10th International Conference on Speech Prosody 2020
25-28 May 2020, Tokyo, Japan

Investigating relationships between intonational and syntactic phrasing in Ruruuli/Lunyala

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Abstract

Ruruuli/Lunyala is a Great Lakes Bantu language mainly spoken in central Uganda. Canonical word order in Bantu languages is generally S V IO DO with adjuncts following, but both arguments and adjuncts can occur in non-canonical positions. Since many Bantu languages, including Ruruuli/Lunyala, are tone languages, it is profitable to investigate non-pitch-related cues to intonational phrasing in these languages. In particular, penultimate lengthening has been identified as a common feature at intonation phrase boundaries in many Bantu languages. Since our data consists of conversations, it can also be fruitful to investigate phenomena in the vicinity of silent pauses, although these do not stand in a one-to-one relationship with either syntactic or intonation phrase boundaries. We investigate the locations of candidate intonation phrase boundaries in relation to syntactic boundaries. We also investigate the phonetic characteristics (e.g. penultimate lengthening) of our candidate intonation phrases in order to confirm the initial phrasing analysis and compare boundary strength associated with different syntactic boundary types.

Index Terms: intonation, phrasing, prosody-syntax interface, Bantu

1. Introduction

Ruruuli/Lunyala or Ruuli (JE103, ISO 639-3: ruc) is an underdescribed Great Lakes Bantu (Niger-Congo) language mainly spoken in the Nakasongola and Kayunga districts of central Uganda. The number of ethnic members of the community is over 230,000 [1]. Most speakers are multilingual: they are often fluent in Ganda, the language of the majority in the area, as well as English, the institutional language of Uganda. In addition, many speakers also speak languages of the neighboring ethnic communities, such as Sogo and Nyoro. It was previously classified as endangered, but thanks to community revitalization efforts it is now considered to be developing [2].

The data used in the present study come from a corpus of naturalistic speech collected in 2017–2019. As of December 2019 the corpus contained about 170,000 words.

1.1. Ruruuli/Lunyala morphology and syntax

Canonical word order in Bantu languages is generally Subject-Verb-Indirect Object-Direct Object with adjuncts following [3]. However, as in many other Bantu languages, both arguments and adjuncts can occur in non-canonical positions. Noun phrases are head-initial and all modifiers follow the head noun. Each noun in singular and plural belongs to one of the twenty noun classes and often carries the respective noun class prefix. Furthermore, Ruruuli/Lunyala nouns regularly carry an augment, also known as pre-prefix or initial vowel [4]. The verbal inflectional morphology is primarily prefixing. Prefixes express such categories as negation, argument indexing, as well as some tense and aspect categories. Other inflectional categories, such as further tense and aspect categories, mood, as well as most derivational categories, such as the causative and applicative, are marked by suffixes [5].

1.2. Ruruuli/Lunyala phonology

According to [6], Ruruuli/Lunyala has a system of five vowel qualities ([i], [e], [a], [o], and [u]), which can additionally contrast in length (short or long), except in word-final position, where no long vowels are permitted except for diphthongs (which must, however, be monomorphemic). Complex syllable onsets of plosive+glide and nasal+plosive are permitted. No syllable codas are permitted. Vowels following plosive+glide clusters, or preceding nasal+plosive clusters, are always long, unless they are word-final. Long vowels can additionally arise through coarticulation processes whereby two adjacent short vowels are merged into one long vowel, taking the quality of the second vowel if the two differ. In other contexts, two adjacent short vowels may coalesce into one short vowel, possibly with an intermediate place of articulation.

Ruruuli/Lunyala is a tone language, minimally involving a contrast between high and low tones, with the mora proposed as the tone-bearing unit [7]. However, at the time of this study, the lexical-tonal analysis for Ruruuli/Lunyala is not yet complete. Thus, investigation of phrase boundary marking can most fruitfully focus on non-pitch-related features, such as duration variations. There is no lexical stress, but it is possible that prominence marking may arise on a phrasal level. It has been suggested that, since Ruruuli/Lunyala has a phonological vowel length contrast, the phenomenon of penultimate lengthening which obtains at phrase boundaries in some other Bantu languages (cf. [8]), does not occur in this language. However, no studies have yet presented empirical evidence regarding this claim.

