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Feeling the Beat in an African Tone Language: Rhythmic Mapping Between Language and Music

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Text-setting patterns in music have served as a key data source in the development of theories of prosody and rhythm in stress-based languages, but have been explored less from a rhythmic perspective in the realm of tone languages. African tone languages have been especially under-studied in terms of rhythmic patterns in text-setting, likely in large part due to the ill-understood status of metrical structure and prosodic prominence asymmetries in many of these languages. Here, we explore how language is mapped to rhythmic structure in traditional folksongs sung in Medumba, a Grassfields Bantu language spoken in Cameroon. We show that, despite complex and varying rhythmic structures within and across songs, correspondences emerge between musical rhythm and linguistic structure at the level of stem position, tone, and prosodic structure. Our results reinforce the notion that metrical prominence asymmetries are present in African tone languages, and that they play an important coordinative role in music and movement.

Keywords: African tone languages, music, rhythm, prosody, metrical structure

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INTRODUCTION

Music has historically served as an important, if somewhat overlooked, source of information on the prosodic organization of language. In particular, patterns of *text-setting*—or the ways in which speakers of a language opt to align text to music—have played an important role in shaping analyses of metrical structure in language (Liberman 1975), syllable weight effects (Vance 1987), and syntactic/prosodic phrasing (Lehrdal and Jackendoff, 1983; Lerdahl 2001; Dell and Halle 2009; Turpin and Laughren 2013). Indeed, some aspects of linguistic theory itself are deeply inspired by aspects of music theory, including the characterization of syllable stress as a manifestation of "prominence" interpreted through a hierarchically organized system of alternating strong and weak beats (Liberman 1975; Liberman & Prince 1977; Kiparsky, 1979; Prince 1983; Kiparsky, 2016). An example from English which illustrates the link between word-level metrical structure and musical structure is given in **Figure 1**. Many native English speakers will intuit that the two words *gérbil* and *giráffe*, which differ crucially in terms of their stress placement (initial syllable vs. final syllable), require different rhythmic structures when incorporated into the song, as demonstrated by the two different rhythmic patterns in the second measure of the song. In this particular rendition, the singer's objective is to place the stressed syllable in either word on an odd-numbered main beat of the

Abbreviations: 1, 1st person; 2, 2nd person; 3, 3rd person; ASSO, associative; CERT, certitude; CL, noun class; COP, copula; COMP, complementizer; DISC, discourse particle; EXCL, exclamative; FOC, focus; H, high tone; ITER, iterative; L, low tone; NEG, negation; OBJ, object; PL, plural; PROX, proximal; REDUP, reduplicant; SG, singular; SUBJ, subjunctive; Q, question particle; VOC, vocable.

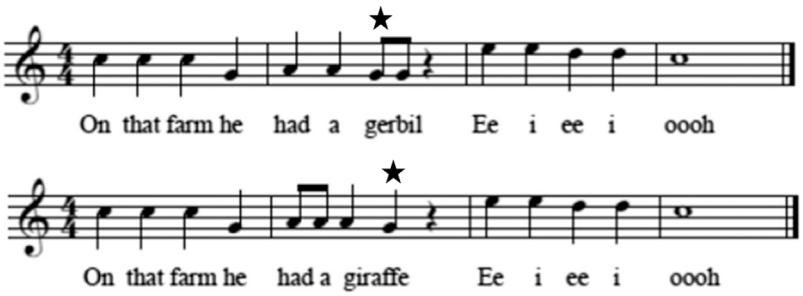

FIGURE 1 | Rhythmic strategies corresponding to *gerbil* and *giraffe* for the song Old MacDonald.

4/4 timed measure, which corresponds with the sense of where the "strong" beat in the musical line is located. Note that readers may intuit that there are other possible rhythmic strategies for the song beyond what is represented in **Figure 1**; the key observation is simply that lexical stress placement predicts the two words should be arranged differently within the rhythmic line; in either case, the stressed syllable of the target animal word is placed on the third beat of the second measure (marked with a star above it).

While the stringency of the constraints governing the mapping of stressed syllables to specific musical beats varies across languages and musical genres, stress nonetheless appears to play an important role in text-setting across a range of languages and musical traditions. For example, evidence from Spanish children's songs presented by Morgan and Janda (1989) demonstrates a tendency for musical downbeats (i.e., the first beat of each measure) to be matched with stressed syllables. They also demonstrate that mismatches between stress and beat strength are tolerated in cases where conflicts arise between a word's syllable count and its stress pattern; in other words, the musical rhythmic structure of a song line is less likely to be altered to accommodate stress patterns, as is commonly done in English songs (e.g., in **Figure 1** for *Old MacDonald*). Similarly, Temperley and Temperley (2012) show that French early 20th century folk songs display quite close alignment between linguistic metrical structure and beat strength, including the regular cooccurrence of musically strong beats with word-final syllables, which are stressed in French (Schane 1968), and the occurrence of metrically weak function words in musically weak positions. Despite this trend, they demonstrate that French songs display a greater degree of mismatch between stress and musical beat strength than English songs. The importance of stress in text-setting can also be found for languages outside of the Indo-European family. For example, Fitzgerald (1998) finds that stress placement is highly regulated in Tohono O'odham traditional songs, with stress obligatorily occurring at the beginning of every song line and prohibited from occurring at line ends. These text-setting rules appear to be quite strict, with various grammatical operations, including vacuous reduplication, employed in the songs in order for the rules to be satisfied.

Cross-linguistic variation in prosody and speech timing appear to be at play in determining some of the observed variation in the strictness of mapping between stress and musical beat structure. For example, Spanish and English have been argued to differ in their speech timing patterns, with Spanish exhibiting more even timing between consecutive syllables (*syllable timing*), and English exhibiting variable timing between syllables (primarily due to unstressed syllable reduction), but more even timing between consecutive stressed syllables (*stress timing*) (Pike 1945, Abercrombie 1967; Grabe and Low 2002; Ramus 2002)[1]. While English songs are found to condense and stretch syllable durations to occupy different musical beat ratios in order for stress to align with strong musical beats, mirroring the process of foot-internal shortening found more generally in English and other stress-timed languages (Fowler 1977; Kim and Cole 2006), this practice is not common in songs in Spanish and other syllable-timed languages[2] (Huron and Ollen 2003; Patel and Daniele 2003).

Not all deviations from stress-beat alignment are attributable to cross-linguistic or cross-dialectal variation in prosody, however. For example, Nancarrow (2010) describes a creative device in Lardil *burdal* songs in which repeated lines will be produced first in their default form with alignment between stressed syllables and musical beat structure, and then again with stress shifted to normally unstressed positions within the text. Temperley (1999) describes a similar phenomenon of *syncopation* in English-based rock music, which involves the characteristic 'misplacement' of stressed syllables onto musically weak beats. Liberman (2007) provides an alternative interpretation of syncopation as involving an underlying *polyrhythm*, such that stressed syllables, rather than being paired with weak beats, are paired with beats which are actually strong if interpreted relative to a competing rhythmic line which is in opposition to the song's primary rhythmic pulse. An example which Liberman draws on is from the Afro-Cuban "habanera rhythm" (also commonly known among music theorists as the *clave* rhythm), which is shown to involve a 3 + 3+2 beat pattern (contrary to the "square" 4 + 4 pattern found across many musical traditions, including in European classical and folkloric music). Indeed, Mead (2007) shows that

[1]Note that many varieties of English show patterns more consistent with syllable-timing (Mesthrie & Bhatt 2008).

[2]Note that Spanish does display some patterns of rhythmic adjustment, as in cases of synalepha (metrically driven vowel elision), which frequently take place within sequences of function words (Espinosa 1924).

stress placement in music featuring this rhythm is driven both by attraction to typically strong beats within a 4 + 4 meter, as well as (to a lesser extent) by the placement of rhythmically accented beats within the habanera pattern.

Thus, stress-beat alignment strategies vary as a function of language and as a function of rhythmic structure within a given musical tradition. In spite of this variability, the role of stress itself in guiding text-setting practices is robust across a wide variety of languages and contexts. Given the importance of stress in determining rhythmic alignment in text-setting, an interesting question concerns whether languages which lack clear evidence of stress—as is the case for many lexical tone languages—also show evidence for rhythmic constraints on text-setting, and if so, how these constraints can be characterized. While correspondences between tones and musical melody have been investigated in some depth in a variety of tone languages, including Cantonese, (Chan 1987; Wong and Diehl 2002), Dinka (Ladd and Kirby 2020), Fe'Fe' (Proto 2016), Hausa (Richards 1972), Mandarin (Chan 1987; Wee, 2005), Shona (Schellenberg, 2009; Schellenberg, 2012), Thai (Ketkaew and Pittayaporn 2014), Tommo So (McPherson and Ryan 2018), Vietnamese (Kirby and Ladd 2016), and Zulu (Rycroft 1959), rhythmic considerations in these languages have received less attention. Interestingly, in some of these languages, tone and rhythm appear to interact in terms of influencing text-setting constraints. In Mandarin Chinese, for example, various studies have suggested that tones occurring on metrically prominent syllables[3] (sometimes termed "prosodic heads") are more resistant to tone sandhi phenomena, whereas non-prominent syllables are more flexible in this regard. In a text-setting study of Mandarin songs, Wee (2015) finds that musical beat structure has a similar influence on tonal melody: while there is a close correspondence between musical melody and phonemic tone value on rhythmically strong beats in the music (a phenomenon Wee refers to as "tonal integrity"), rhythmically weak beats are more tolerant of melody-tone mismatches. Similar findings have been reported for so-called "pitch-accent" languages, such as Japanese (Cho 2017).

Investigations into the role of linguistic rhythm in text-setting have been even sparser among African tone languages[4]. There are likely various reasons for this gap. First off, there has been considerable debate over the existence of stress in many of these languages (see Downing (2004), Downing (2010) for comprehensive overviews); indeed, some researchers have gone so far as to question whether it is even necessary to posit metrical structure in such languages at all (Odden 1999; Hyman, 2014; Hyman, 2015). While several studies have identified possible correlates of metrical structure in African languages beyond canonical stress cues, such as positional restrictions on consonant and vowel contrasts (Akinlabi and Urua 2003), vowel harmony patterns Pearce (2006, 2007), tone spreading patterns (Downing 1990; Leben 2002, 2003; Weidman and Rose 2006; Green 2015), and other morphophonological patterns (Dimmendaal 2012; Green 2015), it has been unclear until recently whether any of these patterns can be linked with rhythmic prominence similar to that found in stress languages[5]. Another reason why rhythmic text-setting studies on African music may be uncommon is that the rhythmic structure of music in many African cultures—including those of broad swaths of West and Central Africa—is characterized as polyrhythmic, meaning that several rhythms may be at play in a given piece of music at one time. For researchers unfamiliar with such rhythms, the task of locating a central "beat" on which to base an analysis may prove challenging.

Given this gap in the literature on rhythmic text-setting in African music, the present work seeks to provide an analysis of text-setting patterns in one particular language and musical context, that of Medʉmba folk songs from the West Region of Cameroon. Medʉmba is an interesting language to examine due to the fact that it shares with several other African tone languages positional restrictions on vowel and consonant contrasts which are characteristic of metrical prominence alternations; recently, (Franich, 2017; Franich, 2018; Franich, 2021) has shown that these asymmetries are linked with rhythmic timing, similar to stressed syllables in languages which have stress. We ultimately show that there are a number of restrictions on how syllables in Medʉmba can be rhythmically mapped to song which depend on such factors as position of a syllable within the stem, tone, and morpho-prosodic status.

Another aspect of the present work which will be of theoretical interest is the fact that Medʉmba folksongs bear the hallmark polyrhythmic structure of West and Central African music, allowing us to investigate how distinct rhythms within the music align with linguistic structure. Our analysis reveals that mapping between metrically prominent syllables and strong beats is flexible across different songs, and even within songs, depending on rhythmic mode. Nonetheless, mapping between linguistic structure and beat structure is far from random: we show that certain syllable types pattern together consistently within a rhythmic mode, whether they are being treated as "prominence-attracting" or not. We also show that some apparent deviations in the mapping of linguistic prominences to strong beats can be understood to constitute an alternative mapping of these elements to competing rhythmic patterns which are reinforced by the drummers within the ensemble (the master drummer, in particular).

[3]While there has been considerable debate as to the existence of stress in Mandarin, a growing body of research supports the idea that metrical prominence asymmetries do exist, even if not marked phonetically by stress (Chao 1948; Yip 1980; Duanmu 1990; Duanmu, 1996; Duanmu, 2004; Moore 1993).

[4]Notable exceptions to this generalization include Schuh (2010) and Schuh (2014) which investigate rhythmic factors such as syllable weight in text-setting patterns in Hausa and other Chadic languages.

[5]Some research within music theory has suggested a role for syllable stress in text-setting in African music (e.g. Agawu 1995; Temperley 2000), but these studies tend not provide a clear linguistic definition for stress.

FIGURE 2 | Photos of the metallophone ("complex ndŭnlàm") and the idiophone ("simple ndŭnlàm") **(left)** and nə̀cà' tin shakers, tómŋkà' standing drum, and the mɛ́nfámə́ sitting drum **(right)**.

TABLE 1 | Consonant and vowel distributions by stem position and affix type.

Consonants				
Stem-initial (48)	Stem-medial (7)	Stem-final (7)	Prefix (1)	Suffix (1)
ᵐʙ, ᵐb, ᵐbʷ, ⁿt, ⁿd, ᶮc, ᶮcʷ, ᶮɟ, ᶮɟʷ, ᵑk, ᵑg, ᵐv, ⁿz, ⁿzʷ, ⁿts, ⁿdz, ⁿʧ, ⁿʤ, ᶮʷ, ᵑʷ, ʙ, b, bʷ, t, d, tʰ, c, cʷ, k, kʰ, kʷ, m, n, ɲ, ŋ, f, v, s, sʷ, z, ʒ, ɣ, ts, dz, ʧ, ʤ, j, l	b, ʔ, l, ɣ, m, n, ŋ	p, t, k, ʔ, m, n, ŋ	n	d
Vowels				
Stem-initial (11)	Stem-medial	Stem-final (1)	Prefixes (1)	Suffixes (1)
i, u, ɪ, ʉ, e, o, ɛ, ɔ, ə, a, ɑ	N/A	ə	ə	ə

The paper proceeds as follows: in §2, we provide an overview of the two Medʉmba folkloric songs investigated in the study. In §3 we provide details of some aspects of phonological and morphological structure in Medʉmba which are most likely to be relevant to text-setting behavior. We then describe our text-setting methodology in §4, and provide results and discussion of this analysis in §5 and §6.

