TONE, UTTERANCE LENGTH AND F0 SCALING

Bruce Connell
York University, Toronto, Canada

E-mail: bconnell@yorku.ca

ABSTRACT

One important strand of research into the scaling of fundamental frequency has been concerned with the hypothesis that utterance length is a determining factor of initial pitch height, with longer utterances involving a higher initial F0 than that found in shorter utterances. Most work in this vein has been done on 'intonation' languages, with very little investigation having been carried out on tone languages, and the effect utterance length might have on the scaling of tones. This study investigates the relationship between utterance length and tone in Mambila. Previous work revealed that, for sentences comprised of all High tones, or of all Low tones, utterance length in Mambila had no effect on the scaling of either initial or final tones. Here utterances of alternating Hs and Ls are investigated. Results confirm those found earlier, that utterance does not determine the scaling of F0 in Mambila. These results are discussed from the point of view of utterance planning and tonal specification.

1 F0 SCALING AND UTTERANCE LENGTH

Declination is perhaps the area of research into fundamental frequency that has received the greatest amount of attention. Among studies of declination, one strand of research pertains to the effect of utterance length on rate of declination or, alternatively, the scaling of initial F0 peaks. The basic hypothesis in this work is that utterance length is a determining factor of initial (and/or final) pitch height. Longer utterances will involve either a higher initial F0 or a lower final F0 than is found in shorter utterances. The first of these two possibilities, higher initial F0, suggests a 'look-ahead' or preplanning mechanism, by which utterance initial F0 values are raised proportionate to utterance length. The second possibility indicates, rather than preplanning, that adjustment may be made 'on-the-fly', and given that F0 range is finite its bottom may be reached before utterance end. Most work in this vein has been done on non-tone languages and has produced mixed results. One finding has been that initial pitch height does increase with sentence length [1, 2], while others have found no such increase [3, 4]. Ladd & Johnson [5], however, propose that constituent structure and related metrical factors, rather than utterance length, have the greatest effect on the scaling of utterance initial F0, and argue that the mixed results found across other studies have to do with the failure to control for such factors.

2 F0 SCALING AND UTTERANCE LENGTH IN TONE LANGUAGES

Very little investigation of this issue has been carried out on tone languages, though they provide an obvious test bed for such hypotheses. Interestingly, the only two known studies on tone languages done from this perspective also offer contradictory findings. Snider [6] for Chumburung reports the height of initial High, but not Low tones in Chumburung to be positively correlated with utterance length, and argues that speakers operate with initial and final F0 targets in mind for L, while for H only a final F0 target is necessary. Lindau [7] found no such effect on initial Highs in Hausa (with the methodology Lindau used it was not possible to investigate Low tone in Hausa with natural sentences). However, despite the difference in results, like Snider, she assumes fixed targets,

ISBN 1-876346-48-5

or anchors, for initial tones, but that in Hausa it applies also to initial Hs. Both final Hs and Ls in Hausa showed more variability, though Lindau doesn't relate this directly to utterance length. Both Chumburung and Hausa have only two tones, and both show a degree of declination across the duration of utterances regardless of tonal structure.

3 F0 SCALING AND UTTERANCE LENGTH IN MAMBILA

The present study examines Mambila, a Bantoid language spoken in the Nigeria-Cameroon borderland. Mambila has four level lexical tones High (H), Upper Mid (UM), Lower Mid (LM), and Low (L); previous work on tone in Mambila [8, 9, 10, 11] has shown that declination (in like-tone sequences) only reliably occurs with L. Preliminary work on F0 scaling in Mambila is reported in [11]. This work showed no correlation between the height of F0 and utterance length for either H or L tones. The present study continues this strand or research, testing this hypothesis that utterance length can effect initial F0 in another environment in Mambila where a downtrend is found, in this downdrift in sentences with alternating H and L tones. Downdrift differs from declination in that it is a cumulative result of a local interaction, while declination is considered to be a global effect. A correlation between initial F0 and utterance length here would provide strong evidence for preplanning in sentence production.

3.1 METHODOLOGY

Five adult native speakers of Mambila, three male and two female, participated in the study. For the purpose of this investigation, sentences with alternating H and L tones of three different lengths, Short (four syllables, i.e. HLHL), Medium (6 syllables, HLHLHL) and Long (8 syllables, HLHLHLHL) were compared. Additionally, two sentences with the opposite sequence, LH, one of 4 syllables (LHLH) and one of 8 syllables (LHLHLHLH) were examined. These formed part of a larger study which also included sentences of different tonal patterns. Mambila syllable structure is simple, essentially either CV or CVC, with no clusters in either onset or coda, hence number of syllables is considered a valid measure of utterance length. The speakers recorded a minimum of five repetitions of the entire list using two randomizations. For the recording speakers were fitted with a laryngograph (electroglottograph) collar, the signal from which was fed into one channel of a stereo digital recorder, while the audio signal was collected in the other channel. Pitch extraction and measurements were done using the Macquirer signal processing package (SciconRD). An analysis of variance was run to test for differences in F0 of initial H tones, initial Ls, final Hs and final Ls for the three different HL sentence lengths and the two LH sentence lengths. Male and female speakers are evaluated separately.

