

Bora drum communication, the typology of emulated speech, and prosodic typology

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1. Introduction

The Bora people of the Northwest Amazon traditionally practice a drummed version of their language, locally called *manguaré*, for long-distance communication. Sequences of drum beats represent phonological and prosodic features of corresponding phrases of the spoken language, such as phonological tones, syllable weight, and possibly some specific consonantal and vowel features. Drummed messages follow a formulaic scheme, but within this, a variety of messages can be efficiently communicated.

Bora drum communication is an acoustic substitutive system for the spoken form of the language, like other drum communication systems, and also like whistled speech and instrumental imitations of speech (by, e.g., xylophones, gongs, jaw harps, mouth arches, flutes, or string instruments) (Sebeok & Umiker Sebeok, eds. 1976). These substitutive systems are far from uniform, as they are based on different phonological and prosodic features of the corresponding spoken language. They selectively highlight structural features of spoken language, according to their relevance in the prosodic structure of the spoken language. Their comparative study allows identifying types of systems, which partially correlate with spoken language types such as tonal vs. non-tonal languages (Meyer 2008).

Bora *manguaré* is one of the very few drummed languages documented so far in South America, most of them having been described in Africa. No drummed form of language has been analyzed with statistical analyses of acoustic measurements so far.

Overview:

- introduce social and linguistic context of Bora *manguaré*
- present a description of the Bora drum communication system, its particular syntax and formulaic structure, and the way in which phonological and prosodic features are transposed from spoken speech, based on acoustic measurements and quantitative analyses of systematically compiled *manguaré* data (section 3).
- discuss Bora drummed language from a comparative perspective of other drummed languages and whistled language (section 4)
- discuss the potential contributions of the Bora drummed language, and other forms of emulated speech, to prosodic typology (section 5)

2. The Bora people and language, and the *manguaré* drums

2.1. Bora people

The approximately 2,000 Bora speakers are located in the Northwest Amazon, on both sides of the Colombian-Peruvian border, not far from Brazil. Their habitat is in dense rainforest environment, along the larger rivers (traditionally more inland). The traditional Bora culture and language are nowadays in danger of being replaced by Colombian-Peruvian mainstream regional culture and regional varieties of Spanish.

2.2. Bora language

Bora (Boran, possibly Witotoan) is a relatively synthetic, agglutinating, almost exclusively suffixing language. It has six phonemic vowel positions in addition to a phonemic distinction of vowel length (represented as double vowel symbols in the practical orthography) (Tables 1-2).

i <i>	ɨ <ɨ>	u <u>
ɛ <ɛ>	a <a>	o <o>

Table 1: Short vowels

i: <ii>	ɨ: <ɨɨ>	u: <uu>
ɛ: <ee>	a: <aa>	o: <oo>

Table 2: Long vowels

Plain consonants are given in Table 3. Almost all have palatal(ized) counterparts (Table 4), which are often (but not always) allophones after /i/ and sometimes /a/.

m <m>		n <n>							
p 	p ^h <p>	t <d>	t ^h <t>			k <g>	k ^h <k>	k ^w <w>	ʔ <h>
		ts <ds>	ts ^h <ds>	tʃ <ll>	tʃ ^h <ch>				
		r <r>							
β <v>									h <j>

Table 3: Plain consonants

m ^j <my>		n ^j <ny>							
p ^j <by>	p ^{jh} <py>	t ^j <dy>	t ^{jh} <ty>			k ^j <gy>	k ^{jh} <ky>	k ^{wj} <wy>	ʔ ^j <hy>
		r ^j <ry>							
β ^j <vy>									h ^j <jy>

Table 4: Palatal(ized) consonants

The syllable structure is (C)V(C), with the restriction that only the glottal fricative (h) and stop (ʔ) may occur in coda position and only if the vowel is short. The four main syllable

types are given in Table 5. Heavy syllables pattern together in some morphophonological processes. The only consonant clusters allowed are glottal fricatives (h) followed by voiceless aspirated consonants and glottal stops (?) followed by voiceless non-aspirated consonants.

light/heavy	scheme	examples
light syllables	(C)V <(C)V>	<i>i.óó.ve.jí</i> ‘proper name’
heavy syllables	(C)V: <(C)VV>	<i>tuu.tá.vaa.be i.óó.ve.jí</i> ‘damaged, proper name’
	(C)Vh <(C)Vj>	<i>tsí.va.híj.kya</i> ‘come!’, <i>új.tyu.vá.ne</i> ‘green’
	(C)V? <(C)Vh>	<i>áh.tsa.kú.ne</i> ‘defeat’, <i>tah.di</i> ‘grandfather’

Table 5: Bora syllable types

Bora has two contrastive tones (high and low) (Weber & Thiesen 2001). The low tone is the marked value, while the high tone is generally assigned by default to syllables with no marked tone. Lexical roots may or may not bear a lexically assigned tone. Suffixes often bear floating tones that dock on the ultimate or penultimate syllable of the stem to which they attach, and there are also ‘tonal morphemes’ (without segmental material).

