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OCP Effects in Suffixes with Burmese Creaky Tone

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Laryngeal features and Obligatory Contour Principle (OCP)

- Laryngeal features and dissimilation (OCP)
  - [voice]
    - Rendaku in Japanese (Vance 2015: 397-)
  - [spread glottis]
    - Deaspiration in Attic Greek & Grassman's law (Steriade 1982: 234)
  - [long VOT] 'ejectives'
    - co-occurrence restriction in Quechua (Gallagher 2014)
  - See also Bennett (2015) for other types of dissimilatory process in consonant phonology

- No known study that reports creaky voice being part of such a phonological process

Burmese

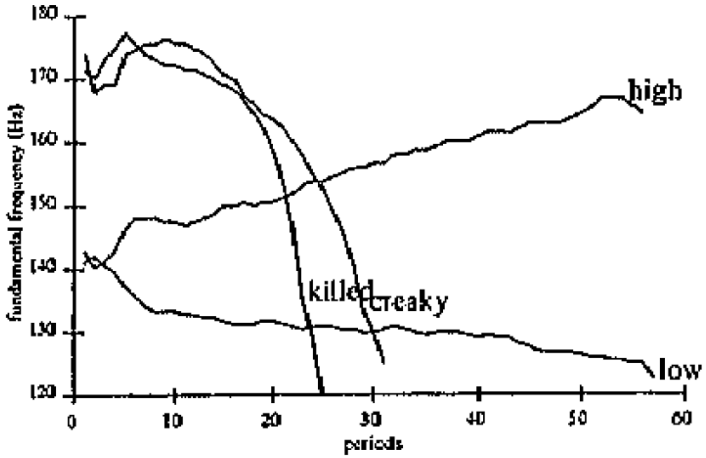
- A Tibeto-Burman language mainly spoken in Myanmar
- Speakers:
  - 32 million (as L1) and 10 million (as L2)

- Burmese is a tonal language

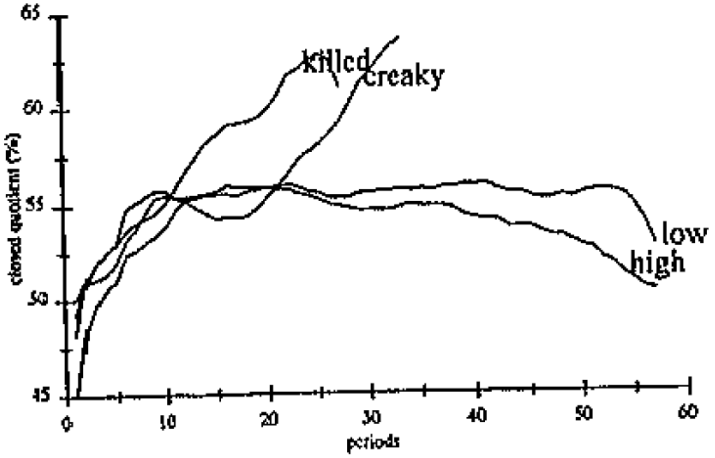
	Okell	IPA (Watkins 2000:145)	
• Low tone	mu	[mù:]	‘nature’
• High tone	mù	[mú]	‘drunk’
• Creaky tone	mú	[mʺ̰]	‘respect’
• Stop tone	muq	[mʊ́ʔ]	‘smooth’

Acoustics of Burmese tone
(Watkins 2000: 142-143)

Fundamental Frequency (F0)



Closed Quotient



/ka: ká: ka̰ ká?/ (ကာ ကား ကာ် ကက်)

Experiment

- Research question
  - Are there OCP-effects for combinations of like tone (creaky-creaky and low-low)?

- Production of creaky vs. low tone
  - Noun + (Suffix) vs. Verb + Suffix

- Verbs have a clause boundary following them.
  - Is this clause-boundary marked by F0 or creakiness?
  - Nouns have no such clause boundary.