3.2 RESULTS

3.2.1 HL Sequences

Table 1 gives means and standard deviations for F0 of the first two syllables of the H–L sentences, and the results of the ANOVA. It may be noted that for both male and female speakers, initial H is raised in the longer utterance, though the difference is very slight and is not significant. The same is true of initial L for the male speakers, while no difference at all is found in this case for the females. These results suggest that utterance length doesn't influence the initial F0 values for either H or L tones.

	Male	
Mean	*Initial H*	*Initial L*
S	143.8 (17.6)	99.9 (10.8)
M	144.3 (18.2)	99.8 (8.8)
L	145.0 (19.7)	101.7 (7.7)
Stats	F (2, 54) = 0.020; p = 0.980, ns	F (2, 54) = 0.092; p = 0.912, ns

	Female	
Mean	*Initial H*	*Initial L*
S	227.3 (27.3)	173.6 (21.6)
M	226.2 (29.3)	173.9 (20.0)
L	229.4 (27.1)	173.9 (20.6)
Stats	F (2, 27) = 0.034; p = 0.967, ns	F (2, 28) = 0.001; p = 0.999, ns

Table 1: Means, standard deviations and statistical results of F0 for the first two syllables of Mambila High–Low utterances for three different sentence lengths, Short, Medium and Long.

ISBN 1-876346-48-5

Table 2 presents results for final H and L for each of the three sentence lengths. In this case, were utterance length to be exerting an influence on F0 scaling, a lower value for each tone would be expected in the longer utterances. In fact, the opposite tendency may be observed in some cases though; indeed, for the female speakers differences between final L for the three sentence lengths are marginally significant, though they run counter to the expectation that the longer the utterance the lower final F0 should be. Other differences across lengths are slight, and none were found to be significant for either group of speakers, again indicating that utterance length does not effect final values of H and L tones.

	Male	
Mean	*Final H*	*Final L*
S	136.7 (17.5)	94.0 (5.7)
M	137.7 (20.1)	93.3 (7.6)
L	138.9 (18.2)	92.7 (6.2)
Stats	F (2, 54) = 0.067; p = 0.935, ns	F (2, 54) = 0.190; p = 0.828, ns

	Female	
Mean	*Final H*	*Final L*
S	219.3 (26.0)	162.6 (8.9)
M	222.6 (29.7)	166.2 (8.5)
L	221.7 (32.1)	173.4 (10.5)
Stats	F (2, 27) = 0.034; p = 0.967, ns	F (2, 27) = 3.483; p = 0.045

Table 2: Means, standard deviations and statistical results of F0 for the final two syllables of Mambila High–Low utterances for three different sentence lengths, Short, Medium and Long.

3.2.2. LH Sequences

Only two different utterance lengths were included for LH tone sequences. Statistical analyses of beginning and endpoints were done using the same procedure as used for the HL sequences. Table 3 gives values for initial Ls and Hs in this sequence. It can be observed that for the longer utterance, both tones start at a higher level than in the shorter sentence, for both males and females, though in no case is the difference significant.

	Male	
	Initial L	*Initial H*
S	100.8 (9.6)	140.9 (20.5)
L	105.0 (12.2)	153.5 (23.9)
Stats	F (1, 34) = 1.704; p = 0.20 (ns)	F (1, 34) = 2.854; p = 0.10 (ns)

	Female	
	Initial L	*Initial H*
S	159.6 (12.2)	228.1 (27..2)
L	164.9 (15.3)	235.5 (31.0)
Stats	F (1, 18) = 0.732; p = 0.403 (ns)	F (1, 18) = 0.302; p = 0.590 (ns)

Table 3: Means, standard deviations and statistical results of F0 for the first two syllables of Mambila L–H utterances for two sentence lengths, Short and Long.

Table 4 presents results for final Ls and Hs in the LH sequence sentences. In this case the difference between final Hs for the female speakers is in the right direction, i.e. the longer utterance shows a lower final value, but even so the difference is not significant.

