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UNIVERSALS OF DOWNDRIFT: THEIR PHONETIC BASIS AND SIGNIFICANCE FOR A THEORY OF TONE

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0. Introduction

In this paper[1] I shall be concerned with three closely related issues concerning the phenomenon of downdrift: 1) the phonetic nature of downdrift (that is, is it an articulatorily based phenomenon or does it have a perceptual explanation?); 2) why does downdrift occur in certain African languages but not in other closely related languages? 3) what is the interaction between downdrift and tonal contrasts, and ultimately how can one be derived from the other? It will be shown that downdrift is the unmarked intonational pattern but that this intonational phenomenon can be blocked when it threatens to obscure a phonemic tonal contrast.[2]

1. What is downdrift?

Briefly stated, the more common use of the term downdrift[3] is with

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[1]I would like to express my deep gratitude to my informants for their great patience and willingness to subject their linguistic knowledge to my investigation: J. Ntangsi (Babanke), M. E. Ngomba-Westbrook (Bakwiri), M. Tadadjeu (Dschang), S. Abubakar and D. Bagari (Hausa), N. Cukwu (Igbo), S. Jackson (Kru), B. Marasha (Shona), A. Falade (Yoruba). I would also like to thank W. Leben and B. Elimelech for helping me with the Hausa and Kru word-lists respectively, J. Ohala for comments on mechanisms involved in the control of pitch, and L. Hyman for working closely with me throughout what has been a joint on-going study on the phonetics and phonology of downdrift, downstep and tonological theory.

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[2]In this paper I will not be concerned with the formalization of downdrift. For recent proposals consult the bibliography in Fromkin [1972], as well as Peters [1973].

[3]In fact different terminologies are used. The phenomenon I am referring to as downdrift is also called automatic downstep [Stewart 1965] in

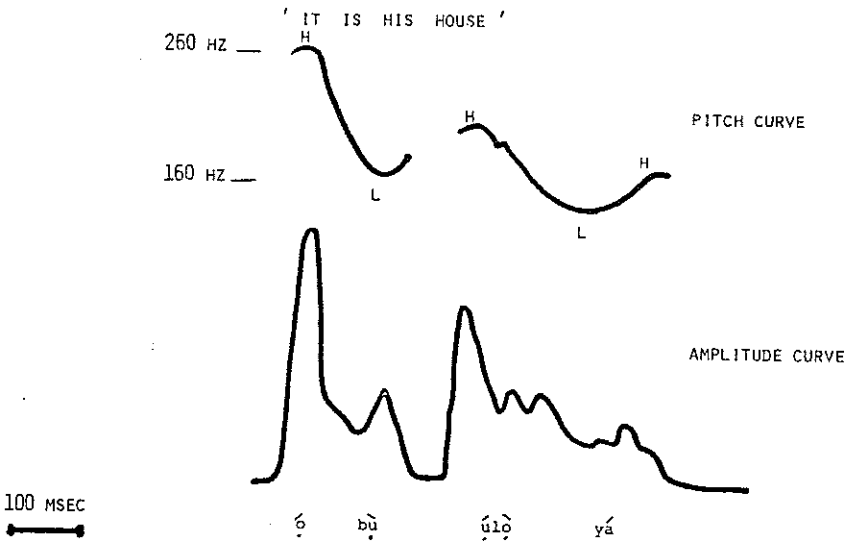

FIG 1. DOWNDRIFT IN IGBO (SEQUENCE H-L-H-L-H)