- Tokens have target words embedded in a sentence:
  - See appendix for the full list of sentences

Data collection

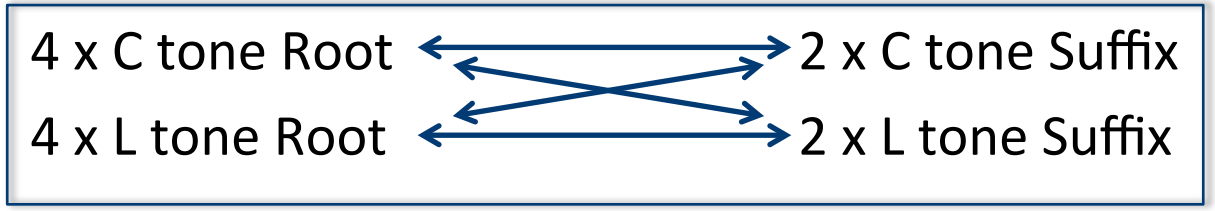
- Participants
  - Eight native Burmese Speakers (4 males, 4 females) between 27 and 41 years old
  - All residing in the USA, arriving after age 20.

- Recording session
  - Marantz PMD-661 digital Field Recorder
  - Shure WH-30 head-worn microphone
  - Quiet room

  - Participants read randomized target sentences from a powerpoint file (three repetitions)
  - The file was advanced by the researcher who monitored the disfluency or unnaturalness of read sentences.

Stimuli
- see the appendix for a full list

- 4 suffixes (2 low tone, 2 creaky tone)
- 8 roots
  - 2 low tone nouns, 2 creaky tone nouns
  - 2 low tone verbs, 2 creaky tone verbs
- 32 combinations + 4 unsuffixed (nominal) roots
  - only 4 unsuffixed nouns used because verbs have obligatory suffixes
- **36 stimuli x 3 repetitions = 108 tokens per speaker**



Methods: annotation

- A Praat script marked interval boundaries based on pauses.
- The 2nd author annotated vowels of target syllables based on the audio-visual cues.
  - The beginning and the end of a vowel were marked using information obtained from the formants in spectrograms.
- Another Praat script separated each target into a single file and automatically assigned a name to these files.

