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AKAN TONE ENCODING ACROSS INDIGENOUS SURROGATE MUSICAL INSTRUMENTS

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Musical surrogate languages like talking drums remain understudied in the linguistics literature, despite their close connection with the phonetics and phonology of the spoken language. African surrogate languages tend to be based on tone, making them a unique angle for studying a language's tonal system. This paper looks at the encoding of Akan tone in three instrumental surrogate languages: the *atumpan* drums, the *seperewa* harp, and the *abɛntia* horn trumpet. Each instrument presents different organological constraints that could shape how the tone system is transposed to musical form. Drawing on novel data elicited with musicians in Ghana, we show that all three systems are built on a two-tone foundation mirroring the Akan tone system, but with subtle differences in the treatment of downstep and intonational effects like phrase-final lowering and lax question intonation.

1. Introduction

Speech and sign are the primary modalities of human language, naturally acquired by children, but language can also be adapted to secondary modalities. The most familiar of these (indeed, to anyone reading this article) is writing, where linguistic content is encoded in visual symbols. But in many communities in Africa and beyond, we find a secondary *auditory* modality: musical surrogate languages. In these systems, linguistic content is encoded in musical form, using instruments like membrane drums (Carrington 1949, Winter 2014, Akinbo 2019, Durojaye et al. 2021, etc.), slit-log drums (Seifart et al. 2018), xylophones (Zemp and Soro 2010, McPherson 2019a, Struthers-Young 2021), flutes (Poss 2005, Carter-Ényì et al. 2021, Moore and Meyer 2021), or jaw harps (Pugh-Kitingan 1982, Proschan 1994, Falk 2003, Blench and Campos 2010). Most—but not all—of these systems encode phonemic aspects of the languages on which they are based, and as such they can be a valuable tool for probing phonological structure and musician's metalinguistic awareness of it (McPherson 2019b). While found all over the world, musical surrogate languages are particularly prevalent in African societies (James et al. 2021). For linguists, these can be important sources of data on spoken language: African surrogate languages tend to be based primarily on tone and rhythm, rather than segmental contrasts, and thus they can shed light on the tonal system of the language.

This article focuses on musical surrogates of one language: Akan, a Central Tano (Kwa) language spoken by roughly 11 million people in Ghana and neighboring countries. Akan is an ideal language to explore the linguistic grounding of musical surrogate languages, as its tone system is relatively well understood; see Section 2.1 for an overview of the Akan tone literature. Further, Akan boasts several musical surrogate systems on different musical instruments, allowing us to compare how organological constraints of the instruments affect the encoding of the language. These surrogates, especially the *atumpan* drumming tradition, are also relatively well documented from a musicological (Nketia 1963, 1971) and even linguistic (Bagemihl 1988) point of view. In this work, we combine insights from published literature, surveyed in Section 2.2, with novel data collected as part of this study to take a deep dive into the encoding of Akan tone in musical form.

We investigate three instrumental surrogates here: the *atumpan* double barrel drums, the *seperewa* 8-stringed lute, and the *abɛntia* horn trumpet. Our research questions are:

1. How is Akan tone represented in musical form?
2. How does the instrumental modality (*atumpan, seperewa, abɛntia*) affect tone encoding, and what can this teach us about the principles of surrogate language phonology?

3. What do the musical surrogate language data say about the phonology of Akan tone and speakers' metalinguistic awareness of it?

The paper is laid out as follows: Section 2 covers previous studies on Akan tone (2.1) and Akan speech surrogates (2.2) that will serve as a foundation for this work. In Section 3, we discuss the creation of our data corpus. Section 4 presents the results, showing that Akan tone encoding is remarkably consistent across instruments, even when the instruments could in principle offer a wider range of encoding possibilities. Finally, Section 5 discusses our results and lays out paths for future research.

2. Background

2.1 Akan tone. The Akan tone system has benefitted from extensive study (Stewart 1965, Schachter and Fromkin 1968, Dolphyne 1988, Abakah 2005 et seq., Paster 2010, to name but a few). It has two phonemic tones, High (H, á) and Low (L, à), which create both lexical and grammatical contrasts. Examples of lexical tone contrasts are shown in (1), from Dolphyne (1988):

(1) a. pápá 'good'
b. pàpà 'fan'
c. pàpá 'father'

(1a) gives an all H-toned word, (1b) an all L-toned word, and (1c) a LH-toned word.

As in many African languages (Hyman 2001, McPherson 2014, Sande 2017, Rolle 2018, Obiri-Yeboah 2021, etc.), grammatical tone plays an important role in the Akan verbal system, where tonal differences correlate with different aspectual meanings, as shown in the following examples from Paster (2010), cited in Genzel (2013):

(2) a. bìsá 'ask (HAB)'
b. bìsà 'ask (IMP)'
c. a-bísá 'ask (PFV)'

With LH tone, the verb *bìsá* 'ask' has a habitual meaning. When replaced with L tone, the interpretation is imperative, while the prefixed form with H tone has a perfective meaning. Replacive grammatical tone and floating tonal morphemes are also found at the level of the noun phrase, as described in Marfo (2004).

In addition to these two underlying tonemes, Akan also displays downstep, analyzed as the result of a floating L tone (Stewart 1993, Abakah et al. 2010, Genzel and Kügler 2011, among others). For instance, the associative marker in Akan is a floating H tone which docks to the following word. In doing so, the newly docked H tone can delink an underlyingly associated L tone, leaving it floating and hence triggering downstep (Abakah 2005):

(3) /nè Ḥ pòmá/ → [nè pó˖má]
PRO ASSOC walking.stick
'Her walking stick'

Such downstep can arise from grammatical morphemes like the associative or from postlexical tone spreading in natural speech, as we will see below.

The intonation system of Akan has also been well studied (Genzel 2013, Kügler 2017). Most relevant to our work here is Akan question intonation, which has been classified as part of the areal "lax" question prosody (Rialland 2007, 2009). In particular, polar questions are marked with a final L

tone (in addition to vowel lengthening, greater intensity, and overall register effects). Below, we will show how Akan surrogate speech on different instruments does (or does not) encode this question intonation. Further, we will investigate the effects of Final Lowering, a rule which Paster (2010) and Kügler (2017) describe as neutralizing H tones to L at the end of an intonational phrase.

For an excellent overview of the literature on Akan, see Kügler (2017).

2.2 Akan surrogate languages. Musical surrogate languages are found all around the world, especially (though not exclusively) in areas of high tone language density such as sub-Saharan Africa, the Amazon Basin, and Papua New Guinea. Certain communities in Southeast Asia, such as the Hmong, boast a number of speech surrogate systems (Falk 2004, Poss 2012), but there are surprisingly few musical surrogate languages in East and Southeast Asia given the tonal nature of the languages in the area.[1] African musical surrogates, especially various forms of so-called "talking drums", have long captured the imaginations of European scholars, including Betz (1898), Labouret (1923), Herzog (1934), Hulstaert (1935), and Burssens (1939), among many others. Early research often likened them to morse code, telephones, or alarm systems. The comparison to morse code is not entirely apt, since musical surrogate languages are a first-order transposition, based directly on the sounds of speech, while morse code is a second-order system, based on the letters of the alphabet which are themselves based on speech (Sebeok and Umiker-Sebeok 1976, James 2021a). But in some communities, they function similarly as a technology to send messages across long distances.

Despite the linguistic underpinnings of these systems, they have historically received little attention from the field of linguistics (McPherson 2019b). (Bagemihl 1988 is an early exception, and we will return to his work shortly.) In recent years, this has begun to change, with detailed analyses of individual surrogate traditions, including Winter (2014) and Ros (2021) on Wolof *sabar* drumming, Seifart et al. (2018) on Bora *manguaré* drumming, McPherson (2019a) on the Sambla balafon, and Akinbo (2019) on the Yorùbá *dùndún*, experimental work on surrogate perception (Durojaye et al. 2021), and discussion of speech surrogate typology (James 2021b). For a recent collection of work on musical surrogate languages, see Winter and McPherson (2022).

Speech surrogacy is very prevalent in Akan culture, especially in the Asante royal courts. It can be performed on a number of different instruments, including different kinds of drums and bells (Nketia 1963), trumpets or horns (Kaminski 2008), or string instruments (Nketia 1963, 1994).

Most previous work on Akan speech surrogacy has focused on drummed speech, especially on the *atumpan*, a set of barrel drums that are the most prominent talking instrument in Akan culture. The set consists of two drums, a lower-pitched "male" drum and a higher-pitched "female" drum. The skin membranes of each drum are played with one hooked stick in each hand. While generally the left hand plays the drum on the left and the right hand the drum on the right, the hands are free to move from one drum to the other as needed. Nketia (1963) discusses various cultural and musicological aspects of Akan instruments, including the *atumpan.* He distinguishes between three modes of playing: 1. signal mode, which is not explicitly linguistic in nature but used to send signals (sometimes long distances); 2. dance mode, which is also not linguistic and is more musical in nature, tied to a synchronous beat; and 3. speech mode, in which linguistic content is reproduced on the drum. It is only this last category that Nketia (1963) considers to be a speech surrogate and that we will concern ourselves with here.

The texts played on *atumpan* drums include a rich repertoire of poetry (Nketia 1958a), proverbs (1958b), eulogies (Nketia 1963), and announcements to the royal court and spectators (Nketia 1971). It can also be used to address dancers or spectators (Nketia 1971), which suggests some degree of creativity or innovation in the messages, even if a large part of the repertoire is conventionalized.

[1] For a map of many known musical surrogate languages, see the *Online Database of Speech Surrogates* (James et al. 2021), available at www.speechsurrogates.org.

