ACOUSTICS OF LEVEL TONES IN GBAGYI

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ROADMAP

- Language Background
- Tone inventory and interaction
- Methodology
- Results
- Discussion and conclusion

LANGUAGE BACKGROUND

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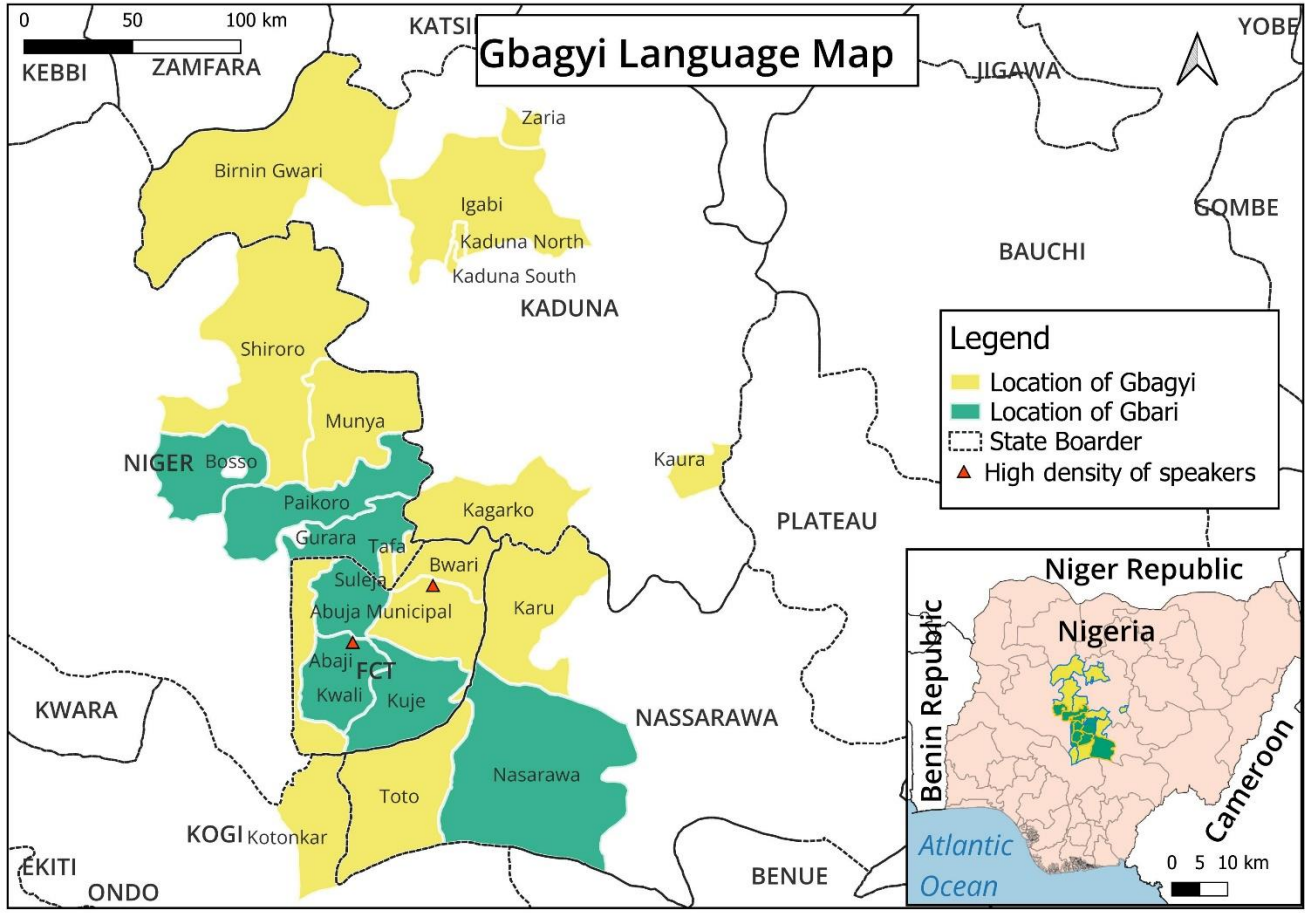
LANGUAGE BACKGROUND

- Gbagyi (*Glottocode*: gbag1258, *ISO 639-3*: gby) : Nupoid, Niger-Congo.
  - Gbagyi and Gbari (also Nupoid) are spoken by the same ethnic group.
  - Uncertain whether they are different languages or dialects of the same language (Rosendall, 1992, 1998, Dalhatu 2021).
- Location: Central Nigeria
- Population: ~1.2 million speakers
- Status: 6a (Vigorous) (*Eberhard et al.* 2024)



TONE INVENTORY AND DISTRIBUTION

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TONE INVENTORY: LEVEL TONES

- Gbagyi is a tone language, which means pitch contrasts bring about distinctions in meaning (Yip, 2002).
  - The language contrast four level tones (Dalhatu 2017, 2021).