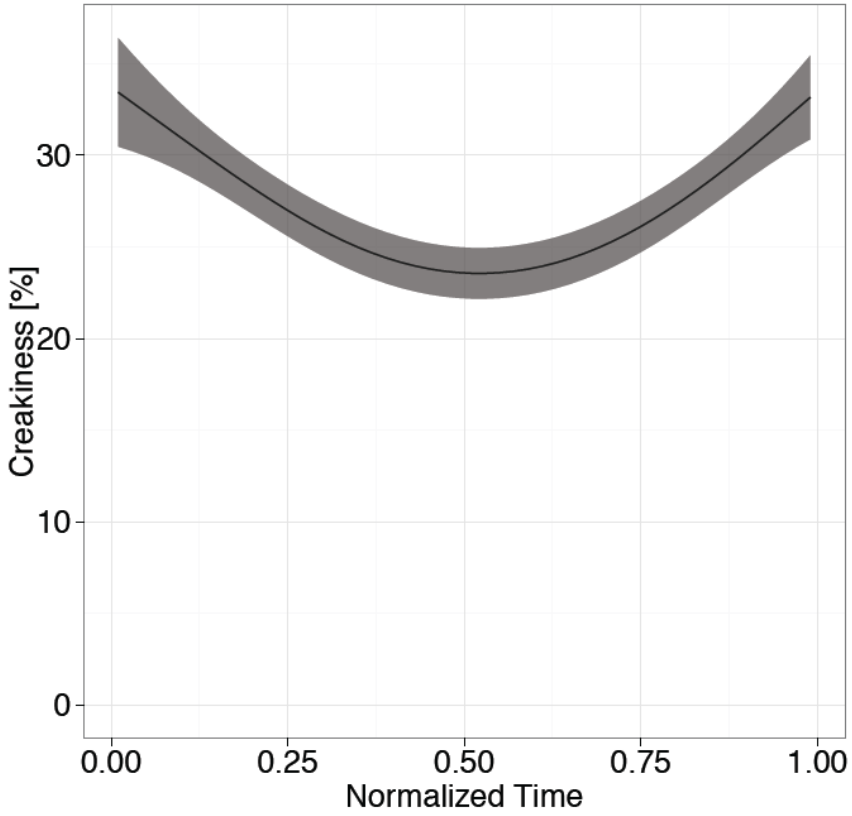
Methods: creakiness algorithm

- A creakiness detection algorithm for use in Matlab (Kane et al., 2013 and Drugman et al., 2014) was used to measure creakiness.
- A composite of acoustic measures that correlate with creakiness is used:
  - Spectral tilt (H2–H1)
  - F0 contour
  - Residual Peak Prominence (RPP)
  - Power Peak Parameters
  - Inter-Pulse Similarity
  - Intra-Frame Periodicity

- Degottex et al., 2014 originally trained the algorithm on databases with creaky sound tokens from English, Finnish, Swedish and Japanese.

Example of a result of the creakiness algorithm

- The creakiness algorithm was run on creaky syllables produced by two male speakers of Burmese



Methods: statistics

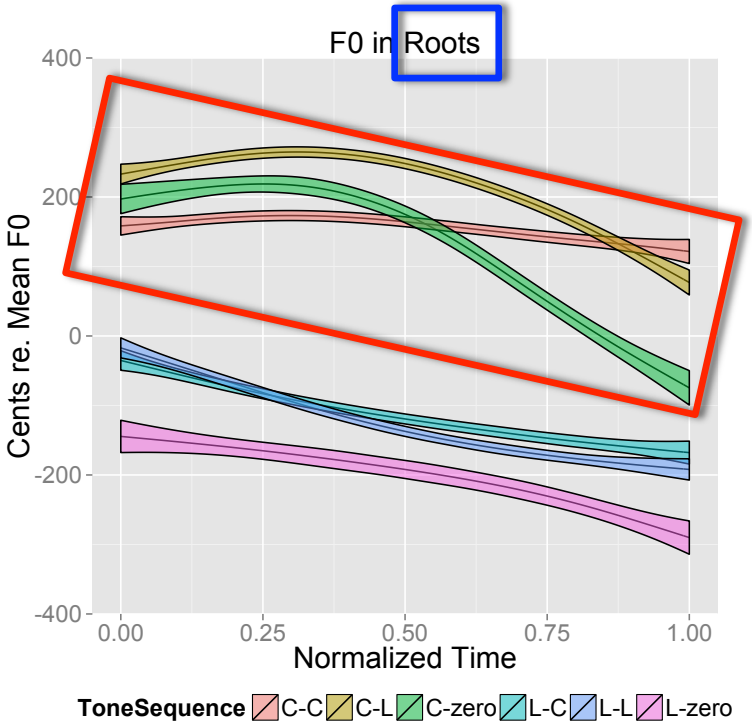
- Tokens were time-normalized prior to fitting a *Smoothing Spline ANOVA (SS-ANOVA)* model for both F0 and creakiness, following Gu (2014).

