UCLA
Working Papers in Phonetics

**Title**
WPP, No. 27: The Tone Tome. Studies on Tone from the UCLA Tone Project

**Permalink**
https://escholarship.org/uc/item/3st6f4rg

**Publication Date**
1974-09-01

eScholarship.org Powered by the California Digital Library
University of California

Victoria A. Fromkin

# Studies on tone from the UCLA Tone Project

THE TONE TOME

UCLA

Working Papers in Phonetics 27

September 1974

# The Tone Tome.

*Studies on tone from the UCLA Tone Project.*

Edited by Ian Maddieson.

*Working Papers in Phonetics 27*

September 1974

University of California, Los Angeles.

*UCLA Working Papers in Phonetics 27*

September, 1974

# Preface

The UCLA Tone Project is a continuation of the work of the UCLA Phonetics Laboratory on linguistic phonetics. The goals of this project are to investigate 1) the phonological and phonetic aspects of tonal phenomena, and 2) respiratory and laryngeal control of speech, particularly as related to phonology (both 'segmental' and 'suprasegmental'). The project is funded by the National Science Foundation through NSF grant GS 37235X. This grant has supported work by the two principal investigators, Victoria A. Fromkin and Peter Ladefoged, by research linguist Ian Maddieson and by Jack Gandour, Laura Meyers and Joy Chuck during the year 1973/4. We have also welcomed Baruch Elimelech, Carl LaVelle, William Welmers, Karen Courtenay, Diana Van Lancker, Dauda Bagari, Roger Remington, Richard Harshman, Louis Goldstein and other co-workers at our weekly meetings and have had the support of the Department of Linguistics, and the advice and assistance of Willie Martin, Ron Carlson and Lloyd Rice in the laboratory. The papers in this volume represent some of the product of this collaboration. As always, appearance in *Working Papers in Phonetics* is in the nature of a record for our internal use, a report to funding agencies and a preliminary public account of work in progress. Work is continuing on aspects of the phonology and phonetics of tone and on the larynx, and further contributions from the Tone Project to *Working Papers* are anticipated.


## Acknowledgements

This volume has been typed by Joan Hayden and Renee Wellin. The editor is grateful for their care and patience, and thanks the contributors for putting their papers in shape. The catchpenny title was suggested by Martin Mould, to whom we are appropriately grateful.

Ian Maddieson.



Correspondence concerning Working Papers in Phonetics should be addressed to:

Professor Peter Ladefoged,
Phonetics Laboratory
UCLA,
Los Angeles, California 90024.



Additional copies of this volume may be obtained for $5.25 from the above address.

# *On the Phonological Representation of Tone*

Victoria A. Fromkin

[Paper presented at the 11th Congress of West African

Languages — Yaoundé, Cameroons, April 1-5, 1974]

A major goal for linguistic theory is to define the notion 'possible human language'. No matter what our theoretical bent, we will probably all agree that a particular language is in a general sense a system which relates sounds and meanings. In a formal sense this system may be regarded as the grammar of the language. We are therefore aiming at a theory of possible grammars. Clearly such a theory must define in a formal and substantive fashion that part of the grammar which concerns the sounds and sound patterns of human language. There is no a priori way of deciding what such sound systems will be. There is, for example, no logical reason why we should find that in most of the languages of the world pitch differences can distinguish meanings. But in fact we know that this is the case. In fact, there is no language in which pitch plays no role. This led Beach to conclude that all languages are tone languages since he believed that any language which uses pitch contrastively in any manner is a tone language.

But such a definition of a tone language does not constrain the theory of grammars sufficiently -- it makes no predictions as to how pitch can function grammatically. It is similar to a definition of language which

---

The paper was written for oral presentation at the conference. Phrasing more appropriate to spoken delivery has been allowed to stand in this version. Any ideas of merit in this paper are as the result of the discussions, research, and insights provided by the 'tone group' at UCLA: Peter Ladefoged, Ian Maddieson, Jack Gandour, Laura Meyers, Joy Chuck, Carl LaVelle, and Baruch Elimelech. I would also like to thank Larry Hyman for his invaluable contributions to my understanding. My acknowledgement to their help does not imply that they agree with my ideas, nor that they are responsible for any weaknesses or errors in this paper. The research on this paper was supported by the NSF Grant#GS 37235X and the NIH Grant#UHPHS NS 9780.

states that all languages utilize sounds produced by the upper respiratory tract. It fails to make explicit the extent to which the sound systems of languages may differ, and the kinds of differences which are 'permissible'.

Since all languages use pitch contrastively, one method of distinguishing between languages classified languages into tone languages and non-tone languages. But what are the criteria by which such classification can be made? One criterion suggested by Pike (1948) depends on whether the pitch on individual syllables makes for lexical contrast. Thus he states:

> "...there may exist languages which one desires to call tonal because, although they do not have contrastive pitch on each syllable, they do have lexically significant contrastive pitch spread over entire words or morphemes. In this book, however, the syllabic type of toneme must be present for a language to be labelled tonal." (p. 5)

Such languages in which lexical contrasts exist due to distinctive pitch on different syllables, or the vowels of these syllables, present no problem in anyone's classification. Many African languages, Amerindian languages, and Sino-Tibetan languages are, by this definition tone languages, as may be illustrated by the following:

(1) Igbo (Welmers 1970) (two contrastive pitches or tones)

| | | |
|---|---|---|
| Low-Low | [àkwà] | 'bed' |
| Low-High | [àkwá] | 'egg' |
| High-Low | [ákwà] | 'cloth' |
| High-High | [ákwá] | 'crying' |

(2) Nupe (George 1970) (three contrastive tones)

| | | |
|---|---|---|
| Low | [bà] | 'to count' |
| Mid | [bā] | 'to cut' |
| High | [bá] | 'to be sour' |

(3) Fe?Fe? -Bamileke (Hyman 1972) (four contrastive tones)

| | | |
|---|---|---|
| Low | [pɯ̀α] | 'bag' |
| Raised-Low | [pɯ̍α] | 'bend over' |
| Mid | [pɯ̄α] | 'go crazy' |
| High | [pɯ́α] | 'two' |

(4) Mandarin Chinese (four contrastive tones)

| | | |
|---|---|---|
| High | má | 'mother' |
| Rise | mǎ | 'hemp' |
| Rise-fall-rise | mã | 'horse' |
| Fall | mâ | 'scold' |

(5) Thai (five contrastive tones)

| | | |
|---|---|---|
| Mid | nāā | 'rice paddy' |
| High | náa | 'younger maternal aunt or uncle' |
| Low | nàa | 'Naa, a nickname' |
| Falling | nâa | 'face' |
| Rise | nǎa | 'thick' |

It is also equally clear that there are languages in which the pitch of syllables does not contrast meaning. French may be cited as an example of a language which is clearly not a tone language.

There are linguists who believe that Pike's definition would still fail to sufficiently distinguish languages in terms of the function of pitch. For example, in Etung (Edmondson and Bendor-Samuel 1966), in the Southern and Western Kyūshū dialects of Japanese (McCawley 1964), and in Mende (Leben 1973), among others, there is lexical pitch or tone but it is suggested that such tone is a feature on morphemes rather than a feature on segments or syllables. One argument suggested by Leben (1973) to support this claim is that in Mende morphemes can have a Low High Low tonal contour but may not have High Low High. He cites the following examples:

(6) mbǎ̂ LHL 'companion'

nyàhâ LHL 'woman'

nìkílì LHL 'grounut'

Furthermore, this restriction applies to words of any number of syllables. This being the case, it appears to be 'ad hoc' to suggest that the domain of tone in this language is the segmental vowel. Rather, it appears that the 'word' is more properly the tone bearing unit.

If these languages are classified as tone languages, then Pike's criterion is clearly too narrow. But McCawley (1964, 1970) believes rather that this criterion is too broad since it would include languages like Japanese and Serbo-Croation which he calls accent or pitch-accent languages. In Serbo-Croation, he points out, once the accented syllable is determined, the pitch contour of the word is predictable. The syllable immediately before the accented one gets a rising phonetic pitch; if that accented syllable is the first one it receives a falling pitch, as shown in (7).

(7) (The asterisk under the vowel signifies accent)

$\text{g}\underset{*}{\text{o}}\text{dina} \rightarrow$ gôdina ; $\text{venč}\underset{*}{\bar{\text{a}}}\text{vati} \rightarrow \text{venč}\check{\bar{\text{a}}}\text{vati}$

'rebel' 'lighthouse keeper'

The rules for accent assignment need not concern us here. McCawley's view is that such languages are typologically different from tone languages. He distinguishes, then, between tone languages in which each syllable must be marked in the lexicon for tone, and accent languages which he considers to be non-tonal. The latter category he divided into three classes: (a) bound accent languages in which the accent or stress (and therefore the pitch contour) is fully predictable. He classifies English as such a language, although others might disagree with him about the predictability of lexical stress; (b) partially free accent languages, like Serbo-Croation and (c) free accent languages like Japanese.

Woo (1969) also distinguishes between tone and non-tone languages but includes under her classification of tone languages those which McCawley calls pitch accent. Her criteria are as follows: tone languages are those in which distinctive tone must be marked on at least one vowel in each lexical item. In this class there is a two way division: (a) lexical tone languages in which the tone must be marked on each vowel such as Igbo, Nupe, Mandarin, Thai etc., and (b) tone harmony languages in which there is a tonal diacritic associated with each lexical form, such as Japanese, Mende, Serbo-Croation. A non-tone language is defined by Woo as one in which the lexicon contains no prosodic features associated with the lexical formatives.

Whether one calls the second category tonal or pitch accent it is clear that languages in the world do fall into one of these three classes. A mere classification of languages, however, does not help to define in specific terms how the grammars of these languages are to be constrained. Can one, for example, expect the same kinds of phonological rules to occur in all of these languages? Clearly, in French one does not expect any phonological rules to have to refer to tonal features or pitch phenomena. Nor would one expect in a language like English that a stress rule will have to include in its environment segmental feature information. That is, no language has been found in which stress is assigned, for example, on the initial syllable unless the first consonant is voiced (See Hyman 1973).

In Kpelle, where words are restricted to a sequence of high tones or low tones, or high tones followed by low tones (Welmers 1962), one would not expect to find a rule which lowers a high tone before another high. Or, in a language like Kinga (Schadeberg 1972) where tones are restricted such that only one high tone can occur in a word, one would not expect a tonal rule which violates this constraint.

Thus, while a classification for its own sake may not be important, given the correct classification we may be able to constrain our theory of phonology such that the classes of possible grammars are narrowed.

## Representation of Tone: Segmental, Suprasegmental or both?

The only reason that I have presented this overly simple and well known typological summary is because it has important influence on the kinds of restrictions we place on grammars of tone languages.

Historically, tone like other 'prosodic' phenomena has been considered 'suprasegmental' but formally treated segmentally, as a feature on vowels. How tone should be represented is not merely a matter of taste; there should be different consequences dependent on the different representations.

Woo's (1969, 1970) proposal, then, that grammars should be constrained so that tone features are to be specified segmentally is a claim about the identity of all phonological features. Furthermore, the hypothesis predicts that there should be no language where such a treatment would obscure important generalizations. Leben (1973) has challenged this claim in suggesting that "tone is a suprasegmental phenomenon in some languages". At the 10th Congress of the West African Linguistic Society in Legon, I presented a paper in support of Woo and in opposition to Leben. I am pleased to be here at this Congress so that I can make a public retraction. Leben's evidence is very convincing. One argument centers around languages such as Mende where there are morphemic restrictions on tonal contours, i.e. where distinctive tones can not occur freely. He shows that such constraints can be accounted for very awkwardly and in a non-intuitive fashion if tone is a feature assigned to either segments or syllables. Consider, for example, a language with two contrastive tones, High and Low. If tone is a segmental feature one might expect any combination of tones to occur: In monosyllables -- HIGH (H), LOW (L); in disyllables -- HH, HL, LL, LH; in trisyllables -- HHH, HHL, HLH, HLL, LHH, LHL, LLH, LLL; etc. In Mende, however, the sequences HL and HHL are prohibited. He argues that this constraint appears ad hoc if tones are features on segments in Mende. If, rather, tones are features are morphemes the possible phonological tone patterns may be restricted as follows:

(8) A.

| Morpheme Features | 1 syl | 2 syl | 3 syl |
|---|---|---|---|
| H | H | H H | H H H |
| L | L | L L | L L L |
| LH | $\overset{\frown}{\mathrm{LH}}$ | L H | L H H |
| HL | $\overset{\frown}{\mathrm{HL}}$ | H L | H L L |
| LHL | $\overset{\frown}{\mathrm{LHL}}$ | L $\overset{\frown}{\mathrm{HL}}$ | L H L |

He suggests that these are the only tone contours permitted. The tonal sequences assigned to morphemes under A. would then be mapped onto segments by two mapping rules to derive the necessary phonetic representation:

(a) "If the number of level tones in the pattern is equal to or less than the number of vowels in the word...put the first tone on the first vowel, the second on the second, and so on.

(b) If the number of level tones in the pattern is greater than the number of vowels in the word...put the first tone on the first vowel, the second on the second and so on; the remaining tones are expressed on the last vowel available.

This proposal therefore predicts that in two syllable words the only contour tone which can occur is a falling tone on the second syllable, (i.e. no *$\overset{\frown}{\mathrm{LH}}$ L for example) and that no contour tones will occur in three syllable words. It further predicts the nonoccurrence of a LLH sequence in a three syllable word or a HLH sequence. This is a strong hypothesis, and these restricted occurrences of tones lends strong support for representing tone in Mende by a suprasegmental matrix assigned to each lexical entry.*

Notice the formal consequences of such empirical data. If tone is a non-segmental feature i.e. a feature of morphemes, then in a formal grammar there must be some way of representing it other than as part of the segmental matrix. This requires then an additional matrix for each lexical item. In addition, at some point the tones must be integrated into the phonological or phonetic representation of the formative which therefore necessitates some formal mapping rules.

If, as in Southern and Western Kyushu (McCawley 1964), one need not specify tonal contours differently for monosyllabic words or disyllabic words, this fact is also "captured automatically if all morphemes in the language are specified with a feature describing the tonal contour" (Leben 1973).

Leben also argues for suprasegmental matrices of morphemes with evidence showing that tonal phenomena behave differently from segmental phenomena. He suggests that the kinds of restrictions on tonal sequences do not pertain to segmental features. That is, a restriction like the one in Mende permitting LHL but no HLH is, he argues, a consequence of the unique characteristics of the suprasegmental nature of tone. He posits that one would not expect to find a phonotactic constraint which permitted [-nasal] [+nasal] [-nasal] but did not permit [+nasal] [-nasal] [+nasal]. This is an interesting point but is negated by examples of sequential constraints on other features such as 'rounding' or 'backness' as observed in vowel harmony languages. In Terena (Bendor-Samuel 1970) nasalization also appears to be a feature assigned to a word rather than a segment. Leben's conclusion is that there may be other features which are best assigned to morphemes rather than segments. But one cannot argue for the suprasegmental nature of tone on the grounds that tones can be restricted in ways in which segmental features can not, and then on finding other such 'segmental features' conclude that these too must therefore be possible suprasegmental features.

It might indeed be found that any 'independently controllable' phonetic (phonological) feature is a candidate for suprasegmental status. This, to some extent, is implicit in the British prosodic analysis theory.

* Following the presentation of this paper, Jan Voorhoeve argued convincingly that Leben's constraints on tone sequences in Mende are not valid and therefore this language does not support a suprasegmental matrix for tones. This does not mean that there are no languages that support the suprasegmental theory, but the cases cited so far are not persuasive. See Voorhoeve (1974), and also Maddieson (1974).

But finding this non-unique status of tone leads us to look for additional differences between tonal phenomena and other phonetic features.

Looking beyond grammatical requirements we do find some interesting data to support this special status. It has long been observed, for example, in studies of child language acquisition that children imitate and respond to intonation patterns very early in life, even before the babbling period (Ervin-Tripp 1966). This has been shown to be true of children learning intonation (non-tonal) languages and tone languages. In one study, children learning Chinese, for example, could be distinguished by their tonal contours from other children.

Aphasic studies have also shown the separation of tonal phenomena from segmental phenomena. Tonal contours may be retained when other phonological features are lost. Lyman reports on a study conducted in Peiping that Chinese aphasics often retain tonal contours despite the loss of segmental information of words. It is also the case that loss of intonation is rare in aphasia.

Evidence from word games presented by Hombert (1973) and by Gandour (personal communication) further reveals that in many languages the tonal contour of a word remains even if syllables are moved.

In Thai, there is a language game *Khamphuan* [KP] (*kham* 'word,' *phuan* 'to switch') which provides some interesting evidence. In this game, one finds a reversal of the syllable-final vowel(s) plus consonant with either a reversal of the tone or with no reversal of tone. The following examples taken from Surintramont (1973) are given by Gandour to illustrate this game:

| (9) | Regular Form | KP1 Form | KP2 Form |
|---|---|---|---|
| 'banana' | klúày hɔ̀ɔ́m | klɔ̀ɔ́m húày | klɔ́ɔ̀m hùáy |
| 'see movie' | duu nàŋ́ | dàŋ́ nuu | daŋ nùú |
| 'dance' | téǹ ram | tam réǹ | tám̀ ren |

In KP1, there is a shift of the syllable vowel(s) and final consonant *plus* the tone, and in KP2, the reversal occurs *without* a tone shift.

Such 'games' do not provide evidence for representing tone suprasegmentally in a particular language but certainly lend support for the characteristics of tone which makes tone a candidate for special treatment in phonology.

Evidence from such sources makes plausible the hypothesis that in certain languages tone is a feature on units larger than a segment, i.e. should be represented suprasegmentally.

To conclude that in some languages suprasegmental representation of tone is necessary does not mean that tone should always be represented in a separate matrix. It is also clear that where there is an interaction between tonal and segmental features, tone features must have already been mapped onto the segmental matrices. This mapping must occur at some point for all languages so that the final phonetic output will contain both segmental and tonal information. When we sing we can produce melodic contours without segmental information -- but when we speak the pitch is not separated from other properties of the speech signal.

Leben correctly, I believe, points out that the mapping of suprasegmental tone onto the segmental matrix will vary from one language to another. One possible criterion which can be used to determine whether tone is to be represented suprasegmentally at all is whether the phonotactic constraints on morphemes are dependent on tonal and segmental contexts. That is, if there are contextual constraints on tonal sequences or tone features, and if these constraints must be stated in reference to segmental features we may conclude that in such a language tone is segmental grammatically.

Thai seems to be such a language. Gandour (1973) presents some data showing the tonal constraints on Thai morphemes. There are five contrastive tones in Thai: HIGH (H), LOW (L), MID (M), FALLING (F) and RISING (R). H and R do not occur when preceded by /p b t d c k ʔ/ except in non-Indic loanwords, onomatopoeic words, and 'particles'.

Within polysyllabic morphemes, CV syllables that begin in a sonorant segment /m n ŋ l r w y/ always carry a *high* tone, and CV syllables that begin in a voicelss unaspirated stop /p t c k ʔ/ always carry *low* tone. The seemingly counterintuitive restrictions will not be discussed here, but what is clear is that one cannot state these restrictions without reference to segmental features. If tone were represented as a suprasegmental matrix assigned to the morpheme there would be no way to reveal these generalizations.

Two criteria have thus been suggested, namely, (1) where tone is a feature on units larger than a segment, tone is to be represented suprasegmentally, and (2) where phonotactic constraints need to refer to both tonal and non-tonal features, tone is to be represented segmentally. We have yet to see whether these are contradictory criteria.

Another criterion is suggested by Leben, namely, that where contour tones which fall on single vowels must be analyzed as sequences of level tones, these sequences will occur suprasegmentally, thereby excluding the need for contour features, at least in these cases. There are clearly cases in which phonetic contours should be derived from underlying sequences. I will not discuss these arguments in detail since they have been presented amply in the literature but will merely cite a few examples.

Some phonetic contour tones are clearly the result of what Hyman and Schuh (1973) call tone spreading; If they are not analyzed as deriving from underlying level tones generalizations will be obscured. Thus in Yoruba one finds a sequence of LOW-HIGH realized phonetically as LOW-RISING. Spreading the low tone onto the high tone vowel reveals the assimilatory character of this process:

(10) $\mathrm{H} \rightarrow \mathrm{LH} / \mathrm{L}$ ____

A rule written using a contour tone feature obscures this:

(11) $\mathrm{H} \rightarrow \mathrm{RISING} / \mathrm{L}$ ____

Similarly, there are cases where downdrift rules operate such that a High tone is lowered when preceded by a Low tone. In many languages this downstepped high also occurs after a falling tone. The rule is a simple one where a falling tone is represented as a sequence of HIGH-LOW.

Hyman (1973) presents further evidence from Mandarin to show that the use of contour features would obscure the assimilatory nature of tonal rules. He refers to two rules cited by Mohr (1973). Mohr uses the following features to designate the pertinent tones usually given by Sinologists in numerical terms:

$$35 = \begin{bmatrix} \text{+High} \\ \text{+Rising} \end{bmatrix}$$

$$55 = [\text{+High}]$$

$$53 = \begin{bmatrix} \text{+High} \\ \text{+Falling} \end{bmatrix}$$

The rules in Mandarin and Cantonese are as follows:

(12) Mandarin: $\begin{bmatrix}+\text{High}\\+\text{Rising}\end{bmatrix} \rightarrow [-\text{Rising}] \;/\; \begin{bmatrix}+\text{High}\\-\text{Falling}\end{bmatrix}$ --- $[-\text{Neutral}]$

i.e. $35 \rightarrow 55 \;/\; 55,\ 35$ ___ T (where T = any tone except neutral)

(13) Cantonese: $\begin{bmatrix}+\text{High}\\+\text{Falling}\end{bmatrix} \rightarrow [-\text{Falling}] \;/$ ___ $\begin{bmatrix}+\text{High}\\-\text{Rising}\end{bmatrix}$

i.e. $53 \rightarrow 55 \;/$ ___ $55,\ 53,\ 5$

Hyman points out that although these two rules "represent the same assimilatory process, the rules do not reveal this identity".

In both rules $3 \rightarrow 5/\ 5$ ___ $5$.

If these tones were represented as sequences of level tones the assimilatory nature of the process would be revealed:

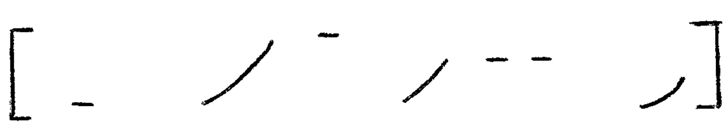
$$\left( 3 = \begin{bmatrix}-\text{High}\\-\text{Low}\end{bmatrix},\quad 5 = [+\text{High}] \right)$$

$$\begin{bmatrix}-\text{High}\\-\text{Low}\end{bmatrix} \rightarrow [+\text{High}] \;/\; [+\text{High}] \_\_\_ [+\text{High}]$$

Can we then conclude that all phonetic contour tones should be represented as sequences of level tones? If one finds cases where a contour tone cannot be decomposed into level tones, if, for example, tone rules which apply after high tones do not apply after a Rising contour, or if rules which apply after low tones do not apply after a falling contour it would be apparent that such tones cannot be represented as sequences. Elimelech (1973) presents evidence that Kru is such a language. Kru is a language in which Downdrift occurs, and which has a High, a Low, a Rising, and a Falling tone. If the Rising tone is derived from a sequence of [Low] [High] one would expect the following:

(14) 'The rice is on the table'

| | | | | | |
|---|---|---|---|---|---|
| kɔ̀ | nǎ | nɛ̃́ | ụ̌ | téblé | kpǔ |
| L | L H | H | L H | H H | L H |



Downstep L LH H LH HH LH

Gliding
rule

This, however, is not what occurs. Rather as shown by Elimelech we get the following pitch contour.

(15) kɔ̀ nǎ nɛ́ ụ̌ téblé kpǔ

Furthermore, in a sequence of rising tones, each subsequent rise begins on a pitch identical to the ending pitch of the preceding tone. Such sequences may be simplified in normal tempo by a rule which changes a rising tone to a high before another rise, but in deliberate speech a sequence of rises is realized as (16a) not as (16b).

(16) jǔ nǎ jě nǐ nǎ     child the saw water the

'the child saw the water'

a.

b.

Elimelech presents additional evidence from the constraints on tonal contours of monosyllables and disyllabic words to show that in Kru important generalizations would be lost were these contours to be represented as level tone sequences.

There is also evidence for contour features in Lue, a Tai dialect spoken in the southern part of the Yunan province of China. Gandour (1974) discusses a problem of a tonal alternation in this dialect using data from Li (1964) showing that contour features not only provide for a simpler solution but a more insightful one. According to Li there are 6 phonemic tones, one of which has two alternate phonetic realizations: Low (11) or Low-Rising (13). The low tone occurs before the Mid-Rising tone (35) or before the Falling tone (31); the Low-Rising tone occurs elsewhere, i.e. before a High (55), a Mid (33), a Lowered-Mid (or raised low) (22) and before phrase boundary as illustrated in (17).

| | | | |
|---|---|---|---|
| (17) | $xa^{13}$ | ## | 'to kill' |
| | $xa^{13}$ | $pet^{55}$ | 'to kill a duck' |
| | $xa^{13}$ | $nok^{33}$ | 'to kill a bird' |
| | $xa^{11}$ | $kun^{31}$ | 'to kill a person' |
| | $xa^{11}$ | $kay^{35}$ | 'to kill a chicken' |

Since the Low-Rising tone occurs in more environments, no matter what feature solution is decided on, the rule will be stated more simply if it is this tone which is lexically specified with the level low tone derivative.

If the contour tones are represented as sequences of level tones, the seven phonetic tones can be specified as in (18).

(18)

| | H (55) | M (33) | L-M (22) | H-Rise (35) | M-Fall (31) | L-Rise (13) | L (11) |
|---|---|---|---|---|---|---|---|
| High | + | - | - | - + | - - | - - | - |
| MID | - | + | - | + - | + - | - + | - |
| LOW | - | - | - | - - | - + | + - | + |

The rule to derive the Low tone from the Low-Rise can then be stated as in (19)

(19) $[+\text{Mid}] \rightarrow \emptyset \;/\; [+\text{Low}] \;\underline{\quad}\; [\alpha\text{Tone}] \;\; [-\alpha\text{Tone}]$

Clearly, the real complexity of this rule is obscured by using the cover symbols '$\alpha$Tone' and '$-\alpha$Tone.'

If contour features are used, one possible specification is as given in (20):

(20)

| | 55 | 33 | 22 | 35 | 31 | 13 | 11 |
|---|---|---|---|---|---|---|---|
| HIGH | + | - | - | + | - | - | - |
| MID | - | + | - | - | + | - | - |
| LOW | - | - | - | - | - | + | + |
| RISING | - | - | - | + | - | + | - |
| CONTOUR | - | - | - | + | + | + | - |

The tone sandhi rule can then be stated as (21):

$$(21)\quad \begin{bmatrix}\text{+Low}\\ \text{+Contour}\end{bmatrix} \rightarrow \begin{bmatrix}\text{-Rising}\\ \text{-Contour}\end{bmatrix} \;/\; \_\_\_ \;[\text{+Contour}]$$

I am not claiming that these are the only features or feature specifications which one could use. I do believe, however, that whatever tonal features are used, the sandhi rule required if contour features are not used would have to be unduly complex and would obscure the simple tonal dissimilation which is revealed by rule (21). I think, therefore, that Gandour's claim is a correct one.

Clearly, then, any feature system must permit a way of representing contours in such languages as distinct from level tone sequences. We clearly need features such as [Rising] and [Falling]. These phonological features also make it possible to represent the phonetic glides required on the phonetic level for those languages that have phonetic contours derived from sequences.

It is not yet clear what features are generally needed to represent tone either suprasegmentally or segmentally. There seem to be problems with every feature set yet proposed.

To discuss the features which have been proposed, their strengths and shortcomings, would require another paper. I think that such a discussion would be premature. Research is now going on in many places concerned with the physiology and perception of tone, the historical development of tone, and synchronic tonal phenomena which will hopefully soon resolve some of the current problems. Any viable feature set must at least account for the following: (1) contrasts between at least 4 level tones (2) indissoluble contour tones (3) the relation between phonation types and tones (4) assimilatory (and also dissimilatory) tonological rules, (5) the natural tone classes required (6) tonal development and tonal change, including tonogenesis. Furthermore the physiological or perceptual correlates of whatever features are used should agree with known physiological and acoustic facts. Perhaps at the 12th Congress someone will present a paper which will provide us with such a set.

The opinions I have expressed here today are still very tentative. We have much to learn about tonal phenomena. The work reported on by many linguists however seems to show that tone languages may be of two types: those in which underlying representation of formatives require suprasegmental matrices and those which require segmental representation of tone. Furthermore, there seems to be further classification required in that in some languages tonal rules never need to refer to segmental features and in others, even in those where there is evidence for suprasegmental tone, rules must refer to segments. In addition, phonetic contours may be derived from sequences of level tones in some languages, whereas in others, the phonological and phonetic representations may both require contour features. A viable theory of language will have to include among the class of possible languages these different types.

References

Bendor-Samuel, J.T. (1970) "Some Problems of segmentation in the phonological analysis of Terena" In Palmer, F.R. (ed.) *Prosodic Analysis*, 214-221. London: Oxford University Press.

Edmondson, T. and J.T. Bendor-Samuel. (1966) "Tone patterns of Etung" *Journal of African Languages*. 5:1-6.

Elimelech, B. (1973) "On the Reality of Underlying Contour Tones" Paper presented at the 48th Annual Meeting of Linguistic Society of America, San Diego, California. Printed in this volume.

Fromkin, V.A. (1972) "Tone features and tone rules" *Studies in African Linguistics*. 3:47-76.

Gandour, J. (1973) "A Preliminary Report on the Suprasegmental (?) Nature of Tone in Thai" Unpublished manuscript.

Gandour, J. (1974) "Remarks on Tone: Evidence from a Southeast Asian Language" Unpublished manuscript.

George, I. (1970) "Nupe Tonology" *Studies in African Linguistics.* 1:100-122.

Hombert, J. M. (1973) "Word Games: Some Implications for Analysis of Tone and other Phonological Processes" Paper presented at the 48th Annual Meeting of Linguistic Society of America, San Diego, California.

Hyman, L.M. (1963) "Discussion Paper on Sino-Tibetan Tone" Paper presented to 6th International Conference on Sino-Tibetan Languages and Linguistics, San Diego, California.

Hyman, L.M. (1973) "The Role of Consonant Types in Natural Tonal Assimilations" in Hyman, L.M.(ed.) *Consonant Types and Tone.* Occasional Papers in Linguistics 1, Linguistics Program, University of Southern California, Los Angeles.

Hyman, L.M. and R.G. Schuh. (1974) "Universals of Tone Rules: Evidence from West Africa" *Linguistic Inquiry.* 5.1:81-116.

Leben, W.R. (1973a) "The Role of Tone in Segmental Phonology" in Hyman, L.M. (ed) *Consonant Types and Tone,* Occasional Papers in Linguistics 1, Linguistics Program, University of Southern California, Los Angeles.

Leben, W.R. (1973b) *Suprasegmental Phonology.* Ph.D. Dissertation, Massachusetts Institute of Technology.

Maddieson, I. (1974) "Low-Raising in Bambara, Mende and Hausa" Unpublished paper.

McCawley, J.D. (1964) "What is a Tone Language?" Paper presented at Summer Meeting of Linguistic Society of America.

McCawley, J.D. (1970) "Some tonal systems that come close to being pitch-accent systems but don't quite make it" In Papers from the Sixth Regional Meeting, Chicago Linguistic Society; 526-532. University of Chicago.

Pike, K.L. (1948) *Tone Languages.* University of Michigan Press. Ann Arbor.

Schadeberg, T.C (1973) "Kinga: a restricted tone system" *Studies in African Linguistics* 4:23-48.

Voorhoeve, J. (1974) "Développements nouveaux dans l'analyse tonale (mende et mandingue)" Paper presented at the 11th West African Languages Congress, Yaoundé, Cameroons.

Welmers, W.E. (1962) "The phonology of Kpelle" *Journal of African Languages* 1:69-93.

Woo, N.H. (1969) *Prosody and Phonology* Ph.D. Dissertation, M.I.T. Available from Indiana University Linguistics Club.

Woo, N.H. (1970) "Tone in Northern Tepehuan" *International Journal of American Linguistics* 36:18-30.

# *A note on tone and consonants**

Ian Maddieson

[Department of Linguistics, University of California, Los Angeles]

Hyman and Schuh (1974) claim that "*consonants affect tone, but tone does not affect consonants*". This claim has been made several times in recent literature (Hyman 1973a : 171, Hyman 1974, Pike 1974 : 173). There are a number of cases which show that it is false.

In the first place, the pitch of voiced consonants is frequently determined by the tone of neighbouring tone-bearing segments. In their phonology of Akan, Schachter and Fromkin (1968 : 115) propose to capture this fact by means of a tone-spreading rule which "copies the tone of a vowel onto adjoining voiced non-vowels in the same syllable". Trutenau (1972) objects that this rule is too broadly defined but the only data given in his paper suggest that an essentially similar rule would adequately describe the pitch of voiced non-tone-bearing consonants in Gã.