Low (L)	gà	“to give”
Mid (M)	gā	“to scatter”
High (H)	gá	“near?”
Super High (S)	gā́	“near”

TONE INVENTORY: CONTOUR TONES

- Gbagyi also has two contour tones.

a.	H-H	ə́wá	‘snake’
	H-HL	ə́wáà	‘judgement’
	M-HL	ləjáà	‘go here’
b.	S-S	sə̋pə̋	‘side’
	S-SL	sə̋pə̋ə̀	‘side?’
	S-SL	nùɲ́ĩi	‘farm this way’

- However, the contour tones only restricted to long vowels and non-initial syllables.

DISTRIBUTION OF LEVEL TONES

- Unrestricted cooccurrence of level tones in Gbagyi.

			Tone of the 2nd syllable			
			H	L	M	S
Tone of the 1st syllable	H	gjé “to scratch?”	másná ‘to laugh’	znúdù ‘to cross’	ɓája ‘to break’	dnáɓwő ‘difficult’
	L	gjè “to sharpen”	àjé ‘clothes’	àgwù ‘chest’	òsu ‘honey’	snàŋá ‘to be sick’
	M	gje “to see”	paʒé ‘tie?’	shnipà ‘door’	potʃe ‘mat’	nakwő ‘cow’
	S	gjé̋ “to scratch”	kwā́nú ‘plate’	sű́kwù ‘please’	tnā́ja ‘rubbing off’	chéwjī́ ‘little/small’

TONE TRANSFER

- Contour tone formation on the second tone (Hyman and Magaji 1970).

a. Falling tone	H-L	→	H-**HL**
	M-L	→	M-**ML**
b. Rising tone	L-H	→	L-**LH**
	L-M	→	L-**LM**

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- However, Hyman and Magaji (1970) suggest that the tone transfer is optional in some lexical items.

THE STATUS OF THE FOURTH LEVEL TONE

- There is a consensus that Gbagyi has four level tones.
- However, studies differ on the status of the fourth tone.
  - The fourth tone is a Super High, with higher pitch than the H tone (Dalhatu 2017, 2021)

    H, L, M and **S**
  - The fourth tone is a Lower-Mid with a lower pitch than the M tone (e.g., Hyman and Magaji 1970, Dalhatu and Gwamna 2012).

    H, L, M and **Lower-M**
- The lower-M tone developed from the lowering effect of a preceding L tone in a sequence of L-M tones (Hyman and Magaji 1970).
  - but the preceding L tone no longer occurs phonetically.

ISSUE 1 WITH THE FOURTH TONE

- The form transcribed as **lower-M** tone in Hyman and Magaji (1970) are **M** in Dalhatu (2021).

	H & M (1970)	L-L		L-**Lower-M**	
	Dalhatu (2021)	L-L		L-**M**	
a.		òsà	‘time’	òda	‘father’
b.		òvjì	‘thief’	òbmja	‘fish’
c.		pàtà	‘cover’	ògbma	‘rain’
d.		jàɓà	‘banana’	gbògŋʷu	‘squirrel’

ISSUE 2 WITH THE FOURTH TONE

- Previous studies present no quantitative acoustic evidence in support of their proposal for level tones in Gbagyi (Hyman and Magaji 1970, Dalhatu 2021).
- No audio recordings of their data were provided.

THE PRESENT STUDY

- In this study, we will investigate whether the level tones in Gbagyi are
  - H, L, M and lower-M (Hyman and Magaji 1970, Dalhatu and Gwamna 2012)
  - H, L, M and S (Dalhatu and Gwamna 2017, 2021).
  - Tone interactions

METHODOLOGY

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PARTICIPANTS

- Data for this study come five speakers of Gbagyi at Nasarawa State University.
- All participants are undergraduate at the university.