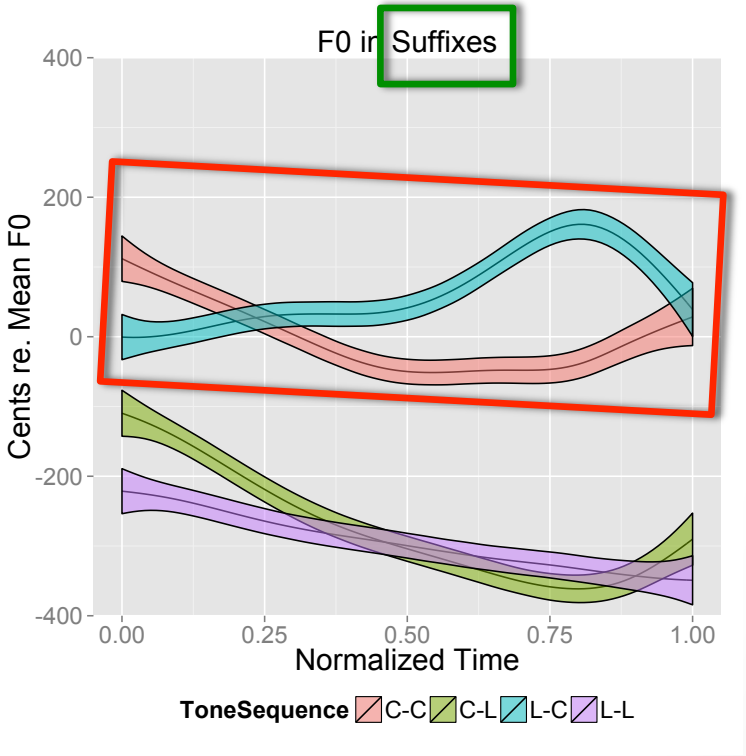
- Evaluation of the fitted model was done by predicting F0 and creakiness every 1 percentage point of the normalized time.

- Plots include 95% Bayesian confidence intervals.
  - Overlapping between confidence intervals corresponds to time-regions where no evidence of a significant difference between tones was found.

Results – Contrastive F0

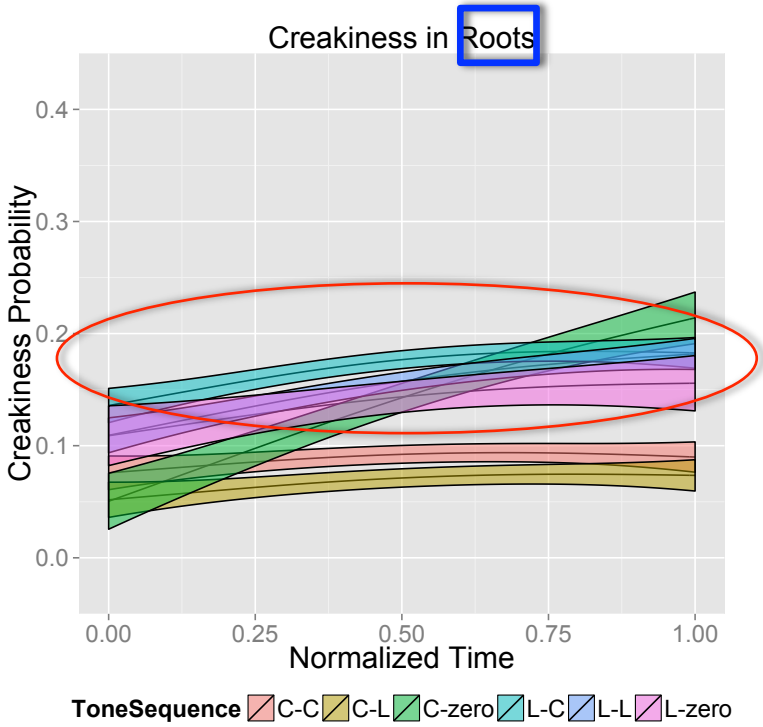
- Mean F0 is higher in creaky tone than low tone for both roots (left, red box) and suffixes (right, red box).