DATA SET

Our data set consists of two Medʉmba folksongs sung in the context of a *ntánlá'* community meeting in the Lafeng quarter of Bangoulap village, located southwest of the city of Bangangte.

The *ntánlá'* meeting is held every 8 days per the Bamileke calendar. *Ntánlá'* derives from *ntáná* meaning "market" and *lá'* "village", literally translating to "village market day", or the day when people rest from manual labor and attend the market to buy and sell goods. The meeting serves primarily as a site for community governance. *Ntánlá'* meetings also serve an important function of bringing community members together during major events, such as after the death of a member, or in preparation for a member's wedding or move to a new location. In our case, the occasion was the return of the second author to his village after being away, and a visit from the first author as a guest. Under all of these special circumstances, music and dance typically take place in combination with monetary transactions meant to fund funeral services, medical expenses, or moving expense (see Jo-Keeling 2011 for details on the link between banking and music-making in Bamileke culture).

The specific style of music to be described comes from the *Làm* folk music tradition, which translates to "iron" or "forge", as it is historically the music of blacksmiths in the region (see Lendja 2016 for a deep history of ironwork in the Bamileke region). *Làm* music is played by a percussion ensemble which is made up of various members of the community; different members may be present and playing instruments on any given meeting day. Many of the instruments played within the ensemble, including the *ndŭnlàm* metallophone and idiophone which keep the pulse of the music, are made of iron. The ensemble is led by a master drummer, who is a fixture of the ensemble. Master drummers are typically identified at a young age within the community and are trained throughout their lives to play the rhythms of local songs. The ensemble recorded for the present work included the metallophone and idiophone, both referred to as *ndŭnlàm* (elsewhere we will refer to the metallophone as the "complex *ndŭnlàm*" and the idiophone as the "simple *ndŭnlàm*"), the *nə̀cà'* tin shakers, the *tómŋkà'* standing drum, and the *mɛ́nfámə́* sitting drum, played by the master drummer (**Figure 2**).

Historically, *Làm* is a music born out of the activities of the forge, to perpetuate in the context of an ensemble the noise and dialogue of the anvils and other tools emanating from local workshops around the village all day long. Importantly, *Làm* music was used as a tool for advertising the products of the forge, such as hoes, dibbles, and other farming equipment, which were on display on tables next to the musicians. The music was used to draw interested customers, and to entice

community members to dance in order to create an even more alluring spectacle for potential buyers. Nowadays, *Làm* music is typically accompanied by a circular dance which is performed by making a round around the musicians who play their different instruments in the center of the performance space. Songs consist of a call and response pattern, with the master drummer calling out to members of the community—often using traditional names of community members—and the community responding in kind. *Làm* music and dance events are some of the most egalitarian of such events in Bamileke culture, given that they are sung and danced without a mask (a feature of certain, more sacred dance rituals), and that they welcome all singers, dancers and instrumentalists regardless of gender or social rank. Just like other folkloric music of the Bamileke people, such as *Késsoú*, *Máŋgàmbéu*, and *Nètchà*, where singers display their talents in a free and creative style, *Làm* events provide the master drummer and other community members the opportunity to express themselves and for the master drummer to speak to the community through song. Through his song, the master drummer greets the community, and also tells the history of the village through proverbs and through listing community members' traditional names and their relationships to one another. The present work will focus specifically on the rhythmic structure of these speech-based songs, how they map to the rhythms played by the instruments in the *Làm* ensemble, and, most importantly, how these musical rhythmic structures interact with aspects of Medʉmba linguistic structure.

PHONOLOGICAL AND MORPHOLOGICAL STRUCTURE IN MEDʉMBA

There are a variety of ways in which linguistic structure has been found to interact with rhythmic properties in music, several of which will be considered in the present section in the context of Medʉmba *Làm* music. As mentioned previously, metrically prominent syllables (whether indexed phonetically by stress, or not) tend to co-occur with musically strong beats across languages. First, we outline various segment-level patterns in Medʉmba which provide evidence for metrical foot structure, which we hypothesize may interact systematically with musical rhythmic structure. We then discuss tonal patterns, which, in addition to interacting with melodic patterns in music, have been shown to influence rhythmic patterns, as well. Finally, we consider evidence from syllable structure and tone in the context of possible syllable weight distinctions, which are also know to play into text-setting patterns in various languages.

Segmental Structure

Medʉmba is one of dozens of Bamileke languages classified within the Eastern Grassfields subgroup of Grassfields Bantu. While evidence suggests these languages are descended from Proto Bantu, Medʉmba and other Grassfields languages look quite different from many well-studied Eastern and Southern Bantu languages in that they have more isolating morphology and have lost many segmental affixes typical of Bantu, some of which persist instead in the form of floating tone morphemes (Voorhoeve 1971; Hyman 2003). Medʉmba patterns with other Grassfields Bantu languages, as well as other Bantu languages from the Northwest regions (those located in Guthrie zones A and B; Guthrie 1948) and several non-Bantu languages of West and Central Africa in exhibiting positional prominence effects, such that stem-initial syllables bear a greater number of consonantal and vocalic contrasts than do non-initial and non-stem syllables (see Hyman et al., 2019 and references therein). In Medʉmba, in stem-initial position and in monosyllabic stems, 48 consonants and 11 vowels can appear (**Table 1**)[6]. In non-initial position, the number of contrasts is reduced to 7 consonants and one vowel ([ə])[7]. Medʉmba displays few segmental affixes, but those that do exist exclusively contain the vowel [ə]. Additional positional restrictions on tone are discussed in Franich, 2021.

Non-compound native stems in Medʉmba are for the most part either monosyllabic (N)CV or (N)CVC or disyllabic (N)CVCV. As described in Franich (2021), in disyllabic forms, distributional asymmetries of consonants shown in **Table 1** derive in part from a lenition process, as demonstrated in examples like (1,2), which targets consonants occurring in foot-medial position[8]. Words such as *ᵐbʷáɣə́* "fire" and *ᵐbálə́* "hill" are realized as disyllabic in isolation or phrase-finally (1a-b), and as monosyllabic phrase-initially or phrase-internally (1c-d). As seen in (1a), the velar stop /k/ is realized as [ɣ] word-internally due to spirantization (as well as voicing). A similar pattern is found for the consonant /d/, which lateralizes to [l] in the same environments where /k/ undergoes spirantization (1b).

(1) Spirantization of /k/ and lateralization of /d/

a.	ᵐbʷáɣé	'Fire'	/ᵐbʷák**k**é/[9]
	sáɣé	'Sauce'	/sák**k**é/
b.	ᵐbálé	'Hill'	/ᵐbád**d**é/
	ᵐvɛ̀lé	'Brother	/ᵐvɛ̀**d**é/

[6]This list includes most of the same consonants and vowels described by Voorhoeve (1965), Voorhoeve (1976), with some departures. For example, while Voorhoeve argued for a contrast between /k/ and /g/ in the language, we find no evidence that these are distinct phonemes in the Bangangte/Bangoulap dialects. Furthermore, root-internally, Voorhoeve's /mf/ is always produced as /mv/ in the dialects examined here; we therefore transcribe them as such. Aspirated consonants are contrastive in loanwords only. Finally, the vowel inventory is updated in places to reflect more recent acoustic analyses of the Bangangte dialect by Olson and Meynadier (2015). Vowels analyzed as diphthongs by Voorhoeve (1965) are also excluded from the present discussion.

[7]Note that in stem-final position, plosive consonants become devoiced.

[8]While Danis (2011) analyzes lenition as conditioned by the prosodic word, Franich (2017), Franich (2021) provides arguments for why a foot-based analysis is more appropriate.

[9]Voorhoeve (1965) treats the underlying medial consonants in examples like (1–3) as /g/ and /d/, rather than /k/ and /d/ (thereby allowing for a more unified treatment of lenition as targeting consonants which are [+voice]). As mentioned in footnote 6, we find no evidence synchronically for a contrast between /k/ and /g/, and velar stops are realized by default as voiceless (with voiced [g] predictable in contexts where it occurs, such as within some prenasalized sequences). We therefore opt to treat the underlying form of the medial consonant in the forms in (1–3) as /k/.

(2) Foot structures for Medʉmba nouns and verbs

a.	$_{Ft}(^{m}b^{w}á\gamma é)_{Ft}$ $_{Ft}(ká\gamma é)_{Ft}$	b.	$_{Ft}(^{m}bálé)_{Ft}$ $_{Ft}(tɛ́lə́)_{Ft}$

As demonstrated in Franich (2017, 2018, 2021), stem-initial syllables in Medʉmba display evidence of rhythmic prominence in speech timing, while stem-final syllables, prefixes, and suffixes display evidence of rhythmic weakness. Assuming that foot/stem-initial syllables behave as rhythmically prominent in music (as they have been found to in speech production), we might expect there to be a systematic relationship between these syllables and musically strong beats.

Pronominal enclitics, which also trigger lenition (if vowel-initial) but which realize the full range of vowel contrasts in the language (3), behave similarly to stem-initial syllables in showing rhythmic prominence in speech timing, though they may be undergoing a process of prosodic weakening.

(3) Lenition triggered by pronominal enclitics

a.	mbwáɣ=ám	mbwáɣ=ú
	'My fire'	'Your fire'
	sáɣ=ám	sáɣ=ú
	'My sauce'	'Your sauce'
b.	mbál=ám	mbál=ú
	'My hill'	'Your hill'
	mvél=ám	mvél=ú
	'My brother'	'Your brother'

Assuming that pronominal enclitics behave similarly to stem/foot-initial syllables in their rhythmic timing in music, we expect similar co-occurrence patterns to hold for both stem/foot-initial syllables and pronominal enclitic syllables in text-setting.

Tonal Structure

Phonemically, Medʉmba has only a binary tonal contrast between high and low tones. Falling and rising tones can occur in many contexts, though they are analyzable, as in most other African tone languages, as sequences of level tones (Leben 1971; Goldsmith 1976; Clements and Goldsmith 1984). For example, verb stems carry one of two tone melodies, H or LH, and can be either monosyllabic or disyllabic. As can be seen in (4), monosyllabic verbs can host LH contours, while the LH melody is distributed as a sequence of two level tones on a disyllabic verb. Phrase-internally, disyllabic verbs are reduced to monosyllabic (N)CVC structure. Reduced verb forms with a LH melody are also realized with a contour tone (4c). For disyllabic verbs with a H melody, reduced forms are realized with a single high tone (4d).

(4) Mono- and disyllabic verbs with H and LH tone melodies

a.	zí "sleep"	zíné "walk"[10]	(phrase-final form)
	ʒú "eat"	ʒʉmə́ "be dry"	(phrase-final form)
b.	bă "be ripe"	bàɣé "split"	(phrase-final form)
	sŏ "press"	sɔ̀ŋé "throw"	(phrase-final form)
c.	zín "walk" (phrase-internal form)		
	ʒʉm "be dry" (phrase-internal form)		
d.	bằk "split" (phrase-internal form)		
	sɔ̀ŋ "throw" (phrase-internal form)		

Falling and rising tones can occur as a result of various other processes, including docking of a floating tone morpheme to a word which is already specified for a tone, as in some instances of the associative construction (5).

(5) Tonal morpheme docking in the associative construction (Voorhoeve 1971)

a.	bàm	ɣ́	mə́n	→	bằm ˩mə́n	'Sack of the child'
	Sack	ASSO	Child			
b.	mə́n	ɣ́	mə́n	→	mə̀n mə́n	'Child of the child'
	Child	ASSO	Child			

Contours may also form where two morphemes merge and a vowel is elided but its tone remains, as happens with a sequence of a complementizer and a pronoun, or a copula and an object focus marker (6).

(6) Tonal contours resulting from merging/vowel elision

a.	zə̀	+	á	→	zə̂
	COMP		1SG.FOC		COMP.1SG
b.	bə́	+	à	→	bə̂
	COP		FOC		COP.FOC

Verbs also undergo a process of tonal overwrite in relative clause, *ex-situ wh*-questions, and in the subjunctive mood, such that all verbs are realized with a falling contour in those contexts, even if underlyingly high toned (7) (Voorhoeve 1976; Keupdjio 2020). Various other morphemes, such as some tense markers, also bear contours which appear to have arisen through historical processes of vowel loss and tone docking.

(7) Falling tone overwrite in relative clauses and *wh*-constructions

a.	bă "be ripe" (main clause form)	bâ "be ripe" (relat./*wh*-/subjunctive form)
b.	zí "sleep" (main clause form)	zî "sleep" (relat./*wh*-/subjunctive form)

One potentially interesting question concerns whether contours formed from different sources—for example, those arising from a word's lexical tone alone vs. those formed

[10]It is standardly assumed, in order to avoid a stem-internal Obligatory Contour Principle violation (Leben 1971), that the high tone in disyllabic examples such as those in (4a) is a single tone linked to both stem syllables (Hyman and Tadadjeu 1976).

through morphological processes—show different patterns in text-setting in Medʉmba. For example, McPherson and Ryan (2018) show that melodic text-setting requirements are more stringent in Tommo So for lexical tone vs. grammatical tone. One could imagine a similar type of dichotomy when it comes to rhythmic constraints; we will explore this possibility in the current data set.

Morphology: The Associative Construction

Another aspect of linguistic structure which will be important to consider in our analysis pertains to morphologically complex forms, including compounds and possessive forms, all of which are formed in Medʉmba using the associative construction, as was seen in (5). This description also extends to traditional names, which typically involve this construction. Though the associative construction can be used to form verbs and adjectives, we limit ourselves here to a description of noun-based constructions, which were the most common within our song dataset.

In the associative construction, the noun class of the head noun in the construction (the leftmost noun) determines the tone of the associative morpheme (H or L) and this tone then docks to the head noun to mark the construction (Voorhoeve 1971). Generally speaking, if the associative tone is opposite that of the head noun, it forms a contour (5a,b); if the two tones match, they merge into a single level tone (8a)[11]. As can be seen in (8b-e), aside from possessive relations, a variety of other relationships between nouns can be conveyed through the associative construction, and several words can be combined to form multiple embedded associative relations. Some of the names of instruments to be described in the present study are also formed through the associative construction (8b).