Participant		Age	Language
P1	M	25	Hausa, English, Gbagyi, Ebira and Bassa
P2	F	25	Hausa, English, Gbagyi, French
P3	F	22	Hausa, English, Gbagyi
P4	F	23	Hausa, English, Gbagyi
P5	M	25	Hausa, English, Gbagyi

STIMULI

- Monosyllabic and bisyllabic words with all possible level tones and tonal cooccurrence.
  - All the syllables in the words are CV.

	Monosyllabic Words	Bisyllabic Words			
		H	L	M	S
H	9 (54)	9 (54)	5(30)	7 (42)	6(36)
L	9 (54)	6(36)	9 (54)	7 (42)	6(36)
M	10 (60)	1(6)	5(30)	10 (60)	7 (42)
S	8 (48)	6(36)	6(36)	2(12)	10 (60)

- To control for the effect of intrinsic F0 of vowel and consonant types (Hombert 1977, Whalen and Levitt 1995), most of the words have non-high vowels and voiced consonants.

PROCEDURE

- The English equivalent of each word in stimuli list is presented to the participants.
- They are instructed to produce the Gbagyi equivalent.
  - The researcher produce guidance if the wrong word is provided.
- In the first sessions, the participants produced the words thrice in isolation to control for the effect of down drift.
- The participants also spoke the words and then hummed it thrice
  - to mitigate the effect of intrinsic F0 and obtain the lowest pitch range for each tone.

PROCEDURE (CONTINUATION)

- The spoken and hummed words are recorded at the sampling rate of 48 kHz, 24bits in a .wav format.
- The tone-bearing vowels were manually annotated in Praat.
- To replicate the pitch trajectory of each tone, we extracted F0 values at 30 equidistance intervals using the Praat script, Prosodypro (Xu 2013).

ANALYSIS

- To match human pitch perception, the F0 values are transformed into semitone (see Stanford 2016, Zhang 2018), using the *f2st* function of the *R* package, *hqmisc* (Quené 2022).
- To increase comparability across participants, the semitone(F0) are z-score normalized for each participant.
- The normalized semitoneF0 (normSemitoneF0) across the 30 equidistance points are plotted using the geom_smooth(aes(), method = "gam") function in ggplot2 (Wickham 2011).

RESULT

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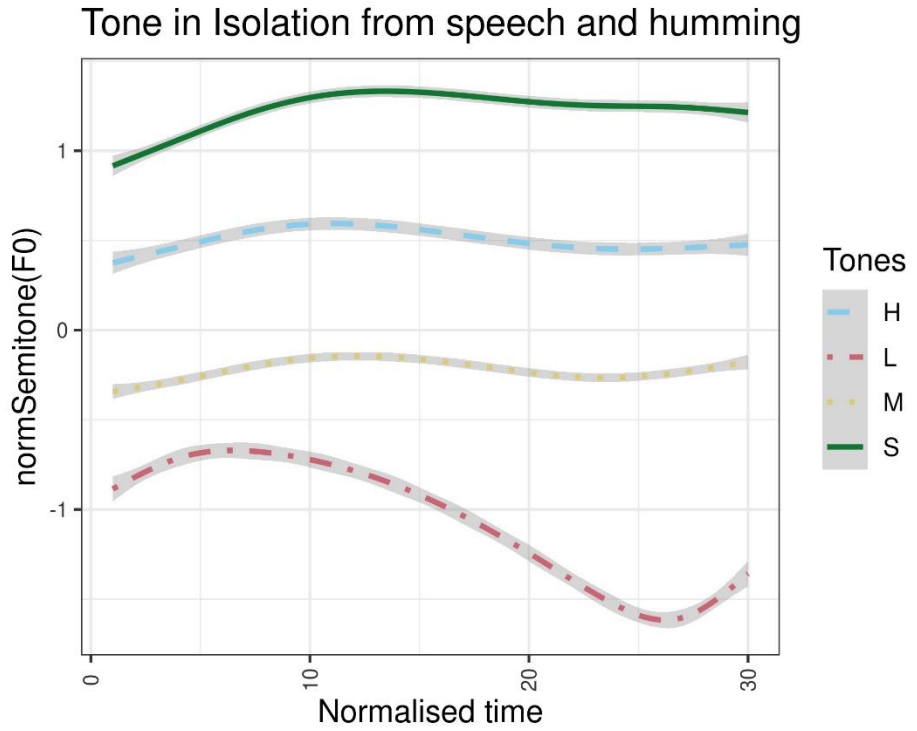
RESULTS: TONES IN ISOLATION