Tone discriminates only relatively few lexical items, but it has many grammatical functions, in derivational and inflectional processes (tone-bearing suffixes) as well as in the marking of nominalization, subordination, and relative clauses (tonal morphemes), as characteristic of “type B” tone languages in terms of Ratliff (1992).

The distribution of tones is heavily restricted by the rule that no two low tones may occur in adjacent syllables except at the end of tone phrases (which may encompass various words). This restriction leads to massive and complicated tone sandhi processes, i.e. delinking or blocking of low tones that are assigned to adjacent syllables (e.g. a floating tone on the ultimate syllable next to a lexical tone on the penultimate syllable of a stem).

As a consequence of this restriction, the number of possible tone patterns a word form can have is drastically reduced. For instance, at a given position in a phrase a trisyllabic word form may only have only three out of nine logically possible tone patterns. The tone pattern alone is thus only a very weak indication of the identity of a word form with a given number of syllables (low functional load).

position in phrase	tone pattern	example
phrase finally	HHL	<i>tsííméne</i> ‘child’
	LHL	<i>tsahíjkyá</i> ‘come!’
	HLL	<i>óóvího</i> ‘scorpion’
phrase medially	HHH	<i>tsííméné</i> ‘child’
	HLH	<i>óóvíhó</i> ‘scorpion’
	LHH	<i>tsahíjkyá</i> ‘come!’

Table 6: Reduced number of possible tone patterns

The Bora tone system counts syllables, not moras. All syllables are treated in the same way in the assignment of tones (e.g. for the assignment of floating tones), regardless of whether they include long or short vowels, or whether a glottal stop or fricative occurs in coda position.

2.3. *The manguaré drums*

The Bora *manguaré* drums are pairs, each about 5 feet long, one with a larger diameter (called ‘female’), and a smaller one (called ‘male’) (Figure 1). *Manguarés* were traditionally built by hollowing hardwood logs with fire (charcoal and blowing), but nowadays axes, machetes, and other metal tools are preferably used.

Each drum can produce two pitches (one on each side of the slit), therefore the pair of drums has four pitches. Only two (one of each drum) are used for the ‘speech mode’ (see below) of drumming. They are beaten with sticks whose ends are covered with rubber.

Manguaré can be heard (and understood) up to a distance of 20 miles according to Whiffen (1915) and Thiesen (1969), or at least 10 miles (Seifart’s observations).

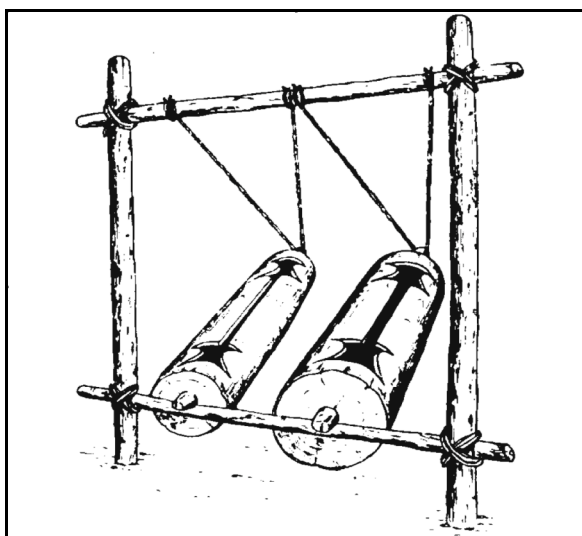


Figure 1: Bora *manguaré* drums (from Thiesen 1996)

Despite striking similarities with some African drums and communication systems (for instance those of Banda Linda, Central African Republic; Cloarec Heiss 1999, Arom 2007), it is unlikely that drum communication was introduced to South America from Africa through the transatlantic slave trade (Nordenskiöld 1930: 46ff).

2.4. *Social contexts of manguaré drumming and basic message types*

Manguaré drums are an important component of traditional culture. Each chief (owner of a roundhouse, encompassing a number of nuclear families), is supposed to have one, which all male members of the community can in principle use.

Drumming is a highly endangered genre of Bora, few young people can drum (well). A number of *manguaré* drums have been sold (mostly to anthropologists) in the past couple of decades, and not all have been replaced.

There are two main types of drummed messages:

1. Strongly formulaic messages or drum sequences that are more musical in nature and that are performed as part of rituals, such as traditional festivals. Some of these make use of all four possible pitches and correspond to syllables of songs. Others include longer sequences that do not correspond to syllables of spoken languages.

