THE ROLE OF MUSIC IN DOCUMENTING PHONOLOGICAL GRAMMAR:

TWO CASE STUDIES FROM WEST AFRICA

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INTRODUCTION

THE LANGUAGE-MUSIC CONNECTION

- Surge in interest on the relationship between language and music
- Heavy overlap in structural and cognitive areas:
  - Sound structure (Lerdahl and Jackendoff 1983, Lehrdal 2001, Patel and Daniele 2002, Iversen et al. 2008, *i.a.*)
  - Syntax (Maess et al. 2001, Patel et al. 1998a, *i.a.*)
  - Processing (Besson and Schön 2001, Zatorre et al. 2002, Schön et al. 2004, Patel et al. 1998b, Kölsch et al. 2004, *i.a.*)

BUT WE'RE PHONOLOGISTS…

- What does this have to do with phonology?

POETIC VERSE AND PHONOLOGY

- Artistic adaptation of language manipulates phonological structure
- Metrics and phonological theory
  - Jakobson (1960), Kiparsky (1973 *et seq*), Halle and Keyser (1969, 1971), Keyser (1969), Hayes (1988), Hayes and Kaun (1996), Hayes and Moore-Cantwell (2011), Ryan (2014, 2017), etc.

MUSIC AND PHONOLOGY

- What can musical practices tell us about phonological structure?
  - Language-based music (though see e.g. Patel 2008 for instrumental classical musical)

➢ Window onto speakers' implicit knowledge of the sound system

TODAY'S TALK

- Two case studies from West Africa
  - Tone-tune association in Tommo So folk songs (vocal music)
  - Surrogate speech of the Sambla balafon (ostensibly instrumental music)
- Evidence for phonological organization
- Probe the interface between phonetics and phonology

➢ Not only can music advance phonological theory, but it can be a key tool in language documentation

MUSIC AND PHONOLOGY

PREVIOUS STUDIES

PREVIOUS WORK

- Text-setting
  - Tonal: Herzog (1934), Leben (1983), Wong and Diehl (2002), Schellenberg (2012), Kirby and Ladd (to appear), *i.a.*
  - Non-tonal: Halle and Lerdahl (1993), Shih (2008), Hayes (2009), Calder (2013), Starr and Shih (2017), *i.a.*
- Grouping and phrasing: Lerdahl and Jackendoff (1993), Katz and Pesetsky (2011), Katz (submitted), *i.a.*
- Rhyme: Zwicky (1976), Holtman (1996), Hanson (2003), Kawahara (2007), Katz (2015), *i.a.*
- Rhythm: Patel and Daniele (2003), Seifart et al. (2018)

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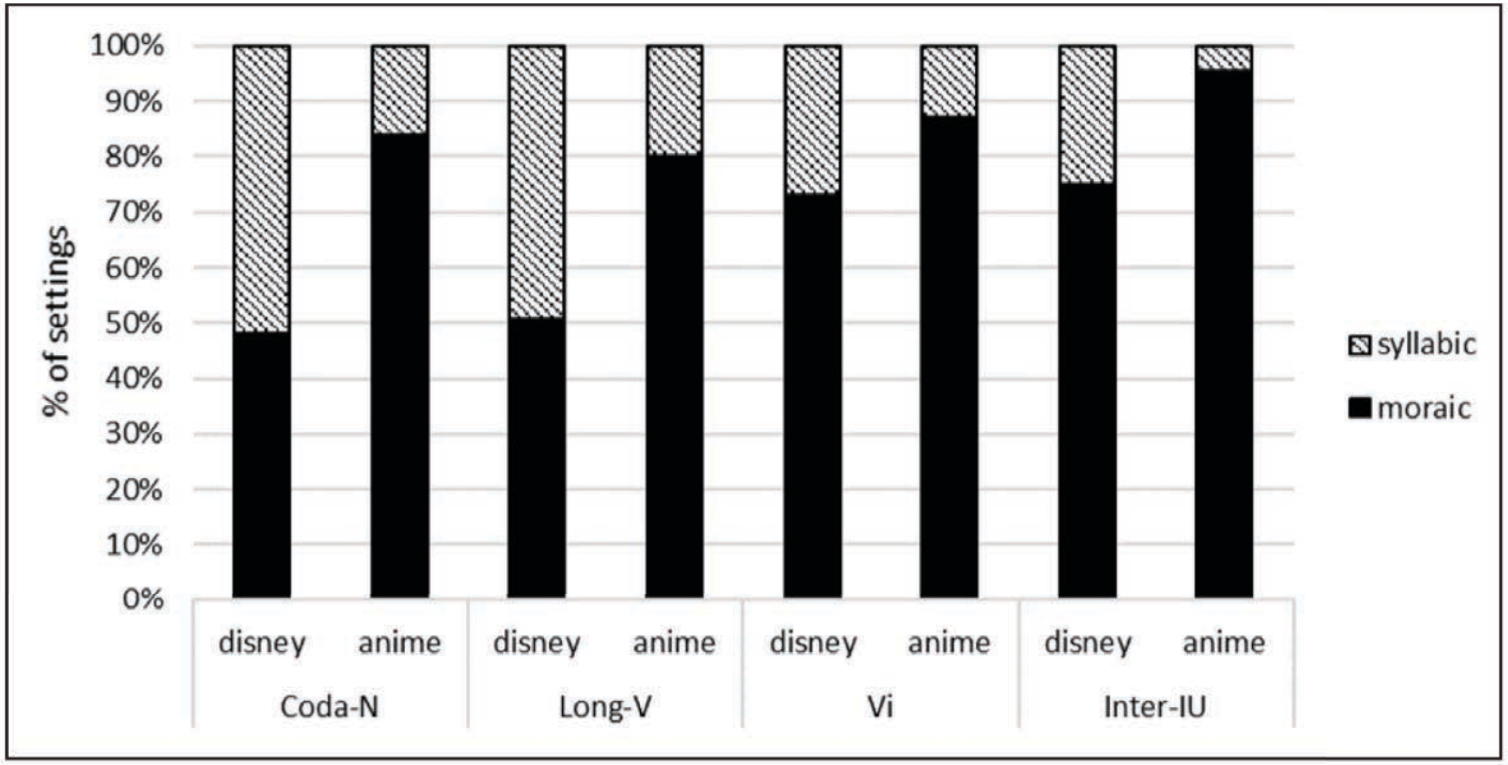
JAPANESE: SYLLABLES OR MORAS?

- The mora clearly important in Japanese phonology (Vance 1987, Otake et al. 1993, Inaba 1998, *i.a.*)
- But does this mean there is no evidence for the syllable? (Labrune 2012)
- Starr and Shih (2017) on Japanese text-setting

JAPANESE: SYLLABLES OR MORAS?

- Both mora-based and syllable-based
- Syllable is a psychologically-real level of the hierarchy
- Consistent with non-musical evidence (e.g. Kawahara 2016)



MUSIC AS EVIDENCE

- Studies of music can provide evidence for:
  - Phonological structure and categories
  - Can be deciding factor in debates on phonological theory

➢ What can we learn about phonology from music in understudied languages?