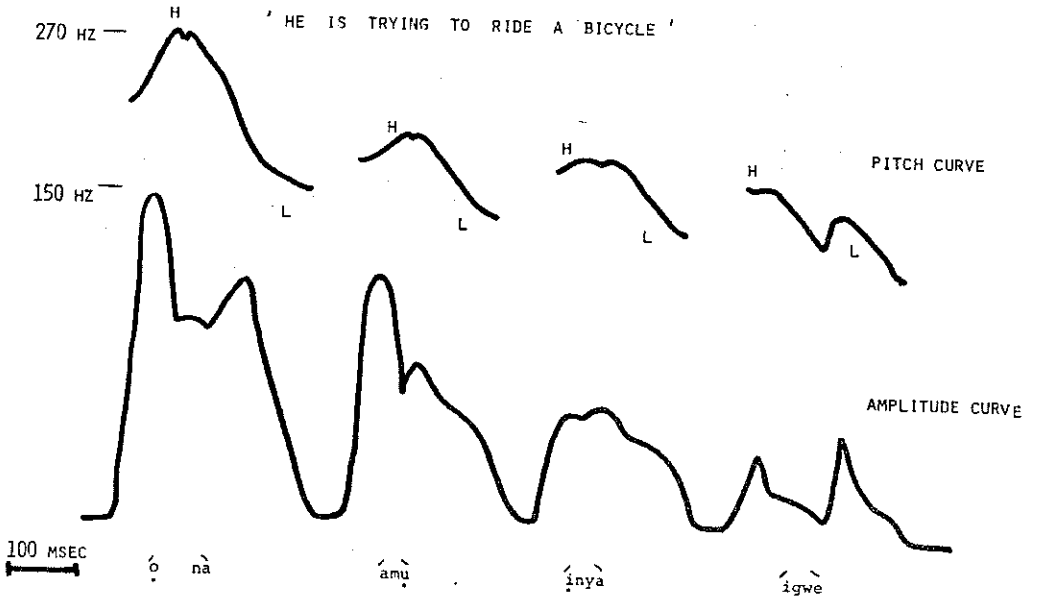

FIG 2. DOWNDRIFT IN IGBO (H-L-H-L-H-L-H-L)

reference to the progressive lowering of a high tone after a low tone.[4] A H-L-H sequence is thus realized as in (1a), rather than as in (1b):

(1a) / ¯ _ ¯ / → [¯ _ —]

(1b) / ¯ _ ¯ / → [¯ _ ¯]

If the sentence is longer, the difference between each identical tone (i.e. alternating lows or alternating highs) is smaller than in the case of a smaller utterance (compare figures 1 and 2). This difference between a short and a long utterance is caused by the fact that each speaker has physiological constraints as far as his pitch range is concerned, and consequently cannot maintain indefinitely the same interval of pitch lowering.

Two characteristics of downdrift which are generally assumed by tonologists are its assimilatory nature and its intonational nature. By vertical assimilation [Hyman 1973a] the high tone of a L-H sequence such as (2a) is lowered, as in (2b); the low tone may be raised[5] as seen in (2c):

(2) (a) (b) (c)
/ _ ¯ / → [_ ¯] → [— ¯]

Although this vertical assimilation is a possible explanation for downdrift, two facts reveal that this is only a partial explanation. First, although vertical assimilation could account for a change from L-H-L-H to L-M-L-M, as in (3a), it does not explain why the intervening lows

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opposition to a non-automatic downstep, also called (phonemic) downstep, which refers to a lowered high tone which contrasts with a non-lowered high. Stewart [1971] relates these two phenomena with downglide (lowering of a low in syllable final position).

[4]The tone marks used in this paper are as follows:

High tone	[¯]	H
Downstepped-High	[—]	'H }
Mid tone	[—]	M } = same phonetic pitch
Low tone	[_]	L
Downstepped Low	[_]	'L
Downglided Low	[¬]	L'

In a tone language, relative pitch is much more important than absolute pitch; consequently the second column showing the phonetic realization of pitch is only given for reference.

[5]It is even sometimes realized as mid tone (see Hyman [1972, 1973a]).

downdrift[6] as can be seen in (3b):

(3a) /_ ¯ _ ¯ / → [_ — _ —]

(3b) /_ ¯ _ ¯ / → [_ — _ _]

Secondly, it does not explain why a H-L sequence, as opposed to a L-H sequence, is not subject to vertical assimilation. Why does downdrift reduce the interval between a low tone and the following high as in (4a), and not reduce the interval between a high and the following low as in (4b):

(4a) /_ ¯ / → [_ —]

(4b) / ¯ _ / → [¯ _]

Is it an arbitrary choice for assimilation to operate on L-H rather than H-L? Apparently not.

In a study of speed of pitch change, Ohala and Ewan [1972] showed that for a given interval it takes more time (and consequently maybe more effort) to go up than to go down in pitch. It thus appears that articulatory ease conditions the reduction of the pitch interval in L-H sequences rather than in H-L sequences, where less effort is required.