2. Relatively informal messages to announce the return of the owner of the roundhouse, or to announce who is the loser of a (non-alcoholic) traditional drinking contest, or ‘calling messages’, which may be used on a daily basis, usually to ask someone to bring something or to come for a certain reason. In this ‘speech mode’ drumming, each beat corresponds to a syllable of a corresponding utterance in the spoken languages. These are the most productive and variable kinds of messages, which of most interest here.

3. The emulation of spoken Bora with *manguaré* drums

3.1. A first illustration

- (1) /k^háʔgúnuúk^houúβú o áʔts^hak^húne/
- káhgúnúko-úvú o áhtsakú-ne*
cahuana drink-DEC 1S defeat-SUB
‘I am defeating the cahuana drink’

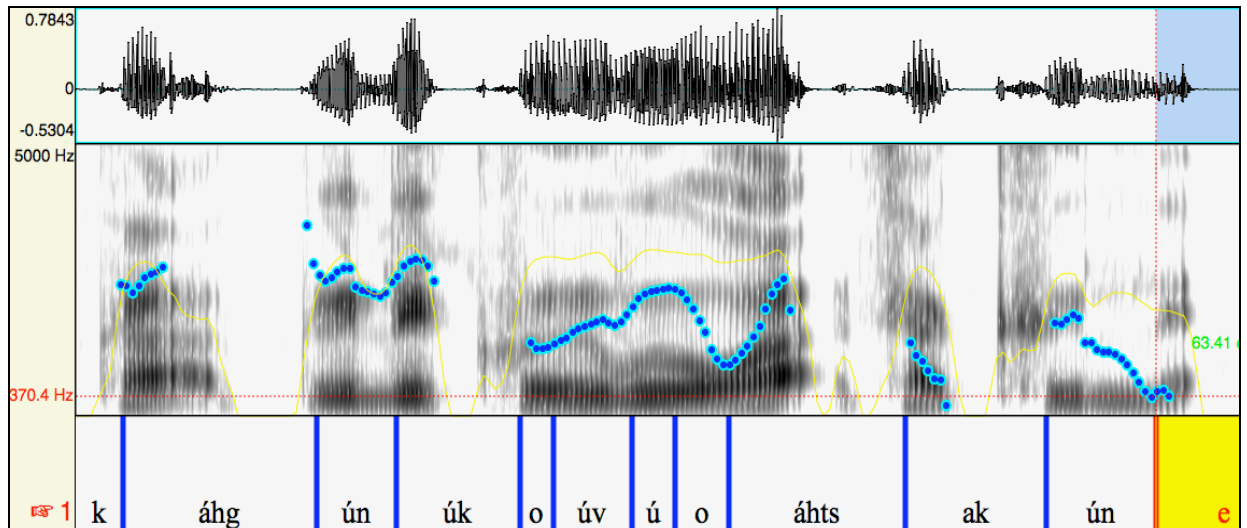


Figure 2: Spoken *káhgúnúkoúvú o áhtsakúne* ‘I am defeating the cahuana drink’

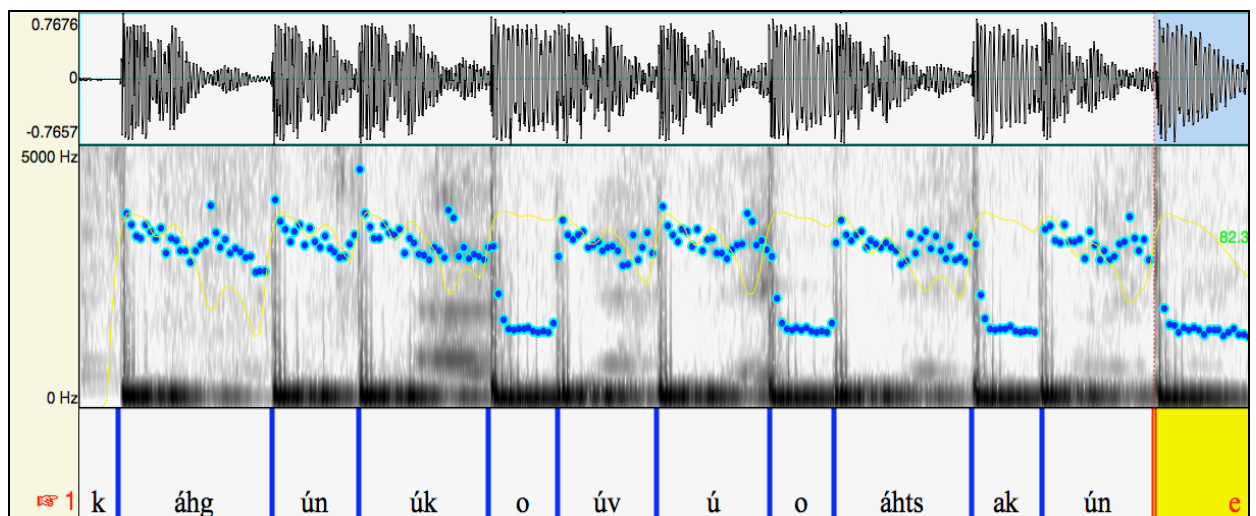


Figure 3: Drummed *káhgúnúkoúvú o áhtsakúne* ‘I am defeating the cahuana drink’