Some historical cases of tone-splitting or tongenesis show that higher tone reflexes follow (originally) voiceless consonants and lower tone reflexes follow voiced consonants. Similarly, studies on natural and synthesized speech in English and Russian show that in these languages pitch is briefly raised after voiceless obstruents and lowered during and after voiced obstruents. These are among the well-known consonant effects on the pitch of following vowels, but we can also find both historical and synchronic rules which show that tonal distinctions can determine voice onset time in adjacent consonants. In the Ọhụ̃hụ dialect of Igbo, Dunstan and Igwe (1966:74) report that the 'glottal fricatives' which they symbolize as /h, h̃, hj, h̃j/ appear to be partially voiced before low tones. This is a synchronic rule in which low tone determines an earlier voice onset time for preceding consonants. In Jingpho, words with low tone vowels and final voiceless stops voice the final stops in a process of

*The research on this paper was supported by the NSF Grant #GS 37235.

gemination when certain particles (such as an affirmative, possessive or imperative marker) follow. The alternation seen between yàk 'difficult' and yàggai 'it is difficult' is precisely a case of the allegedly non-occurring type of rule that Hyman and Schuh represent as:

$$p \rightarrow b \;/\; \grave{V} \;\text{---}\; \grave{V}$$

where intervocalic voicing occurs only when surrounding vowels are low tone. Note that for cát 'tight', cáttai 'it is tight' there is no alternation of voicing. Maran (1971, 1973) prefers to regard Jingpho as a language without underlying tonal contrasts. He takes a form with a voiced final consonants as underlying in these alternating forms and predicts the preceding low tone from the voiced consonant and then devoices the consonant in final position. Because of the assumptions about glides that are required, this seems a less natural account of the facts than granting that Jingpho has underlying tonal contrasts.

If, however, this alternative solution to the Jingpho problem is preferred (despite the problems raised by an essentially diacritic use of the sumbols h and ħ) and the underlying form for the word meaning 'difficult' is yag, then there must be a historical change in the direction of voicing those consonants that followed low tones and a reanalysis of the voicing as the distinctive cue. The comparative evidence does not support a reconstruction of original final voiced consonants in those cases that show the alternation in modern Jingpho between voiceless and geminated voiced consonants. Proto-Lolo-Burmese, parent language of both the Loloish languages and the Burmese languages, including Jingpho, cannot be shown to have had any voiced final stops (Burling 1967, Matisoff 1972) and the oldest written records of any Lolo-Burmese language (Old Burmese) do not show them either. A few representative cases are given below:

| gloss | P-Lolo-Burmese (Matisoff 1972) | Jingpho |
|---|---|---|
| 'spirit' | nat (low tone group) | nát |
| 'run' | kyat (high tone group) | gàt (with voiced geminate form) |
| 'kill' | C-sat (low tone group) (C = voiced prefix) | sàt (with voiced geminate form) |

Unless all other trace of the original voicing of final stops has been lost not only in the Burmese languages but also in the Loloish languages, then the voiced alternating forms in Jingpho, whether underlying or not, must be innovations which depended on a pre-existing tonal distinction.

Voicing and lowering of pitch do not go together in all languages in synchronic or diachronic processes (see Li 1965:152, Maddieson 1974). In the Tai family there are rather more cases where the tone reflexes are higher when originally voiced stops preceded than when voiceless ones preceded (Brown 1965, Sarawit 1963). We might therefore expect also to find languages in which the occurrence of high tones conditions an earlier onset of voicing in adjacent consonants. In Siamese, stops in the voiceless aspirated series have two possible pronunciations; one with delayed voice onset time and one with an onset of voicing which almost coincides with the release of the stop. The second type, which may be described as breathy voiced, generally occurs when a high pitch follows. The normal voiceless aspirated type generally occurs when a low pitch follows. Either type may occur when a mid tone follows (for details see Gandour 1974). This is an example of a rule by which an earlier onset of voicing is conditioned by occurrence of high pitch.

Other cases where historical changes among consonants have been determined by differing tonal environments are known from the Sinitic and Miao-Yao families, from Kam-Sui and from the Puyi dialects in the Tai family. In several Miao dialects, Yung-sui et al. (1972) found that there were different reflexes of prenasalised voiced obstruents depending on the following tone. It is well known that similar differences concerning aspiration can be found in modern reflexes of earlier voiced obstruents in many Chinese dialects. Since Chinese linguistic history is documented with more precision than most other language families these examples are particularly persuasive. The rhyme tables and spellers of the Middle Chinese period give us phonological statements and phonetic descriptions with which later varieties of Chinese can be compared. The comparison shows that Middle Chinese voiced stops and affricates have voiceless aspirated reflexes preceding original level tone and voiceless unaspirated reflexes preceding original contour tones in Mandarin, Cantonese, Taishan and other varieties (see Cheng 1973 for an accessible account). The Middle Chinese descriptions require interpretation, but the disagreement about whether the original series involved should be reconstructed as plain or 'aspirated' voiced obstruents does not affect the demonstration of the point that it is the tones which have conditioned the different consonant reflexes.

Tonal differences have also affected the distinction between fricative and affricate in Chinese. Pulleyblank (1970) shows that Mandarin has aspirated palatal affricates preceding original level tone and unaspirated palatal fricatives preceding original contour tones as reflexes of earlier palatal and retroflex fricatives and affricates; for example:

| Original segment | Mandarin reflex | |
|---|---|---|
| | Tone 2 | Tone 4 |
| Middle Chinese palatal fricative | ch'eng "to fill" | sheng "full" |
| Middle Chinese palatal affricate | ch'eng "to ride" | sheng "vehicle" |

The original fricatives and affricates merged together before a new distribution of fricative and affricate realisations emerged conditioned by the tones (Pulleyblank 1974).

In many Scandinavian dialects, two tonal accents contrast words which are otherwise identical. Originally monosyllabic words have Accent 1, originally bisyllabic or polysyllabic words have Accent 2. Due to compounding and epenthesis some Accent 1 words now have more than one syllable, and due to contraction some Accent 2 words are now monosyllabic. In Oslo Norwegian, for example, bunden 'the floor' has Accent 1 (a rising pitch pattern) but bunden 'bound (participle)' has Accent 2 (a falling-rising pitch pattern) (Kock 1901). In standard Danish, however, the accent difference is not realised as a tonal difference. Instead the words with Accent 1 have a glottal stop (stød) at the end of the accented syllable. Larsen (1890) also reports that there is little accentual difference in some of the southernmost Norwegian dialects and a glottal stop characterises Accent 1. Most scholars accept that the Danish situation represents an innovation resulting from tonal differences in the parent language of all the continental Scandinavian dialects. This process represents another instance where tone historically affected neighbouring consonants; in this case introducing a new consonantal articulation to the inventory.

These cases show that tonal effects on consonants are fairly widespread. Further research will surely bring to light many more cases than those reviewed here or already reported elsewhere in the literature. The generalisation that "*consonants affect tone, but tone does not affect consonants*" is therefore hasty. If the belief that tones do not affect consonants is repeated sufficiently often, researchers will not be on the lookout for such phenomena and the myth will become further entrenched. This is a particularly regrettable possibility because there does not seem to be any reason to expect the purported generalisation to be true.

Although they say they are giving an inventory of natural rules in their article, Hyman and Schuh do not explain why they think it is natural that "*consonants affect tone but tone does not affect consonants*". However, the most readily accepted 'natural' process is assimilation, and consonantal influence on tone has often been viewed as an essentially assimilatory process. An extreme statement of this view is the suggestion by Halle and Stevens (1971) that voiceless obstruents and high tone vowels on the one hand share the same laryngeal adjustment, namely, stiff vocal cords; and voiced obstruents and low tone vowels also share the same adjustment, namely, slack vocal cords. One theory of assimilation, proposed by Schachter (1969), is that marked feature values determine assimilation. If we imagine a language with two tone levels in which low tone could be regarded as unmarked and we assume that voicelessness for intervocalic consonants is marked, then the prediction is that a [ + stiff] consonant will not be affected by surrounding [ - stiff] vowels, but that it will cause the tones to be raised on the vowels. This conforms with what Hyman and Schuh claim about the direction of assimilation between consonants and tones. However, in the syllable-initial position voiceless obstruents are probably the unmarked category and hence there is no prediction of tone-raising. Yet the Chinese split into yin and yang tonal registers resulted from differences among initial consonants.

Hyman and Schuh, following Lukas (1969), discuss one model in which there is no need to posit assimilatory influence of consonants on tones. They suggest that the nature of an intervening consonant may act to block or permit tonal assimilations between two vowels. For example, in the sequence V̀CV̌ with a voiced intervocalic consonant the rising pitch of the second vowel can been seen as perseveration of low pitch into an underlying high tone vowel in the second syllable which is permitted by the voiced nature of the intervening consonant (cf. also Hyman 1973). In such cases the most obvious interpretation is that the tone of the first syllable has affected the consonant which follows, in the way suggested by Schachter and Fromkin's tone-spreading rule. The pitch of the consonant then determines the pitch level at which the next vowel begins. In this case it seems proper to talk of assimilation, but it is the consonant which assimilates to the preceding vowel before in turn assimilating the second vowel.

In other cases the process by which consonants affect tone is not an assimilatory process in the way that these are usually conceived. No property of the consonant that is pertinent to its classification as a consonant is transferred to the vowel. And, as noted above, consonants with the same classification have different effects on the pitch of the following vowels. Any theoretical model that predicts a single correlation of consonant types and tone is false. This is one of several serious problems with Halle and Stevens' proposal. Similarly, a suggestion such as Hyman and Schuh's "phonetic hierarchy from those consonants that have the greatest tone lowering effect to those consonants that have the greatest tone raising effect" makes no allowance for diversity. An adequate theory must be able to account for various consonant effects on pitch and also for the effects of tone on consonants. Phonetically it is useful to distinguish *transitions* from assimilation. For example, there are inevitable acoustic transitions of vowel formants determined by the place of articulation of adjacent consonants. These acoustic effects are the result of the articulatory transition from the position for one segment towards the position for the next. Assimilation occurs when the articulatory position for a segment is adapted in some way in order to ease the transition to or from an adjacent segment. The significance of acoustic transitions as perceptual cues for, say, the place of articulation of postvocalic stops is well known. The studies showing that small pitch distinctions are clues to perception of phonation type (Chistovitch 1969, Haggard et al. 1970) demonstrate that these are analogous to the formant transitions, not that they are assimilatory in nature. The transitions in vowel formants arise because the changing shape of the oral cavity as the speaker moves from one segment to the next changes its acoustic filtering properties. Similarly, a change in the muscular setting of the larynx or the aerodynamic conditions surrounding the glottis would produce the possibility of a transitional fundamental frequency effect. Most occasions when passing from consonant to vowel or from vowel to consonant will present this possibility because the segments do not share the same vocal cord tension and rate of air-flow through the glottis, these being the two primary variables determining rate of vocal cord vibration. But, because there are a number of factors involved in determining the rate of vocal cord vibration, it does not seem possible to make simple predictions about unique correlations or the direction of effect. For example, a downward movement of the larynx may slacken the vocal cords (which lowers the frequency of vibration) but would tend to increase air-flow through the glottis (which raises the frequency of vibration). The balance of these two factors may vary even in repetitions of the same utterances (depending on other variables such as the stage in the respiratory cycle, etc.).

Consonants with different widths of glottal opening can be expected to show differing pitch transitions to the following segment resulting from differing rates of air-flow through the glottis. Such transitions, if consistent, may be useful perceptual cues and finally develop into distinctive differences of pitch. Equally the linguistic use of pitch (mainly achieved by varying vocal cord tension and by permitting or resisting variation in subglottal air pressure dependent on respiration) may be useful perceptual cues and finally develop into distinctive differences of pitch. Equally the linguistic use of pitch (mainly achieved by varying vocal cord tension and by permitting or resisting variation in subglottal air pressure dependent on respiration) may be expected to produce transitional effects to and from adjacent segments, which could develop from sub-distinctive to distinctive status. For example, Kock, following Sievers, suggests that the Danish glottal stop

> " .. must have arisen in the following way; in the course of the tensing of the vocal cords required to produce the rapidly rising pitch contour of the stem syllable of words with Accent 1 the tensing was over-articulated so that the vocal cords momentarily closed"*

It seems probable that an adequate theory of the interaction of tone and consonants must consist of two parts. The first is a dynamic model able to relate, at least, the factors affecting

1) sub-glottal pressure, and

2) supraglottal pressure (the difference between these two being one factor in determining rate of air-flow),

3) width of glottal opening (also a determinant of air-flow, and determinant of the presence of fundamental frequency),

4) vocal cord tension (itself dependent on tension of the crico-thyroid and other laryngeal muscles).

This model would include the distinctive values along these parameters and would enable the transitions that will occur to be predicted. The second part must be a psychological model which explains the process by which non-distinctive differences assume a distinctive function.

---

* In the original "Der stoss dürfte in der weise enstanden sein, dass beim spannen der stimmbänder, um das rasch steigende portament auf der wurzelsilbe von wörtern mit der accent 1 zu bewirken, dieses spannen so ubertrieben wurde, dass die stimmbänder sich momentan schlossen." (Kock 1901:124).

References

Brown, J.M. (1965) *From Ancient Thai to Modern Dialects* Social Science Association Press, Bangkok.

Burling, R. (1967) *Proto-Lolo-Burmese International Journal of American Linguistics* 33.2. Part II. Issued simultaneously as Publication 43, Indiana University Publications in Anthropology and Linguistics, Mouton, The Hague.

Cheng, T.M. (1973) "The phonology of Taishan" *Journal of Chinese Linguistics* 1.2: 256-322.

Chistovitch, L.A. (1969) "Variations of the fundamental voice pitch as a discriminatory cue for consonants" *Soviet Physics-Acoustics* 14: 372-378.

Dunstan, E. and G.E. Igwe (1966) "Two views of the phonology of the Ọh̃ụh̃ụ dialect of Igbo" *Journal of West African Languages* 3.2. 71-75.

Gandour, J.T. (1974) "Consonant types and tone in Siamese" Published in this volume.

Haggard, M., S. Ambler and M. Callow (1970) "Pitch as a voicing cue" *Journal of the Acoustical Society of America* 25: 105-113.

Halle, M. and K.N. Stevens (1971) "A note on laryngeal features" *Quarterly Progress Report* 101: 198-213. Research Laboratory of Electronics, M.I.T.

Hyman, L.M. (1973a) "The role of consonant types in natural tonal assimilations" *Consonant Types and Tone* 153-179. (*Southern California Occasional Papers in Linguistics* 1). University of Southern California, Los Angeles.

Hyman, L.M. (1973b) *Consonant Types and Tone (Southern California Occasional Papers in Linguistics* 1). University of Southern California, Los Angeles.

Hyman, L.M. (1974) "Discussion paper on Sino-Tibetan tone" presented at the 6th International Conference on Sino-Tibetan Languages and Linguistics. Forthcoming in the *Proceedings* (ed. B. Tsou).

Hyman, L.M. and R. Schuh (1974) "Universals of tone rules: evidence from West Africa" *Linguistic Inquiry* 5.1: 81-115.

Kock, A. (1901) *Die Alt- und Neuschwedische Accentuierung unter Berücksichtigung der anderen nordischen Sprachen* (Quellen und Forschungen zur Sprach- und Culturgeschichte der Germanischen Völker 87) Trübner, Strassburg.

Larsen, A.B. (1890) [Indberetning fra adjunkt Amund B. Larsen om reiser foretagne med offentligt stipendium i årene 1888-90 for at studere bygdemålene i Kristiansands stift] *Universitets- og skole-annaler* Ny række 5: 267-289. (Continued in 6: 209-260. 1891).

Li, F-K. (1965) "The Tai and the Kam-Sui Languages" *Lingua* 14: 148-179. (Indo-Pacific Linguistic Studies, I Historical Linguistics ed. G.B. Milner and E.J.A. Henderson).

Lukas, J. (1969) "Tonpermeable und tonimpermeable Konsonanten im Bolanci (Nordnigerien)" *Ethnological and Linguistic Studies in Honor of N.J. van Warmelo* (Ethnological Publications 52) 113-138. Department of Bantu Administration and Development, Pretoria, South Africa.

Maddieson, I. (1974) "A possible new cause of tone-splitting: evidence from Cama, Yoruba and other languages" Published in this volume.

Maran, L. (1971) *Burmese and Jingpho: A study of tonal linguistic processes (Occasional Papers of the Wolfenden Society on Tibeto-Burman Linguistics* 4), Center for Asian Studies, University of Illinois, Urbana.

Maran, L. (1973) "On becoming a tone language: a Tibeto-Burman model of tonogenesis" *Consonant Types and Tone* 97-114. *(Southern California Occasional Papers in Linguistics* 1). University of Southern California, Los Angeles.

Matisoff, J.A. (1972) *The Loloish Tonal Split Revisited* (Research Monograph 7) Center for South and Southeast Asia Studies. University of California, Berkeley.

Pike, E.V. (1974) "A multiple stress system versus a tone system" *International Journal of American Linguistics* 40.3: 169-175.

Pulleyblank, E.A. (1970) "Late Middle Chinese" *Asia Major* 15.2: 197-239.

Pulleyblank, E.A. (1974) "Late Middle Chinese and Southern Dialects" presented at the 6th International Conference on Sino-Tibetan Language and Linguistics. Forthcoming in the *Proceedings* (ed. B. Tsou).

Sarawit, M. (1973) *The Proto-Tai Vowel System* Ph.D. thesis, University of Michigan, Ann Arbor.

Schachter, P. (1969) "Natural Assimilation Rules in Akan" *International Journal of American Linguistics* 35: 342-355.

Schachter, P. and V.A. Fromkin (1968) *A Phonology of Akan: Akwapem, Asante and Fante (Working Papers in Phonetics* 9) University of California, Los Angeles.

Trutenau, H.J.M. (1972) "To spread or not to spread: a hard look at a 'tone-spreading' proposal, and limitations on requirements of pitch-specification in tone languages" Paper presented at the 10th West African Languages Congress, Legon.

Yung-Sui, L., C. K'o-chung and C. Ch'i-kuang (1959) "Some problems concerning initials and tones in the Miao language" *Yü yen yen chiu* 4: 65-80. Translation by Chang Yü-hung and Chu Kwo-ray *Miao and Yao Linguistic Studies* (ed. H.C. Purnell) Department of Asian Studies, Cornell Univeristy, Ithaca, New York, 1972, pp. 83-110.

# *A possible new cause of tone-splitting - evidence from Cama, Yoruba and other languages*[1]

Ian Maddieson

[Department of Linguistics, University of California, Los Angeles]

## 1. Introduction

This paper will review the evidence that Proto-Niger-Congo was a tone language with only two level tones and seek to find the evidence that will explain how some of the descendant languages have more than two tones. In particular it will show how synchronic tone rules in Cama and consonant correspondences between Cama and Yoruba suggest a new factor in historical tone splitting - the difference between fortis and lenis articulation - may have been discovered.

## 2. Tone in Niger-Congo

A large majority of the present-day Niger-Congo languages have typologically similar two-level tone systems, some have more complex tone systems and a few are non-tonal. Comparative studies show that not only may consonant types and vowel qualities be reconstructed but also that cross-language correspondences of tone can be demonstrated. Niger-Congo historical studies first reached maturity in the Narrow Bantu field. Although Meinhof (1899) and Bourquin (1923) did not reconstruct tonal distinctions in their 'Urbantu' word stems, Nekes (1911a) maintained, on the basis of correspondences between Yaunde and Shanbala, that Proto-Bantu had a two-level tone system, and he extended his evidence to more languages in later papers (1911b, 1928). Other scholars[2] have confirmed Nekes' conclusion. Comparative studies of other Niger-Congo subgroups also generally indicate a prior two-level system[3], and wider comparisons show that the two levels correspond across the groups. The 'Proto-West-Sudanic' forms of Westermann (1927) sometimes marked high or low tone, as do the reconstructions in Armstrong (1964) and the Benue-Congo Comparative Wordlist (Williamson and Shimizu 1968, Williamson 1973b). Similarly Voorhoeve's Ekoid-

Bamileke-Bantu 'pseudoreconstructions' (1967) and Cook's extension of these to Efik (1968), as well as de Wolf's phonological sketch of Proto-Benue-Congo (1971:51) agree on an earlier two-level tone system. Stewart (1970), in some of the most careful work on comparative reconstruction in West Africa, shows that a two-level tone system must have existed in a construct that he calls 'Proto-Volta-Bantu', which is the latest common ancestor of:

1. the Potou Lagoon languages Cama (Ebrie) and Mbato (cf Dumestre 1971:311),

2. the Volta-Comoe languages (Stewart 1966), and

3. the Narrow Bantu languages, as represented by Guthrie's Common Bantu starred forms (1967 ff).

Stewart only compared these three language groups, but their latest common ancestor should also be the ancestor of a large number of Niger-Congo languages at present usually grouped under the labels Kwa and Benue-Congo (Greenberg 1963) but which I would prefer to label jointly Southern Niger-Congo as I share the doubts of many other scholars on the correctness of the division established between the supposed Kwa and Benue-Congo families.

## 3. Models for tone change

If Proto-Niger-Congo had only two tone levels, then the languages which currently have tone systems with more levels must have developed these from the earlier two-level system. We need to explain how a typological change could take place to alter the two-level system into one of three levels (as in Yoruba, Igala, Birom, Jukũn etc) or of four levels (as in Igede, Toura, Ndoro or the Nikki dialect of Bariba) or even of five levels (as in the Mbembe languages Ashuku and Kporo). Processes which result in the multiplication of the number of tones in a language are known as 'tone-splitting' processes. Three models have been put forward for this kind of change. They may for convenience be labelled the *downdrift, sandhi* and *phonation type* models. I will examine these to seek the one that will explain why Yoruba has three tones.

### i) the downdrift model

The 'downdrift model' suggests that differing pitch exponents for the same underlying tone level which arise as a result of the superimposition of intonational patterns, such as downdrift, can develop into new contrastive tone levels. In the course of the long debate over downstep (Stewart 1965, Armstrong 1968, Williamson 1970 etc) it has often been suggested that languages like Akan provide a possible model for tone-splitting[4]. Akan has downdrift, and synchronic rules that produce a high-downstepped high sequence of tones when a low tone segment is deleted between two high tones (which differ in pitch because of downdrift). It also has a rare lexical downstepped high tone which probably arose historically from the loss of a low tone intervening between two high tones. A further spread of this phenomenon could yield a third tone of much wider distribution than the present (non-automatic) downstep tone in Akan. This third tone would presumably continue to show that it had arisen in positions following high tone only by showing a skewed distribution, so this model does not explain the derivation of a true mid tone, such as there is in Yoruba, that is not subject to such restrictions on its distribution. Dwyer (1973:248-250) has suggested that Southwestern Mande did develop a third contrastive tone when the complementary distribution of mid and low phonetic levels in disyllabic nouns was 'spoiled' by the borrowing of low-low nouns from Northern Mande, and the distribution of the three tones does still largely reflect the earlier complementarity.

ii) the sandhi model

In many languages the same underlying has variant phonetic forms according to the tones which precede or follow. Tone sandhi rules are particularly well known from numerous Chinese dialects (for some examples see Wang 1967). In many of the Chinese cases the phonetic motivation for the rule is obscure but we can imagine how a language with two basic tone levels but with a tendency for high tones to be somewhat lowered when a low tone follows and for low tones to be somewhat raised when a high tone follows could develop into a language with four levels if the conditioning environment was lost or absorbed. This is essentially the kind of process that is sketched for Fe?Fe? by Hyman (1972) and for Dschang by Tadadjeu (1974). A merger of the raised low and lowered high tones into a mid tone could result in a three-level system evolving from an earlier two-level one. In Yoruba, however, there is evidence that the third tone arose because the original low tone split into low and mid variants, while the high tone was unperturbed. In Niger-Congo two-level languages the general pattern is for the high tone to dominate over the low (see Maddieson 1972, and Schachter 1969, Williamson 1972). Because Yoruba high tone dominated over both low and mid tones we may assume that the original high is preserved as Yoruba high. Stahlke (1972) has presented other evidence from internal reconstruction, including the relative frequency of tones on monosyllabic verbs, that confirm the original identity of low and mid tones. While I think it is probable that some of the mid tones derive from earlier high-low or low-high sequences, there does not seem to be the comparative or internal evidence to sustain this explanation for them all.

iii) <u>the 'phonation type' model</u>

In many languages there are contextual modifications of pitch which depend on the manner of articulation of surrounding consonants, often the glottal state or phonation type being the crucial factor. Such contextual modification can become the basis for the restructuring of a tone system - as was already known to philologists in the time of the T'ang dynasty in China. Traditional Chinese philology distinguishes yin and yang descendants of tones from an earlier simpler tonal system. The split into a higher (yin) and lower (yang) variety depended on the initial consonant. Recently the question of consonant influence on tone has attracted sufficient interest for a conference to be devoted specifically to the subject (Hyman 1973). Various contrasts of phonation types or manners of articulation have been claimed or demonstrated to have a historical splitting effect on tones or to introduce tonal contrasts to a language that previously lacked them. The most widely discussed is the distinction between voicing and voicelessness, especially in obstruents. Lea (1972, 1973) and others (e.g. Chistovitch 1969, Haggard, Ambler and Callow 1970) have shown that nondistinctive pitch differences in vowels occur in languages like English and Russian following voiceless obstruents, voiced obstruents, and sonorants and these can be important perceptual clues to the recognition of the nature of the preceding consonant. Where lower pitch at the beginning of the vowel or a lower tone reflex occurs following (originally) voiced obstruents as in present-day English and in the historical development of some Chinese dialects (e.g. Cantonese, Taishan - Cheng 1973), southwestern Tai dialects (Brown 1965), in ten of thirteen Loloish languages (Matisoff 1972) and Cham in the Malayan-Indonesian group of languages (Haudricourt 1972:61, Blood 1964:516 fn 5) to mention only a few, it may be that the supraglottal obstruction causes a reduction in transglottal pressure and airflow through the glottis is slowed, consequently the rate of vocal cord vibration is reduced (cf Lea 1973). Ladefoged (1972:74) remarks that "the rate of flow of air depends in part on the subglottal pressure ..... But it is also partially dependant on the position of the vocal cords themselves. When the glottis is spread open there is obviously a potentially higher rate of flow than when it is narrowed." These complementary explanations suggest why voiceless sounds may be followed by higher pitch and why voiced obstruents may be followed by a depressed pitch, with perhaps voiced sonorants forming a third intermediate class (cf the situation in Ewe, Ansre 1961). However about an equal number of cases of the reverse historical correlation can be found, of voicing with higher pitch and voicelessness with lower pitch - for example in Sui (Haudricourt 1972:68-9), the central branch of the Tai family (Brown 1965, Sarawit 1973) many of the Northern Tai languages, Nasu and Lü-Ch'üan among the Loloish languages, Chaochow and Shaowu among the Min Chinese dialects (Norman 1973) etc. There are also many individual languages that show both of these developments, giving both correlations in differing environments (e.g. the Po-Pei dialect of Chinese which has the first with tone A or C but the second with tone B). We will return to this reverse correlation of tone with voicing later, after considering the earlier history of Southern Niger-Congo consonantism.

## 4. Fortis/lenis contrast in Southern Niger-Congo

In Yoruba, unlike standard Ewe (Ansre 1961, Stahlke 1971), there are few if any clues in a present-day correlation of classes of consonants and different tones to help in the reconstruction of earlier tonal facts. All consonants precede or follow all tones. If there is a connection between tone and consonant type in Yoruba, it must lie in some feature which has lost its distinctive value (through merger, shift etc) in the course of the evolution of the language. The consonant system of modern 'standard' or 'Common' Yoruba is a fairly simple one (if one ignores recent 'educated' loans) and some degree of simplification looks inherently probable. It contains only 17 consonants and no clusters are permitted. The consonants are as follows;

| | | | | | |
|---|---|---|---|---|---|
| voiceless stops | | t | č | k | kp |
| voiced stops | b | d | ǰ | g | gb |
| vl continuants | f | s | ʃ | h | |
| vd continuants | m,w | l | y | | w |

Yoruba lacks the distinction between 'fortis' and 'lenis' articulations which is probably to be reconstructed for the latest common ancestor of Southern Niger-Congo. Evidence of a widespread distinction between fortis and lenis consonants can be found in the Potou Lagoon languages ('Western Kwa'), in languages of Edo group ('Eastern Kwa' - see Laver 1967, Elugbe 1973, Ladefoged 1974 etc) and in the Cross River 3 languages (these are the Upper Cross group of the Delta-Cross Division of Cross River according to Cook's classification and include Mbembe, Ufia and Agbo - Bendor-Samuel and Spreda 1969, KoHumono - Cook 1969, and Kukele): Less clearly visible traces remain in the Lower Niger group in Ẹkpẹyẹ (Clark 1971, Williamson 1973:14-5), in Ịjọ and elsewhere. Cama is one of the languages which has a four-way contrast among stops at the same place of articulation; voiced fortis, voiced lenis, voiceless fortis and voiceless lenis. Stewart (1970:3) remarks that "the articulatory nature of the lenis feature has not been precisely determined by instrumental means, but it appears to consist in the absence of the heightened oral cavity pressure which, in other languages, commonly occurs as a redundant feature of obstruents". Among the voiceless stops the lenis set lack aspiration (cf. Kim 1965). The voiced lenis stops have been characterised as 'implosive' but they are not truly so, rather they are more like nasals which typically lack a build-up of pressure in the oral cavity because of the nasal escape. They seem easily to pass into nasals and to be perceptually close to them - compare the description of similar voiced stops in East London speech in Beaken (1971). Williamson describes the so-called 'implosives' of Ekpeye as 'semi-sonorants' and the conception of these sounds as intermediate between the normal stops (fortis) and sonorants seems appropriate. Elugbe has data on similar sounds from Okpamheri which show that the lenis stops are shorter in duration than corresponding fortis ones and that in, for example, an alveolar place of articulation the area of contact of the articulators during the closure is smaller. This difference between fortis and lenis stops is constant for both the voiced and voiceless sets.

Obviously one might describe the differences between the stops in Cama in terms of four distinct types rather than insisting on two paired oppositions, voiced/voiceless and fortis/lenis. Stewart protests that this would "obscure ... the situation in the language as a whole" but he does not give any examples of how this is true. However there are a number of cases in the history of the languages which share this distinction which require that the lenis voiced stops (the 'implosives') and the unaspirated voiceless stops be classed together as members of the same natural class. For example, in Mbato it is these two sets which have merged in the process of reduction of the four-way contrast to a three-way contrast.

In Cama the fortis feature is involved in the tone rules. Final low tone glides downwards. In disyllabic nouns (which invariably have a high tone prefix) the second tone is raised if it is an underlying low but it retains the downglide, which becomes superfically distinctive. This raising occurs regardless of the nature of the intervening consonant (except for the qualification below). Then, either a high or low is lowered after a fortis voiced consonant. Thus a four-way superficial distinction of pitch is produced. The following examples from Stewart illustrate his analysis:

| Gloss | I. Under-lying | II. Down-glide | III. Low Raising | IV. Lowering | V. Phonetic Transcription |
|---|---|---|---|---|---|
| "grass" | ábị̀ | ábị̀ ↓ | ábị́↓ | ábị̀↓ | [ábı̑] [¯ ˎ] |
| "drum" | áḅị̀ | áḅị̀ ↓ | áḅị́↓ | --- | [áɓî] [¯ ˎ] |
| "water" | ã́dú | --- | --- | ã́dù | [ńdù] [¯ _] |
| "tongue" | ádẹ́ | --- | --- | --- | [álé] [¯ ¯] |

Naturally one could take the view that the lowering of tones after fortis voiced consonants only affected high tones and that the consonant acted to inhibit the raising of low shown in III rather than having this low tone be just raised and then lowered. In either case the mechanism whereby a tone-split could emerge can be seen, lower varieties of both high (level) and low (falling) tones occurring after the voiced fortis stops. A rule of tonal depressing following fortis consonants has also been reported for Kukele (Fajen 1970). Explanations and conjectures about why fortisness should depress tone will be deferred until the final section of the paper.