Stewart [1971] points out that a low in utterance final position normally involves a falling contour (i.e. [¬]), a process which he terms downglide. He argues that a low tone should be analysed as involving such a downglide, but that this downglide is wiped out in all positions except utterance finally. Consider the following diagram:

(5) H L H

¯ ⋮ d_1 ⋮ ¯ $d_1 = d_2$
¬ ⋮ d_2

Because of the falling nature of the low tone, the distance between the level of the high tone and the beginning of the low will be the same as the distance between the end point of the low and the level of the following high. In other words, $d_1 = d_2$ on our diagram.

A more widely accepted claim assigns to downdrift an intonational function, since it is used only in certain sentence types (for instance, statements), but not in others (for instance, questions); cf. Schachter [1965]. This is quite correct as can be seen from figure 3, where the same sentence used both in statement and question form is presented from Hausa.

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[6]For the rest of this paper I will use the term downdrift to refer to the lowering of like tones (consecutive or not).

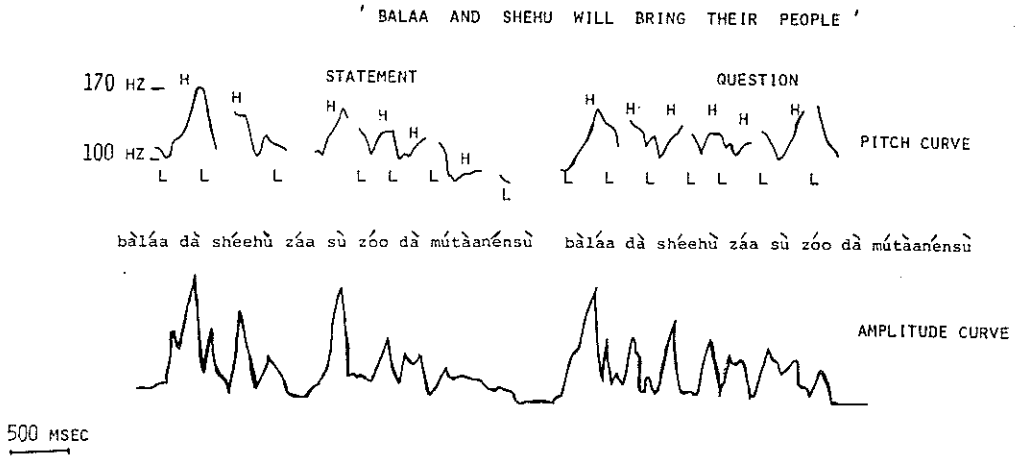

FIG 3. INTONATIONAL NATURE OF DOWNDRIFT (HAUSA QUESTION)

However, simply stating that downdrift is purely an intonational phenomenon is not very interesting in itself if we do not address ourselves to the more important questions raised at the outset of this paper. But before answering those questions, let us first look at the factors involved in the regulation of pitch.

Fundamental frequency, the physical correlate of pitch, is essentially controlled by two factors, the aerodynamic forces and the muscular activity of the larynx. In order to explain the gradual lowering of pitch range associated with downdrift we have to assume that either the subglottal pressure decreases progressively as the sentence proceeds or that something happens in the muscular activity of the larynx (caused either by a lack of active control leading to a lowering of pitch or by an active lowering). First, because data presented by Lieberman [1967, 1970] are not very conclusive,[7] and secondly because a progressive change in muscular activity seems to be unmotivated, I should admit that I have not been able to propose an articulatorily based explanation to account for the intonational nature of downdrift. But, nevertheless, I will provide evidence in a moment showing that this natural lowering process is not always found. In other words, I am suggesting that a natural assimilatory process can be blocked when it threatens to create a perceptual confusion.

[7]The lowering of subglottal pressure is not progressive at all. In fact, it happens only very shortly before the end of the utterance (breath group).