1.3. Intonational and syntactic phrasing in Bantu

Particularly since many Bantu languages, like Ruruuli/Lunyala, are tone languages, non-pitch-based cues to prosodic phrasing take on an important functional role for communicating information structure, as opposed to pitch/intonational cues alone. Many Bantu languages show marking of right edges of prosodic phrases (of various levels) through, e.g. phrase-final lengthen-

10.21437/SpeechProsody.2020-81

ing or constraints on tone spreading. Chichewa, Chitumbuka, Símákonde, and Zulu, for example, require prosodic phrases to have penultimate lengthening [9, 10, 11, 12]. In addition to, or instead of, duration marking, tonal structures may also be modified to mark phrase edges. In Bemba, H tones can spread through toneless syllables to the end of a word or beyond preceding a phrase boundary, but tone spreading is constrained to maximally two following syllables if there is no upcoming boundary [13]. In Kikuyu, floating L tones can only trigger downstep on other tones at the right edge of a phonological phrase [14].

Phrasing is often essential for focus marking. VP-internal or post-verbal material in Bantu languages is generally given a new or focus interpretation [15]. In Zulu, phrase boundaries systematically follow focused elements when the focus phrases with the verb, and when it does not, morphological object marking on the verb is obligatory [12]. Phrasing can also mark dislocated elements; there are multiple possibilities for how phrase marking of such dislocated elements may arise. [16] proposes that dislocation in Bantu languages can be either asymmetric, with either left-side or right-side dislocations separately phrased, or symmetric, with dislocations on both sides being separately phrased. Northern Sotho, for instance, shows an asymmetric pattern where right-dislocated elements are separately phrased, but not left-dislocated ones [17]. Chichewa, on the other hand, shows an asymmetric pattern where dislocations on both sides can have separate phrases [18]. Bemba is reported to be symmetrical, with both right- and left-dislocated topics phrased separately from the main clause [19].

Some work has also addressed intonational phrasing in Bantu languages. [19] reports for Bemba that H% and L% boundary tones arise at intonation phrase ends, with L% marking declaratives, subject, and topics, and H% following contrastive topics and relative clauses. In Shingazidja, L% also marks declaratives, but H% follows subject, topic, contrastive topic, and relative clauses [20].

2. Methodology

We extracted 358 candidate intonation phrases from our corpus of Ruruuli/Lunyala conversations; the data involved came from 5 speakers (4 female; 1 male). For each candidate intonation phrase, we annotated the syntactic structure of the content, identifying locations where potential phrase boundaries aligned with syntactic-structural boundaries. Since the tonal analysis for Ruruuli/Lunyala is not yet complete, we investigated non-pitch-related phonetic features that might be associated with phrase boundary marking.

2.1. Syntactic phrases

For each intonation phrase we annotated whether it corresponds to a syntactic phrase and if yes, what type of a phrase it is. We used the following tags: S for clause, VP for verb phrase, PP for prepositional phrase (for this study, we considered Ruruuli/Lunyala phrases headed by a noun in a locative noun class as PPs), and NP for noun phrase. Since some intonation phrases were not co-extensive (i.e. shared both initial and final boundaries) with any of the syntactic phrase types by being either larger or smaller, we also annotated whether their initial and final boundaries overlap with syntactic phrase boundaries and the type of the respective phrases.

Only 7.0% of right-side intonation phrase boundaries, and 4.5% of left-side intonation phrase boundaries in our data set were not co-extensive with the same syntactic unit as their corresponding opposite-edge boundary.

