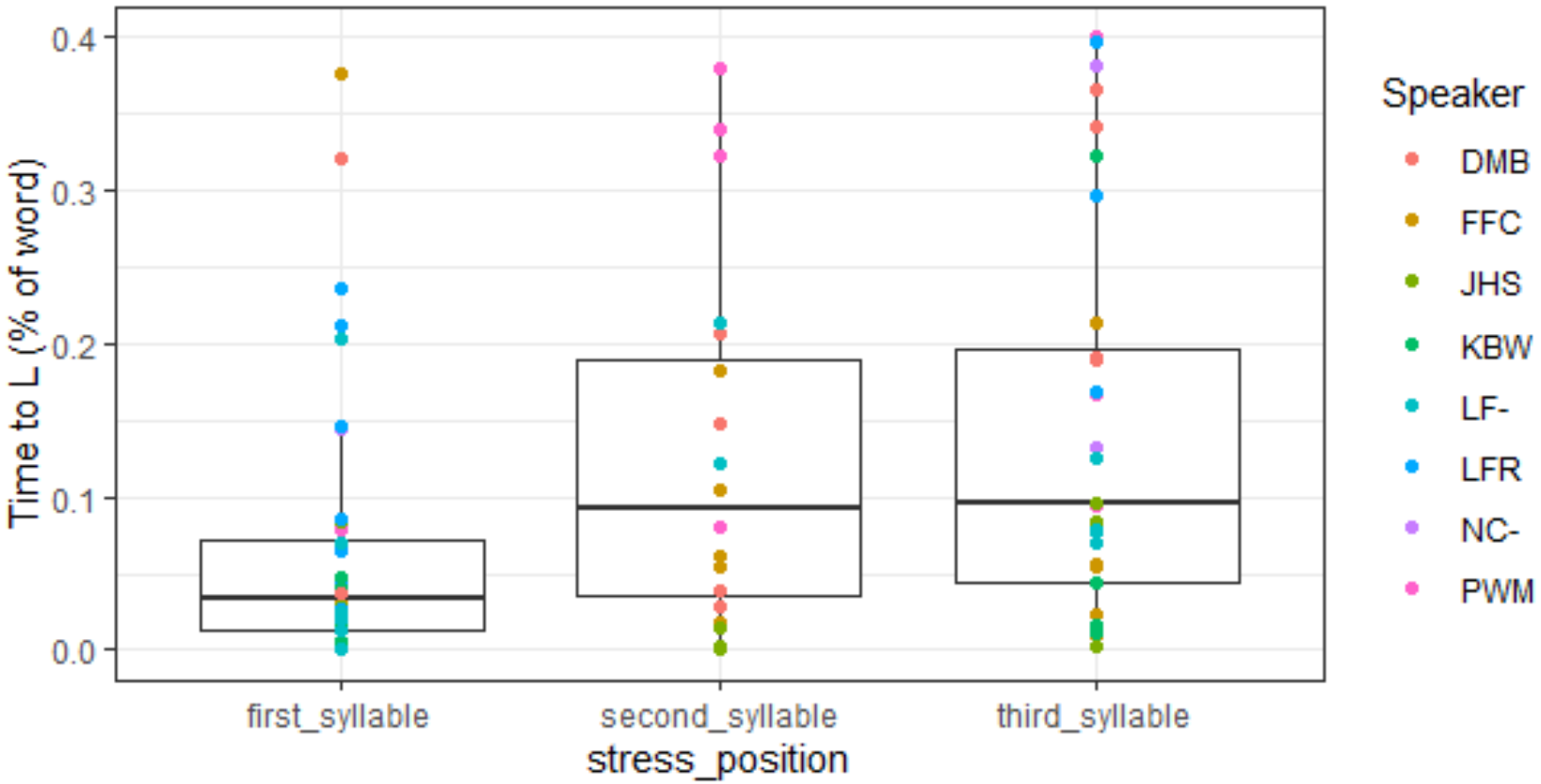
Adding stress position does not improve the model
(χ^2 = 2.43, p = 0.30; AIC increases from 756 to 758)



Inconsistent w/ G1 (%L “stays”); G2-G4 OK

Timing of initial L

- Stress position significant (χ^2 = 11.63, p = 0.003; AIC decreased from -132.9 to -140.5).
- L tone starts later on words with later stress: 2nd syllable (β = 0.07, p = 0.03); 3rd syllable (β = 0.09, p = 0.0001).