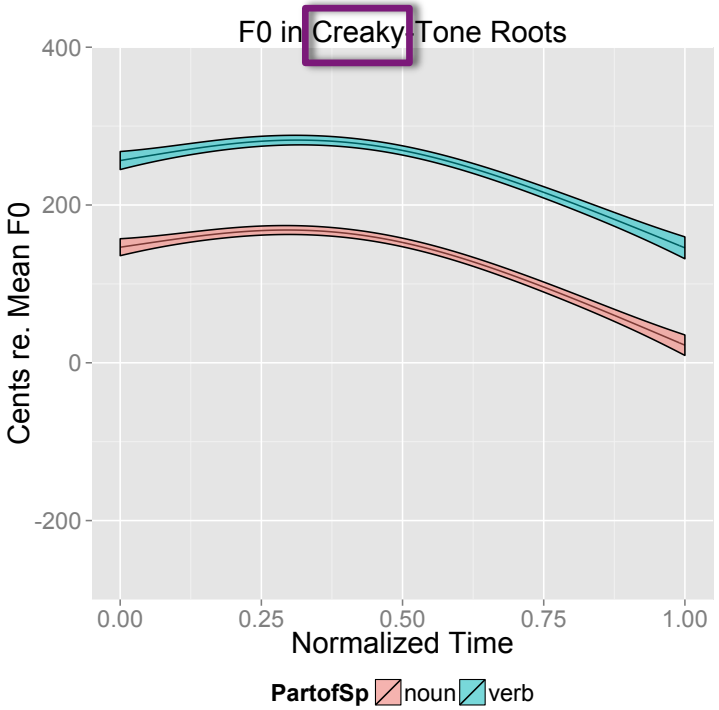
Results –Contrastive Creakiness

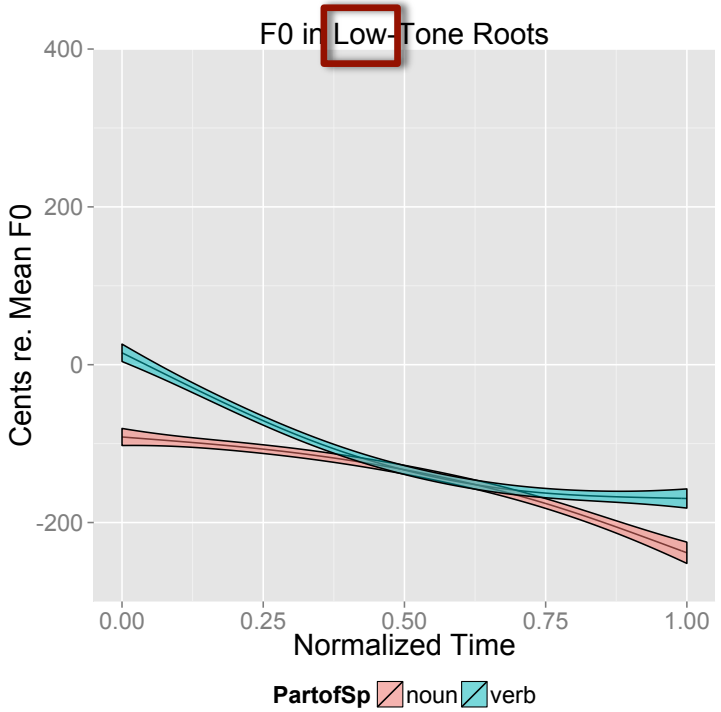
- Low-tone roots (left, in red circle) are creakier than creaky-tone roots, except creaky-tone roots without a suffix (the green line).
- All suffixes are quite creaky (right).
  - Low-tone suffixes are creakier than creaky-tone suffixes.



Results – F0 in Nouns & Verbs

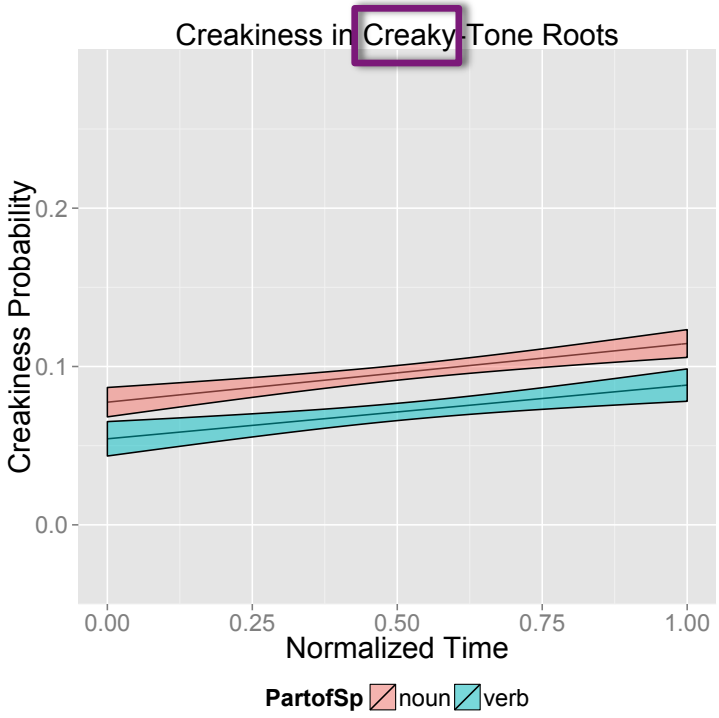
- F0 is higher in verbs (emerald) than nouns (beige) independent of the presence of a suffix
- This difference is more pronounced in creaky tone (left) than in low tone (right).

