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The interaction of polar question and declarative intonation with lexical tone in Moro

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Abstract

This paper examines tone-intonation interactions in the Thetogovela dialect of Moro in declarative assertive statements and polar questions. Polar questions may have an optional final question particle. Moro has high and low lexical tones. We predicted that tone realizations would differ between declarative statements and polar questions due to the intonation system. To test this prediction, two male speakers produced subject-verb-object sentences with target objects of varying tonal patterns in a carrier phrase, as either declaratives or polar questions. Speakers maintained a difference between high and low target tones in both sentence types. However, speakers had higher F0s overall for polar question carrier phrases than declaratives; declaratives showed greater F0 declination. Both declaratives and questions exhibit a phrase final fall, but lexical tone of bisyllabic objects are well differentiated in declaratives. In questions, tonal space for bisyllabic objects is compressed with level or rising tone patterns, while the falling tone pattern exhibits a large range difference in questions. The results of this study show that lexical tone targets are generally maintained, but intonation can impact tone realizations through pitch raising and compression.

Index Terms: Moro, intonation, tone

1. Introduction

Moro is a Kordofanian (Niger-Congo) language spoken in the Nuba Mountains region in South Kordofan State in the Republic of Sudan. Moro has two contrastive tones, high (H) and low (L), as shown by the following minimal pairs. Low tone is unmarked. All data are from the Thetogovela dialect of Moro.

(1) *ŋaləŋa* 'song' *ŋálə́ŋá* 'kingdom'
warά 'baobab tree' *wárά* 'chicken'

Polar questions can be distinguished from assertive declarative sentences in Thetogovela Moro by a low-toned question particle /-a/ attached to the last word in the question as in (2b). Other than this particle, there are no morphological or syntactic differences between neutral assertive declaratives and polar questions. (Abbreviations used: CL= noun class; RTC = root clause; PFV= perfective; QP = question particle)

(2) a. *kúkːu* *g-a-mː-ó* *kódʒa-ŋ*
CLg.Kuku CLg-RTC-take-PFV CLg.Koja-CASE
'Kuku married Koja.'
b. *kúkːu* *g-a-mː-ó* *kódʒa-ŋ-a*
CLg.Kuku CLg-RTC-take-PFV CLg.Koja-CASE-QP
'Did Kuku marry Koja?'

A low-toned low vowel question particle is widely attested in African languages in the Sudanic belt [1, 2]. However, the question particle is optional in Moro, and is typically absent after words ending in vowels. There is no signifiant lengthening of the penultimate or the final vowel in either declaratives or polar questions to signal a declarative/polar question distinction. Since variation in F0 is standardly used to signal intonation, we predict that F0 may also be employed to signal intonation in Moro, but that it could potentially interact with the lexical tone function of F0. Prior research has demonstrated that intonational tone in some languages may avoid associating to the same syllable as lexical tone (Stockholm Swedish, [3], Roermond Dutch, [4]) or neutralize lexical tone distinctions (Slave [5]). However, in other languages, such as Mandarin [6], Hausa [7], Xhosa [8] or Akan [9], intonation is superimposed on lexical tone resulting in expanded pitch range or register. The present experiment was conducted to determine the overall prosodic pattern of assertive declaratives and polar questions in Moro, and in particular, to test the effect of intonation on lexical tone.

2. Methods

2.1. Materials

The experiment consisted of 33 subject-verb-object sentences in which the subject-verb portion of the sentence was a 'carrier phrase' with a LH LHL tone pattern (*ŋɛɾá ŋanwána* _____ 'the girl is taking care of _____'). The following object varied by lexical tone pattern and length (bisyllabic, trisyllabic). In this article, for reasons of space, we present results from sentences with the bisyllabic objects only (patterns: HH, LL, HL, LH).

In order to maintain cross-category and cross-speaker comparisons, and to eliminate the influence of the question particle on intonation, some sentences were removed from analysis. There were 10 sentence types in total, all with vowel-final objects (3 with HH objects, 2 with LL, 2 with HL and 3 with LH).