CASE STUDY 1: TOMMO SO TONAL TEXTSETTING

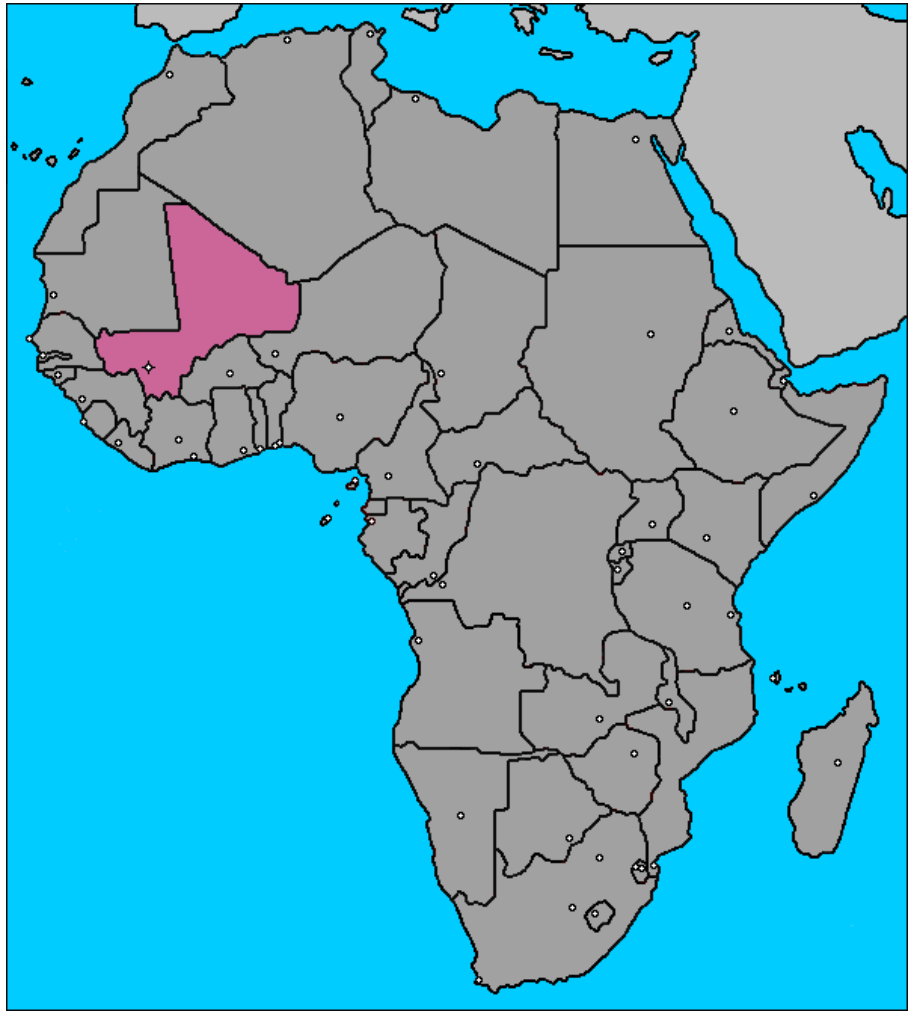
JOINT WORK WITH KEVIN RYAN (HARVARD)

TOMMO SO

- Dogon language spoken in Mali by approx. 60,000 speakers
- Primary fieldwork from 2008-2012
- Tone system:
  - L, H, ∅ (McPherson 2011)

dàmmá	'hoe'	LH
dámmá	'village'	H
dámmá=gɛ	'the village'	H=∅

- Intricate system of replacive grammatical tone (McPherson 2014, McPherson and Heath 2016)



THE RESEARCH QUESTION

- What is the relationship between linguistic tone and musical melody?
- Vast and growing literature on the question (e.g. Schellenberg 2012, Kirby and Ladd to appear, references cited therein)

THE RESEARCH QUESTION

Language	Paper	Number of Artifacts	Number of transitions	Parallel	Not opposing
Cantonese Chinese	Wong & Diehl (2002)	4	281	92%	98%
Ewe	Jones (1959)	1	105	68%	95%
Ewe*	Hornbostel (1928)	1	35	49%	89%
Hausa	Richards (1972)	1	380	53%	96%
Kalami (Gawri)	Baart (2004)	14	434	48%	89%
Shona	Schellenberg (2009)	3	140	53%	67%
Thai	List (1961)	8	*no data*	76%	*no data*
Wu-Ming Tai	Mark & Li (1966)	6	(320 syll)	63%	*no data*
Xhosa*	Starke (1930)	25	281	67%	95%
Zulu*	Rycroft (1959, 1979)	2	36	92%	97%

Schellenberg (2012:270)

WOMEN'S FOLK SONGS

- Recorded 1.5 hours of sung music in January, 2012
- Largely call and response
- Solo verse elaborates on a repeated chorus using some improvisation
- Pentatonic scale, with roughly the following corresponding notes:

E♭	F	A♭	B♭	C
1	2	4	5	6

WOMEN'S FOLK SONGS

CODING THE DATA

- Transcribed 11 minutes consisting of eight songs
  - 172 musical lines
  - 2223 musical bigrams (two note sequences)

CODING THE DATA

- Coded each bigram for:
  - Tone (e.g. HH, HL, etc.)
  - Change in note (e.g. -1, 2, 0, etc.)
  - Juncture strength
    - 0 = within-word, 1 = clitic, 2 = word
  - Lexical vs. grammatical tone
  - Improvised vs. rote
  - Position in line
  - Singer

yaandO	21	-1	L	H	L	H	0	LL	II	T
ndO gi	21	1	H	L	H	L	2	LL	II	T
ginE	21	-1	L	H	L	H	0	LL	II	T
nE uwO	21	0	H	H	H	H	2	LL	II	T
uwO nE	21	1	H	0	H	0	1	LL	II	T
nE gwE	21	-2	0	H	0	H	2	LL	IR	T
gwE na	21	0	H	L	H	L	2	LG	RR	T
nale	21	1	L	L	L	L	0	GG	RR	T
lee	21	1	L	L	L	L	0	GG	RR	T
e em	21	0	L	L	L	H	2	GG	RR	T
emkE	21	-2	L	H	H	H	3	GL	RR	T
kEmin	21	1	H	H	H	H	0	LL	RR	T
minjE	21	1	H	H	H	H	0	LL	RR	T
jE sa	21	1	H	L	H	H	2	LG	RR	T
same	21	1	L	L	H	L	0	GG	RR	T

BASIC RESULTS

- Following the methodology in Schellenberg (2012), Kirby and Ladd (to appear), etc.
  - **Parallel**: (up with up, level with level, down with down)
  - **Contrary**: (up with down, down with up)
  - **Oblique**: (up with level, down with level)