(8) Examples of the associative construction

a.	mvə̀n chief	x̀ ASSO.CLI[12]	mə́n child	→	mvə̀n mə́n	"Chief of the child"
b.	ndùn drum	x́ ASSO.CLII	làm Iron	→	ndʉ̌nlàm	"Metallophone"
c.	ndà house	x́ ASSO.CLV	ncà Word	→	ndǎncà	"Palace of justice"
d.	ndǎncà pal. of just	x́ ASSO.CLV	Bangangté Bangangté		→	ndǎncǎ Bangangté "Bangangté palace of justice"
e.	nyə̀m creature	x̀ ASSO.CLI	nkù PL.leg	x̀ nkuə̀ ASSO four	→	nyə̀mnkùnkuə̀ "Quadruped"

The associative construction is commonly used in the construction of traditional names, including those referred to as ndàp, which are assigned by generation to children through the mother's side (though women also receive a separate ndàp from the father's side). Some of these names are semantically transparent, such as *ʙʷǒndà*, comprised of *ʙʷǒ* "good" and *ndà* "gift," literally translating to "good gift," or *mântú'kámə́*, comprised of *má* "mother", *ntú'* "calabash/vessel", and *kámə́* "power/nobility", which translates directly to "mother of the vessel of power," a reference to the noble status of individuals bearing this particular ndàp (for further details on the history of ndàp names and nobility in Medʉmba culture, see Mkammi 2009).

Other names are less transparent, but bear evidence of being derived from similar constructions. As will be seen in §5, a feature of many Medʉmba folkloric songs is a series of greetings of individuals in the community by their traditional names.

Unlike disyllabic stem syllables, associative forms each contain two or more noun stems, each of which is hypothesized to contain a metrical head. It is possible, however, that there exists internal metrical structure to the associative construction, similar to what is found with compound stress in languages like English, in which the syntactic head and its complement receive distinct levels of prominence. In our analysis, therefore, we will pay attention to which members of an associative construction occur in which positions within the rhythmic structure of songs.

Syllable Weight

One outstanding question related to phonological structure in Medʉmba concerns whether the language distinguishes between syllables of different weights. There is no clear evidence of a vowel length distinction in the language, nor is there evidence for distinct patterning between CV and CVC syllables that might suggest that coda consonants contribute to syllable weight. However, there are some aspects of phonological patterning which suggest that weight could play a role. One piece of evidence concerns positional restrictions on tone. Specifically, Franich, 2021 shows that foot-initial syllables, which typically align with the left edge of the stem, are uniquely able to bear contour tones, whereas non-initial syllables are prohibited from bearing contours. As was seen in (4), native monosyllabic stems of various shapes can host contour tones. Since Medʉmba features few native polysyllabic words bearing contour tones which are unambiguously monomorphemic, English loanwords provide a source of evidence that contours are limited to stem-initial position. As

[11]However, see Voorhoeve (1971) for exceptions to this generalization.
[12]Noun class numbering is based on Voorhoeve (1968).

seen in (9), whereas monosyllabic words and syllables bearing primary stress in English are normally borrowed with a high tone, those with nasal codas are typically borrowed into Medʉmba with a falling contour.

(9) English loanwords in Medʉmba; CVN syllables borrowed with falling contours

a.	tʰí	[tʰi]	"Tea/coffee"
b.	kát	[kʰa:d]	"Card"
c.	há.mə̀	[ˈhæ.mə]	"Hammer"
d.	sú.ndì	[ˈsʌn.ˌdej]	"Sunday"
e.	bà.ná.nà	[bə.ˈna.nə]	"Banana"
f.	pîn	[pɪn]	"Pin"
g.	tâm	[tajm]	"Time"
h.	ⁿgûm.nə̀	[ˈgʌv.nə]	"Governor"
i.	sîŋ.lì	[ˈsɪŋ.glət]	"Singlet"

However, HL contours are only permitted on such syllables when they occur stem-initially: if a disyllabic word with a second syllable of CVN shape is borrowed, for example, an epenthetic vowel is inserted after the nasal (either [i] or [ə], depending on the place of articulation of the preceding consonant), and the HL contour is distributed as separate H and L tones across the final two syllables (10). Note that words of the shape CVCVN are licit in the language, as evidenced by forms like *bə̀lə̀ŋ* "potato," indicating that tone, and not segmental phonotactics, must be motivating epenthesis in the forms in (10).

(10) HL contours limited to stem/foot-initial position

	Medʉmba loanword		English source IPA	English translation
a.	dósínì	(*dósîn)	[ˈdʌzən]	"Dozen"
b.	flébánə̀	(*flébân)	[ˈfɹaj ˌpan]	"Fry pan"

Franich (2021) shows that this pattern can be accounted for by analyzing these trisyllabic forms as involving a disyllabic foot aligned to the left edge of the stem (11). From this perspective, vowel epenthesis can then be seen as a strategy for avoiding a contour tone on the weak syllable of the foot.

(11) Foot-based analysis of trisyllabic loans

a.	dósínì	$_{FT}$(dósí)$_{FT}$ nì
b.	flébánə̀	$_{FT}$(flébá)$_{FT}$ nə̀

Given that many languages show a correspondence between weight and metrical prominence, one way to account for this fact would be to posit that foot-initial syllables in Medʉmba are (or can be) heavy, while non-initial syllables are light. This treatment would be in line with analyses of African tone languages which posit the mora as the tone-bearing unit—where two moras are present, a contour tone may occur; where only one mora is present, only a level tone may occur (Hyman 1985). It is also notable that syllables bearing contour tones in Medʉmba have been found to be significantly longer in duration—up to double in length—than those bearing level tones (Franich, 2014)[13].

This link between contour tones, duration, and syllable weight is open to other interpretations, however: Zhang (2002, 2004) provides evidence that contour tone licensing need not make reference to moras, and that positional restrictions on contour tone licensing may be better captured through positional markedness constraints which prohibit contour tones from surfacing in positions which are articulatorily and/or perceptually ill-suited to bear contour tones (i.e., syllables with shorter/less sonorous rhymes which cannot facilitate efficient production and perception of contour tones). Importantly, there is no evidence in Medʉmba that syllables in stem/foot-initial position are generally longer in duration than in other positions, and contour tones in the language are allowed on all syllable types, including both CV and CVC syllables with both voiced and voiceless coda consonants (the latter generally forming a poor phonetic host for a contour tone, as reflected in Zhang, 2002 cross-linguistic typology).

Zhang's approach assumes that phonetic properties of syllables have a direct influence on their tone-bearing abilities. The account therefore dispenses with the traditional mora-based representational account of contour tone licensing. Another alternative to Zhang's proposal is found in Gordon (1999), Gordon (2001), who recognizes a role for phonetic properties such as sonority and duration in influencing contour tone licensing, but still argues for a representational account. Specifically, Gordon proposes an enriched typology of weight distinctions which can make reference to the kinds of phonetic properties Zhang considers, but which are formalized using skeletal slots to represent timing units. In the case of a language like Medʉmba, where contours are allowed on syllables of all shapes but where vowels are clearly longer in the presence of a contour tone, an analysis might involve a constraint that contour tones only be realized on vowels with two timing slots.

The different ways in which representational theories and phonetically based theories like Zhang's conceive of the relationship between duration and contour tone licensing could have interesting implications for the present musical analysis. Assuming there is a principled relationship between timing in language and music for Medʉmba, as has been found for other languages (Patel and Daniele 2003), this relationship may or may not reflect weight-based distinctions. Contour toned

[13]This pattern would mimic the behavior of a typologically rare foot type, the "uneven trochee" (Hayes 1995): while iambic feet typically display durational asymmetries across initial/nonhead and final/head syllables, trochees do not show such durational asymmetries, instead favoring other types of phonetic prominence asymmetries, such as asymmetries in loudness. Uneven trochees are not completely unheard of in the realm of African languages, however: Green (2015), for example, documents variable cases of uneven CVV.CV trochees in Bambara, a Mande language, which he argues are undergoing a change toward becoming more typical CV.CV trochees.

syllables of different shapes vary widely in their rhyme durations in Medʉmba, with CVC syllables typically realized with much shorter durations than CV syllables (Franich, 2014). We might expect, then, that note durations of contour-toned syllables in text-setting will be quite variable, too, if no reference is being made to a more abstract, uniform weight distinction between contoured and level-toned syllables. On the other hand, if syllable weight, and not just phonetic duration, is being relied upon as a guide for text-setting, we might expect more uniform note durations for contoured syllables, regardless of their shape.

To review, Medʉmba does not display robust evidence for a syllable weight distinction, as in languages with clear minimal pairs for vowel length. However, contour-toned syllables in Medʉmba show both longer duration than level-toned syllables, and also distributional restrictions which prohibit them from occurring in prosodically weak positions. Both of these phenomena are consistent with the treatment of contour-toned syllables as phonologically heavy, though other explanations are possible. Examining text-setting patterns of note length for contoured vs. level-toned syllables may provide us a window into this complicated area of the grammar. If it is the case that contour-toned syllables are heavier than level-toned syllables in the language, we might predict that they will occupy greater note lengths than corresponding level-toned syllables in text-setting, and that the mapping between note length and tone will be consistent and based on relatively uniform abstract weight distinctions, rather than variable as a function of phonetic duration alone.

Summary

To summarize, we will pay specific attention to the position of syllables within a stem/foot, the tone of syllables, and their morphological status in our text-setting analysis. Taking these areas as a starting point, several hypotheses can be made. First, we hypothesize that stem/foot-initial syllables may behave differently from non-initial syllables and segmental affixes in being drawn with greater frequency to rhythmically strong beats. We also hypothesize that note length may be determined by aspects of tone and morpho-prosodic structure, with contour toned syllables most likely to occupy the greatest note lengths, and stem-final/affix syllables most likely to occupy the shortest note lengths, being less prosodically prominent. An open question concerns whether finer-grained note length distinctions will be observed between contour-toned syllables of different shapes. It is also possible that contour tones formed through different means, e.g., those which represent a word's lexical tone vs. those which are formed through the concatenation of a floating "grammatical" tone or from tonal overwrite, might display distinctive rhythmic properties. If, for example, grammatical tones are generally less faithfully realized in text-setting as found in McPherson and Ryan (2018), floating grammatical tones may not contribute as reliably to a syllable's rhythmic timing within songs. Finally, we will pay attention to whether word stems within the associative construction consistently behave as separate prosodic units, or whether they may form a single unit under any circumstances.

METHODOLOGICAL APPROACH

A challenge in evaluating the degree to which rhythmic structures in the Medʉmba language and music align is that we must decide on a strategy for representing musical rhythms in a way that will facilitate such a comparison. Medʉmba folkloric music of the kind described here is not traditionally written down; thus, there is no notational system indigenous to the culture that would facilitate such a comparison. Rather, transmission of music is experience-based: newer drummers learning to play the music do so by playing it alongside more experienced drummers, and community members learn dance steps by dancing alongside their elder family members.

There are a variety of ways in which music theorists have approached the question of notating African music, many of which dispense with notions of Western staff-based-notation such as the time signature. Chernoff (1991), for example, notates rhythms as continuous lines of alternating symbols reflecting the sounding of an instrument or the feel of a metrical pulse. Others, such as Anku (2000), opt to represent African rhythms in terms of cycles of sets of beats, each set having one regulative beat which need not be associated with any type of audible "accent" or note onset. These approaches essentially dispense with treating musical beat structure as hierarchically organized, an implicit feature of Western staff-based notation, where time-signatures reflect the division of pulses into beats and measures (Temperley 2000). However, there is reason to believe that music from West and Central Africa is—or at least can be—hierarchically organized. Toussaint (2013), for example, uses an empirical approach based on the probabilistic positioning of note onsets across beats in several different African rhythms[14], showing that note onsets (drum beat attacks, chord changes, etc.) are more likely to occur in certain beat positions than others, and that multiple, discrete levels of beat strength can be seen to emerge from these positional restrictions on note onsets. This is in spite of the fact that the specific pattern of metrical organization differs between the examined African songs, where metrical patterns tend to be arranged in a 3-3-2 beat pattern, and other styles of music, such as German folk songs, where beats are arranged in 4-4-4 grouping patterns. Importantly, Toussaint points out that these implied patterns of beat strength in African songs, unlike in much Western folk and classical music, need not occur with explicit acoustic accenting (as through increased duration or loudness). This latter point accords with Agawu's analysis of Ghanaian music as having clear rhythmic structure

[14]This work does not mention explicitly which regions of Africa are represented in the analysis, though patterns described are consistent with Central and West African rhythms.

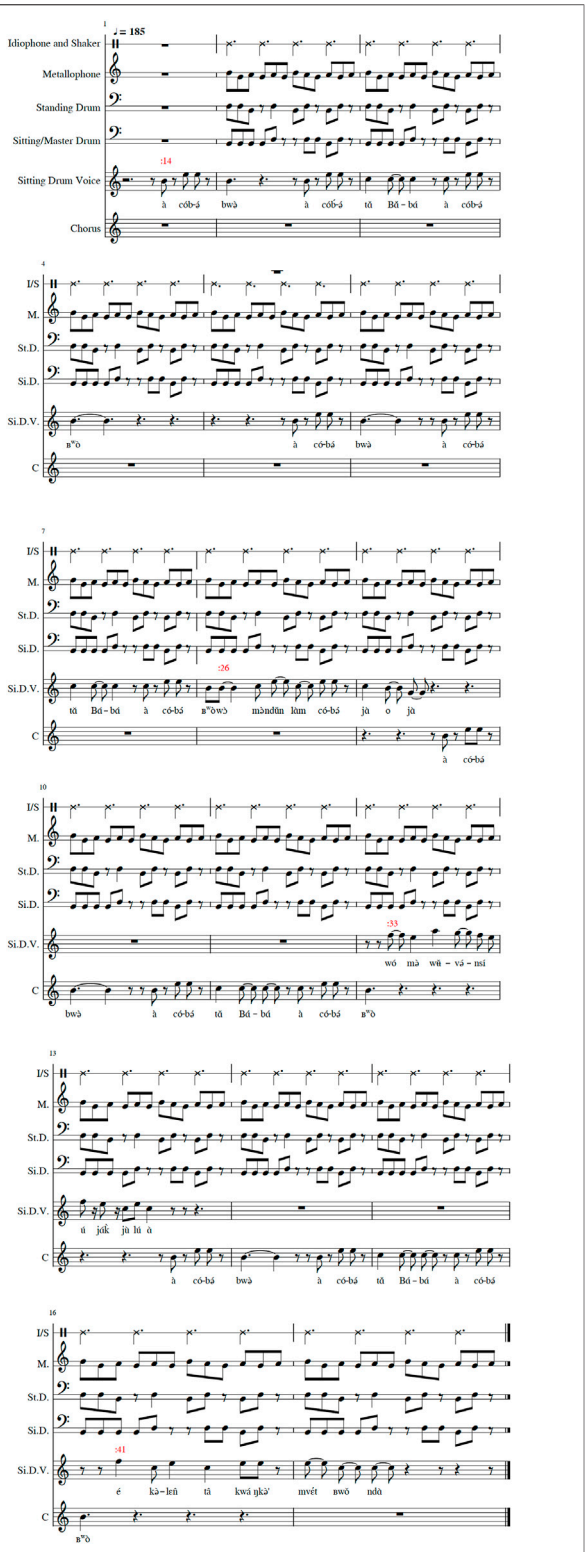

FIGURE 3 | Staff transcription of Song 1.