Nketia (1971) lays out further details of surrogate speech on the *atumpan* drums. As in most documented musical surrogate languages (James et al. 2021), the Akan system is based almost entirely on tone and speech rhythm. The rhythm is dictated by syllable shape, where light syllables, consisting of just a vowel (V), a consonant and a vowel (CV), or a syllabic nasal (N) are played with a short stroke, heavy syllables (CVN, according to Nketia) are played a long stroke, and vowel sequences and CrV syllables are played as a "double stroke", or in percussion terminology, a flam. Linguistic tone is encoded by playing on either the male or female drum. Nketia lays out a detailed description of the Akan tone system, including lexical and grammatical tones, and states that by and large, the drums reproduce these tones faithfully by assigning H-toned syllables to the female drum and L-toned syllables to the male drum. Given the limitations of the instrument, producing just two pitches, Nketia notes that intonational effects like downdrift or non-automatic downstep are not encoded, and he further notes that automatic downstep is ignored (i.e., that a downstepped H is played simply as a H).

Bagemihl (1988) proposes an independent component of phonology that maps the speech tones of Akan to drummed speech. He corroborates the findings of Nketia (1971) by formalizing the following Tonal Realization rule:

(4) Tonal Realization: Assign spoken high tones to the high-pitched drum; assign spoken low tones to the low-pitched drum. (Bagemihl 1988: 60)

He argues that a formal phonological rule of this nature is required, as Akan drummed speech only represents phonological tones and not any of what he groups together as "intonational elements"–for instance, intonation, downdrift, or downstep. In fact, Bagemihl goes so far as to generalize that "instrumental surrogates of tone languages do not represent intonational elements; whistle surrogates of tone languages do" (pg. 72). He argues that, since postlexical rules such as vowel elision or tone sandhi between words are uniformly encoded in speech surrogates but intonational effects are not, the conversion of spoken language to surrogate phonology must take place at a level after postlexical rules but before "postsyntactic" rules like downstep/downdrift and ultimately phonetic implementation. However, more recent work on musical surrogate languages, including Akinbo (2019) on the Yorùbá tension drum, Struthers-Young (2022) on the Northern Toussian balafon, Meyer and Moore (2021) on Gavião wind instruments, and McPherson (2022) on the Igbo *ọ̀jà* flute show that these intonational elements, especially downstep and downdrift, are in fact encoded in some instrumental surrogates. The question, then, is whether deeper study of Akan surrogates will reveal any of these intonational effects, and if not, what makes its surrogate systems different from those that do.

Previous studies have also investigated speech surrogacy on the ivory trumpets used in the royal Asante court. The general term for these trumpets in Akan is *mmɛn* (sg. *abɛn*), which means "horns". They are made from hollowed out elephant tusks with a rectangular slot cut in near the tip and a finger hole at the tip of the horn which can be open or closed. Sound is produced by the vibrations of the lips in the slot, with pitch altered by changing the speed of vibration (lipping) in addition to opening or closing the fingering hole and thus changing the overall length of the resonating chamber.

Kaminski (2008) describes the surrogacy of the *ntahera* trumpet ensemble, a group of musicians who play at the shrine of the *ntahera* spirit in Kumase. Speech surrogacy passages known as *mmaranee* are played principally by the *seseɛ* 'speaker', the lead trumpeter. The *seseɛ* plays two primary pitches by lipping, both with the fingering hole closed; these two pitches are about a minor second apart. A higher pitch can be made by opening the fingering hole, but it appears to be used mostly to signal the end of a song. Finally, pitch falls from the lower of the two notes are attested in the transcriptions, typically at the end of the line. Thus, like the *atumpan*, the *seseɛ*'s speech surrogacy system is primarily based on two pitches (setting aside the falls and the song-final higher notes) onto which Akan's two tones can be mapped. Unlike the *atumpan,* which shows a more or less one-to-one ratio between

syllables in the spoken message and strikes on the drum, Kaminski reports that *sesɛɛ* surrogacy involves a great deal of syllable elision. This elision supposedly helps obscure the messages, lending a degree of secrecy and courtliness to the *ntahera* speech.

The trumpets of the *ntahera* ensemble are longer than another set of trumpets known as *mmɛntia,* literally "short horns", which are reportedly used for playing shorter texts than the longer courtly repertoire of the *sesɛɛ*. Kaminksi (2008) reports that *mmɛntia* do not elide their syllables the way that the *ntahera* ensemble does, but rather there is a nearly one-to-one correspondence between syllables and notes. Nevertheless, Kaminski's transcription in Figure 5 (2008: 135) shows some vowel elision between adjacent vowels, and the disyllabic word *soro* 'heaven' with medial /r/ corresponds to just one note. The trumpet in our data collection is an *abɛntia*, and we will see in Section 4.3 that the number of notes does indeed closely match the number of syllables in the spoken phrase.

Arhine (2009) describes the use of the same horn trumpets in the Fante royal court. She likewise notes that the lead instrument, the *sɛsɛ,* produces two notes and provides detailed measurements on its sound production.

Finally, the literature on Akan surrogacy makes brief reference to a stringed lute known as the *seperewa.* The number of strings varies between 6 and 8 (Nketia 1994), arranged in two rows, which are tuned diatonically. The left hand plays one row of strings, and the right hand the other, with the thumb and index fingers of each hand plucking the strings. The instrument appears to be primarily musical rather than linguistic, but Nketia (1971) does mention the occasional use of the *seperewa* to communicate with other musicians. He does not go into further detail on the form that *seperewa* surrogacy takes.

3. The data corpus

In our study, we directly compare surrogate tone encoding on three Akan musical instruments—the *atumpan,* the *abɛntia,* and the *seperewa*—by using the same elicitation lists for all three instruments. The *atumpan* and *seperewa* were also both played by the same musician, Osei Korankye, holding constant the particular individual's phonological grammar (and understanding of speech surrogacy).

Data were collected in Accra, Ghana in two recording sessions, the first in January of 2022 and the second in July of the same year. Our first elicitation list took as its base a set of proverbs drawn from the literature on Akan speech surrogacy: 24 were drawn from Kaminski (2008) and 6 from Nketia (1963). To increase the size of the data corpus, the second author supplemented these with an additional 21 Akan proverbs and phrases, resulting in a total of 51 phrases. As half of these were naturally occurring in at least one Akan speech surrogate tradition (though not necessarily all three), we did not control for phonological factors like length or tone. This first round of data collection was carried out by our research assistant, Isaac Boadu, at the University of Ghana School of Performing Arts. Isaac pronounced each proverb or phrase in turn after which Osei Korankye played it on either the *atumpan* or *seperewa*; Osei prompted each phrase for the *abɛntia* player, Kofi Boakye. This methodology does raise the question of whether musicians are attempting to match the acoustic target produced by the elicitor rather than tapping into their deeper phonological representations; subsequent work could present the stimuli to the musicians in written form to try to control for this possibility (though for languages or communities without a strong written tradition, this methodology would be unavailable).

The second data collection session in July used an elicitation list compiled from the controlled materials in Genzel's (2013) dissertation. The list consists of all H-toned phrases, all L-toned phrases, and alternating H/L phrases, in both declarative and polar interrogative form for a total of 90 phrases. It was compiled by Jonathan Barnes with the goal of studying Akan whistled speech, and we chose to use it to facilitate eventual cross-modal comparison with instrumental speech. These phrases are not part of the natural speech surrogate repertoire, and thus their rendition in musical form represents active encoding of novel utterances to a surrogate modality rather than possible recall of a previously learned

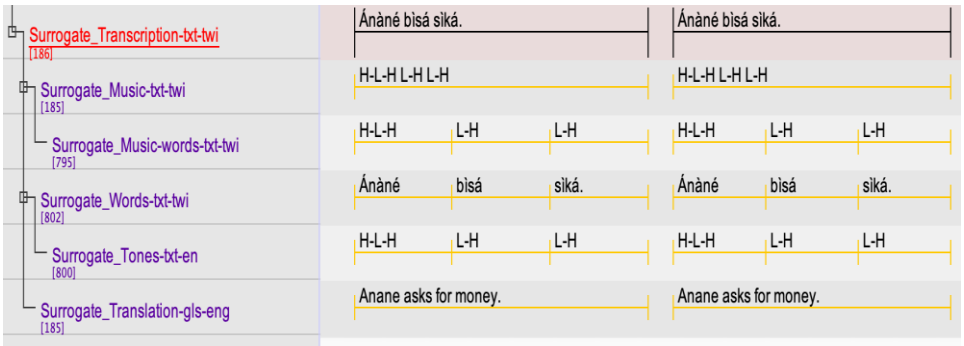
musical phrase. The second author directly oversaw this data collection, pronouncing each phrase himself, asking the musician to repeat it in spoken form first (a step which was not part of the first data collection) and then play it twice on their instrument. Both elicitation lists can be found in the Appendices of this paper.

Data were recorded using a Zoom Q8 Handy Video Recorder with its internal stereo microphone. Recordings were made in a quiet outdoor space with minimal background noise. All recordings were then transcribed by hand using ELAN, with separate tiers for the musician's speech and the surrogate phrases. Underneath the top parent tier for the surrogate speech, which contains simply the Akan phrases, is a tier for musical transcription, which was carried out by the first author and research assistants. Musical transcription was straightforward for the *atumpan* and the *seperewa,* both of which have discrete pitches that can be both auditorily and visually confirmed. Since both instruments produced just two pitches for surrogacy (more on that below), these pitches were transcribed into ELAN as H and L to facilitate comparison with tone. Though rhythm is not the main focus of this article, we took a coarse-grained look at it: single beats corresponding to a spoken syllable were separated by a hyphen, with spaces for word boundaries. Flams or rapid beats in quick succession corresponding to a single syllable (or vowel sequence) had no hyphen. For instance, *Pàpá* 'father' is played on the *atumpan* as L-H, with a single L-toned strike and a single H-toned strike. *Kúkúó-bá* 'small pot', on the other hand, is played H-HH-H, with the vowel sequence *úó* represented with a flam. Future work will investigate the encoding of speech rhythm, as studies of other speech surrogate traditions have shown a close match in the micro-timings of speech and surrogate forms (Seifart et al. 2018, McPherson 2021).

