

# Tones and melodies of Tuwuli nouns

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ACAL / April 10, 2021

# Roadmap

- An introduction to the language, dataset, and questions
- Some phonological generalizations from data and observations
- A melody analysis to capture the generalizations
- An accentual analysis to account for melody-TBU mapping
- An OT analysis to implement the mapping mechanisms

# Tuwuli (Harley 2005)

- Tuwuli: A Kwa language spoken in the Volta Region of South-Eastern Ghana by about 11,000 speakers
- Noun class markers: prefixes with different tones
- Tones: H, L<sup>1</sup>
- Tone-bearing units: syllables ( $\sigma$ )

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<sup>1</sup>Also a word-final  $\widehat{HL}$ , but it is a tonal pattern rather than a tone by itself

## Data and observations

Prefix	Root	Prefix Tone	Root Tone	Gloss
ú	stí	H	H	'louse'
ó	tî	H	ĤL	'person'
ò	viò	L	L	'idol'
ò	dzóʔ	L	H	'squirrel'
ò	klâ	L	ĤL	'soul'

Table: Tone distribution before monosyllabic roots

- H-toned prefixes appear before H-initial roots.
- L-toned prefixes appear before L-&H-initial roots.

## Observation 1: prefix tone distribution

Prefix Tone	Root Tone
H	H, HH, HHH, $\widehat{HL}$ , HL, $H\widehat{HL}$ , HHL, $HH\widehat{HL}$
L	H, HH, HHH, $\widehat{HL}$ , HL, $H\widehat{HL}$ , HHL, $HH\widehat{HL}$ L, LL, LLL, LH, LHH, $L\widehat{HL}$ , $LH\widehat{HL}$

Table: Tone distribution

- H-toned prefixes appear before H-initial roots.
- L-toned prefixes appear before L-&H-initial roots.

## Observation 2: tonal sequence distribution

Prefix Tone	Root Tone
H	H, HH, HHH, $\widehat{HL}$ , HL, $HH\widehat{L}$ , HHL, $HHH\widehat{L}$
L	H, HH, HHH, $\widehat{HL}$ , HL, $HH\widehat{L}$ , HHL, $HHH\widehat{L}$ L, LL, LLL, LH, LHH, $L\widehat{HL}$ , $LHH\widehat{L}$

Table: Tone distribution

- The tonal sequence  $\widehat{HL}$  only appears word-finally.

# Research questions

- What is the underlying tone for the noun class marker?  
→ Tonal underspecification
- What is the underlying melody inventory for Tuwuli?  
→ Melody analysis (Zoll 2003)
- What is the mapping between melodies and TBUs?  
→ (improved) Accentual analysis (Hyman 2006)
- How to implement the analysis in an OT framework?  
→ OT (Prince & Smolensky 1993); Tone in OT (Zoll 2003)

# Generalizations

## Claim 1

The tonal sequence  $\widehat{L}H$  exists in the underlying representation, on the left edge exclusively. It always surfaces as H.

## Claim 2

The prefix tone is underspecified. The prefix copies the first toneme (H/L) from the root tone.



# Claim 1: $\widehat{LH}$ tonal sequence exists underlyingly

SR <sup>2</sup>	Tonal SR	Gloss
ś-stí	H-H	'louse'
ò-dzóʔ	L-H	'squirrel'

- Same root tone environment, different prefix tone realizations.

<sup>2</sup>The vowel quality [ATR] difference is beyond the scope of this study. ▶

# Claim 1: $\widehat{LH}$ tonal sequence exists underlyingly

UR	SR	Tonal UR	Tonal SR	Gloss
O-stí	ś-stí	∅-H	H-H	'louse'
O-dzǒ?	ò-dzó?	∅- $\widehat{LH}$	L-H	'squirrel'

- To obtain one single underlying form for the prefix, we posit that the root-initial H following L-toned prefixes is underlyingly an  $\widehat{LH}$  tonal sequence.

# Claim 1: $\widehat{LH}$ tonal sequence exists underlyingly

UR	SR	Tonal UR	Tonal SR	Gloss
O-stí	ś-stí	∅-H	H-H	'louse'
O-dzǫ?	ò-dzó?	∅- $\widehat{LH}$	L-H	'squirrel'

- We retain the symmetry between  $\widehat{HL}$  and  $\widehat{LH}$  tonal sequences.
- $\widehat{LH}$  appears on the left edge,  $\widehat{HL}$  on the right edge.
- This claim invites a tonal underspecification analysis for the noun class marker.