## 5. Cama-Yoruba Correspondences

The Cama data suggests that the fortis/lenis distinction may have contributed to the splitting of the Yoruba low tone before loss or merger of consonants resulted in the reduced Yoruba consonant inventory. I searched for regular phonetic correspondences in an attempt to confirm this hypothesis. Unfortunately few items are available in published or other form in those languages which have a thorough-going fortis/lenis distinction. Much of what is available does not carry tone marks or has an imperfectly worked-out tone system. Cama items can be found in Vogler (1968), Dumestre (1970, 1971), and Stewart (1970), but although other lists can help to establish the correspondences between consonants, only Stewart's fully tone-marked list and, with some reservations, a list supplied by Stewart at an early stage in his analysis to Ladefoged in 1962 can testify to tonal correspondences. However, we can observe the distribution of tones in Yoruba in relation to the consonants for which correspondences can be found. Yoruba items have mostly been sought in the dictionaries of Abraham (1958) and Delano (1969) and in Fresco's dialect study (1970).

i) <u>Cama lenis voiced stops</u>

Following Stewart, subdotted letters will be used for the lenis stops in phonological transcriptions. The lenis voiced bilabial stop /ḅ/ has a nasal variant, [m] , in a nasal environment, but elsewhere is [ɓ] . A reasonable number of good correspondences suggest that Cama /ḅ/ corresponds with a Yoruba /w/ except before a Yoruba nasal vowel when the correspondence is /ḅ/ : /m/:

| Cama item | gloss | phonetic | Yoruba | gloss |
|---|---|---|---|---|
| ã́ḅú | "arm" | [ḿmṍ] | ọwọ́ | "hand' |
| ḅá | "come" | [ɓá] | wá | "come" |
| ḅo | "take" | [ɓo] | mú | "take, grasp, etc." |
| ḅu | "cut down" | [ɓu] | wo | "collapse, demolish, fall" |
| aḅi | "excrement" | [aɓi] | imĩ́* | "faeces" |
| ḅi | | [ɓi] | | |

*In Ondo, Okitipupa, and Oba dialects this is [iwĩ]

One possible correspondence suggests /ḅ/ : /f/ :

| | | | | |
|---|---|---|---|---|
| ḅo | "break" | [ɓo] | fọ́ | "break into pieces" |

This would appear to be homophonous in Cama with the word meaning "take", but it has a different reflex in Yoruba. Perhaps there was some additional distinction in the antecedants of these two words. For Stewart the lenis voiced alveolar stop /ḍ/ is a "purely theoretical base form" as, in the dialect he investigated, "it is replaced with [n] if it is before or after a [+nasal] vowel, and with [l] otherwise". Dumestre (1970, 1971) shows that there are dialects in which a [ɗ] pronunciation actually occurs in non-nasal environments. The /ḍ/ in Cama corresponds most frequently to a Yoruba /l/ but sometimes corresponds with /r/:

| Cama item | gloss | phonetic | Yoruba | gloss |
|---|---|---|---|---|
| ḍá ã́ḍá / aḍa | "sleep" | [lã́ ñaã́] [ala] | lã́ | "dream" |
| ḍò | "go" | [lò] | lọ | "go" |
| ḍù | "repair, sew" | [lù] | lu | "pierce" used with abéré "needle" |

| Cama item | gloss | phonetic | Yoruba | gloss |
|---|---|---|---|---|
| ãḍu | "mushroom" | [nnu] | olú | "any mushroom or fungus" |
| ãḍuḍu | "dust" | [nnuɗu] | èérú | "dust, ash" |
| ã́ḍṹ | "palm oil" | [ńnṍ] | ẹrú | "palm oil" |
| ã́ḍã́ | "animal" | [ńnã́] | ẹran | "animal, meat" |

Before a high front oral vowel the correspondence is /ḍ/: /j/:

| | | | | |
|---|---|---|---|---|
| ḍí | "eat" | [lí] | jẹ | "eat" |

Note that no *lí *li or *lì exists in Yoruba. The vowel correspondence i:e here suggests the possibility that the Yoruba form had a suffix which merged with the stem vowel; viz jíà > jẹ. One aberrant correspondence is the following:

| | | | | |
|---|---|---|---|---|
| ã́ḍẽ́ | "tongue" | [ã́lẽ́] | èdè | "language" |

If these are truly corresponding forms then an unusual shift of lenis to fortis must have occurred in the Yoruba form.

Cama voiced fortis stops

Cama /b/ seemed difficult to match as words which were cognate could not easily be found. It seems probable that /b/ corresponds with Yoruba /b/ if the following are in fact good cognates:

| Cama item | gloss | phonetic | Yoruba | gloss |
|---|---|---|---|---|
| bɔ̃ | "be rotten" | [bɔ̃̀] | bu | "go mouldy" |
| be | "belch" | [bè] | bi | "vomit" |

Similarly Cama /d/ seems to correspond to Yoruba /d/:

| | | | | |
|---|---|---|---|---|
| ã́dṹ | "water" | [ńdù] | odò | "river" |
| adu-ɓɛ | "river" | [aduɓɛ] | | |
| ada | "bat" | [ada] | àdọ́n | "fruitbat" |
| di | "arrive, come out, come down" | [di] | dé | "arrive" |
| dr̃ẽ | "resound" | [dɾ̃ɛ̃] | dún | "sound" |

Perhaps a second series of correspondences is suggested by

| | | | | |
|---|---|---|---|---|
| du | "snake" | [du] | ejò | "snake" |
| adudu | "rainy season" | [adudu] | òjò | "rain" |

The /d/ : /j/ correspondence here might be restricted to cases where a high back vowel had originally followed */d/. If so, it is not clear why Cama <u>ndu~ adu</u> corresponds with <u>odò</u>; perhaps it should be paired with òjò. An aberrant correspondence seems to be

| | | | | |
|---|---|---|---|---|
| dò | "forge" | [dò] | rọ | "forge" |

We may summarize the probable correspondences between the voiced fortis and lenis consonants in Cama and Yoruba segments by saying that, in general, the fortis ones correspond with voiced stops in Yoruba and the lenis ones correspond with sonorants.

iii) <u>Cama voiceless stops</u>

Cama fortis voiceless stops clearly correspond with Yoruba voiceless stops, but the lenis ones proved difficult to find cognates for. One etymology, 'foot', seems to suggest that Cama lenis /ṭ/ corresponds with Yoruba /s/[5].

Given that the number of segmental correspondences is sufficient for us to have confidence in them (and, considering the meagre sample of Cama available for comparison, the number is quite impressive and includes a number of very widely-attested Niger-Congo roots), we can consider the correlation of consonant type and tone[6]. An interesting fact emerges: all the Yoruba forms cognate with Cama forms having a lenis consonant show either high or mid tone after it and not low tone, with the exception of the aberrant form <u>èdè</u> which of course has a consonant which normally corresponds to a fortis consonant in Cama. Similarly the Yoruba forms cognate with Cama forms having a fortis consonant show either a high or a low tone and not mid tone, except for the aberrant example of the mid-tone verb <u>ro</u>, which has a consonant that would normally correspond with a lenis consonant in Cama. There is one further exception here; the verb <u>bu</u> "go mouldy".

In the smaller number of cases for which there is full tonal data and direct correspondence of tone can be investigated, we find that, with the lenis consonants, Cama high tone corresponds with Yoruba high tone four times, and Cama low tone corresponds with Yoruba mid tone twice.

Twice also Cama high tone corresponds with Yoruba mid tone, one of these cases being ẹ̣je (?<ḍì̥a). With the fortis consonants, we have evidence only for one tonal correspondence, which is of Cama high with Yoruba low (if the "water, river" etymology is correct). These results show that there is a strong possibility that fortisness has acted historically as a depressor of tone[7]. Since this is so, it is worth considering the phonetic plausibility of such an effect.

## 6. Explanation of the phenomenon

Stewart (1970:8) suggests that the differing effects on tone of the voiced fortis and lenis stops in Cama arise because the fortis stops do act in the way described by Lea (i.e. the supraglottal obstruction produces an equalisation of the pressure drop across the glottis, with a consequent drop in the rate of air-flow through the glottis and therefore also a drop in pitch) but the lenis stops do not do so. He speculates that the heightened pressure in the oral cavity is avoided with the lenis stops "possibly by lowering the larynx, or by relaxing the walls of the oral cavity and allowing them to expand, or both". Since lowered larynx position and lowered pitch tend to correlate with each other (Vanderslice 1967), the larynx is probably not lowered, but Stewart is probably right in his suggestion that the walls of the oral cavity are not stiffened at all. In addition if the closure is held for a shorter duration and is a less extensive contact, then the opportunity for pressure to build up will not be there. Only if the articulation is 'fortis' (i.e. with stiffened cavity walls preventing expansion of the cavity size and with more extensive contact and/or longer duration) will voiced obstruents tend to depress pitch.

## 7. Wider relevance

The suggestion that differences in consonant tensity may be relevant for pitch variation has wider relevance than just for Southern Niger-Congo. Norman (1973) has suggested a need to reconstruct a six-way contrast between types of initial stops in Proto-Min Chinese. Beside plain (unaspirated) and aspirated series he proposes that a third set, which he describes as 'softened', must be posited to account for the correspondences between Min dialects. There are voiced and voiceless members of each of the three series, making a six-way distinction possible at one place of articulation. He does not speculate on the phonetic nature of the 'softened' stops but does suggest at least for the voiced softened series that they "underwent a process of lenition" perhaps because of the influence of some type of voiced segment prefixed to the roots in question. His paper shows that in Amoy the descendants of the earlier tones can be accounted for by splits conditioned only by the difference between voiced and voiceless initials, but in some other dialects there are divergent developments after the softened series. In Kienow for example there is a reflex of original tone 2 (= shang) and tone 4 (= ru ) after the voiced softened series, whereas following the other two voiced series there is a 44 reflex of these same two tones. More interestingly, in Shaowu there is a 55 reflex of tone 1 (= ping) after the voiceless softened series, whereas the other two series of voiceless initials are followed by a 11 reflex of the same tone. Perhaps in this case an original distinction of fortis and lenis stops conditioned a tone split along the same lines as is suggested in this paper for Yoruba, with a higher reflex after lenis stops than is found after fortis ones.

It may also be the case that, in the many cases in which it is found that there are lower tone reflexes after voiceless consonants than after voiced ones if the standard reconstructions are followed, the change can be understood if we see the distinctive feature that separates the series of consonants to be a fortis/lenis one rather than a voiced/voiceless one. In support of this speculation is the fact that many languages of the world, including English, have voiced obstruents which are less 'fortis' in nature than the corresponding voiceless ones (Gimson 1962). Although the tensity feature in English is subordinate to the voicing feature and does not act to reverse the expected correlation of voicing with lower pitch, in other languages the voicing distinction could well be subordinate, and thus the reverse correlation is explained. The comparison of Yoruba and Cama has shown that the study of the possible effect on tone of an independent feature of tensity is a worthwhile avenue to explore in the realm of consonant effects on tone and possible tone-splitting; fields which remain full of mysteries despite the increased attention devoted to them in recent years.

Footnotes

[1] This work was in part supported by grant NSF GS31235X to the Phonetics Laboratory, University of California, Los Angeles.

[2] Including Hulstaert (1934), Greenberg (1948), Hoffmann (1952-3), Meeussen (1954), Guthrie (1967 ff) and Kähler-Meyer (1967-8).

[3] See for example Williamson (1965:6) for Proto-Ijo and Proto-Lower-Niger (1973a:5), Heine (1968) for Proto-Togo-Remnant, Stewart (1966) for Proto-Volta-Comoe, Dwyer (1973) for Proto-Southwestern-Mande (cf also Welmers 1973), Long (1971) for Proto-Northern-Mande, Elugbe (1973) for Proto-Edo, etc. On the other hand Proto-Yoruba-Igala, according to Williamson (n.d.) and Silverstein (1973), and Proto-Jukunoid according to Shimizu (1971) had three levels.

[4]Stewart (1971) has more recently proposed that the three level system seen in Yoruba is more conservative than the two-level plus downstep system of languages like Akan. On this reading the downstep tone is the remnant of the formerly more widely distributed mid tone. The mechanism by which this is achieved is complex and the proposal seems to ignore the much greater frequency and wider distribution geographically of the two-level system.

[5]The regular correspondence in Igala for Yoruba /s/ is the voiceless alveolar tap /ɽ̥/, while Yoruba /t/ corresponds with Igala /t/ (Silverstein 1973). Obviously a lenis voiceless alveolar stop and a voiceless alveolar tap are similar segments, and probably Igala is conservative in retaining /ɽ̥/ here rather than innovative as Silverstein suggests.

[6]Where we find voiced stops in Yoruba corresponding with voiced fortis stops in Cama we also find voiced stops in Igala. Where Yoruba has /r/ (</d/) Igala has /l/. Among the Cama voiced lenis stops, /ḅ/ corresponds with Igala /w/ and occasionally /m/, and /ḍ/ corresponds with Igala /n/, confirming the similarity of these stops to nasals. Except among noun prefixes, where Igala has high tone when Yoruba has mid, tones in Yoruba and Igala coincide. We may therefore state that correlations of tone and consonant type that hold between Cama and Yoruba hold between Cama and Proto-Yoruba-Igala (including Itsekiri).

[7]Stewart (1972) has pointed out that the three groups of consonants that we need to distinguish in Ewe in order to formulate the tone rules can be distinguished by dividing the voiced category into fortis and lenis groups, and has suggested that this division is also a trace of the earlier wider distribution of the fortis/lenis contrast in Niger-Congo and its interaction with tone.

References

Abraham, R.C. (1958), *Dictionary of Modern Yoruba*, University of London Press.

Ansre, G. (1961), *The Tonal Structure of Ewe*, (Hartford Studies in Linguistics 1) Hartford Seminary Foundation, Connecticut.

Armstrong, R.G. (1964), *The Study of West African Languages*, Ibadan University Press.

Armstrong, R.G. (1968), "Yala (Ikom): a terraced-level language with three tones," *J.W.A.L.* 5.1. 49-58.

Beaken, M. (1971), *A Study of Phonological Development in a Primary School Population of East London*, Ph.D. thesis, London University.

Bendor-Samuel, J.T. and K.W. Spreda (1969), "Fortis Articulation: a feature of the present continuous verb in Agbo," *Linguistics* 52:20-26.

Blood, D.L. (1964), "Applying the criteria of patterning in Cham phonology," *Văn-Hoá Nguyệt-San* 13.4:510-520.

Bourquin, W. (1923), *Neue Ur-Bantu-Wortstämme*, Berlin.

Brown, J.M. (1965), *From Ancient Thai to Modern Dialects*, Social Science Association Press, Bangkok.

Cheng, T.M. (1973), "The phonology of Taishan," *Journal of Chinese Linguistics*, 1.2:256-322.

Chistovitch, L.A. (1969), "Variations of the fundamental voice pitch as a discriminatory cue for consonants," *Soviet Physics - Acoustics* 14:372-378.

Clark, D.J. (1971), "Three 'Kwa' languages of the Niger Delta," *Journal of West African Languages* 8.1:27-36.

Cook, T.L. (1968), "Efik/Ekoid-Bamileke-Bantu", Paper presented at the Leiden meeting of the Benue-Congo Working Group, West African Linguistic Society.

----- (1969), *Some Tentative Notes on the KòHǔmōnò Language*, (Research Notes 2.3), University of Ibadan.

Delano, I.O. (1969), *Dictionary of Yoruba Monosyllabic Verbs*, (2 Vols.), Institute of African Studies, University of Ifẹ, Nigeria

De Wolf, P.P. (1971), *The Noun Class System of Proto-Benue-Congo,* Mouton, The Hague.

Dumestre, G. (1970), "Contribution à l'étude phonologique de l'ébrié (Basse Côte d'Ivoire)," *Annales de L'Université d'Abidjan Serie H Linguistique* 3.1:19-30.

----- (1971), *Atlas Linguistique de Côte D'Ivoire: Les Langues de la région lagunaire,* (Documents Linguistiques XIX), Institut de Linguistique Appliquée, Université d'Abidjan, Ivory Coast.

Dwyer, J.D. (1973), *The Comparative Tonology of Southwestern Maude Nominals,* Ph.D. thesis, Michigan State University.

Elugbe, B. (1974), *Comparative Edo Phonology,* Ph.D thesis, University of Ibadan.

Fajen, J. (1970), Talk on morphotonology of Kukele given at the Linguistic Seminar, University of Ibadan.

Fresco, E.M. (1970), *Topics in Yoruba Dialect Phonology (Studies in African Linguistics,* Supplement 1).

Gimson, A.C. (1962), *An Introduction to the Pronunciation of English,* Arnold, London.

Greenberg, J.H. (1948), "The tonal system of Proto-Bantu," *Word* 4:196-208.

----- (1963), *The Languages of Africa,* IJAL 29:1, reprinted 1966 Mouton, The Hague and Indiana University, Bloomington.

Guthrie, Malcolm (1967-     ), *Comparative Bantu,* (four vols.) Gregg, Farnborough.

Haggard, M., S. Ambler and M. Callow (1970) "Pitch as a voicing cue," *Journal of the Acoustical Society of America* 25:105-113.

Haudricourt, A.G. (1972), "Two-way and three-way splitting of tonal systems in some Far Eastern languages," (translated by C. Court) in *Tai Phonetics and Phonology,* Central Institute of English Language, Bangkok, 58-86. Originally appeared in *Bulletin de la Societe de Linguistique de Paris.* 56.1:163-180 (1961).

Heine, Bemd (1968), *Die Verbreitung und Gleiderung der Togorestsprachen,* Dretrich Reimer, Berlin.

Hoffmann, Carl F. (1952-3) "Zur Verbreitung der Zahlwörtstämme in Bantusprachen," *Afrika und Übersee* 37:65-80.

Hulstaert, R.G. (1934), "Les Tons en Lonkundo," *Anthropos* 29:57-97, 399-419.

Hyman, Larry M. (1972), *A Phonological Study of Feʔ Feʔ-Bamileke (Studies in African Linguistics*, Supplement 4)

-----(1973), *Consonant Types and Tone (Southern California Occasional Papers in Linguistics* 1) University of Southern California, Los Angeles.

Kähler-Meyer, Emmi (1967-8), "The Tones in Urbantu," *Afrika und Übersee* 51.2: 81-90.

Kim, C.W. (1965), "On the autonomy of the tensity feature in stop classification, with special reference to Korean stops," *Word* 21: 339-359.

Ladefoged, P. (1972), "The features of the larynx," *Journal of Phonetics* 1.1:73-84.

----- (1974), "Implications of some African phonetic data," Paper presented to plenary session, 5th Annual African Linguistics Conference, Stanford.

Laver, J. (1967), "A preliminary phonology of the Ayele dialect of Etsako," *Journal of West African Languages* 4.2:53-56.

Lea, W.A. (1972), *Intonational Cues to the Constituent Structure and Phonemics of Spoken English*, Ph.D. thesis, Purdue University.

----- (1973), "Segmental and suprasegmental influences on fundamental frequency contours," in Hyman (1973) 15-70.

Long, R.W. (1971), *A Comparative Study of the Northern Mande Languages*, Ph.D. thesis, Indiana University.

Maddieson, Ian (1972), "Tone system typology and distinctive features," *Proceedings of the Seventh International Congress of Phonetic Sciences* (edd. A. Rigault and R. Charbonneau) Mouton, The Hague, 957-961.

Matisoff, J.A. (1972), *The Loloish Tonal Split Revisited* (Research Monograph 7) Center for South and Southeast Asia Studies, University of California, Berkeley.

Meeussen, A.E. (1954), "The tones of prefixes in Common Bantu," *Africa* 24: 48-54.

Meinhof, Carl (1899), *Grundriss einer Lautlehre der Bantusprachen*, Brockhaus, Leipzig. (2nd ed. Reimer, Berlin: 1910) English version by N.J. van Warmelo Reimer-Vöhsen, Berlin:1932)

Nekes, P.H. (1911a), "Die Bedeutung der musikalischen Töne in der Bantusprachen," *Anthropos* 6: 546-574.

-----(1911b), "Die musikalischen Töne in der Dualasprache," *Anthropos* 6: 911-919.

----- (1928), "Zur Tonologie in den Bantusprachen," *Festschrift Schmidt* Vienna, 80-92.

Norman, J. (1973), "Tonal development in Min," *Journal of Chinese Linguistics* 1.2: 222-238.

Sarawit, M. (1973), *The Proto-Tai Vowel System* Ph.D. thesis, University of Michigan.

Schachter, P. (1969), "Natural assimilation rules in Akan," *IJAL* 35: 342-355.

Silverstein, R. (1973), *Igala Historical Phonology*, Ph.D. thesis, University of California, Los Angeles.

Shimizu, K. (1971), *Comparative Jukunoid : an introductory survey*, Ph.D. thesis, University of Ibadan.

Stahlke, H. (1971), *Topics in Ewe Phonology*, Ph.D. thesis, University of California, Los Angeles.

----- (1972), "The development of the three-way tonal contrast in Yoruba," Paper presented at the 3rd Annual Conference on African Linguistics, Bloomington, Indiana. Forthcoming in the *Proceedings* of the conference (ed. E. Voeltz), Indiana University Press.

Stewart, J.M. (1965), "The typology of the Twi tone system," (with comments by P. Schachter and W.E. Welmers), preprint from *Bulletin of the Institute of African Studies* 1, University of Ghana, Legon.

----- (1966), "Comparative study of the Volta-Comoe languages," *Research Review* (Institute of African Studies, University of Ghana, Legon) 2.2: 41-47.

----- (1970), "The lenis stops of the Potou Lagoon languages," paper presented at the 9th West African Languages Congress, Freetown.

----- (1971), "Niger-Congo : Kwa," in *Current Trends in Linguistics Vol 7 : Linguistics in Sub-Saharan Africa* (ed. T. Sebeok), Mouton, The Hague, 179-212.

----- (1972), " 'Implosives' in Proto-Bantu ?" Paper presented at the 10th West African Languages Congress, Legon.

Tadadjeu, M. (1974), "Floating tones, shifting rules and downstep in Dschang-Bamileke," Paper presented at the 5th Annual Conference on African Linguistics, Stanford, California.

Vanderslice, R. (1967), "Larynx vs. lungs : cricothyrometer data refuting some recent claims concerning intonation and 'archetypicality'," *Working Papers in Phonetics* (University of California, Los Angeles) 7: 69-79.

Vogler, P. (1968), "Esquisse phonologique de l'Ebrie," *Annales de l'Universite d'Abidjan, Serie H, Linguistique* 1.1: 60-65.

Voorhoeve, J. (1967), "Ekoid-Bamileke-Bantu," Paper presented to the Benue-Congo Working Group, 7th West African Languages Congress, Lagos.

Wang, W.S-Y. (1967), "The phonological features of tone," *IJAL* 33.2: 93-105.

Welmers, W.E. (1973), *African Language Structures*, University of California Press, Berkeley.

Westermann, D. (1927), *Die westlichen Sudansprachen und ihre Beziehungen zum Bantu* (*M.S.O.S.* 30, Beiheft), de Gruyter, Berlin.

Williamson, K. (n.d., c.1960) "Proto-Yoruba-Igala," unpublished Yale University term paper (reference from Silverstein 1973).

----- (1965), *A Grammar of the Kolokuma Dialect of Ijo* (West African Language Monographs 2), Cambridge University Press.

----- (1970), "Downdrift/downstep," in *Tone in Generative Phonology* (ed. I. Maddieson), *Research Notes* (University of Ibadan) 3.2-3: 22-33.

----- (1972), "Summary of tonal behaviour," in *Assimilation and Elision in West African Languages*, *Research Notes* (University of Ibadan) 5.2-3: 93-101.

----- (1973a), "The sound system of Proto-Lower-Niger," Paper presented to the 4th Annual Conference on African Linguistics, Queens College, New York.

----- (1973b), *Benue-Congo Comparative Wordlist Vol II*, West African Linguistic Society, Ibadan.

----- and K. Shimizu (1968), *Benue-Congo Comparative Wordlist Vol I*, West African Linguistic Society, Ibadan.

# *Tone Patterns in Hausa: A Re-analysis of Hausa Downdrift*

Laura Meyers

[Paper presented at the

Fifth Annual Conference on African Linguistics

Stanford, California]

This paper investigates the nature of Hausa tone patterns in utterances with downdrift.* The data given throughout the paper was analyzed in the following manner. A corpus was constructed with the aid and advice of my informant, Malam Abba Kano, a native Hausa speaker born and raised in Kano, Nigeria. We then taped him reading the data in the sound-proof room in the UCLA Phonetics Laboratory. The tape was processed through a pitch extraction device developed in the phonetics lab, resulting in Oscillomink recordings. These recordings were then measured with reference to a calibration taped at the same session.

## 0. Introduction

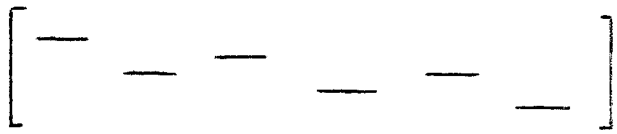
Hausa is a tone language. That is, it meets the criteria set up by Pike for tone languages in that it has "lexically significant, contrastive, relative pitch on each syllable" (1948). Hausa has two lexical tones: high and low. It also has a falling tone. In section two I will provide evidence that the falling tone should be analyzed as a sequence of two level tones, high followed by low, as suggested by Greenberg (1941). Hausa also has downdrift. Abraham was the first to point out that in Hausa "when a low tone occurs, a tone following it, whose tone is high, never quite reaches its high pitch, but stops short of it" (1941). Hodge and Hause, in a more detailed analysis of Hausa tone, claim that "every drop from high to low is two (steps) and every rise from low to

---

* It will be assumed that downdrift occurs in neutral declarative sentences. The patterns and rules discussed here are not assumed to occur in questions, imperatives etc.

My thanks go to Ian Maddieson, Peter Ladefoged, Paul Schachter, Vicki Fromkin and the other members of the tone group for interesting discussions during preparation of this paper. The work for this paper was supported by NSF Grant GS 37235X.

high, one (step)" (1941). Thus, a Hausa utterance consisting of several sequences of high-low tones is claimed to have the pattern in (1):

(1) 

Even within the speech of a single speaker, pitch in Hausa is relative. As Pike points out, for Hausa and other similar languages, "the absolute pitch is not pertinent as such. Rather, the pitch of one syllable in contrast to the pitches of neighboring syllables constitutes the essence of tonemic distinctions"(1967). Thus, a high tone at the end of an utterance in Hausa, may be, and quite often is, lower in pitch than a low tone at the beginning of the same utterance.

Throughout the literature on Hausa tone, downdrift is described as a downward contour that results from the unequal distances between unlike tones. In the first section of this paper I will show that like tones also manifest a downward contour. Downdrift is also traditionally described as either an intonational phenomenon characterizing neutral intonation, as in Kraft (1968), Hodge and Hause (1944) and Ladefoged (1971) or as an assimilatory process where high tone following low tones are assimilated downward, as in Abraham (1941) and Hyman (1973), and Hyman and Schuh (1974)*. I will show that downdrift in Hausa is both intonational and assimilatory.

In this paper, I formulate a re-analysis of Hausa downdrift within the transformational model. I propose a set of phonological rules for Hausa which I claim explain what downdrift is in Hausa. I will assume that underlying forms will be specified for tone, with the exception of those few morphemes which have predictable polar tone. The morphemes will be specified in the lexicon as having one step between low tone and a following high tone, and two steps between high tone and a following low tone. An analysis which specified Hausa underlying morphemes as having equal distances between both types of sequences would be unnecessarily abstract in that it would allow underlying forms which are not possible morphemes in Hausa. Since the abstractness controversy is not crucial to this discussion I will not pursue it here. There must also be an obligatory rule, hereby dubbed the Traditional Pitch Distance Rule, which operates on derived forms, and across morpheme boundaries to maintain the lexical distance of one step between low and following high, and two steps between high and following low tones. This rule is a Vennemann-type anywhere rule which serves both to state a constraint on the language and to maintain the required distance between tones on the

---

* Hyman and Schuh (1974) claim that downdrift may also involve the raising of low tone between two high tones. See their paper for further discussion.

output of other rules. I will also assume that there are rules in Hausa which assign pitch 1 to an utterance initial high tone, and pitch 3 to an utterance initial low tone. The rules discussed so far are not new, but merely assign to Hausa utterances the traditional contour shown in (1). In this paper I present three new rules. The first rule that I will discuss lowers tones after like tones. The second, a rule of dissimilation of high tone before low tone, maximizes the distance between a high tone and a following low tone. The third, a rule of total assimilation of high tone to a preceding low tone, neutralizes the distance between a high tone and preceding low tones. These rules support my claim that downdrift in Hausa is both an intonational and an assimilatory phenomenon.

## 1. Like-Tone Lowering: Intonational Downdrift

Hodge and Hause claim that "a series of two or more phonemically like tones remain on the phonetic level of the first" (1944). That is, they and other subsequent Hausa-ists claim that when a Hausa utterance contains a sequence of like tones, either a sequence of all high tones, or a sequence of all low tones, these tones will all be realized on the same phonetic pitch as the first tone in the sequence. That this is not the case can be seen in figures I and II. Figure I is of a recording of a sentence composed of high tones only:

2) 'yā'yā sun dāwo* 'the children have arrived'

Each syllable is at least 5 hz lower than the preceding syllable, even though the sentence is composed of high tone morphemes only. The utterance begins at a pitch of 120 hz and ends at a pitch of 90 hz. Figure II is of the utterance:

3) inā̀ dà àyàbà dà àkwàtī̀ 'I have a banana and a box'

This sentence is composed of an initial high tone followed by all low tone syllables. The pitch level from the first low tone syllable to the last low tone syllable descends 88 hz. Figure II demonstrates that sequences of low tones also descend in pitch. Because of data such as that shown in Figures I and II, I suggest the following rule for Hausa:

4) Like-Tone Lowering
Tones are lowered after like tones.

This rule is not unusual. It is usually regarded as an intonational phenomenon.

To test this rule I taped data read by my informant and processed it as discussed in the introduction. From a corpus of 32 utterances where the structural description of the Like-Tone Lowering rule was met

---

* The transcription of sentences is based on the normal Hausa orthography in use in Nigeria with the addition of a macron (-) to mark long vowels and a grave accent (\`) to mark lexical low tones.

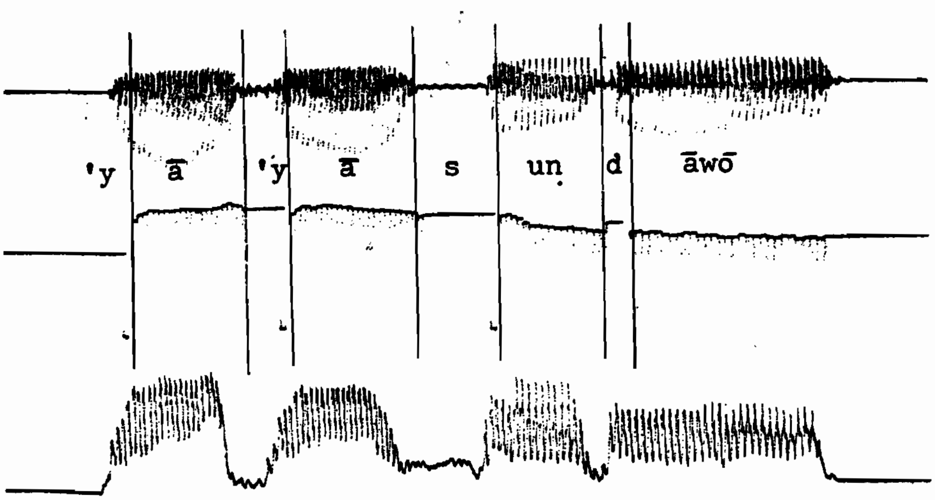



Figure I __'yā'yā sun dāwō__

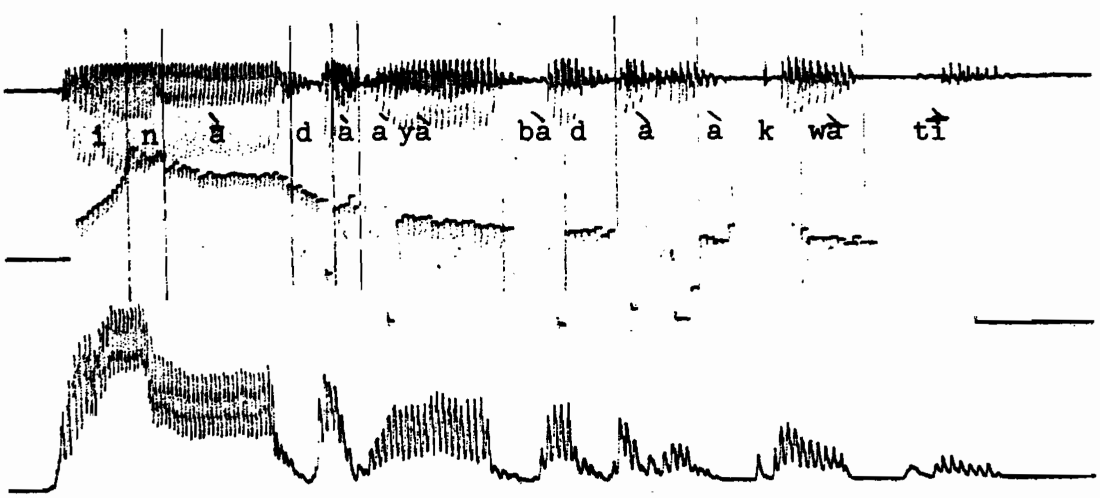



Figure II __inà dà àyàbà dà àkwàtī__

a total of ninety times, I obtained the following results:

| | | |
|---|---|---|
| 5) | total times rule applied: | 75 |
| | total exceptions: | 15 |
| | average hz lowered: | 5.6 |

All of the exceptions were cases where, in a sequence of more than two tones, the second like tone was not lowered, but lowering occurred on either the following like tone, i.e. the third like tone (6 cases) or on the fourth like tone. In five of the exceptions, with sequences of high tones, the first high tone was rising towards high, the second was higher, following high tones were lowered. In these cases it seems that the target high was not reached by completion of the first syllable, and the second syllable, therefore, continued higher to reach the target. From this data I concluded that Like-Tone Lowering is an optional but preferred rule in Hausa.

We have seen that a downward contour always occurs in Hausa declarative sentences - even in those sentences consisting of just like tones. The smooth gradual curve downward that results from Like-Tone Lowering will be called intonational downdrift. It is a very natural process of lowering and probably results from a decrease in subglottal pressure as the utterance progresses. (This hypothesis is tentative - I don't have experimental support.) Since this lowering occurs in the majority of languages it is a good candidate for a universal and perhaps should not be considered a rule of Hausa, but rather, an intonational universal stated a single time in the metatheory. If this lowering process is so natural why doesn't it occur in all tone languages - why don't Yoruba and other langauges have Like-Tone Lowering?* The occurance of Like-Tone Lowering in Hausa and the non-occurance of Like-Tone Lowering in Yoruba probably can be explained in terms of phonological space. Hausa, with only two lexical tones, can allow sequential like tones to take up more "space," i.e. to descend throughout a certain range without the probability of confusion with the other lexical tone. In Yòruba, with high, mid, and low tones, if a high tone were lowered by the Like-Tone Lowering rule, the lowered tone could easily be confused with a mid tone. It is probable, for perceptual reasons, that Like-Tone Lowering will only occur in languages with few lexical tones.