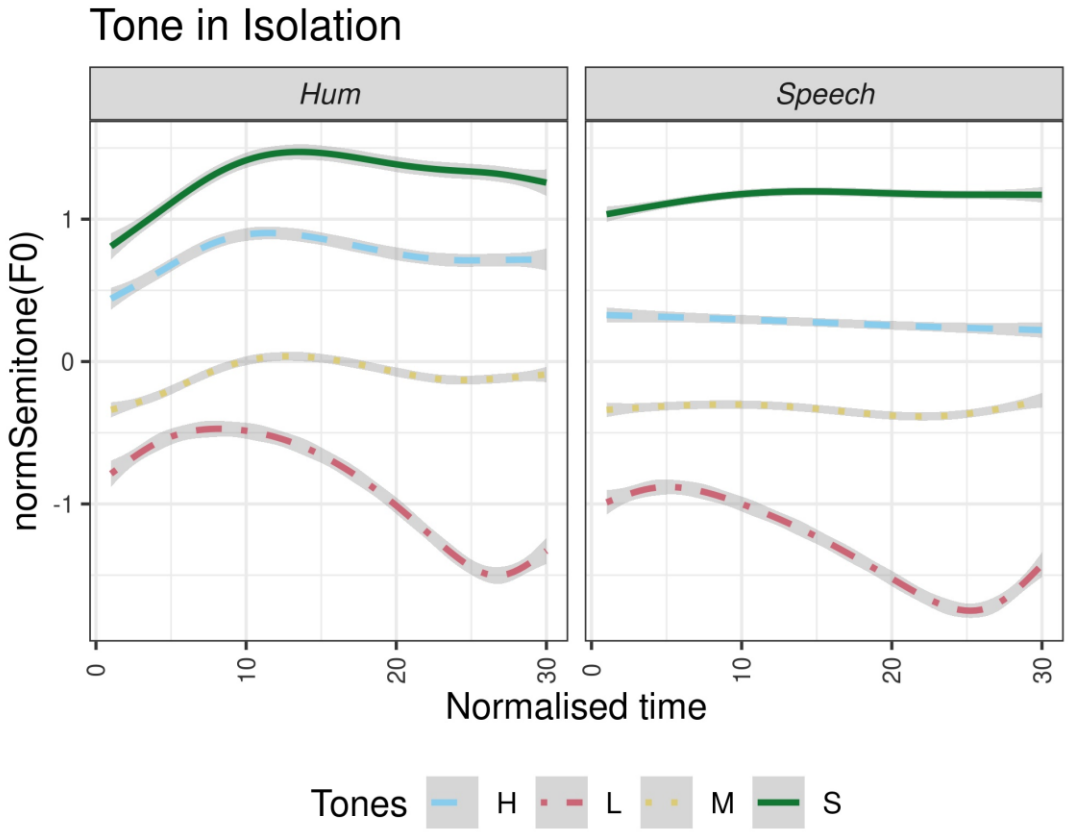
- Combined results from the four participants.
- Effect of tones on pitch height
  - Linear mixed effect model
  - *dependent variable* = normSemitone#%, *fixed effect* = tones, *random effect* = Participants
  - Example: lmer(normSemitone20~Tones + (1|Participants),data = Isolation_Interval)
  - Significance codes (p-value): '***' 0.001, '**' 0.01, '*' 0.05, 'ns' 0.1
  - We set significant level at $p \leq 0.05$



	S	H	M	L
F020%	***(t=11.66)	***(t=-12.25)	***(t=-31.36)	***(t=-24.73)
F050%	***(t=11.56)	***(t=-13.69)	***(t=-35.35)	***(t=-24.59)
F080%	*** (t= 13.20)	***(t=-13.13)	***(t=-40.96)	***(t=-23.23)