## Claim 2: Prefix tone is underspecified

Prefix Tone	(Underlying) Root Tonal Pattern
H	H, HH, HHH, $\widehat{H}L$ , HL, $H\widehat{H}L$ , HHL, $HH\widehat{H}L$
L	$\widehat{L}H$ , $\widehat{L}HH$ , $\widehat{L}HHH$ , $\widehat{L}HL$ , $\widehat{L}HL$ , $\widehat{L}H\widehat{H}L$ , $\widehat{L}HHL$ , $\widehat{L}HH\widehat{H}L$ L, LL, LLL, LH, LHH, $L\widehat{H}L$ , $LH\widehat{H}L$

- If the prefix tone is underlyingly H:  $H \rightarrow L / \_\_\{\widehat{L}H, L\}$
- If the prefix tone is underlyingly L:  $L \rightarrow H / \_\_\{\widehat{H}L, H\}$
- If the prefix tone is underspecified: tone copying ✓

# Tuwuli melody inventory

Prefix Tone	(Underlying) Root Tonal Pattern
H	H, HH, HHH, H <sup>̂</sup> L, HL, HH <sup>̂</sup> L, HHL, HHH <sup>̂</sup> L
L	L, LL, LLL L <sup>̂</sup> H, L <sup>̂</sup> HH, L <sup>̂</sup> HHH, LH, LHH L <sup>̂</sup> H <sup>̂</sup> L, L <sup>̂</sup> HL, L <sup>̂</sup> HH <sup>̂</sup> L, L <sup>̂</sup> HHL, L <sup>̂</sup> HHH <sup>̂</sup> L, L <sup>̂</sup> H <sup>̂</sup> L, L <sup>̂</sup> HH <sup>̂</sup> L

Table: Tonal patterns revisited

## Tuwuli melody inventory

Melody	$\sigma$	$\sigma\sigma$	$\sigma\sigma\sigma$
H	H	HH	HHH
HL	$\widehat{HL}$	HL, $HH\widehat{L}$	HHL, $HHH\widehat{L}$
L	L	LL	LLL
LH	H	LH, HH	LHH, HHH
LHL	$\widehat{HL}$	HL, $HH\widehat{L}$ , $LH\widehat{L}$	$HHL$ , $LHH\widehat{L}$ , $HHH\widehat{L}$

Table: From melodies to surface tonal patterns

- Each melody in the underlying representation maps to the syllables in various ways, and outputs the tonal patterns in the surface representation.

# “Optionality”

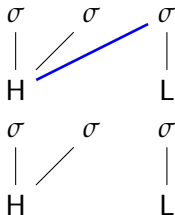
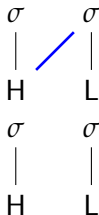
Melody	$\sigma$	$\sigma\sigma$	$\sigma\sigma\sigma$
H	H	HH	HHH
HL	$\widehat{HL}$	HL, $HH\widehat{L}$	HHL, $HHH\widehat{L}$
L	L	LL	LLL
LH	H	LH, HH	LHH, HHH
LHL	$\widehat{HL}$	HL, $HH\widehat{L}$ , $LH\widehat{L}$	HHL, $HHH\widehat{L}$ , $LHH\widehat{L}$

Table: Optionalities in melody-syllable associations

- **Optionality 1**: whether the final syllable is linked to H
- **Optionality 2**: whether the first syllable is linked to H
- **Optionality 1+2**: the two optionalities combined

# Optionality 1

Melody	$\sigma$	$\sigma\sigma$	$\sigma\sigma\sigma$
HL	$\widehat{H}L$	HL, $\widehat{HHL}$	HHL, $\widehat{HHHL}$

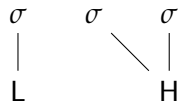
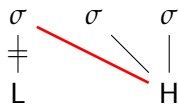
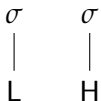
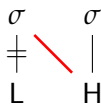


- **Optionality 1:** whether the final syllable is linked to H



## Optionality 2

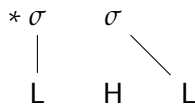
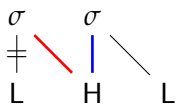
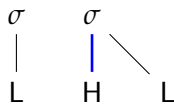
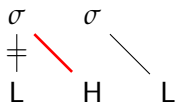
Melody	$\sigma$	$\sigma\sigma$	$\sigma\sigma\sigma$
LH	H	LH, HH	LHH, HHH



- **Optionality 2:** whether the first syllable is linked to H

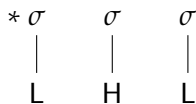
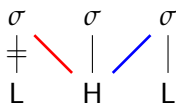
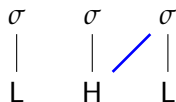
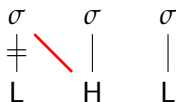
# Optionality 1+2