Transcription of the *abɛntia* data was considerably more difficult. While the horns are described as producing two pitches, in practice, pitch is far more gradient, since the two pitches are produced by lipping. This was especially true for the first elicitation session, and we set aside the bulk of those horn data here for future acoustic analysis, though we offer some thoughts on the playing style in Section 4.3 below. The second elicitation session proved easier to transcribe, with the exception of final syllables. We also present a preliminary acoustic analysis of those data below.

To produce the data corpus, the Akan phrase tier and the musical transcription tier were both tokenized, i.e., split up into word level annotations. The tone patterns of these words were then extracted and added to a new tier. Figure 1 provides a screenshot of the ELAN data organization.

Figure 1. ELAN hierarchical data organization. Each level of the surrogate transcription is tied together with the participant code "Surrogate". The top-level tier, Transcription-txt-twi, contains the Akan phrases that were elicited, Music-txt-twi contains the phrase-level musical transcription, which is split up word-by-word in Music-words-txt-twi. The Akan phrases are tokenized to words in Words-txt-twi, with their tone patterns extracted to Surrogate_Tones-txt-en. Finally, the English translation is found in Translation-gls-eng.



These tiers were then exported into tab-delimited text files where the columns of data could be sorted according to word tone, musical pitches, or phrases. Any discrepancies between expected tone and musical pitches were rechecked for errors or tagged for any reasons, contextual or otherwise, that tone and notes may not perfectly align. Finally, words and musical renditions were classified into their overall melodies, e.g., *pàpá* 'father' and *kɔ̀tɔ̀kɔ̀-héné* 'chief of Kɔtɔkɔ' were both classified as LH, as would be musical sequences L-H and L-L-H. It is at this level that we base our analyses in Section 4. Note that we base our analyses on surface-level tones, including grammatical tone, downstep and intonational falls, rather than at an underlying or lexical level.

4. Results

By and large, tone encoding was remarkably consistent, even across organologically different instruments. In this section, we will address the tone encoding on each instrument in turn. We look specifically at the following questions of tone encoding:

1. How are the two basic tones, H and L, encoded on the instrument?
2. Is downstep encoded, and if so, how?
3. Is question intonation encoded, and if so how?
4. Is phrase-final neutralization encoded?
5. How do instrumental considerations influence or constraint tone encoding?

4.1 Atumpan. Our final atumpan corpus consisted of 1383 words: 588 from the first elicitation and 795 from the second. As the results from the two elicitations are quite similar, we present the data in aggregate in Table 1.

Table 1. Akan word melodies (columns) vs. drummed melodies (rows), aggregated across the two elicitation sessions.

Spoken: / Played:	H	L	HL	LH	HLH	LHL	LHLH	!H	H!H	!HL	LH!H	LH!HL
H	339		4	17		1		9	3			
L	2	379	17			1		4		2		
HL	4		59			8			1			
LH				377	2	1		5			6	
HLH				1	59				1			
LHL				2		69						
LHLH							2				3	
LHLHL												3
X		1										

The cells highlighted in gray represent a perfect match between the spoken tone sequence and the tone sequence played by the *atumpan*; these perfect matches account for 92.5% of the data, showing

that by and large, Nketia (1971) and Bagemihl (1988) are correct in their assessment that *atumpan* speech surrogacy operates by translating the H and L tones of Akan to H and L pitches on the drums. Nevertheless, there are cases where the two diverge. We will take these column by column, looking at how spoken tone melodies map to drum sequences.

Spoken H tones map to H 98% of the time, with just 6 exceptions. Three of these cases involve a spoken H tone played as L. All three of these cases come from a single phrase, shown in (5):

(5)	L-H	L	L-H	L	L
	Ǹsúó	à	èdɔ́	!wó	nó
	water	REL	love	2SG	DEF
	'It is the water that likes you….'				

The drummed equivalent is shown above each word. The hyphen between tones (e.g., L-H) indicates that each is played as a separate beat, and these beats typically correspond to syllables; we will see more complex rhythms below. As we can see, both the !H of *!wó* and the following H of *nó* are played on the L-toned drum. We will discuss the representation of downstep later in this subsection, but since *nó* is in principle the same level as the preceding downstepped H in speech, then if the former is played on L, it is logical for the latter to be as well. Beyond this, however, there is some variation in the surface pronunciation of *nó* in the data. The pronunciation of the research assistant who prompted the drummer is reflected in (5), but in the drummer's own pronunciation (it was he who prompted the trumpeter), *nó* is pronounced L, likely due to phrase-final neutralization. Thus, there are two possible explanations for the tone-drum mismatch: It either maintains the level tone sequence after a downstepped H, or it reflects a neutralized phrase-final tone. Three further exceptions likewise relate to downstep: the spoken sequence *gyé !sóró* 'only heaven' (from Kaminski 2008) is played as HL H-H; in other words, the trigger of downstep on *sóró* is played as a L appended to the H of *gyé*.

L-toned words are exceptionlessly played as L on the *atumpan.* The last row, with X as the drum melody, represents a case where the spoken syllable was in fact not represented at all in the drummed speech, which likely constitutes an error.

HL-toned words show more variation than either of the simple melodies L and H. First, the data contain four tokens of supposedly HL-toned words played as H. All four of these are found in the second elicitation session, with the same overall phrase, shown in (6). The HL-toned word in question is the final definite marker *nô.* Lexically a H-toned word, it becomes a falling tone in speech due to question intonation. However, it is played on the *atumpan* as simply H, as shown in the drummed rendition above the Akan phrase:

(6)	H-HH	H	(H-H)	H
	kúkúó	bá	(pápá)	nô?
	pot	DIM	good	DEF
	'The (good) small pot?'			

Here, the two drummed tones without a hyphen indicate a double strike, or flam. Thus, the vowel sequence /uo/ in *kúkúó* is rendered with a double H strike rather than each vowel getting its own beat.

In two other cases in which the elicitor prompted a question ending in *nô* (other variations of this same phrase), the musician responded with a statement instead, and so these cases are counted as a perfect match between the lexically H-toned *nó* and the drummed H. While we may be tempted to take the examples in (6) as evidence that question intonation is not reflected in drummed speech, we find other examples in which the intonational fall is played, such as (7):

(7)	L-H	L-H	L-H	LH	L	HL
	Pàpá	Kòfí	kàsá	kyèrɛ́	nè	bâ?
	Father	Kofi	talk.HAB	point_to.HAB	PRO	child
	'Father Kofi talks to his child?'					

The final word *bá* 'child' is also lexically H-toned but pronounced with a fall due to question intonation. In these cases, the drummer always plays HL (as a flam). It is unclear why cases like (6) should represent a mismatch while those in (7) faithfully reproduce question intonation, though we see a few possible explanations. It could be that the drummer played a statement by mistake, as happened in other cases (though we were able to flag some of these thanks to his pronunciation of the phrase before playing it). Another possibility is that functional items like definite *nó* differ from lexical items like *bá,* or the sentence fragment in (6) could be treated differently from a full sentence like (7). Ultimately, it may simply be the case that question intonation is only variably reproduced in surrogate speech. Further data are required to tease apart these possibilities.

The other 16 mismatches involve HL played as L. Six of these can be understood as the result of syllable elision, where the H-toned initial nasal of *ńtèè* 'hasn't heard' or *ḿmrɛ̀* 'don't get tired' are absorbed into the preceding word, leaving only L to be played on the drum. Other cases involve words like *bíò* 'again' or *bɔ́ɔ̀* 'played', transcribed as HL-toned words in their original sources (Genzel 2013 and Nketia 1963, respectively), but which are pronounced by the musicians with low pitch and played as L; the cases of *bíò* are sentence-final so could be understood as phrase-final lowering, but the cases of *bɔ́ɔ̀* are phrase-medial (*bɔ̀r-bɔ̀ré bɔ́ɔ̀ à-déɛ́* 'The creator created things'). Nevertheless, both HL-toned words are preceded by H tones, and thus we could understand these as cases of tonal absorption (Hyman and Schuh 1974), reflected on the drum. Curiously, we have not seen active tonal absorption of this sort reported elsewhere in the literature on Akan.

LH words are more frequent than HL, and 94% are played as LH on the *atumpan*. The most common mismatches involve LH played as simply H by the drum. Most of these cases involve vowel elision, where the initial L-toned vowel is elided in speech. This often yields a spoken downstepped H on the remaining word. An example is shown in (8), where the initial vowel of *ènɛ́* 'today' is elided.

(8)	H-L-H	L-H	L-H	H
	Ánànɛ́	bìsá	sìká	[ɛ̀]!nɛ́
	Anane	ask.HAB	money	today
	'Anane asks for money today.'			

Thus, while the transcription of the full word gives the impression of a mismatch, further inspection reveals a closer connection between spoken and drummed tones. Note again here that the spoken downstepped H is played simply as H on the *atumpan*; we will return to downstep later in this section.

We find two cases where LH words are played as LHL on the *atumpan*. One is the result of a following L-toned pronoun being absorbed into the preceding word (rhythmically, it is treated as part of the same syllable as the preceding word), while the other may simply be an error. The word in question is *ɔ̀dómánkómá* 'the creator', in the phrase *ɔ̀dómánkómá ɔ̀-bɔ́ɔ̀ à-déɛ́* 'the creator created things' (Nketia 1963). This is played once in the corpus as L-H-HH-H-HL, with a final fall, on the *atumpan.* This is likely an error, as the word appears four other times in the corpus without the final L tone.