	Male	
	Final L	*Final H*
S	98.9 (9.9)	133.9 (21.3)
L	98.3 (11.1)	137.1 (26.9)
Stats	F (1, 34) = 0.31; p = 0.861 (ns)	F (1, 34) = 0.146; p = 0.705 (ns)

	Female	
	Final L	*Final H*
S	158.4 (10.6)	212.8 (30.9)
L	158.3 (7.7)	204.2 (26.9)
Stats	F (1, 18) = 0.001; p = 0.981 (ns)	F (1, 18) = 0.440; p = 0.515 (ns)

Table 4: Means, standard deviations and statistical results of F0 for the final two syllables of Mambila L–H utterances for two sentence lengths, Short and Long.

4 DISCUSSION

The results presented above, combined with earlier results reported for like-tone sequences in Mambila [11] indicate that for Mambila speakers, utterance length does not play a role in determining either the beginning or the end point F0 of High or Low tone utterances in their language. The

ISBN 1-876346-48-5

failure to find a correlation between initial or final pitch height in Mambila tones and length of utterance is interesting. It concurs, first, with Snider's [6] results for Low tone in Chumburung, a typical two tone language, but not his findings for High, which did present a higher initial F0 according to utterance length. The present results also agree with Lindau's [7] findings for Hausa. There are a number of possible explanations for these findings. First, one might argue that for L to increase in F0 would risk allowing it to overlap with the tone above – Lower-Mid in Mambila or High in Chumburung – thereby creating a situation of potential ambiguity. A constraint to inhibit this need not necessarily apply to initial High, which would be free to rise in order to accommodate declination in a longer utterance where endpoints are specified. This may be the case in Chumburung. In Mambila, however, H is no more free to rise than L, and a different solution must be sought. An alternative suggestion, similar to what was proposed by Snider for Chumburung L, and Lindau for initial H in Hausa, that both start and end points are specified or act as anchors, is that F0 values for individual tones in Mambila are fairly narrowly specified, making for a rather tightly constrained system. This differs from Snider and Lindau in that their proposals appear to relate the invariability of initial and/or final tones to sentence or phrasal specifications, rather than tonal specifications. More generally, however, there is agreement in the work on tone languages since, unlike the scenario envisaged by, e.g. Cooper & Sorenson [1], declination rate in these languages is not fixed or predetermined, but may be seen as a byproduct of tonal or other considerations. Finally, I return to the question of preplanning. It was mentioned at the outset that one implication of a correlation between utterance length and F0 scaling is that preplanning exists, while the failure to find a correlation might indicate otherwise, planning done 'on-the-fly'. The present results, while they don't find finding a correlation between utterance length and F0 scaling, nevertheless don't lead us to a rejection of preplanning. Rather, they show that other events or aspects of speech production may take greater priority than declination.

REFERENCES

[1] W. Cooper and J. Sorenson, *Fundamental Frequency in Sentence Production*. Heidelberg: Springer, 1981.

[2] J. 't Hart "Explorations in automatic stylization of F0 curves," *IPO Annual Progress Report,* 14, pp. 61–65, 1979.

[3] M. Liberman and J. Pierrehumbert, "Intonational invariance under changes in pitch range and length," in *Language and Sound Structure,* M. Aronoff and R. Oehrle, Eds., pp. 157–233. Cambridge MA: MIT, 1984.

[4] N. Thorsen, "Intonation patterns and stress group patterns in declarative sentences of varying length in ASC Danish," *Annual Report of the Institute of Phonetics, University of Copenhagen*, vol. 14, pp. 1–29, 1980.

[5] D. R. Ladd and C. Johnson, "'Metrical' factors in the scaling of sentence-initial accent peaks," *Phonetica*, vol. 44, pp. 238–245, 1987

[6] K. Snider "Tone and utterance length in Chumburung: An instrumental study," paper presented at the 28th Colloquium on African Languages and Linguistics, Leiden, 1998.

[7] M. Lindau, "Testing a model of intonation in a tone language," *Journal of the Acoustical Society of America*, vol. 80, pp. 757–764, 1986.

[8] B. Connell, "Four tones and downtrend: a preliminary report on pitch realization in Mambila," in *New Dimensions in African Linguistics and Languages. Trends in African Linguistics, Vol. 3*, P. F. A. Kotey, Ed., pp. 75–88, Trenton, NJ: Africa World Press, 1999a.

[9] B. Connell, "Mid tone downtrends in Mambila," Paper presented to the 7th Manchester Phonology Meeting 1999b.

[10] B. Connell, "Downdrift, downstep and declination," In *Typology of African Prosodic Systems*, U. Gut and D. Gibbon, Eds., pp. 3–12, Bielefeld: University of Bielefeld, 2002.

[11] B. Connell "Pitch realization and the four tones of Mambila," in *Cross-Linguistic Studies of Tonal Phenomena,* S. Kaji, Ed., Tokyo: Research Institute for the Language and Cultures of Asia and Africa, in press.

ISBN 1-876346-48-5