Note in Figures 2-3: downstep (section 3.3), ‘regularized rhythm’ in drumming (section 3.6), and alignment according vowel-to-vowel interval instead of syllables (section 3.6)

3.2. *The special syntax, special phrases, and formulae of drummed messages*

Drummed messages contain a number of special syntactic and lexical features when compared to spoken language, which contribute to their intelligibility: special ‘suffixes’, special ‘vocabulary’, and a formulaic syntax for building messages.

Drummed nouns and verbs are marked by bisyllabic ‘suffixes’, which increase their length and mark them as nouns and verbs. Nouns usually take a suffix that is translated into spoken language as *`-úvu* (‘deceased’, floating low tone on ultimate syllable of stem). Verbs usually take a suffix that is translated into spoken language as *`-híkya* (‘repeated action’, floating low tone on ultimate syllable of stem) (examples 2-3).

- (2) a. SPOKEN BORA
ííbíí-haamí-ne
 coca-CL:LEAF-PL
 ‘coca leafs’
- b. DRUMMED BORA
ííbíí-haamí-ne-úvu
 coca-CL:LEAF-PL-DEC
 ‘coca leafs’

- (3) a. SPOKEN BORA
tsíva
 bring.IMP
 ‘bring!’
- b. DRUMMED BORA
tsíva-híkya
 bring.IMP-REP
 ‘bring!’

To disambiguate names for animals (which are often mentioned in *manguaré* drumming), these are elaborated, making them longer than those in spoken language.

- (4) a. SPOKEN BORA
biírímu-ji
 agouti-CL:2DIM.ROUND
 ‘agouti (small rodent)’
- b. DRUMMED BORA
íámé tuutávaabe biírí-mu níwáko-úvu
 animal damaged agouti-PL hair-DEC
 ‘agouti (lit. deceased hair of agoutis, damaged animal)’

- (5) a. SPOKEN BORA
niivú-wa
 deer-CL:2DIM.STRAIGHT
 ‘deer’
- b. DRUMMED BORA
iámé tuutávaabe néébá niivúwa-úvu
 animal damaged anetto deer-CL:2DIM.STRAIGHT-DEC
 ‘deer (lit. damaged animal, anetto deer)’

As part of the formulaic structure (Figures 4-6), a trisyllabic element with two long vowels is inserted between clan name and proper name, this is translated as *tuutávaabe* (lit. ‘the damaged’). This element marks clearly the end of the clan name and beginning of the proper name.

	:				:	
: MES’GE TYPE:	:	ADDRESSEE			:	: MESSAGE :
		CLAN NAME	FORMULA	(:): PROPER N.(:)		
(see Figure 5)					(see Figure 6)	

Figure 4: One basic scheme of calling messages

		:(CONTINUED ->)			
: MESSAGE TYP :		: ADDRESSEE :			
		CLAN NAME	FORMULA	(:) PROPER NAME (:)	
<i>íkyookaré tsa-híjkyá</i> now come-REP ‘come now’		<i>méwaaǰí</i> hawk, sp.	<i>tuutávaabe</i> damaged	<i>ióóveǰí</i> proper name (Juan)	
<i>íkyookaré dícha</i> now come.IMP ‘come now’		<i>ínyejé</i> palm, sp.		<i>llihýo</i> proper name (Manuel)	
<i>íkyookaré tsíva-híjkyá</i> now bring-REP ‘bring now’		<i>núhbajé</i> sun/moon		<i>kúwájibíjka</i> proper name (Roberto)	
		<i>ohwámú</i> fox, sp.		<i>llíjkyau</i> proper name (Rolando)	
		<i>boánámú</i> anaconda, sp.		<i>úútyawa</i> proper name (Eli)	
		<i>pahtúwámyú</i> palm, sp.		<i>márimúllahájtsi</i> proper name (Antonio)	
		<i>tóóllemé</i> Ocaina people		<i>rohdsíba</i> proper name (Rodolfo)	
	(etc.)		(etc.)		