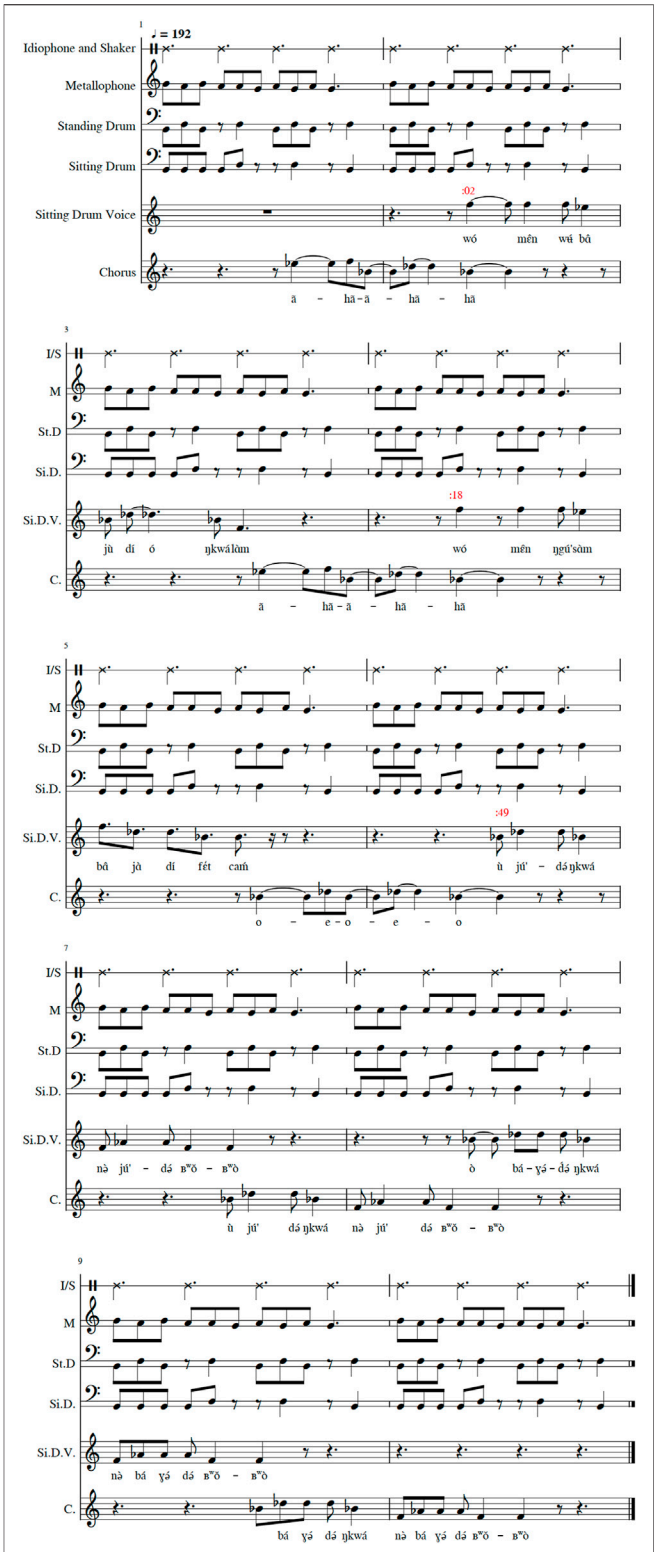

FIGURE 4 | Staff transcription of Song 2.

(which guides, for example, the coordination of dance feet) without having a rigid alternation of accented and non-accented beats.

Agawu (1995) argues that the use of Western musical notation, while not without potential problems, is an appropriate choice, particularly as this approach can facilitate comparison of African musical rhythms with those from other musical traditions (pp. 185–195). In the present work, we follow music theorists such as Agawu in adopting staff-based notation, which allows us not only to observe clearly how different instruments and voices within the ensemble interact, but also provides us with some level of precision in notating note durations, which will form an important part of our text-setting analysis[15]. Agawu stresses that the use of such a staff-based approach for representing rhythm does not necessarily entail the acceptance of a fixed hierarchical beat structure, in which there is a sense of a single beat within a measure being consistently treated as metrically "strong" to the exclusion of other beats. Rather, there is ". . .a multiplicity of competing accents, which are always held in check by a simple, regular background" (p. 191). This brings up the additional issue of how to determine what the appropriate grouping pattern is for something like meter/time signature within this music. Here, we follow Agawu, Anku (2000), Toussaint (2015) and others in using repeating rhythmic motifs among instruments to establish rhythmic grouping patterns, as well as Kubik (1983) in exploring cues beyond the music itself, incorporating information about the timing of dance steps and body movements to guide our thinking on where the pulse of the music is optimally felt. Note that melodies are encoded only approximately within staff-based notation; since the primary focus of the present work is on rhythmic structure, no formal analyses of musical key was conducted on these songs. Finally, for ease of interpretation, we also include grid-based notations of song parts to facilitate the visualization of alignment of main beats and beat fractions with linguistic structure. Note that some slight deviations exist between the staff- and grid-based representations since the 12-beat subdivisions in the grid make it more constrained in the rhythmic patterns it can capture.

ANALYSIS

We start by characterizing some of the basic rhythmic elements of the song structures, which are transcribed in **Figures 3**, **4** (red timestamps allow the reader match the transcription to the accompanying sound recordings). In both songs, the simple *ndŭnlàm* (idiophone) and the *nəcà'* (tin shakers) double one another in playing a consistent pulse throughout each song. These parts define the basic beat of the song, and we follow Agawu (1995), Anku (2000), Toussaint (2015) in interpreting the attacks of these instruments as falling on the whole numbered beats of the measure throughout the song. We note, too, that dancers' arm movements and footsteps are aligned with these beats: specifically, dancers' arms move back and forth on every hit of the idiophone and shake of the shaker (**Figure 5**), and dancers take a step forward on every other attack of these two instruments (what we have indicated as the odd-numbered beats of the song measures) (**Figure 6**).

As indicated in **Figures 3**, **4**, assuming a 12/8 compound meter, these instruments sound four times per measure, at equal intervals. Layered on top of these instruments is the sound of the complex *ndŭnlàm* (iron metallophone), which realizes a triplet eighth note pattern for every beat of the idiophone and *nɔ̀cà'* (except for the final beat of each measure of Song 2). Over this rhythmic backdrop, the *tómŋkà'* (standing drum) and *mɛ̂nfámɔ́* (sitting drum played by the master drummer) add their voices, introducing syncopation at various points with respect to the rhythmic line played by the idiophone and shaker. In Song 1, for example, the standing drum sounds an extra-long note beginning on the second triplet eighth note of the second beat, while the master drummer highlights the second triplet eighth note of the third beat by not playing on the first one. In Song 2, the standing drummer highlights the second triplet eighth note of the second and fourth beats in a similar manner, while the sitting drummer highlights the second triplet eighth notes of the third and fourth beats[16]. The frequent occurrence of these drum beats on the *second* note of the triplet pattern can often give the feel of a different subdivision of the beat structure altogether, in which measures are broken down into three groups of four eighth notes, rather than four groups of three; this represents a classic duple vs. triple polyrhythmic opposition found in many genres of West and Central African music (Temperley 2000).

As will be described below, several of the predicted patterns described in §3 are substantiated in Songs 1 and 2, including the preferred timing of stem-initial syllables on main beats within the song, and timing of stem-final syllables, affixes, and functional elements on beat fractions. Interestingly, this pattern is found to be completely reversed within one particular motif found in Song 2, but prominent and non-prominent syllables nonetheless continue to pattern together within that section. We also find that syllables occurring outside of main beats frequently occur on beat fractions which are accentuated by the sitting drum, further emphasizing a polyrhythmic pattern. In terms of tone, we find that both contoured and level-toned monosyllabic stems tend to occupy the same note length of two triplet eighth notes (though some exceptions apply in the case of compounds),

[15]As one editor points out, a shortcoming of using staff-based notation is that its implied hierarchical nature may obscure some microvariation in note timing which might arise if, for example, two or more voices are not perfectly rhythmically aligned. We acknowledge this shortcoming, and the potential for some oversimplification of timing in our staff-based representations. Of course, an ideal investigation of rhythmic timing would involve time-locked individual recordings of each voice in the ensemble, which we do not have access to at present; we would like to undertake this type of investigation at a future time.

[16]Note that there is further variation in the rhythms that the drummers play from verse to verse, but the patterns transcribed here represent recurring patterns throughout the songs.

FIGURE 5 | Dancers' swing arms back and forth for very attack of the idiophone and shaker.

while individual syllables in disyllabic roots each occupy a single triplet eighth note; affixes and many function words also tend to occupy shorter note lengths. Patterns of phrase-final lengthening are also reflected in note durations at the ends of musical phrases. We now provide more detailed, line-by-line analysis of each song.

Song 1: Line-by-Line Analysis

Focusing now on the sung portions of Song 1, we hear the master drummer and chorus trading lines throughout both songs, in a call-and-response pattern. The master drummer initiates the song before the chorus joins in. Song 1 begins with the master drummer repeating a line to the chorus, one time as a solo, the second with the accompaniment of the drummers. The second of these two repetitions is the first line that appears in the staff-based representation of Song 1 (starting at :14 in the sound file of that song). This first line is presented in (12), with separate lines for surface phonetic pattern, underlying phonological structure, gloss, and translation, and in a grid formulation in **Figure 7**. Toneless syllables receive their tone either by default (as in the 3sg pronoun *a*) or through tone spreading (as in the final syllable of verb stem cóbə). Floating tone morphemes are indicated with a H or L in the gloss line.

the song. The line is the same each time, and always initiated on the second triplet of the third beat of the measure, and continues for another measure and a half, with the final syllable *bʷó* (the result of merging *bʷə́* "there" and *ò*, a marker of certitude/evidential) initiating the final measure of the line on the first beat.

Within this line, we can notice a few interesting patterns. Looking at the positions within the rhythmic line where individual syllables fall, the main beats (numbered in **Figure 7**), where they are articulated, are occupied exclusively by stem-initial syllables. For example, the fourth beat of the initial syllable is initiated with the stem-initial syllable in *cóbə* "speak," the first beat of the second measure is occupied by *bwə̀* "there" (combined with the certitude marker) and the first beat of the third measure is occupied by *tà* "far away" (combined with the H associative marker). It is interesting to note that main beats 1 and 4 are always articulated in the opening lines/chorus, while beats 2 and 3 are left empty; indeed, Beats 1 and 4 seem to show great similarities in their patterning throughout the song. The significance of the first and fourth beats in a 12/8 rhythm has been observed in other African musical traditions (Vetter 1996).

Looking now to syllables which do not occur on whole-numbered beats, the picture is more mixed. Among the elements occurring in these rhythmic positions are the stem-final syllable in *cóbə* "speak," the third person singular pronoun *a*, and the two syllables in *Bǎbá*,

(12) Master drummer's opening line/chorus

à	cóbə́	bʷə̀	à	cóbə́	tǎ	Bǎbá	à	cóbə́	bʷò
a	cóbə	bʷə̀	a	cóbə	tà.H	Bǎbá	a	cóbə	bʷə̀+ò
3SG	speak	there	3SG	speak	far.ASSO	Bǎbá	3SG	speak	there + CERT

"It speaks from over there, it speaks from the Bǎbá (river) (it's clear) it speaks from there."

As we have analyzed Song 1 to involve a 12/8 time signature, grids are comprised of 4-beat measures with each beat divided into triplets, for a total of 12 pulses per measure. Thus, each individual pulse represents a triplet eighth note unit within the staff notation. In addition to labeling the whole numbered beats of the measure within the grids with numbers 1–4, we have also labeled those beat fractions where the two drums (abbreviated St and Si for "standing" and "sitting," respectively) provide articulations.

The opening line, with the same rhythm, will become the refrain of the chorus after the master drummer begins singing the verses of the name of the river being sung about. Alignment of syllables by morpheme type and tone for the chorus is summarized as proportions in **Figures 8**, **9**. As can be seen in **Figure 8**, the majority of elements occurring on beat fractions appear to be stem-final and functional elements, with the exception of the two syllables in *Bǎbá*. Interestingly, several of the syllables occurring outside of whole numbered beats (including the second syllable of *Bǎbá*) occur on beat fractions which are articulated by one of the two drummers (see also **Figure 7**). In terms of tone, following from the fact that stem-final syllables are more common on beat fractions, we

FIGURE 6 | Dancers' synchronized forward steps occur on every other attack of the idiophone and shaker.