2.2. Phonetic segmentation

Since Ruruuli/Lunyala does not permit syllable codas, the syllable nucleus (i.e. the vowel) is the most likely domain for final lengthening phenomena. For each phrase identified, the final three vowels produced by the speaker in the phrase were segmented and labelled with their quality and quantity (short or long). Diphthongs were initially included in the labelling, but due to their low frequency and the difficulty in some cases of determining whether a transcribed diphthong should be treated instead as a case of coalescence (cf. Section 1.2 above), they were not used in the final analysis. The short vowels [i] and [u] are subject to elision in certain contexts; when these vowels were elided, their location was labelled and the duration measurement hand-corrected to 0. For each labelled vowel, its duration was measured, and jitter (i.e. the period-to-period variability in frequency in the signal) was automatically extracted as a measure of voice quality, since informal observation suggested that phrase-final vowels often tended to be produced with breathy voice. [21] report that less periodicity was the acoustic feature most strongly correlated with perception of breathy voice by listeners in their study; thus jitter should be higher for vowels produced with breathy voice. All measurements were taken using Praat [22], and jitter was calculated using Praat's default settings.

3. Results

3.1. Co-extension of syntactic and intonational phrases

Of our 358 candidate intonation phrases, 263 (73.5%) were co-extensive (i.e. shared both initial and final boundaries) with some kind of syntactic phrase. Of the intonation phrases which were co-extensive with a syntactic phrase, 198 (75.3%) were co-extensive with an S. Of the remaining intonation phrases, 24 (9.1%) were co-extensive with VPs, 17 (6.5%) were co-extensive with NPs, and 14 (5.3%) were co-extensive with PPs.

3.2. Phonetic features at intonation phrase boundaries

Linear mixed models were built using the statistical software R [23] and package `lme4` [24]. The criterion for statistical significance is set at $\alpha < .05$ for all models. The models were built using a maximum structure including the following predictors: vowel quality ([i], [e], [a], [o], [u]), phonological vowel duration (long/short), position of the syllable in the phrase (antepenultimate, penultimate, final), and type of syntactic phrase boundary (S, VP, NP, PP, other); however, since most of these predictors did not attain statistical significance, only simplified models are reported below. Selection of the simplified models was carried out based on the AIC, with a lower AIC value reflecting a better model fit. All models included random intercepts for speaker and individual phrase (to account for local speech rate). Models were additionally attempted with random slopes for speaker, but the models failed to converge.

Segmental duration is somewhat increased in the penultimate vowel preceding a phrase boundary, and substantially increased in the final vowel preceding a phrase boundary. Although the final vowel is always phonologically short in terms of the segmental phonology (cf. Section 1.2), its duration can equal or even surpass the duration of a preceding long vowel, as shown in Figure 1. A significant interaction was found between

the predictors phonological vowel length and location in phrase. Penultimate long vowels were longer than antepenultimate long vowels; final short vowels were also significantly longer than antepenultimate long vowels, while antepenultimate short vowels were significantly shorter (cf. Table 1). Figure 1 visualizes this stepping-up pattern in both phonologically long and short vowels.

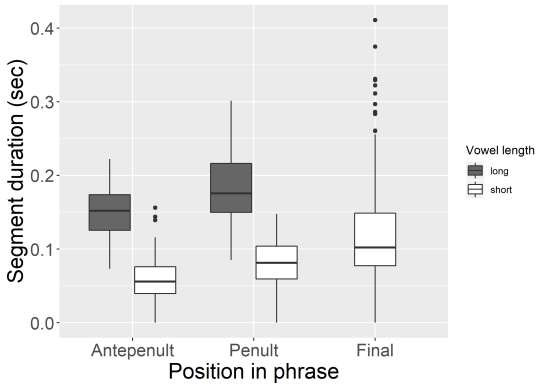

Figure 1: *Vowel duration in the final three syllable nuclei in phrases.*

Table 1: *Fixed-effects results (final) for linear mixed model predicting vowel duration (in seconds); long antepenultimate vowels were the intercept for the model. AIC = -1644.3 (null model: -1337.3).*

Fixed effect	Estimate	St. Error	t-value (p-value)
Antep:Long(int)	0.1538	0.0110	14.016 (.000)
Penult:Long	0.0297	0.0098	3.045 (.002)
Final:Short	0.0629	0.0094	12.315 (.000)
Antep:Short	-0.0955	0.0094	-10.174 (.000)
Penult:Short	-0.0068	0.0120	-0.565 (.572)

Jitter is decreased in the penultimate vowel preceding a phrase boundary, and increased in the final vowel preceding a phrase boundary, irrespective of vowel quality or what kind of syntactic boundary arises, as shown in Figure 2. The results of the model are shown in Table 2.