## 2. High-Tone Raising: Dissimilation

We have already noted that, in traditional accounts of tone, Hausa is said to maintain a greater distance between high tones followed by low tones (2 steps) than it maintains between low tones and following high tones (1 step). This distance exists both within morphemes and across

---

* Carl Lavelle has found that Yoruba does not allow lowering of like tones.

morpheme boundaries (but see section 3 below). That Hausa maximizes the distance between high tones and following low tones is supported by my discovery of the following rule:

6) High-Tone Raising
When a sequence of two or more high tones precedes a low tone, the last high tone before the low tone will be raised higher than the preceding high tone.

That this rule exists for Hausa can be seen by the pair of utterances (7) shown in Figure III.

7) a. sābon birni 'new city'

b. sābon gàrī 'new town'

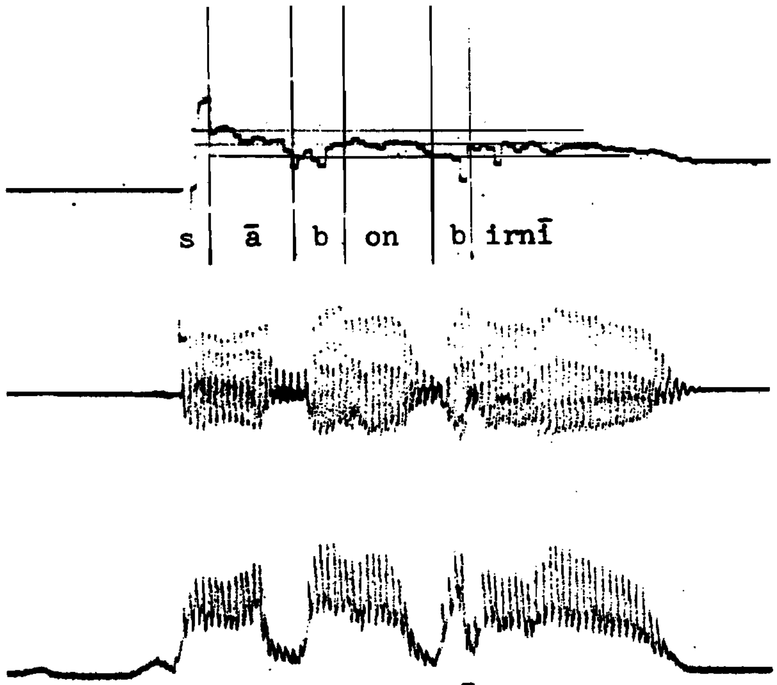
The top graph in Figure III shows the adjective sābō(n) 'new', tone pattern HH, followed by the noun birni 'city' also HH. High Tone Raising has not applied since its structural description is not met, but Like-Tone Lowering has applied. The lower graph has the same high tone adjective, this time followed by the noun gàrī 'town' which has a LH pattern. High-Tone Raising has applied to the second syllable of sābon, the last high tone before the low tone, raising it 6 hz higher than the preceding high tone. Notice that the rule applied to the word sābon only when it's structural description was met. That the second syllable of sābon was not raised in (7a) shows that the raising in (7b) was due to the application of the High-Tone Raising rule and was not due to segmental influence, vowel length or anything peculiar to the particular lexical item.

Greenberg claims that the falling tone in Hausa is a sequence of two tones, high followed by low. It is of interest, therefore, to find out whether when a falling tone follows a high tone, the initial portion of the falling tone, i.e. the high part of the falling tone, is higher than the preceding high tone. If the falling tone is analyzed as a sequence of high followed by low, then a falling tone preceded by a high tone meets the structural description of the High-Tone Raising rule. In Figure IV we see that the initial portion of the falling tone is raised as is predicted by this general rule. Figure IV is an Oscillomink recording of (8) which has a high-falling-high tone pattern.

8) fitôwa 'coming out'

The second syllable begins 5 hz higher than the initial high tone. It is easy to find diachronic evidence to support Greenberg's hypothesis. The application of the High-Tone Raising rule to the initial portion of the falling tone provides evidence for a synchronic analysis of the falling tone as a sequence of two level tones, high followed by low.

The High-Tone Raising rule is found in other non-related languages




sābon birnī

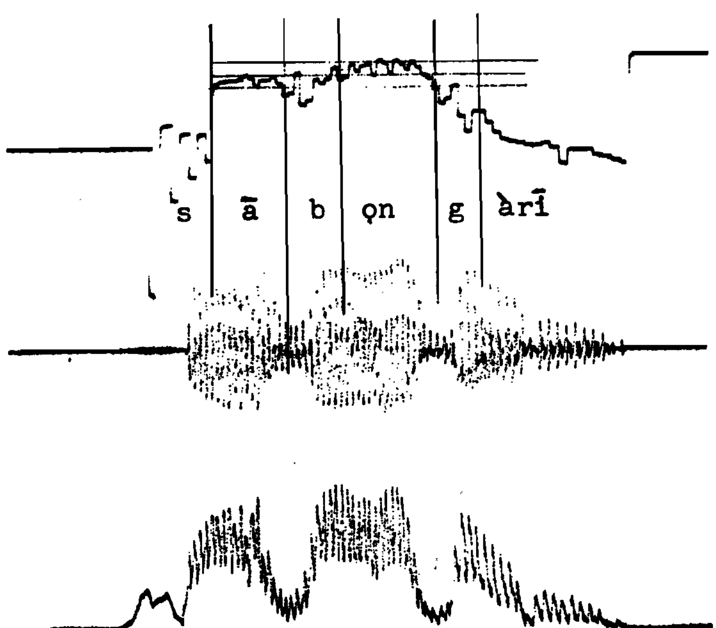



**Figure III** sâbon gàrī

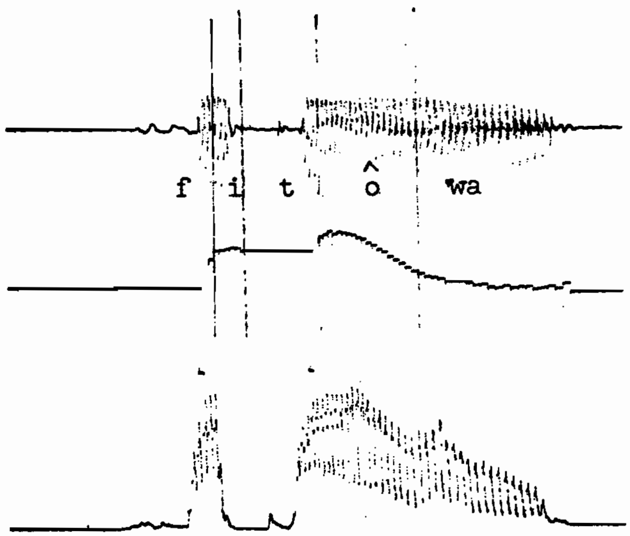



Figure IV __fitôwa__

such as Xhosa. (Lanham, 1963). There is also evidence that it existed at a previous stage in Temne and Izi, and in Engenni. Meeussen and Pike claim that these languages have upstep, which results from the raising of a high tone before a low tone, with subsequent loss of the low tone. (Meeussen 1970, Pike 1970).

To test this rule I constructed a corpus where the structural description of the rule was met a total of 36 times. Taped data read by my informant was processed through the pitch extraction device. I obtained the following results:

| | | |
|---|---|---|
| 9) | total times rules applied: | 33 |
| | total exceptions: | 3 |

In all three of the exceptions the high tone immediately preceding the low tone, although not raised, was equal in pitch to the preceding high tone. The Like-Tone Lowering rule discussed in section (1) did not apply although its structural description was met. It is possible, though, that both Like-Tone Lowering and High-Tone Raising occured. First, the lowering rule lowered the pitch below the pitch of the preceding high tone, then raising raised it back to the level of the preceding high tone. From the data just discussed I concluded that High-Tone Raising is an optional but preferred rule in Hausa.

Hyman and Schuh suggest that dissimilation is rarely a natural diachronic rule, because "cases of assimilation far outnumber the cases of dissimilation" and they prefer to look for alternative explanations of apparent cases of dissimilation (1974). I would argue that just as assimilation is a natural process for articulatory reasons, dissimilation is natural for perceptual reasons, namely, dissimilation maximizes perceptual differences between two sounds. I would explain the non-occurance of High-Tone Raising in many languages again in terms of phonological space. Hausa with two lexical tones can allow such a rule because a high tone followed by a raised high tone cannot be misinterpreted as mid followed by high tone. Yoruba does not have a High-Tone Raising rule. If it did, there could be perceptual confusions between sequences of high tone followed by raised high tone, mid tone followed by high tone, and low tone followed by mid tone.

Finally, note that the High-Tone Raising rule conspires with the Traditional Pitch Distance rule which maintains a two-step distance between high and following low tone, to maximize the distance between high tones and following low tones in Hausa.

## 3. High-Destruction: Assimilatory Downdrift in Hausa

We have seen that although Hausa maximizes the space between high tones and following low tones, traditional accounts of Hausa downdrift claim that there is only one step between a low tone and a following high. I have found that Hausa in most cases totally assimilates a high tone to a preceding low tone, so that the assimilated tone is equal to the preceding low tone in pitch. I state this rule as follows:

10) High-Destruction Rule
A high tone following a low tone is lowered to the same pitch as the preceding low tone.

That this rule operates in Hausa can be shown by figures V and VI. Figure V is of the following word:

11) kujḕrā 'chair', HLH pattern.

As you can see, the High-Destruction rule has applied and the final underlyingly high syllable has been lowered to the same pitch as the preceding low tone. The Like-Tone Lowering rule has then applied lowering the final syllable to a pitch even lower than the preceding low tone. The High-Destruction rule applies whenever its structural description is met, and thus can apply across entire sentences as can be seen in Figure VI which shows the sentence (12).

12) Mālàminsù yanā̀ bā sù nāmà.

'Their teacher is giving them meat'

This sentence is composed of sequences of HL patterns. The High-Destruction rule applied to each high tone, while the distance between the lowered high tone and the following low tones was maintained by the Traditional Pitch Distance rule* As the end of the utterance gets

---

* A problem of rule ordering arises here. For the Like-Tone Lowering rule to apply to the output of High-Destruction rule the high which is lowered must be relabeled as low. It must also be relabeled as low in order to prevent the Traditional Pitch Distance rule from raising it back to the underlying distance of one stop higher than the preceding low tone. But if this lowered high tone is relabeled as low, the Traditional Pitch Distance rule will not apply to create the desired distance between the lowered high tone and any following low tones. It is obvious from my data that this distance is maintained. In some cases the distance between the lowered high and a following low tone is the same, say 5 herz, as would be the result if the Like-Tone Lowering rule had applied, but the slope of the output of the Traditional Pitch Distance rule is more extreme and

(footnote continued on next page)

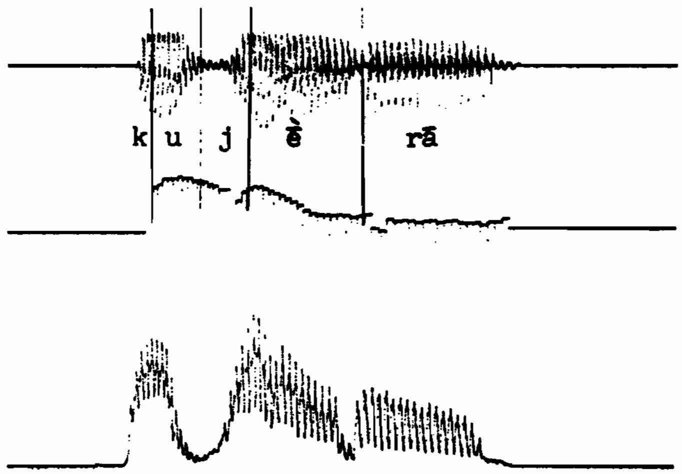



Figure V <u>kujḕrā</u>

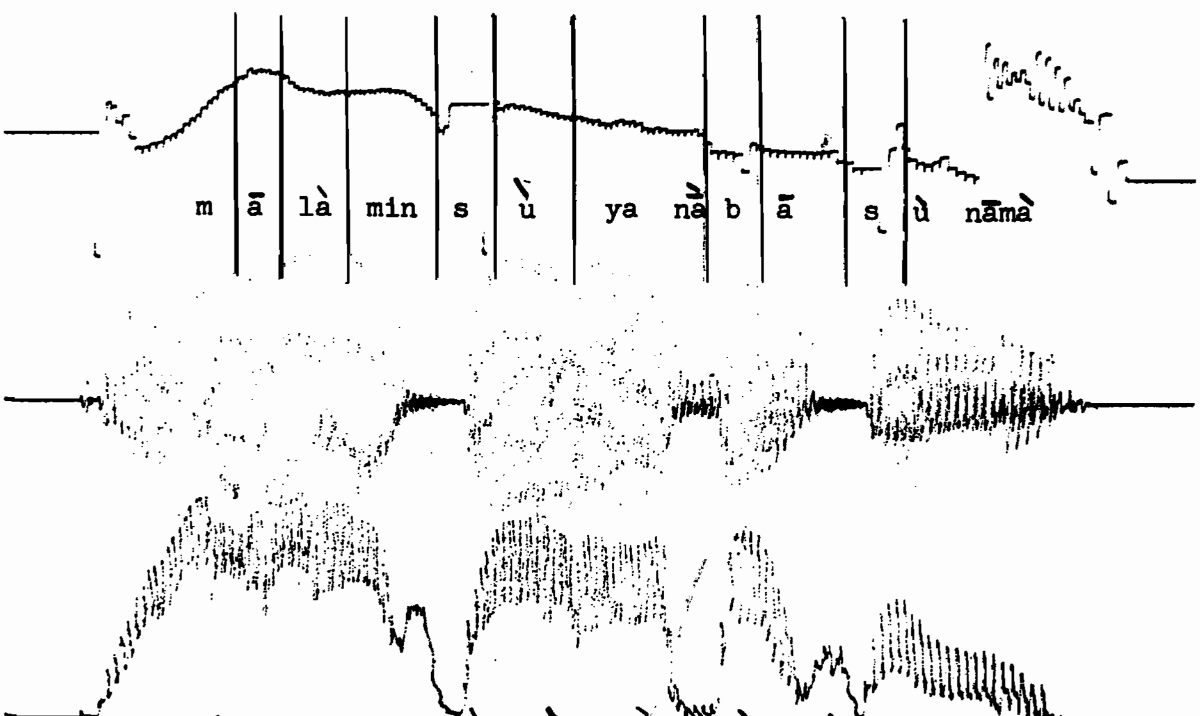



Figure VI Mālàminsù yanà bà sù nāmà

closer, the contrasts are lessened. The final two tones are below 70 hz and are not measurable with our pitch extraction device. The chunkier, less gradual pattern seen in Figure VI which results from High-Destruction will be called assimilatory downdrift.

To test the High Destruction rule I constructed a corpus where the environment was met a total of 47 times. I obtained the results shown in (13):

13) High-Destruction results:

group 1: words in isolation (utterance final or before pause)

applied: 14
exceptions: 0

group 2: before L (HLHL pattern):

applied: 15
exceptions: 4

---

(continued from previous page)

shorter than the slope which results from Like-Tone Lowering, it looks like (a) rather than (b):

a)  b) 

One possible solution, suggested by Ian Maddieson, is to state that part of the Traditional Pitch Distance rule which maintains the distance between high tone and following low tone so that the distance is stated as a negative value of the previous pitch, i.e., the pitch is stated as the pitch of the preceding syllable (pitch$_1$) minus a certain number of steps, i.e., [pitch$_1$ -2 steps]. This distance would be maintained even after the high tone was lowered. Another possible solution is to claim that the part of the Traditional Pitch Distance rule that maintains the distance between high tones and following low tones is global, that it applies to any syllable whose underlying tone is high, regardless of what its specification is at the time the rule applies.

group 3: before H (HLHH pattern):

| | |
|---|---|
| applied: | 8 |
| exceptions: | 6 |

| | |
|---|---|
| total applications: | 37 |
| total exceptions: | 10 |

Because of this data I concluded that the High-Destruction rule applies as shown in (14):

14) obligatory with words in isolation, or utterance final or before pause.

optional but preferred if low tone follows (HLHL pattern)

optional before high tone. (HLHH pattern)

There is a natural explanation for this distribution. First, if the high tone which would be lowered by the preceding low tone is followed by a high tone, HLHL pattern, I would claim that this high tone is strengthened by the following high tone, and therefore, is not as susceptible to the assimilatory strength of the preceding low tone. Second, if another low follows the high tone, i.e. if the high is surrounded by low tones, it would be more susceptible. Finally, if the high tone occurs utterance finally, or before pause, it is pulled down by both the preceding low tone, and the strong lowering influence of the utterance boundary. The rule also did not apply to LLH words in isolation or in sentence. I claim that this is because if it did apply to these morphemes, it would create morphemes with a LLL pattern. This pattern, I claim, is not acceptable in Hausa; it occurs on a very few morphemes, most of them borrowings. The distribution of the application of the High-Destruction rule also explains the data in (11) as well as all other occurances of HLH nouns. If underlying HLH nouns are always realized as HLL in isolation why posit them as being underlying HLH at all? The answer is found in the results shown in (14). HLH nouns undergo alternation, that is, before words beginning in high tones, the High-Destruction does not apply nearly 50% of the time.

This rule is also not unheard of. Meeussen (1970) claims that there is a phenomenon in Bwamu, Bamileke and Kaje which he calls total downstep, where a high tone is assimilated to the pitch of a preceding low tone, after which the conditioning low tone is lost. This rule of assimilation also probably has a natural phonetic explanation. The gesture required for making a high tone is more difficult, requires more effort, than the effort that would be required to maintain the low tone over another syllable. According to Ladefoged, a change from low pitch to high always requires a gesture of the cricothyroid muscles, but maintaining a low pitch quite often requires no additional articulatory gestures (Peter Ladefoged, personal communication). It is also the case that if a high tone follows a low tone in Hausa it is usually realized phonetically as a rising tone. Ohala and Ewan (1973) found that rising pitches require a lot of "effort." Therefore, assimilation of high tones to preceding low would be preferred and more natural in Hausa than articulating a high tone after a low tone. I must stress here that I have no experimental evidence on muscular activity for Hausa.

Hyman and Schuh claim that there is an "assymetry in the tonal assimilations of lows and highs. It is often said that a high tone can raise a low tone to a high tone, but a low tone cannot lower a high tone to a low tone." (1974:96). That is, they claim that sequences of LHL cannot become LLL, and that sequences of HLH cannot become HLL. This is not the case in Hausa. Note that in Hausa it has been claimed that low tone is the marked tone. Therefore, assimilation to low tone in Hausa is assimilation to the marked tone, and thus is "natural assimilation" according to the claims made by Schachter (1969). We have also seen that assimilation of high tones to low tones is natural and expected. I would expect to find rules similar to <u>High-Destruction</u> in other languages with downdrift. However, I <u>would</u> claim that there is a restriction on the occurrence of such rules in many languages. In order to maintain any tonal contrasts in the language after the application of such a rule it is necessary that a low tone following a lowered high tone can be extended by the <u>Traditional Pitch Distance</u> rule to a pitch considerably lower than the preceding tones. Because of this, a rule like the <u>High-Destruction</u> rule could not exist in languages such as Yoruba, with more than two lexical tones. It would lead to perceptual confusions. If the rule applied in Yoruba to an underlying HLHL string, the resulting pattern could be confused with HMML.

Leben (1971) claims that the following exceptionless rule occurs in Hausa:

15) <u>Low-Tone Raising</u>

$$\underset{}{L} \quad \underset{[+\text{long}]}{L} \quad \# \rightarrow L \quad \underset{[+\text{long}]}{H}$$

He claims that "this rule converts a sequence of two low tones at the end of a word into a sequence of low tone plus high tone, when the final syllable contains a long vowel" (1971). The <u>High-Destruction</u> rule provides counterexamples to this rule, as can be seen in Figure V.*

---

* Thanks to Marian Bean for reminding me of this.

In that example the word ends in a long vowel but the final syllable is nevertheless low. It is obviously not the case that Hausa disallows this pattern, since the High-Destruction rule derives it.

## 4. Conclusion

Downdrift in Hausa has been shown to be the result of the application of a set of phonological rules. There are two different patterns of downdrift in Hausa. The first, intonational downdrift, is a smooth gradual curve, which results from Like-Tone Lowering and looks like (16):

(16) 

This type of downdrift has a natural phonetic explanation and occurs in a majority of languages in the world. The second type of downdrift, assimilatory downdrift, is a chunkier less gradual curve, and results from High-Destruction and the Traditional Pitch Distance rule. It looks like (17):

(17) 

Because of restrictions on phonological space High-Destruction does not occur in many tone languages. Finally, the High-Tone Raising rule and the Traditional Pitch Distance rule conspire to maintain distances between highs and following lows to help maintain tonal contrasts within the language. It will be interesting to find whether these rules are indeed restricted because of phonological space only to languages with few lexical tones.

## References

Abraham, R.C. (1941), *Modern Grammar of Spoken Hausa*, Government Printer: Kaduna.

Greenberg, J. (1941), "Some problems in Hausa phonology," *Language* 17.4: 316-323.

Hodge and Hause (1944), "Hausa tone," *Journal of the American Oriental Society* 64.2:51-52.

Hyman, L. (1973), "The role of consonant types in natural tone assimilations," in *Consonant Types and Tone* (ed. L. Hyman) Southern California Occasional Papers in Linguistics, No. 1, University of Southern California, Los Angeles.

Hyman, L., and R. Schuh (1974), "Universals of Tone Rules," *Linguistic Inquiry* 5.1:81-116.

Kraft, C. and S. Abubakar (1965), *Introduction to Spoken Hausa*, Michigan State University, E. Lansing.

Ladefoged, P. (1967), "Linguistic phonetics," *Working Papers in Phonetics* No. 6, UCLA.

Lanham, L. (1963), "The Tonemes of Xhosa," *Studies in Linguistics* 17.

Lavelle, Carl (1974), "An experimental study of Yoruba tones," paper presented at the 5th Annual Conference of African Linguistics, Stanford 1974.

Leben, W. (1971), "The morphophonemics of tone in Hausa," in *Papers in African Linguistics* (ed. Kim and Stahlke) Linguistic Research Inc.: Edmonton, Alberta.

Meeussen, A.(1970), "Tone typologies for West African languages," *African Language Studies* 11:266-271.

Ohala, J. (1973), "The physiology of tone," in *Consonant Types and Tone* (ed. L. Hyman) Southern California Occasional Papers in Linguistics, University of Southern California, Los Angeles,

Ohala, J. and W. Ewan (1973), "Speed of Pitch Change," (Abstract), *Journal of the Acoustical Society of America* 53:345.

Pike, K. (1948), *Tone Languages*, University of Michigan Press, Ann Arbor.

----- (1970), *Tagmemic and Matrix Analysis Applied to Selected African Languages* , Summer Institute of Linguistics, University of Oklahoma.

Schachter, P. (1969), "Natural assimilation rules in Akan," *International Journal of American Linguistics* 35.4:342-355.

# *Tone Alternations in the Etsako Verb**

Baruch Elimelech

[Paper presented at the 3rd Annual Conference on African Linguistics

Queen's College, New York]

In this paper I shall attempt to provide a historical account for the various tense/aspect distinctions of the Etsako verb which are characterized by a complex set of tone alternations. Thus, an illustration of different tone alternations are given in (1).

(1) He + buy + ... (The verb is underlined.)

| | NOUN | | PAST | PRESENT | CUSTOMARY |
|---|---|---|---|---|---|
| a. | àkpà | 'cup' | ɔ̌ dâkpà | ɔ̀ dàkpá | ɔ̀ dâkpà |
| b. | úkpò | 'cloth' | ɔ̌ dúkpò | ɔ̀ dúkpò | ɔ̀ dúkpò |
| c. | àtásà | 'plate' | ɔ̌ dâtásà | ɔ̀ dá'tásà | ɔ̀ dá'tásà |
| d. | ɛ́làmhì | 'meat' | ɔ̌ dɛ́làmhì | ɔ̀ dɛ́làmhì | ɔ̀ dɛ́làmhì |
| e. | útékwì | 'chair' | ɔ̌ dútékwì | ɔ̀ dùtékwì | ɔ̀ dútékwì |

While all verbs fall within one tone class, the exact phonological representation of this verb class is not obvious. For example, in (1a) the verb has a falling tone in the past tense and the customary tense but a low in the present tense. It has a high tone in (1b) in all constructions. It would be possible to provide a simple statement for each paradigm. However, such an analysis would make the claim that there is no generalization to be drawn from the data. Far from making this claim, I should like to explore various approaches to the problem at hand.

---

*Etsako is the name used for a group of Edo dialects spoken in Etsako Division, Mid-Western State, Nigeria. The dialect treated here is spoken in Ekphei which has approximately 12,000 speakers. This study, however, is based solely on the speech of Mr. Omoh Tsatsako Ojior who served as the informant.

I have given all of the possible tone classes of bisyllabic and trisyllabic nouns for reference as in (2). It should be noted that all nouns end in a low tone in Etsako.

(2) Tone classes of bi- and tri-syllabic nouns:

| | | | |
|---|---|---|---|
| H-L | : | úkpò | 'cloth' |
| L-L | : | àkpà | 'cup' |
| H-H-L | : | útékwì | 'chair' |
| H-L-L | : | ɛ́làmhì | 'meat' |
| L-L-L | : | àgbàfɛ̀ | 'rice' |
| L-H-L | : | àtásà | 'plate' |

I. PAST TENSE CONSTRUCTION:

In Etsako, the sentence structure of the past tense consists of a pronoun, verb-stem, and a noun, as illustrated in (3) with the uncontracted and the contracted forms of the sentences.

| (3) | UNCONTRACTED | | | | | | CONTRACTED |
|---|---|---|---|---|---|---|---|
| a. | ɔ̌ | + | dɛ́ | + | àkpà | → | ɔ̌ dâkpà |
| | he | | buy | | cup | | 'he bought a cup' |
| b. | ɔ̌ | + | dɛ́ | + | úkpò | → | ɔ̌ dúkpò |
| | he | | buy | | cloth | | 'he bought cloth' |
| c. | ɔ̌ | + | dɛ́ | + | àtásà | → | ɔ̌ dâtásà |
| | he | | buy | | plate | | 'he bought a plate' |

In order to explain the tone alternations in the past tense construction and how they came about, one must reconstruct the basic sentence structure of Proto-Etsako, In Proto-Etsako, the basic sentence structure was as in (4).

(4) Sentence structure (reconstructed):

PRO + Tense/Aspect Marker + Verb Stem + Noun

Thus, the Proto-form of the basic sentence structure of the past tense can be represented as in (5).

(5) Proto-form of the basic sentence structure of past tense:

$$(C)\grave{V} + \acute{V} + C\acute{V} + VCV$$

Pron PAST verb noun

The pronoun consisted of either a V or a CV syllable, as seen in (6) below. The pronouns carried low tone. The tense/aspect marker carried high tone, and the verb carried high tone. The noun had various tone sequences after being contracted with the verb, although it must end with low tone, as pointed out.

(6) Etsako subject pronouns:

| | | | |
|---|---|---|---|
| [i] | 'I' | [mha] | 'we' |
| [u] | 'you (sg.)' | [wa] | 'you (pl.)' |
| [ɔ] | 'he, she, it' | [e] | 'they' |

We can assume that tonal alternations are due primarily to two processes: 1) tonal assimilations of various kinds; 2) loss of segmental information. Thus, tones frequently carry the distinctive mark of a lost syllable or morpheme. Both are involved in the history of Etsako. I suggest that the various tone differences found were at one time conditioned by tense/aspect markers which have since been lost. This is illustrated in (7) for the past tense:

(7) History of past tense construction:

$$\underset{(a)}{(C)\grave{V} + \underset{PAST}{\acute{V}} + C\acute{V} + VCV} \rightarrow \underset{(b)}{(C)\grave{V} + \underset{PAST}{\acute{}} + C\acute{V} + VCV} \rightarrow \underset{(c)}{\check{V} + C\acute{V} + VCV}$$

In stage (a) the tense/aspect marker consists of a segment and a high tone. In stage (b) the segment is lost, leaving a floating high tone. The floating high tone has now acquired the full burden of distinguishing the past tense from other constructions. Therefore, in order to maintain its grammatical effect, and not to be lost, it has to attach itself to a new syllable. Consequently, in stage (c) it shifts to the left causing the preceding low tone of the pronoun to become a rising tone. To further illustrate this change, a sample derivation is given in (8).

(8) (a) (b) (c)

ɔ̀ + ´ + dɛ́ + àkpà → ɔ̌ dɛ́ àkpà → ɔ̌ dâkpà 'he bought a cup'

he PAST buy cup

In (8a) the floating high tone shifts to the left. In (8b) the low tone of the pronoun has become rising. In (8c) the vowel of the verb has been deleted but the tone of the verb remained causing the low tone of the initial syllable of the noun object to become falling.

On the other hand, if the floating high tone shifts to the right rather than to the left as in (9), it would be absorbed by the high tone of the verb-stem thereby losing its ability to distinguish the past tense construction from the customary, which is illustrated in (10).

(9) The avoided merger of past and customary tenses:

(a) (b)

(C)V̀ + ´ + CV́ + VCV → *(C)V̀ + CV́ + VCV (*= incorrect for past tense)

PAST

(10)

(a) (b)

(C)V̀ + ∅ + CV́ + VCV → (C)V̀ + CV́ + VCV

CUST

In (9a) the floating high tone shifts to the right. In (9b) it has been absorbed by the high tone of the verb, therefore yielding (9b) to be the same as (10b). This point of tense merger is further illustrated in the sample derivation of (9') and (10').

(9') Past tense:

(a) (b)

ɔ̀ + ´ + dɛ́ + àkpà → *ɔ̀ dâkpà (*= incorrect for past tense)

he PAST buy cup 'he bought a cup'

(10') Customary:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | (a) | | | | (b) | |
| ɔ̀ + | ∅ | + | dɛ́ | + | àkpà | → | ɔ̀ dâkpà | 'he buys cups' |
| he | CUST | | buy | | cup | | | |

As can be seen, in order to avoid such merging, the floating high tone of the past tense must shift to the left. As a result of this shift, the rising tone of the pronoun is now the only mark of the past tense construction.

II. THE PRESENT TENSE CONSTRUCTION:

The present tense construction is illustrated in (11) in its uncontracted and contracted forms:

| (11) | UNCONTRACTED | | | | | | CONTRACTED | |
|---|---|---|---|---|---|---|---|---|
| a. | ɔ̀ | + | dɛ́ | + | àkpà | → | ɔ̀ dàkpá | 'he is buying a cup' |
| | he | | buy | | cup | | | |
| b. | ɔ̀ | + | dɛ́ | + | úkpò | → | ɔ̀ dúkpò | 'he is buying cloth' |
| | he | | buy | | cloth | | | |
| c. | ɔ̀ | + | dɛ́ | + | àtásà | → | ɔ̀ dá'tásà | 'he is buying a plate' |
| | he | | buy | | plate | | | |

The tone alternations in the present tense construction are explained by reconstructing the Proto-forms of the basic sentence structure of the present tense, as seen in (12).

(12) Proto-Etsako:

| | | | | | | |
|---|---|---|---|---|---|---|
| (C)V̀ | + | V̀ | + | CV́ | + | VCV |
| pron | | PRES | | verb | | noun |

Again, the pronoun carried low tone, and the verb high tone, but this time the tense/aspect marker carried low tone.

We can assume again that the various tone differences found were at one time conditioned by a tense/aspect marker which has since been lost. This fact is revealed when we look at the history of the present tense construction which is represented schematically in (13), and is illustrated in (14).

(13) History of present tense construction:

(a)
(C)V̀ + V̀ + CV́ + V̀CV̀ →
PRES

(b)
(C)V̀ + ` + CV́ + V̀CV̀ →
PRES

(c)
(C)V̀ + CV̀́ V̀CV̀ →

(d)
(C)V̀ + CV̌́ V́CV́ →

(e)
(C)V̀ + CV̀ V́CV́ →

(f)
(C)V̀ + CV̌́CV́ →

(g)
(C)V̀ + C̀VCV́

(14) Sample present tense derivation with tone absorption (Hyman and Schuh 1972):

L͡H H → L H

a. ɔ̀ + ` + dɛ́ + àkpà (by low tone spread)→

he PRES buy cup

b. ɔ̀ + dɛ̌́ + àkpà (by high tone spread)→

c. ɔ̀ + dɛ̌́ + ákpá (by tone absorption)→

d. ɔ̀ + dɛ̀ + ákpá (by contraction) →

e. ɔ̀ + dǎ́ kpá (by tone absorption)→

f. ɔ̀ + dàkpá 'he is buying a cup'

In stage (a) in (14), the basic sentence structure of the present tense is reconstructed with a low tone pronoun, a floating low tone which carries tense, a high tone verb stem, and a low tone noun. In stage (b) the floating low tone shifts to the right causing a rising tone on the verb stem. In stage (c) the initial low tone of noun objects is raised after the rising tone of the verb stem. If the noun has all underlying low tones, then a high tone is spread throughout the noun. In the (d) stage the high portion of the rising tone is absorbed by the following high tone of the noun object. In stage (e) the verb and the noun object are contracted yielding another rising tone which is followed by a high tone. In stage (f) the high portion of the rising tone is absorbed by the following high tone. Thus, the verb stem that was once a high tone is now a low tone.

Now that we have seen what happens in this construction when we have low-low nouns, we should now consider what happens when we have high-low nouns, as seen in (15).