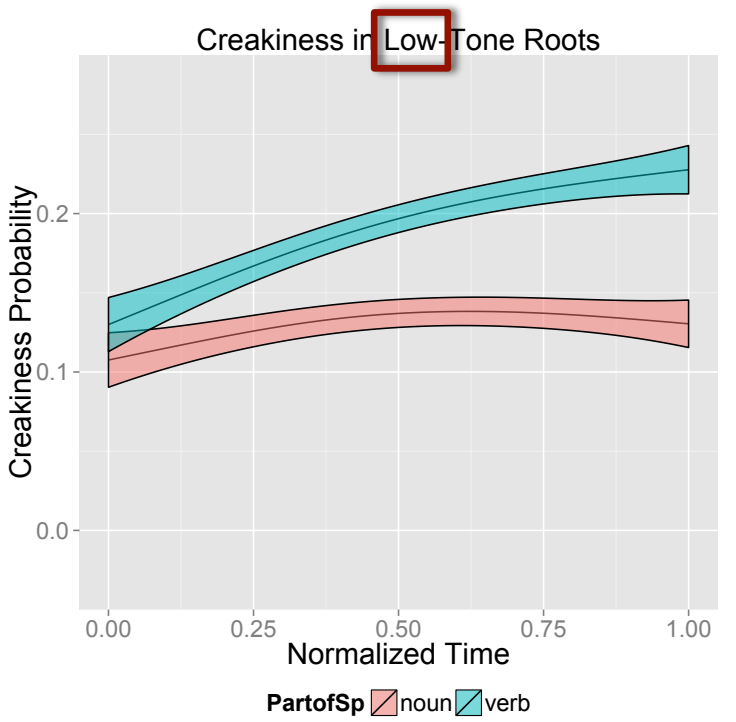




Results – Creakiness in Nouns & Verbs

- Creaky-tone nouns (beige) are creakier than creaky-tone verbs (emerald).
- Low-tone verbs (emerald) are creakier than low-tone nouns (beige) .