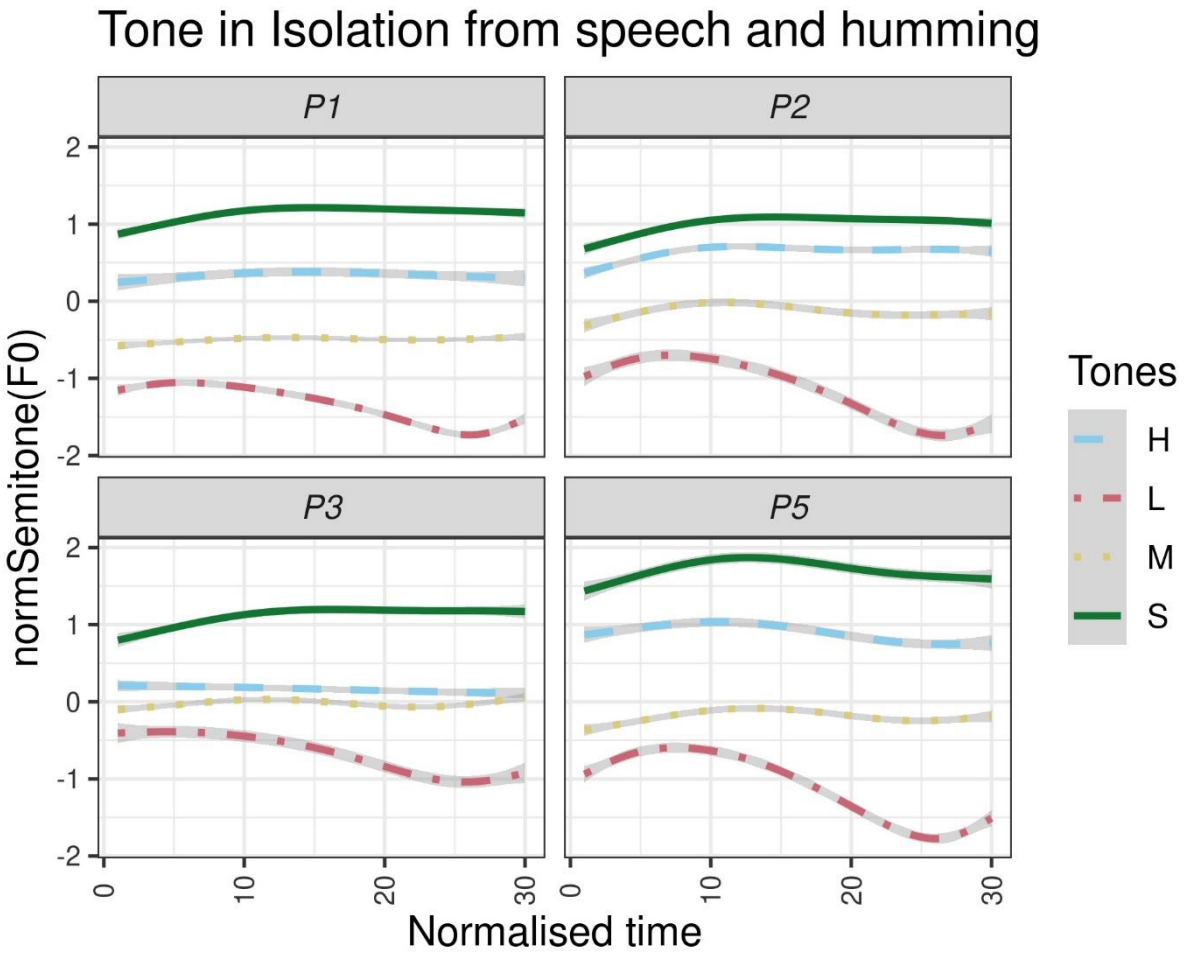
RESULTS: TONES IN ISOLATION

- The tones have relatively similar pitch heights and trajectories in spoken and hummed words with some minor variation.
  - Compared to the speech form, the onsets of the pitch heights in the humming mode start at a relatively lower range for each tone.
  - From the mid point to the end, the pitch height of the tones are higher in the humming mode.
- The distinction between the speech and humming mode is statistically significant for each tones at 20%, 50% and 80% interval except for the M tone.



