A foot-based reanalysis of edge-in tonal phenomena in Bambara

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I. Optimal Tone Mapping and "edge-in" tonal forms in Bambara

Bambara, a Manding language spoken in Mali, has five tone patterns for quadrisyllabic nouns (Rialland & Badjimé 1989). Data from Bambara of Bamako (Mamadou (Sangaré) Badjimé's dialect)

(1)	a.	L → LLLL	bùgùnìnkà	'a whip'
	b.	H → HHHH	jánkárábú	'a rogue'
	c.	HL → HHLL	kúlúkùtù	'a ball'
	d.	LH → LLHH	gàrìjɛ́gɛ́	'a chance'
	e.	LHL → LLHL	kòròkárà	'a tortoise'

There are no forms such as *HHHL or *HLLL. Therefore, Bambara does not employ left-to-right or right-to-left tone association and spreading. Instead, Rialland and Badjimé (1989) argue that it requires "edge-in" association and edge-in spreading of lexical tone melodies:

(2) a. kúlúkùtù 'a ball'
H L

b. gàrìjɛ́gɛ́ 'a chance'
L H

Zoll (2003) has argued for *Optimal Tone Mapping*, a theory which dispenses with "directionality" in tone mapping (i.e. left-to-right, right-to-left), but advocates interaction of constraints on tone sequencing:

(3) a. CLASH: No high tone sequence on adjacent TBUs
b. LAPSE: No non-high tone sequence on adjacent TBUs

(4) CLASH > LAPSE
ex. Kukuya trisyllables
LLL, HHH, HLL, LLH, LHL
*HHL, *LHH (violate CLASH)

(5) LAPSE > CLASH
ex. Hausa non-derived trisyllabic forms
LHL, HLH, LHH, HHL
*LLH, *HLL (violate LAPSE)

Edge-in association and edge-in directional spreading are problematic for Zoll's account (Zoll 2003:264), as edge-in forms violate both CLASH and LAPSE equally:

(6)

kulukutu *'a ball'* H L			LAPSE	CLASH
a.	HHLL	kúlúkùtù	*!	*
b. ☹	HHHL	kúlúkútù		**
c.	HLLL	kúlùkùtù	**!	

(7)

kulukutu *'a ball'* H L		CLASH	LAPSE
a.	HHLL kúlúkùtù	*!	*
b. ☹	HLLL kúlùkùtù		**
c.	HHHL kúlúkútù	**!	

We argue that Bambara tone does not require edge-in association if tones are associated within optimally bisyllabic "tonal feet" (Bamba 1991; Bickmore 2005, 2003; Leben 1997, 2002, 2003; Zec 1999; deLacy 2002):

(8) (kú.lú)(kù.tù)
H L

By adopting tonal feet, all three directional association patterns are replaced with constraints on tonal configurations. Edge-in is no longer problematic for Optimal Tone Mapping.

Moreover, tonal feet offer a better characterization than edge-in directional tone mapping for three puzzling properties of Bambara tonal melodies:

(9) i) Alternate tonal patterns of trisyllabic nouns (ex. mángòrò/mángórò 'mango')
ii) Association of the LHL tonal pattern
iii) Tone shift caused by the 'liaison high tone' in definite phrasal contexts.

II. An "edge-in" analysis of Bambara tone

Rialland & Badjimé (1989) argue that Bambara nouns have five possible tonal melodies: H, L, HL, LH, and LHL (see Appendix for a full inventory of tonal melodies and noun shapes in Bambara).

For **monosyllabic** and **bisyllabic** nouns, association is unproblematic: only H and L melodies are attested:

(10) a. bálá 'a balafon' b. bàlà 'a porcupine'

For **trisyllabic** nouns, all five attested melodies can be derived by edge-in association, supplemented by directional spreading. Tones associate to the edge syllables, then spread R-to-L to fill the remaining syllable(s):

(11)

a. mángòrò	b. bànfúlá	c. sàkéné	d. gàlàmà	e. súngúrún
H L	L H	L H L	L	H
'a mango'	'a hat'	'a lizard'	'a ladle'	'a young girl'

Edge-in association *and* edge-in spreading must be assumed for HHLL and LLHH **quadrisyllables** (see (2)). To account for tri-tonal LLHL quadrisyllables (*kòròkárà*) an edge-in analysis must stipulate:

i) tones left over after the edge syllables are filled associate preferentially at the *right* edge of the word and
ii) tones spread L-to-R to fill remaining unassociated syllables (*or* tones spread from the edge syllable inwards)

