A LONG-DISTANCE DEPENDENCY IN YORÙBÁ TONE REALIZATION

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ABSTRACT

This paper reports an experimental investigation of the F_0 interpretation of tone sequences in Yorùbá, with special reference to the phenomena of downstep and H Raising. It examines a long-distance dependency between the F_0 realization of an initial H tone and the choice of a tone occurring several syllables away, and discusses its consequences for models of F_0 interpretation.

1. INTRODUCTION

Downstep is a pattern in which later tones are scaled lower than earlier tones of the same category within a given prosodic unit. Most current models of F_0 interpretation treat downstep either in terms of a rule which iterates from left to right across the phrase, computing the F_0 value of each new tonal target as a function of the immediately preceding F_0 target value [1], or in terms of a downward resetting of the overall register within which tones are realized [2,3]. We present evidence that these models are not able to account for the specific nature of downstep in Yorùbá, and suggest an alternative interpretation of F_0 downtrends in terms of regressive upstep (right-to-left register raising). The experimental corpus and methodology upon which this study is based are described in [4], to which the reader is referred for further details.

2. TONE IN YORUBA

Yorùbá, spoken in Nigeria, is a tone language with three lexically distinctive tone levels, H (high), M (mid), and L (low). We follow the usual practice of marking H tones with an acute accent and L tones with a grave accent, leaving M tones unmarked. Minimal pairs include ìlú (LH) 'city', ìlu (LM) 'perforator', and ìlù (LL) 'drum'. A regular rule of Tone Spread extends a L tone to the beginning of a following H tone syllable, causing e.g. 'city' to be realized with the high-rising pattern [ìlǔ]; similarly, underlying HL sequences are realized as high-falling [4,5].

Previous studies have elicited certain generalizations about the phonetic realization of surface tone sequences in Yorùbá [4,6], of which two are of special relevance here. *Downstep* occurs non-distinctively in Yorùbá, where it is triggered by HL sequences occurring early in the sentence; no other tone sequences are regular downstep triggers. *H Raising* causes H tones in HL sequences early in the sentence to be realized with higher values than H tones in other contexts.

Given the similarity of the contexts in which Downstep and H Raising occur, Connell and Ladd ([6]: 17-19) raise the question whether apparent Downstep effects on H tones in Yorùbá might be entirely reducible to H Raising; their data was unable to satisfactorily resolve this question. One of the specific concerns of this paper (as it was of the larger study from which it is drawn [4]) will be to determine whether H tones really do "step down" in HLHL sequences. A more general concern will be to sort out the relative contributions of Downstep and H Raising in tone realization, and to determine whether both principles are independently needed to account for phonetic generalizations.

3. EXPERIMENTAL DESIGN

In order to address these questions, we constructed a set of test sentences devised to allow us to examine the F0 values of H tones (henceforth called the "target H tones") in a variety of contexts. Each sentence contained a target H tone as its first and third tone. Two parameters were systematically varied: the tone following the first H tone and the tone following the second one. The test sequences can be schematized by the formula "HXHY", where X and Y are to be understood as variables taking H, M, and L tones as their values. These sequences were placed in a constant tonal frame to eliminate any final lowering effects. The sentences constructed in this way are given below:

Set A: HXHY, X=H
1. Déwálé rélá bọ̀ fún Láyẹmí
2. Déwálé rolú bọ̀ fún Láyẹmí
3. Déwálé ràwé bọ̀ fún Láyẹmí

Set B: HXHY, X=M
4. Mọ́yẹmí rélá bọ̀ fún Láyẹmí
5. Mọ́yẹmí rolú bọ̀ fún Láyẹmí
6. Mọ́yẹmí ràwé bọ̀ fún Láyẹmí

Set C: HXHY, X=L
7. Máyọ̀mí rélá bọ̀ fún Láyẹmí
8. Máyọ̀mí rolú bọ̀ fún Láyẹmí
9. Máyọ̀mí ràwé bọ̀ fún Láyẹmí

All sentences in sets A-C have identical syntactic structure, in which a proper-noun subject is followed by a serial verb predicate introduced by a contracted V+N sequence (e.g. *rélá* is the contraction of / ré / 'pick/ + / ilá / 'okra' created through a regular process of vowel elision). Glosses in each set are 'X (picked okra / bought mushrooms / bought books) for Layẹmi', respectively. The first five syllables contain only sonorants, to eliminate the perturbatory effects of obstruents [7]. The variable X of the HXHY schema is instantiated by a H tone in set A, a M tone in set B, and a L tone in set C, and the variable Y is instantiated by H, M, and L tones in that order in the three sentences of each set. Thus all possible instantiations of the HXHY schema are represented in the data.