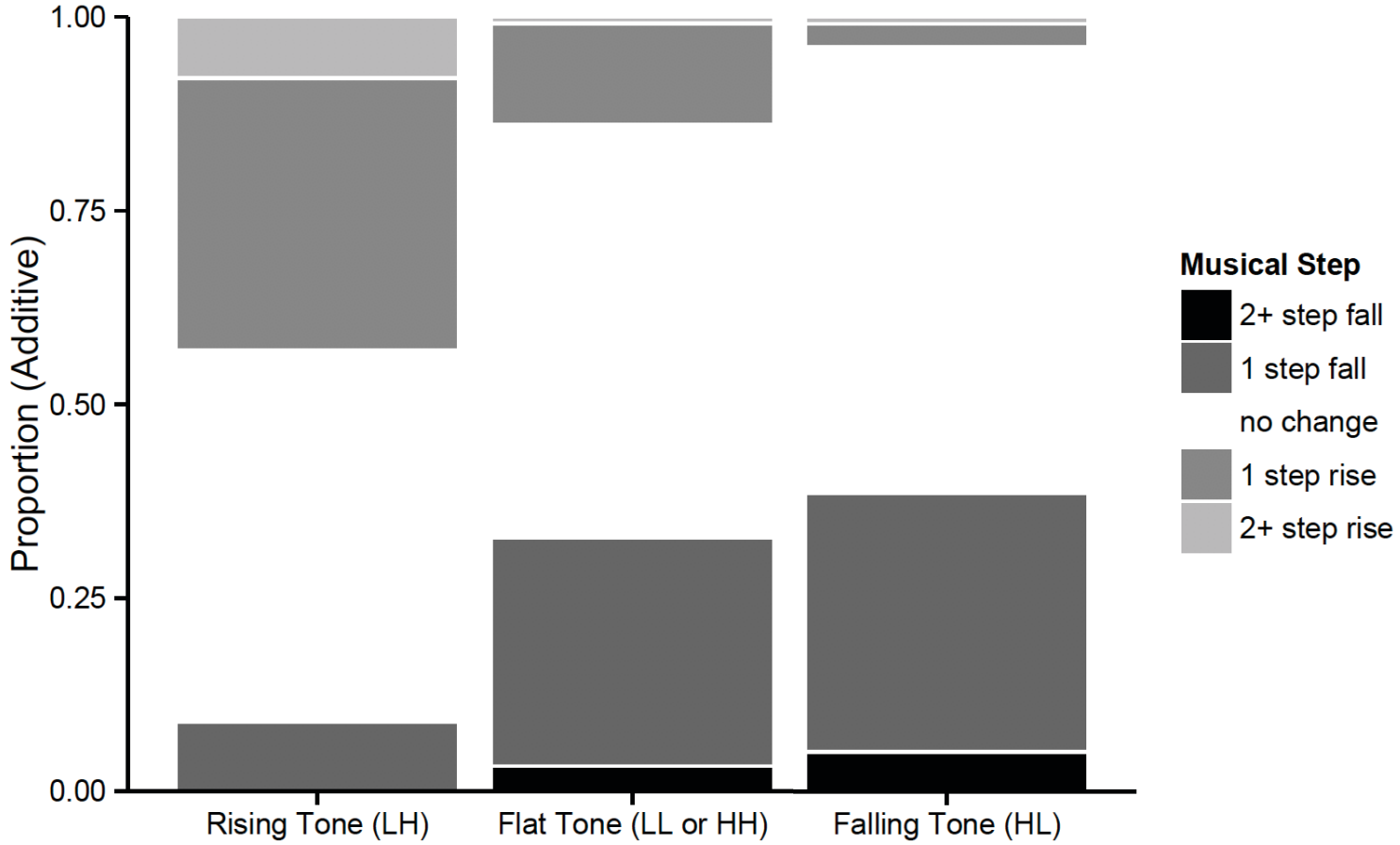
BASIC RESULTS

- **Contrary** mappings avoided
- **Oblique** mappings tolerated

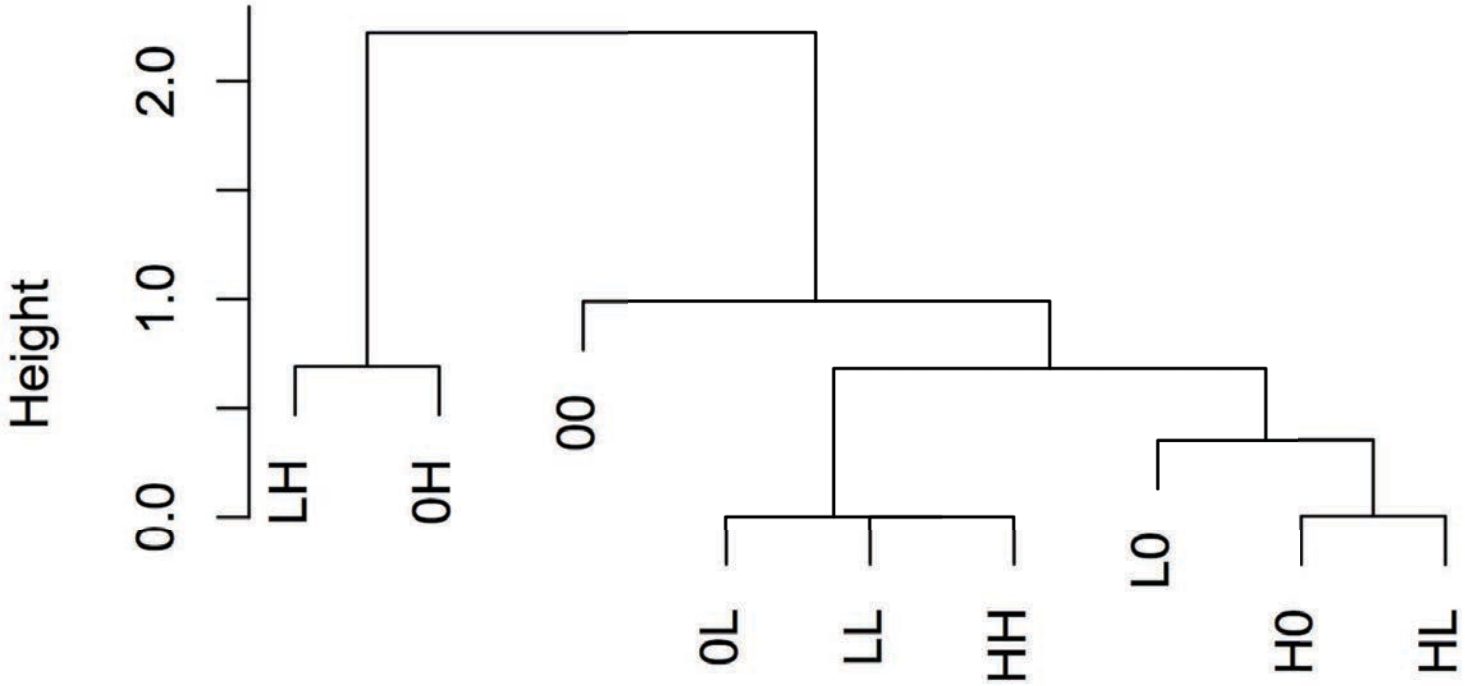
	musical sequence				
	2+ up	*1 up*	*same*	*1 down*	*2+ down*
up (LH)	**40 (80%)**	**178 (62%)**	243 (29%)	46 (12%)	0 (0%)
same (LL or HH)	7 (14%)	97 (34%)	**404 (48%)**	238 (60%)	27 (61%)
down (HL)	3 (6%)	10 (4%)	193 (23%)	**112 (28%)**	**17 (39%)**

INTERVAL SIZE

- Contrary mappings more strongly avoided in larger musical intervals
  - 1 step: 10.0% contrary
  - 2+ steps: 3.2% contrary