The one case of LH played as HLH is also likely an error: *à-déɛ́* is played in this case as HL-HH, whereas two other times in the corpus it is played as HH (as expected due to initial vowel elision).

As we move to more complex tone melodies (3+ tones), we find increasingly fewer data points. Out of 61 cases of the three-tone melody HLH, 59 are reflected faithfully on the *atumpan* as HLH. The

two mismatches are once again the result of initial vowel elision, where an initial H tone is elided in both speech and surrogate speech, leaving simply LH to be reflected by the drum. LHL shows a bit more variation, with only 69 of 80 cases played as LHL. The next most frequent drummed equivalent is HL, with 8 cases, which we can generally ascribe to initial vowel elision. Interestingly, five of these are the interrogative equivalent of the phrase in (8); the fact that they are played as HL shows that the *atumpan* is, in this case, encoding the falling question intonation. The final word *ènê* 'today' (marked here with question intonation) is played once as H; it is not clear whether this reflects variable encoding of question intonation or if the musician interpreted the prompt as a statement instead. The LHL word *ǹtétèà* 'ants' is played once as L-L, but we suspect this is an error, since the phrase was immediately repeated and this word played instead as H-L (the loss of the initial L due to elision of the nasal).

Both examples of four-tone melody LHLH are encoded faithfully. Both cases are the praise *òtúmfúó* 'mighty one', played on the drum as L-HL-HH; once again, the final vowel sequence is rendered as a flam, as is the syllabic nasal.

The last four columns of the table involve downstepped H tones in spoken Akan. Given that the drums produce only two pitches, H and L, these cannot be faithfully represented and must either be encoded as H (closer to the underlying representation) or L (representing the lower surface pitch). Another possibility is that the drum can "undo" downstep, which is generally triggered by a floating L tone in Akan, either from an underlyingly floating grammatical L or an underlyingly linked L tone delinked by other tonal processes (e.g. vowel elision). The spoken melodies in our corpus represent surface forms, thus !H could be either from a floating grammatical L or a derived floating L.

Our corpus contains 18 cases of the melody !H. Half of these are rendered as H on the *atumpan*, as predicted by Nketia (1971) and Bagemihl (1988). Consider the following phrase, in which the downstep on *wó* can be encoded as either H or L:

(9)	L-H	L	L-H	H~L	L
	ǹsú[ó]	à	èdɔ́	!wó	nò
	water	REL	love	2SG	DEF
	'It is the water that likes you….'				

This downstep is not the result of vowel elision, but rather the dissimilatory, OCP-triggered non-automatic downstep that causes a second H in succession to be downstepped. The drummer may choose to play it as H rather than L so as to preserve the contrast with the following L tone on *nò,* or, as we saw in (5), he may encode it as L to reproduce the pitch drop following *èdɔ́.*

A similar situation holds for the phrase in (10), where the downstep on *!ká* is likewise not the result of vowel elision:

(10)	H	(L-)H	H ~ L	L-L-HH
	Wó	m̀mɔ́	!ká	w[ɔ̀] àhèmfíé
	2SG	NEG.break	debt	at palace
	'You do not go for debt at the chief's palace'			

Here, however, we find variation. In four repetitions, the downstepped H is played as H three times, as in (9), but once it is played as L. We also find variation in the playing of *m̀mɔ́*, which is sometimes faithfully encoded as L-H and other times played as simply H.

We saw above with *gyé !sóró* 'only heaven' that the downstepped H is due to a floating L tone, which is played in this case appended to the previous H tone (i.e. *gyé* is played a HL). This allows the drum to encode the fact that this is not a pure sequence of H tones, but without lowering the pitch of H-toned *sóró* itself. In other cases, the triggering L tone is played on the downstepped word, rendering it LH on the drum. We see variation in the corpus for these forms, as shown in (11):

(11)	L-(L)H	(L)H	LH
	èngyàé	!kyɛ́	sòá
	it.NEG.stop.PST	hat	carry
	‘It does not stop carrying’		

The spoken downstepped H of *!kyɛ́* is sometimes played as simply H and sometimes as LH. (The initial word *èngyàé* likewise varies between L-H and L-LH, though this has no bearing we can see on the question of downstep, and both remain variants of the overall melody LH.)

In four cases (two repetitions each of two different words), an underlyingly LH-toned word is pronounced as !H on the surface, presumably due to leftward spreading of the H tone displacing the underlying L. The two words in question are *sìká* ‘money’ and *kyèrɛ́* ‘point to/directed at’. Despite these surface pronunciations as !H, the *atumpan* uniformly plays the words with underlying L-H tone.

(12)	H-L-H	L-H	L-H	H
	Ánàné	bìsá	!síká	[è]nɛ́
	Anane	ask.HAB	money	today
	‘Anane asks for money today’			

The first elicitation presents five tokens of the spoken melody H!H. Three tokens are played on the *atumpan* as all H. Two of the three are repetitions of the phrase in (13); note that the spoken prompt varies in pronunciation between *tí!tíré* and *títìrè,* arguably due to final lowering, but the drum always encodes the word as all H-toned:

(13)	L-LL	LH	H-L-LL-L	H-HH
	ɔ-bɔ̀ɔ̀	kwàwú	ákwàbràfɔ̀	tí-!tíré
	3SG-create.PST	Kwawu	Akwabrafo	prominent
	‘He created Kwawu Akwabrafo, the prominent.’			

Interestingly, this example is drawn from Nketia (1963), who provides a musical transcription of an *atumpan* rendition; in his work, *tí-!tíré* (unmarked for tone in the original) is played H-LH, another strategy we have seen for the encoding of downstep (or, thought of another way, playing the underlying tone melody).

The third H!H word played as H varies with a second rendition as HL. This example is shown in (14):

(14)	L-LH	L-H-H-H ~ L-H-H-L
	ɔbrá	y[ɛ] àkwán!túó
	life	COP journey
	‘Life is a journey’	

This is an interesting case, because while it is not uncommon for the drummer to use both hands to play two consecutive notes (especially double note strikes) on the same drum head, in both of these tokens (non-contiguous in the elicitation), the first two H tones of *àkwán!túó* are consistently played with only the right hand; the left hand is then used either on the L-toned drum (at the drummer’s left), or on the H-toned drum. This left-handed H-toned strike produces a subtly but noticeably lower pitch than the two preceding H tones played with the right hand. We have not seen such subtleties of *atumpan* pitch (and its relation to surrogate tone) discussed elsewhere in the literature, nor does it stand out in any systematic way in our data, so it may simply be a coincidence, but handedness of playing and location of the strike on the drum membrane are topics that merit further study.

Finally, one H!H token is played on the *atumpan* as HLH: *mɛ́!mmá* 'don't give'. However, this form varies even in speech between [mɛ́!mmá] and [mɛ́m̀má], and thus it is likely that the *atumpan* is simply representing the underlying complex tone pattern.

The corpus contains two tokens of a word pronounced with !HL tone, from the phrase in (15):

(15)

L-H	HH	L-LL
òtwé	dúá	!é-tìà
antelope	tail/tree	NOM-short

'The antelope's tail is short'

Both renditions on the drum play the !HL word as all L, as (15) shows. Similar patterns, i.e. variation between playing downstepped H as H or playing the L tone left floating in speech, are attested in the more complex melodies LH!H and LH!HL.

We will now summarize the key generalizations about Akan tone encoding on the *atumpan.* First, Nketia (1971) and Bagemihl (1988) are largely correct that Akan H tones are encoded on the H-toned drum and L tones on the L-toned drum. Deviations from this pattern can generally be attributed to the effects of downstep and phrase-final lowering, though as the data have shown, the *atumpan* data do not support the neutralization of phrase-final H and L. It is only when combined with the influence of downstep (either on that syllable or on the preceding one) that an otherwise H-toned final syllable can be played instead as L. In other words, individual effects which may otherwise go unencoded in surrogate speech can gang up and force a closer match to the surface pitch contour than the phonemic tones. Second, as we have just seen, downstepped H is not always played as H, as previous literature suggested. Depending upon its location, its origins (in a floating L tone vs. OCP-triggered downstep), and sometimes simple free variation, it can be played as either H or L. Downsteps arising from more complex underlying tone sequences are often found to be "unpacked" by the *atumpan* by playing the LH or HL sequence whose L ends up floating in speech. In other words, there appears to be a preference to play underlying tone sequences on the *atumpan* when possible. Third, and in the same vein, some intonational elements are played by the *atumpan*, namely falling question intonation and downstep, contra Nketia (1971) and Bagemihl (1988). While it is subject to some variation, falling tones derived from question formation are commonly played on the drum as a HL sequence. Finally, at the intersection of tone and rhythm, it is the output of vowel elision that is represented in drummed speech, and so two adjacent identically-toned vowels (or vowel+nasal) can be encoded with a single corresponding strike on the drums.

In the next subsection, we compare these *atumpan* results to the results from the *seperewa.*

4.2 Seperewa. Recall from Section 2.2 that the *seperewa* is a stringed lute with 6-8 strings. The instrument used in our data corpus has eight strings with a diatonic tuning. With this larger tonal inventory, one might expect the encoding of a broader range of Akan tonal phenomena, such as downdrift or declination. However, we were surprised to find that the *seperewa*, with a few small differences highlighted below, almost perfectly mirrors the surrogate speech of the *atumpan*, since only two of the eight strings were used in surrogate speech. Thus, while eight distinct pitches are principle possible on the instrument, in practice, this is reduced to a two-way contrast when encoding language. The two strings used for surrogacy in our data corpus correspond to Western musical notes A and B below middle C, but because the distinction is binary and to facilitate comparison with the *atumpan,* we transcribe these as L and H, respectively.