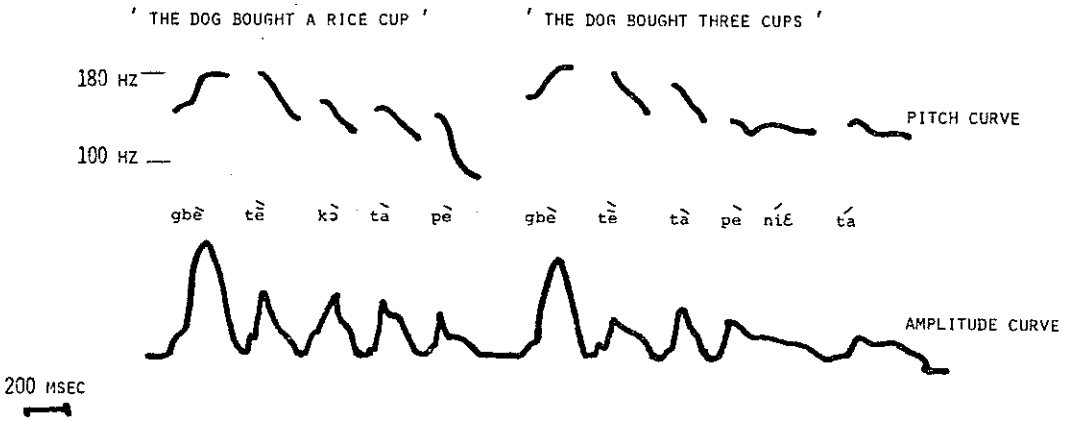

FIG 4. SEQUENCES OF LOWS IN KRU

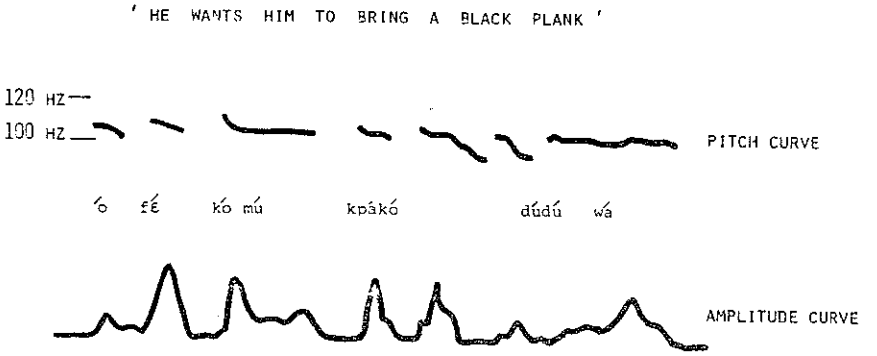

FIG 5. SEQUENCES OF HIGHS IN YORUBA

2. Properties of downdrift

Let us examine what characteristic manifestations have been reported for languages having downdrift. It is generally admitted that in such languages successive lows do downdrift (see figure 4), but successive highs do not (see figure 5). Two remarks should be made from these observations.

First, a possible assumption to account for these different behaviors of sequences of identical tones (lows vs. highs) would be to claim that a different mechanism is involved in controlling a high (vs. low) fundamental frequency (assuming, for instance, that the higher tension involved in the realization of a higher pitch would play a significant role). This possibility is ruled out by the fact that in a pitch-accent language such as Japanese, highs in sequence do lower [Weitzman 1969; Han 1962]. Consequently it does not seem that the fact that highs in sequence stay level should be explained in terms of articulatory constraints.

Second, since a sequence of highs remain on an even high pitch level, while a sequence of lows is realized as a falling contour, it may be possible to view the descending low tones of a H-L-H-L-H-L sequence as a cause of the downdrift of highs.

However, there is more involved in downdrift than lows staying at their "normal" intonational place and pulling highs down. For instance, it seems universal among languages having downdrift that alternating highs lower faster than alternating lows in a L-H-L-H... sequence. In a language like Igbo, alternating low tones lower very slowly in comparison with consecutive lows in L-L-L... sequences. This suggests that in this case at least we have to assume that the high tones also have an assimilatory influence (namely a raising effect) on the preceding low.

It was assumed for a long time that downstep could not occur without downdrift. This was largely the result of a restricted familiarity with African tone systems at that time. A similar ignorance seems to have led to the generalization that languages which have downdrift realize consecutive high tones as in (6a), but consecutive low tones as in (6b):

(6a) H-H-H-H-H [‾ ‾ ‾ ‾ ‾]
(6b) L-L-L-L-L [_ _ _ _ _]

In fact, counterexamples to both of these manifestations can be found. As can be seen in figure 6, consecutive high tones do lower in Shona. We saw earlier that this was not true in the case of Yoruba (cf. La Velle [1974]) and I could have presented similar findings for languages such as Igbo which have both downdrift and downstep.