Figure 5: Examples of the contents of calling messages (part 1)

(-> CONTINUED FROM ABOVE)	:	
:	MESSAGE	:
		CLOSING
<i>úme núhba-úvu-ke me kóvátso-híjkyá-ki</i> salt sun-DEC-ACC 1PL.SUB burn-REP-PURP 'in order to burn salt (lit. the deceased sun of salt)'		<i>íllure állíbye</i> now lie.NMLZ-CL:M.SG <i>ne-hdínye</i> say-IMP.NEG 'now don't say (that I am a) liar'
<i>ííbíí-haamí-ne-úvu me wárhko-híjkyá-ki</i> coca-CL:LEAF-DEC-PL 1PL.SUB toast-REP-PURP 'in order to toast coca (deceased) leafs'		
<i>me wátyu-té-híjkyá-ki</i> 1PL fish-DIR-REP-PURP 'in order to go fishing'		
<i>ííbíí me déljkyu-híjkyá-ki</i> coca 1PL.SUB chew-REP-PURP 'in order to chew coca'		
<i>iámé tuutávaabe bíírí-mu níwáko-úvu</i> animal damaged agouti-PL hair-DEC <i>me dó-híjkyá-ki</i> 1PL.SUB eat-REP-PURP 'in order to eat agouti (lit. the deceased hair of agoutis)'		
<i>iámé tuutávaabe néébá níivú-wa-úvu</i> animal damaged anetto deer-CL:2DIM.STRAIGHT-DEC <i>me dó-híjkyá-ki</i> 1PL eat-REP-PURP 'in order to eat deer (lit. the deceased anetto deer)' (etc.)		

Figure 6: Examples of the contents of calling messages (part 2)

3.3. Tones/pitch of beats

Only one side of each slit drum is used for the speech mode of drumming, i.e. two contrastive tones. *Manguaré* represents surface tones, after the application of tone sandhi rules and tone phrase marking, but before the application of intonational modulation such as downstep.

3.4. Number of beats per syllable

There is one drum beat per syllable (not mora), the beats fall on the onset of vowels, the interbeat interval thus corresponds to a vowel-to-vowel interval (section 3.6).

3.5 Intensity of beats

The amplitude at which a beat is drummed is probably not random, but it is unclear so far if it regularly corresponds to a feature of spoken language. It cannot have a high functional load as differences in amplitude of *manguaré* drum beats are easily distorted in acoustic propagation at large distances.

3.6. Length of pauses between beats (*Interbeat Duration, IBD*)

Given the limited potential for contrastiveness of tone patterns and amplitudes, much of the contrastiveness of sequences of *manguaré* beats resides in the length of the pauses between beats (reflecting distinctions of syllable weight and possible some consonantal and vowel features). Accordingly, this aspect of Bora drum communication has been analyzed in most detail for the present study.

Data and method

The drummed messages were produced on Seifart's request and video-recorded with simultaneous non-compressed audio recording with an external microphone placed about 20 feet away from the *manguaré*. The original data is archived in Seifart et al. (eds., 2009).

Drummed messages were transcribed in ELAN, usually within a few days after recording, by Seifart together with the native speaker/drummer Manuel Mibeco, noting inconsistencies ('slip of the drum') and reduced intelligibility, which do occur and which can be identified by native speakers/drummers.

We selected a total of 95 typical *manguaré* messages of Type 2 (mostly 'calling messages', see section 2.4) from five different expert Bora *manguaré* drummers. Each of these messages contains about 15 words and a total of about 60 drum beats/syllables, which adds up to a database of 5,700 pairs of drum beats/syllables. So far, only interbeat durations within words are taken into account.

Based on the time-aligned transcription, the duration of the pause between two beats (interbeat duration) was measured semi-automatically using Matlab.

Preliminary results 1: Systematicity across drummers/speakers

All drummers respect IBD categories of more than about 50 ms (at which two beats can be perceived as distinct, see Seifert et al. 1995) (Table 7)

dr'r	<i>tsahíjkyá</i> 'come!'	<i>tsahíjkyá</i> 'come!'	<i>ínyejé</i> 'palm (sp.) clan'
MM	0.098(0.016)/0.245(0.016)	0.126(0.021)/0.207(0.046)	0.232(0.022)/0.063(0.02)
JP	0.073(0.018)/0.261(0.02)	0.099(0.010)/0.208(0.009)	0.227(0.012)/0.087(0.022)
JR	0.103(0.022)/0.297(0.023)	0.165(0.026)/0.220(0.021)	0.202(0.022)/0.130(0.035)
RR	0.101(0.046)/0.208(0.056)	0.093(0.015)/0.218(0.05)	0.192(0.012)/0.077(0.02)

Table 7: Average IBDs and standard deviation in three word forms by four drummers

Preliminary results 2: Asymmetry in duration according to tone sequence

Although syllable types and tone distribution are relatively independent in spoken Bora, there is a marked asymmetry in IBDs according to tone pattern (Tables 8-10). This probably constitutes a rhythmic pattern of the *manguaré* that is independent of spoken Bora (in addition to the regularization of IBDs, see Figures 2-3). Physical properties of the *manguaré* drums (e.g. inertia of drum sticks) explain this pattern only partially, it seems to be to some extent a cultural convention, possibly contributing to a 'driving' rhythm. The contrasts of IBDs by tone interaction is highly significant, when comparing only one interval type (C)VCV(V), and when comparing all three interval types.