Our final *seperewa* corpus consists of 1032 words, 288 from the first elicitation and 742 from the second. As the table below demonstrates, the results are almost identical to the *atumpan,* despite major organological differences between the instruments. Recall also that the same musician played both the

atumpan and the *seperewa*, and so if only two pitches are used on each instrument, we might expect exactly the same encodings across the two modalities. However, some small differences emerge, especially as regards downstep, which we will discuss below.

Table 2. Akan word melodies (columns) vs. plucked melodies (rows), aggregated across the two elicitation sessions.

Spoken: / Played:	H	L	HL	LH	HLH	LHL	HLHL	LHLH	!H	H!H	!HL	LH!H	LH!HL
H	253		2	8					1				
L	1	296	10			2			4		1		
HL		1	39	1		24				3	1		
LH				264	2				3			1	
HLH				2	49								
LHL						42						2	
HLHL							2						
LHLH								2				2	
LHLHL													2
X	12												

In Section 4.1, we saw a case in which the *atumpan* played a H-toned word as L: the definite article *nó* in phrase-final position after a downstepped H (see example (9) above). This same musical encoding is found on the *seperewa.* All other H-toned words are played as H.

On the *seperewa,* though, we find more overall mismatches between the prompted phrase and the played phrase with missing notes. In 12 cases, H-toned words appear to be missing in the *seperewa* rendition, typically coming from complex variations on the phrase *kúkúó bá pápá páá nó* 'the very good small pot'. As there were other variations of this phrase (*kúkúó bá nó, kúkúó bá pápá nó*), it is likely that these were simply mistakes, or the musician lost count of how many H tones he had already played (or how many *pa* syllables he had represented!).

Turning to L-toned words, we find only one exception in which the L tone is played as HL on the *seperewa:*

(16) L-LH HL
brèmpóń brà
mighty come
'Come mighty one'

Here, both *póń* and *brà* are played as contour tones rather than level tones, in each case starting on the note of the previous syllable (L-H –> L-LH, and H # L –> H-HL). While not, to our knowledge, an active phonological process in Akan, this kind of tone spreading is attested in other tonal languages

such as Yorùbá (Akinlabi and Liberman 1995). Note that *brèmpóǹ* played as L-LH does not count as a mismatch in our analysis, as the overall melody remains LH.

The mismatches with HL-toned words are more or less the same as with the *atumpan.* Some question-final words like *nô,* expected to be played with HL to reflect the falling intonation, are instead played as H, as they were on the drums. The word *bíò* 'again', transcribed in Genzel (2013) as HL, is played as L on both the drums and the *seperewa,* but being played after a H tone, it could reflect tonal absorption. Recall that the word *bɔ́ɔ̀* on the *atumpan* was likewise played as L, and also followed a H tone. On the *seperewa,* in contrast, it is played as HL. We also find two cases on the *seperewa* in which the question-final falling tone on definite *nô* is played a L, rather than H or HL (two other attested renditions on comparable words):

(17)

H-H-H	H	L
kúkúó	bá	nô?
pot	DIM	DEF

'The small pot?'

This simplification of HL to L on *nô* is not seen in the *atumpan* data.

Turning to LH-toned words, once again their musical renditions are mostly faithful (LH), but in cases of mismatch, they are most likely to be played as H due to vowel elision. We find one case of LH played as HL on the *seperewa* in the word *ǹgyé* 'don't take/cease'; the musician pauses before this word (the pause is not found in speech), so we suspect this is an error.

This vowel elision also accounts for the two HLH mismatches in the *seperewa* data, both of which are played as LH. An example is shown in (18):

(18)

L	L-H	L-L-H
nà	ɔ̀mmɔ́	#ákyèkyèdé
but	3SG.NEG.break	tortoise

'But he/she does not break a tortoise'

As we can see, the final vowel of *ɔ̀mmɔ́* and the initial vowel of *ákyèkyèdé* coalesce (represented here as *ɔ́#á*) and are played with a single H tone on the *seperewa*. We could also have treated this case as a mismatch for *ɔ̀mmɔ́*, played with L, and *ákyèkyèdé* as H-L-L-H; by and large, we have represented vowel elision in the data corpus as loss of V2 rather than V1, unless there is clear (vowel quality) evidence that elision occurs in the opposite direction. Either way, the total number of mismatches in the corpus will remain constant, but they may be shifted from one cell in the table to another.

LHL simplification to HL is likewise the result of vowel elision on the *seperewa*. For instance,

(19)

H-L-H	L-H	L-H	HL
Ánàné	bìsá	sìká	[è]!nê?
Anane	ask.HAB	money	today

'Anane asks for money today?'

The LH-toned word *ènέ* 'today' becomes LHL thanks to question intonation. The first vowel is elided after *sìká,* leaving HL, which is played on the *seperewa.* However, we find an interesting contextual variant of this phrase in which LHL is played instead as L. If we replace *sìká* 'money' in (19) with the noun phrase *sìkà bɔ́nè* 'bad money', *ènê* is instead played as L:

(20)

H-L-H	L-H	L-L	H-L	L
Ánàné	bìsá	sìkà	bɔ́nè	[è]nê?
Anane	ask.HAB	money	bad	today

'Anane asks for bad money today?'

This may again be the combined effects of downstep, phrase-final lowering, and local tone assimilation. When the initial vowel of *ènέ* is elided, it leaves a floating L, which triggers downstep on the following H tone. This syllable is phrase-final, and thus also subject to phrase-final lowering. Finally, it follows a L tone. In spoken Akan, it is pronounced at the same level as the final syllable of *bɔ́nè*, and this pronunciation is reflected on the *seperewa.* Note also that this example shows that grammatical tone overlays, such as those found in compounding and modification (Marfo 2004), are encoded in surrogate speech: lexically LH-toned *sìká* 'money' becomes all L in this modified noun phrase, and it is these L tones that are played on the instrument.

The subtle difference we find between *atumpan* surrogate speech and the *seperewa* can be found mostly in the domain of downstep. Though variable in both modalities, on the *atumpan,* H tone encodings are more common than L, while the opposite is true on the *seperewa.* Out of 8 tokens of !H played on the *seperewa*, 4 are played as L compared to only 1 as H; 3 are "unpacked" to LH. All 3 tokens of H!H are played as HL; none are played all H. Most telling are the same phrases that are played on the *atumpan* with all H representing downstep, but with L or HL on the *seperewa.* For instance, we can consider the *seperewa* rendition of the phrase in (13), in which *tí-!tíré* was played as all H on the *atumpan*:

(21)

L-LL	LH	H-L-HL-L	H-HL ~ H-L
ɔ-bɔ̀ɔ̀	kwàwú	ákwàbrâfɔ̀	tí-!tíré
3SG-create.PST	Kwawu	Akwabrafo	prominent

'He created Kwawu Akwabrafo, the prominent.'

We see variation between H-HL and H-L to encode *tí-!tíré;* note, however, that the elicitor did produce the word as H-L rather than H-!H; he also pronounced *Akwabrafo* with a falling tone on the penultimate syllable rather than L as in the *atumpan* elicitation. Nevertheless, we also find this H-L pronunciation in the prompting of the *atumpan*, and still the word was played H-HH.

Similarly, !H words played as H on the *atumpan* are found as L on the *seperewa.* Consider the phrase *gyé !sóró* 'only heaven', played as HL HH on the *atumpan.* On the lute, we find instead H L, with a single H tone encoding *gyé* and a single L tone encoding *!sóró*; this is representative of a rhythmic difference we commonly find between the two instruments, where physiological constraints may make it more difficult for a musician to pluck a rapid two identical note sequence than to drum it.

To summarize this subsection, surrogate speech on the *seperewa* looks nearly identical to the *atumpan.* Despite having a full scale of notes to draw from, only two are used for surrogate speech, and these are deployed for Akan's two tones in the same way as we saw on the *atumpan.* Some subtle differences are found, the most systematic of which pertains to downstep: while the *atumpan* privileges encoding downstepped H as H, the *seperewa* privileges the pitch drop and plays it instead as L. We will discuss this difference further in Section 5.