A perceptual explanation accounts for these different behaviors in a rather straightforward manner. That is, in Shona, a high tone can be realized with a lower pitch than the immediately preceding high since

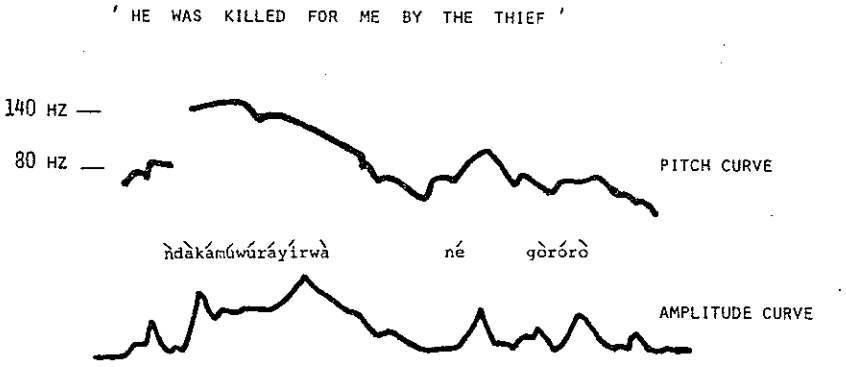

FIG 6. SEQUENCES OF HIGHS IN SHONA

Shona does not have a mid tone (like Yoruba) or a downstepped high (like Igbo)[8] to create a perceptual confusion in that position.

Before attributing any validity to this perceptually oriented account of lowering vs. non-lowering of consecutive high tones, I would like to show that the same explanation holds to account for the lowering vs. non-lowering of consecutive low tones.

As I mentioned earlier, it is generally admitted that sequences of consecutive lows do lower, but it has been considered as such a low level phonetic process that very often linguists do not even mention this fact. This phenomenon becomes much more interesting in the light of our basic assumption about the nature and the occurrence of downdrift; namely that downdrift is the unmarked intonational pattern always present unless blocked for constrastive purposes.

Pursuing this line of thought, if the lowering of successive low tones is the expected intonational pattern, we should be able to find languages where such a lowering is blocked in order to avoid confusion between low and downstepped low. If this question has not been raised before, it is mainly because languages having such a contrast (between low and downstepped low) were not attested. Dschang dialect of Bamileke [Tadadjeu 1974] has four lexical tones: High, Downstepped-high, Low and Low with downglide. These four possibilities can occur after low tone as illustrated in figure 7. There is a fifth possibility since Low-Low contrasts

[8] There is, however, an automatic lowering of a High when the syllable begins with a "depressor" consonant.