(12) a. kòròkárà b. * kòrókárà c. *kòrókàrà

Thus, Rialland & Badjimé's edge-in account requires a series of steps:

(13) i) edge-in association
ii) leftward spreading for bi-tonal trisyllables
iii) edge-in spreading for bi-tonal quadrisyllables (not full leftward spreading *HLLL)
iv) edge-in spreading or rightward spreading for tri-tonal quadrisyllables

⇒ **BUT… these patterns emerge naturally from a tonal foot account.**

III. A tonal foot approach

Basic generalizations:

(14) i. Tones associate within binary feet in bisyllabic and quadrisyllabic nouns but full binary footing is not possible for monosyllabic or trisyllabic forms
ii. Exhaustive parsing of syllables into feet is assumed, and a degenerate foot is located at the left edge of trisyllabic nouns: (σ)(σσ)

A set of high-ranked constraints governing foot construction are assumed (Yip 2002):

(15) a. MAX-T: Every input tone has an output correspondent
b. DEP-T: Every output tone has an input correspondent
c. PARSE-σ: All TBUs (syllables) must be parsed into a tonal foot
d. RH-TYPE: TROCHAIC: Feet are left-headed
e. FTBIN: Tonal feet must contain only two TBUs (syllables) *(violable)*

To ensure that the degenerate monosyllabic foot appears at the left edge in trisyllabic nouns, we employ NON-FINALITY (HD):

(16) NON-FINALITY(HD): No heads of feet word-finally

(17) σσσ ⇒ a. (σ̲)(σ̲σ) b. *(σ̲σ)(σ̲) ex. (bàn)(fúlá) (mán)(gòrò)

This is ranked above the companion constraint CLASH(HD):

(18) CLASH(HD): There are no adjacent heads of tonal feet (after Zoll 2003).

For LH and HL melodies, tones spreads within the binary foot rather than crossing foot boundaries (see Bickmore 2003, Pearce 2006), the result of a constraint ALIGN-T-HD, which requires association of lexical tones to foot heads:

(19) ALIGN(T, HD): Align the head of a tonal foot with the left edge of a tonal span (after Zec 1993)

(20)

kulukutu *'a ball'* H L	ALIGN(T,HD)	NON-FINALITY (HD)	CLASH(HD)
a. (kú̲lù)(kù̲tù) H L	*!		
b. (kú̲)(lú̲)(kù̲tù) H L	*!		**
c. ☞ (kú̲lú̲)(kù̲tù) H L			

(21)

mangoro *'a mango'* H L	ALIGN(T, HD)	NON-FINALITY(HD)	CLASH(HD)
a. ☞ (má̲n)(gò̲rò) H L			*
b. (má̲n)(gó̲rò) H L	*!		*
c. (má̲ngó)(rò̲) H L		*!	

⇒ **Under an edge-in analysis, trisyllabic tonal patterns require both edge-in association and an additional leftward spreading rule**

⇒ **With tonal feet, the constraints ALIGN(T,HD) and NON-FINALITY(HD) produce the effects of both leftwards spreading and edge-in spreading**

IV. Alternate tonal melodies of trisyllabic nouns

Only bi-tonal trisyllabic nouns have an alternate tonal melody:[1]

(22) a. HL mángòrò *'mango'* c. LH bànfúlá *'hat'*
b. mángórò d. bànfùlá

[1] Rialland & Badjimé report an additional pattern: *mángóró* and *bànfùlà*, which they relate to compounds – *mángóró-sún* 'mango tree' or *bànfùlàbá* 'big hat'. The first word bears the initial tone and the second formative is always H tone. The same pattern is found with other forms: /sàkénè - mùsò / → [sàkènèmúsó] 'female lizard'.

While the standard "dictionary" forms (22a) and (22c) satisfy NON-FINALITY (HD), the alternate forms (22b) and (22d) are those which satisfy CLASH (HD). (Note that alternate footing of mono-tonal and tri-tonal trisyllables produces no effect: (sà)(kɛ́nɛ̀) (sàkɛ́)(nɛ̀))

CLASH(HD) forces at least one TBU to intervene between the beginning of each tonal span:

(23)

mangoro *'a mango'* H L	CLASH(HD)	NON-FINALITY(HD)
a. (mán)(gò.rò) H L	*!	
b. ☞ (mán.gó)(rò) H L		*

Under an edge-in account, two opposite spreading rules are needed:

(24) a. mán.gó.rò L-R Spreading b. mán.gò.rò R-L Spreading

The tonal foot analysis and the directional spreading analysis seem comparable in this regard, but allowing for both types of directional spreading has consequences for the quadrisyllables…

V. The distribution of tri-tonal LHL melody for quadrisyllablic nouns

The LHL melody maps to a quadrisyllabic noun as LLHL (kòròkárà). We argue that this is due to constraints on tonal heads. Heads of feet prefer H tones:

(25) *HD-L: No low tones on the heads of tonal feet (de Lacy 2002)

Therefore, (LL)(HL) is preferable to (LH)(LL).