4.3 Abɛntia. Both elicitation sessions gathered data on a third instrument, the short ivory trumpet known as *abɛntia*. Surrogate speech on ivory trumpets, particularly the longer ones in the *ntahera* ensemble of Kumasi, was discussed by Kaminski (2008), who suggested that two pitches are produced and used for encoding tone, thus broadly mirroring what we have seen so far on the *atumpan* and *seperewa*. While our data suggest that this may be, largely speaking, true, the notes played by the instrument are considerably less precise than the discrete drums or strings we have just described. The two notes are produced by lipping (and can be reinforced by opening and closing the fingering hole), and so the notes are more continuous, and this renders transcription much more difficult. In the second recording, the notes were more clearly identifiable as either H or L, but there were still many cases that defied easy categorization. Given this difficulty, we leave comprehensive treatment of the *abɛntia* data

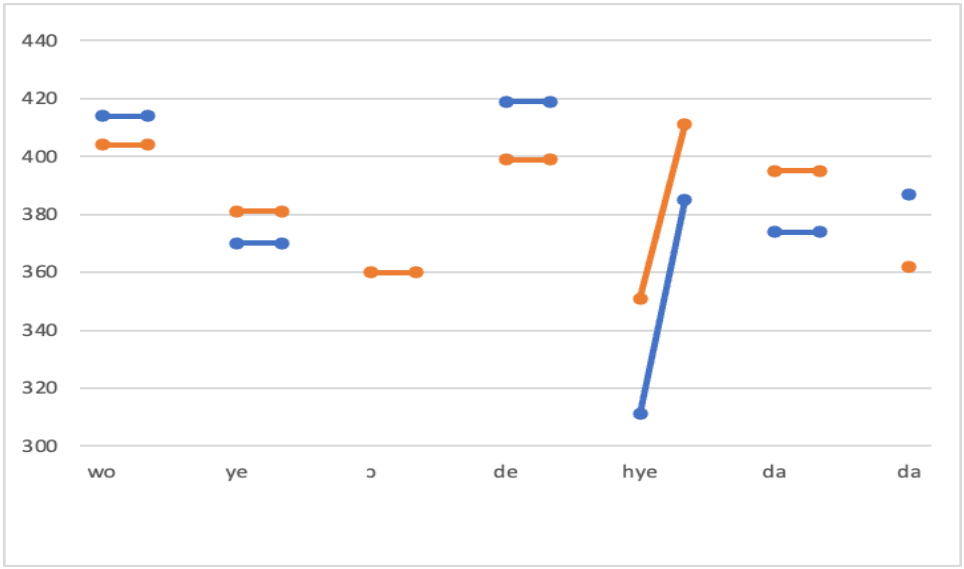
to future work. Here, we will sketch out our impressions and observations and provide some illustrative instrumental measures.

At times, the pitch contours on the instrument suggest a gradient, surface-level mapping between spoken tone and its surrogate encoding, rather than a binary distinction between H and L tone. This was especially true of the musician in the first elicitation session. The f0 traces of the instrument are messy, with doubling and halving rife at the edges of each note, so we have opted to graph the f0 means from around 40ms of relatively level pitch in the middle of each note. Two repetitions of the phrase in (22) are plotted together in Figure 2.

(22) wó yè ɔ̀dé!hyé dàdà
2SG COP royal already
'You are a royal already'

The syllable *ɔ̀* in one of the renditions is too short and weak to collect f0 information, but the auditory perception is that it is lower in pitch than preceding *yè* and following *dé*; in other words, auditorily, the descending melody of the first three notes emerges in both renditions. The syllable *hyé* is played on a clear rising glide in both renditions.

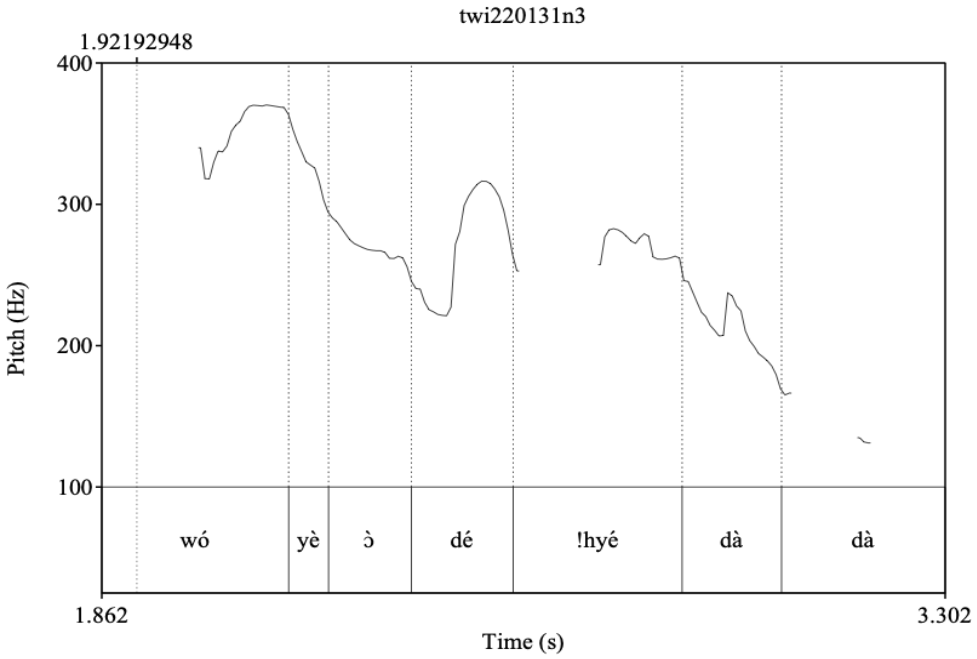
Figure 2. Two *abɛntia* renditions of 'You are a royal already'



While the data in Figure 2 represent just two tokens, insufficient to draw any greater conclusions, they are illustrative of two points. First, Figure 1 shows the gradient nature of the *abɛntia*'s pitch data and the resulting challenge in classifying its notes into two categories, H and L. Second, the measurements here are suggestive that there could be something systematic in these gradient notes, since these two renditions of the phrase, played in separate recordings (i.e. not back to back), both follow the same overall pitch trajectory: three descending notes, a return to the initial pitch, a rising glide, and a small drop to the final notes. If the notes were meant to be binary, and any deviations from this binary classification were a mere accident, then why should the two renditions be so similar?

It naïves possible that *abɛntia* players are able to more closely mimic speech tone by virtue of the pitch flexibility of the instrument. For comparison, the f0 trace of the elicitor's speech is provided in Figure 3.

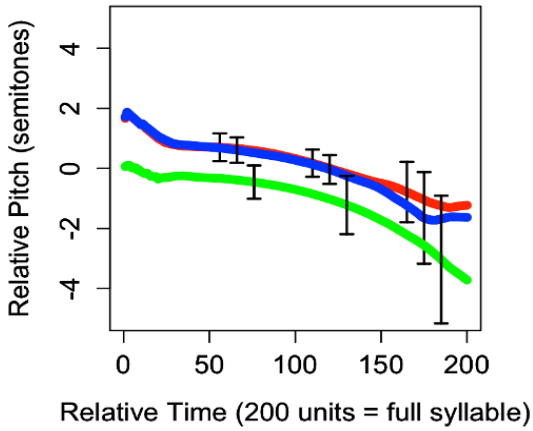
Figure 3. F0 trace of the spoken phrase 'You are a royal already'



The syllable *!hyé* is pronounced on a downstepped H tone; the rise played by the *abɛntia* may represent the unpacking of a floating L tone that triggers this downstep (despite the fact that the instrument is capable of producing a gradiently lower pitch!). The final two syllables also fall more in spoken Akan than on the *abɛntia,* which could relate to the fact that surrogate speech tends not to encode final lowering to the extent that it is seen in speech. Further, the *abɛntia* does not encode the downdrift we see in speech on the syllable *dé;* in the musical rendition, it is equally as H as the first H tone in the phrase. Nevertheless, some phonetic aspects are found, such as the descending sequence of the first three syllables. Thus, the *abɛntia* produces a puzzling mix of phonetic and phonological aspects of Akan tone, at least based on the limited data we are able to analyze in our corpus.

We also studied the acoustic characteristics of final syllables in the second set of *abɛntia* data, whose notes felt more categorical. However, final syllables often show a pitch fall on the trumpet (also represented in the musical transcriptions in Kaminski 2008), and it was not clear to us as we were transcribing whether these were intentional (i.e. representing falling question intonation) or non-linguistic, either stylistic or merely an artifact of the air pressure in playing the final note. To test whether a difference could be found in the playing of falling tones versus H tones, we extracted the f0 information from all final syllables in the second set of data using a Praat pitch extraction script (Zhong 2013) and tagged them for whether their corresponding syllable was transcribed as H, L, or HL (falling question intonation). Using an R script developed by Stanford (2013), we normalized the pitch contours for each syllable to semitones and plotted the means of each group. The results are shown in Figure 4.

Figure 4. Normalized f0 traces of L-toned (green), H-toned (red), and HL-toned (blue) final syllables.



These results show that while L tones and H tones are distinguished on the *abɛntia,* as we would expect if the instrument is able to produce a two tone contrast, there is no significant difference between H and HL tones. It may be that since all final syllables fall (as can be clearly seen in these normalized pitch traces), there is no clear way for musicians to explicitly distinguish falling tones. The mean f0 is slightly (though not significantly) lower for HL tones, though, and the error bars show a larger and lower range of final pitches than H tones, so it may be that a larger corpus would show a significant difference, though to our ears, it is subtle at best. The results in Figure 3 likewise show that once again, despite claims in the literature of phrase-final tone neutralization in Akan, this neutralization is not reflected in surrogate speech.

In summary, the *abɛntia* data we collected suggest that the encoding of Akan tone works largely similarly to what we have seen on the other instruments, but the notes played by the instrument are not as categorical and thus we leave further analysis to more detailed phonetic work. The ability to produce gradient pitch may lend itself to a more phonetic surface level of tone encoding, as was found for Yorùbá tone played on the *dùndún* tension drum (Akinbo 2019), though this ability may not radically change the way the instrument encodes syllables with downstep. More data and analysis are required to tease apart these questions.

5. Discussion

We began this paper with a series of questions, and here, we suggest how the results of our study contribute towards answering them.

3. How is Akan tone represented musically?

We have seen that the primary basis for surrogate tone encoding is the binary contrast between H and L, which are mapped onto H and L pitches of the instrument. Both lexical and grammatical tone are encoded, as was described by Nketia (1971) and Bagemihl (1988). More surprisingly, though, some postlexical and intonational effects are also encoded. First, falling question intonation, reported in Genzel (2013), is variably encoded as a HL sequence on the final syllable. Second, while it is the surface tone sequence that is generally encoded by the instruments, surface downsteps can instead be played on the instruments by explicitly playing the floating L. Third, though neither downstep nor phrase-final lowering play a consistent role in surrogate tone encoding, their combined effects can contribute to phonemic H tones being encoded instead as L. Finally, the *seperewa* is more likely to

encode downstepped H as L rather than H, showing once again that contra Bagemihl (1988), surrogate speech on musical instruments can encode downstep.