	VCV(V)			VVCV(V)			Vh/jCV(V)		
	n	ave	stdv	n	ave	stdv	n	ave	stdv
LH	783	0.130	0.051	125	0.207	0.083	279	0.225	0.048
HH	653	0.177	0.043	218	0.211	0.054	169	0.240	0.056
LL	909	0.210	0.028	226	0.237	0.037	96	0.256	0.040
HL	1390	0.220	0.030	243	0.249	0.039	364	0.260	0.042

Table 8: Influence of tone configuration on interbeat duration

Preliminary results 3: The effect of interval (syllable) types and consonants on IBD

Three basic interval (syllable) types (VCV(V), VVCV(V), and Vh/jCV(V)) correlate with different IBDs (Table 8 and Figure 7).

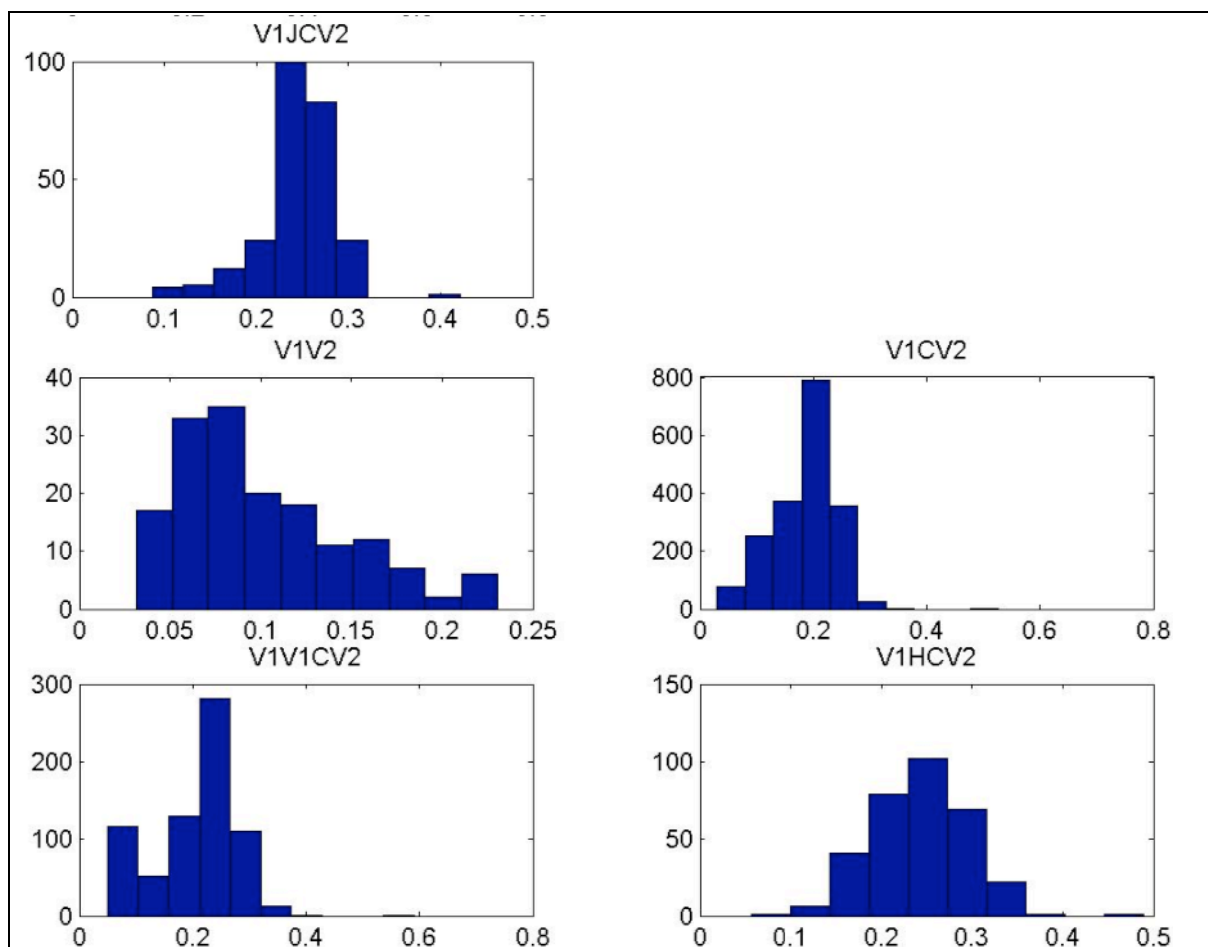


Figure 7: Gaussian distribution of effect of interval(syllable)-type on IBD

At a more fine-grained level, different consonants in the interval also correlate with different IBDs (Table 9 and Figure 8). Presence vs. absence of palatalization on consonants in the interval (e.g. /t^j/ vs. /t/) is not borne out in IBDs and not taken into account in Table 9 and Figure 8.