GROUPING OF TONAL TRANSITIONS



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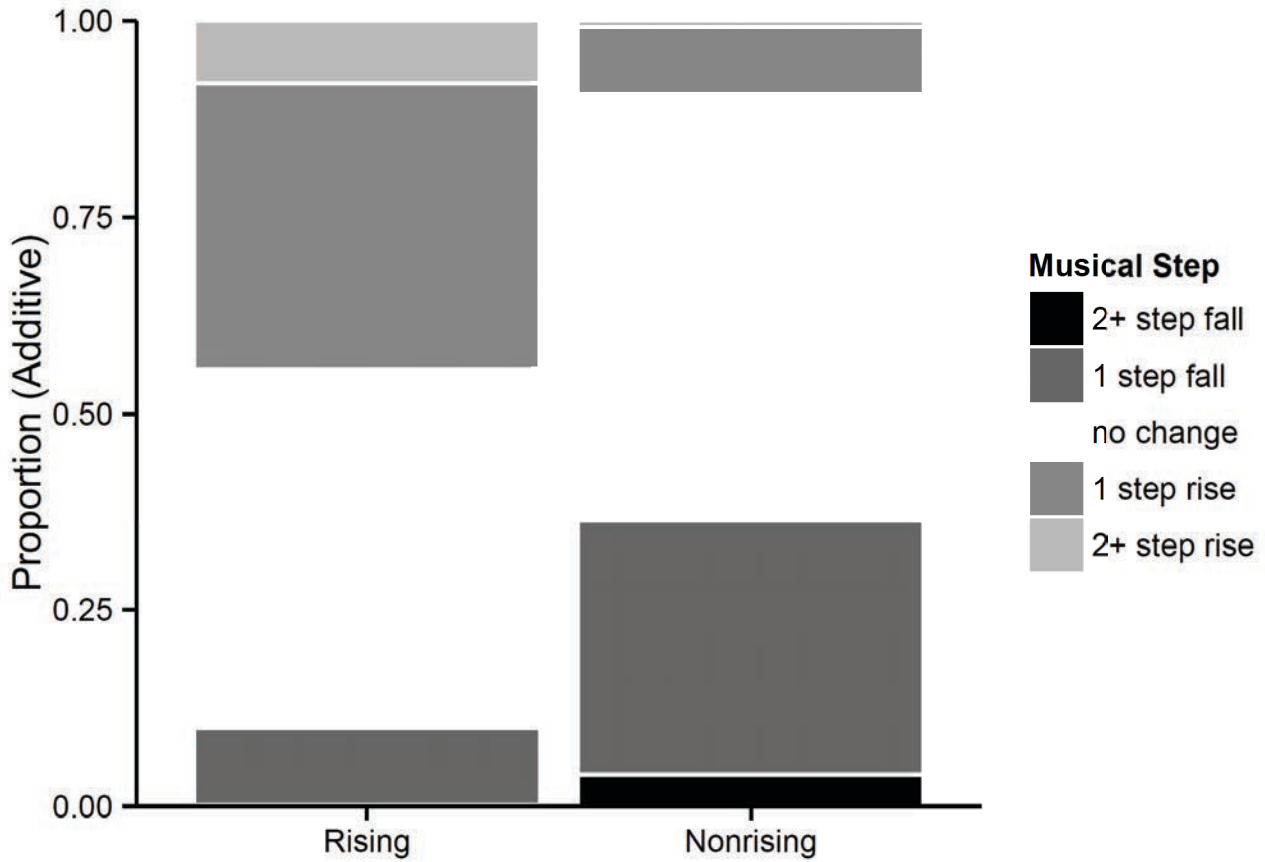


OTHER FACTORS MODULATING STRICTNESS

- Juncture strength (stricter within word than across)
- Position in line (stricter at the ends of lines)
- Lexical or grammatical tone (stricter for lexical tone)
- Rote vs. improvised material (stricter for rote)

MODELING TONE-TUNE ASSOCIATION

- Maximum entropy harmonic grammar (Goldwater and Johnson 2003, Hayes and Wilson 2008, *i.a.*)
- Input: Tonal bigram
  - Surface tone
  - Lexical tone
  - Juncture strength
  - Position in line
- Output: Musical transition

L, L Lex = LH Intraword .85
-2
-1
0
1
2

MODELING TONE-TUNE ASSOCIATION

- *CONTRARY: Penalize contrary mapping by the absolute size of the interval separating the two notes.
- Stringency hierarchies (*CONTRARY_{CG} = clitic group, *CONTRARY_{LEX} = lexical tone)
- *NONPARALLEL: Penalize any non-parallel mappings by absolute size of the interval separating the two notes.
- Musical constraints: *STEP and *UP

MODELING TONE-TUNE ASSOCIATION

L, L lex=LH, crossword	Obs'd N	Obs'd p	Gen'd p	$\mathscr{H}$	*Step .869	*Contrary .864	*Up .467	*Nonparallel .349	*Contrary$_{CG}$ .282	*Contrary$_{Lex}$ .163
a. −2	0	.000	.054	−2.436	−2	0	0	−2	0	0
b. −1	1	.026	.182	−1.218	−1	0	0	−1	0	0
c. 0	28	.737	.616	−0.000	0	0	0	0	0	0
d. 1	9	.237	.114	−1.685	−1	0	−1	−1	0	0
e. 2	0	.000	.034	−2.903	−2	0	−1	−2	0	0

RETURNING TO SPOKEN TOMMO SO

- Two insights from tonal text-setting on Tommo So phonology:
  - Rising vs. non-rising
  - Latent effect of lexical tone

RISING VS. NON-RISING

- Organizing principle of tonal textsetting
  - *CONTRARY(broad): penalize rising melody on non-rising tone and non-rising melody on rising tone
  - Inclusion improves model fit
    - Improves AIC by 6

RISING VS. NON-RISING

- Organizing principle of Tommo So (lexical) tone
- Native vocabulary entirely /LH/ or /H/ (rising or non-rising)
  - 6% of nouns are HL (mostly loanwords from Fulfulde)
- Grammatical overlays almost never rising (instead: {H}, {L}, {HL})

PHONETICS OR PHONOLOGY?

- Both HH and HL sequences are phonetically falling
  - ~.6 semitones for HH and ~3.5 for HL
- LH can be phonetically rising or level
  - Near-total downdrift (HLH)

➢ Rises are salient

PHONETICS OR PHONOLOGY?

- Tonal text-setting informed by either:
  - Phonetic facts that LH is the only tone to remain level or rise -or-
  - The phonological division between LH and H (/{L}/{HL}) in the phonological grammar

LEXICAL AND GRAMMATICAL TONE

- Latent effect of lexical tone in text-setting words with a grammatical tone overlay

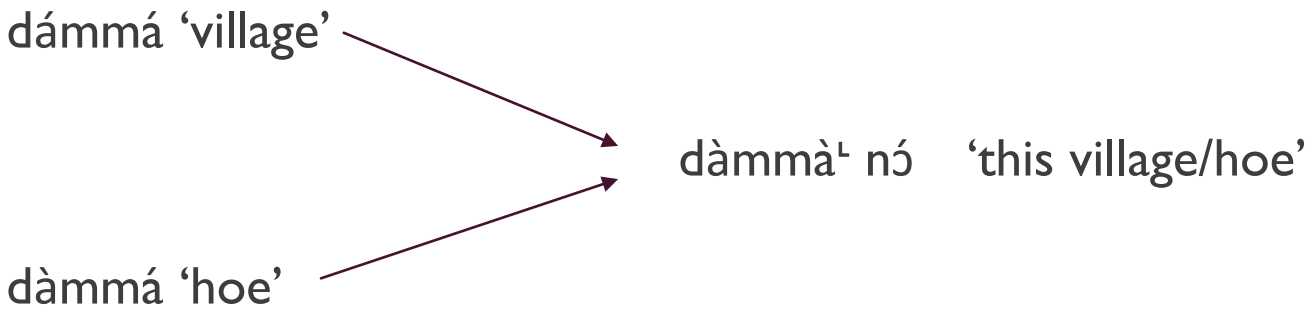
Surface tone sequence	Underlying tone sequence	% of musical changes that are rises	Out of N total bigrams
Nonrising	Nonrising	17%	116
Nonrising	Rising	36%	42
Rising	Nonrising	82%	11
Rising	Rising	100%	6

HOW WE MODELED IT

- Input contains both surface tone and underlying tone
- *CONTRARY and *$\text{CONTRARY}_{\text{LEX}}$

INCOMPLETE NEUTRALIZATION?