Inconsistent w/ G1 (%L “stays”) & G2 (%L spreads); G3-G4 OK

Summary of results

pitch slope from L to H

- ✗ ~~varies with stress position~~ ~~G1 (%L "stays")~~
  ~~*(greatest* in words with 1σ stress;~~
  ~~smaller in words with stress on a later syllable)~~
- ✓ stable across stress position G2–G4

timing of initial L target

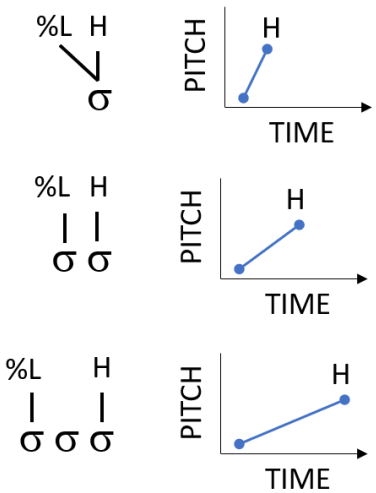
- ✗ ~~consistent across stress position~~ ~~G1 (%L "stays")~~
  ~~and G2 (%L spreads)~~
- ✓ varies with stress position G3 (%L "jumps") and
  (earliest in words with 1σ stress; G4 (%L lexicalizes)
  later in words with stress on a later syllables)

Word prosodic typology

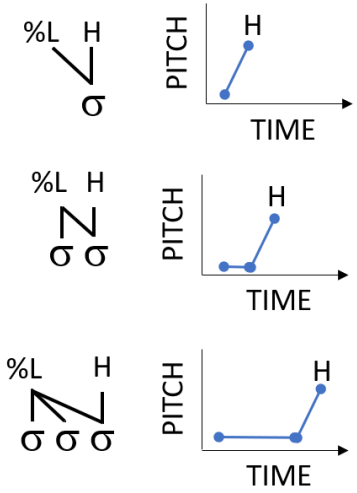
Compatible grammars with Blackfoot pitch patterns

Incompatible

G1: %L "stays"

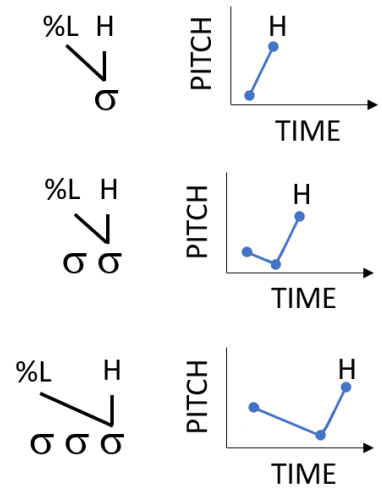


G2: %L spreads

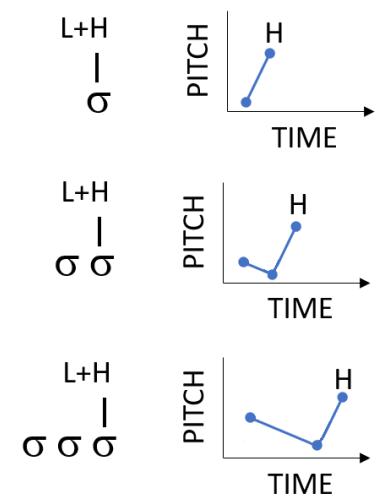


Compatible

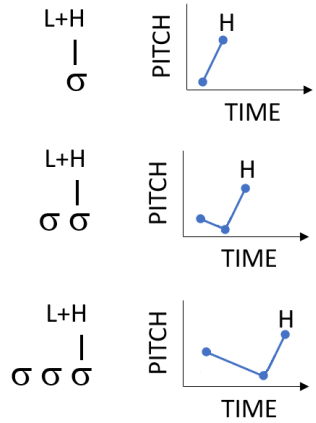
G3: %L "jumps"



G4: %L lexicalizes



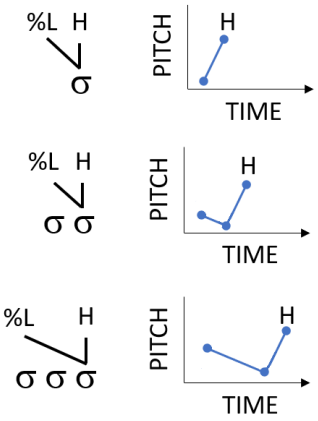
Against G4 (%L lexicalizes)



- Tonogenesis! (L+H pitch accent)
- Expectations:
  - Independent L and H tones
  - Potential contrast with other pitch accents
- Reality:
  - L+H vs. Ø
  - H is not independent
    - occurs only as part of the manifestation of stress
    - higher f0 (“H”), longer duration, greater intensity)
  - No contrast with L, L+H, H+L, …
- Conclusion: L+H is not lexicalized

(Kaneko 1999, Van Der Mark 2003, Weber 2016, 2020, Stacy 2004)

Blackfoot has G3 (%L “jumps”)



- No tonogenesis
- H: is epenthesized; docks to stressed syllable
- %L: required by the prosodic domain
  - co-occurs with a boundary
  - but “jumps” to the stressed syllable
  - e.g. a “mobile boundary tone”!