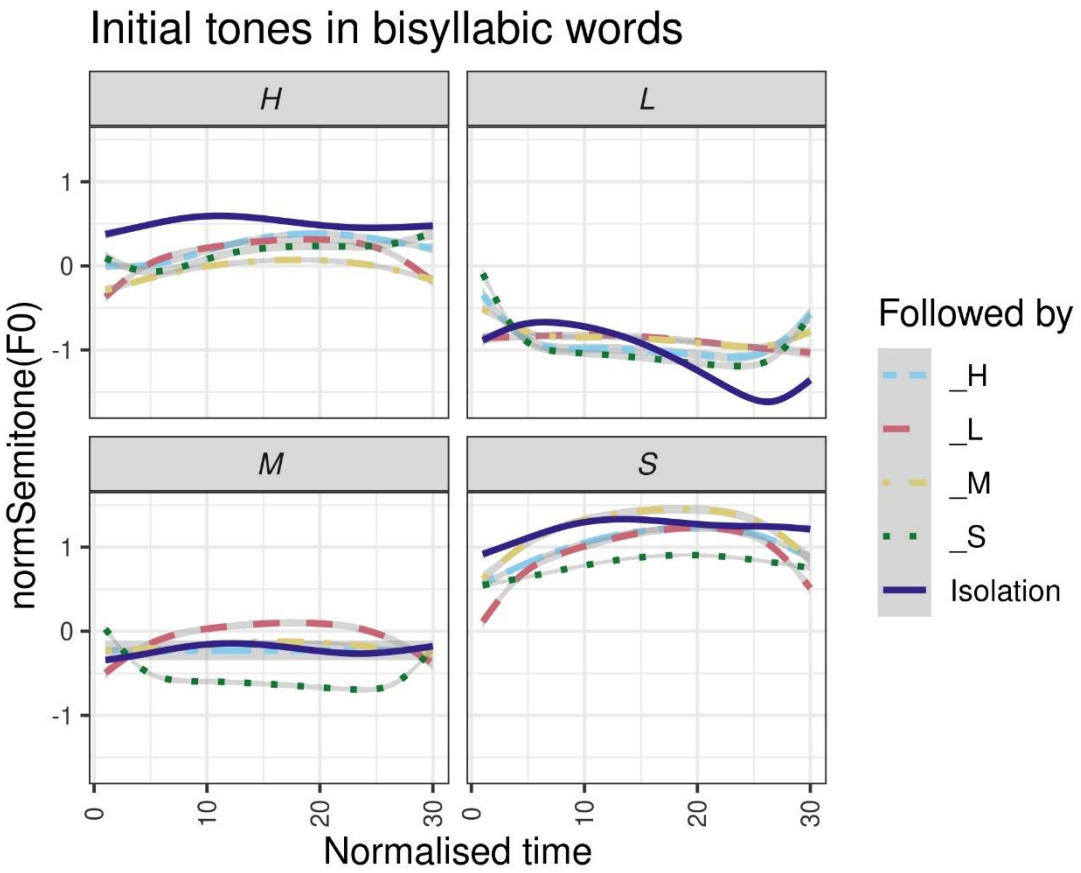
RESULTS: TONES IN ISOLATION

- The pitch heights and trajectories are similar for all the participants, with some inter-speaker variations.
  - Pitch heights of H and S closer for P2 than the other participants.
  - The pitch heights of M and H are closer for P3 than other participants.