(15) Sample present tense derivation with tone simplification (Hyman and Schuh 1972):

$\overset{\frown}{\text{LH}}$ L → H L

| | | |
|---|---|---|
| a. | ɔ̀ + ̀ + dɛ́ + úkpò<br>he PRES buy cloth | (by low tone spread) → |
| b. | ɔ̀ + dɛ̌ + úkpò | (by tone absorption) → |
| c. | ɔ̀ + dɛ̀ + úkpò | (by contraction) → |
| d. | ɔ̀ + dǔ kpò | (by tone simplification) → |
| e. | ɔ̀ + dúkpò | 'he is buying cloth' |

In stage (a) the reconstruction of the basic sentence structure is the same as stage (a) in (14) except for the fact that the noun object has a high-low sequence of tones. In stage (b) the floating low tone shifts to the right causing a rising tone on the verb stem. In the (c) stage, the high portion of the rising tone is absorbed by the following high tone of the noun object. In stage (d) the verb and the noun object are contracted yielding another rising tone, but this time the rising tone is followed by a low tone. If the rising tone of the verb stem is followed by a low tone, then the rising tone is simplified to a high tone, as seen in stage (f).

Thus, it seems to me that the surface realization of the floating low tone creates a polarization effect.

Notice that if this low tone were to shift to the left instead of the right, it would be lost and therefore have no effect in distinguishing any of the present tense forms from the customary, as seen in (16).

(16) The avoided merger of present and customary tenses:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Present: | ɔ̀ | + | ` | + | dɛ́ | + | útékwì | → | *ɔ̀ dútékwì |
| | | | PRES | | | | | | |
| Customary: | ɔ̀ | + | Ø | + | dɛ́ | + | útékwì | → | ɔ̀ dútékwì |
| | | | CUST | | | | | | |

Thus, in order to avoid merger in these cases, the floating low tone of the present tense shifts to the right yielding the polarization effect seen in (14) and (15) that will distinguish the present tense from the customary.

## II. THE CUSTOMARY CONSTRUCTION:

The last basic sentence structure that I would like to mention is the customary. The customary, like the other two tenses, consists of a pronoun, verb-stem, and a noun, as can be seen in (17).

| (17) | UNCONTRACTED | | | | | | CONTRACTED | |
|---|---|---|---|---|---|---|---|---|
| a. | ɔ̀ | + | dɛ́ | + | àkpà | → | ɔ̀ dâkpà | 'he buys cups' |
| | he | | buy | | cup | | | |
| b. | ɔ̀ | + | dɛ́ | + | úkpò | → | ɔ̀ dúkpò | 'he buys cloth' |
| | he | | buy | | cloth | | | |
| c. | ɔ̀ | + | dɛ́ | + | àtásà | → | ɔ̀ dá'tásà | 'he buys plate' |
| | he | | buy | | plate | | | |

The Proto-form of the basic sentence structure of the customary was as in (18).

(18) Proto-Etsako:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Customary: | (C)V̀ | + | Ø | + | CV́ | + | VCV |
| | pron | | CUST | | verb | | noun |

The customary differs from the PAST and PRESENT in that its tense/aspect marker is zero. Since there was no tense/aspect marker to be lost and no floating tones to attach themselves to other syllables, the customary seems to be the least affected construction by tonal alternations. It, therefore, seems to me that the customary is the most basic of the three constructions presented and the least changed since Proto-Etsako. The other constructions, after having lost their tense markers, had to alter their tone structure in order not to merge with the customary, as seen in (19).

(19) Customary: ɔ̀ dútékwì (where the constructions differ is underlined)

Past: ɔ̌ dútékwì

Present: ɔ̀ dùtékwì

One can clearly see the affects of the floating high tone and low tone in (19) in order to keep the past tense and present tense from merging with the customary.

## IV. SUMMARY

As a summary, I would like to bring all the constructions together and compare then as in (20).

(20) a. Past: ɔ̀ + ´ + dɛ́

b. Present: ɔ̀ + ` + dɛ́

c. Customary: ɔ̀ + ∅ + dɛ́

If the high tone of (a) moves to the right, then the past tense and the customary would merge, therefore, it moves to the left. If the low tone of (b) moves to the left, then the present tense and the customary would merge, therefore, it moves to the right.

There is, however, a potential merger of the present tense and the customary if a noun object has all underlying low tones, as in (21).

(21) a. [àkpà] 'cup'

b. [àgbàfɛ̀] 'rice'

If the floating low tone, however, moves to the right in the present tense, then compare the present tense and the customary in (22) and (23).

(22) ɔ̀ + ̀ + dɛ́ + àkpà → ɔ̀ dɛ̌ àkpà 'he is buying a cup'
PRES

(23) ɔ̀ + ∅ + dɛ́ + àkpà → ɔ̀ dɛ́ àkpà 'he buys cups'
CUST

The language does not permit rising tones in lexical morphemes. Generally, when an intermediate rising tone is followed by a low tone, we get simplification of this rising tone to high, as we have seen in so many cases (cf. 15). This would however cause the output of (22) to merge with (23) as seen in (24).

(24) ɔ̀ + dɛ̌ + àkpà → *ɔ̀ dɛ́ àkpà (if tone simplification applies)

It therefore became necessary for the language to spread the high tone of the verb over all the low tones of the noun, as in (25).

(25) High tone spread:

ɔ̀ + dɛ̌ + àkpà → ɔ̀ dɛ̀ ákpá

ɔ̀ + dɛ̌ + àgbàfɛ̀ → ɔ̀ dɛ̀ ágbáfɛ́

This is later modified by contraction and absorption as in (26).

(26) ɔ̀ dɛ̀ ákpá → ɔ̀ d ǎ kpá → ɔ̀ dàkpá 'he is buying a cup'

The general rule is for the high tone to spread over all successive low tones of LL, LLL, LLLL, etc. as in (27).

(27) àkpà → ákpá 'cup'

àgbàfɛ̀ → ágbáfɛ́ 'rice'

The reason again could be interpreted as avoiding merger, as seen in (28).

(28) Possible mergers:

a. *ágbàfɛ̀ (cf. ɛ́làmhì 'meat')

b. *ágbáfɛ̀ (cf. útékwì 'chair')

If you get (28a) where the first low tone is raised to high, it would merge with nouns of the class like /ɛ́làmhì/. If you get (28b) where the first two low tones are raised to high, it would merge with nouns of the class like /útékwì/. Therefore, the only way to keep nouns with low tone throughout distinct is to raise them as a unit. Since no nouns have an underlying final high tone, no merger is possible.

At this point, a few remarks on tonal representation are appropriate. The above would seem to provide evidence for positing that low tone is assigned to the whole word in these cases rather than to each syllable. Further evidence for this suprasegmental representation of low tone is seen in (29).

(29) Initial raised low tone:

a. àtásà → á'tásà (from intermediate â tásà)

b. ɔ̀ɣɛ̀dɛ́ɛ̀ → ɔ́ɣɛ̀dɛ́ɛ̀, but not *ɔ́ɣɛ́'dɛ́ɛ̀ 'banana'

In (29a) we have LHL → H'HL after raising the initial low tone of the noun. In (29b) we get LLHL → HLHL after raising the intial low tone of the noun, but we do not get HH'HL.

Therefore, it is not a question of high tone spreading until it is checked by another high. Rather, it simply means that the high spreads over one low tone only. In /ɔ̀ɣɛ̀dɛ́ɛ̀/ (29b) this means that only [ɔ̀] is raised to [ɔ́] because in the underlying representation, each syllable of this word must be marked for tone. But in \`/akpa/ or \`/agbafɛ/, there is only one low tone assigned to the whole word and when this one low tone is raised, the whole word goes up to high as a unit. Thus, Etsako appears to be a language in transition, one in which syllable tone is giving way to word tone.

<u>Bibliography</u>

Hyman, Larry M. and Russell G. Schuh. (1972) "Universals of Tone Rules". *Stanford Working Papers in Language Universals*, 10:1 - 50.

*On the Reality of Underlying Contour Tones*

Baruch Elimelech

[Paper presented at the 48th Annual Meeting of the

Linguistic Association of America, December 28-30, 1973, San Diego]

A currently discussed topic in the study of tone concerns the underlying representation of contour tones. For example, Wang argues that contour tones should be represented by phonological features such as Rising, Falling and Convex. He further proposes that tones should be represented phonologically as suprasegmental features with the syllable as their domain. Woo, on the other hand, claims that all contour tones should be underlyingly represented as sequences of level tones (high, low, etc.) and that the distinctive features of tone should exclude contour features.

While this difference in approach may be interpreted as merely a discussion of how to formally represent phonetic contours, the controversy in fact goes well beyond this. In this paper I should like to first address myself to the implications concerning the nature of tone systems inherent in each approach. It will be shown that languages are found which confirm the conflicting implications made by each approach and that consequently some languages will have to be analyzed with underlying contour tones, while others will have to be analyzed with underlying sequences of level tones.

By way of introduction, I shall mention briefly some of the arguments which support the notion that contour tones must be represented as sequences of level tones. The evidence shows that unless this is the case, generalizations would not be revealed in a well-motivated way.

There are many African languages which are basically level tone languages (for example, with High and Low). These languages frequently have rules of tone spreading (as discussed by Hyman and Schuh), whereby contour tones are derived from sequences of level tones on different syllables. As seen in (1).

(1) /mọ́tò/* 'car' [ ¯ ╲ ]

/ìwé/ 'book' [ _ ╱ ]

/Adé kò rọ́kọ̀/ 'Ade did not see a vehicle' [- ¯ ╲ ╱ ╲]

Yoruba converts underlying Low-High to Low-Rising and underlying High-Low to High-Falling. The question is whether this process should be conceptualized as in (2), where rising and falling tones result from a change in features, or as in (3), where contour tones are derived by a process of tone feature spreading onto a single vowel:

(2) [+L] [+H] $\rightarrow$ [+L] [+R] (or) [+H] $\rightarrow$ [+R]/[+L]---

[+H] [+L] $\rightarrow$ [+H] [+F] [+L] $\rightarrow$ [+F]/[+H]---

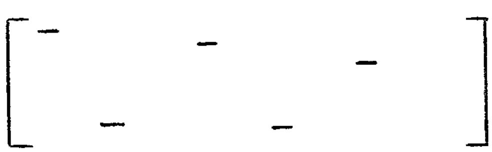
(3) L H $\rightarrow$ L $\widehat{\mathrm{LH}}$

H L $\rightarrow$ H $\widehat{\mathrm{HL}}$

Such assimilatory rules have been handled both in terms of contour features as well as in terms of sequences.

Leben has demonstrated that such contours must be represented as a sequence of level tones in languages characterized by the process of downdrift. Many African languages have a rule by which successive high tones are lowered when preceded by intervening low tones, as seen in (4):

(4) H L H L H



In (4) the second and third High tones are realized as progressively lower than the preceding Highs, because of the intervening Low tones. (I shall not address myself to the lowering of low tones in such cases).

The point that Leben makes is that if Rising and Falling are analyzed respectively as Low-High and High-Low on one vowel, then they should be expected to take part in this process of downdrift. In particular, as seen in (5a),

*(´) = high tone, ( ) = mid tone, (`) = low tone, (ˇ) = rising tone, (^) = falling tone, ('´) = downstepped high tone.

(5) a. H $\widehat{\mathrm{LH}}$ b. $\widehat{\mathrm{HL}}$ H

[ ¯ ╱ ] [ ╲ – ]

we should expect that a rising tone will not rise as high as a preceding High, because the Low part of the Low-High tone will pull it down--by downdrift. Similarly, as seen in (5b), we should expect that a High tone following a Falling tone should not be realized as high in pitch as the High part of the Falling tone. The Low part of the High-Low tone has lowered it, just as High is lowered when preceded by High-Low on two separate syllables. Thus, in such languages rising tones function as if they were a combination of Low followed by High on one vowel, just as falling tones function as if they were a combination of High followed by Low. Not to recognize this fact would cause the downdrift rule to become complex and ad hoc, since it would be necessary to somehow incorporate notions of rising and falling tones into downdrift rules--whereas the sequence analysis would allow one to show this process to be part of the general downdrift phenomenon.

Leben further provides examples from Maninka to show not only that contour tones must be analyzed as sequences of level tones, but also that theses tones must be features on morphemes, represented in a suprasegmental matrix. He proposes a phonological process of "tone mapping" which assigns the appropriate tone to individual vowels, as seen in (6):

(6) $^{LH}$/sa/ 'snake' → [ ╱ ]

$^{LH}$/muso/ 'woman' → [ _ ¯ ]

In (6) the underlying form is to the left of the phonetic pitches represented in brackets. Thus, the tone mapping rule will map the suprasegmental representation of Low-High which is assigned to underlying morphemes as in (7):

(7) [sa] 'snake' [muso] 'woman'
LH L H

If a Maninka morpheme has an underlying LH representation, and consists of only one syllable, this underlying Low-High will be realized as a phonetic Rising tone. On the other hand, if such a morpheme consists of two syllables, the phonetic form will have the Low part of the Rising tone on the first syllable, and the High part of the rising tone on the second syllable. This analysis accounts for tonal constraints on mono-and polysyllabic morphemes in a principled fashion.

There seems then to be clear evidence for both the sequential analysis of contour tones and the suprasegmental representation of tones, at least in some languages. I would like to present arguments in favor of the opposite analysis, that is, the use of contour features in lexical representation.

Consider a language with a High and a Low tone and a rising tone. What kind of evidence may be decisive in support of representing the Low to High rise by simply a contour rising feature?

We might tentatively hypothesize that if the beginning and end points of a rise or fall are both sequences of level tones at the phonological level, then these tones could be decomposed into the individual level tones as noted in the examples already cited. If, on the other hand, the starting and finishing points of the contours have no independent existence, then no such decomposition should be permitted in the grammar.

This second approach makes the claim that units represented by the feature Rise or Fall will not participate in tone processes otherwise applicable to sequences of level tones. Let me outline a hypothetical language which should be possible if contours are single features, but impossible if contours are analyzed as sequences.

A language has a rule of the form in (8):

(8) A /R/ is realized as beginning at the phonetic end-point of the preceding tone. A rising tone is realized as beginning at the phonetic end-point of the preceding tone.

Examples of how this would work are given in (9):

| | | | |
|---|---|---|---|
| (9) | ba<br>L | ba<br>R | [ ] |
| | ba<br>H | ba<br>R | [ ] |
| | ba<br>R | ba<br>R | [ ] |

The second tones in the above three hypothetical forms are realized, then, as a rise from Low to High, a rise from High to Superhigh and a rise from the highest point of a downdrifted high rise.

Typically, African languages do not reveal this. Instead, the phonetic realizations are found as seen in (10a):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (10) | a. | ba<br>L | ba<br>R | [ _ / ] | b. | ba<br>L | ba<br>L | [ _ _ ] |
| | | ba<br>H | ba<br>R | [ ¯ / ] | | ba<br>H | ba<br>L | [ ¯ _ ] |
| | | ba<br>R | ba<br>R | [ / / ] | | baba<br>L H | baba<br>L H | [ ¯ _ ¯ ] |

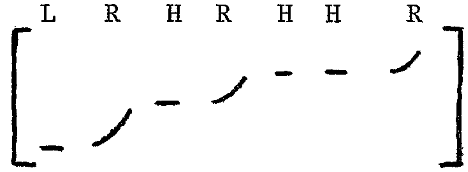
In (10a) we find that in each instance of the rising tone, the starting point is at the pitch identical to that of a low tone, as shown in (10b), and the end point is identical with the expected downdrifted high tone.

A situation which is similar to the hypothetical language in (9) exists in Kru*. In this language there is a High, a Low, a Rising and a Falling tone. ( shall not be concerned here with the details of falling tones in this paper). Downdrift also exists in Kru. What is of interest here is that the rising tone in citation forms is realized as a rise from a High to a Superhigh pitch, as seen in (11):

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (11) | jǔ<br>R | 'child' | [ / ] | cf. | bá<br>H | 'pepper' | [ ¯ ] |

Second, in slow speech, each rising tone is realized as starting no lower than a High (which is downdrifted after Low, of course), but is progressively higher and higher after every other Rising tone, as seen in the example in (12):

(12) kɔ̀ nǎ nɛ́ ǔ téblé kpǔ 'the rice is on the table'
L R H R H H R



* Kru is spoken in Liberia, Ivory Coast and Sierra Leone. The dialect treated here is Nana Kru. This study is based solely on the speech of Mr. Sayon Jackson who served as the informant.

However, it should be pointed out that there is a general simplification rule which is of the form in (13):

(13) R + R → H R (or) R → H / — R

Any rising tone followed by another rising tone is simplified to a High in normal speech. Thus, a sequence of rising tones as represented in (14)

| | | | | | | |
|---|---|---|---|---|---|---|
| (14) | jǔ | nǎ | jě | nǐ | nǎ | 'the child saw the water' |
| | R | R | R | R | R | |
| | child | the | saw | water | the | |

is realized normally as in (15a), not as in (15b):

(15) a. [¯ ¯ ¯ ¯ ˊ]

b. [ˊ ˊ ˊ ˊ ˊ]

It is, I believe, significant, however, that when Kru speakers slowly emphasize sequences of rising tones as in (14), the result is that of (15b), and not that of (15c):

(15) c. *[ˊ ˊ ˊ ˊ ˊ]

If we represented the rising tone as a sequence of Low followed by High, an ad hoc rule would have to be added to the grammar stating that only in the case where the sequence Low-High occurs on a single vowel, is this sequence realized as a glide from the pitch of the previous level tone to a super high tone.

Note that the representation of the rise as a Low followed by a High would force a different rule for such tones than for those where similar sequences are found. Thus, in (16),

| | | | | | | |
|---|---|---|---|---|---|---|
| (16) | ɔ́ | tè | bá | [¯ _ ¯] | 'he buys pepper' | (not *[¯ ¯ ¯]) |
| | H | L | H | | | |

the sequence Low-High is not realized as a rise from High to superhigh.

A second argument for the use of a contour feature rise in Kru comes from the nature of underlying tone in Kru. There are four contrasting tones on monosyllabic words, exemplified in (17):

(17) kɔ̀ 'rice' [ _ ]    jǔ 'child [ / ]
L    R

bá 'pepper' [ ¯ ]    sû 'chicken' [ \ ]
H    F

Similarly, there are four contrasting tone patterns on bisyllabic words, as seen in (18):

(18) tapɛ 'cup' [_ _]
L L

nụmo 'wine' [¯ ¯]
H H

kele 'inside' [¯ /]
H R

kita 'coconut' [¯ \]
H F

We may summarize these patterns as (19).

| (19) | Monosyllabic | Bisyllabic |
| --- | --- | --- |
| | L | L-L |
| | H | H-H |
| | R | H-R |
| | F | H-F |

Since there are only four possible tone patterns on bisyllabic words, corresponding exactly to the four tone patterns on monosyllabic words, we can assume that tone is a feature assigned to words (or morphemes) in this language and not to segments or syllables. For to assign the four tones found in monosyllabic words to either syllabic segments or syllables would make the false prediction that there would be 16 tone patterns in bisyllabic words in Kru, as in (20):

| | | | | |
|---|---|---|---|---|
| (20) | L-L | *L-H | *R-L | *F-H |
| | H-H | *L-R | *R-H | *F-F |
| | H-R | *L-F | *R-R | *F-R |
| | H-F | *H-L | *R-F | *F-L |

Thus, we may conclude that tone is a property of words in Kru and must therefore be represented by a suprasegmental matrix. The representations of the bisyllabic words in (19) would therefore be as shown in (21):

(21) $^{L}$/tapɛ/ 'cup' $^{R}$/kele/ 'inside

$^{H}$/nụmo/ 'wine' $^{F}$/kita/ 'coconut'

These suprasegmental tones are assigned to segmental vowels via the kind of mapping rules discussed by Leben.

Those who would not want to abandon the sequential analysis might suggest that the Rising tone should be represented as a sequence of a High tone followed by Super high tone. One problem which arises from such an analysis is that we would be forced to include an additional tone which occurs only after High, only when the High and Super high fall on the same vowel.

In addition, if, for example, the rising tone of the word 'inside' given in (21) were to be represented in this way, similar to the representation of the rising tone of Maninka as a sequence of a Low tone followed by a High, we could expect the following phonetic realization of 'inside' to be that as given in (22):

(22) *[kele] 'inside' [ - ‾ ]
H S

That is, just as the underlying Low-High of $^{LH}$/sa/ 'snake' in Maninka was distributed over the two syllables of $^{LH}$/muso/ 'woman', we should expect a proposed High-Superhigh of /ju/ 'child' in Kru to be distributed over the two syllables of /kele/ 'inside'. This, however, does not happen. Instead, the first syllable is realized on a high pitch, while the second manifests the typical High to Superhigh rising tone. Thus, this further suggests that the rising tone is not decomposable, that is, not capable of being distributed over two vowels.

Instead, if the Rising tone is in fact a single feature, and if the underlying representation of 'inside' is as indicated in (21), then what we expect is that this underlying Rising tone will be mapped over the two syllables, just as an underlying Low or High is mapped over the two syllables of 'cup' and 'wine', respectively, as seen in (23):

| | | | | |
|---|---|---|---|---|
| (23) | Underlying representation: | $^{L}$tapɛ | $^{H}$nụmo | $^{R}$kele |
| | After tone-mapping : | tapɛ<br>L L | nụmo<br>H H | kele<br>R R |

We have already cited a tone simplification rule in (13), whereby a sequence of two rising tones is simplified into a High followed by a Rising tone. This same rule, as predicted by this analysis, is applicable to the post-tone-mapping form of 'inside' in (23), as shown in the derivation in (24):

| | | | | | | |
|---|---|---|---|---|---|---|
| (24) | Underlying representation: | $^{R}$kele | cf. | $^{R}$ju + | $^{R}$na | 'the child' |
| | After tone-mapping : | kele<br>R R | | ju<br>R | na<br>R | |
| | After tone simplification: | kele<br>H R | | ju<br>H | na<br>R | |
| | Phonetic form : | [ ˉ ˊ ] | | [ ˉ | ˊ ] | |

Thus, the phonetic realization High-Rising follows automatically from the principle of tone mapping outlined by Leben, and the operation of the tone simplification rule in (13). The sequence analysis would not be able to yield the correct phonetic output without adding some ad hoc adjustment, since it predicts, as argued in (22), that the first tone will be High and the second Superhigh.

Furthermore, if the rise is represented by underlying High and Superhigh (or Extreme) level tones, with the glide derived by a phonetic rule, one must explain why an underlying Low followed by High is not realized phonetically as a Low-High glide or contour. That is, one would expect, as pointed out by Hyman and Schuh that the more natural phonetic gliding effect would occur between the two tones maximally distinct. Yet this does not occur in Kru if this alternative solution is adopted.

We can therefore conclude that rising tones are necessary in the underlying representation of at least one language.

References


Fromkin, V.A. (1972) "Tone Features and Tone Rules" *Studies in African Linguistics* 3:47-76.

Hyman, L.M. (1973) "The Role of Consonant Types in Natural Tonal Assimilations". In *Consonant Types and Tone* (L. Hyman, Ed.) 151-179. Southern California Occasional Papers in Linguistics No. 1. University of Southern California, Los Angeles.

Hyman, L.and R.G. Schuh (1972) "Universals of Tone Rules" *Stanford Working Papers in Langauge Universals* 10:1-50.

Innes, G. (1966) *An Introduction to Grebo*. School of Oriental and African Studies. University of London.

Leben, W.R. (1971) "Suprasegmental and Segmental Representation of Tone" *Studies in African Linguistics,* Supplement 2: 183-200.

Leben, W.R. (1973) "The Role of Tone in Segmental Phonology" In *Consonant Types and Tone* (L. Hyman, Ed.) 115-149. Southern California Occasional Papers in Linguistics No. 1. University of Southern California, Los Angeles.

Leben, W.R. (1973) *Suprasegmental Phonology*. Doctoral Dissertation. M.I.T.

Wang, W. S-Y. (1967) "Phonological Features of Tone" *International Journal of American Linguistics* 33:93-105.

Woo. N. (1969) *Prosody and Phonology*. Doctoral Dissertation. M.I.T.

# *The Glottal Stop in Siamese: Predictability in Phonological Description**

Jack Gandour

## 0. INTRODUCTION

According to the 'standard theory' of generative phonology (Chomsky and Halle 1968), segments that are predictable must be derived by phonological rule; such segments are not allowed in underlying forms. The glottal stop in Thai, however, suggests that this proposed constraint on a theory of phonology is too strong. In this paper I will attempt to show that even though the glottal stop could be derived by phonological rule, it must still be present in underlying forms; otherwise linguistically significant generalizations are either obscured or left totally unexpressed.

There has been much disagreement among Thai linguists over whether the glottal stop is present in underlying forms (or their equivalent) or not. Those who have assumed the former include Henderson (1949), Hass (1964), Warotamasikkhadit (1967), and Surintramont (1973); those who have assumed the latter include Gedney (1947), Gillette (1955), Abramson (1962), Noss (1964), and Warutamasintop (1973).

In section 1 of the paper I present the facts and compare two alternative solutions to the problem of the glottal stop. One solution omits the glottal stop from underlying forms; the other solution includes it. In section 2, I give internal linguistic evidence that supports the solution that includes the glottal stop in underlying forms.

## 1. ALTERNATIVE SOLUTIONS

In monosyllabic forms like those in (1), the glottal stop occurs phonetically in both initial and final position.

---

* Thanks to Ian Maddieson, Vicki Fromkin, and Peter Ladefoged for many helpful comments and suggestions on this paper.
Work supported by NSF Grant GS37235.

(1)

| Initial Position | | Final Position | |
|---|---|---|---|
| baw | 'be light' | phùt | 'to emerge' |
| ?aw | 'to take' | phù? | 'be rotten' |
| fay | 'fire' | sàp | 'vocabulary' |
| ?ay | 'stream' | sà? | 'to shampoo' |
| tòk | 'to fall' | lák | 'to steal' |
| ?òk | 'breast' | lá? | 'to abandon' |

The glottal stop could be inserted in final position after a single vowel when no other final segment is present, and in initial position before a vowel when no other initial segment is present.

(2) $\emptyset \rightarrow ? \;/\; \#\_\_\_\,V$

(3) $\emptyset \rightarrow ? \;/\; CV\,\_\_\_\#$

In the polysyllabic forms in (4) the glottal stop occurs in medial position in citation forms only. (The citation form is used when speaking in a slow deliberate style of speech or when carefully pronouncing the word in isolation; the surface form is used when speaking in a normal conversational style of speech.)

(4)

| Citation Form | | Surface Form |
|---|---|---|
| kà?wii | 'poet' | kawii |
| sà?taaŋ | (Thai monetary unit) | sataaŋ |
| má?lá?kɔɔ | 'papaya' | malakɔɔ |
| ?à?nú?yâat | 'to allow' | ?anúyâat |
| má?phráaw | 'coconut' | maphráaw |
| tà?kray | 'scissors' | takray |

The citation forms could be derived by inserting the glottal stop after short open syllables.

(5) $\emptyset \rightarrow ? \;/\; V\_\_\_\; C \; \left( \left\{ \begin{matrix} l \\ r \\ w \end{matrix} \right\} \right) \; V$

In other polysyllabic forms such as those in (6) the glottal stop also occurs in medial position in surface forms.

(6)

| Citation Form | | Surface Form |
|---|---|---|
| sà??àt | 'be clean' | sa?àt |
| lá??ìat | 'be detailed' | la?ìat |
| chà??ɔ̂ɔn | 'to coax' | chà?ɔ̂ɔn |
| sà??ew | 'waist' | sa?ew |

The surface forms could be derived by inserting a glottal stop after a short open syllable followed by a vowel.

(7) $\emptyset \rightarrow ? \;/\; CV\_\_\_V$

Still another rule would be required to geminate the glottal stop in this environment in citation forms.

On the other hand, if the input forms to the above-mentioned rules contain a syllable boundary, we can reformulate rules (2) and (3) as (8) and eliminate rules (5) and (7).

(8) $\emptyset \rightarrow ? \;/\; \begin{array}{ll} \$\_\_\_V & \text{(i)} \\ CV\_\_\_\$ & \text{(ii)} \end{array}$

Sample derivations for the citation forms are given in (9) (a morpheme boundary (+) includes a syllable boundary ($), see Hooper 1972).

(9)

| | | | | |
|---|---|---|---|---|
| Underlying Form: | +àan+ 'to read' | +sà+ 'to shampoo' | +à$nú$yâat+ 'to allow' | +sà$àat+ 'be clean' |
| Rule 8 (i) | +?àan+ | -- | +?à$nú$yâat+ | +sà$?àat+ |
| Rule 8 (ii) | -- | +sà?+ | +?à?$nú?$yâat+ | +sà?$?àat+ |
| Citation Form: | ?àan | sà? | ?à?nú?yâat | sà??àat |

To derive the correct surface forms (11), however, another rule (10) is required that deletes word-medial occurrences of the glottal stop.

(10) $? \rightarrow \emptyset \;/\; CV\_\_\_C \left( \begin{Bmatrix} l \\ r \\ w \end{Bmatrix} \right) V$

(11)

| | | | | |
|---|---|---|---|---|
| Surface Form: | ?àan | sà? | ?anúyâat | sa?àat |

So far, I have shown that it is possible to predict the occurrences of the glottal stop with a syllable boundary and two phonological rules - the glottal stop insertion rule (8) and the glottal stop deletion rule (10).

Next I want to consider an alternative solution that assumes the glottal stop is present in underlying forms. This solution requires only one rule (12) that deletes word-medial occurrences of the glottal stop in the derivation of surface forms.

(12) ? $\rightarrow$ ∅ / ___C

Sample derivations are given in (13)

| (13) | | | | |
|---|---|---|---|---|
| Underlying Form: | +?àan+ 'to read' | +sà?+ 'to shampoo' | +?à?nú?yâat+ 'to allow' | +sà??àat+ 'be clean' |
| Citation Form: | ?àan | sà? | ?à?nú?yâat | sà??àat |
| Rule (12) | -- | -- | ?anúyâat | sa?àat |
| Surface Form: | ?àan | sà? | ?anúyâat | sa?àat |

The polysyllabic forms in (14) that contain internal morpheme boundaries show clearly that rule (12) also applies across morpheme boundaries.

| (14) | | | |
|---|---|---|---|
| Underlying Form: | phǒnlá? +máay 'fruit' 'wood' 'fruit' | rátthà? +sàat 'state' 'science' 'political science' | má?nútsà?yá?+châat 'man' 'nationality' 'mankind' |
| Citation Form: | phǒnlá?máay | rátthà?sàat | má?nútsà?yá?châat |
| Surface Form: | phǒnlamáay | rátthasàat | manútsayáchâat |

I have now presented two alternative solutions to the problem of the glottal stop in Thai. One solution excludes the glottal stop from underlying forms, the other solution includes it in underlying forms. Both solutions can account for the same data. In the next section, I will show, however, that the internal linguistic evidence supports the latter solution.

## 2. EVIDENCE IN SUPPORT OF AN UNDERLYING GLOTTAL STOP

In this section five arguments are given in favor of the solution that includes the glottal stop in underlying forms.

(a) To select the glottal stop as the segment to be inserted by rule is totally arbitrary. One could just as easily have chosen to insert one of the other segments that occurs in syllable-initial or syllable-final position. For example, among the obstruents only /p t k ?/ occur in syllable final position. If /p/ were selected as the segment to be inserted by rule, one could say that /p/ occurs in syllable-final position after a single vowel when no other final segment is present.

(b) If a glottal stop is present in underlying forms, the statement of distribution of the five lexical tones in Thai can be simplified.

All five tones - mid, low, falling, high, rising - may occur on a syllable that ends in a vowel, nasal, or semivowel. Only a low or high tone may occur on a syllable that ends in a stop (p t k ʔ) preceded by a short vowel; only a low or falling tone may occur on a syllable that ends in a stop ( p t k) preceded by a long vowel or diphthong.

A summary of the restrictions on the distribution of the five lexical tones and examples is presented in Table I ( '+' indicates that the tone (column) may occur on the syllable structure (row); '-' indicates that the tone may not occur.) Examples are given in Table II.

TABLE I

| | Mid | Low | Falling | High | Rising |
|---|---|---|---|---|---|
| CVV | + | + | + | + | + |
| CV(V)N | + | + | + | + | + |
| CV(V)G | + | + | + | + | + |
| CVS | - | + | - | + | - |
| CV ʔ | - | + | - | + | - |
| CVVS | - | + | + | - | - |

N = m n ŋ S = p t k
G = w y

Note that the tonal restriction on a syllable that ends in a glottal stop preceded by a single vowel is identical to the restriction on a syllable that ends in /p t k/ preceded by a single vowel. If the glottal stop is present in syllable-final position in underlying forms, then the tonal restriction can be stated in a straightforward manner: only low or high tone may occur on a syllable that contains a single vowel followed by a stop. If the glottal stop is not present in syllable-final position in underlying forms, then we are left to explain the peculiar distribution of the low and high tone. Why should a CV syllable carry only a low or high tone, while other syllables that end in a sonorant segment carry all five tones? Moreover, why should a CV syllable have the same restriction on tones as a CVS syllable? These anomalous restrictions disappear if the glottal stop is present in underlying forms.