DRUM-ACCENTED FRACTIONS					**St**			**Si**							
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**			**1**		
LYRICS								à		có	bɔ́				
DRUM-ACCENTED FRACTIONS					**St**			**Si**							
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**			**1**		
LYRICS	bwə̀							à		có	bɔ́				
DRUM-ACCENTED FRACTIONS					**St**			**Si**							
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**			**1**		
LYRICS	tă		bɑ̌		bá			à		có	bɔ́		bwò		

FIGURE 7 | Grid representation of master drummer's opening lines and chorus. Numbers 1–4 represent whole-numbered beats on which the idiophone/shaker sound and dancers move. Individual cells represent beats on which the complex ndünlàm/metallophone sounds. St/Si represent beat fractions on which the Standing or Sitting drum sounds. Gray filled cells indicate beats on which the voice is sounding.

see that these beats, where are articulated, are largely associated with toneless syllables. Beat 1 is mixed between L and LH toned syllables, while Beat 4 is consistently H. The master drummer's accented beat fractions on the sitting drum always occur on low tone syllables, while the standing drum accents beat fractions consistently on high tones; this pattern in fact parallels the tuning of the two drums, as the larger *mênfámə̀* sitting drum sounds at a lower pitch than the tall, thin *tómŋkà'* standing drum[17].

Another aspect of this initial line that is important to examine is the relative note durations attributed to each syllable in the line. In **Figure 3**, while the disyllabic verb root *cóbə* receives one eight note of the triplet pattern on each syllable every time it is uttered[18], monosyllabic roots such as *tà* (combined with a floating associative morpheme) and *bwə̀*(combined with the certitude marker) and the two syllables in *Bǎbá* receive double this note value. The third person singular pronoun *ɑ* also consistently occupies a single eighth note value. This is consistent with the idea that disyllabic stems such as *cóbə* possess a similar overall weight to monosyllabic stems, both of which are overall heavier than the pronoun. However, we note that two of these monosyllabic stems are combined with additional morphemes, and two bear contour tones, two facts which may also contribute to greater note length for those syllables. We note, as well, that words occurring in final position of a musical line were consistently lengthened more than in any other position, mimicking a linguistic process of phrase-final lengthening (Turk and White 1999). This provides us with evidence of alignment not only in terms of metrical structure, but also in terms of prosodic grouping in the songs (Dell and Halle 2009).

Shifting our attention now to the master drummer's verses, which are improvised each time, we see much more rhythmic variety across different verses. This pattern mirrors findings from McPherson and Ryan (2018) on improvised vs. rote lyrics described for Tommo So folk music. The master

[17]Thank you to one of the editors for pointing out this potential link.

[18]We note that there is some variation in note length assigned to the final syllable of *cóbə* "speak" as it seems this syllable is sometimes matched with a single eighth note, and sometimes a longer quarter note. This variation is not represented in the staffs or grids provided. As we discuss in §6, outside of a musical context, there would typically be a focus marker *à* that would be uttered between the verb and the word *jà* "where" or the word *bwə̀* "there." Thus, it seems the singer is alternating between two forms, one the simple verb form, and the other with the addition of the focus marker, which corresponds with additional note length.

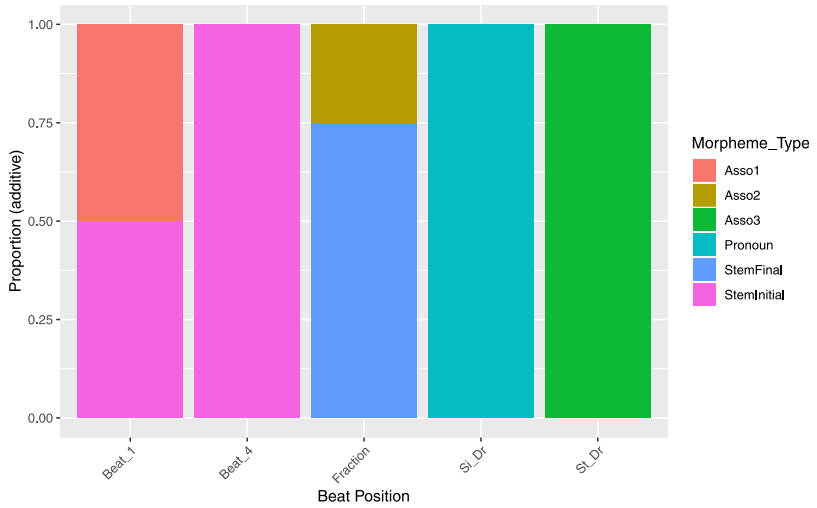

FIGURE 8 | Alignment of syllables by morpheme type in the opening lines/chorus of Song 1 represented as proportions of occurrences.

drummer's (henceforth MD) verses each consist of essentially one line each, which can range in length from 9 to 11 syllables. Here, we analyze ten lines of his part. Each of these lines involves the MD singing directly to the community, often calling out to different members using their *ndàp* or another social name they may have. Examples of three of these lines are given in (13–15). Note that for some particles listed, such as the exclamative particle *mə*, it is unclear whether the particle bears a low tone underlyingly or whether it may be toneless and surfacing with a default low tone.

(13) Line 1, master drummer verse, Song 1

wò	mə̀	ndŭn-làm	cóbə́	jà	ò	jà
wo	mə	ndùn.H-làm	cóbə	jà	o	jà
VOC	EXCL	ndùn.ASSO-làm	Speak	Where	VOC	Where

"Where does the ndŭnlàm speak from?!"

(14) Line 2, master drummer verse, Song 1

wó	mə̀	wŭ	və́.ˡnsí	ú	ják	jù	lú	à
wo	mə	wù.H	və́.nsǐ	u.H	ják	jù	lú	à
VOC	EXCL	2SG.ASSO	sit.down	2SG.SUBJ	pass. afternoon	2SG.OBJ	PROX	Q

"You who are sitting down, how are you this afternoon?!"

(15) Line 3, master drummer verse, Song 1

é	kə̀-lə̂n	tâ-kwá-ŋkə̀'	mvɛ́t	ʙʷŏ-ndà
e	kə̀-lə̀n.HL	tá.L-kwá.H-ŋkə̀'	mvɛ́t.H	ʙʷò.H-ndà
VOC	NEG-know.SUBJ	tá.ASSO-kwá.ASSO-ŋkə̀'	brother.ASSO	ʙʷò.ASSO-ndà

"Tâ-kwá-ŋkə̀' is the brother of ʙʷŏ-ndà!"

Lines 1 and 3 in examples (13) and (15) above represent one of two forms that the MD's lines standardly take, incorporating a total of 9 syllables—we refer to this as "Song 1, Motif 1," or S1M1, for short. Six out of the ten lines analyzed followed the structure of S1M1. As can be seen in **Figure 10** (where lines have been ordered by motif), though the word structures vary across lines 1 and 3, there is overall considerable parallelism across lines in terms of rhythmic distribution (i.e., beat position at which words are initiated within the rhythmic line) and note duration. So, for example, the prefix of the exclamative *kə̀-lə̂n* (literally "not know", comprised of a negative prefix and the root *lə̂n* "know" in its subjunctive form) in (15), which occurs in measure 16 in **Figure 3**, occurs on the same beat and occupies a similar note length to the monosyllabic exclamative particle *mə̀* in (13) occurring in measure 8. Similarly, the words that follow these two syllables—the first syllable *ndŭn* in *ndŭn-làm* in (13) and the root *lə̂n* in (15)—occur on the same beat and occupy the same note lengths, both longer than their preceding syllables (two eight notes to the preceding syllables' single eight notes). It is interesting that both of these syllables bear contour tones, albeit with different tone values (LH vs. HL) and formed through two different processes, the first through concatenation of a floating morpheme, and the other through a process of tonal overwrite.

Another observation concerns the note durations of the syllables in the word *cóbə* "speak", which are each the same duration as the previously mentioned exclamative particle and prefix, such that the entire verb together comprises the same duration (two eighth notes) as one of the two contoured syllables previously discussed. A closer look at text-setting of other morphemes indicates, however, that level-toned monosyllabic forms can also occupy notes of two triplet eight notes in length, as is the case for the low-toned word *jà* "where" and the high-toned word *və́* "sit." This would seem to indicate that such level-toned CV words possess a different musical status than the exclamative particle and prefix, consistent either with a difference in prominence or syllable weight between the two types of level CV syllables. Finally, we

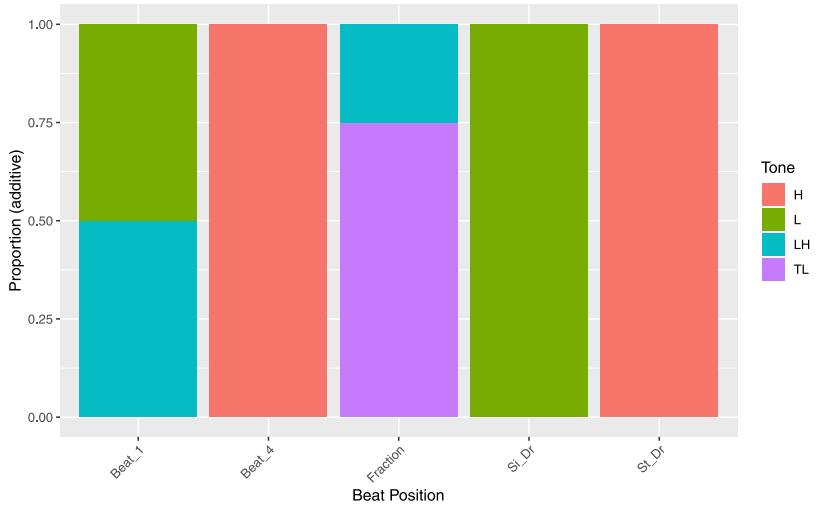

FIGURE 9 | Alignment of syllables by tone in the opening lines/chorus of Song 1 represented as proportions of occurrences.

see that certain compound forms are treated similarly in terms of their note lengths to disyllabic stems like *cóbə*, such as the last two syllables of the ndàp *tâkwáŋkə̀*. Here, the final two syllables of the traditional name are assigned the same note duration when combined as the first, contoured syllable of the name.

In contrast to examples (13) and (15), Line 2 presented in example (14) has an additional syllable, and a somewhat different rhythmic structure from the other two lines—we refer to this as Song 1, Motif 2 (abbreviated as S1M2; four of the ten lines analyzed followed this pattern). Lines like this are partially lexicalized and always feature a measure with several tied pairs of triplet eighth notes and second measure containing some variant of the greeting *ú ják jù lú à* (roughly, "How are you this afternoon?"). This last phrase is condensed into a little over half of a measure, with the first four syllables receiving single triplet eighth note lengths, and the final question particle receiving double the duration. Here, even the verb root is reduced in duration from what would have been expected in Lines 1 and 3. In contrast, in the first part of the line, the exclamative particle *mə̀* is realized with two triplet eighth notes, as opposed to the single eighth not it was associated to in lines 1 and 3. Thus, there appears to be flexibility in terms of note length for morphemes depending on whether they occur in a line of S1M1 or of S1M2.

Turning now to beat alignment patterns within the MD's lines, we analyze the morphological and tonal composition of each main beat, broken down by motif in the master drummer's singing for Song 1, in **Figures 11**, **12**. We note first that S1M2 involved no syllables articulated on either Beat 4 or on the beat fraction articulated by the sitting drum played by the master drummer. Apart from this, the specific morphological makeup of each syllable is quite varied across the two motifs: for example, while Beat 1 in S1M1 is made up nearly entirely of stem-initial syllables, Beat 1 in S1M2 is primarily made up of pronouns, with Beat 2 containing some stem-initial syllables, as well. Both motifs show a higher proportion of high tones on main beats than on beat fractions (including those fractions which are articulated by the drummers). Interestingly, contour tones appear to be entirely absent on main beats in S1M1, being more common on beat fractions (in spite of the similar tone patterns and morphological structures of contours found across motifs). In S1M2, contours occur on Beats 1 and 3 as well as on beat fractions (including the one articulated by the standing drum), but not on Beat 2. Within both motifs, we see considerably more variability in morpheme type occurring at beat fractions, as opposed to on whole beats. Certain syllable types, including stem-final syllables, prefixes, vocables, exclamative particles, question particles, and other discourse particles only occurred on beat fractions. Interestingly, the morphological makeup of the sitting drummer's accented beat fraction is both more consistent and more likely to contain stem-initial syllables (either monosyllabic stems, or as a part of an associative construction) than other beat fractions.

Song 2: Line-by-Line Analysis

Moving now to Song 2, we will only discuss the master drummer's song patterns, since the regular chorus in this song is composed entirely of vocables. Later in the song, the chorus repeats two verses identically to the master drummer—this pattern will be described below in the context of Song 2, Motif 2 (S2M2) of the master drummer's song. Transcriptions, glosses, and translations for four of the ten lines analyzed for this song are given in (16–19). Similar to findings for Song 1, we see in

Line 1, master drummer verse (Motif 1 / S1M1)												
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**				
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS		wò			mə	ndŭn		làm		có	bá	
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**				
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS	jà		o		jà							
Line 3, master drummer verse (Motif 1 / S1M1)												
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**				
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS			é		kə	lə̂n		tâ		kwá	ŋkə’	
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**				
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS	mvét		ʙ^{w}ŏ		ndà							
Line 2, master drummer verse (Motif 2 / S1M2)												
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**				
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS			wó		mə		wŭ		və́		nsí	
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**				
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS	ú	ják		jù	lú	à						

FIGURE 10 | Grid representation of three lines of master drummer's verses, Song 1. Numbers 1—4 represent whole-numbered beats on which the idiophone/shaker sound and dancers move. Individual cells represent beats on which the complex ndünlàm/metallophone sounds. St/Si represent beat fractions on which the Standing or Sitting drum sounds. Gray filled cells indicate beats on which the voice is sounding.

Figure 4 a pattern in which note lengths of monosyllabic stem syllables and contoured particles, such as *jú'*, *mên*, *bâ*, and *jà* are longer (usually 2 triplet eighth notes), while pronouns such as *wʉ́*, and *jù* and affixes such as the iterative suffix *-dɔ́* and the infinitival prefix *nɔ̀-* tend to occupy shorter note lengths, usually one triplet eighth note. There are, however, some exceptions to this. For example, the first syllable in the traditional name *ŋgú'sàm* (occurring in measure 4), which appears to derive from a possessed nominal construction (*sàm* being one class of possessive enclitic pronoun), is only one triplet eighth note in length. Interestingly, *sàm* bears the same note length—the equivalent of two eighth note triplets—as the preceding contoured word *mên* "child" (modified with a high associative marker). This does not seem to be an isolated occurrence, as the pronoun enclitic, *cám* (occurring in the following measure), bears the same note duration of two eighth note pulses, which is equal to that of the monosyllabic noun it modifies, *fét* "brother." Thus, it seems that possessive enclitics deviate from other pronouns in having note lengths more similar to noun stems. It is interesting to note that these pronominal enclitics tend to have a CVC shape, whereas subject pronouns more often have a V or CV shape. This could reflect a phonological weight distinction among pronouns of different types. However, note that stems of both CV and CVC shapes, regardless of whether they bear a level or contour tone, tend to pattern similarly in note length, suggesting that different syllable shapes does not universally map to different phonological weights, at least in a way that is observable through these songs.