- Grammatical consists of word-level overlays (McPherson 2014, Heath and McPherson 2013, McPherson and Heath 2016)
  - {L} when modified by adjectives, demonstratives, relative clauses, nominal possessors
  - {H(L)} when modified by pronominal possessors (inalienable)

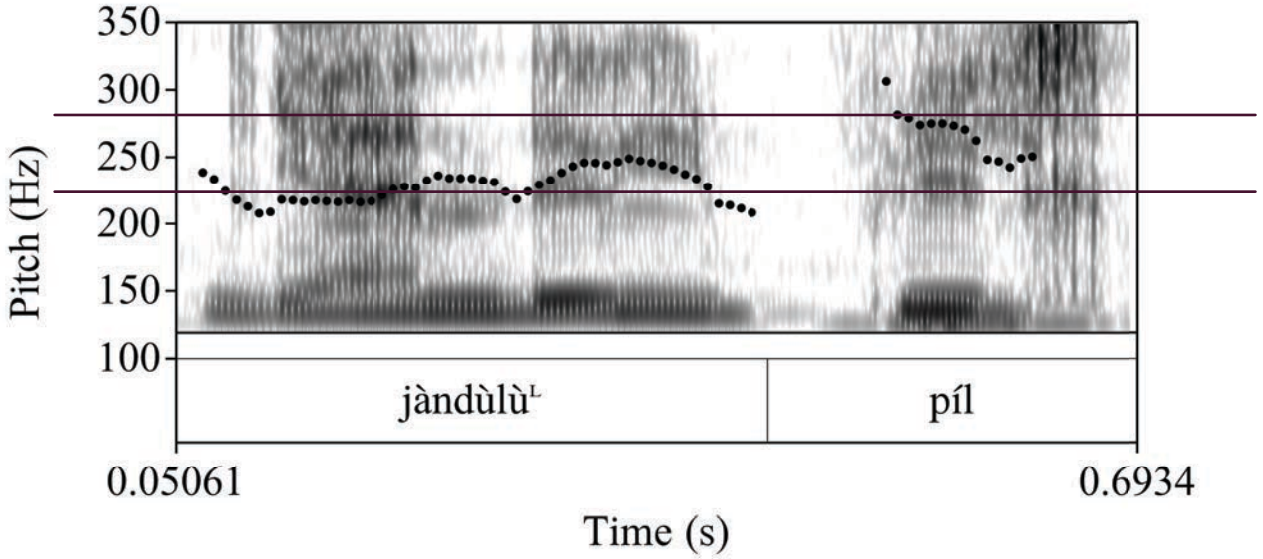


INCOMPLETE NEUTRALIZATION

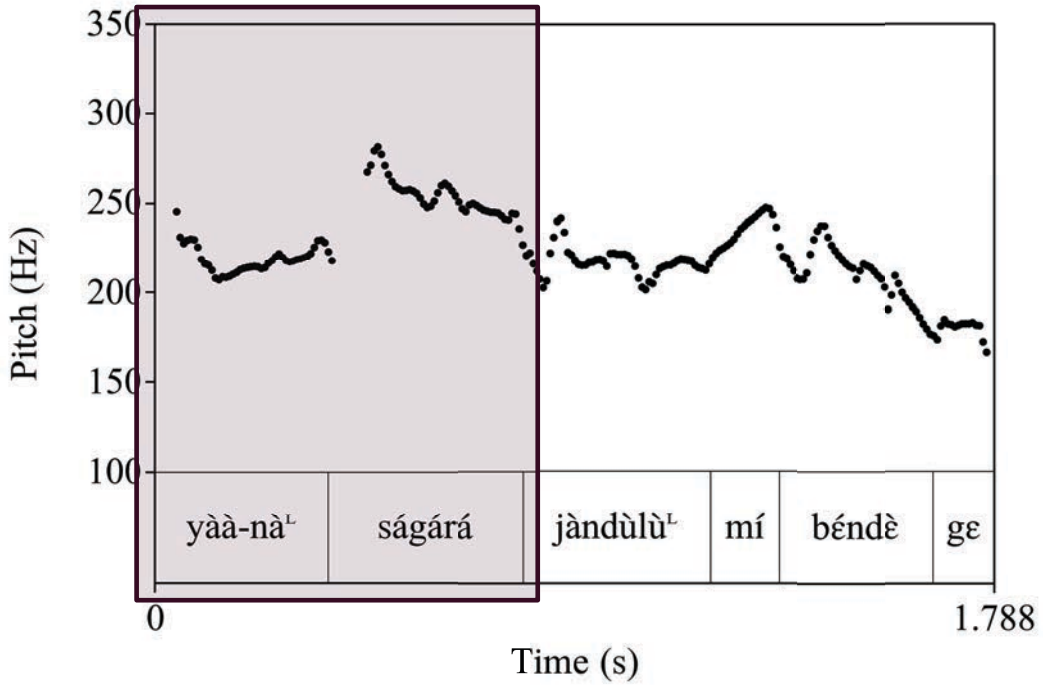
- Data suggestive of variably incomplete neutralization/application of overlays

jàndúlu ‘donkey’

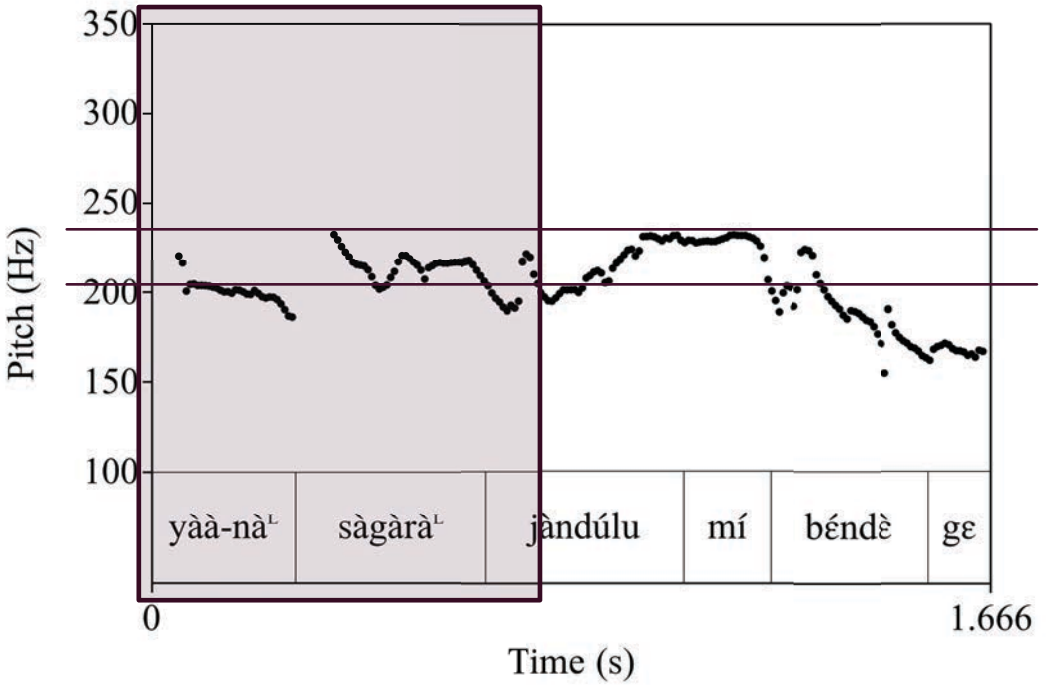
jàndùlùᴸ píl ‘white donkey’



INCOMPLETE NEUTRALIZATION



The young woman's donkey that I hit….