TABLE II

| Mid | Low | Falling | High | Rising |
|---|---|---|---|---|
| maa 'to come' | khàa 'galangal' | khâa 'to kill' | rúu 'to know' | sɨ̌a 'tiger' |
| pen 'to be' | sàn 'to vibrate' | tôn 'tree' | náam 'water' | phǒn 'result' |
| fay 'fire' | kày 'chicken' | lâw 'liquor' | ráay 'be evil' | khǎay 'to sell' |
| | sàp 'vocabulary' | | ráp 'to receive' | |
| | sàt 'animal' | | rát 'state' | |
| | phàk 'vegetable' | | lák 'to steal' | |
| | tè? 'to kick' | | lá? 'to abandon' | |
| | bàap 'sin' | rûup 'picture' | | |
| | bàat 'Thai monetary unit' | rîit 'to iron' | | |
| | dɔ̀ɔk 'flower' | phâak 'region' | | |

(c) In citation form there are a large nummer of disyllabic morphemes in which the initial syllable has the shape CV? and carries low tone, and the final syllable begins in a sonorant segment. In this environment, the final syllable carries rising tone if it ends in a sonorant segment, low tone if it ends in /p t k ?/. This morpheme structure condition does not apply if either the initial syllable carries high tone or the final syllable begins in a nonsonorant segment. Examples are given in (15).

| | Citation Form | | Surface Form |
|---|---|---|---|
| (15) | sà?wǎn | 'heaven' | sawǎn |
| | thà?nǒn | 'road' | thanǒn |
| | chà?lə̌əy | 'to answer' | chalə̌əy |
| | sà?mùt | 'ocean' | samùt |
| | cà?rìt | 'conduct' | carìt |
| | sà?nùk | 'be fun' | sanùk |
| | sà?rà? | 'vowel' | sarà? |
| but | sà?phaa | 'assembly' | saphaa |
| | sà?kun | 'family line' | sakun |
| | phá?laŋ | 'power' | phalaŋ |
| | chá?ləəy | 'prisoner of war' | chaləəy |

Most of the exceptions are non-Indic loanwords. Gedney (1947:59 ) notes one word of Pali-Sanskrit origin that violates this constraint - samaakhom 'club' /+sà?maa + khom+/.

If no syllable-final glottal stop is present in underlying forms, then the morpheme structure condition would have to be complicated in order to handle forms like [sarà?] 'vowel". Rather than simply saying that a low tone accompanies a final syllable that ends in a stop consonant, the morpheme structure condition would have to say that a low tone accompanies a final syllable that ends in a stop consonant or a single vowel. Why should this be so? Once again, the presence of the glottal stop in the underlying form permits a phonetically-motivated, economical generalization.

(d) Co-occurrence restrictions that obtain between tone and syllable-initial consonants also point to a glottal stop in the underlying form.

No high or rising tone occurs on a syllable that begins in an unaspirated stop consonant (p b t d c k ?). Forms such as *tǎa *bǎa *?úu are not allowed. The exceptions to this restriction fall into well-defined morpho-syntactic classes: non-Indic loanwords, onomatopoeic words, and exclamations.

| | | |
|---|---|---|
| (16) | ?ɔ́ksicen | 'oxygen' |
| | kúuk | 'call of a nightbird' |
| | báa | 'bah!' |

The glottal stop then behaves like other syllable-initial consonants of the same type. With a glottal stop present in the underlying form, the environment for this tonal restriction is simply $\$ \left\{\begin{matrix}\text{-sonorant}\\ \text{-continuant}\\ \text{-aspirated}\end{matrix}\right\}$ ; otherwise, the environment would also have to include a vowel. We are then left to explain why a syllable that begins in either a vowel or an unaspirated stop should have the same effect on tone.

(e) With a glottal stop present in the underlying form, every syllable on the phonological level of representation begins with a consonant and every short syllable ends with a consonant. The structure of the phonological syllable may be symbolized as (17).

$$(17) \quad \$ \quad C \quad (C) \quad \left\{\begin{matrix}VC\\ VV(C)\end{matrix}\right\} \quad \$$$

Without a glottal stop present in the underlying form, syllables that begin and end in a vowel would also have to be allowed for. A CV syllable does of course occur on the phonetic level of representation.

## 3. CONCLUSION

Whether a segment should be present in the underlying form or not depends on more than one part of the grammar. A segment that can be derived by phonological rule must not necessarily be abstracted out of the underlying form. The Thai glottal stop is just such a segment. Unless it is present in the underlying form, certain linguistically significant generalizations are either obscured or lost altogether.

## References

Abramson, Arthur S. (1962), "The vowels and tones of Standard Thai: acoustical measurements and experiments," *International Journal of American Linguistics* 28.2 (part 3).

Chomsky, Noam and Morris Halle (1968), *The Sound Pattern of English,* Harper and Row, New York.

Gedney, William J. (1947), *Indic Loanwords in Spoken Thai,* Unpublished doctoral dissertation, Yale University.

Gillette, Josephine A. (1955), *Prosodic Features of Bangkok Thai,* Unpublished master's thesis, Georgetown University.

Haas, Mary R. et. al. (1964), *Thai-English Student's Dictionary,* Stanford University Press.

Hooper, Joan (1972), "The syllable in phonological theory," *Language* 48.3: 525-540.

Noss, Richard B. (1964), *Thai Reference Grammar,* U.S. Government Printing Office, Washington, D.C.

Surintramont, Aporn (1973), "Some aspects of underlying syllable structure in Thai: evidence from Khamphuan - a Thai word game," *Studies in the Linguistic Sciences,* 3.1:121-142.

Warotamasikkhadit, Udom (1967), "Some phonological rules in Thai," *Journal of the American Oriental Society* 87.4:541-574.

Warutamasintop, Worawut (1973), "The syllable boundary in Thai phonology," Unpublished paper, UCLA.

# *Consonant Types and Tone In Siamese**

Jack Gandour

## 0. INTRODUCTION

The relationship between various consonant types and tones has been of special interest in considering the role of tone in a generative phonology. It is relevant to several theoretical issues including, among others, distinctive phonological features of tone (Halle and Stevens 1971, Ladefoged 1973), segmental versus suprasegmental representation of tone (Schachter and Fromkin 1968, Leben 1973), synchronic tone rules (Hyman 1973, Mohr 1973, Hyman and Schuh 1974), and historical development of tone (Haudricourt 1961, Matisoff 1973, Maran 1973).

To help resolve these theoretical issues, detailed phonetic information about the interaction between various consonant types and tone studies have been done (Lehiste and Peterson 1961, Mohr 1971, Lea 1973). All of these earlier studies deal primarily with the influences of preceding and following consonants on pitch. All of them are based on nonsense syllables from languages that do not have lexically contrastive pitch.

This paper presents the results of an investigation of the effects of preceding consonants on tone in Siamese, a language that has lexically contrastive pitch on individual syllables.

Of previous instrumental studies of tones in Siamese, none of them deal with consonantal influences on pitch. Abramson (1962) presents average fundamental frequency contours of tones on monosyllabic citation forms; Palmer (1969) gives the phonetic shapes of tones in a specified phonological environment in connected speech; Hiranburana (1971) analyses the phonetic shapes of tones in fast, casual speech.

The paper is divided into 4 major sections. In Section 1, the materials and methods employed in the study are presented. The results

---

*I want to thank all the members of the Tone Group at UCLA for many helpful comments and suggestions on this paper, especially Peter Ladefoged and Ian Maddieson. The work on this paper was supported by NSF grant GS37235X.

of the investigation are given in Section 2. In Section 3, some relevant theoretical issues are discussed. Further discussion of more speculative issues is presented in Section 4.

1. PROCEDURE

1.1 Eight consonant segments from Siamese were chosen for investigation:

| | |
|---|---|
| p | t |
| pʰ | tʰ |
| b | d |
| | s |
| | n |

The test material consisted of nonsense syllables of the shape $CV_1^TV_2$ where C = [p pʰ b t tʰ d s n], $V_1 = V_2$ = [a i u], T = (1) mid-level (2) low-level (3) high-rising-falling (4) high-rising (5) low-rising, hereafter MID ( ), LOW (`), FALLING (^), HIGH (´), RISING (ˇ), respectively.

A reading list was prepared containing 360 nonsense syllables (8 consonants x 3 vowels x 5 tones x 3 tokens).

| | | |
|---|---|---|
| Caa | Cii | Cuu |
| Caa | Cii | Cuu |
| Caa | Cii | Cuu |
| Caa | Cii | Cuu |
| Caa | Cii | Cuu |

This list contained 15 tokens of each consonant, all placed in utterance-medial position in the frame

mii ___ 'Here is/are______'

and written in the Siamese alphabet, which indicates tonal differences.

Some of the syllables used as test material were not meaningless, and actually occur in the language.

The reading list was arranged in random order and then read by a male (24 years old) native speaker of Siamese. The speaker was instructed to read the list at normal speed. The recording was made at a single session under laboratory conditions.

The tapes were then analyzed using the Pitch Extraction System at the UCLA Phonetics Laboratory. A Siemens Oscillomink paper recording device registered the fundamental frequency curves continuously, and, on separate channels, a continuous oscillogram of the wave form and amplitude.

A phonetic transcription from the tapes was added to the oscillogram. Segmentation was based on characteristic features of the recorded wave forms and fundamental frequency curves.

Frequency values were read off the oscillogram with a pitch scale (0.5 mm = 2.5 hz) prepared from the calibration curves of the instruments.

1.2 The fundamental frequency contour from immediately before (for voiced consonants) or after (for voiceless consonants) the release of the preceding consonant to the end of the nonsense syllable was divided into (1) CC ('consonantal contour') - that stretch of the pitch curve affected by preceding consonants and (2) TC ('tonal contour') - that stretch of the pitch curve not affected by preceding consonants. In Figure 1 below, the part of the chart to the left of the dashed line represents CC, the part of the chart to the right of the dashed line TC.

Four fundamental frequency parameters were defined - (1) F (closure), (2) F (onset), (3) F (peak), (4) F (tone), as illustrated in Figure 1.

(1) F(closure) - lowest fundamental frequency value before release of voiced consonant
(2) F(onset) - initial fundamental frequency value after release of consonant
(3) F(peak) - highest fundamental frequency value after release of voiced consonant
(4) F(tone) - fundamental frequency value at beginning of stretch of pitch curve not affected by preceding consonant

In Figure 2, the F parameters are illustrated on pitch curves from actual oscillograms.

The location of each point was determined by visual inspection of the pitch curve for MID, LOW, FALLING, HIGH, RISING tones preceded by each consonant segment. That stretch of the pitch curve that did not vary with different types of preceding consonants was taken to be TC, its beginning point F(tone). Tracings from oscillograms of the pitch curve

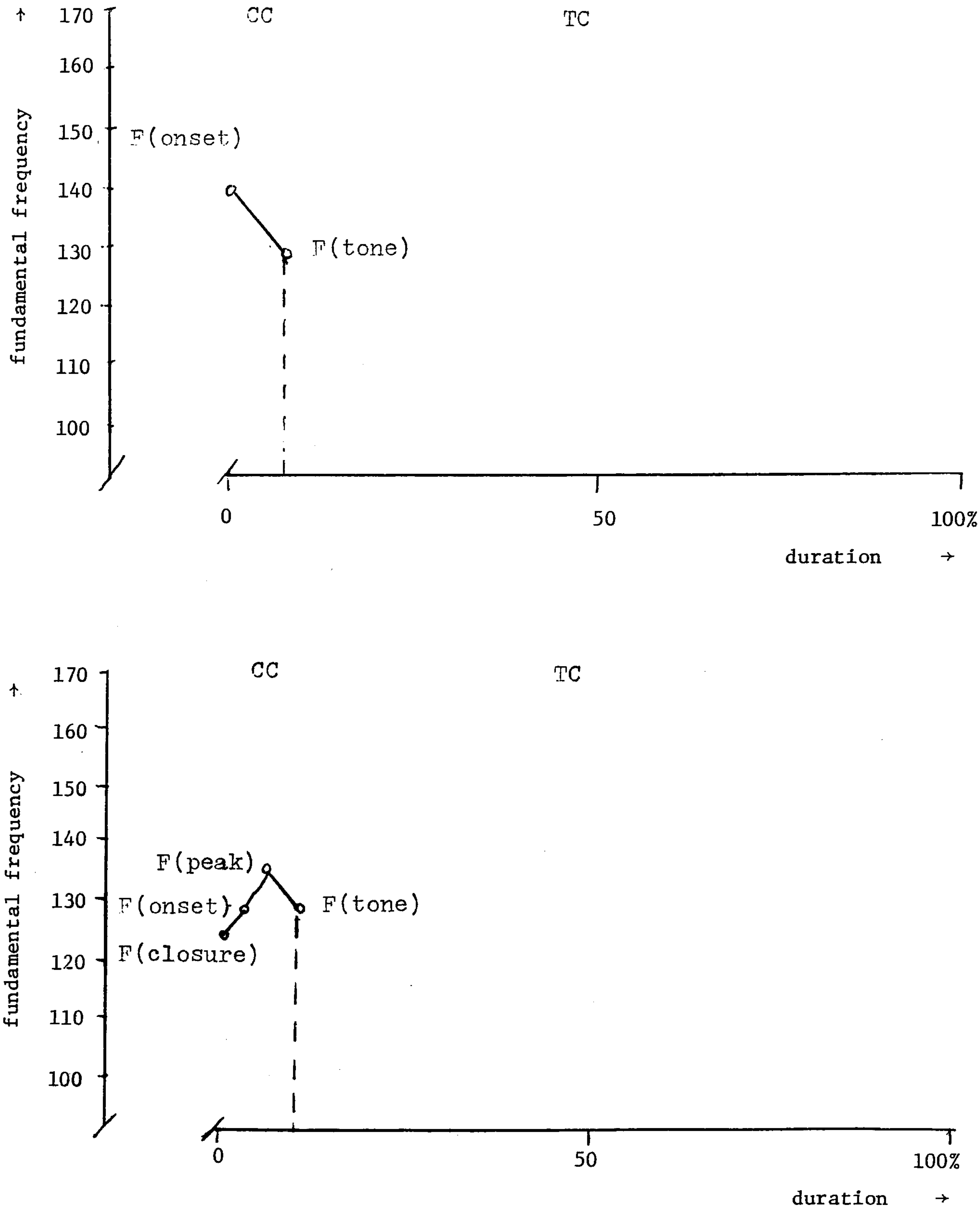



Figure 1. Pitch curves illustrating definitions of F parameters for (a) voiceless and (b) voiced consonants

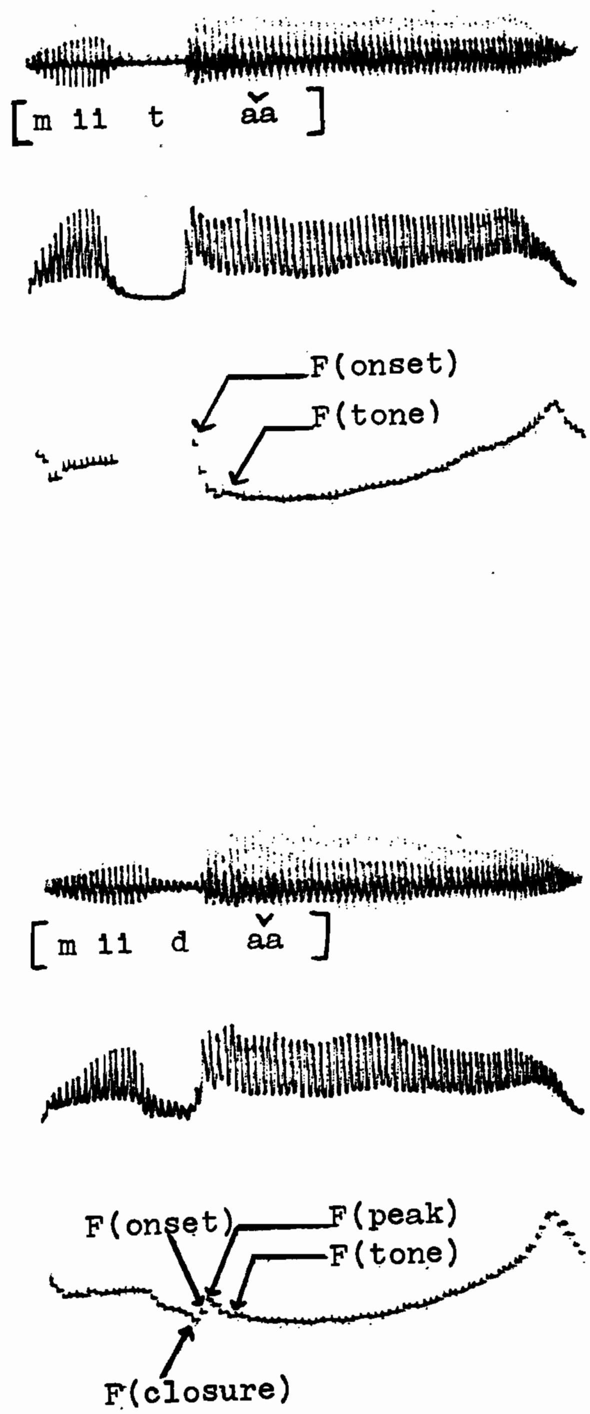



Figure 2. Oscillograms illustrating definitions of F parameters for (a) voiceless and (b) voiced consonants.

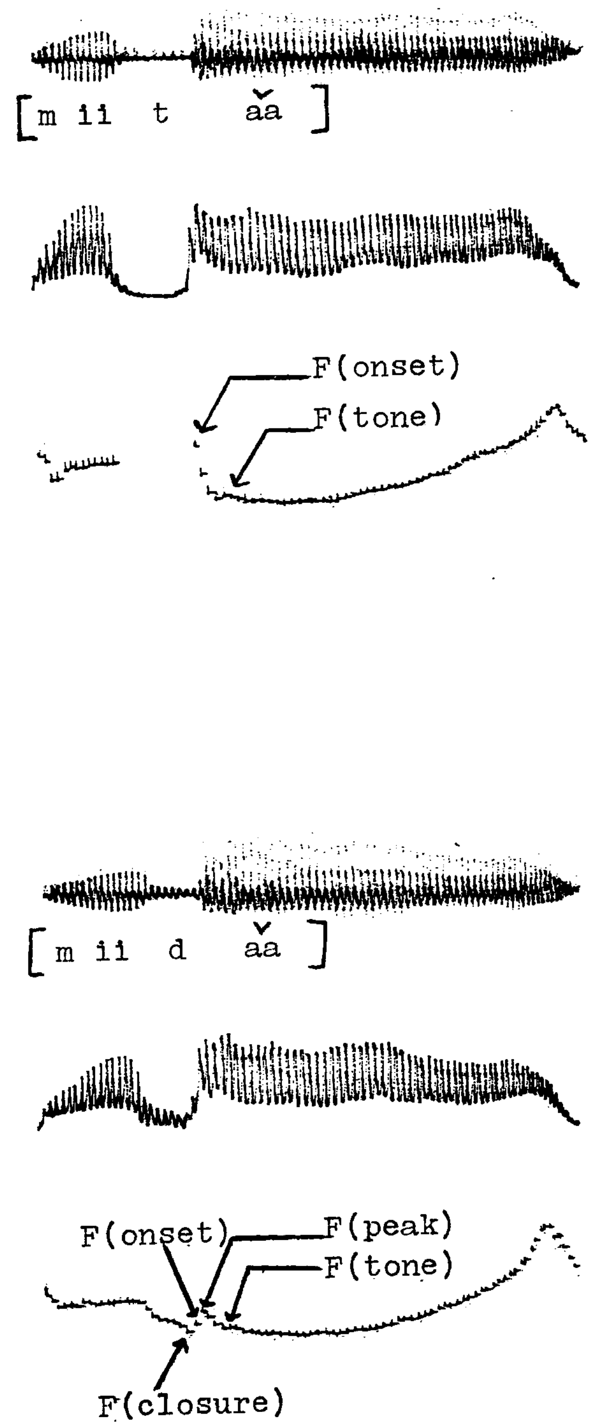



Figure 2. Oscillograms illustrating definitions of F parameters for (a) voiceless and (b) voiced consonants.

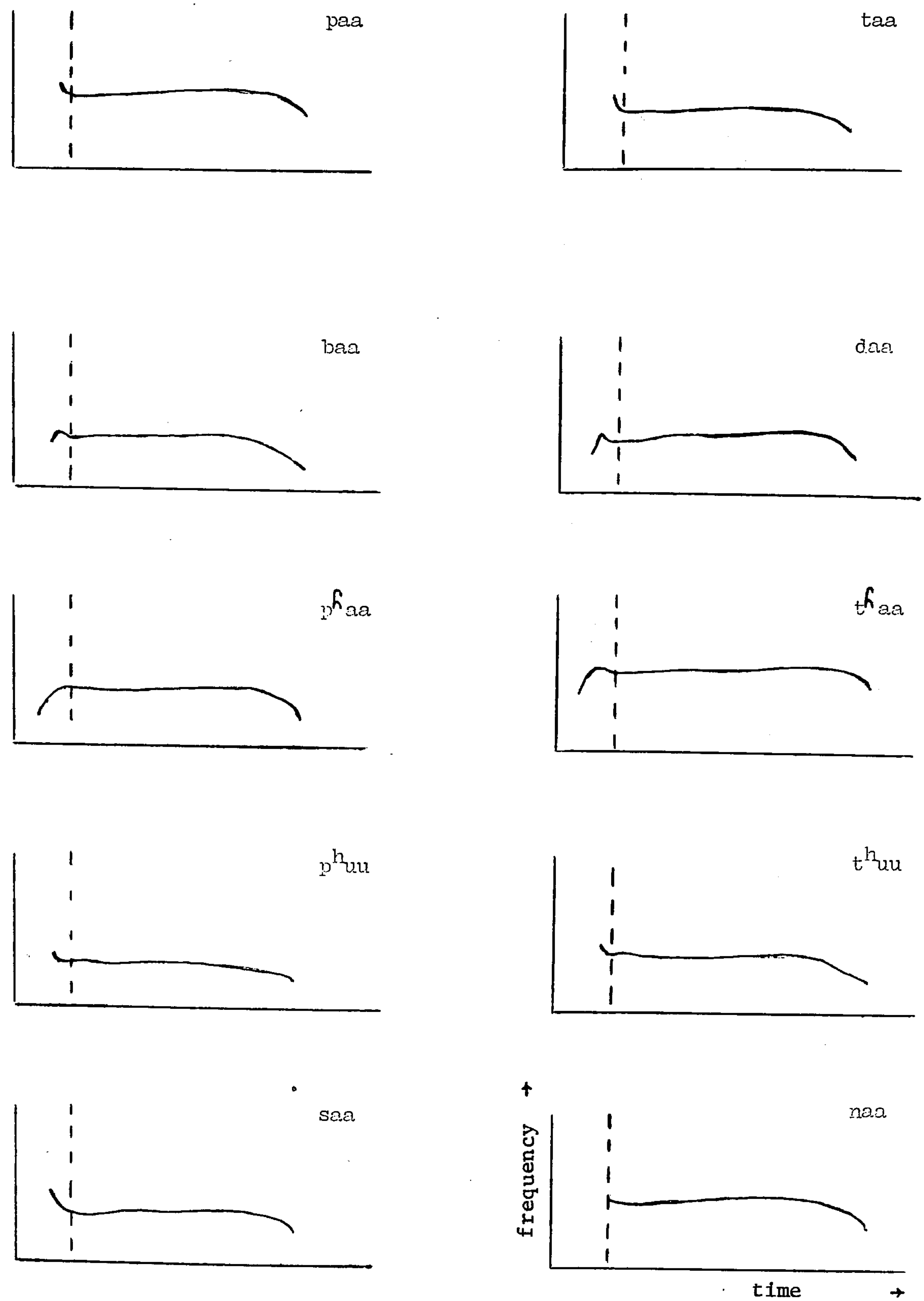



Figure 3. Fundamental frequency contours for MID tone.

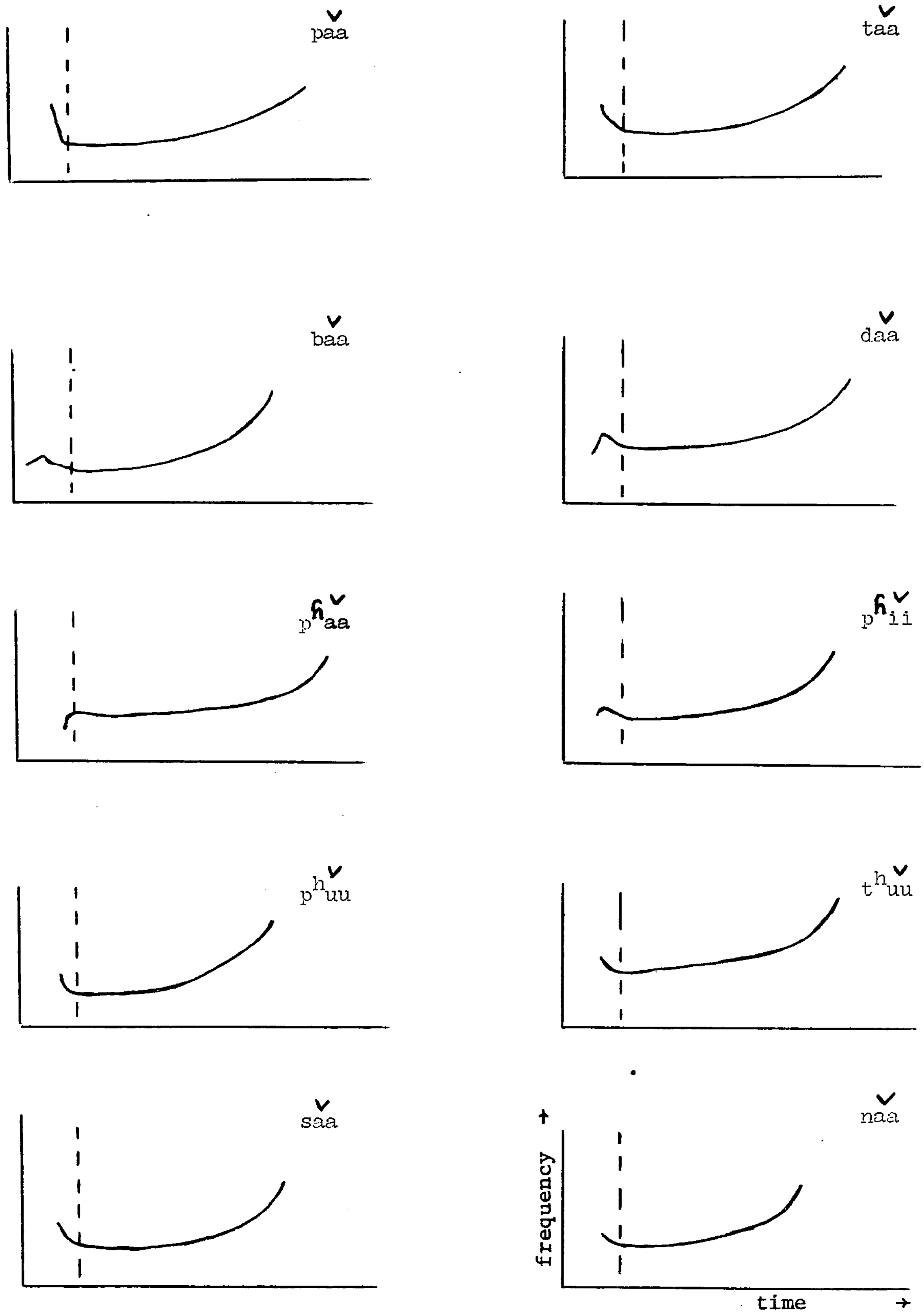



Figure 4. Fundamental frequency contours for RISING tone.

for MID tone and RISING tone preceded by different consonant types, presented in Figures 3 and 4, illustrate how this was done. The dashed line represents F(tone). It may be seen that the shape of the curve to the right of the dashed line is very similar in all these utterances. There are differences in absolute level from utterance to utterance which will be discussed later. The two different kinds of aspirated stops will also be discussed later in the paper.

The extent of influence of preceding consonants on tone (in percentage), for each consonant type-tone group, was determined by calculating the average percentage of duration of CC to that of CC + TC. TC was measured from F(tone) to the end of the nonsense syllable for all consonant types; CC was measured from F(onset) to F(tone) for voiceless consonants, from F(closure) to F(tone) for voiced consonants. Six tokens of each member of a consonant type-tone group were selected for measurement - 2 tokens for each of the 3 vowels [a i u]. Due to artifacts introduced by the Pitch Extraction System, not all nine tokens for each consonant type-tone group could be used for measurement. In addition, the average duration (in milliseconds) of CC was calculated.

2. RESULTS

2.1 The selection of the F(tone) point appears to be valid. No strict measurement beyond F(tone) is found to be necessary for determining consonantal influences on pitch.

Visual inspection of the TC contours indicates that they are uniform and consistent for each tone (i.e., MID LOW FALLING HIGH RISING) irrespective of preceding consonant type.

More importantly, if one can show that there is no significant difference in pitch at F(tone) for a given tone when preceded by different consonant types, then it follows that no point beyond F(tone) is significantly affected by different types of preceding consonants.

The results of a grouped data T Test, presented in Table I, show that there is no significant difference in F(tone) values on any of the tones for voiceless [p t] and voiced [b d] consonants.

Due to the splitting of the voiceless aspirated consonants into two groups (cf. Section 2.2) with an uneven distribution depending on the tone and following vowel, it is not possible to show that there is no statistical difference for any class of consonants.

The average F(tone) values for tones preceded by alveolar consonants are given in Table II. Again, due to the uneven distribution of the two

TABLE I

Results of Grouped Data T Test for F(tone) values of Voiceless Unaspirated and Voiced Stops

| | Group 1 [p t] | | Group 2 [b d] | | T Score |
|---|---|---|---|---|---|
| | Mean F(tone) | Standard Deviation | Mean F(tone) | Standard Deviation | |
| MID | 117.08 | 14.53 | 122.08 | 11.95 | -0.9204 |
| LOW | 108.33 | 12.99 | 106.11 | 14.09 | 0.3478 |
| FALLING | 131.15 | 10.83 | 138.07 | 8.30 | -1.8292 |
| HIGH | 132.91 | 11.76 | 125.83 | 14.59 | 1.3091 |
| RISING | 115.00 | 12.24 | 109.28 | 10.35 | 1.3333 |

TABLE II

Average F(tone) Values For Alveolar Consonants

| | F(tone) | | | | |
|---|---|---|---|---|---|
| | MID | LOW | FALLING | HIGH | RISING |
| t | 123 | 115 | 134 | 138 | 120 |
| tʰ | 126 | 114 | 140 | --- | 109 |
| tʱ | 126 | 116 | 142 | 134 | 112 |
| d | 123 | 114 | 139 | 133 | 112 |
| s | 117 | 116 | 141 | 135 | 114 |
| n | 124 | 120 | 139 | 140 | 110 |
| Combined Avg. | 123 | 116 | 139 | 136 | 113 |

TABLE III

Average F(onset) Values For Stops,
F(peak) Values For Voiced Stops

| | [p t] | [pʰ tʰ] (1) | [pʱ tʱ] (2) | [b d] | |
|---|---|---|---|---|---|
| | F(onset) | F(onset) | F(onset) | F(onset) | F(peak) |
| MID | 136 | 132 | 123 | 120 | 126 |
| LOW | 136 | 116 | 114 | 109 | 114 |
| FALLING | 148 | 140 | 136 | 133 | 142 |
| HIGH | 146 | --- | 128 | 123 | 132 |
| RISING | 137 | 124 | 113 | 114 | 118 |

TABLE IV

Average Duration of CC For Voiceless and Voiced Consonants
In Percentage of Duration of Total Contour and
Actual Number of Milliseconds

| | [p t] | | [s] | | [b d] | |
|---|---|---|---|---|---|---|
| | Distance From F(onset) To F(tone) | | Distance From F(onset) To F(tone) | | Distance From F(closure) To F(tone) | |
| | % | No. of Msec | % | No. of Msec | % | No. of Msec |
| MID | 6.5 | 30 | 4.4 | 20 | 11.0 | 50 |
| LOW | 5.7 | 30 | 4.0 | 21 | 9.3 | 41 |
| FALLING | 4.6 | 18 | 2.8 | 10 | 10.5 | 46 |
| HIGH | 4.3 | 17 | 4.0 | 16 | 10.0 | 40 |
| RISING | 6.0 | 26 | 7.3 | 31 | 9.5 | 50 |

groups of aspirated consonants, these average F(tone) values are based on only two tokens for each consonant, both tokens followed by either [ɨ] or [u]. No tokens of [$t^h$] occur before a HIGH tone.

2.2 The Average F(onset) values for stops and F(peak) values for voiced stops are given in Table III. For the aspirated stops, two qualitatively different consonantal contours were observed - (1) high-falling slope into the vowel (2) low-rising-(falling) slope into the vowel. The latter contour accompanies a 'breathy' pronounciation of the aspirated stops. Throughout the paper, it will be necessary to treat the 'plain' and 'breathy' allophones of the Siamese aspirated stops as separate consonant types.

The average F(onset) value for voiceless unaspirated stops is 15% higher than for voiced stops, 13% higher than for the 'breathy' aspirated stops, 8% higher than for the 'plain' aspirated stops. The average F(onset) value for voiceless unaspirated stops is 10% higher than the F(peak) value for voiced stops.

2.3 Immediately after voiceless consonants, the fundamental frequency contour is high and falling. The distance of the fall in pitch, however, varies depending on the initial pitch height on the following vowel. The longer falls in pitch tend to occur before lower pitch heights, the shorter falls in pitch before higher pitch heights. The average falls in pitch for voiceless unaspirated stops, 'plain' aspirated stops, and voiceless alveolar fricative are presented in Figure 5. No occurrences of 'plain' aspirated stops before HIGH tone were found in the data.

The greatest fall in pitch accompanies voiceless unaspirated consonants. Note especially that the fall in pitch is greater for voiceless unaspirated consonants than for 'plain' aspirated stops.