2.2. Speakers

Two male speakers of Thetogovela Moro participated in the study. Both are above the age of 40 and currently reside outside the main Moro-speaking area, Speaker #1 in the United States, and Speaker #2 in Omdurman, Sudan in a primarily Moro-speaking community. Both participants also speak Sudanese Arabic and English. The results for each speaker were analyzed separately as preliminary analyses found that speakers exhibited different patterns.

2.3. Procedures

Recordings took place in a sound proof both in the Phonetics Lab at UC San Diego. Stimuli were elicited in two blocks. In the first block, speakers produced neutral assertive declar-

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ative sentences for each object. In the second block, speakers produced polar questions for each object, and the experimenter answered *aa* 'yes' after each question. Each object was presented as a picture in a PowerPoint presentation. Photos were used instead of written materials so that participants could optionally add a question particle. However, this method did at times result in the speakers using another word than the one intended. Sentences with non-target words were excluded for the final analysis. Speaker #1 produced four repetitions of each type of utterance and Speaker #2 three repetitions.

2.4. Annotation

All annotations were conducted in Praat using the TextGrid facility. The H or L lexical tone target of each syllable was marked, the maximum peak for H and the minimum valley for L. F0 values were then pulled from those points for data analysis. Undefined values due to creaky voice were not included. Maximum and minimum values were measured instead of vowel midpoints as H and L targets do not always align with midpoints. Microprosodic effects of neighboring consonants were minimized by using words that contained primarily sonorants, and avoiding measurements at the edges of the vowel.

2.5. Statistical Analyses

To test for significant effects, linear mixed effects models for all analyses were run in R [10], using the `lme4` package version 1.1-7 [11]. Two analyses were conducted: 1) the F0 targets of the LH LHL carrier phrase itself (syllables 1-5), and 2) the F0 of the final syllable minus the F0 of the first syllable of the final object of the sentence. The first analysis was conducted on all sentence types (those ending in bisyllabic and trisyllabic objects) while the second analysis was only conducted on sentences ending in bisyllabic objects. Separate models were run for each speaker as preliminary analyses found the two speakers used different realizations. Separate analyses were run instead of simply adding speaker as a random effect to more thoroughly explore these individual differences.

To test for effects on the carrier phrase, two models were run (one per speaker). The dependent variable was F0 in Hertz at the H or L target of the syllable. The fixed effects were context of the sentence (declarative, polar question), syllable number (1-5), and tone (L, H). Context and syllable number were included as an interaction. All fixed effects were coded with contrast coding, except syllable number which was included as a continuous variable. Sentence was included as a random slope by context and syllable number. This was the maximal, uncorrelated random-effects structure that would converge.

To test for effects of F0 change (range) of the bisyllabic final objects, two models were run (one per speaker). The dependent variable was F0 in Hz of the final syllable of the target minus F0 in Hz of the first syllable of the target. The fixed effects were context of the sentence (declarative, polar question), whether the overall object shape was level or contour (LL and HH vs. LH and HL), and tone on the final syllable of the object (syllable 7, L, H); all possible two-way interactions and the three-way interaction were included. All fixed effects were coded with contrast coding. Sentence was included as a random intercept. These were the maximal, uncorrelated random-effects structure that would converge.

For all models, significance of fixed effects was assessed using model comparison. Alpha was set at $p < 0.05$.

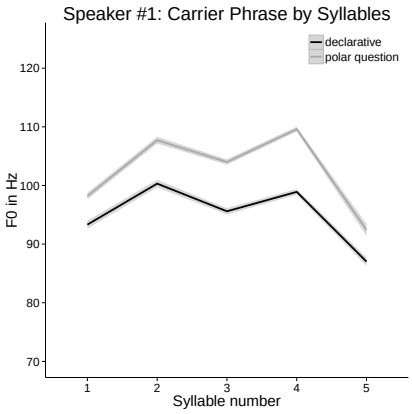

Figure 1: *Speaker 1: carrier phrase ŋɛrá ŋanwána - declarative vs. polar question*

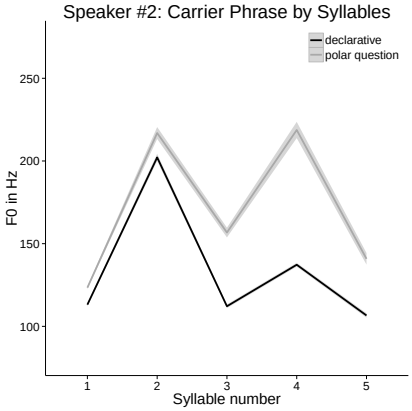

Figure 2: *Speaker 2: carrier phrase ŋɛrá ŋanwána - declarative vs. polar question*

3. Results

3.1. Carrier Phrase

Numerically both speakers exhibited raised F0 in the questions for the subject-verb carrier portion, as shown in Figures 1 and 2. Grey bars indicate 95% confidence intervals.