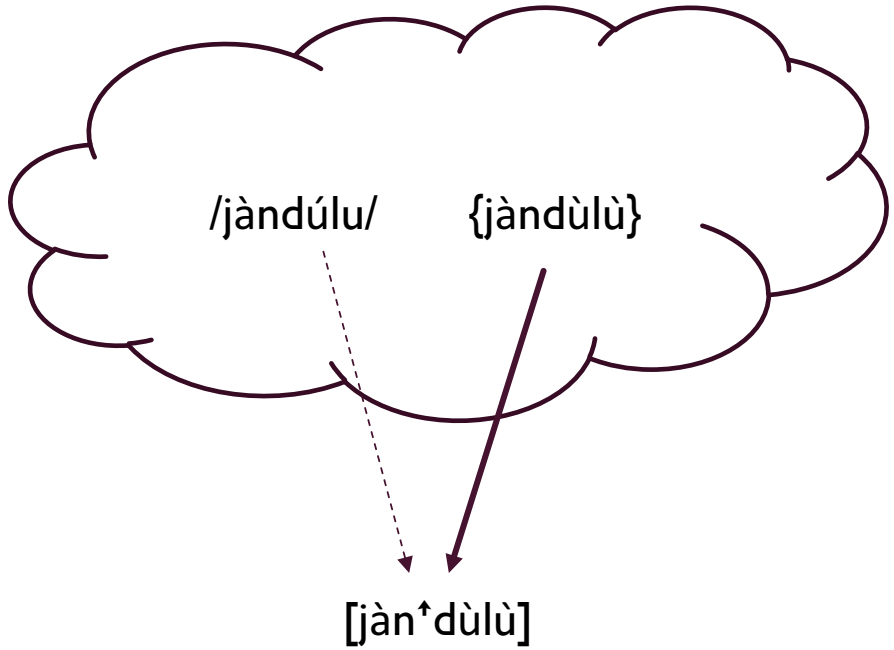


The young woman whose donkey that I hit…

PHONOLOGICAL ACTIVATION

- Lexical tone and grammatical tone both activated
  - Bleed through of lexical tone

➢ As with rising vs. non-rising, this raises question of phonetics or phonology in tonal textsetting



INTERIM SUMMARY

TOMMO SO TONAL TEXT-SETTING

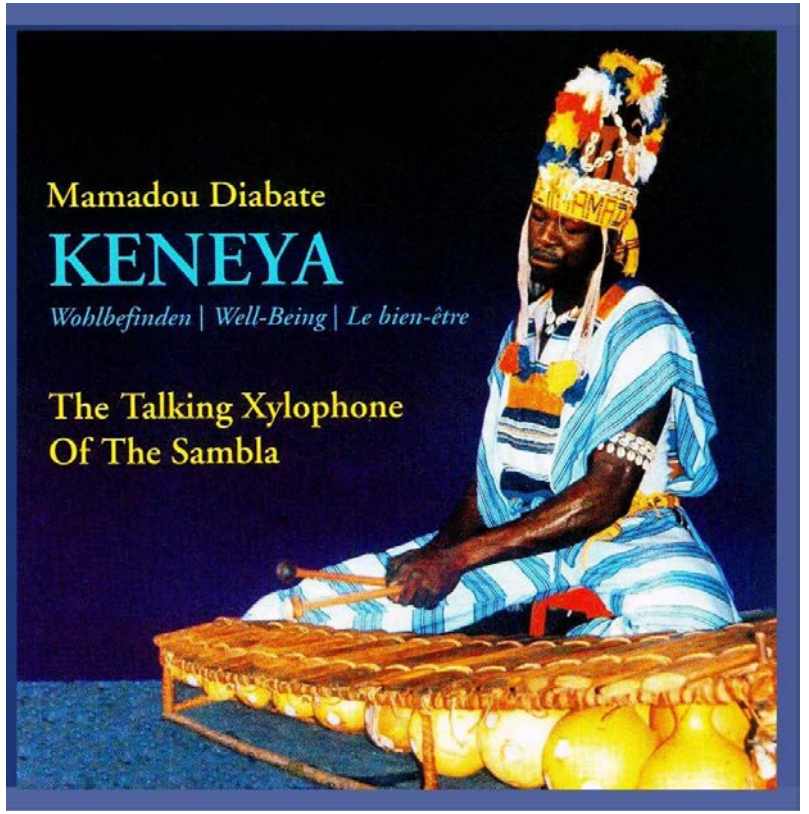
- Linguistic tone constrains musical melody
- Binary distinction between rising and non-rising tone sequences
- Strictness modulated by numerous grammatical and extra-grammatical factors
  - Many find parallels in metrics

IMPORTANT TAKE-AWAYS

- Tighter connection between phonology and phonetic implementation
- Musical adaptation is a window into a speaker's implicit knowledge of their phonology

INCREASING TONAL COMPLEXITY

- Tone-tune association in a (supposed) three-tone language?
- Seenku music in Burkina Faso