Melody	$\sigma$	$\sigma\sigma$	$\sigma\sigma\sigma$
LHL	$\widehat{H}L$	HL, $\widehat{HH}L$ , $L\widehat{H}L$	HHL, $\widehat{HHH}L$ , $L\widehat{HH}L$



# Optionality 1+2

Melody	$\sigma$	$\sigma\sigma$	$\sigma\sigma\sigma$
LHL	$\widehat{H}L$	HL, $\widehat{HHL}$ , $L\widehat{H}L$	$\widehat{HHL}$ , $\widehat{HHHL}$ , $L\widehat{HHL}$



# Puzzle

- Is there real optionality in melody-to-syllable mapping in Tuwuli?
- How to capture the possible tone contours and rule out the impossible ones?

# Puzzle

- Is there real optionality in melody-to-syllable mapping in Tuwuli? No.
- How to capture the possible tone contours and rule out the impossible ones? Accentual marking on prosodic words.

## Accentual analysis

- Hyman 2006: Prosodic words can be marked with tone accents. The accentual marking requires a TBU to be associated with a H tone, or any contour tone with a H toneme.
- Notation for TBUs with accentual marking:  $\sigma'$

Prefix	Root	$\sigma'$	$\sigma'\sigma$	$\sigma\sigma'$	$\sigma'\sigma'$	$\sigma'\sigma\sigma$	$\sigma\sigma\sigma'$	$\sigma'\sigma\sigma'$
H	H							
H	HL							
L	L							
L	LH							
L	LHL							

Table: Accentual Marking of Tuwuli

# Monosyllabic prosodic words

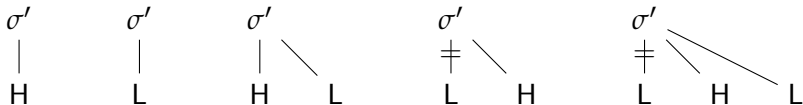


Table: The mapping of melodies onto monosyllabic prosodic words

Prefix	Root	$\sigma'$	$\sigma'\sigma$	$\sigma\sigma'$	$\sigma'\sigma'$	$\sigma'\sigma\sigma$	$\sigma\sigma\sigma'$	$\sigma'\sigma\sigma'$
H	H	H						
H	HL	$\widehat{HL}$						
L	L	L						
L	LH	H						
L	LHL	$\widehat{HL}$						

Table: Accentual Marking of Tuwuli

# Disyllabic prosodic words: HL and LH

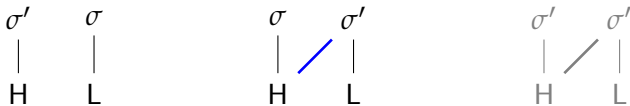


Table: The mapping of the melody HL

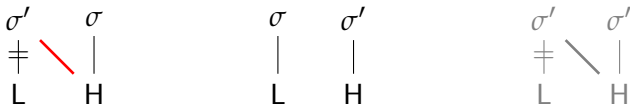


Table: The mapping of the melody LH



# Disyllabic prosodic words: LHL

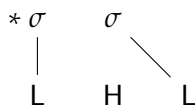
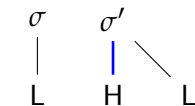
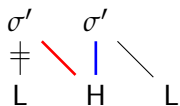
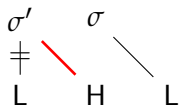


Table: The mapping of the melody LHL

# Disyllabic prosodic words

Prefix	Root	$\sigma'$	$\sigma'\sigma$	$\sigma\sigma'$	$\sigma'\sigma'$	$\sigma'\sigma\sigma$	$\sigma\sigma\sigma'$	$\sigma'\sigma\sigma'$
H	H	H	HH	HH	HH			
H	HL	$\widehat{H}L$	HL	$HH\widehat{L}$	$HH\widehat{L}$			
L	L	L	LL	LL	LL			
L	LH	H	HH	LH	HH			
L	LHL	$\widehat{H}L$	HL	$LH\widehat{L}$	$HH\widehat{L}$			

Table: Accentual Marking of Tuwuli

# Trisyllabic prosodic words: HL and LH

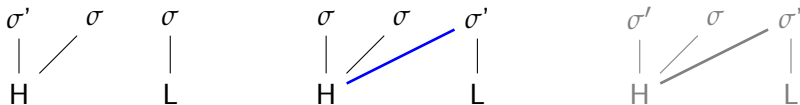


Table: The mapping of the melody HL

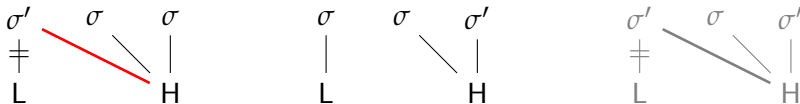
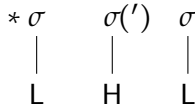
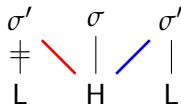
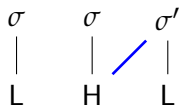
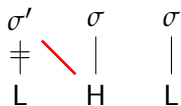