2.4 Immediately after the release of voiced stops, the fundamental frequency contour is rising-falling. The longer rises in pitch tend to occur before higher pitch heights, the shorter rises in pitch before lower pitch heights. The average rises in pitch for voiced stops are given in Figure 6. The fall in pitch from F(peak) to F(tone) averages 6 hz across all tones.

2.5 Average fundamental frequency contours for voiceless unaspirated stops [p t] and voiced stops [b d] followed by MID, LOW, FALLING, HIGH, RISING tones are represented in Figure 7(a-j).

Unlike Lea's (1973:35) findings, a slight rise before the fall in slope after voiceless consonants was <u>not</u> evident for any of the voiceless consonants investigated.

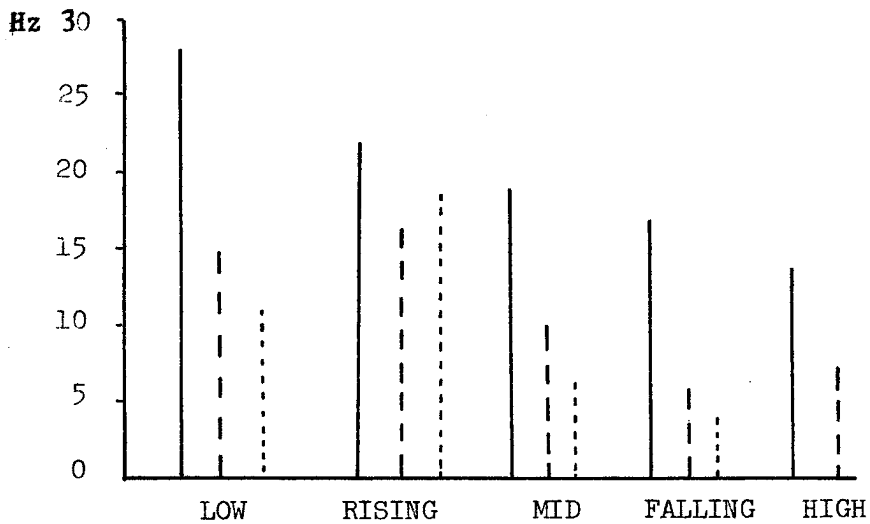



Figure 5. Average fall in pitch between F(onset) and F(tone) for voiceless consonants. [p,t] - solid line, [ph, th] - dashed line, [s] - dotted line.

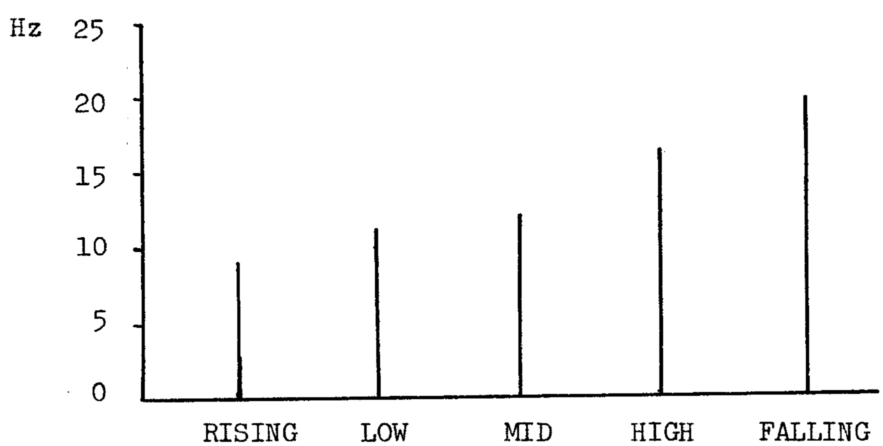



Figure 6. Average rise in pitch between F(closure) and F(peak) for voiced stops.

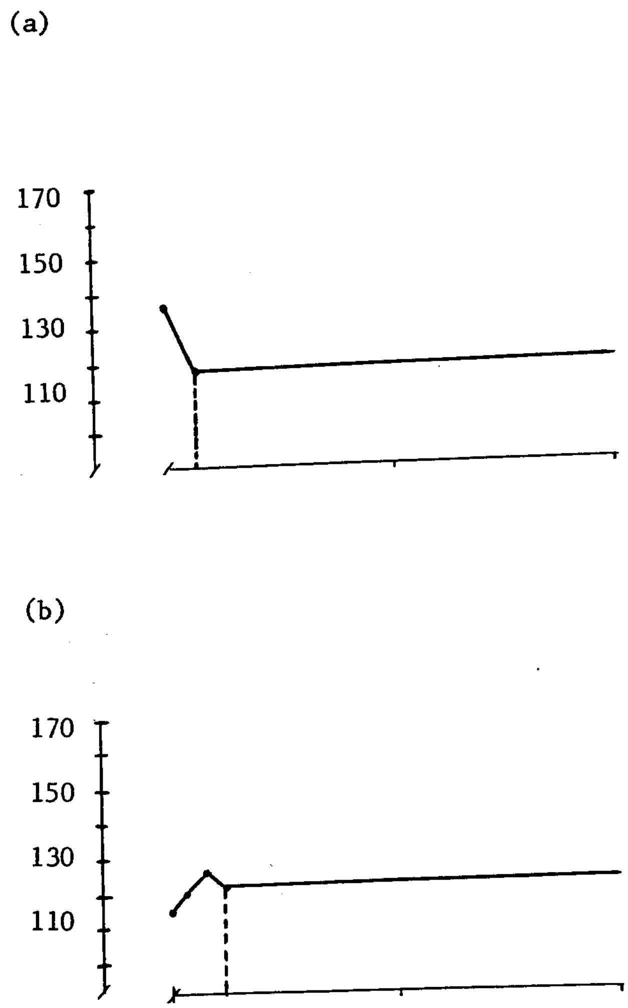
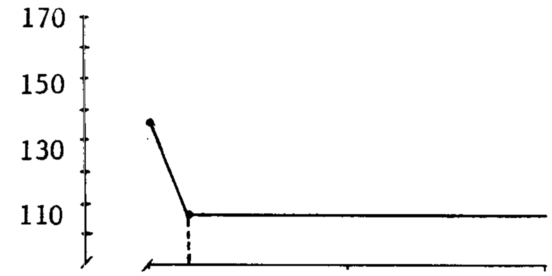
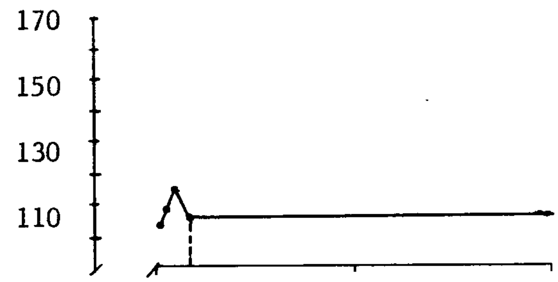



Figure 7. Average pitch curves for voiceless unaspirated stops ( a c e g i) and voiced stops (b d f h j) preceding MID LOW FALLING HIGH RISING tones.

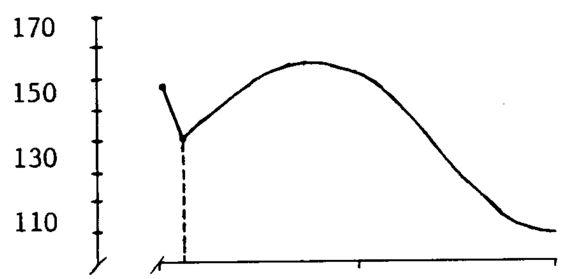
(c)


170
150
130
110

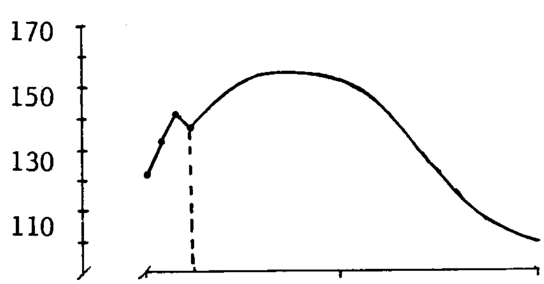
(d)


170
150
130
110

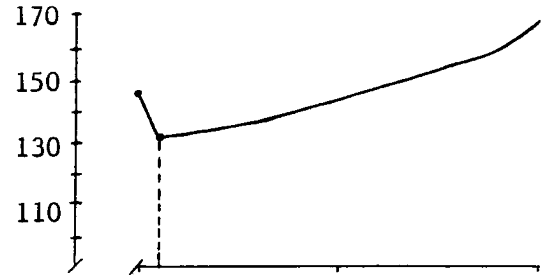
(e)


170
150
130
110

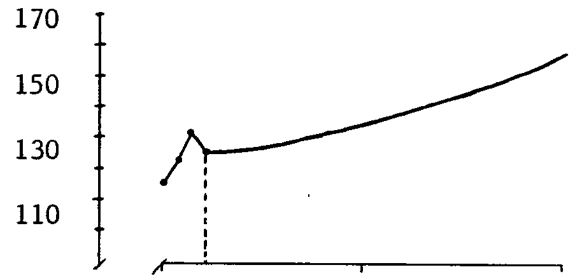
(f)


170
150
130
110

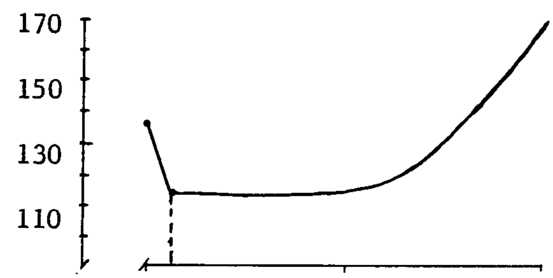
(g)


170
150
130
110

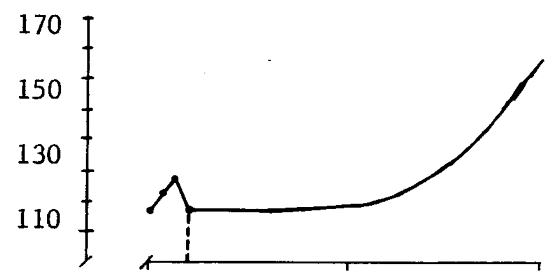
(h)


170
150
130
110

(i)


170
150
130
110

(j)


170
150
130
110

2.6 Average fundamental frequency contours for voiceless alveolar fricative [s] followed by MID, LOW, FALLING, HIGH, RISING tones are represented in Figure 8.

2.7 The voiced nasal [n] has no noticeable effect preceding MID, FALLING, and HIGH tones, i.e. for these tones F(onset) and F(tone) are coterminous. When it precedes LOW and RISING tones, [n] shows a falling slope into the vowel. The average fundamental frequency contours for [n] preceding LOW and RISING tones are represented in Figure 9 (cf. Abramson 1962:127).

2.8 Fundamental frequency contours for 'plain' aspirated stops are similar to those for voiceless alveolar fricatives on MID, LOW, FALLING, and RISING tones (cf. Figure 8, Section 2.6). An average pitch curve for the 'breathy' allophone preceding HIGH tone is provided in Figure 10 below for comparison with Figures 7g-h (cf. Section 2.5) and Figure 8d (cf. Section 2.6).

2.9 As pointed out in Section 2.2, Siamese has a 'breathy' allophone of the aspirated stops. Its distribution, as compared to the 'plain' allophone, on MID, LOW, FALLING, HIGH, RISING tones is given in Figure 11.

The 'breathy' allophone occurs more frequently before tones that start at higher pitch heights. The higher the tone, the more likely is to occur. Ranking the tones of Siamese - RISING LOW MID HIGH FALLING - in order from lowest to highest initial pitch height (cf. Table II, Section 2.1 - see also Abramson 1962:127) agrees closely with a ranking of the tones in order from lowest to highest percentage of 'breathy' allophones of the aspirated stops.

2.10 Since Siamese has lexically contrastive pitch, it is possible to see clearly the extent of influence of preceding consonants on pitch. Table IV presents the results of measurements of CC relative to TC for voiceless unaspirated and voiced stops, and the voiceless alveolar fricative.

For [p t] the average number of milliseconds for CC is 24.2, for [s] 19.6, for [b d] 35.4.

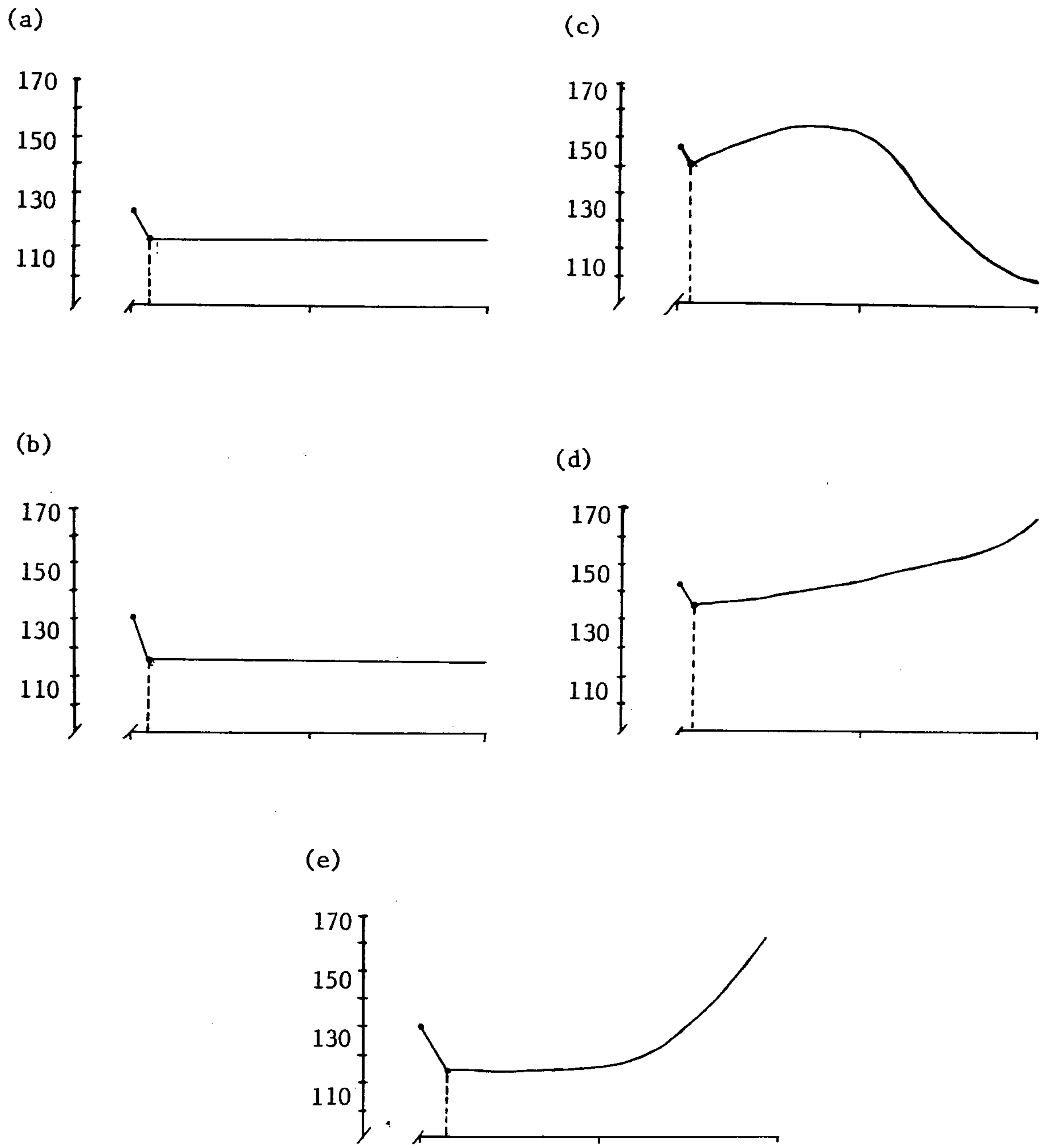



Figure 8. Average pitch curves for voiceless alveolar fricative preceding
(a) MID (b) LOW (c) FALLING (d) HIGH (e) RISING tones

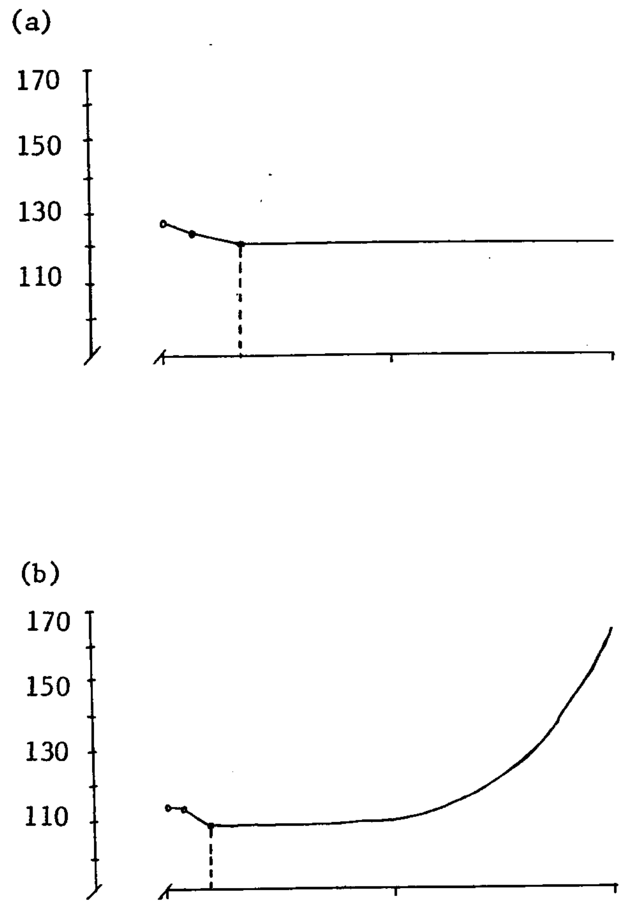



Figure 9. Average pitch curves for voiced alveolar nasal preceding (a) LOW and (b) RISING tones.

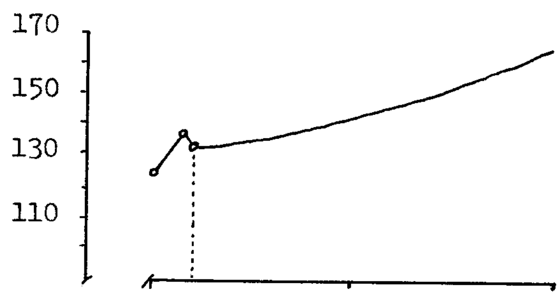



Figure 10. Average pitch curve for 'breathy' allophone of aspirated stops preceding HIGH tone.

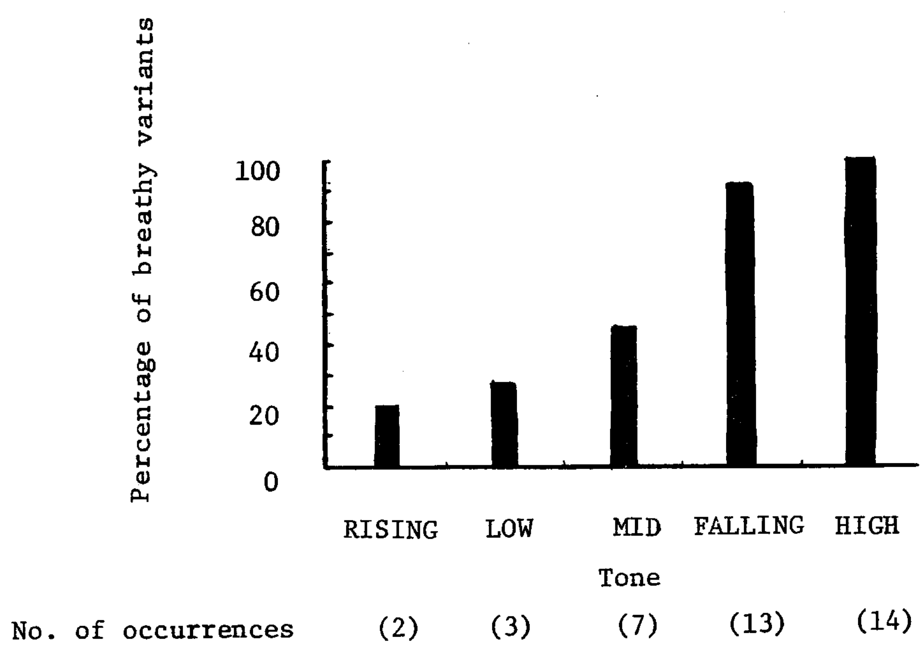



Figure 11. Distribution of breathy variant of aspirated stops by tone.

## 3. DISCUSSION

3.1 The F(onset) values given in Table I (Section 2.1) more or less agree with earlier studies. Lea (1973;43), using a larger set of consonants from English, found that F(onset) values are about 20% higher when the preceding consonant is voiceless, as compared to when the consonant is voiced, and that peak fundamental frequency values (F(onset) for voiceless consonants, F(peak) for voiced consonants) in stressed vowels are about 10% higher when preceded by voiceless consonants than when preceded by voiced consonants. Lehiste and Peterson (1961) also using a set of consonants from English, likewise found that higher fundamental frequencies occurred after a voiceless consonant and considerably lower fundamental frequencies occurred after a voiced consonant.

These F(onset) values would seem to support the hypothesis that voiceless consonants are associated with high pitch, voiced consonants with low pitch (Halle and Stevens 1971). But when one considers the shortness of the consonantally perturbed portion of the fundamental frequency contour, the Halle-Steven's hypothesis that the same articulatory gesture produces high tones and voiceless consonants, low tones and voiced consonants, appears less plausible.

Their hypothesis predicts an absence of effect when voiced consonants are followed by a low tone or voiceless consonants are followed by a high tone. The results of this experiment, however, show that a fall in pitch after the release of voiceless consonants and a rise-fall in pitch after the release of voiced obstruents is still evident when followed by a high tone and a low tone, respectively.

3.2 Immediately after the release of voiced obstruents, the fundamental frequency rises from the low values it has within the consonant, to yield <u>rising-falling</u> fundamental frequency contours at the boundaries between voiced obstruents and the following vowel. This rising-falling contour occurs with voiced obstruents regardless of the tone on the following vowel. Thus, it is to be considered the 'intrinsic' fundamental frequency contour for voiced obstruents.

Lea (1973) found that the fundamental frequency contour was simply rising for voiced obstruents. However, in his investigation the consonants preceded a stressed vowel in final position which invariably yielded a falling contour. Since the falling contour was constant for all the test items, it was not possible to decide nonarbitrarily whether to attribute part of the falling contour to the voiced obstruent or not.

3.3 As shown in Figure 5 (Section 2.3) the fall in pitch after the release of voiceless consonants is related to the initial pitch level of the TC of the following vowel. The shorter falls in pitch occur when the voiceless consonant is followed by a vowel that has a higher initial pitch level; the longer falls in pitch occur when the voiceless consonant is followed by a vowel that has a lower initial pitch level. Indeed, the order of the voiceless consonants ranked from greatest to least fall in pitch, corresponds closely to the order of the Siamese tones ranked from lowest to highest initial pitch level (cf. Abramson 1962:127).

I appears that there is a target laryngeal configuration for a given type of consonant which remains constant regardless of the pitch level on the following vowel. This target for each type of consonant is a pitch determinant.

Surprisingly, the fall in pitch after voiceless unaspirated stops is greater than after the 'plain' aspirated stops. The unaspirated stops have higher F(onset) values than the aspirated ones. Why this is so is not entirely clear. We would expect the airflow to be greater for the 'plain' aspirated stops, and consequently expect them to have a greater tone raising effect than corresponding voiceless unaspirated stops (cf. Ladefoged 1973, Hyman and Schuh 1974).

3.4 Precise measurements of average fundamental frequency contours for the tones of Siamese pronounced on monosyllabic citation forms are presented in Abramson (1962). The TC presented in this paper mostly agree with Abramson's but do not show an initial drop in pitch on the LOW and RISING tones or the final fall in pitch on the MID and HIGH tones. That Abramson found a fall at the beginning of LOW and RISING tones can now be seen to be due to the influence of a preceding nasal consonant (cf. Figure 9 (a-b), Section 2.7) in the forms that Abramson used. The fall after MID and HIGH tones in Abramson's examples can be attributed to the environment before pause since it does not appear when these tones occur in non-final position.

4. FURTHER DISCUSSION

4.1 In historical-comparative studies of Tai languages and dialects, modern p and $p^h$ that show one series of tone reflexes from earlier voiced consonants have been commonly assumed to come from *b (Li 1954, Gedney 1973, Sarawit 1973). Similarly, for t and $t^h$, k and $k^h$. They are assumed to come from *d and *g, respectively. Instead of *b *d *g, I propose murmured stops *b̤ *d̤ *g̤ (see also Egerod 1960:76-7).

Instrumental data on aspirated stops in Siamese (cf. Sections 2.2, 2.8, 2.9) clearly suggest vestigial traces of breathy voiced stops. These 'breathy' allophones of aspirated stops have also been found in other Tai dialects, particularly among those dialects spoken in southern Thailand (Egerod 1960:66, f.n. 17).

If we reconstruct *b̤, then it becomes possible to posit the following natural line of phonetic development – *b̤ → $p^ɦ$ → $p^h$ → p. If, on the other hand, we reconstruct *b, we must allow for the highly unnatural sound change *b → $p^h$.

Most Tai languages and dialects have traveled the complete route, i.e. they show voiceless unaspirated stops as reflexes of earlier breathy voiced stops. Out of 18 representative Tai dialects, 14 dialects have p as the modern reflex, only 4 dialects have $p^h$ (data taken from Sarawit 1973).

Interestingly, a similar kind of breathy aspirated sound is reported to occur in Wu dialects of Chinese (Egerod 1960:66, f.n. 17), which led Karlgren to reconstruct "voiced aspirated" sounds for Ancient Chinese (Karlgren 1954:220).

4.2 In the historical development of tone languages much evidence has been given (Haudricourt 1961, Li 1966, Matisoff 1973) in support of the hypothesis that higher tonal reflexes more often follow original voiceless consonants than voiced consonants. This hypothesis assumes that, at an earlier stage of a language, a higher pitch and a lower pitch redundantly mark voiceless and voiced consonants, respectively. These differences in pitch become contrastive just in case the distinction in voicing between the consonants is lost.

It is necessary then to state explicitly what part of the fundamental frequency contour associated with voiceless and voiced consonants could lead to an interpretation of the tone on the following vowel as high and low, respectively. As shown in Figure 1 (cf. Section 1.2), the typical slope into the vowel is falling for voiceless consonants, rising-falling for voiced consonants.

Lea (173:64) suggests that perception of high versus low tone cannot depend on the relative fundamental frequency values of the preceding slope <u>into the vowel</u>, but instead must depend on relative values <u>within the vowel</u>. Results of measurements of F(tone) values (cf. Table II, Section 2.1) and CC durations (cf. Table IV, Section 2.10) for voiceless and voiced consonants, however, makes Lea's hypothesis implausible. If Lea's hypothesis were correct, we would expect to find a significant difference in F(tone) values for voiceless and voiced consonants on MID, LOW, FALLING, HIGH, RISING tones. The results of measurements of F(tone) values as presented in Tables I and II (cf. Section 2.1), however, suggest that this is not always the case.

Thus, we must look at the relative fundamental frequency values of the preceding slope into the vowel after voiceless and voiced consonants for possible perceptual cues for high and low tone, respectively. It is unlikely that the speaker cues on the rise of the slope (from F(closure) to F(peak)) in voiced consonants and the fall of the slope (from F(onset) to F(tone)) in voiceless consonants. Otherwise, we would expect voiced consonants to lead to high tone, voiceless consonants to low tone.

It is more likely that a speaker of a non-tonal language, that is a potential candidate for developing into a tonal language, cues on either (1) the F(onset) values associated with voiceless and voiced consonants or (2) the F(onset) values of the voiceless consonants versus F(peak) values of voiced consonants (cf. Table III, Section 2.2) for the interpretation of high and low tone, respectively.

4.3 It is interesting to speculate on the development of falling and rising contour tones. Lea (1973:65-6) hypothesizes that it is an extension of the preceding slope into the vowel that could lead to the development of falling and rising tones. Thus, we would expect falling tones to develop from earlier voiceless consonants and rising tones from earlier voiced consonants.

A cursory examination of the distribution of falling and rising contour tones in modern Tai dialects (Haudricourt 1961, Brown 1965, Sarawit 1973), however, makes Lea's suggestion implausible as an explanation for the origin of contour tones in Tai languages and dialects. One does not find a correlation between falling and rising tones in modern Tai dialects and Proto-Tai voiceless and voiced initials (Li 1954, Gedney 1967, Sarawit 1973), respectively.

A more plausible hypothesis, for the Tai language family at least, is that lexical contour tones develop from already existing level tones in order to maximize perceptual distance in the tone system. Tonal systems that contain lexical contour tones normally have 4 or more contrastive tones. Practically all Tai languages and dialects have lexical contour tones. Thus, it is not at all surprising that Gedney (1973:424) reports that "no Tai dialect has been found with fewer than than 5...contrastive tones..." It is surely not accidental that lexical contour tones are found most frequently in tonal systems with a greater number of contrastive tones.

A mechanism for the development of falling contour tones that immediately suggests itself is based on the observation that all tones tend to fall in pitch before pause. Suppose then, at an earlier stage, a language had 4 contrastive tones. In order to maximize perceptual distance, the fall in pitch is exaggerated on one or more of the level tones, later becoming a contrastive falling tone.

This mechanism would not account for the development of rising contour tones. Rising tones appear to be secondary developments in a further attempt at maximizing perceptual distance. Their 'marked' status as compared to falling tones is suggested by the following: falling tones far outnumber rising tones (Ohala 1973), falling tones may require less physiological effort (Ohala and Ewan 1973).

Although the above remarks have been mostly speculative, they clearly suggest a number of tone perception experiments involving discrimination of level versus contour tones (cf. Gandour 1974b).

REFERENCES

Abramson, Arthur S. (1962), "The vowels and tones of standard Thai: acoustic measurements and experiments," *IJAL*, Publication 20.

Brown, J. Marvin (1965), *From Ancient Thai to Modern Dialects*, Bangkok: Social Science Association Press of Thailand.

Egerod, S. (1961),"Studies in Thai Dialectology," *Acta Orientalia* 26:1-2: 43-91.

Gandour, J. (1974a),"The features of the larynx: N-ary or binary?" Paper to be presented at 4th Annual California Linguistics Conference, Univ. of Southern California.

Gandour, J. (1974b), "Level and contour tones: phonological space." In preparation, UCLA.

Gedney, W.J. (1967), "Thailand and Laos," *Current Trends in Linguistics Vol III, Linguistics in South-East Asia* (ed. T. Sebeok), The Hague: Mouton.

Gedney, W.J. (1973), "A checklist for determining tones in Tai dialects" *Studies in Linguistics in Honor of George L. Trager* (ed M.E. Smith) The Hague:Mouton.

Haudricourt, A.G. (1961), "Bipartition et tripartition des systèmes de tons dans quelques langues d'Extrême-Orient," *Bulletin de la Société de Linguistique de Paris* 56:163:80.

Halle, M. and K.N. Stevens (1971),"A note on laryngeal features," *Quarterly Progress Report* No. 101:198-213. Research Laboratory of Electronics, M.I.T.

Hiranburana, S. (1971), *The Role of Accent in Thai Grammar,* Unpublished doctoral dissertation, Univ. of London.

Hyman, L. (ed.) (1973), *Consonant Types and Tone,* (Southern California Occasional Papers in Linguistics No. 1) Los Angeles: Linguistics Program of Univ. of Southern California.

Hyman, L. and R. Schuh (1974), "Universals of tone rules: evidence from West Africa," *Linguistic Inquiry* 5.1:81-115.

Karlgren, B. (1954), "Compendium of phonetics in ancient and archaic Chinese," *BMFEA* 22.

Ladefoged, P. (1973), "Features of the larynx," *Journal of Phonetics* 1.1:73-83.

Lea, W.A. (1973), "Segmental and suprasegmental influences on fundamental frequency contours," *Consonant Types and Tone* (Southern California Occasional Papers in Linguistics No.1) ed. by Larry M. Hyman, 15-70. Los Angeles: Linguistics Program of USC.

Leben, W.R. (1973), *Suprasegmental Phonology* Unpublished doctoral dissertation, M.I.T.

Lehiste, I. and G. Peterson (1961), "Some basic considerations in the analysis of intonation." *Journal of the Acoustical Society of America* 33:419-25.

Li, Fang-Kuei (1954), "The relationship between tones and initials in Tai," *Studies in Comparative Austroasiatic Linguistics,* ed. by Norman Zide, 82-88. The Hague: Mouton.

Mohr, B. (1971), "Intrinsic variations in the speech signal," *Phonetica* 23:65-93.

Maran, L. (1973), "On becoming a tone language: a Tibeto-Burman model of tonogenesis," *Consonant Types and Tone* (Southern California Occasional Papers in Linguistics No. 1) Edited by Larry Hyman, 97-114, Los Angeles: Linguistics Program, University of Southern California.

Matisoff, J. (1973), "Tonogenesis in Southeast Asia," *Consonant Types and Tone* (Southern California Occasional Papers in Linguistics, No. 1) edited by Larry Hyman, 71-95. Los Angeles: Linguistics Program at University of Southern California.

Mohr, B. (1973), "Tone rules and the phonological representation of tones," Paper presented to the Sixth International Conference on Sino-Tibetan Language and Linguistics, University of California at San Diego.

Ohala, J. and W. Ewan (1973), Speed of Pitch Changes (Abstract). *Journal of the Acoustical Society of America* 53:345.