(26)

korokara *'a tortoise'* L H L	ALIGN(T, HD)	*HD-L
a. (kòró)(kárà) L H L	*	**!
b. (kòró)(kárà) L H L	**!	*
c. ☞ (kòrò)(kárà) L H L	*	*

*HD-L avoids the stipulation of rightward association of the leftover H tone found with edge-in.

Moreover, under an edge-in analysis, one expects an alternate melody for tri-tonal quadrisyllables.

Standard form: spread tone from the left edge rightward (as with *alternate* trisyllable)

(27) a. kòròkárà b. bànfùlá

Alternate form (unattested): spread tone from the right edge leftward (as with *standard* trisyllable);

(28) a. * kòrókárà b. bànfúlá

=> The ability to spread from L-R or R-L (as with trisyllables) would predict a LHHL melody (28a), which is not attested. Alternately spreading could be restricted to edge syllables, which would rule out medial spreading.

=> Under the tonal foot analysis, alternate tonal patterns in trisyllables follow from the placement of the degenerate foot (determined by NON-FINALITY(HD) AND CLASH(HD)).
Quadrisyllabic forms have only binary feet, so no alternate quadisyllables are predicted.
No additional restrictions on spreading are required

VI. High Liaison Tone and Alternation in Final Tones on Nouns

In definite phrasal contexts, a 'liaison' H tone associates to the final syllable of the noun. It changes the final L tone to H (or creates a contour in the case of monosyllables – (29a)).

(29)	*Indefinite*			*Definite*		
a.	L	bà dôn	*'It is a goat'*	L͡*H*	bă dòn	*'It is the goat'*
b.	LL	bàlà dôn	*'It is a porcupine'*	L*H*	bàlá dòn	*'It is the porcupine'*
c.	LLL	gàlàmà dôn	*'It is a ladle'*	LL*H*	gàlàmá dòn	*'It is the ladle'*
d.	LLLL	bùgùnìnkà dôn	*'It is a whip'*	LLL*H*	bùgùnìnká dòn	*'It is the whip'*
e.	HLL	mángòrò dôn	*'It is a mango'*	HL*H*	mángòró dòn	*'It is the mango'*
f.	HHLL	kúlúkùtù dôn	*'It is a ball'*	HHL*H*	kúlúkùtú dòn	*'It is the ball'*
g.	LHL	sàkénè dôn	*'It is a lizard'*	L͡HL*H*	săkènέ dòn	*'It is the lizard'*
h.	LLHL	kòròkárà dôn	*'It is a tortoise'*	LHL*H*	kòrókàrá dòn	*'It is the tortoise'*

For the LHL tone pattern, the H tone shifts leftwards (29g,h) to accommodate the extra H liaison tone.

(30)

	Indefinite		*Definite*
a.	sàkénè	b.	săkènέ
	L H L		LH LH

(31)

	Indefinite		*Definite*
a.	kòròkárá	b.	kòrókàrá
	L H L		LH LH

For definite *sǎkɛ̀nɛ́* (30b) there are four tones and three syllables. Therefore it is necessary to create a contour tone (contours only emerge when there are more tones than TBUs – MAX-T > *CONTOUR).
Rialland & Badjimé (1989) do not explain why the contour tone in *sǎkɛ̀nɛ́* appears in initial position rather than elsewhere.

The tonal foot account predicts an **initial** contour due to ALIGN(T, HD) and *HD-L. Only one footing and tone pattern emerges as optimal; there is no alternate tonal pattern for this word (CLASH(HD) and NONFINALITY(HD) are ranked lower).