interval type	average IBD	standard deviation	groups w/ about 50 ms difference
VjV	0.063	0.024	1
VV	0.075	0.031	
VhV	0.105	0.036	2
VmV	0.114	0.035	
VvV	0.128	0.046	
VdV	0.128	0.053	
VwV	0.151	0.019	3
VnV	0.156	0.026	
VtV	0.157	0.046	
VkV	0.160	0.021	
VtsV	0.164	0.046	
VhCV	0.167	0.045	
VjCV	0.214	0.040	4

Table 9: IBD and different consonants after short vowels in L-H configuration

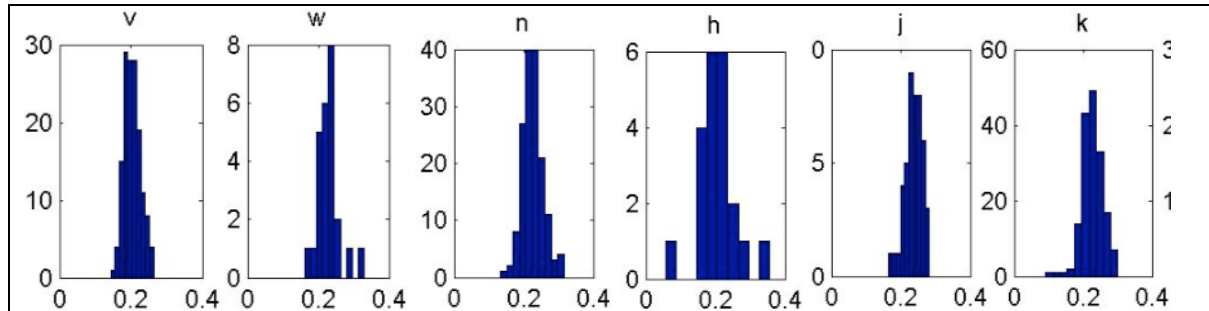


Figure 8: Distribution of effects of consonant-in-interval on IBD

Preliminary results 4: IBD contrast of noun marker vs. verb marker

suffix	average	standard deviation	significance of difference, based on one-way ANOVAs
-úvú	0.184 s	0.045 s	statistically significant
-híjkyá	0.227 s	0.055 s	(F(3.87)=5.56; p=0.019<.02)
-úvu	0.234 s	0.021 s	highly statistically significant
-híjkyá	0.252 s	0.040 s	(F(3.89)=23.51; p=2.75E-06<.0001)

Table 10: IBD contrast between -úvu (DEC, noun marker) vs. -híjkyá (REP, verb marker)

Preliminary results 5: IBD and syllables vs. vowel-to-vowel intervals

The onsets of the second syllable involved in an IB are relevant for the IBD (Table 8-9). The onsets of the first syllable involved in an IB do not seem to influence the IBD (Table 11). The unit that the *manguaré* interbeat duration picks up on is thus more closely related to the vowel-to-vowel interval than to the syllable (see Figure 3).

Groups	Count	Average	Standard Deviation
1 st syl. without C onset	676	0.22260503	0.0317
1 st syl. with C onset	715	0.21690769	0.0291

Table 11: No IBD contrast according to consonantal onset of first syllable involved ((C)VCV in LH-configuration)

Summary and discussion

IBDs are remarkably consistent across speakers/drummers

Manguaré drumming has characteristic rhythmic properties, independent of spoken Bora, which is modulated according to phonological and prosodic properties of utterances of spoken Bora.

Syllable (interval) types and consonantal features are represented in IBDs.

The unit that the interbeat duration picks up on is the vowel-to-vowel interval rather than the syllable. The beginning and end point of this unit mark the p[erceptual]-center (or center of gravity), i.e. the point in time that is relevant for rhythmic structuring.

Question for future research include refined measurements of these parameters in spoken language data, the role of word boundaries, and perception/comprehension experiments.