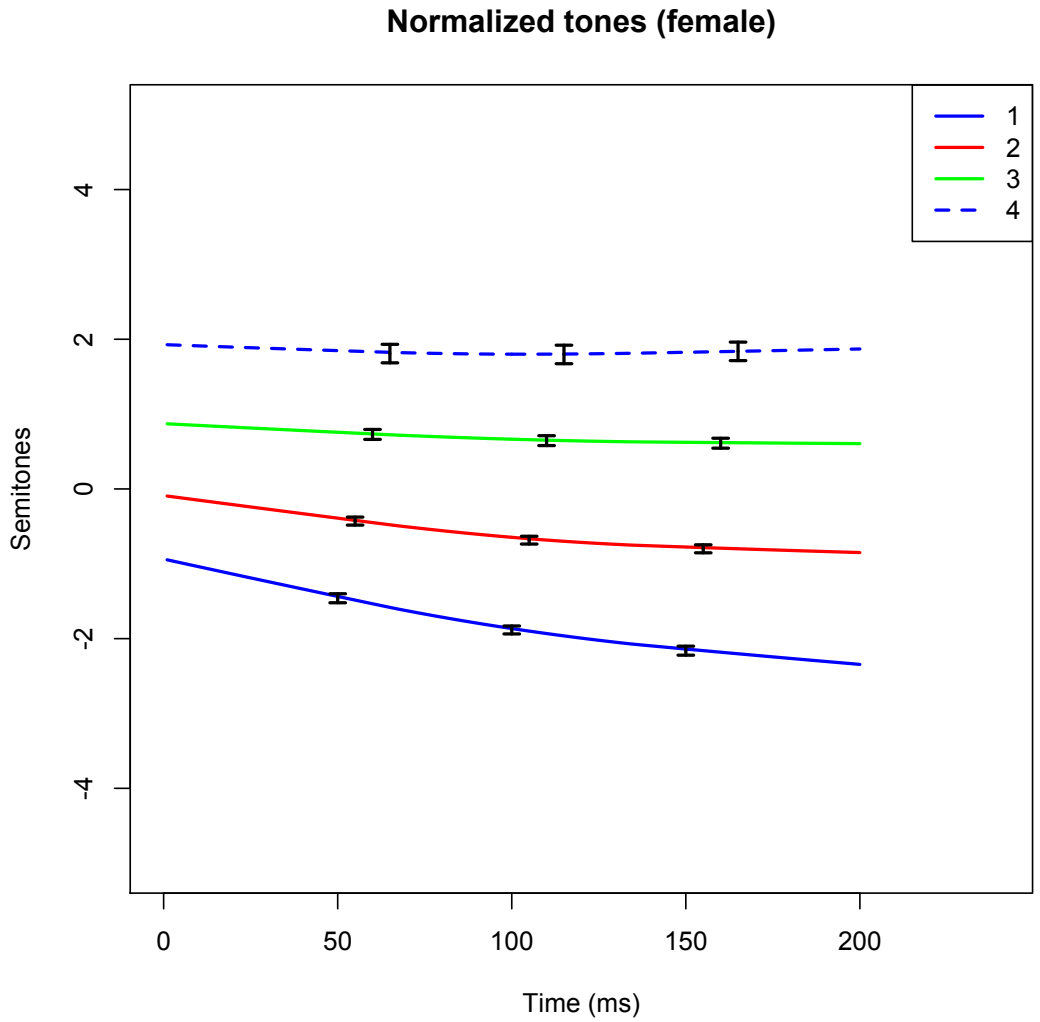


CASE STUDY 2: THE SAMBLA BALAFON

SAMBLA AND SEENKU

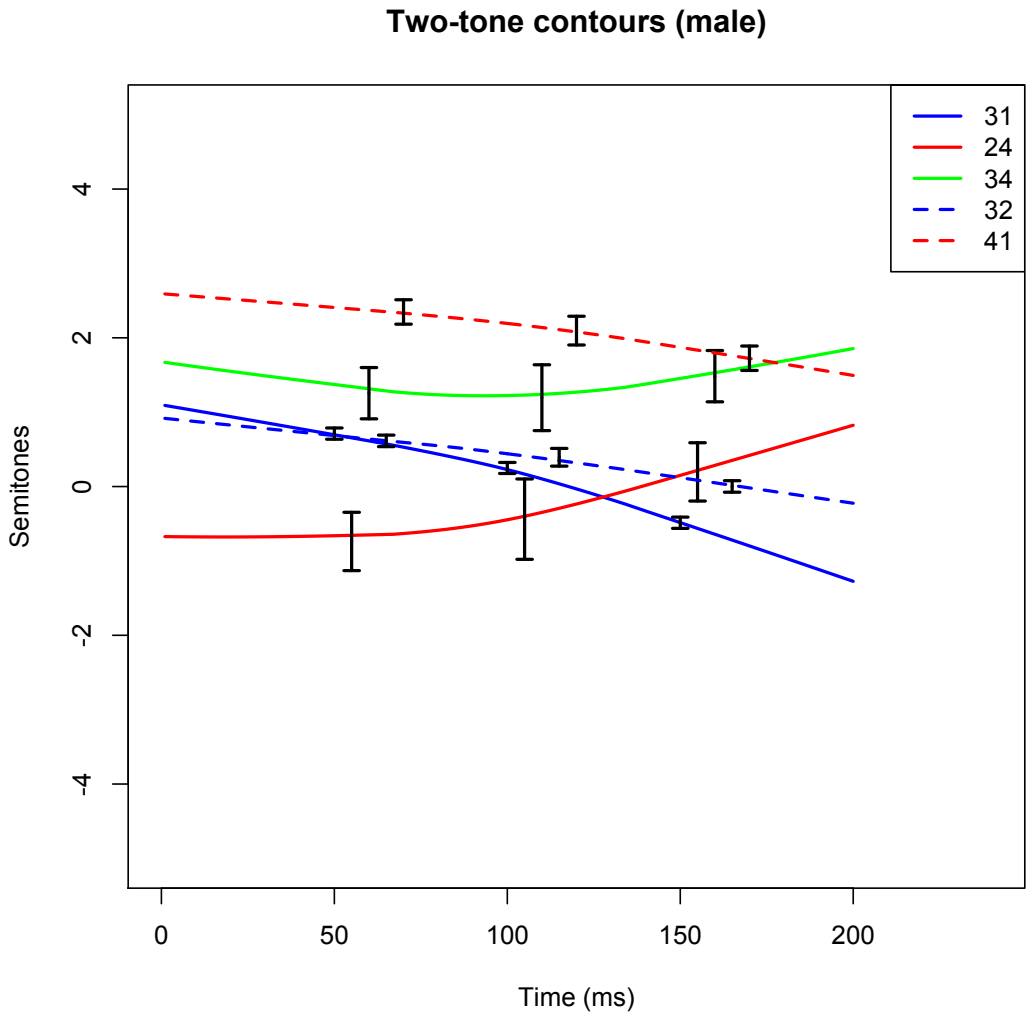
- Sambla: Mande ethnic group in southwestern Burkina Faso
  - Exonym for people and language
- Seenku: endonym for the language
- Western Mande, Samogo
- ~15,000 speakers
- Primary fieldwork 2013-present

TONE SYSTEM



- Four contrastive levels
  - Super-high (S, á)
  - High (H, á)
  - Low (L, à)
  - Extra-low (X, ầ)

TONE SYSTEM



- Multiple contours
  - Falling:
    - SX
    - SH
    - HX
    - HL
  - Rising:
    - LS
    - XH
    - HS
  - Complex:
    - XHX
    - LSX
    - HXS, etc.

WORD/SYLLABLE STRUCTURE

- Mostly mono- and sesquisyllabic (Matisoff 1990, Pittayaporn 2015)

  (Cə)CV(V)(n)

Monosyllabic		Sesquisyllabic	
tɛ́	‘who’	təgɛ̂	‘chicken’
gɔ̋ɛɛ	‘woods’	dəgɔ̌ɛɛ	‘place(s)’
dɜ̀ân	‘basket holder’	ɲəgân	’guinea fowl’

SAMBLA BALAFON

SAMBLA BALAFON

- Pentatonic scale:
  - 1
  - ♭ 3
  - 3
  - 5
  - 6

SURROGATE LANGUAGES

- Linguistic form mapped to non-linguistic modality
- Two types (Stern 1957)
  - Abridgement systems encode phonemic aspects
  - Lexical ideogram systems symbolize concepts
- Found world-wide on all sorts of instruments:
  - Drums (e.g. Yoruba, Beier 1954)
  - Flutes (e.g. Gavião, Moore and Meyer 2014)
  - Trumpets (e.g. Asante, Kaminski 2008)
  - Jaw harps (e.g. Khmu, Proschan 1994)

METHODS

- Transcribed 135 phrases for notes and inter-strike duration
  - Both elicited and naturally occurring phrases
- ~823 words
- Coded for a number of factors

Line	Word	Syllable	Tone	Note(s)	Total duration	Contour	Long	Diphthong	Sesquisyllabi	Coda
1	1	jo̍	HL	Bc3-T3	259	Y	N	N	N	N
1	2	mənì	L	T3-T3	282	N	N	N	Y	N
1	3	nǎ	LS	Bc3-B4	278	Y	N	N	N	N
1	4	mó	H	Bc3	181	N	N	N	N	N
1	5	bồ	X	Tc3	192	N	N	N	N	N
1	6	təgòn	L	T3-T3	275	N	N	N	Y	Y
1	7	təgòn	L	T3-T3	f335.416666	N	N	N	Y	Y

PRINCIPLES OF ENCODING

- Always encoded:
  - Tone (lexical and grammatical)
  - Vowel length
  - Sesquisyllabicity
- Never encoded:
  - Segmental information
- Sometimes encoded:
  - Coda nasals
  - Postlexical tone

TONE ENCODING

- M̋í 'we'
- Mó 'I' ...nă səmâ 'will dance'
- M̋̃ 'one'

TONE ENCODING

S (8)					
Sk (6)					
T (5)					
Bg (3)					
J (b3)					
B (1)					
	mí mó mə̰̃	nă		səmâ	

TONE ENCODING

- Depends on the mode of the song (i.e. no absolute tone-note mapping)
  - But the most general mode is centered around note 1 (known as the *bg̃g̃-ɲà* 'balafon-mother')

	B (1)	J (b3)	Bg (3)	T (5)	Sk (6)	S (8)
S	0	1	8	22	38	158
H	4	0	72	85	154	28
L	2	1	9	73	15	7
X	101	2	93	57	14	15

CONTOUR TONES

S (8)												
Sk (6)												
T (5)												
Bg (3)												
J (b3)												
B (1)												
Words	jò̩		mənı̀		nă		mó	bɔ̀	təgòn		təgòn	
Durations	107	152	65	217	73	182	190	193	99	188	85	…

Jò̩	mənı̀	nă	mó	bɔ̀	təgòn-təgòn
water	drink.ANTIP	PROSP	1SG	kill.IRREAL	RED-completely

'I am dying of thirst.'