These sentences were recorded as part of a larger experimental corpus by two native speakers of standard Yorùbá, TJ (a male in his thirties) and KG (a male in his twenties). Each subject read the full list of randomized, tonally-annotated sentences twelve times. Sentences judged to have been read with incorrect tones were discarded. The remaining sentences were then digitized at a sampling rate of 10 kHz using the Entropics Waves+ software on a SUN Workstation. After further elimination of sentences with incomplete F_0 tracks, ten tokens of each sentence from TJ and nine tokens by KG were retained for analysis.

These sentences are appropriate for testing the Downstep and H Raising rules described above. If speakers apply Downstep at HL junctures, we expect the second H tone (H_2) to be lower than the first (H_1) in the HLHY sentences of set C, but not in the others. If speakers apply H Raising, we expect H tones to be higher in HL sequences than they are in otherwise similar HH and HM sequences. (Furthermore, we expect H Raising to apply twice in the HLHL sequence of example 9, but at most once in other target sequences.)

A further expectation is that all the sentence-initial raised H tones of set C should have about the same F_0 values, regardless of the tonal composition of later portions of the sentence. In particular, the initial H in the HLHL sequence of example 9 should have the same value as the initial Hs in the HLHH or HLHM sequences of examples 7 and 8. This is because neither Downstep nor H Raising, as formulated in current models, access information from later, nonadjacent tones in the tonal string. In other words, we should find no anticipatory long-distance dependencies. Indeed, such non-local access would be theoretically prohibited by the principle of adjacency, which requires that rules can make reference only to elements that are adjacent in the representation [8], if we extend this principle to phonetics.

4. RESULTS

Figure 1 presents the results for TJ in column 1 and for KG in column 2. Graphs (a) and (d) present the data from Set A, graphs (b) and (e) from Set B, and graphs (c) and (f) from Set C. Each graph overlays the averaged F_0 tracks for the three sentences of the given set. Tracks labelled with circles show sentences in which Y=H, those labelled with lozenges show sentences in which Y=M, and those labelled with triangles show sentences in which Y=L. Two F_0 values are given for each syllable, one taken toward the beginning and one toward the end, as indicated on the x-axis.

In Figure 1, realizations of target H tones are assigned alphanumeric labels and boxed for ease of reference. Each H tone followed by a L tone is realized by three F_0 values, two coinciding with the syllable bearing the lexical H tone and one occurring at the beginning of the following L tone syllable, to which the H tone extends by Tone Spread (section 2). These H tone values are labelled a, b, and c. All other H tones are represented by only two values, those labelled a and b.