4. Bora *manguaré* in a comparative perspective

4.1. Types of ‘drummed languages’ and their study

Three broad types of ‘drummed languages’ can be distinguished, and some are mixed:

1. Signaling systems that use repertoires of drummed codes with no iconic relationship to the sound structure of the spoken language, like the Morse code. These constitute parallel languages confined only to drumming. They are attested in Melanesian languages (Zemp and Kaufmann 1969).
2. Musical drumming pieces that are conventionally vocalized (usually with nonsense syllables) for mnemotechnical purposes, like in Newar (e.g. Wegner & Kölver 1992)
3. Drum languages that represent phonological and prosodic features of the spoken languages (drummed emulations of speech), like Bora *manguaré*, and a number of cases from Africa, possibly in addition to cases in East Asia and further instances from South America (Stern 1957).

Only drummed forms of languages of type 3 will be taken into account in the following because they are of most interest for linguistics and prosody in particular. Their study is in general not advanced (but see Sebeok & Umiker-Sebeok; eds.; 1976; Locke & Agbeli 1980; Niangoran-Bouah 1980; Bagemihl 1988; Junzo 1990; Pacere 1991; Cloarec-Heiss 1997, 1999; Essien 2000; Arom 2007).

The following generalization, drawn from this literature, may serve as a basis for initial comparison and for eventually developing typological parameters:

- The majority of drum languages are associated with tonal languages
- Drummed messages are often structured into “general formulae”, and “specific formulae”, and proper names play an important role in them
- Phrases are often separated by pauses
- Phonological surface tone patterns are usually exactly rendered through different drum pitches
- Register tones may be represented by single beats, contour (rising and falling) tones by a succession of two beats
- Downstep is usually not represented
- Syllable weight may or may not be rhythmically represented
- Different classes of consonants may have an effect on IBDs

4.2. The typology of whistled forms of languages

Like drummed forms of language, whistled forms of languages select specific acoustic cues to enable long-distance communication. Unlike drummed languages, they are mostly used for everyday conversation and do not usually present the kind of formulaic structure of drum languages. Their study (both of individual systems and typologically) is much more advanced than that of drummed forms of languages.

The main contrastive dimension of whistled languages is fundamental frequency, in which primarily two frequency attributes of spoken speech are emulated: pitch (F0) and timbre (vowel quality, distribution of frequencies in spectrum).

There are two basic types of whistled languages (Busnel and Classe 1976; Meyer & Gautheron 2006; Patel 2007; Meyer 2008):

- “tonal” whistled languages that represent F0; they are mostly used for tonal languages e.g. in Mazatec (Cowan 1948), and
- “articulated” whistled languages that represent features of vowels (and consonants); they are mostly used for non-tonal languages such as *El Silbo Gomero* of Spanish (Classe 1956).

Vowel qualities are represented by attributing the highest pitches to /i/ (reflecting the acute quality of their timbre), and the lowest pitches to /o/ and /u/, while /e/ and /a/ are intermediate (Meyer 2008).

Consonant qualities may be represented by, e.g., more rapid articulatory movements for certain consonants, such as /j, l, n, t/.

In addition, there are a number of kinds of intermediate strategies. For example, Siberian Yupik and Amazonian Gaviaõ and Surui whistled forms use both the tonal and articulated whistling transpositions. Consonant qualities are also represented in “tonal” whistled languages and the F0 of intonation may be represented in “articulated” whistled languages.

5. Emulated speech and prosodic typology

The fact that communication is possible by representing (almost) exclusively prosodic features shows that prosody can have a high functional load (vs. segmental contrasts).

The prosodic features that individual emulated speech systems select reveal *which* prosodic features carry a particularly high functional load for a given language. These include

- F0 (particularly for tone languages)
- more or less fine-grained distinctions of syllable (interval) types

Emulated speech also reveal prosodic attributes of phonological segments, including

- consonantal duration in drumming and whistling
- F0 representation of vowel timbres in whistling

The systematicity of emulated speech shows that prosody (at least with respect to certain prosodic features) is highly structured, and it indicates certain aspects of *how* speech is prosodically structured. For instances, the basic unit for *manguaré* rhythm (interbeat duration) is the vowel-to-vowel interval, not the syllable.

Emulated speech systems represent one level of prosodic structure. Therefore they are typically blind to more underlying prosodic structures such as

- tone sandhi derivation (Bora)
- boundary tone marking s vs. lexical tones (Bora)
- vowel harmony (Turkish whistled language)

and to higher-level derivation of prosodic surface structure, such as

- downstep
- intonation

Emulated speech systems may have prosodic (rhythmic) features independently of the corresponding spoken language, showing that they are conventional representational systems, not mere imitation of spoken language.

Abbreviations

1 - first person, 2DIM - two dimensional, ACC - accusative case, CL - classifier, DEC - deceased, DIR - directional, IMP - imperative, M - masculine, NEG - negation, NMLZ - nominalization, PL - plural, PURP - purposive, REP - repeated action, SG - singular, SUB - subordination

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