For the carrier phrase, Speaker #1 had a significant effect of context, with polar questions having a higher F0 than declaratives [β = 6.07, *SE* = 0.65, $\chi^2(1) = 70.17$, $p < 0.001$]; Speaker #2 did not have a significant effect of context. Both speakers had a significant effect of syllable number, with a drop in F0 throughout the carrier phrase [Speaker #1: β = -1.19, *SE* = 0.11, $\chi^2(1) = 63.31$, $p < 0.001$; Speaker #2: β = -2.05, *SE* = 0.50, $\chi^2(1) = 15.77$, $p < 0.001$]. Both speakers had a significant effect of tone, with L tones having a lower F0 than H tones [Speaker #1: β = -9.08, *SE* = 0.22, $\chi^2(1) = 687.72$, $p < 0.001$; Speaker #2: β = -68.28, *SE* = 1.40, $\chi^2(1) = 1018.30$, $p < 0.001$]. Finally, both speakers had a significant interaction of context and syllable number [Speaker #1: β = 0.44, *SE* = 0.19, $\chi^2(1) = 5.15$, $p < 0.05$; Speaker #2: β = -11.49, *SE* = 0.97, $\chi^2(1) = 126.90$, $p < 0.001$]. Follow up simple linear regressions found that for both speakers there was a significant drop in F0 throughout the carrier phrase for both contexts, but the effect was more pronounced for declaratives than polar questions

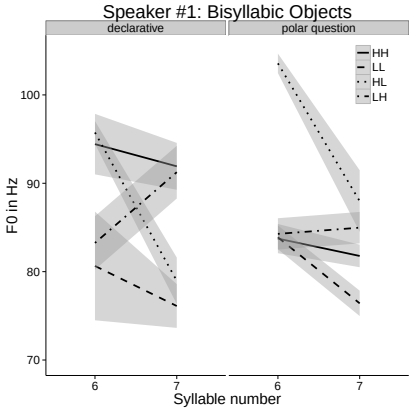

Figure 3: *Speaker 1: F0 range of bisyllabic sentence final objects - declarative vs. polar question*

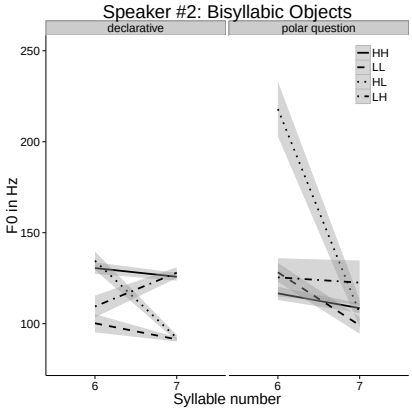

Figure 4: *Speaker 2: F0 range of bisyllabic sentence final objects - declarative vs. polar question*

[Speaker #1: declaratives – r = -0.36, $p < 0.001$, polar questions – r = -0.19, $p < 0.001$; Speaker #2: declaratives – r = -0.30, $p < 0.001$, polar questions – r = -0.12, $p < 0.05$].

3.2. Bisyllabic Final Object F0 Change

Turning to the sentence final bisyllabic objects, Figures 3 and 4 illustrate the pitch range and register of the four tone patterns by speaker. The full summary of results for bisyllabic objects is presented in Table 1. As the three-way interaction of context, object shape, and final syllable tone was significant for both speakers, this section will focus on unpacking the interaction.