2. How does the choice of instrument (*atumpan, seperewa, abɛntia*) affect tone encoding, and what can this teach us about the principles of surrogate language phonology?

We looked at three organologically different instruments: a set of two barrel drums with different pitches, an 8-stringed lute tuned diatonically, and an ivory horn trumpet whose different notes are produced by the vibration of the lips and the opening and closing of a single fingering hole. These different instruments constrain the mapping of speech to music in different ways. The *atumpan* is the most restrictive, in that only two pitches are possible, corresponding to which drum is struck. Unlike drums like the djembe or the Indian178an e*a*, there is not a vast array of different ways to strike the membranes resulting in different pitches or timbres. Thus, surrogate speech is reduced to a binary: H or L. This privileges the encoding of morphophonemic tone, as it is not possible for the instrument to capture subtler aspects of linguistic pitch.

The *seperewa* and the *abɛntia*, organologically, offer more pitch possibilities: the *seperewa* with its 8 distinct notes and the *abɛntia* with its continuous pitch. We might expect this to result in finer-grained encoding of surface tone (as seen with other instruments with larger scales, like the Tusia balafon or the Igbo *òjà,* or instruments with continuous pitch like the Yorùbá *dùndún*), but for Akan, this turned out not to be true. On the *seperewa*, only two of the eight strings were used, and thus the instrument offers the same possibilities for tone encoding as the *atumpan.* The *abɛntia* data were less clear, but musicians report playing two notes, so this is likely the base of the trumpet's surrogate encoding as well, though microtonal fluctuations occur (whether intentionally or not remains to be seen).

Thus, in broad strokes, tone encoding was the same across all three musical modalities, suggesting that for Akan speakers, the underlying tone system (with its binary contrast) may dictate the form of speech surrogacy; we will return to speakers' metalinguistic awareness of their phonology shortly. Another possibility is that one surrogate instrument, likely the *atumpan* given its prominence as an instrument of speech surrogacy in Akan culture, has defined what speech surrogacy looks like in the culture, and the other instruments simply follow the course that it has charted. This may well be the case for the *seperewa*, which is much less commonly used for speech surrogacy. As Nketia (1994) writes, "When [the *seperewa*] player wishes to be serious or challenging, he can quote from the proverbial songs of priests or *proverbs in the repertoire of drum language* or other court repertoire" (pg. 7, italics our own). Quoting drum language would entail using just two tones, as we have seen in our data here.

But despite the broad similarities across the three instruments, subtle differences in tone encoding did emerge. Between the *atumpan* and the *seperewa*, the *atumpan* was more likely to encode !H as H, and the *seperewa* was more likely to encode it as L. We hypothesize that this difference may relate to the different musical uses of the instruments. The *atumpan* is the most prominent Akan instrument for surrogate speech and has a vast repertoire of common phrases, and thus potentially a more rote system of rules for transferring Akan tones to musical form. The *seperewa,* on the other hand, is primarily used for music making rather than linguistic communication. It is frequently accompanied by sung lyrics, and sung melodies in Akan must not contradict the melodic movement of speech (Nketia 1994); thus, in sung melodies, a H!H sequence will tend to be sung across a falling musical interval. We conjecture that, if a *seperewa* player is accustomed to obeying the melodic movement of speech tones in the music, then this may be ported over to speech surrogacy on the instrument as well.

As we also saw in Section 4.3, the *abɛntia*'s malleable pitch may play a role in more closely mimicking the phonetic contours of spoken tone. This close mapping would not be possible on either the *atumpan* or the *seperewa*, with their discrete notes. If this pattern proves to hold true of further data,

then it would provide further evidence that musical surrogate language phonology is not a monolithic system, even for a particular language, but rather it is a function of what sounds the instrument can produce to mimic the sounds of speech.

3. What do the musical surrogate language facts say about speakers' metalinguistic awareness of Akan tone?

To be able to productively create new surrogate utterances (not simply reproduce rote phrases), a musician must be keenly aware of their language's tone system. But at what level? The fact that these Akan surrogate traditions are all based on two pitches reveals that speakers recognize the two phonemic tones of the language. If, for instance, downstepped H were a third phoneme, equal to L and H, then we would expect to see surrogate speech adapted to three pitches rather than two. Tone awareness must be at least morphophonemic (not simply underlying), as the instruments encode morphological tone and grammatical tone processes such as tonal overlays in nominal compounds.

But our data also point to metalinguistic awareness of more surface-level tone. This includes postlexical tone processes, such as downstep, intonational effects like falling question intonation, and even possibly phonetic implementation, as suggested by some of the *abɛntia* data. In other words, speakers demonstrate detailed and multifaceted awareness of the phonetics and phonology of their language and can translate this awareness onto the musical modality. Depending upon the possibilities offered by the instrument, musicians appear to be able to target different levels of structure, demonstrating very nuanced metalinguistic awareness of tone.

An open question remains whether we find differences in tonal awareness between musicians and non-musicians. Although Creel et al. (2023) show that Akan speakers do not show a benefit for pitch perception in general as compared to speakers of other tone languages like Mandarin, they found evidence that participants who are musically inclined display better pitch perception than those who are less musically inclined. The surrogate languages are generally practiced by musicians, who may already have a keen ear for tone; or, by virtue of learning a surrogate language tradition, this may further develop this metalinguistic awareness beyond what anaïvee speaker may possess. Therefore, coupled with the findings from Creel et al., we could probe this question in a future experiment targeting non-musician speakers of Akan, seeing how they encode speech on the *atumpan* as compared to professional musicians.

A number of other avenues remain for future work. First, we need a better understanding of the *abɛntia* surrogate system. As we discussed in Section 4.3, the horn may encode more phonetic detail of the tone system that a discrete classification of notes cannot capture. Future work should pursue an acoustic analysis of the data, perhaps with a comparison to Akan whistled speech, another surrogate system that can make use of gradient pitch. We would also like to carry out a more controlled study of downstep to tease apart its different encoding across the instruments, the effects of phrasal position, and its underlying sources, in addition to exploring the realization of downstep in words played in isolation. On the flip side of controlled experiments, it would also be interesting to compare our elicited results to more naturalistic examples from performance settings, and to gather data from more musicians to be able to carry out cross-musician comparison in surrogate speech encoding. Finally, the tonal analyses here should be complemented with analyses of other aspects of surrogate speech such as rhythm. We have demonstrated the rhythm in broad strokes here, distinguishing between single notes and double notes, but we suspect that surrogate rhythm matches speech rhythm in more subtle ways, as reported for other traditions such as Bora *manguaré* drumming (Seifart et al. 2018) or the Sambla balafon (McPherson 2021). We could also investigate whether intensity plays a role in the *atumpan* system. In the Yorùbá *dùndún* surrogate system, for instance, intensity is used by at least some musicians to encode vowel height (Villepastour 2010:82). While we see no indications of this use of

intensity in the Akan systems, another mark of question intonation in Akan is greater final intensity, and it would be interesting to see if this is encoded in surrogate speech.[2]

To conclude, we hope to have shown how linguistic study of musical surrogate languages can further our understanding of the spoken languages on which they are based. Such traditions are common on the African continent, and yet they have received little attention from linguists. As more and more of these systems are linguistically documented, we will be able to see if any consistent patterns emerge in how humans transpose speech onto musical instruments and how this transposition is affected by musical, instrumental, and cultural constraints.

Appendices

The elicitation lists below present the stimuli as they were given in their original source and as they were given to the elicitors during data collection. Some sources had tone marking in the stimuli and others did not. The ELAN files in our archived data contain our tonal transcriptions, which reflect the speakers' surface pronunciation.

Recordings and transcriptions

All recordings and transcriptions have been archived in the Endangered Languages Archive and are available (with a free account) at the following URL:
https://www.elararchive.org/dk0748

Elicitation list 1

Woye ɔdehye dada	You are of ancient royal blood	Kaminski (2008)
Osei-ee!	Osei!	Kaminski (2008)
Nipa brɛ brɛ kwa brɛ kwa brɛ kwa	Human beings tire, tire, tire for nothing	Kaminski (2008)
Gye soro gye soro gye ase ase	Only heaven, only heaven, only earth, no one else	Kaminski (2008)
Opoku ten-ten-ten-ten	Tall Opoku	Kaminski (2008)
Asante Kɔtɔkɔhene	King of the Asante porcupines	Kaminski (2008)
Okosu Akyeao Prempon bra	The elder who elders fear	Kaminski (2008)
ɔdɔkroɔ Kwanta dan kesɛɛ na se awuno[3]	Great Odokroo Kwanta is feared	Kaminski (2008)
ɔtwe dua etia	The an'elope's tail is short	Kaminski (2008)
Firi tete	From ancient time	Kaminski (2008)
ɔde sparana pra ne ho	But it uses it to clean itself	Kaminski (2008)
ɔgyapam ɛne wo ntɛtea	The leaves and the ant	Kaminski (2008)
Boafo ako, ako	Boafo fight, fight	Kaminski (2008)

[2] Thanks for Frank Kügler for bringing up this possibility.

[3] This final word "awuno" likely constitutes a mistake in Kaminski's work, and it was variably corrected by the elicitor resulting in some confusion with the musicians. Any corresponding musical renditions have been removed from the final analyses.