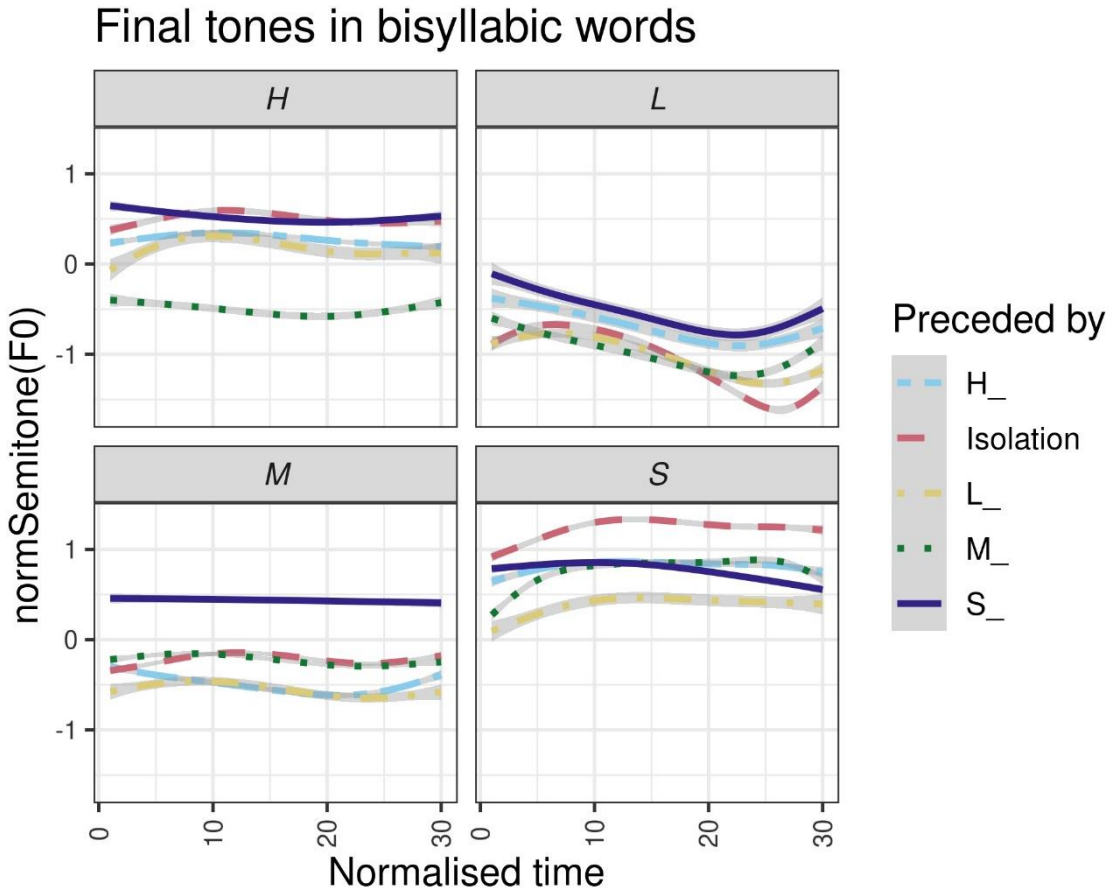
RESULTS: INITIAL TONE AND TONAL COOCCURRENCE

- Compared to when it occurs in isolation, the H tone has a significantly lower pitch height as the initial tone in a sequence of two tones.
- The M tone is significantly higher when the following tone is a L tone but significantly lower when the following tone is a S tone.
- The onset and offset of the L tone are significantly higher in the initial position, compared to when it occurs in isolation.
- The S tone is statistically significantly lower at all intervals, when the following tone is S.



RESULTS: FINAL TONE AND TONAL COOCCURRENCE

- The pitch height of the H tone is lower when the preceding tone is H and L, but lowest when the preceding tone is M.
- The H tone starts at slightly lower pitch and rises at the 10th equidistance point when preceded by a low tone.
- The M tone is higher when the preceding tone is S but lower when the preceding tone is H or L.
- When preceded by H, M or S, the L tone starts at a higher pitch and falls till the end. This distribution is statistically significant.
- The S tone starts from a relatively lower pitch height and rises when preceding tone is M or L.



DISCUSSION AND CONCLUSION

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DISCUSSION AND CONCLUSION

- The results of this work support H, M, L and S as the lexically contrastive level tones in Gbagyi (in line with Dalhatu 2017, 2021).
- The pitch trajectories of the second tone in a sequence of two tones are consistent with tone transfer (Hyman and Magaji 1970).
  - The H and S tones surface as rising tones when the preceding tone is L.
  - The L and M tones surfacing as falling when the preceding tone is higher (i.e., H, S or M).
- The H and S tones having lower pitch height when the followed by an identical tone (or any tone for an H tone).

DISCUSSION AND CONCLUSION

- The pitch height of the M varies depending on the following or preceding tone.
  - The effect of the preceding and following tone on the varying pitch height of the M tone is possibly the motivation for proposing phonological Lower-M tone (Hyman and Magaji 1970).
- The results of this work contributes to the typology of tones in Nupoid languages.
  - Nupoid does not only contrast H, L and M tones (e.g., Blench 1989, Passetti 2022, Rolle 2022), but also an S tone.

DISCUSSION AND CONCLUSION

- Some future directions.
  - The behaviour of the level tones, especially the S tone, in tonal operations (tone replacement in grammatical tone and postlexical contexts, loanword adaptation, etc.).
  - Do other Nupoid languages also have an S tone?

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