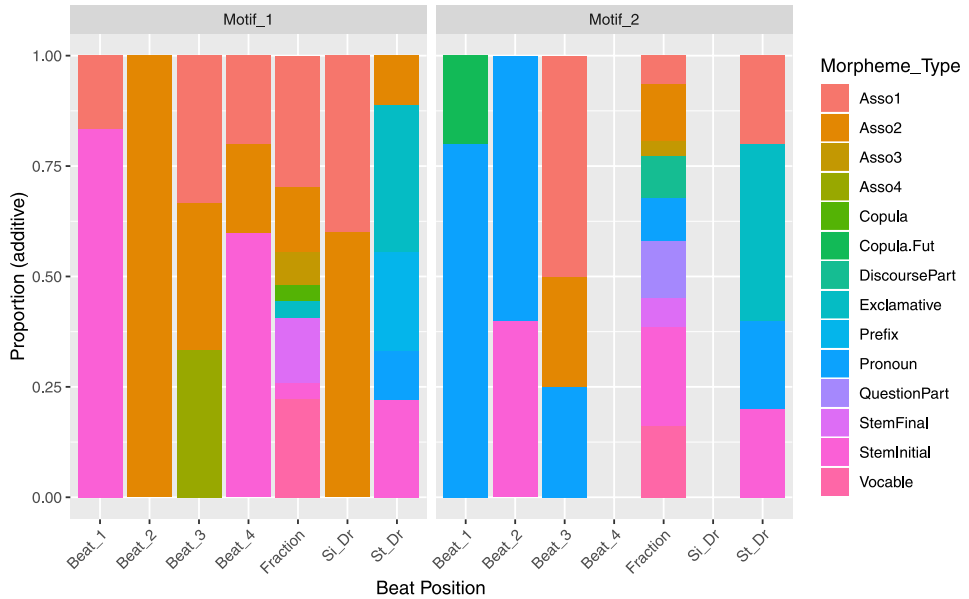

FIGURE 11 | Alignment of syllables by morpheme type and motif in master drummer's verses of Song 1 represented as proportions of occurrences.

(16) Line 1, master drummer verse, Song 2

wó	mɛ̂n	wʉ́	bâ	jù	dí	ó	ŋkwá	làm
wo	mén.L	wʉ́	bɛ́.à	jù	dí	o	ŋkwá	làm
VOC	child.ASSO	Who	COP + FOC	2SG.OBJ	DISC	DISC	Song	làm

"Whose child represents the song you choose?"

(17) Line 2, master drummer verse, Song 1

wó	mɛ̂n	ŋgú'sàm	bâ	jà	dí	fɛ́t	cám
wo	mén.L	ŋgú'sàm	bɛ́.à	jà	dí	fɛ́t =	cám
VOC	child.ASSO	ŋgú'sàm	COP + FOC	Where	DISC	brother	1SG.POSS

"My brother, where is the child of ŋgú'sàm?"

(18) Line 3, master drummer verse, Song 1

ù	jú'-dɛ́	ŋkwá	nɛ̀-jú'-dɛ́	ʙʷõʙʷò
u	jú'-dɛ́	ŋkwá	nɛ̀-jú'-dɛ́	ʙʷõʙʷò
2SG	groove.ITER	Dance	INF-groove-ITER	beautiful.REDUP

"Dance sensually, beautiful ones."

(19) Line 4, master drummer verse, Song 1

ò	báɣə-dɛ́	ŋkwá	nɛ̀- báɣə-dɛ́	ʙʷõʙʷò
o	báɣə-dɛ́	ŋkwá	nɛ̀- báɣə-dɛ́	ʙʷõʙʷò
2SG	bend.ITER	Dance	INF-bend-ITER	beautiful.REDUP

"Bend and dance, beautiful ones."

Examining now the beat alignment of syllables in Song 2, we break the song down again into two different motifs, based on lexical content and rhythmic patterning. Song 2, Motif 1 (abbreviated S2M1), represented by Lines 1 and 2 as presented in (16) and (17), typically consists of 9 syllables, while Song 2, Motif 2 (abbreviated S2M2), represented by Lines 3 and 4 as presented in (18) and (19), consists of 9–10 syllables. Seven out of the ten lines analyzed followed the pattern of S2M1, and three followed the pattern of S2M2. Once again, there is strong (but not perfect) rhythmic parallelism within S2M1, despite lexical and morphological variation. Lexical content varies considerably across motifs, as can be seen by comparing examples (16–17) with examples (18–19). In particular, the verb forms found in (18–19), which are a fixture of this motif, include both prefixes and suffixes; though such morphological elements do occur within some lines of S2M1, they occur less consistently, as evidenced by their absence in (16–17). S2M1 also contains a greater number of stem-initial syllables on average per line than S2M2. As can be seen in **Figure 13**, many of the same beats are occupied across both motifs, though there are some differences, such as the presence of a syllable on the standing drummer's accented beat fractions.

Figures 14, **15** show more striking differences between the two motifs by breaking down beat positions by morpheme type and tone. Whereas stem-initial syllables are favored on Beat 1 in S2M1, Beat 1 is comprised entirely of prefixes in S2M2. Likewise, Beats 2 and 4 in S2M2 are made up entirely of suffixes, while affixes in S2M1 occur exclusively on beat fractions, which are also primarily occupied by stem-final syllables, question particles, and other types of discourse particles. Though the greater scarcity of stem-initial syllables within S2M2 may explain some of this difference in patterning, it is striking that stem-initial syllables, where they do occur in S2M2, occur exclusively on beat fractions, and never on

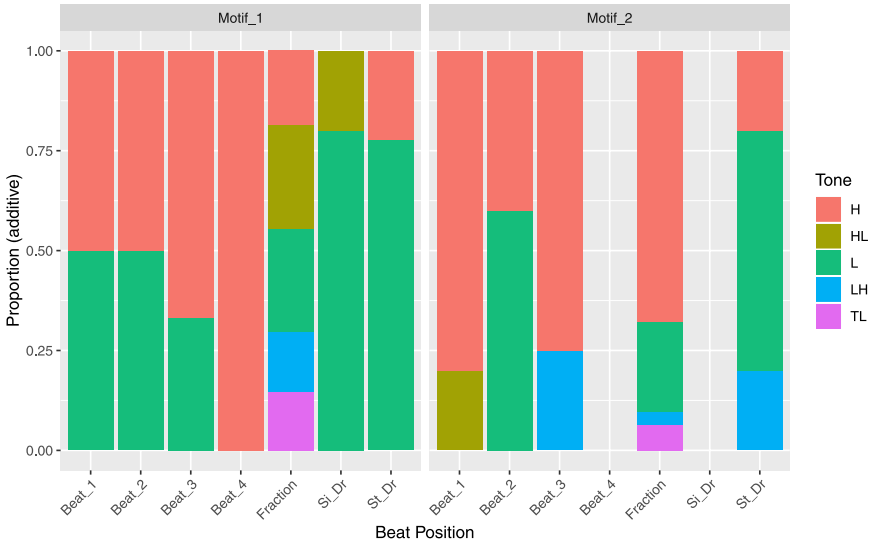

FIGURE 12 | Alignment of syllables by tone and motif in master drummer's verses of Song 1 represented as proportions of occurrences.

main beats. The greatest proportion of stem-initial syllables are in fact found on the beats articulated by the sitting drum/master drum, who sounds his drum only in the presence of stem-initial syllables. As with Song 1, beat fractions are more variable across both motifs in Song 2 than main beats in terms of the types of morphemes they host.

In terms of tone, we see much more variability overall in S2M1 than in S2M2 in terms of which tones occur. In both motifs, interestingly, low tones appear to be strongly preferred on Beat 1; they are also preferred on Beat 3 in S2M1. Outside of Beat 1, high tones are strongly preferred in all positions in S2M2. Contour tones are once again seen to be just as common, if not more common, on fractions of beats as on whole numbered beats in Song 2.

DISCUSSION

Our analysis illustrates the creative flexibility of rhythm in Medumba *Làm* folk songs while also highlighting some consistent patterns in the mapping between music and language. To begin with, rhythmic variation is highly dependent on the voices and parts being considered: at the level of the percussion ensemble, the drummers clearly have more flexibility to deviate from the underlying pulse of the music than do the other instruments. Likewise, as the storyteller and creative center piece within the ensemble, the master drummer has far more rhythmic flexibility in sung portions of the music compared with the chorus who responds to him. However, rhythmic "deviations" in both drumming and singing are systematic: though patterns vary measure by measure, there are recurring intervals at which the two drums sound (and conspicuously do not sound) throughout the songs. In particular, regular occurrence of drumbeats on the second note within triplet eighth note groupings in **Figures 3**, **4** can be interpreted as an alternate rhythmic line which is felt in 3, rather than 2, which is highlighted by the drummers. Such a pattern of conflicting duple and triple rhythmic lines overlaid on one another is consistent with a polyrhythmic analysis of this music, a pattern which is often found in the music of Central and West Africa, more generally (Temperley 2000). We can conclude from all of this that text-setting in Medumba *Làm* folk songs is governed by multiple underlying rhythms; we unpack this observation a bit more below.

Rhythmic Alignment and Mismatch Between Language and Song

In spite of the considerable rhythmic variation noted within and among the songs in our dataset, we find substantial alignment between song structure and linguistic structure in the sung parts of both the chorus and the master drummer voices. In the first song, both the chorus refrain and S1M1 of the master drummer's verses reflect a preference for stem-initial syllables (whether occurring within isolated stems or as a part of an associative construction) to be placed on whole-numbered beats within the staff-notated lines. Meanwhile, stem-final syllables and other prosodically weak particles are relegated to beat fractions. Indeed, the prevailing pattern is one in which whole-numbered beats within the song are either occupied by stem-initial syllables or are completely empty; rarely are they found to host a prosodically weak element.

S1M2 breaks with this pattern somewhat in that pronoun—including many subject pronouns, which consistently receive shorter note lengths—are found in abundance on main beats. Pronouns also feature heavily into main beats in S2M1, where they also occur in parallel positions with stem-initial syllables on several beats. Even within rhythmic motifs where pronouns are given main beat status, however, we find that other types of function words,

	Line 1, master drummer verse (Motif 1 / S2M1)											
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**			**St.D/ Si.D**	
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS					wó			mɛ̀n		wá	bâ	
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**			**St.D/ Si.D**	
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS	jù	dí	ó			ŋkwá	làm					
	Line 2, master drummer verse (Motif 1 / S2M1)											
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**			**St.D/ Si.D**	
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS					wó			mɛ̀n		ŋgú’	sàm	
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**			**St.D/ Si.D**	
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS	bâ		jà	dí		fɛ́t	cám					
	Line 3, master drummer verse (Motif 2 / S2M2)											
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**			**St.D/ Si.D**	
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS							ù	jú’		də́	ŋkwá	
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**			**St.D/ Si.D**	
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS	nə̀	jú’		də́	ʙʷə̌		ʙʷó					
	Line 4, master drummer verse (Motif 2 / S2M2)											
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**			**St.D/ Si.D**	
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS						ò		bá	ɣə́	də́	ŋkwá	
DRUM-ACCENTED FRACTIONS					**St.D**			**Si.D**			**St.D/ Si.D**	
WHOLE-NUMBERED BEATS	**1**			**2**			**3**			**4**		
LYRICS	nə̀	bá	ɣə́	də́	ʙʷə̌		ʙʷó					

FIGURE 13 | Grid representation of three lines of master drummer's verses, Song 2. Numbers 1–4 represent whole-numbered beats on which the idiophone/shaker sound and dancers move. Individual cells represent beats on which the complex ndünlàm/metallophone sounds. St/Si represent beat fractions on which the Standing or Sitting drum sounds. Gray filled cells indicate beats on which the voice is sounding.

including discourse particles, as well as stem-final syllables, remain confined to beat fractions instead of main beats. These observations are consistent with a view whereby pronouns occupy a kind of middle-ground prosodically, neither consistently weak, nor consistently strong. On the subject of pronouns, we also found that certain types of pronouns—namely possessive pronominal enclitics—are consistently produced with longer note duration, and can also occur at musically strong positions. This is consistent with earlier work demonstrating rhythmic prominence of these enclitic syllables within non-musical speech production tasks (Franich, 2017; Franich, 2018; Franich, 2021).

Interestingly, the overall pattern of alignment between stem-initial syllables and whole-numbered beats is completely reversed in the context of S2M2: here, affixes reign supreme in filling main beat positions, while stem-initial syllables are consistently located on beat fractions. The systematicity with which these two types of syllables—affixes, on the one hand, and stem-initial syllables, on the other—are swapped in terms of their beat positions across motifs within Song 2 is a

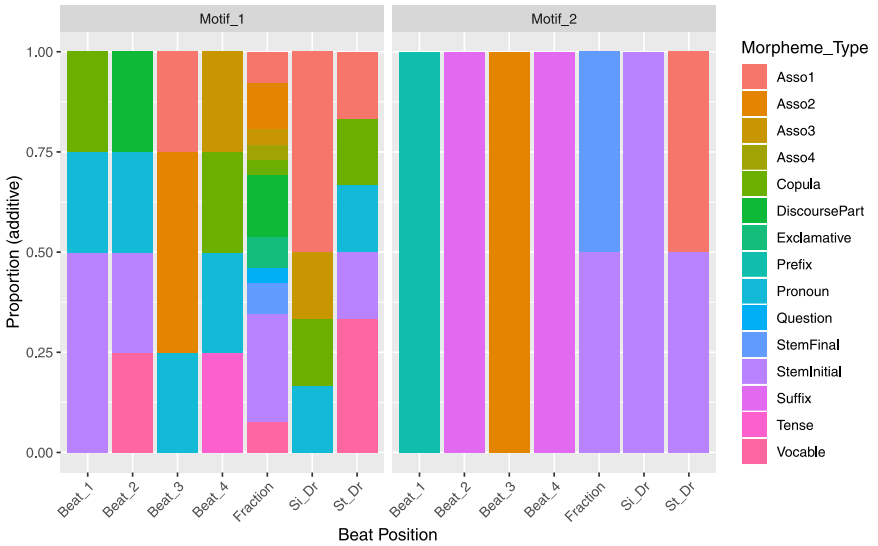

FIGURE 14 | Alignment of syllables by morpheme type and motif in master drummer's verses of Song 2 represented as proportions of occurrences.