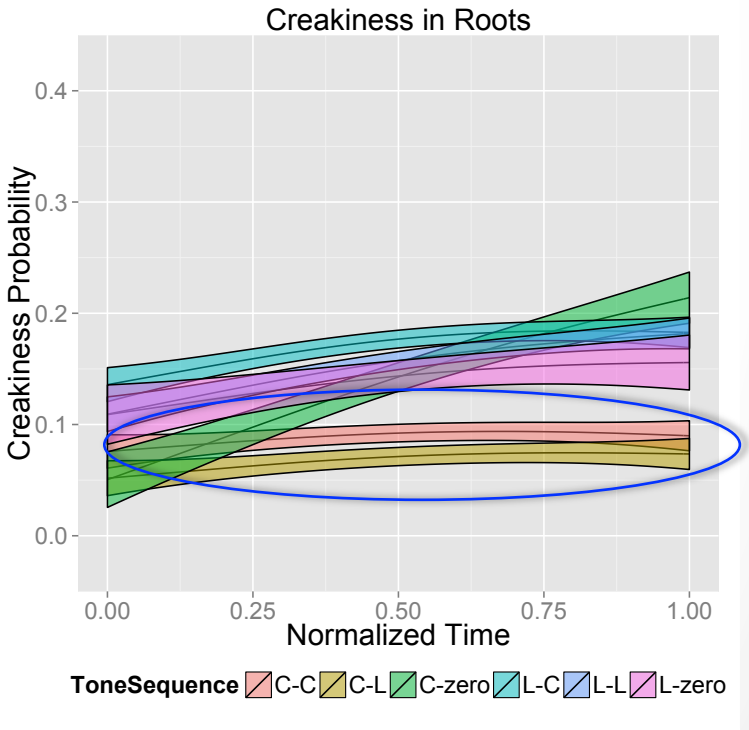




Discussion – OCP Effects

- Research question
  - Are there OCP-effects for combinations of like tone (creaky-creaky and low-low).

- There is no OCP-effect in low tone vowels.
- In C_{root}-C_{suffix} sequences, C_{root} is not creaky, a possible OCP effect.
  - Note that C_{root} without a suffix is creaky.
- However, C_{root} in C_{root}-L_{suffix} sequences is also not creaky.



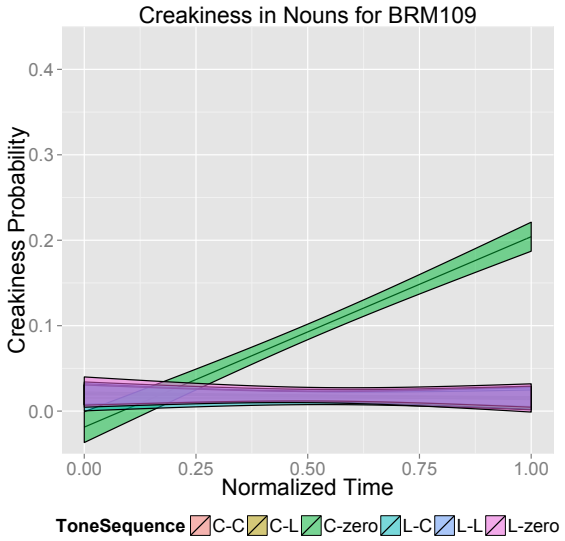
Discussion – Prosodic Account

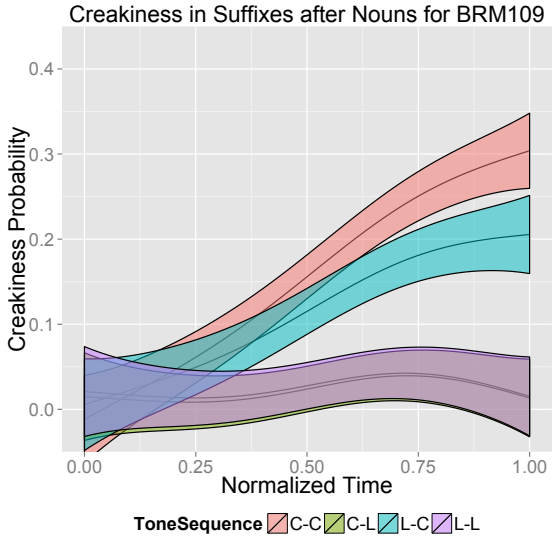
- ***Observation: Verbal roots (plus a suffix) are followed by a clause boundary, and are marked by:***
  - Increased F0 in clause-final creaky tone syllables.
  - Increased creakiness in clause-final low tone syllables.

- ***Hypothesis: Prosodic boundaries are characterized by a composite of creakiness and F0.***
  - When the clause-final syllable is low tone:
    - Prosodic boundary marked by increased creakiness.
  - When the clause-final syllable is creaky tone:
    - Prosodic boundary marked by increased F0.
  - The prosodic boundaries are phonetically marked by creakiness or F0, depending on the context (low or creaky tone).