Table: The mapping of the melody LH

\* C.f. directionality analysis (Hyman 2006):  
rightward H-spreading for HL, leftward H-spreading for LH

# Trisyllabic prosodic words: LHL



**Table:** The mapping of the melody LHL

# Trisyllabic prosodic words

Prefix	Root	$\sigma'$	$\sigma'\sigma$	$\sigma\sigma'$	$\sigma'\sigma'$	$\sigma'\sigma\sigma$	$\sigma\sigma\sigma'$	$\sigma'\sigma\sigma'$
H	H	H	HH	HH	HH	HHH	HHH	HHH
H	HL	$\widehat{HL}$	HL	$HH\widehat{L}$	$HH\widehat{L}$	HHL	$HHH\widehat{L}$	$HHH\widehat{L}$
L	L	L	LL	LL	LL	LLL	LLL	LLL
L	LH	H	HH	LH	HH	HHH	LHH	HHH
L	LHL	$\widehat{HL}$	HL	$LH\widehat{L}$	$HH\widehat{L}$	HHL	$LHH\widehat{L}$	$HHH\widehat{L}$

Table: Accentual Marking of Tuwuli

# OT constraints

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DEP(TONE) Assign a violation for each inserted melody tone.

IDENT(TONE) Assign a violation for each changed melody tone.

MAX(TONE) Assign a violation for each deleted melody tone.

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\*R No  $\widehat{LH}$  in the output.

\*CLASH No H sequence on adjacent TBUs (\*HH, \*HH $\widehat{L}$ , etc.).

\*LAPSE No L sequence on adjacent TBUs (\*LL, \*LL $\widehat{H}$ , etc.).

H-ACCENT Assign a violation for each L tone on a  $\sigma'$ .

---



# DEP, IDENT >> \*LAPSE, H-ACCENT

	$\sigma'\sigma\sigma$ L	*R	DEP(TONE)	IDENT(TONE)	*LAPSE	H-ACCENT	MAX(TONE)	*CLASH
	HHL		*!					
	HHH			*!				**
☞	LLL				**	*		



## \*LAPSE &gt;&gt; \*CLASH

	$\sigma' \sigma \sigma$ HL	*R	DEP(TONE)	IDENT(TONE)	*LAPSE	H-ACCENT	MAX(TONE)	*CLASH
	HLL				*!			
☞	HHL							*

\*LAPSE >> \*CLASH captures the generalization that  $\widehat{LH}$  always shows up on the left edge, and  $\widehat{HL}$  on the right edge.

# \*R; H-ACCENT >> MAX(TONE), \*CLASH

	$\sigma' \sigma'$ LHL	*R	DEP(TONE)	IDENT(TONE)	*LAPSE	H-ACCENT	MAX(TONE)	*CLASH
	$\widehat{\text{LHH}}\widehat{\text{L}}$	*!						*
	$\widehat{\text{LHL}}$					*!		
☞	$\widehat{\text{HH}}\widehat{\text{L}}$						*	*

\*R captures the L-delinking process that accompanies the association between H and the first TBU.

# OT Summary

## Constraint ranking

\*R, DEP(TONE), IDENT(TONE) >>

\*LAPSE, H-ACCENT >>

MAX(TONE), \*CLASH

# Summary

- This project accounts for the tonal patterns in Tuwuli nouns. The language has two tonemes (H, L) and five underlying melodies (H, L, HL, LH, LHL). The noun class marker copies the first toneme from the root.
- Our analysis suggests the original accentual analysis is insufficient to capture the association mechanism in Tuwuli. Prosodic words can be marked with tone accents on (i) left edge, (ii) right edge, or (iii) both edges.
- We provide an OT analysis to formalize our generalizations and implement the mapping from melodies to TBUs.

## Discussion: Takeaway

- The accent plus directionality analysis (Hyman 2006) does not provide a consistent analysis for Tuvuli, but allowing tone accents to show up on both edges does.
- A parallel argument in stress assignment in Turkic languages: an interacting changeable dynamic stress accent can lead to words with accents on both edges (Johanson & Johanson 2015).