(32)

sakene *'the lizard'* L H L H	ALIGN(T, HD)	*HD-L	NON-FNALITY(HD)	CLASH(HD)
a. (sa̱)(kɛ̱nĕ)	**!			*
b. (sa̱kɛ́)(nĕ)	*	*!	*	
c. (sa̱kɛ̂)(nɛ́)	**!		*	
d. (sa̱)(kɛ̱nɛ́)	*	*!		*
e. (sǎ)(kɛ̱nɛ́)	*	*!		*
f. ☞ (sǎkɛ̀)(nɛ́)	*		*	

Summary:
Tonal feet employ basic constraints on foot construction and association of tones to foot heads which:

i) captures binary tonal distribution
ii) allows for alternate forms only with bi-tonal trisyllables
iii) explains LHL tonal distribution and position of initial contour in *sǎkɛ̀nɛ́*

Edge-in association must employ a series of stipulatory constraints on association and spreading to account for basic trisyllables and quadrisyllables and requires additional stipulations to explain the LHL tonal pattern association

VII. An alternate tonal foot analysis: Leben (2002, 2003)

Leben (2002, 2003) also proposes tonal feet for Bambara, but not to address the 'edge-in' problem, only to account for trisyllabic nouns.

(33) **Ingredients of Leben's analysis**:

a) tonal feet are maximally binary
b) tonal feet parse a form exhaustively
→ trisyllabic nouns: either (σσ)(σ) or (σ)(σσ) (lexical specification)
c) tone melodies LH and H are assigned to feet
d) high 'liaison' tone in definite contexts is analyzed as part of the tonal melody of the noun (see Creissels 1978, Dumestre 1994)

(34) Tone patterns discussed in Leben (2002, 2003)
– shading indicates non-overlap with Rialland & Badjimé (1989)

	Indefinite context		*Definite context*		
a.	HHH	kámélén	HHH	kámeleń	'young man'
b.	LHH	jàkúmá	LHH	jàkúmá	'cat'
c.	HLL	mángòrò	HLH	mángòró	'mango'
d.	LLH	tùbàbú	LLH	tùbàbú	'European'
e.	LHL	nyə̀nínsà	LH͡LH	nyə̀nínsă	'fever'
f.	L͡HLL	jănkàmù	L͡HLH	jănkàmú	'black scorpion'
g.	HHL	kábásù	HH͡LH	kábásŭ	'chalk'

(35) Analysis for *definite* forms (with final H liaison tone)

a.	(Hσσ)(Hσ) / (Hσ)(Hσσ)	(kámé)(leń) / (ká)(mélén)	'young man'
b.	(LHσ)(Hσσ)	(jă)(kúmá)* → (jà)(kúmá)	'cat'
c.	(Hσ)(LHσσ)	(mán)(gòró)	'mango'
d.	(LHσσ)(Hσ)	(tùbá)(bú)* → (tùbà)(bú)	'European'
e.	(Hσσ)(LHσ)	(kábá)(sŭ)	'fever'
f.	(LHσσ)(LHσ)	(nyə̀nín)(să)	'black scorpion'
g.	(LHσ)(LHσσ)	(jăn)(kàmú)	'chalk'

Patterns (35b) and (35d) undergo a rule of H tone deletion applying at foot boundaries:

(36) *H Deletion*

L H] [H]
↓
0

b. LH H → L H
(jă)(kúmá) → (jà)(kúmá)

d. L H H → L H
(tùbá)(bú) → (tùbà)(bú)

This same rule is used to delete the 'H liaison tone' when it occurs in indefinite contexts before H-toned [té] 'it is not'[2]

(37) H L H H → H L H
(mán)(gòró) (té) → (mán)(gòrò) (té)

It is difficult to compare our analysis to Leben's due to the fact that his data source reports more tone patterns.

[2] Leben states that this tonal change does not occur before low-toned [dòn]. This is not in accordance with Rialland & Badjimé's data (which reports [dôn]) or other sources. Courtenay (1974) proposes a similar rule but triggered by a following H or #, which would account for the tone change before either a H or L toned following word. Leben further states that only words that end in a (LH) tonal foot lose the final H tone in indefinite contexts (e.g. (mán)(gòró) → (mán)(gòrò) but not (tùbà)(bú)). This is not reported in other sources. In Dumestre (1994), words like *jàkúmá* are realized as all low-toned before [té], whereas they are not in Rialland & Badjimé or other sources, so some dialectal differences must be at play.