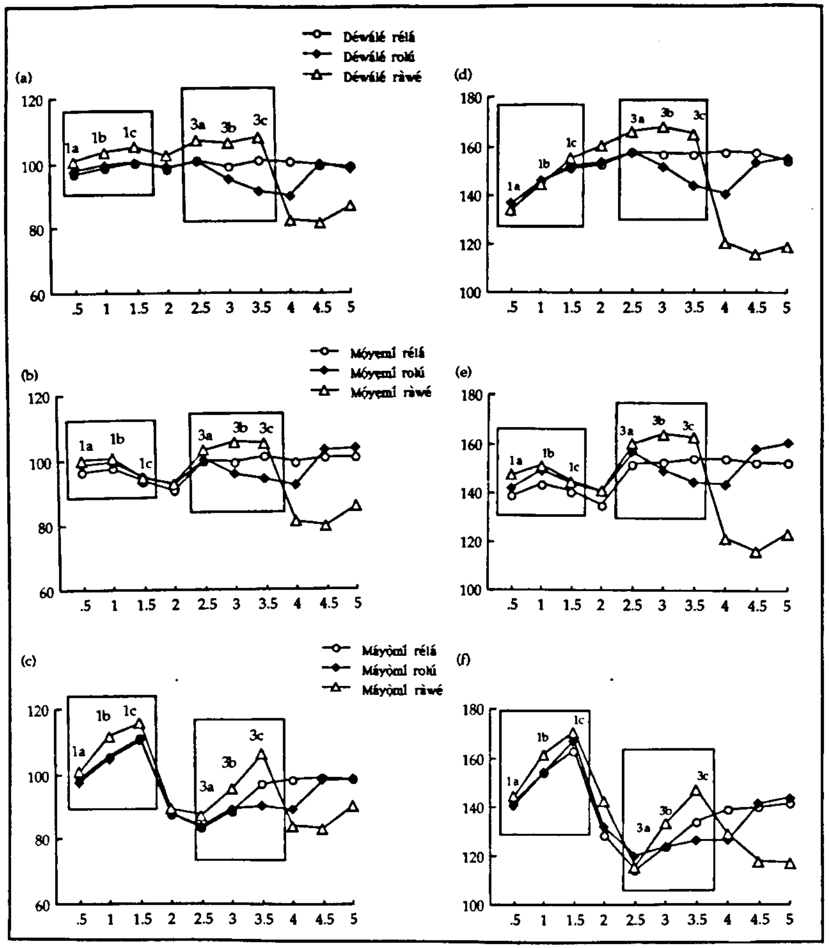

Figure 1. Overlay of F_0 contours of the sentences of sets A, B, and C.

A comparison of all graphs shows that our first two expectations are confirmed. First, we see that H_2 is lower than H_1 in the set C sentences (graphs (c, f)), but nowhere else; indeed, in the other sets H_2 is usually realized at values slightly higher than H_1. This result confirms that Downstep applies across HLH sequences, and cannot be reduced to H Raising.

A second result is that H Raising applies to H tones before L tones, also as expected. This is shown by a comparison of the H_1 values labelled 1a-c in the set C comparable H_1 values in the other graphs. It is also shown by a comparison of the H_2 tracks labelled with triangles in all graphs (representing sentences 3, 6, and 9, in which Y=L) with the other tracks. In all cases, these tracks reach higher F_0 values at points 3b and 3c than do the other tracks; these are, of course, the points that represent a H tone before a L tone.

In contrast, our third expectation is not confirmed, as is shown by an examination of the F_0 tracks in the bottom graphs, (c) and (f). Here the F_0 tracks labelled with

quence of sentence 9, display higher H_1 values than the others (points 1a-c). In other words, the selection of L as the value of Y in the sequence HLHY correlates with higher values of H_1.

As the F_0 differences here are somewhat smaller than the previous ones, we performed a two-way ANOVA to detect possible interactions between tones X and Y and the H_1 values observed at points 1a, 1b, and 1c. The results are shown in Table 1.

	TJ	KG
P-values: point 1a		
X	n.s	n.s
Y	.0140	.0191
X*Y	n.s	n.s
P-values: point 1b		
X	.0001	n.s
Y	.0005	n.s
X*Y	n.s	n.s
P-values: point 1c		
X	.0001	.0001
Y	.0065	n.s
X*Y	n.s	n.s

Table 1. ANOVA results.

P-values under .05 are taken as showing that the null hypothesis—that there was no effect of the identity of tones X and Y on F_0 values at points 1a,b,c—should be rejected. We see that the identity of tone X significantly affected the value of H_1 at point 1c for both speakers, and also at point 1b for TJ, confirming the effect of H Raising. Moreover, it shows that the identity of tone Y significantly affected the value of tone H_1 at point 1a for both speakers, and also at points 1b and 1c for TJ. In other words, the choice Y=L is significantly correlated with the raising of H_1. (There was no significant interaction between tones X and Y.)[1]

5. DISCUSSION

As mentioned earlier, current models of downstep predict that the F_0 value of a sentence-initial raised H tone in sentences like those of set C cannot be affected by the choice of nonadjacent tones to its right. In such models, the anticipatory long-distance dependency observed in sentence 9 can be accounted for only by making explicit reference to nonadjacent tones. Such an analysis would violate the principle of adjacency, and would be quite arbitrary.

This result suggests that "Downstep" and "H Raising" in Yorùbá may be artefacts of an inadequate F_0 interpretation model. In Laniran's 1992 dissertation [4: chs. 5, 6], an alternative view is proposed in which both phenomena are viewed as manifestations of *regressive upstep*. In this view, HL sequences do not trigger downstep (register lowering) to their right, but upstep (register raising) to their left. Since upstep is cumulative, the precessive H tones in a HLHL sequence will be assigned higher values as we scan from right to left. This model has the advantage of accounting for downtrends across HLHL sequences and H Raising before L in terms of a single mechanism, and directly explains the otherwise coincidental fact that both apply only in HL sequences.

ACKNOWLEDGEMENT

We thank John Kingston for helpful guidance on several aspects of this study.

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1 A third speaker examined in the fuller study on which this paper is based [4] showed trends similar to those of TJ and KG, but which failed to reach statistical significance.