Simple linear regressions were conducted for each object type to see where an effect of context was present. Speaker #1 did not have a significant effect of context for HH, HL, or LL objects, but did have a significant effect for LH objects [r = -0.81, $p < 0.001$]. Speaker #1 was thus consistent in range across contexts for level objects (HH, LL) and falling objects (HL); however, when an object was rising (LH), the degree of the rise was not maintained in polar questions. Speaker #2 had a trending effect for HH objects [r = -0.37, p = 0.08], and a significant effect for LL, HL, and LH objects [LL - r = -0.91, $p < 0.001$; HL - r = -0.98, $p < 0.001$; LH - r -0.83, $p < 0.001$]. The interaction appears to be then that for all object types, the decrease between syllable one and two was always larger for polar questions, however to different degrees. It is interesting to note that even for LH objects, where the final tone should be higher than the previous one, the difference between tones was negative for polar questions, while it was positive for declaratives.

Table 1: *Model results for F0 change of sentence final bisyllabic objects separated by speaker.*

Speaker #1	β	*SE*	$\chi^2(1)$	p
(intercept)	-5.70	0.36	n.a.	n.a.
context	-0.90	0.72	1.57	0.21
object shape	-0.57	0.72	0.63	0.43
final syllable tone	13.51	0.72	39.63	< 0.001
context × object shape	-4.58	1.43	9.53	< 0.01
context × final syllable tone	-4.95	1.43	11.02	< 0.001
object shape × final syllable tone	14.33	1.43	27.88	< 0.001
context × object shape × final syllable tone	-6.55	2.87	5.03	< 0.001
Speaker #2	β	*SE*	$\chi^2(1)$	p
(intercept)	-23.61	0.76	n.a.	n.a.
context	-28.82	1.51	114.94	< 0.001
object shape	-22.26	1.51	31.46	< 0.001
final syllable tone	48.73	1.51	46.88	< 0.001
context × object shape	-33.52	3.03	65.90	< 0.001
context × final syllable tone	33.04	3.03	64.78	< 0.001
obeject shape × final syllable tone	72.85	3.03	41.14	< 0.001
context × object shape × final syllable tone	30.30	6.05	20.83	< 0.001

Numerically, speakers particularly diverged on their realization of the LL objects. For LL objects, Speaker #1 showed only slight effects of context, and if any effect, it was a decrease in the difference for polar questions, a smaller F0 fall between the two syllables. Speaker #2 showed a clear effect of context, with a larger difference for polar questions than declaratives. This is illustrated in the example pitch tracks in Figure 5 for the LL word *ŋaɲa* 'grass'. Note that both the declarative and the polar question showed a final fall, an indication of a L boundary tone for both utterance types. Additionally, in general, Speaker #2 used larger pitch ranges across all categories and contexts than Speaker #1. Summaries of these results by speaker are presented in Figures 3 and 4 for the full realizations and Figures 6 and 7 for the differences between syllables.

4. Discussion

The analyses found clear effects of intonation on tone realization. Speaker #1 has a small pitch range, but shows significant overall F0 raising in questions. Speaker #2 does not show a significant effect of context. The subject portion of his carrier phrase is similar between declaratives and questions; however, there is a significant drop in the H tone of the verb in the declarative utterances compared to questions. This suggests that an automatic downstep of the second H is suspended in questions, as in Hausa [7]; see also [12]. Global raised pitch can be expressed as a h register [7] or with %q-raised notation in ToBI transcription. We view it as phonological, and not as phonetic compensation to accommodate the final L%, as in the analysis of Akan in [9]. With respect to the lexical tone of bisyllabic objects, Figures 3 and 4 show a clear differentiation of the four tonal patterns in declaratives for both speakers. Despite general declination, speakers produce L and H targets at the same F0 re-

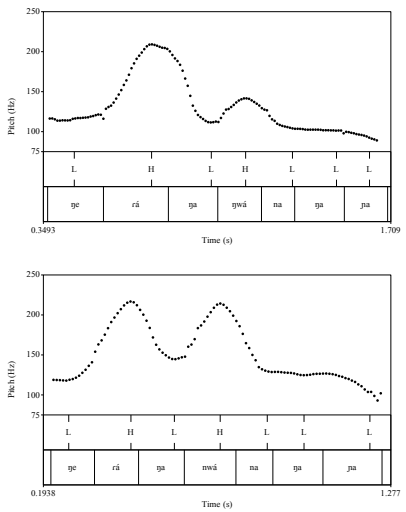

Figure 5: *Pitch tracks of ŋerá ŋanwána ŋaŋa. Declarative (above): 'the girl is taking care of the grass' and Question (below): 'Is the girl taking care of the grass?'*