(38) Tone patterns reported in Rialland & Badjimé (1989)

	Indefinite context		*Definite context*		
a.	HHH	súngúrún	HHH	súngúrún	'young man'
b.	LHH	bànfúlá	LHH	bànfúlá	'cat'
c.	HLL	mángòrò	HLH	mángòró	'mango'
d.	LLL	gàlàmà	LLH	gàlàmá	'ladle'
f.	LHL	sàkɛ́nɛ̀	L͡HLH	sǎkɛ̀nɛ́	'lizard'

Leben's anlysis cannot account for two main aspects of the Rialland & Badjimé data:

i) Tone shift with the LHL pattern - an initial contour in the indefinite form is not present in the definite form (indef. *sǎkɛ̀né* / def. *sàkénɛ̀* 'lizard'. Leben's analysis predicts no tone shift on a par with indef. *jǎnkàmù* / def. *jǎnkàmú* 'black scorpion'

ii) Leben's analysis cannot extend to the quadrisyllabic noun patterns. It can only generate four tone patterns (two tonal melodies LH and H x two bisyllabic feet).

(39) *Italics indicate patterns not predicted*

	Indefinite context		*Definite context*		
a.	*LLLL*	*buguninka*	*LLLH*	*buguninká*	'rogue'
b.	LHH	jánkárúbú	HHHH	jánkárúbú	'whip'
c.	HHLL	kúlúkùtù	HHLH	kúlúkùtú	'bowl'
d.	LLHH	gàrìjégé	LLHH	gàrìjégé	'chance'
e.	*LLHL*	*kòròkára*	LHLH	kòrókàrá	'tortoise'

i) it cannot derive LLLH *bùgùnìnká* or its indefinite form LLLL *bùgùnìnkà*
ii) as with sǎkɛnɛ́ / sakɛ́nɛ, it cannot derive the indefinite *kòròkára* with tone shift, predicting **kòrókàrà*

An adaptation of our analysis to Leben's data requires:

i) lexical specification of position of degenerate foot (as in Leben's analysis)
ii) LH contour tones allowed, but only in degenerate feet, no HL contours
   → LHL produces (jǎn)(kàmù) and (nyənín)(sà), disallows *(nyənìn)(sâ),
   → predicts (kábá)(sǔ) 'chalk def.' but (mán)(gòró) not *(mán)(gòrǒ) 'mango def.'
   → predicts no contours in quadrisyllables, as there are no degenerate feet
iii) definite and indefinite forms must match in tone association (output-output faithfulness)

VIII. Conclusion

Constraints on tonal feet, incorporating the notion of a foot head, offer a superior account of Bambara tonal patterns than an edge-in directional analysis.

- ♦ utilize general constraints on foot construction and tonal association
- ♦ adds to body of research connecting tone distribution to metrical structure
- ♦ Zoll (2003)'s theory of Optimal Tone Mapping is no longer undermined by the case of Bambara.

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Appendix

	Indefinite			*Definite* - *liaison H fuses with final H*		
a.	L	bà dôn	*'It is a goat'*	L+*H*	bă dòn	*'It is the goat'*
b.	H	bá dôn	*'It is a river'*	H+*H*	bá dòn	*'It is the river'*
c.	L	bàlà dôn	*'It is a porcupine'*	L+*H*	bàlá dòn	*'It is the porcupine'*
d.	H	bálá dôn	*'It is a balafon'*	H+*H*	bálá dòn	*'It is the balafon'*
e.	L	gàlàmà dôn	*'It is a ladle'*	L+*H*	gàlàmá dòn	*'It is the ladle'*
f.	H	súngúrún dôn	*'It is a young girl'*	H+*H*	súngúrún dòn	*'It is the young girl'*
g.	HL	mángòrò dôn	*'It is a mango'*	HL+*H*	mángòró dòn	*'It is the mango'*
	HL	mángórò dôn		H+*H*	mángóró dòn	
h.	LH	bànfúlá dôn	*'It is a hat'*	LH+*H*	bànfúlá don	*'It is the hat'*
	LH	bànfùlá dôn		LH+*H*	bànfùlá don	
i.	LHL	sàkénè dôn	*'It is a lizard'*	LHL+*H*	săkènć dòn	*'It is the lizard'*
j.	L	bùgùnìnkà dôn	*'It is a whip'*	L+*H*	bùgùnìnká dòn	*'It is the whip'*
	H	jánkárúbú dôn	*'It is a rogue'*	H+*H*	jánkárúbú dòn	*'It is the rogue'*
k.	HL	kúlúkùtù dôn	*'It is a ball'*	HL+*H*	kúlúkùtú dòn	*'It is the ball'*
l.	LH	gàrìjégć dôn	*'It is a chance'*	LH+*H*	gàrìjégć dòn	*'It is the chance'*
m.	LHL	kòròkárà dôn	*'It is a tortoise'*	LHL+*H*	kòrókàrá dòn	*'It is the tortoise'*