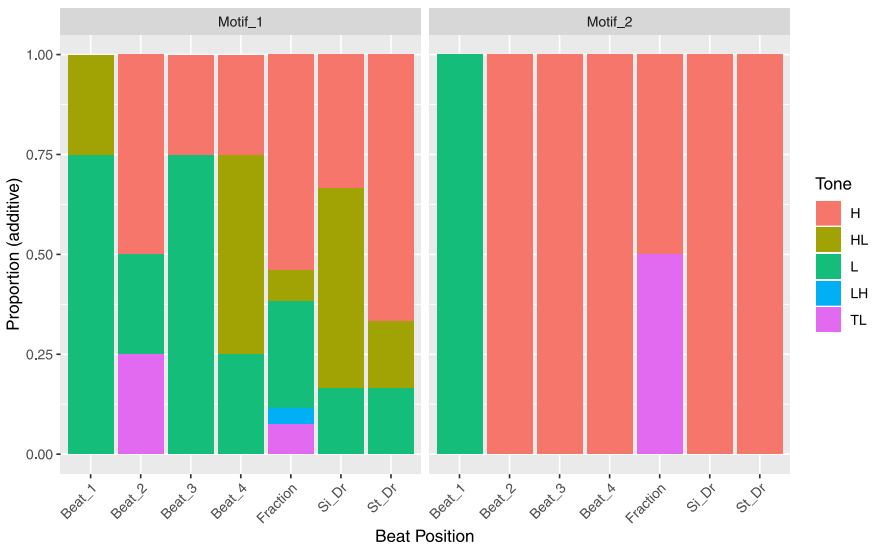

FIGURE 15 | Alignment of syllables by tone and motif in master drummer's verses of Song 2 represented as proportions of occurrences.

testament to the internal consistency of each syllable type regarding their rhythmic role. S2M2 is somewhat of an outliner across all of the rhythmic structures investigated, suggesting that the exchange of rhythmic roles between affixes and stem-initial syllables reflects a subversion of the usual link between the primary rhythmic pulse of the song and linguistically prominent stem-initial syllables. In this way, this pattern somewhat resembles what was described for Lardil *burdal* songs in §1 (Nancarrow 2010). Whether this pattern is idiosyncratic in Song 2 as presented here, or representative of a more broadly employed creative device in text-setting, is unclear; data from additional songs and genres would be useful in answering this question.

Another interesting source of consistency we find in the mapping of musical rhythm to language structure is in the syllables on which the master drummer accents beat fractions outside of the main beats on the *mɛ̂nfámɔ́* sitting drum. Across the three different motifs (S1M1, S2M1, and S2M2), the morphological makeup of these beats is typically one of the most consistent of any beat position, and considerably more consistent than what is found for the accented beat fractions of the *tómŋkà'* standing drum. The morphology corresponding to

the accented fractions of the *mɛ̂nfámə́* is also similar to what is found on main beats, in that stem-initial syllables and pronouns tend to be favored in these positions when those types of syllables are overall aligning with main beats within a particular motif, and affixes are preferred when those syllables are instead populating the main beats within a motif. Indeed, it is as if these beat fractions are behaving themselves as main beats, which falls out naturally if we assume that they *are*, in fact, main beats, when contextualized within a competing triple rhythm overlaid on the duple rhythm being reinforced by the idiophone/shaker and dancers. The consistency of the morphological makeup on the master drummer's articulated beats also makes sense if we consider the difficult rhythmic task of the master drummer, who is essentially reinforcing *both* rhythms at once through his singing and his playing: this is likely more easily done if what the hands and the voice are doing is rhythmically and structurally consistent and somewhat predictable.

Tone, Syllable Structure, and Text-Setting

In terms of tone, we again found considerable variation in text-setting patterns. In most rhythmic motifs, high tones tended to be preferred on main beats, with low tones more common on beat fractions, and toneless syllables occurring exclusively on beat fractions. A major exception to this is in Beat 1 of Song 2 for both motifs, where low tones were more prevalent (they were also more prevalent on Beat 3 within the first motif). Interestingly, contour tones, where they did occur, tended to be as common—if not more so—on beat fractions as on main beats. An exception to this is in S1M2, where contours occurred to some degree on both Beats 1 and 3. Overall, however, there does not seem to be any strong rhythmic preference when it comes to the positioning of contour tones within the rhythmic line.

Turning now to note durations, we found that contoured syllables did consistently occur with longer note lengths (usually two eighth notes/one quarter note) in the data set. We observed no clear differences in alignment or duration between words bearing contour tones arising from their own underlying lexical tone (e.g., *ʙwə̌* "beautiful"), those derived from concatenation of a floating tone morpheme (e.g., *mɛ̂n* "child.asso"), or those derived from a tonal overwrite process (e.g., *lɛ̂n* "know.subj"); rhythmic differences between LH rising and HL falling contours were also not apparent in our data set. There was also no consistent difference between contour-toned syllables of different syllable shapes, as might have been predicted if musical note lengths were based on pure durational differences across syllables. This suggests that contour tones were given a uniform treatment in terms of note length, apparently reflective of a more abstract mapping between linguistic structure and musical beat structure.

Importantly, it was not only contour-toned syllables which bore relatively longer note lengths in the songs: monosyllabic stems of all syllable shapes also tended to bear similar note lengths of two eighth notes/one quarter note. Thus, it seems tone is not the primary driver of increased note length. Note lengths for disyllabic stems also tended to constitute a total of two eighth notes, with a single eighth note assigned to each syllable. Given that stems are thought to align with feet in this language (see §3.1), assuming a moraic account of syllable weight, this pattern could reflect the very common cross-linguistic constraint requiring that feet minimally contain two moras (Prince and Smolensky 1993). However, it is also possible that this pattern reflects a phonetically based pattern of foot-internal shortening, rather than a weight-based pattern (Fowler 1977; Kim and Cole 2006).

Another area of the grammar in which syllables are consistently mapped to shorter note lengths is among functional item such as discourse particles and affixes. It is well-known that function words in the world's languages tend to be prosodically weaker than lexical words; thus, this pattern may simply be a reflection of relative syllable prominence. We note, though, that stem-initial syllables, despite bearing greater rhythmic prominence, are only realized with greater note length in monosyllabic words, and not within disyllabic stems; thus, there is no perfectly straightforward mapping between syllable prominence and note length in our dataset. This gives us further reason to consider a weight-based analysis in which functional items are both prosodically weak and light in terms of their syllable weight. We conclude that there is still no clear answer from the present work about whether Medʉmba does contrast syllables in terms of weight, but it appears a purely phonetic explanation of the mapping between syllables and note lengths falls short of capturing some of the generalizations that speakers/singers are making when enacting this mapping.

Finally, we note that there are several cases in which mismatches occur between musical beat strength and note length in the songs presented here. For example, while contour-toned syllables and monosyllabic stems regularly occur with longer note lengths, they need not always be positioned on "strong" musical beats; conversely, though subject pronouns tend to bear shorter note lengths, they also consistently occur on main beats within the rhythmic line. This is in spite of our earlier observation that stem-initial syllables and monosyllabic stems (which also tend to take up longer note lengths) are generally preferred on main beats in most rhythmic motifs, with stem-final syllables and affixes (which bear shorter note lengths) occurring outside of these beats. The relationship between note length and beat strength is therefore not absolute, and is almost certainly modulated by other factors, such as overall position within the sentence/phrase.

Song-Based Deviations From Linguistic Structure

Finally, we note that grammatical structure within songs can deviate in some interesting ways from what is expected in everyday speech. For example, unlike in regular speech, stem-final syllables are able to be overtly produced phrase-medially in these songs. One example of this is the initial line/chorus of Song 1, in which the word *cóbə* "speak" is produced with two syllables, where it would normally be produced without the final vowel. Also missing from this construction as it would usually occur is the focus marker *à* which would normally occur between the verb *cób* 'speak' and the following directional *ʙwə̀* "there" (i.e. *à cób* ***à*** *ʙwə̀*). It is interesting to note that the verb consistently occurs with an eighth note rest after it in Song 1, almost as if rhythmic space is being held for the focus marker, even though it isn't being produced. Another place where a stem-final syllable is produced phrase-internally is in Song 2, where the group sings *ó báyə́-də́ ŋkwá* ("o, bend and dance"), instead of *ò bá**k**-də́ ŋkwá*, as would be expected in regular speech. These patterns may reflect an older form of the language where stem-final syllables were produced

regularly in all contexts, before being reduced in phrase-internal position; however, the historical evolution of these syllables is as yet unclear. It is also possible that these patterns simply reflect an idiosyncrasy of song structure which deviates from the spoken language grammar.

CONCLUSION

The present work has provided description and analysis of mapping patterns between language and music in Medumba folkloric songs from the *Làm* blacksmith tradition. Our findings provide support for earlier work suggesting that syllables in the language differ in terms of their prosodic strength: as predicted, stem-initial syllables in the language, which are analyzed as metrically prominent, tend to be preferred on musically prominent beats, while non-initial and non-stem syllables, generally speaking, are preferred on less prominent beats. However, we have also highlighted various aspects of rhythmic flexibility which suggests that mapping between linguistic strength and musical strength is not absolute in these songs. Nonetheless, even where mismatches between musical structure and linguistic structure did emerge, they were principled, in that syllables of distinct morpho-prosodic status tended to pattern together in either being attracted to, or repelled by, musically strong beats within any given rhythmic motif. Our results thus highlight the fact that rhythmic variability of a particular morpho-prosodic structure within song does not indicate its lack of rhythmic status, but rather a flexibility in the mapping constraints between language and music. Variability in mapping constraints can only be ascertained through careful analyses of distinct rhythmic modes within and across songs. Finally, it should be noted that the present work represents a rich, but small dataset on Medumba speech-based song. Undoubtedly, a wider survey of musical genres from the region will reveal additional patterns and complexities which can increase our understanding of musical and linguistic grammars, and mappings between the two.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Delaware Institutional Review Board. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

KF conceived of the study and oversaw all data collection, data processing, analyses, and manuscript preparation. ALN assisted with data collection and contributed to data interpretation and manuscript writing.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomm.2021.653747/full#supplementary-material

REFERENCES

Abercrombie, D. (1967). *Elements of General Phonetics*. Chicago, IL: Aldine-Atherton.

Agawu, V. K. (1995). *African Rhythm: A Northern Ewe Perspective*. Cambridge University Press.

Akinlabi, A., and Urua, E. E. (2003). Foot Structure in the Ibibio Verb. *J. Afr. Languages Linguistics* 24 (2), 119–160. doi:10.1515/jall.2003.006

Anku, W. (2000). Circles and Time: A Theory of Structural Organization of Rhythm in African Music. *J. Soc. Music Theor.* 6, 1.

Chan, M. K. M. (1987). Tone and Melody Interaction in Cantonese and Mandarin Songs. *UCLA Working Pap. Phonetics* 68, 132–169.

Chao, Y. R. (1948). *Mandarin Primer*. Cambridge: Harvard University Press. doi:10.4159/harvard.9780674337145

Chernoff, J. M. (1991). The Rhythmic Medium in African Music. *New Literary Hist.* 22 (4), 1093. doi:10.2307/469080

Cho, S.-H. (2017). Text Alignment in Japanese Children's Song. *Penn Working Pap. Linguistics* 23, 1. Accessible online at http://repository.upenn.edu/pwpl/vol23/iss1/5/.

Clements, G. N., and Goldsmith, J. (1984). *Autosegmental Studies in Bantu Tone*. Dordrecht, Netherlands: Foris.

Danis, N. (2011). "Downstep and Contour Formation in Medumba: A Prosodic Account," in Proceedings of the 42nd Annual Conference on African Linguistics.

Dell, F., and Halle, J. (2009). "Comparing Musical Textsetting in French and in English Songs," in *Towards a Typology of Poetic Forms*. Editors Jean-Louis, Aroui, and Andy. Arleo (Amsterdam: John Benjamins), 63–78. doi:10.1075/lfab.2.03del

Dimmendaal, G. (2012). Metrical Structures: A Neglected Property of Nilotic (And Other African Language Families). *Stud. Nilotic Linguistics* 5, 1–26.

Downing, L. (2010). "Accent in African Languages," in *A Survey of Word Accentual Patterns in the Languages of the World*. Editors R. W. N. Goedemans, H. G. van der Hulst, and E. A. van Zanten (Berlin, Germany: Mouton de Gruyter), 381–427.

Downing, L. J. (1990). Local and Metrical Tone Shift in Nguni. *Stud. Afr. Linguistics* 21, 261–317.

Downing, L. J. (2004). What African Languages Tell Us about Accent Typology. *Zaspil* 37, 101–136. doi:10.21248/zaspil.37.2004.247

Duanmu, S. (1990). *A Formal Study of Syllable, Tone, Stress and Domain in Chinese languages*. Cambridge (MA): MIT. [dissertation].

Duanmu, S. (1996). Pre-juncture Lengthening and Foot Binarity. *Stud. Linguistic Sci.* 26, 95–115.

Duanmu, S. (2004). Tone and Non-tone Languages: An Alternative to Language Typology and Parameters. *Lang. linguistics* 5 (3), 891–924.

Espinosa, A. M. (1924). *Synalepha and Syneresis in Modern Spanish*. Washington: Hispania, 299–309. doi:10.2307/331182

Fitzgerald, C. M. (1998). The Meter of Tohono O'odham Songs. *Int. J. Am. Linguistics* 64 (1), 1–36. doi:10.1086/466345

Fowler, C. A. (1977). *Timing Control in Speech Production*. Bloomington: Indiana University, Linguistics Club.