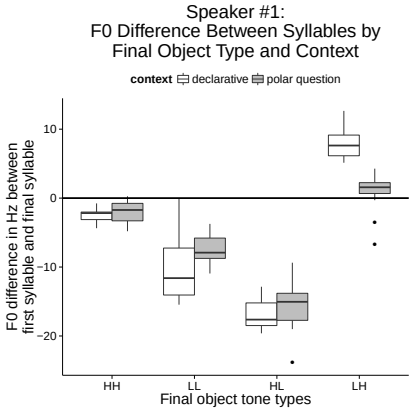

Figure 6: *F0 difference of bisyllabic sentence final objects - declarative vs. polar question for Speaker #1.*

gardless of tone pattern. This is not the case for polar questions. Tone compression is observed for LL, HL and HH tone patterns. The HH pattern is very similar between declaratives and questions, showing no significant change in range for either speaker. Figure 3 and 4 indicates a lower F0 in questions, although pitch register was not tested in the statistical model. This means that there is little rise from the preceding L tone in the carrier phrase verb to the first H of the HH object. Both speakers show a range difference in questions for LH, indicating a significantly flatter F0 realization. The initial L is thus realized with higher F0 in questions, but the final H fails to rise, and falls due to the final low boundary tone. This results in overlap between LH and HH realizations in questions. The LL object pattern is similar to HH in terms of range differences, but shows a larger final fall in questions, a significant effect for Speaker #2. This is due to the fact that the preceding words in the carrier portion of the question, even those with L tone, have higher F0. Finally, unlike the initial high tone in the HH pattern, the H tone of the HL pattern has a higher F0 in questions compared to declaratives for both

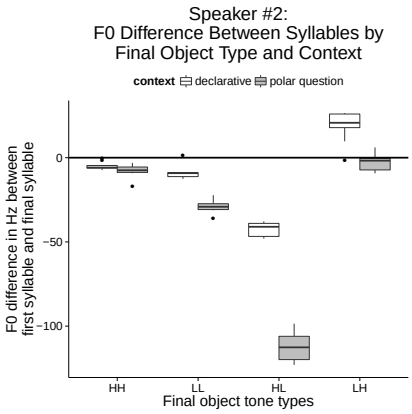

Figure 7: *F0 range of bisyllabic sentence final objects - declarative vs. polar question for Speaker #2.*

speakers. There is no compression. For Speaker #1, the range is similar in declaratives, although there is higher pitch register in questions. For Speaker #2, both range and register are expanded for the H tone in HL questions, but the final L is realized at the same F0 target for both declaratives and questions.

In conclusion, polar questions are indeed distinguished from assertive declarative utterances in Moro by F0 intonation. Lexical tone targets are maintained but exhibit raised F0 or pitch expansion in the earlier part of the utterance. For Speaker #2, raised F0 is maintained in questions, but the declarative shows downstep on the second H. There appears to be a L% boundary tone that marks the end of both declaratives and questions; this is responsible for the fall phrase-finally for both. Raised F0 in questions is followed by phrase-final compression of the lexical tone distinctions in questions for LL, HH and LH, but not for HL.

5. Conclusions

In this paper, we investigated how intonation interacts with lexical tone in simple sentences in Moro. Declaratives are marked by tonal declination and a final low boundary tone. Polar questions show raised F0 in the early part of the sentence, but compression of F0 in the final word. Pitch compression reduces distinctions between lexical tones in polar questions. Typologically, Moro resembles other African languages in the use of falling final pitch to indicate polar questions [1, 2]. However, it also uses pitch raising or expansion non-finally. This is a preliminary study that uses constructed sentences and controlled environments to determine basic intonation patterns and their effect on lexical tone. This methodology has drawbacks due to the 'laboratory' situation. Sociolinguistic differences between the speakers, as well as the controlled experiment, may have influenced differences in speakers' productions. However, since Moro is an endangered language, ideal conditions are not possible at this exploratory stage. Future work should involve more natural utterances and more speakers.

6. Acknowledgements

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7. References

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