VOWEL LENGTH

S (8)				
Sk (6)				
T (5)				
Bg (3)				
J (b3)				
B (1)				
Words	à	nă		kɛ́
Duration	282	41	389	…

à nă kɛ́ 'he will go'

S (8)					
Sk (6)					
T (5)					
Bg (3)					
J (b3)					
B (1)					
Words	à	nă		kɛ̀ɛ	
Duration	265	66	304	91	…

à nă kɛ̀ɛ 'it will dry up'

SESQUISYLLABICITY

S (8)				
Sk (6)				
T (5)				
Bg (3)				
J (b3)				
B (1)				
Words1	səgə̀		bâ	
Words2	bɛ̀ɛ		kərɛ̂	
Duration	78	294	71	…

səgə̀ bâ 'ram'

bɛ̀ɛ kərɛ̂ 'boar'

LEXICAL AND GRAMMATICAL TONE

- Do we see the same behavior in the surrogate language as in Tommo So text-setting?
  - No!
- Grammatical tone is always encoded
  - Both tonal morphemes and grammatically-constrained sandhi

GRAMMATICAL TONE

- Plural formation
  - Vowel fronting
  - **Tone raising**
  - Suffixation of two features, [+front] and [+raised] (McPherson 2017)

	X	L	H	S
upper	-	-	+	+
raised	-	+	-	+

bɛ̏ɛ → bɛ̀ɛ ‘pig(s)’

bí → bǐ ‘goat(s)’

GRAMMATICAL TONE

- Argument-head tone sandhi (McPherson in press, under review)
  - Possessor + inalienable noun
  - Object + irrealis verb
  - DP + postposition

à bą́	‘hit him!’
mó bą̀	’hit me!’
mí bą́	’hit us!’

GRAMMATICAL TONE

- Both encoded on the balafon

mó nă bí są̃
1SG PROSP goat.PL buy.IRREAL
'I will buy goats'

Plural: bî → bí

Sandhi: bí są̀ → bí są̃

S (8)					
Sk (6)					
T (5)					
Bg (3)					
J (b3)					
B (1)					
Words	mó	nă		bí	są̃
Duration	226	35	272	292	…

POSTLEXICAL TONE

- Rarely encoded

Contour tone simplification:

Spoken: /mó nă/ → [mó ˈnấ] or [mó nà]

Balafon: N/A

S (8)					
Sk (6)					
T (5)					
Bg (3)					
J (b3)					
B (1)					
Words	mó	nă		bĩ	są̃
Duration	226	35	272	292	…

LEVEL OF ENCODING

- Surface phonetic ← Tommo So
- Postlexical phonological
- Lexical phonological/morphophonological ← Seenku
- Underlying form

A QUESTION OF MODALITY?

- Sung music vs. surrogate speech
  - Availability of segmental contrasts
- Functional load of the tone system

➢ Would the same be true for Seenku tonal text-setting?

SEENKU TONAL TEXT-SETTING

- Koko te So
  - Vocal
  - (Balafon)
  - (Flute)

SUNG VERSION

- Absolute tone-note mapping doesn't pattern like the balafon

	B (1)	J (b3)	Bg (3)	T (5)	Sk (6)	S (8)
S	1	0	15	14	13	12
H	7	0	22	32	12	7
L	9	0	5	3	4	3
X	10	0	25	19	13	4

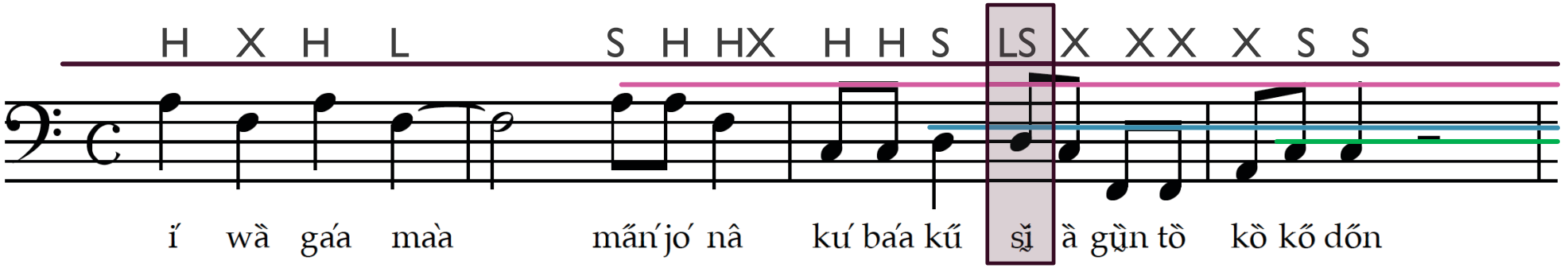
TONE-TUNE ASSOCIATION

- Strict relative (directional) tone-tune mapping:
  - Stricter than Tommo So (oblique mappings avoided)

Music: / Tone:	+2	+1	0	-1	-2
Up	**10 (83%)**	**515 (88%)**	9 (14%)	1 (2%)	2 (8%)
Same	2 (17%)	7 (12%)	**52 (80%)**	15 (31%)	3 (13%)
Down	0	0	4 (6%)	**33 (67%)**	**19 (79%)**

TONE-TUNE ASSOCIATION

- Return of postlexical tone:



LEVEL OF ENCODING, REVISITED

- Surface phonetic ← Sung music (segmental content available)
- Postlexical phonological
- Lexical phonological/morphophonological ← Surrogate speech (segmental content unavailable)
- Underlying form

DISCUSSION

MUSIC AND PHONOLOGICAL THEORY

- Musical adaptation as evidence for implicit knowledge/psychological reality of:
  - Phonetics (Katz 2015, Tommo So tonal realization?)
  - Phonological structure (Starr and Shih 2017, balafon surrogate language)
  - Allophonic variation and postlexical processes (Seenku singing)
- Evidence can be used to test boundaries between components

DOCUMENTING AND ANALYZING PHONOLOGY

- Surrogate languages a valuable tool in "decoding" a novel tone system
  - Amplifies tonal contrasts
  - Window onto underlying form

LANGUAGE DOCUMENTATION

- Documenting the linguistic practices of a speech community
  - Music as a linguistic practice
- Topic of interest to the community
- Music is also endangered

FUTURE WORK

- Further investigation of Seenku sung music
  - A disappearing tradition
- Corroborate hypotheses about phonetics-phonology interface in non-musical ways
- A larger cross-linguistic and cross-modal study
  - Do surrogate languages typically encode underlying structure?
  - Is text-setting of vocal music usually sensitive to surface realization?
  - Where does an "oral" surrogate language like whistled speech (e.g. Rialland 2005) fall?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