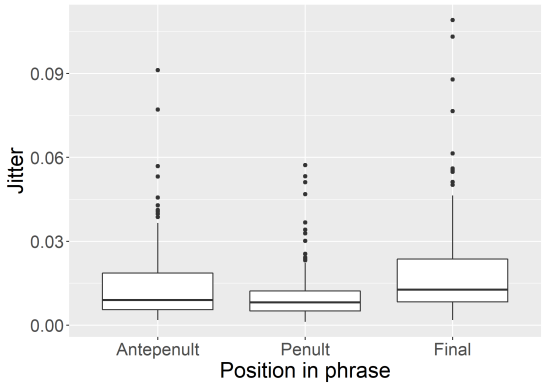

Figure 2: *Jitter in the final three syllable nuclei in phrases.*

Table 2: *Fixed-effects results (final) for linear mixed model predicting jitter; antepenultimate vowels were the intercept for the model. AIC = -2079.3 (null model: -2056.7).*

Fixed effect	Estimate	St. Error	t-value (p-value)
Antepenult (int)	0.0162	0.0041	3.937 (.013)
Penult	-0.0039	0.0017	-2.271 (.024)
Final	0.0053	0.0018	2.978 (.003)

A slight negative correlation (Kendall's τ=-0.163, Z=-4.608, p<.001) was found to obtain between degree of segmental lengthening and degree of jitter. Thus, to the extent that both lengthening and jitter are cues to phrase-finality, they appear to be complementary rather than additive.

3.3. Syntax and relative boundary strength

Since phrase-final short vowels could be produced with very long duration, we investigated whether there was any evidence of a bimodal distribution of final vowel length, which could be evidence for some kind of categorical boundary. However, while the possible duration of short vowels is much more variable in phrase-final position, as shown in Figure 3, there does not seem to be strong evidence for a bimodal distribution of final vowel duration, as the slope in the density plot falls off gradually. Mean short vowel duration in final position is longer in VPs and NPs than in Ss and PPs (cf. Table 3), but this difference does not attain statistical significance, perhaps due to the large imbalance in number of tokens available. No other effects of relative boundary strength across syntactic categories were found in the data, likely for the same reason.

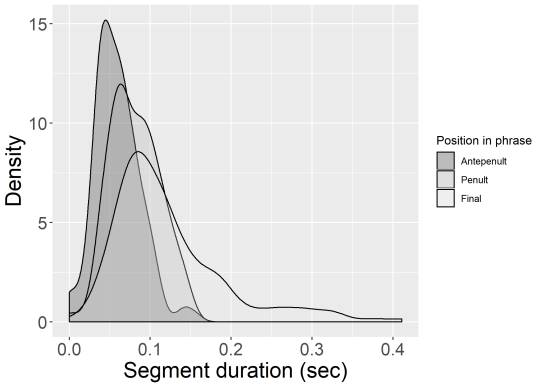

Figure 3: *Short vowel duration in the final three syllable nuclei in phrases.*

Table 3: *Mean duration of short vowels in final position in different syntactic phrase types.*

Syntactic phrase	Short vowel duration (sec)
NP	0.147
PP	0.107
S	0.118
VP	0.158

4. Discussion

4.1. Intonation phrase boundary marking

Although it has been suggested that penultimate lengthening does not arise in Bantu languages which retain a phonological vowel contrast, in our data, both the penultimate and final syllables show increased duration in comparison to the antepenultimate vowel; this effect obtains for all vowel qualities and both vowel durations. Additionally, speakers often used non-modal phonation quality (operationalized in the current study as jitter) in the final vowel of a phrase. Although jitter may only be a rough approximation of variability in phonation, the quantitative results confirm the impressionistic observations made upon listening that breathy voice was frequently used in phrase-final syllables.