Gumu brɛ brɛ	Loosen it slowly	Kaminski (2008)
Momma so!	Lift it up!	Kaminski (2008)
Yeama yen ho so!	We have lifted it up	Kaminski (2008)
Tie	Listen!	Kaminski (2008)
ɔkwan atware asuo	The path has crossed the river	Kaminski (2008)
Asuo atwa ɔkwan	The river has crossed the path	Kaminski (2008)
181an ɛbɔɔ kwan no kɔtoo asuono	We made the path to cross the river	Kaminski (2008)
Asuono firi tete	But the river was made in ancient time	Kaminski (2008)
ɔdomankoma ɔbɔadeɛ	By God the Creator	Kaminski (2008)
Firi tete	In ancient time	Kaminski (2008)
ɔ̀dómánkómá bɔ̂ɔ à-déɛ	The creator created things	Nketia (1963)
Bɔ̀r-bɔ̀ré bɔ̂ɔ à-déɛ	The creator created things	Nketia (1963)
ɔ̀bɔ̀ɔ déɛbén?	What did He create?	Nketia (1963)
ɔ̀bɔ̀ɔ sɛ́n	How did He create?	Nketia (1963)
ɔ̀bɔ̀ɔ kyèrɛ̀mà	He created the drummer.	Nketia (1963)
ɔ̀bɔ̀ɔ kwàwú ákwábràfò titire	He created Kwawu Akwabrafo (warriors), the prominent.	Nketia (1963)
otumfuɔ	Mighty one	Second author
etuo to a, ɛtwere barima bo	When a gun fires/shots, it remains'on a man's chest	Second author
bisabisafoɔ, nyera kwan	one/those who asks (for a path), does not miss his/her way/path	Second aut'or
hu m'ani so ma me nti na atwe mmienu nam	It is for support that, makes two antelopes walk together	Second author
dua koro gye mframa a ebu	If a single tree receives the wind it breaks -->Two heads are better than one	Second auth'r
Toa n'apɛ 181an eoma sa ne kɔn	It is the bottle that allows itself for a rope to be tied around its neck	Second author
etire ntee a ɛngyae kyɛ soa	As long as the head remains, it will continue to wear a cap/hat	Second author
nsuo a ɛdɔ wo no'na ɛkɔ w'ahina mu	It is the water that likes you that enters your water-bottle (water-cooler)	Second author
ahwene te wɔ mpanin/mpa anim a ebi nyera	When beads tear in front of elders, none gets lost	Second author
dua a ɛbɛwɔ woɔ no, yetu aseɛ na yentwa so	We uproot the tree that can cause havoc, but not to cut it in order not for it to geminate again.	Second author
dua a ɛbɛn na etwie	it is the trees that are closer that cross each other	Second author

anomaa kyɛre dua so a ɔgye boɔ	If a bird stays at a place on a tree for long a stone gets thrown at it	Second author
nkuro dɔɔso a yɛntena faako ngye animguase	When there are several communitie' you don't stay at one place to suffer	Second author
mpanin se sɛ wo kotodwe mu yɛ mmrɛ a wo mmɔ ka wɔ ahemfie	Our elders say, he who apologizes always avoid fines	Second author
anomaa antu a obuada	it is a lazy bed who goes to bed hungry	Second author
brɔfrɛ a ɛyɛ dɛ na abaa da aseɛ	a sweet bearing pawpaw attracts eaters	Second author
abofra bɔ nwa na ɔmmɔ akyekyede	a child break' a snail's shell but not that of a tortoise	Second author
Ɔbra yɛ akwantuo	Life is a journey	Second author
Mekɔ a Memma bio yɛka no kuroti.	It is only the wise who declares his/her intentions at the outskirt of the town.	Second author
Wankɔ bi a wose yɛanko	It is only the person who traveled that can speak about traveling experiences	Second author
Baabi dehyeɛ tumi kɔdane baabi akoa	A citizen/royal of one country becomes a slave on a strange land	Second author

Elicitation list 2

Anane bisa?	Anane asks?
Kukuoba papa no?	The good small pot?
Kukuoba no	The small pot
Wɔfa Asare fi Akyemfo?	Uncle Asare comes from Akyemfo?
Anane bisa sika bɔne ɛnɛ	Anane asks for bad money today
Wɔfa Ado Asare fi Akyemfo	Uncle Ado Asare comes from Akyemfo
Papa Kofi kasa kyerɛ ne ba?	Father Kofi talks to his child?
Anane bisa sika?	Anane asks for money?
Kukuoba papa no bɔ daa	The good small pot breaks everyday
Anane bisa sika bɔne ɛnɛ?	Anane asks for bad money today?
Wɔfa Ado Asare fi Akyemfo	Uncle Ado Asare comes from Akyemfo
Kukuoba no?	The small pot?
Kukuoba papa no	The good small pot
Asare fi Akyemfo	Asare comes from Akyemfo
Anane bisa sika	Anane asks for money

Anane bisa?	Anane asks?
Asare fi Akyemfo?	Asare comes from Akyemfo?
Papa Kofi kasa kyerɛ ne ba bio	Father Kofi talks to his child again
Anane bisa sika bɔne ɛnɛ?	Anane asks for bad money today?
Papa Kofi kasa kyerɛ ne ba	Father Kofi talks to his child
Kukuoba papa no	The good small pot
Kukuoba no	The small pot
Kukuoba no	The small pot
Asare fi Akyemfo	Asare comes from Akyemfo
Papa Kofi kasa kyerɛ ne ba?	Father Kofi talks to his child?
Anane bisa sika ɛnɛ	Anane asks for bad money today
Anane bisa sika?	Anane asks for money?
Papa Kofi kasa?	Father Kofi talks?
Papa Kofi kasa?	Father Kofi talks?
Yaw fi Akyemfo	Yaw comes from Akyemfo
Papa Kofi kasa	Father Kofi talks
Papa Kofi kasa?	Father Kofi talks?
Anane bisa sika ɛnɛ?	Anane asks for money today?
Kukuoba papa no bɔ daa?	The good small pot breaks everyday?
Anane bisa sika?	Anane asks for money?
Yaw fi Akyemfo	Yaw comes from Akyemfo
Asare fi Akyemfo	Asare comes from Akyemfo
Wɔfa Asare fi Akyemfo?	Uncle Asare comes from Akyemfo?
Anane bisa sika ɛnɛ	Anane asks for money today
Papa Kofi kasa kyerɛ ne ba bio?	Father Kofi talks to his child again?
Wɔfa Ado Asare fi Akyemfo?	Uncle Ado Asare comes from Akyemfo?
Anane bisa sika ɛnɛ?	Anane asks for money today?
Anane bisa	Anane asks

Wɔfa Ado Asare fi Akyemfo?	Uncle Ado Asare comes from Akyemfo?
Wɔfa Asare fi Akyemfo	Uncle Asare comes from Akyemfo
Papa Kofi kasa kyerɛ ne ba bio	Father Kofi talks to his child again?
Papa Kofi kasa kyerɛ ne ba	Father Kofi talks to his child
Wɔfa Asare fi Akyemfo?	Uncle Asare comes from Akyemfo?
Papa Kofi kasa kyerɛ ne ba bio	Father Kofi talks to his child again
Papa Kofi kasa kyerɛ ne ba bio	Father Kofi talks to his child again
Kukuoba no?	The small pot?
Anane bisa sika bɔne ɛnɛ	Anane asks for bad money today
Anane bisa?	Anane asks?
Kukuoba papa no?	The good small pot?
Kukuoba papa paa no bɔ daa	The very good small pot breaks everyday
Anane bisa	Anane asks
Kukuoba papa no	The good small pot
Kukuoba papa no?	The good small pot?
Yaw fi Akyemfo?	Yaw comes from Akyemfo?
Anane bisa sika	Anane asks for money
Asare fi Akyemfo?	Asare comes from Akyemfo?
Papa Kofi kasa kyerɛ ne ba bio?	Father Kofi talks to his child again?
Wɔfa Ado Asare fi Akyemfo	Uncle Ado Asare comes from Akyemfo
Yaw fi Akyemfo	Yaw comes from Akyemfo
Anane bisa	Anane asks
Anane bisa sika ɛnɛ	Anane asks for money today
Kukuoba no?	The small pot?
Yaw fi Akyemfo?	Yaw comes from Akyemfo?
Kukuoba papa paa no bɔ daa	The very good small pot breaks everyday
Papa Kofi kasa kyerɛ ne ba?	Father Kofi talks to his child?
Kukuoba papa no bɔ daa?	The good small pot breaks everyday?

Yaw fi Akyemfo?	Yaw comes from Akyemfo?
Wɔfa Asare fi Akyemfo	Uncle Asare comes from Akyemfo
Papa Kofi kasa	Father Kofi talks
Kukuoba papa paa no bɔ daa?	The very good small pot breaks everyday?
Kukuoba papa no bɔ daa	The good small pot breaks everyday
Anane bisa sika ɛnɛ?	Anane asks for money today?
Asare fi Akyemfo?	Asare comes from Akyemfo?
Wɔfa Ado Asare fi Akyemfo?	Uncle Ado Asare comes from Akyemfo?
Kukuoba papa paa no bɔ daa	The very good small pot breaks everyday
Anane bisa sika bɔne ɛnɛ?	Anane asks for bad money today?
Kukuoba papa paa no bɔ daa?	The very good small pot breaks everyday?
Kukuoba papa no bɔ daa?	The good small pot breaks everyday?
Kukuoba papa paa no bɔ daa?	The very good small pot breaks everyday?
Anane bisa sika	Anane asks for money
Kukuoba papa no bɔ daa	The good small pot breaks everyday
Papa Kofi kasa kyerɛ ne ba	Father Kofi talks to his child

Abbreviations

ASSOC associative
COP copula
DEF definite
DIM diminutive
HAB habitual
IMP imperative
NEG negative
NOM nominalizer
PFV perfective
PST past
PRO pronoun
REL relativizer
SG singular

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