Franich, K. (2014). Contour tones and prosodic structure in Medʉmba, in *Proceedings of the 40th Annual Meeting of the Berkeley Linguistic Society*. Editor H. Lueng, 102–124.

Franich, K. (2021). *Metrical Prominence Asymmetries in Medʉmba, a Grassfields Bantu Language*. Language 92 (2).

Franich, K. (2017). *The Interaction of Prominence, Rhythm, and Tone in Medʉmba*. Chicago (IL): University of Chicago. [dissertation].

Franich, K. (2018). Tonal and Morphophonological Effects on the Location of Perceptual Centers (P-centers): Evidence from a Bantu Language. *J. Phonetics* 67, 21–33. doi:10.1016/j.wocn.2017.11.001

Goldsmith, J. (1976). *Autosegmental Phonology*. Cambridge (MA): MIT. [dissertation].

Gordon, M. (2001). A Typology of Contour Tone Restrictions. *Stud. Lang.* 25, 405–444. doi:10.1075/sl.25.3.03gor

Gordon, M. (1999). *Syllable Weight: Phonetics, Phonology, and Typology*. Los Angeles, CA: UCLA. [PhD Thesis].

Grabe, E., and Low, E. L. (2002). Durational Variability in Speech and the Rhythm Class Hypothesis. *Pap. Lab. Phonology* 7.

Green, C. R. (2015). The Foot Domain in Bambara. *Language* 91 (1), e1–e26. doi:10.1353/lan.2015.0009

Guthrie, M. (1948). *The Classification of the Bantu Languages*. Oxford University Press.

Hayes, B. (1995). *Metrical Stress Theory: Principles and Case Studies*. Chicago, IL: University of Chicago Press.

Huron, D., and Ollen, J. (2003). Agogic Contrast in French and English Themes: Further Support for Patel and Daniele (2003). *Music Perception* 21 (2), 267–271. doi:10.1525/mp.2003.21.2.267

Hyman, Larry. (1985). *A Theory of Phonological Weight*. Dordrecht: Foris. doi:10.1515/9783110854794

Hyman, L. M. (2014). "Do all Languages Have Word Accent?," in *Word Stress: Theoretical and Typological Issues*. Editor H. van der Hulst (Cambridge University Press), 56–82.

Hyman, L. M. (2015). *Positional Prominence vs. Word Accent: Is There a Difference?* Berkeley, CA: UC Berkeley Phonology Lab Annual Report, 86–99.

Hyman, L. M. (2003). Why Describe African Languages? 4th World Congress on African Linguistics/34th Annual Conference on African Linguistics. Rutgers University.

Hyman, L. M., Rolle, N., Sande, H., Chen, E., Jenks, P., Lionnet, F., et al. (2019). "Niger-Congo Linguistic Features and Typology," in *The Cambridge Handbook of African Linguistics and A History of African Linguistics*. Editor E. Wolff (Cambridge University Press).

Hyman, L. M., and Tadadjeu, M. (1976). Floating Tones in Mbam-Nkam. *South. Calif. Occas. Pap. Linguistics* 3, 57–111.

Jo-Keeling, S. R. (2011). *'Musicking Tradition in Place: Participation, Values, and Banks in Bamiléké Territory'*. Ann Arbor (MI): University of Michigan. [dissertation].

Ketkaew, C., and Pittayaporn, P. (2014). Mapping between Lexical Tones and Musical Notes in Thai Pop Songs. Proceedings of the 28th Pacific Asia Conference on Language. *Inf. Comput. (Paclic)* 28, 160–169.

Keupdjio, H. S. (2020). *The Syntax of A'-dependencies in Bamileke Medumba*. Vancouver(BC): University of British Columbia. [dissertation].

Kim, H., and Cole, J. (2006). "*Evidence for Rhythm Shortening in American English as Conditioned by Prosodic Phrase Structure*," To appear in the Proceeding of 42nd annual Meeting of the Chicago Linguistic Society.

Kiparsky, P. (1979). Metrical Structure Assignment Is Cyclic. *Linguistic Inq.* 10 (3), 421–441.

Kiparsky, P. (2016). *Stress, Meter, and Text-Setting. The Handbook of Historical Phonology*. Oxford, UK: Oxford University Press.

Kirby, J., and Ladd, D. R. (2016). "Tone-melody Correspondence in Vietnamese Popular Song," in Proceedings of the 5th International Symposium on Tonal Aspects of Languages (TAL-2016), 48–51.

Kubik, G. (1983). ""Transkription Afrikanischer Musik Vom Stummfilm" [Transcripton of African Music from Silent Film]," in *Musik in Afrika*. Editor Artur. Simon (Berlin: Museum für Völkerkunde), 202–216.

Ladd, D. R., and Kirby, J. (2020). "Tone–Melody Matching in tone-Language Singing," in *The Oxford Handbook of Language Prosody*. Editors C. Gussenhoven and A. Chen (Oxford University Press), 676–687.

Leben, W. (2002). Tonal Feet and the Adaptation of English Borrowings into Hausa. *Stud. Afr. Linguistics* 25, 139–154.

Leben, W. (2003). "Tonal Feet as Tonal Domains," in *Trends in African Linguistics 5: Linguistic Typology and Representations of African Languages*. Editor J. Mugane (Trenton, NJ: Africa World Press), 129–138.

Leben, W. R. (1971). *Suprasegmental Phonology*. Cambridge (MA): MIT. [dissertation].

Lehrdal, F., and Jackendoff, R. (1983). *A Generative Theory of Tonal Music*. Cambridge, MA: MIT Press.

Lendja, N. A. B. (2016). "La territorialisation/dérritorialisation du corps du roi: Bamiléke-Bangoulap (Cameroun)," in *Les territoires du sacré: images, discours, pratiques*. Editors R. Ziavoula, A. Kouvouama, and P. Yengo, 73–111.

Lerdahl, F. (2001). The Sounds of Poetry Viewed as Music. *Ann. N. Y. Acad. Sci.* 930, 337–354. doi:10.1111/j.1749-6632.2001.tb05743.x

Liberman, M. (2007). *Rock Syncopation: Stress Shifts or Polyrhythms?* LanguageLog (blog), published. Retrieved from http://itre.cis.upenn.edu/~myl/languagelog/archives/005154.html.

Liberman, M. (1975). *The Intonational System of English*. Cambridge (MA): MIT. [dissertation].

Liberman, M., and Prince, A. (1977). On Stress and Linguistic Rhythm. *Linguistic Inq.* 8, 249–336.

McPherson, L., and Ryan, K. M. (2018). Tone-tune Association in Tommo So (Dogon) Folk Songs. *Language* 94, 119–156. doi:10.1353/lan.2018.0003

Mead, R. (2007). *Text-to-tune Alignment in the Music of La Charanga Habanera*. Palo Alto (CA): Stanford University. [undergraduate thesis].

Mesthrie, R., and Bhatt, R. M. (2008). *World Englishes*. Cambridge : Cambridge University Press. doi:10.1017/cbo9780511791321

Mkammi, J. (2009). *Les noms et les titres de noblesse dans le Nde*. Bangangte, Cameroon: Comité de Langue pour l'Etude et la Production des Œuvres Bamiléké-Medumba.

Moore, C. B. (1993). Phonetic Observations on Tone and Stress Levels in Mandarin Classifiers. Proceedings of the 5th North American Conference on Chinese Linguistics 29.

Morgan, T. A., and Janda, R. D. (1989). "Musically-conditioned Stress Shift in Spanish Revisited: Empirical Verification and Nonlinear Analysis," in *Studies in Romance Linguistics, Selected Proceedings from the XVII Linguistic Symposium on Romance Languages*. Editors C. J. Kirschner and A. DeCesaris (New Jersey: Rutgers University).

Nancarrow, C. (2010). What's that Song about?: Interaction of Form and Meaning in LardilBurdalSongs. *Aust. J. Linguistics* 30 (1), 81–92. doi:10.1080/07268600903134046

Odden, D. (1999). "Typological Issues in Tone and Stress in Bantu," in Proceedings of the Symposium on Cross-Linguistic Studies of Tonal Phenomena: Tonogenesis, Typology, and Related Topics. Editor Shigeki Kaji (Tokyo: ILCAA), 187–215.

Olson, K., and Meynadier, Y. (2015). "On Medumba Bilabial Trills and Vowels," in Proceedings of the 18th International Congress of Phonetic Sciences (Glasgow, Scotland: The Scottish Consortium for ICPhS 2015).

Patel, A. D., and Daniele, J. R. (2003). Stress-Timed vs. Syllable-Timed Music? A Comment on Huron and Ollen (2003). *Music Perception* 21, 273–276. doi:10.1525/mp.2003.21.2.273

Pearce, M. (2007). "Iambicity in Kera," in Proceedings of the 37th Annual Conference on African Linguistics. Editors D. L. Payne and J. Pena (Somerville, MA: Cascadilla Proceedings Project), 66–76.

Pearce, M. (2006). The Interaction between Metrical Structure and Tone in Kera. *Phonology* 23 (2), 259–286. doi:10.1017/s095267570600090x

Pike, K. (1945). *The Intonation of American English*. Ann Arbor, MI: University of Michigan Press.

Prince, A. (1983). Relating to the Grid. *Linguistic Inq.* 14, 19–100.

Prince, A., and Smolensky, P. (1993). *Optimality Theory: Constraint Interaction in Generative Grammar*.

Proto, T. (2016). "Methods of Analysis for Tonal Text-Setting. The Case Study of Fe'Fe' Bamileke," in Proceedings of the 5th International Symposium on Tonal Aspects of Language (Buffalo, New York). doi:10.21437/tal.2016-35

Ramus, F. (2002). Language Discrimination by Newborns: Teasing Apart Phonotactic, Rhythmic, and Intonational Cues. *Annu. Rev. Lang. Acquisition* 2. doi:10.1075/arla.2.05ram

Richards, P. (1972). A Quantitative Analysis of the Relationship between Language Tone and Melody in a Hausa Song. *Afr. Lang. Stud.* 13, 137–161.

Rycroft, D. (1959). African Music in Johannesburg: African and Non-african Features. *J. Int. Folk Music Counc.* 11, 25–30. doi:10.2307/834851

Schane, S. (1968). *French Phonology and Morphology*. Cambridge, MA: MIT Press.

Schellenberg, M. (2012). Does Language Determine Music in Tone Languages? *Ethnomusicology* 56 (2), 266–278. doi:10.5406/ethnomusicology.56.2.0266

Schellenberg, M. (2009). "Singing in a Tone Language: Shona," in Selected Proceedings of the 39th Annual Conference on African Linguistics: Linguistic Research and Languages in Africa. Editors A. Ojo and L. Moshi (Somerville, MA: Cascadilla Proceedings Project), 137–144.

Schuh, R. G. (2010). *The Form and Metrics of Ngizim Songs. Ms*. Los Angeles, CA: UCLA.

Schuh, R. G. (2014). Where Did Quantitative Metrics in Hausa and Other Chadic Songs Come from? Proceedings of the 1st International Conference on Endangered Languages. Kano: Japan, August 2014. doi:10.1628/978-3-16-153197-2

Temperley, D. (1999). *Syncopation in Rock: A Perceptual Perspective*. Cambridge University Press.

Temperley, D. (2000). Meter and Grouping in African Music: A View from Music Theory. *Ethnomusicology* 44 (1), 65. doi:10.2307/852655

Temperley, N., and Temperley, D. (2012). Stress-meter Alignment in French Vocal Music. *J. Acoust. Soc. Am.* 134 (1), 520–527. doi:10.1121/1.4807566

Toussaint, G. T. (2015). Quantifying Musical Meter: How Similar Are African and Western Rhythm? *Anal. Approaches World Music* 4, 1.

Toussaint, G. T. (2013). *The Geometry of Musical Rhythm: What Makes a "Good" Rhythm Good?* Taylor & Francis Group: CRC Press.

Turk, A. E., and White, L. (1999). Structural Influences on Accentual Lengthening in English. *J. Phonetics* 27, 171–206. doi:10.1006/jpho.1999.0093

Turpin, M., and Laughren, M. (2013). Edge Effects in WarlpiriYawulyuSongs: Resyllabification, Epenthesis, Final Vowel Modification. *Aust. J. Linguistics* 33 (4), 399–425. doi:10.1080/07268602.2013.857569

Vance, T. (1987). *An Introduction to Japanese Phonology*. Albany: State University of New York Press.

Vetter, R. (1996). *Rhythms of Life, Songs of Wisdom: Akan Music from Ghana*. West Africa: Compact disc recording and 24-page accompanying booklet. Smithsonian/Folkways SFCD 40463.

Voorhoeve, J. (1976). *Contes Bamileke*. Museé Royal de L'Afrique Centrale.

Voorhoeve, J. (1965). The Structure of the Morpheme in Bamileke (Bangangté Dialect). *Lingua* 13, 319–334.

Voorhoeve, J. (1971). Tonology of the Bamileke Noun. *J. Afr. Languages* 2, 44–53.

Voorhoeve, J. (1968). Noun Classes in Bamileke. *Lingua* 21, 584–593. doi:10.1016/0024-3841(68)90077-6

Wee, L-H. (2015). Unraveling the Relation between Mandarin Tones and Musical Melody. *J. Chin. Linguistics* 35 (1), 128–144.

Weidman, S., and Rose, S. (2006). A Foot-Based Reanalysis of Edge-In Tonal Phenomena in Bambara. Paper Presented at West Coast Conference on Formal Linguistics 25. Seattle, WA: University of Washington. doi:10.21236/ada463728

Wong, P. C. M., and Diehl, R. L. (2002). How Can the Lyrics of a Song in a Tone Language Be Understood? *Psychol. Music* 30, 202–209. doi:10.1177/0305735602302006

Yip, M. (1980). *The Tonal Phonology of Chinese*. Cambridge (MA): MIT. [dissertation].

Zhang, J. (2002). *The Effects of Duration and Sonority on Contour Tone Distribution–Typological Survey and Formal Analysis*. Los Angeles, CA: UCLA. [PhD Thesis].

Zhang, J. (2004). "The Role of Contrast-specific and Language-specific Phonetics in Contour Tone Distribution," in *Phonetically Based Phonology*. Editors B. Hayes, R. Kirchner, and D. Steriade (Cambridge University Press), 157–190. doi:10.1017/cbo9780511486401.006

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