Discussion – Non-Prosodic Effect in Nouns

- Nouns differ from verbs in that they are not followed by a clause boundary.
- ***Hypothesis: The tonal contrast in nouns is preserved.***
  - 4 of 8 speakers had (slightly) more creakiness in creaky-tone than in low-tone nouns (or following suffixes).
  - 1 of these 4 speakers did not have an F0 contrast in nouns (shown below).
  - The remaining 4 speakers did not show any creakiness contrast.
- We need more evidence that a creakiness contrast exists in nouns.





Discussion – Lack of Creakiness

- Creaky tones were not consistently creaky. Why?
  - Contrast is expressed via raised F0 instead of creakiness.
  - Genuine variability
    - 4 of 8 speakers show (weak) evidence of contrastive creakiness in nouns.
  - Prosody
    - Targets from only one position within a sentence (cf. Lee & Win 2014).
  - Age of speakers
    - Our speakers are relatively young.
    - Diachronic Shift: F0 is the primary cue for creaky tone, and not creakiness in younger speakers.

Conclusion

- Creaky tone is characterized by raised F0 in 7 of 8 speakers.
- Prosodic boundaries are marked by increased F0 or creakiness, whichever is ***not*** the primary cue in the vowel.
  - Increased F0 in creaky-tone vowels
  - Increased creakiness in low-tone vowels.
- Creaky tone was not consistently characterized by creakiness in all but 1 of 8 speakers.
  - Speakers vary on creakiness levels.
  - F0 did not vary to the same extent.
- Future Research: Do Burmese speakers use F0 more than creakiness in perception of creaky tone?
  - Do high tone & killed tone also display context-dependent creakiness?

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Appendix – Stimuli

Transcription based on OKELL, John (2010 [1994]) "An Introduction to the Spoken Language Book1", DeKalb: Northern Illinois University Press.

1. Nga-gá nwe caiq-teh.
2. Nga-gá lu mè-deh.
3. Nga-gá né gǎyú mǎ-saiq-p'ù.
4. Nga-gá lá myin-deh.
5. T'ǎmìn ma-yin mǎ-sà-ba-néh.
6. Thu-dó la-yin pyàw-ba.
7. Nga-gá nwe-go caiq-teh.
8. Nga-gá lu-go mè-deh.
9. È-da má-yin dhǎdí t'à-ba.
10. Khǎmyà lú-yin ǎp'àn-k'an-yá-meh.
11. Nga-gá né-go gǎyú mǎsaiq-p'ù.
12. Nga-gá lá-go myin-deh.
13. Di ǎthì ma-da sà-ló mǎ-yá-bù.
14. Yan-goun-go la-da mò-ywa-deh.
15. Di hniq nwe-ha pu-deh.
16. Di-hma lu-ha nèh-deh.
17. Di zǎbwèh má-da lè-deh.
18. Lu-dwe lú-da mǎkàun-bù.
19. Theiq mǎca-dhè-gin-gá né-ha pu-deh.
20. Mǎné-gá lá-ha tha-deh.
21. Pàn-dhì-ha ma-déh ǎthì-ba.
22. Cǎnaw la-déh myó-gá yan-goun-ba.
23. Di hniq nwe-ha mǎ-pu-bù.
24. Di-hma lu-gá mya-deh.
25. Thu-dó má-déh thiq-ta-gá lè-deh
26. Thu-dó lú-déh lu-bba
27. Theiq mǎca-dhè-gin-gá né-gá pu-deh.
28. Mǎ-né-gá lá-gá tha-deh.
29. Pàn-dhì ma-ló mǎsà-bù.
30. Thu-dó la-ló cǎnaw-dó thwà-deh.
31. Di hniq nwe-yéh ǎpu-gá pyìn-deh.
32. Da-gá lu-yéh nà-ba.
33. Thu-dó má-ló ywé-ba-deh.
34. Cǎnáw eiq-ko lú-ló paiq-s'an mǎshí-dáw-bù.
35. Thu-dó la-méh né-yéh lá-gá ò-gouq-pa
36. Da-gá lá-yéh ǎlìn-yaun-ba

ကျေးဇူးတင်ပါတယ်။

คุณ ขอบคุณ

ありがとう