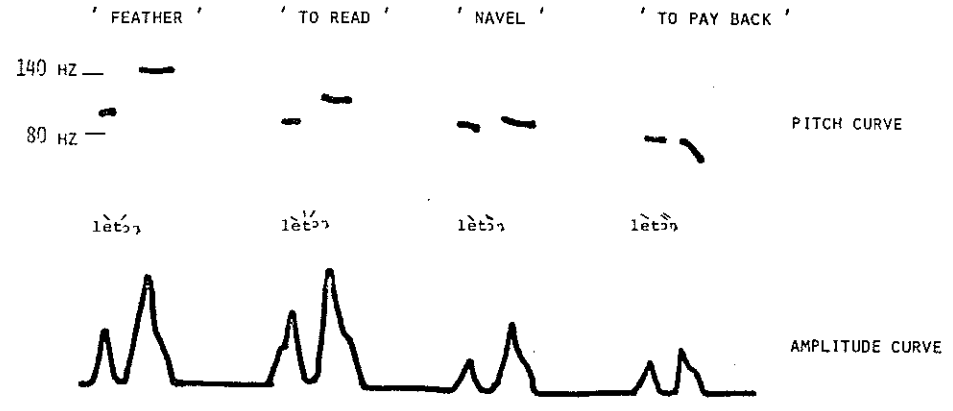

FIG 7. THE FOUR LEXICAL TONES OF DSCHANG

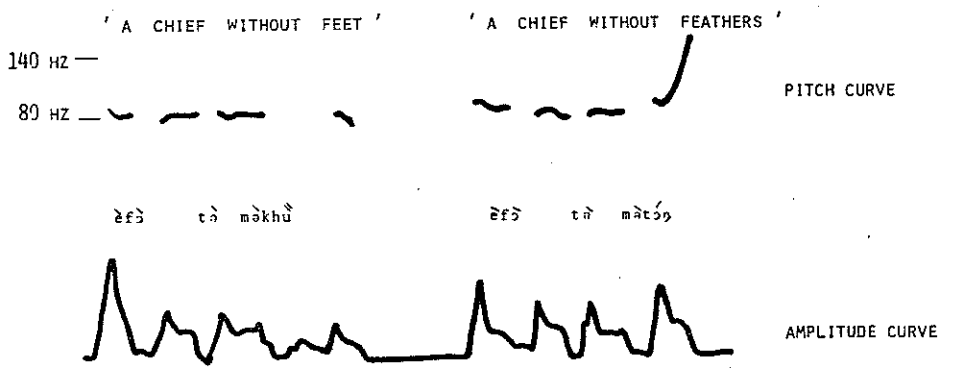

FIG 8. SEQUENCES OF LOWS IN DSCHANG

with Low-Downstepped Low (i.e. [_ _] vs. [_ _]). In order to preserve this contrast a sequence of consecutive lows should not lower. In fact this is exactly what happens in Dschang, as can be seen in figure 8 (the second utterance is presented in order to show the pitch range used by the speaker).[9] Needless to say, sequences of high tones do not lower in Dschang, so as to preserve the contrast between H-H and H-'H as in the case of Igbo-like languages. Also, downdrift does not occur in L-H-L-H sequences, in order to preserve the contrast between L-H and L-'H.

At this point, it is quite relevant to draw a comparison between downdrift and nasalization. We know that if nasalization is not contrastive in a given language, a vowel will get some degree of nasalization when followed by a nasal consonant; the phonetic explanation for this is quite simple--namely, for anticipatory reasons, the soft palate starts lowering before the onset of the nasal consonant and consequently altering the oral quality of the vowel. This anticipatory lowering of the soft palate does not occur, or at least occurs to a lesser extent, in languages with a contrast between oral and nasalized vowels [Clumeck 1974]. It seems reasonable to assume that, in this case, the anticipatory movement is blocked in order to avoid obscuring the nasalization contrast on the vowel preceding the nasal consonant. This process is identical to what I am suggesting for downdrift.

Downdrift is a natural, unmarked intonation with an ultimate but as yet unknown articulatory motivation. But this process can be blocked when it threatens to obscure a tonal contrast.

3. Downdrift and tone systems

In this paper I have used information from tone systems to explain downdrift; it is obvious that the more accurate data we have from various languages, the more we will be able to make generalizations with regard to the relationship between the phonological status of a given tone system and the form that downdrift takes in this language. And conversely, we may be able to make valuable predictions on the tone system only by observations from downdrift. In other words, I have shown that it was possible to make predictions about the restrictions imposed on the "normal", unmarked realization of downdrift just by considering the tone system itself. I am now suggesting that it is possible to make predictions in the opposite direction--that is, gaining insight into the tone system by observations of the restrictions imposed on certain particular tone sequences.

I propose that the manifestations of downdrift should be checked in three different kinds of sequences: L-L-L..., H-H-H..., and H-L-H.... From these three criteria, eight categories can be differentiated as

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[9] A Low-High sequence can be realized as Low-Rising in utterance final position.

shown in Table A. It should be pointed out that there are more possibilities than those presented in Table A, because the blocking of the downdrift of consecutive Highs can be due to the existence of Downstepped-high or Mid. An important question which has not been raised yet deals with the choice of a criterion allowing us to decide whether we have downdrift or not; in other words, how do we decide whether two tones are identical or different? We are back to the problem of tone perception, and as I said earlier, data are badly needed in this area. Although experimental work has shown that under laboratory conditions subjects can differentiate tones less than one cycle per second apart [Flanagan and Saslow 1958], this is obviously not realistic for speech under normal conditions. I suggest that tones should be at least ten cycles per second (10 Hz) apart, for an average male voice, in order to have a different phonemic status.

H-H-H	L-L-L	H-L-H	'OLD TERMINOLOGY'	POSSIBLE CONTRASTS	LANGUAGES
0	0	0	DS	A,B,C	DSCHANG
0	0	1	DD, DS	A,B	NOT ATTESTED
0	1	0	DS, M	A,C	YORUBA
0	1	1	DS,DD	A	IGBO
1	0	0		B,C	NOT ATTESTED
1	0	1	DD	B	NOT ATTESTED
1	1	0			IMPOSSIBLE
1	1	1	DD		HAUSA, SHONA