## Discussion: Further research

- Why not  $\sigma\sigma'\sigma$ ?
  - It would wrongly predict an unattested LHL contour.
  - A similar case: stress accents are never assigned from the center to edges.
- What about words with more than 3 TBUs?
  - There are few data points.
  - Morpheme boundaries might play a role.
- What can be done next?
  - To test our analysis on a wider range of data.
  - To explore accentual marking in other languages.

# Acknowledgements

Thanks to Prof. Adam Jardine for his advising, to the Rutgers PhonX group for their feedbacks, and to the 2020 Fall QPW group for their advice and comments on my abstract!

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## Appendix 1: More data (H)

Prefix	Root	Prefix	RootSR	RootUR	Gloss
ó	stí	H	H	H	'louse'
ó	wún.yá	H	HH	HH	'mosquito'
ó	wó-lá.té	H	HHH	HHH	'crocodile'
ó	tî	H	ĤL	ĤL	'person'
ó	kí.kò	H	HL	HL	'monkey'
ó	nyó.lê	H	HĤL	HĤL	'man'
kó	né-yó.lè	H	HHL	HHL	'jealousy'
ó	kú.ná.wâ	H	HHĤL	HHĤL	'widow'

Table: Prefixes with H tones

## Appendix 1: More data (L)

Prefix	Root	Prefix	RootSR	RootUR	Gloss
ò	viò	L	L	L	'idol'
ò	là.tè	L	LL	LL	'owner'
ò	nàn.tsù.è	L	LLL	LLL	'cow'
ò	dzóʔ	L	H	R	'squirrel'
ò	gbé.ní	L	HH	RH	'hunter'
à	mán.dí.é	L	HHH	RHH	'custom'
ò	kpè.té	L	LH	LH	'dog'
ò	bò.lí.tsó	L	LHH	LHH	'bride'

Table: Prefixes with L tones

## Appendix 1: More data (L)

Prefix	Root	Prefix	RootSR	RootUR	Gloss
ò	klâ	L	F	RF	'soul'
ò	mú.mù	L	HL	RL	'a dumb person'
ò	kó.bâ	L	HF	RF	'friend'
ò	kpé.lí.wà	L	HHL	RHL	'grasscutter'
ò	sú.mú-nê	L	HHF	RHF	'servant'
lè	pà.mê	L	LF	LF	'knife'
ò	bò-kpá-nê	L	LHF	LHF	'witch'

Table: Prefixes with L tones

## Appendix 2: More possibilities

Prefix	Root	$\sigma'$	$\sigma'\sigma$	$\sigma\sigma'$	$\sigma'\sigma'$	$\sigma'\sigma\sigma$	$\sigma\sigma\sigma'$	$\sigma'\sigma\sigma'$
H	H	H	HH	HH	HH	HHH	HHH	HHH
H	HL	$\widehat{H}\widehat{L}$	HL	$\widehat{H}\widehat{H}\widehat{L}$	$\widehat{H}\widehat{H}\widehat{L}$	HHL	$\widehat{H}\widehat{H}\widehat{H}\widehat{L}$	$\widehat{H}\widehat{H}\widehat{H}\widehat{L}$
L	L	L	LL	LL	LL	LLL	LLL	LLL
L	LH	H	HH	LH	HH	HHH	LHH	HHH
L	LHL	$\widehat{H}\widehat{L}$	HL	$\widehat{L}\widehat{H}\widehat{L}$	$\widehat{H}\widehat{H}\widehat{L}$	HHL	$\widehat{L}\widehat{H}\widehat{H}\widehat{L}$	$\widehat{H}\widehat{H}\widehat{H}\widehat{L}$

Prefix	Root	$\sigma'$	$\sigma'\sigma$	$\sigma\sigma'$	$\sigma'\sigma'$	$\sigma'\sigma'\sigma$	$\sigma\sigma'\sigma'$	$\sigma\sigma'\sigma$
H	H	H	HH	HH	HH	HHH	HHH	HHH
H	HL	$\widehat{H}\widehat{L}$	HL	$\widehat{H}\widehat{H}\widehat{L}$	$\widehat{H}\widehat{H}\widehat{L}$	HHL	$\widehat{H}\widehat{H}\widehat{H}\widehat{L}$	HHL
L	L	L	LL	LL	LL	LLL	LLL	LLL
L	LH	H	HH	LH	HH	HHH	LHH	LHH
L	LHL	$\widehat{H}\widehat{L}$	HL	$\widehat{L}\widehat{H}\widehat{L}$	$\widehat{H}\widehat{H}\widehat{L}$	HHL	$\widehat{L}\widehat{H}\widehat{H}\widehat{L}$	<b>LHL</b>