- The prosodic domain which co-occurs w/ %L is highly active elsewhere in Blackfoot grammar.
  - Domain for: epenthesis, vowel coalescence, stress.
  - Left edge prohibits glides
  - Domain-restricted processes: /t/ → [ts] / ___ i

(Elfner 2006, Bliss 2013, Weber 2020)

Analysis for Blackfoot (%L “jumps”)

1. Stress-H (Str-H): Stressed syllables must have an H tone.
2. Boundary-L (Bndry-L): There must be a L tone for every boundary.

3. Align-T-$^{\text{l}}\sigma$ (Al-T-$^{\text{l}}\sigma$): Each tone should align with a stressed syllable.
4. Align-T-L (Al-T-L): Each tone should align with the left edge of the domain.

5. Dep-Link(T): Don’t add association lines between TBUs and tones.
6. Dep-T: Every output tone has an input correspondent.

Analysis for Blackfoot (%L “jumps”)

/ [σ ˈσ /	Str-H	Bndry-L	Al-T-ˈσ	Dep-Link(T)	Dep(T)	Al-T-L
a. [σ ˈσ	*!	*!				
b. H | [σ ˈσ		*!		*	*	*
G1 c. L H | | [σ ˈσ			*!	**	**	*
G2 d. L H ⟍⟋ [σ ˈσ				***!	**	*
☞G3 e. L H ⟋⟍ [σ ˈσ				**	**	**

[= left boundary of prosodic domain

Factorial typology

Grammar	Crucial ranking			Notes
G3: %L “jumps”	Al-T-$^{l}\sigma$, Dep-Link(T)	$>>$	Al-T-L	Enhance salience of $^{l}\sigma$
G1: %L “stays”	Dep-Link(T), Al-T-L	$>>$	Al-T-$^{l}\sigma$	Mark boundary
G2: %L spreads	Al-T-$^{l}\sigma$, Al-T-L	$>>$	Dep-Link(T)	All of the above
G4: %L lexicalizes	Faith	$>>$	Al-T-$^{l}\sigma$, Dep-Link(T), Al-T-L	Faithful to pitch accents

Discussion

Summary

- Phonological status of the L pitch minimum?
  - %L co-occurs with prosodic domain
  - in Blackfoot, this “jumps” to the stressed syllable
- Typology of intonational grammars?
  - Blackfoot is intermediate between static boundary tones and lexicalized pitch accents

Interaction of word and phrasal prosody

We derive Blackfoot pitch contour through the interaction of word and phrasal prosody.

- Word prosody = lexical stress
- Phrasal prosody: emerges from interaction of contraints controlling tone and tone location

This results in the same phonetic intonational pattern as a lexicalized pitch accent

- Ambiguous pitch contours = two possible grammars
- G3 vs. G4 make further testable predictions (ask us!)

Mobile boundary tones

Is a boundary tone still a boundary tone if it doesn't occur at a boundary?

- **Yes** (on our analysis).
- "Boundary tones" emerge because markedness requires a tone for each boundary.
- Location on the surface is dictated by the the grammar.

Acknowledgements

- Thanks to Francis First Charger, John Heavy Shield, Kim Black Water, Leo Fox, Natalie Creighton, Peter Weasel Mocassin, and others who have shared their language with me and literally made this project possible. Nitsíkohtaahsi'taki!
- Phonology Reading Group at Yale (esp. Sarah Babinsky, Sammy Anderson, Chelsea Sanker, Roslyn Burns for helpful comments!)

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Grammar constrains “pathways to change”

- Perhaps some speakers have induced G4 (%L lexicalizes): tonogenesis (Stacy 2004)
- Alternatively, all speakers would *converge* on G3 (%L “jumps”) if there is evidence elsewhere in the input (verbs?)
- Further predictions of G3 (%L “jumps”) could be tested experimentally w/ nonce words (%L on first syllable):
  - G4 predicts: faithful %L production
  - G3 predicts: %L “jumps” to stressed syllable