There was a slight negative correlation between segmental lengthening and degree of jitter; that is, jitter was generally lower when there was more phrase-final lengthening (either penultimate or final), and vice versa, indicating that these cues may alternate with one another rather than being used in an additive way. However, since no perceptual tests were done at this stage, it is not clear to what degree the jitter measurements would correspond with a listener's impression of breathy voice (or other non-modal phonation). Thus, this feature probably deserves a more in-depth investigation. A different quantitative measure, such as harmonics-to-noise ratio, might also yield a clearer result. Since the data were taken from spontaneous interaction, it is also possible that phonation quality variations could be associated with turn-taking or floor-holding behavior, as has been found for other languages (cf. e.g. [25]). However, this possibility is beyond the scope of the current work.

Although it had been previously suggested that Rurululi/Lunyala does not demonstrate phrase-final penultimate lengthening since its segmental phonology includes contrastive short and long vowels, we find evidence for phrase-final lengthening in both the final and the penultimate syllable nuclei, affecting both short and long vowels. This suggests an additive effect of phrase-final lengthening on top of phonological length. However, since only short vowels occur phrase-finally, their phonological length is fully predictable and they can be more flexibly employed by the prosodic system for functions above the level of lexical identity. [19] reports lengthening in the final syllable at intonation phrase boundaries in Bemba, so perhaps the penultimate and final lengthening belong to different levels of structure (cf. Section 4.2 below). Alternatively, the lengthening of the final vowel adjacent to a boundary could be an articulatory effect resulting from a decrease in stiffness of articulatory gestures in the vicinity of phrase boundaries, as suggested by [26].

4.2. Syntax and boundary strength

We found only weak evidence for a relationship between differential boundary marking strength for different types of syntactic phrases, in that phrase-final short vowels tended to be longer in VPs and NPs than in Ss and PPs. However, the total number of VPs, NPs, and PPs in the study is so low that this difference might simply arise from measurement error. Further investigation is required on this point.

In the current data, the majority of intonation phrases were co-extensive with syntactic phrases, and particularly with clauses. As a result, it is difficult to make any claims about the symmetry or asymmetry of phrasing around non-canonically-located arguments and adjuncts.

The high degree of coextension between our candidate phrases and full syntactic clauses indicates that the phrases we labelled were indeed intonational phrases and likely not lower-level prosodic/phonological phrases, which have been reported for other languages as the domain of penultimate lengthening (cf. Section 1.3). Any lower-level prosodic phrase would almost certainly have its final edge coincide with that of an intonational phrase, so it is possible that (some of) the phonetic phenomena observed in this study actually arise as edge markers for this lower-level phrase. Once the analysis of the tone system is complete, evidence from pitch production may lend additional support to the project of determining whether a two-level system is motivated.

5. Conclusions

In a quantitative investigation of intonation phrases arising in spontaneous speech in Rurululi/Lunyala, we find that most intonation phrases are coextensive with a syntactic phrase of some kind, primarily with clauses. For all types of syntactic phrases, intonation phrase boundaries are marked (at least) with vowel lengthening in both the final and penultimate syllables in the phrase, as well as with increased jitter (i.e. less periodicity) in the final vowel, sometimes to a very dramatic extent. The evidence for penultimate lengthening is particularly interesting in the face of proposals that the phonological vowel length contrast could hinder such a phenomenon. The current study is exploratory in nature, and requires substantial future work, both to specify the phonetic and phonological phenomena associated with possible multiple levels of phrasing, as well as to eventually merge intonational effects with the lexical tone system.

6. Acknowledgements

This work was supported by the Volkswagen Foundation Knowledge for Tomorrow Project 'A comprehensive bilingual talking Lururuli/Lunyara-English dictionary with a descriptive basic grammar for language revitalisation and enhancement of mothertongue based education' (PI: Dr. Saudah Namyalo).

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