1 = DOWNDRIFT 0 = NO DOWNDRIFT DS = DOWNSTEP DD = DOWNDRIFT M = MID TONE

A = CONTRAST H-H VS. H-'H OR H-M B = L-L VS. L-'L C = L-H VS. L-'H OR L-M

TABLE A. RELATIONSHIP BETWEEN DOWNDRIFT AND TONE SYSTEM

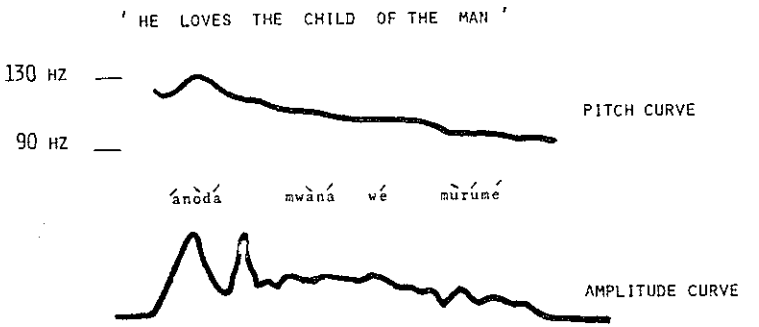

FIG 9. DOWNDRIFT IN SHONA

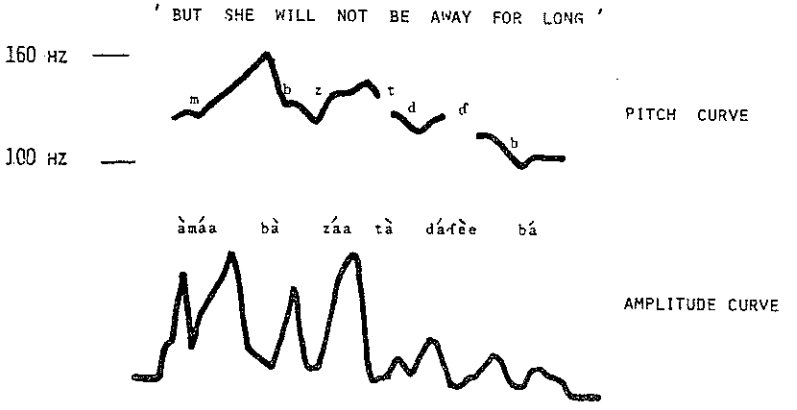

FIG 10. CONSONANT TYPES AND TONE (HAUSA)

4. Downdrift and related phenomena

By looking at downdrift I came across two phenomena which can have both phonetic and phonological interest. The first phenomenon has to do with the process sometimes referred to as tonoexodus [Lea 1973], a process by which a language can lose its tones. In Shona where lexical tone has a low functional yield, a L-H-L-H... sequence can be realized as in figure 9 if the intervening consonants are carefully chosen (sonorants in this case). This suggests that tonal contrasts are becoming less and less important and that it may be that Shona is on its way to becoming a stress language (cf. Swahili). It is interesting to note that Shona stress is realized in penultimate position with extra length, extra loudness and sometimes extra pitch change on the affected vowel.

The second phenomenon has to do with consonant types. It is not generally admitted that consonant types can influence downdrift; in fact as can be seen in figure 10, a H-L-H... sequence can be realized in a quite unexpected way if the intervening consonants are appropriately chosen (voiceless consonant between High and Low, voiced between Low and High). In this case the low tone will be realized as a falling tone and the next high will not be higher than the end point of the low tone. The only important difference is that the high tone will be level as opposed to the falling contour of the low tone. Thus, Meyer's [1974] notion of "high tone destruction", a term she uses to describe this latter state of affairs, is inappropriate unless it is recognized that the important perceptual cue of a non-low tone is the lack of such a fall. Of course, too little is known about tone perception at this time to be able to draw any further conclusions from these still restricted observations.

5. Conclusion

An increasing number of linguists agree that phoneticians and phonologists should work in closer proximity than they have in the past. I hope I have shown in this paper that more than just an agreement is involved if we want to attribute a real explanatory power to phonology. In order to be able to propose true explanatory solutions to phonological problems, phonologists should be ready to get their hands dirty in the field as well as in the laboratory. As Lehiste [1970] puts it, "A phonologist ignores phonetics at his own peril". In this paper we have seen that phonetic tendencies can be counteracted by phonological considerations. Thus, to Lehiste's statement it seems appropriate to add, "A phonetician ignores phonology at his own peril".

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