Palmer, A. (1969), "Thai tone variants and the language teachers," *Language Learning* 19:3-4:287-299.

Sarawit, M. (1973), *The Proto-Tai Vowel System*, Unpublished doctoral dissertation, University of Michigan.

Schachter, P. and V. Fromkin (1968), *A Phonology of Akan: Akuapem, Asante, and Fante*, (Working Papers in Phonetics No. 9) UCLA.

# *On the Representation of Tone in Siamese**

Jack Gandour

## Introduction

It has recently been suggested for Siamese (or Standard Thai, the national language of Thailand) that phonological tone be represented as a feature on segments (Hiranburana 1971, Leben 1971a, 1971b, 1973a, 1973b) and that phonological contour tones be represented with sequences of level tone features.

Unfortunately, the facts upon which both authors base their arguments are incorrect. Their arguments depend crucially on the simplification of contour tones to level tones in certain positions in fast, casual speech. The results of acoustical measurements of tones in these positions in fast, casual speech (cf. Section 2), however, indicate that the contour tones do not change to level tones, thus making their arguments unacceptable. Nonetheless, there are other facts in the language that do lend support to their position (cf. Section 3). This paper will argue for treating tones segmentally in Siamese and contour tones as sequences of level tones on the phonological level of representation.

There are 4 main sections in this paper. In Section 1, facts on the phonetic shapes of tones on monosyllabic citation forms are presented. In Section 2, the results of acoustical investigation of tones in certain positions in fast, casual speech are discussed. In Section 3, the other facts are cited that do support a segmental analysis of tone in Siamese, and a sequential analysis of contour tones. In Section 4, a case of tone neutralization is examined in view of different proposed sets of distinctive features of tone.

---

* Many thanks go to the members of the Tone Group - especially Peter Ladefoged, Ian Maddieson, and Vicki Fromkin - for helpful comments and suggestions on earlier versions of this paper. I also want to thank my Siamese informants - Smornrat Bhukkarat, Phon Khampang, and Pruk Chatprachai - whose kind assistance made the study possible. This work was supported by grant NSF GS 37235X.

1. <u>Phonetic shapes of tones in slow, deliberate speech</u> 

Siamese has 5 contrastive tones on 'smooth' syllables (i.e., those syllables ending in a nasal, glide, or vowel): (1) mid-level MID ( ), (2) low-level LOW (\`), (3) high-rising-falling FALLING (^), (4) high-rising HIGH (´), (5) low-rising RISING(ˇ).

(1) khaa 'be stuck'

(2) khàa 'a kind of spice'

(3) khâa 'to kill'

(4) kháa 'to engage in trade'

(5) khǎa 'leg'

The average fundamental frequency contours for these 5 contrastive tones pronounced on monosyllabic citation forms containing double vowels are represented graphically in Figure 1 (adapted from Abramson 1962: 127).

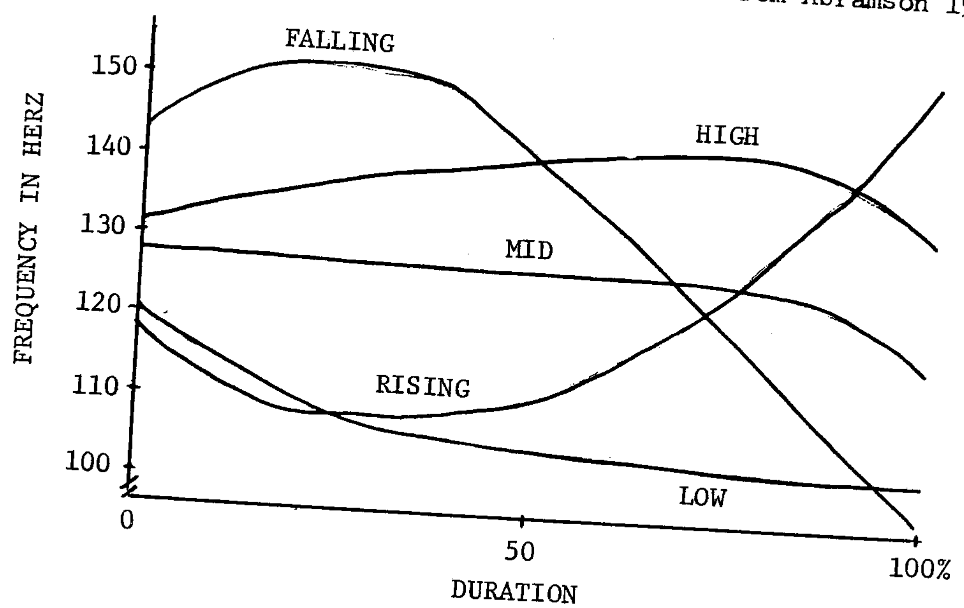



Figure 1. Average Fundamental Frequency Contours for Tones on Double Vowels.

For a discussion of consonantal influences on these fundamental frequency contours, see Gandour (1974a).

On 'checked' syllables (i.e., those syllables ending in p t k ? ) there are only 3 contrastive tones. For 'short' checked syllables (i.e., those checked syllables containing a short vowel) a low-level tone contrasts with a high-level tone; for 'long' checked syllables (i.e., those syllables containing a long vowel or diphthong), a low-level tone contrasts with a high-rising-falling tone. The tones on these checked syllables may be regarded as phonetic variants of the contrastive tones on the smooth syllables - the low-level tone being associated with (2)

LOW, the high-level tone being associated with (4) HIGH, the high-rising-falling tone being associated with (3) FALLING.

(2) phìt 'be wrong'

(4) phít 'poison'

(2) yàak 'to want'

(3) yâak 'be difficult'

Interestingly enough, such an analysis based on the principles of phonetic similarity and complementary distribution agrees with the 'traditional' numbering of tones in Siamese (Gedney 1969: 424). However, whether or not one chooses to identify the tones on the checked syllables with those that occur on smooth syllables is not relevant to the theoretical questions raised in this paper.

The MID and RISING tones never occur on checked syllables. The FALLING tone occurs on short checked syllables in only a few words, e.g., $k^h$lâk 'be crowded'; the HIGH tone occurs on long checked syllables in only onomatopoetic and non-Indic loanwords, e.g. kúuk 'call of a nightbird', káat 'gas'.

## 2. Phonetic shapes of tones in fast, casual speech

### 2.1 Conflicting presentations of the facts

The facts concerning the phonetic shapes of tones in fast, casual speech have been disputed by Siamese scholars. The disagreement revolves around the *number* and *type* (level or contour) of contrastive tones possible in certain unstressed positions. No less than four different presentations of the facts have appeared in the literature (Henderson 1949, Noss 1964, Hiranburana 1971, Surintramont 1973, among others).

Table I below gives a summary of the four different presentations. The tones listed in the leftmost column are the lexical tones (i.e. those tones that occur on monosyllabic citation forms); the tones listed in columns (i), (ii), (iii), and (iv) are the sandhi tones (i.e. those tones that are reported to occur in certain positions in connected speech). At the intersection of a given column and row is the sandhi tone corresponding to the lexical tone in the same row.

| LEXICAL TONES | SANDHI TONES (i) Henderson (1949) Leben (1973) | (ii) Gillette (1955) Noss (1964) | (iii) Hiranburana (1971) | (iv) Warotamasikkhadit (1967) Surintramont (1973) |
|---|---|---|---|---|
| HIGH | HIGH | HIGH | HIGH | HIGH |
| FALLING | MID | HIGH | HIGH | FALLING |
| RISING | MID | HIGH | HIGH/LOW | RISING |
| MID | MID | NONHIGH | MID | MID |
| LOW | LOW | NONHIGH | LOW | LOW |

Table I. Sandhi tones in fast casual speech: four presentations

Analyses of tone sandhi phenomena in Siamese have differed considerably depending on which account of the facts the author accepts. Henderson (1949) and Leben (1971a, 1971b, 1973a, 1973b) base their analysis on (i), Gillette(1955) and Noss (1964) on (ii), Hiranburana (1971) on (iii) and Warotamasikkhadit (1967) and Surintramont (1973) on (iv).

(i), (ii), (iii), and (iv) represent different claims about the number and type of sandhi tones that contrast in fast, casual speech. (i) claims that three level sandhi tones contrast - HIGH, MID, and LOW with the FALLING and RISING contour tones changing to the MID level tone; (ii) claims that only 2 level sandhi tones contrast - HIGH and NONHIGH, with FALLING and RISING contour tones changing to HIGH level tone and LOW and MID merging into NONHIGH; (iii) claims that three level sandhi tones contrast - HIGH, MID, and LOW, with the FALLING contour tone changing to a HIGH level tone, the RISING contour tone changing to a HIGH level tone on syllables that begin with a voiced consonant and a LOW level tone on syllables that begin with a voiceless consonant; (iv) claims that the contrast between all five lexical tones is maintained in fast, casual speech.

All the authors mentioned above who accept (i), (ii), or (iii) agree that the neutralization of contour tones in fast casual speech takes place on the unstressed initial syllable (containing a *long* vowel) of bisyllabic noun compounds. The list of minimal/near-minimal pairs of noun compounds in Table II illustrates the different claims made by (i), (ii), (iii), and (iv). The tones in the numbered column are the sandhi tones that are supposed to occur on the first member of the noun compound in fast, casual speech according to the different analyses.

| LEXICAL TONES | | SANDHI TONES (i) | (ii) | (iii) | (iv) |
|---|---|---|---|---|---|
| pùu + naa<br>'paternal 'name'<br>grandfather' | 'Grandfather Naa' | LOW | NONHIGH | LOW | LOW |
| puu + naa<br>'crab' 'field' | 'landcrab' | MID | NONHIGH | MID | MID |
| mɔ̂ɔ + yaa<br>'pot' 'medicine' | 'medicine pot' | MID | HIGH | HIGH | FALLING |
| mɔ̌ɔ + yaa<br>'doctor' 'medicine' | 'doctor' | MID | HIGH | HIGH | RISING |
| khɔ̂ɔ + tɔ̀ɔ<br>'point' 'to connect' | 'joint' | MID | HIGH | HIGH | FALLING |
| khɔɔ + tɔ̀ɔ<br>'neck' 'to connect' | 'nape' | MID | NONHIGH | MID | MID |
| nâa + náam<br>'front' 'water' | 'riverbank' | MID | HIGH | HIGH | FALLING |
| náa + náam<br>'younger' 'name'<br>aunt or<br>uncle' | 'Aunt/Uncle Nam' | HIGH | HIGH | HIGH | HIGH |
| khɔ̌ɔŋ + hæ̂æŋ<br>'thing' 'to be dry' | 'dry foodstuffs' | MID | HIGH | LOW | RISING |
| thɔɔŋ + thæ̂æŋ<br>'gold' 'bar' | 'gold ingots' | MID | NONHIGH | MID | MID |
| mǎa + khæ̀ŋ<br>'dog' 'to compete' | 'race dog' | MID | HIGH | HIGH | RISING |
| máa + khæ̀ŋ<br>'horse' 'to compete' | 'racehorse' | HIGH | HIGH | HIGH | HIGH |

Table II. Sandhi tones on the first member of bisyllabic noun compounds according to (i), (ii), (iii), and (iv).

## 2.2 Methods and materials: acoustical investigation of tones in fast, casual speech

In order to test which one of the 4 accounts is correct, pairs of bisyllabic noun compounds distinguished minimally or near-minimally by the lexical tone that occurs on the initial syllable were selected as test material. For each compound, the initial syllable contained a long vowel.

The list included as many pairs of noun compounds that could be found with a minimal contrast in lexical tones on the first member followed by a MID, LOW, FALLING, HIGH, RISING tone on the second member of the compound. 45 such pairs of bisyllabic noun compounds are possible; 29 were found. Only words that actually occur were used in the study. They are given in Table III. Parenthesized numbers indicate that no actually occurring minimal pair of noun compounds could be found with that particular combination of tones.

Each pair of noun compounds was placed in an identical sentence context, for example:

| | | |
|---|---|---|
| chǎn 'I' | chɔ̂ɔp 'like' | khâawthay 'Thai rice' / chaawthay 'Thai people' |
| man 'it' | pen 'is' | khɔ̂ɔtɔ̀ɔ 'joint' / khɔɔtɔ̀ɔ 'nape of neck' |

A reading list was prepared containing 164 sentences (3 tokens of each of the 58 members of 29 pairs of noun compounds) and written in the Siamese alphabet.

The reading list was arranged in random order and then read by the speaker, first at a slow speech tempo, and then at a fast speech tempo. For the former, the speaker was told to "speak in a slow, deliberate speech style"; for the latter, the speaker was told to "speak as fast as you can while maintaining a natural speech rhythm".

| 1st Member of Noun Compound | 2nd Member of Noun Compound M | L | F | H | R |
|---|---|---|---|---|---|
| LOW/MID | 1 | (2) | (3) | 4 | (5) |
| HIGH/MID | (6) | 7 | 8 | (9) | (10) |
| FALLING/HIGH | 11 | (12) | 13 | 14 | (15) |
| FALLING/MID | 16 | 17 | 18 | 19 | 20 |
| FALLING/LOW | 21 | (22) | (23) | (24) | 25 |
| FALLING/RISING | 26 | 27 | 28 | 29 | 30 |
| RISING/HIGH | (31) | 32 | 33 | 34 | (35) |
| RISING/MID | 36 | 37 | 38 | (39) | 40 |
| RISING/LOW | 41 | 42 | 43 | (44) | (45) |

1. pùunaa 'Grandfather Naa'
   puunaa 'landcrab'
(2)
(3)
4. pòoŋmaáy 'hollow log'
   pooŋmaáy 'wooden bell'
(5)
(6)
7. maápaà 'wild horse'
   naapaà 'cultivable land'
8. chaáŋbaân 'domesticated elephant'
   thaaŋbaân 'person(s) at home'
(9)
(10)
11. naâtaa 'looks'
    naátaa 'Aunt/Uncle Taa'
(12)
13. naâbaân 'front of house'
    maábaân 'domesticated horse'
14. naâmaáy 'crossbow'
    naámaáy 'Aunt/Uncle May'
(15)
16. khaâwthay 'Thai rice'
    chaawthay 'Thai people'
17. khɔ̂ɔtɔ̀ɔ 'joint'
    khɔɔtɔ̀ɔ 'nape'
18. naâbaân 'front of house'
    naabaân 'lawn'
19. naânaám 'riverbank'
    naanaám 'waterfield'
20. khɔ̂ɔhaǎ 'charge'
    khɔɔhɔ̌y 'throat'
21. paâdææŋ 'Aunt Daeng'
    paàdææŋ 'deciduous forest'
(22)
(23)
(24)
25. khaâwsaǎn 'husked rice'
    khaàwsaǎn 'news'
26. mɔ̂ɔyaa 'medicine pot'
    mɔ̌ɔyaa 'doctor'
27. mɔ̂ɔkhày 'pot for eggs'
    mɔ̌ɔkhày 'Dr. Khay'
28. mɔ̂ɔkhaâw 'rice pot'
    mɔ̌ɔkhaâw 'Dr. Khaaw'
29. khɔ̂ɔthaáw 'ankle'
    khɔ̌ɔŋaáw 'a kind of weapon'
30. mɔ̂ɔphiǐ 'mystery pot'
    mɔ̌ɔphiǐ 'witch doctor'
(31)
32. maǎkhæ̀ŋ 'racedog'
    maákhæ̀ŋ 'racehorse'
33. maǎbaân 'dog'
    maábaân 'domesticated horse'
34. maǎmaáy 'a kind of squirrel'
    maánaám 'seahorse'
(35)
36. khɔ̌ɔŋcham 'dry foodstuffs'
    thɔɔŋcham 'gold'
37. maǎpaà 'wolf'
    naapaà 'cultivable land'
38. khɔ̌ɔŋwaân 'snack'
    thɔɔŋyɔ̂ɔn 'title of Thai song'
(39)
40. khɔ̌ɔŋluǎŋ 'property of royal family'
    thaaŋluǎŋ 'public highways'
41. mùudǽæŋ 'a pork dish'
    muúdææŋ 'Sgt. Daeng'
42. khaǎ?ɔ̀ɔn 'thigh'
    khaà?ɔ̀ɔn 'a kind of spice'
43. mùubaân 'domesticated pig'
    muùbaân 'village'
(44)
(45)

Table III. List of noun compounds used as test material according to tonal combinations on first and second member of compound.

Recordings were made from the speech of 3 Thai nationals speaking Siamese - 2 male (24 and 34 years old) and 1 female (28 years old). The female subject and the younger male subject were born and raised in the capital city of Bangkok. The older of the male subjects came from Nakhon Phanom province in the northeastern part of Thailand.

The tapes were then analyzed by the pitch extraction system at the UCLA Phonetics Laboratory. A Siemens Oscillomink paper recording device registered the fundamental frequency curves continuously and, on a separate channel, a continuous oscillogram of the wave form. A phonetic transcription from the tapes was added to the oscillogram. Segmentation was based on characteristic features of the recorded wave forms and fundamental frequency curves. Frequency values were read off the oscillogram with a pitch scale (0.5 mm = 2.5 hz) prepared from a tape with pure tones of known frequency.

Measurements of duration of the initial syllable in the noun compounds were made from oscillograms as well as narrow-band spectrograms (made from a Kay Sound Spectrograph). Only those fast speech tokens whose durations were less than or equal to half of the average duration of the 3 slow speech tokens were selected for pitch measurements. By this procedure, fast speech was operationally defined as being at least twice as fast as slow speech. Both oscillograms and narrow-band spectrograms were used for comparing the pitch curves of the slow and fast speech tokens of each member of a pair of noun compounds.

## 2.3 Results: acoustical investigation of tones in fast, casual speech

Acoustical measurements of tones on the first syllable in bisyllabic noun compounds show that none of the tone neutralizations implied in (i), (ii), or (iii) ever occur, i.e. the contrast between all 5 lexical tones is maintained in fast, casual speech. In other words, (iv) is correct.

In particular, the FALLING and RISING contour tones do not neutralize to MID level tone. They simply become progressively shorter in shorter stretches of time.

Oscillograms and narrowband spectrograms of representative fast speech tokens for a few pairs of noun compounds are given in Figure 2 below. The number accompanying each pair corresponds to the number of the noun compound pair in the list given in Table III.

(a) 27

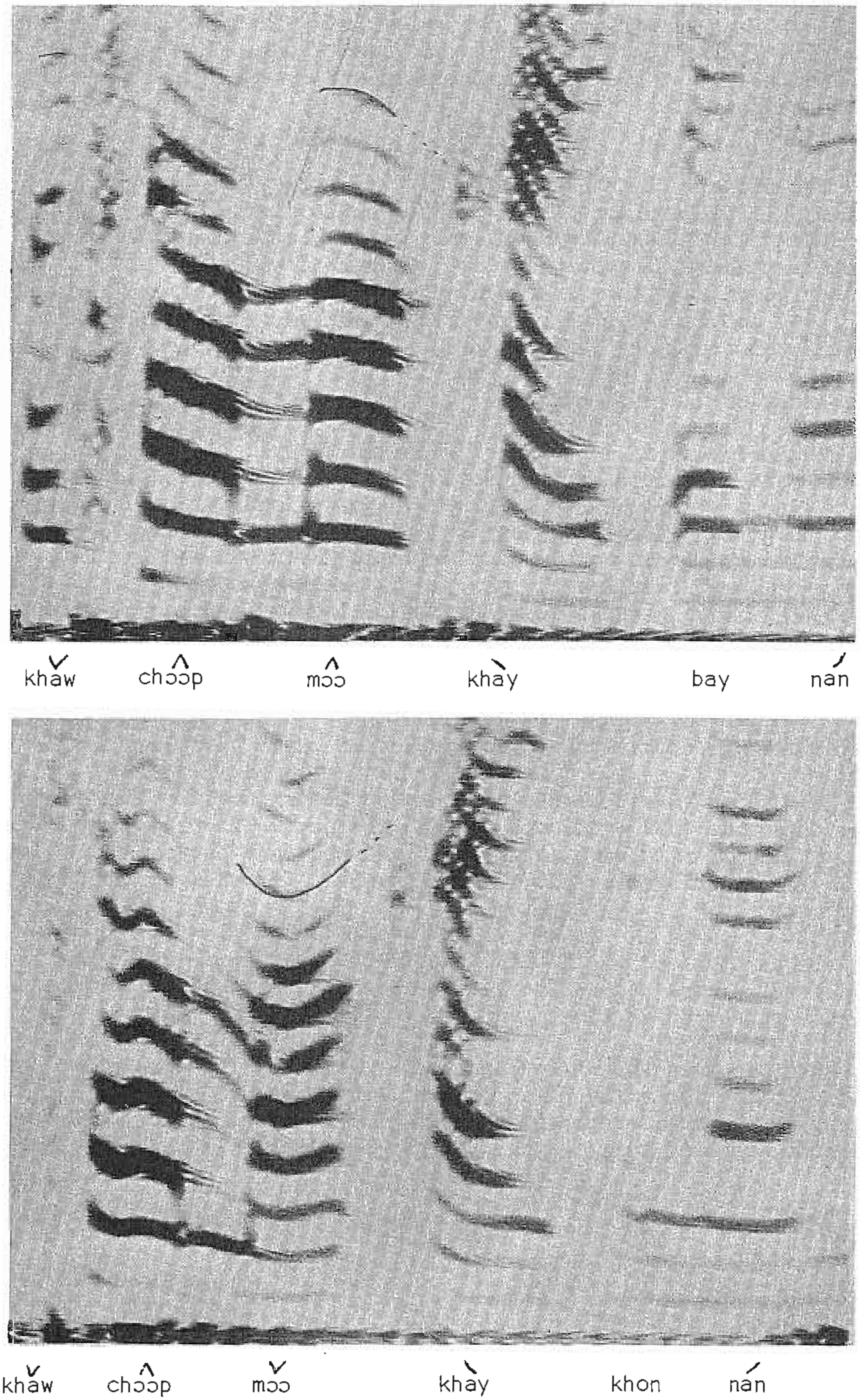
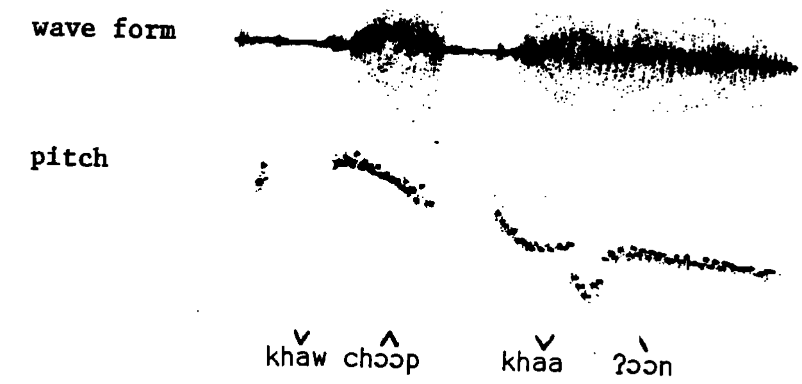
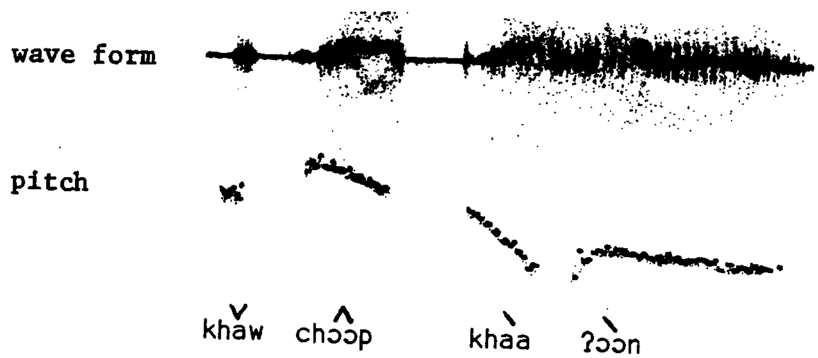


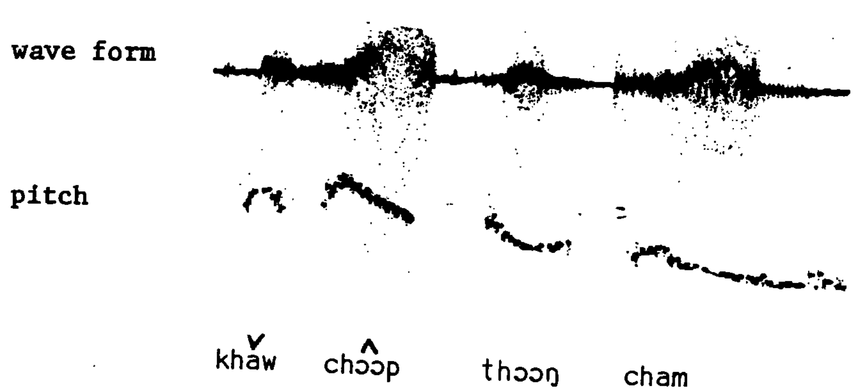

Figure 2. Narrowband spectrograms (a) and oscillograms (b-f) of representative fast speech tokens of pairs of noun compounds.

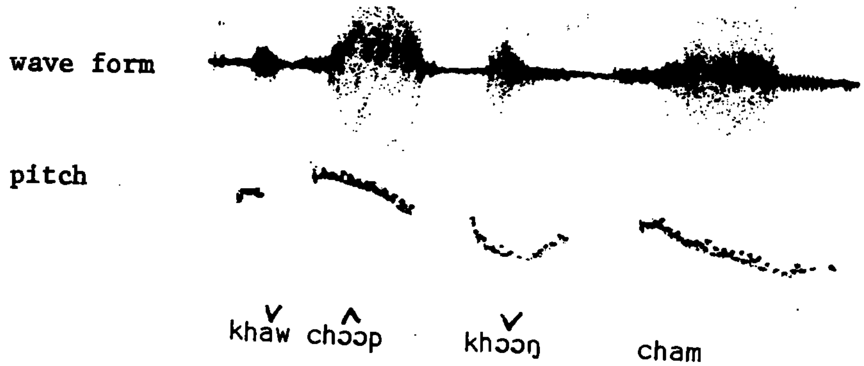
(b) 42.


wave form
pitch
khǎw chɔ̂ɔp khǎa ʔɔ̀ɔn


wave form
pitch
khǎw chɔ̂ɔp khàa ʔɔ̀ɔn

(c) 36.

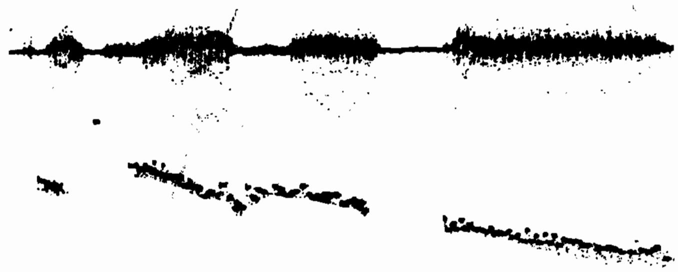

wave form
pitch
khǎw chɔ̂ɔp thɔɔŋ cham


wave form
pitch
khǎw chɔ̂ɔp khɔ̌ɔŋ cham

(d) 11.

wave form

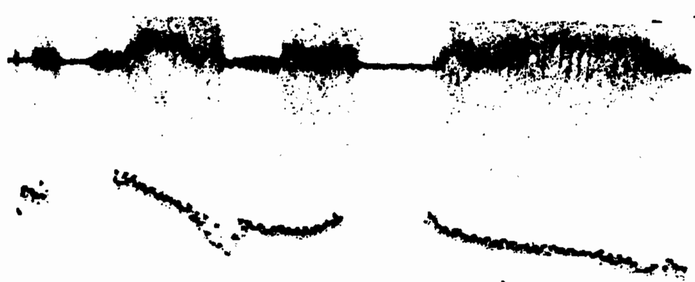
pitch



khǎw chɔ̂ɔp nâa taa

wave form

pitch



khǎw chɔ̂ɔp náa taa

(e) 20.

wave form

pitch

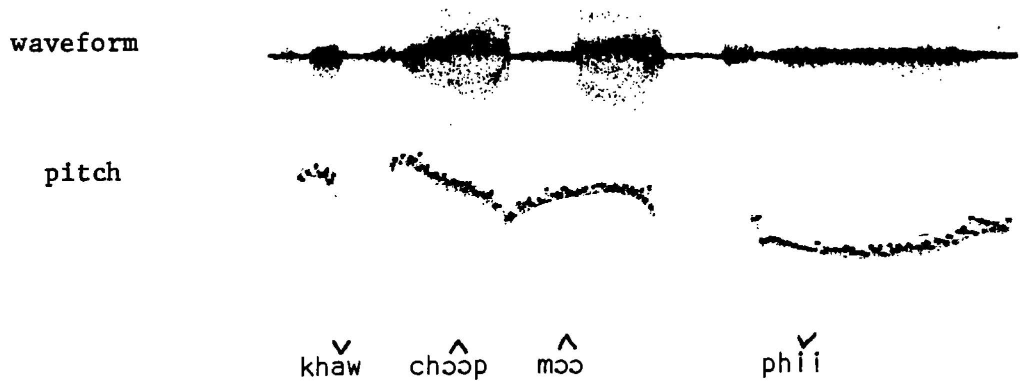
khǎw chɔ̂ɔp khɔ̂ɔ hǎa

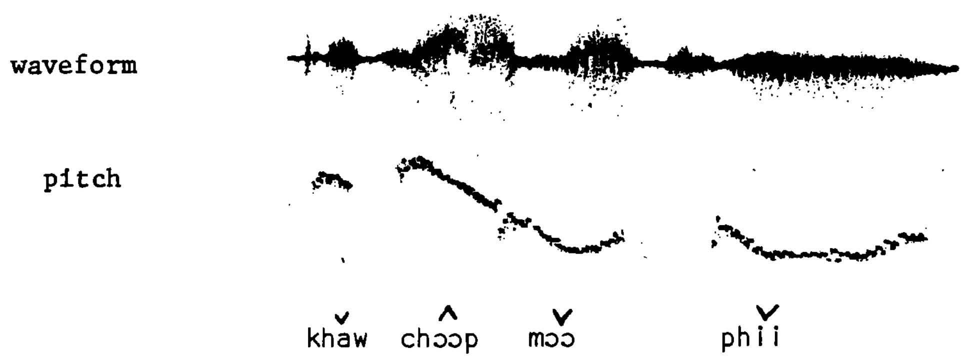
wave form

pitch

khǎw chɔ̂ɔp khɔɔ hɔ̌y

(f) 30


waveform
pitch
khǎw chɔ̂ɔp mɔ̂ɔ phǐi


waveform
pitch
khǎw chɔ̂ɔp mɔ̌ɔ phǐi

## 2.4 Discussion: acoustical investigation of tones in fast casual speech

Earlier investigations of sandhi tones in fast, casual speech apparently were not carried out with the use of systematically controlled sentence frames. Thus, we find enormous discrepancies in the presentation of the facts from author to author.

With the aid of reliable instruments, however, we see that the tonal distinctions are preserved in the fast style of speech, as correctly observed by native Thai scholars like Warotamasikkhadit (1967) and Surintramont (1973). No instruments had been used in the earlier investigations.

Some might object that the subjects simply were not speaking at a rate that would normally be associated with the fast, casual speech style. The operational definition of fast speech 'twice as fast as slow speech', however, seems quite reasonable. In a study of English diphthongs, Gay (1968) found the same order of magnitude between the mean diphthong durations for slow speech and fast speech, i.e. the diphthongs in slow speech are approximately twice as long (in msec) as in fast speech.

# 3. Theoretical issues regarding tone in Siamese

In this section, various theoretical issues currently being debated on the role of tone in a generative phonology (Woo 1969, Maddieson 1970; Halle and Stevens 1971, Fromkin 1972, Leben 1973, among others) are discussed. In Section 3.1, the arguments advanced by Leben (1971a, 1971b, 1973a, 1973b) and Hiranburana (1971) for a segmental representation of tone in Siamese are shown to be inadequate, since they depend crucially on the simplification of contour tones in fast casual speech (cf. Section 2.3). Nevertheless, other arguments for a segmental representation of tone in Siamese can be made. These arguments are presented as well as arguments for representing contour tones as sequences of level tone features in Section 3.2.

## 3.1 Previous arguments for segmental tone features in Siamese

Traditionally, tone in Siamese has been considered to be a property of the syllable. More recently, it has been proposed (Leben 1971a, 1971b, 1973a, 1973b, Hiranburana 1971) that tone is a property of an individual voiced segment, not the syllable.

According to Leben (1973b) tone must be analyzed as a feature on segments if and only if at some point in the derivation it is sensitive to phonological rules that either (1) contain information about surrounding segments or (2) collapse two or more segments into one.

Regarding the second type of phonological rule, the collapsed segment is in some sense to be interpreted as a "compromise" (Leben's term) between the original underlying segments, i.e., the collapsed segment is composed of some of the features of each of the original underlying segments. Leben cites nasalized vowels in French as an example of a collapsed segment that results from a compromise between a vowel and a following nasal consonant. A schematic representation of such a vowel nasalization rule is given below:

$$\begin{array}{llllll} \text{segments} & V & + & N & \rightarrow & \tilde{V} \\ \text{features} & \begin{bmatrix}+\text{vocalic}\\ -\text{nasal}\\ \cdot\\ \cdot\\ \cdot\end{bmatrix} & & \begin{bmatrix}-\text{vocalic}\\ +\text{nasal}\\ \cdot\\ \cdot\\ \cdot\end{bmatrix} & \Rightarrow & \begin{bmatrix}+\text{vocalic}\\ +\text{nasal}\\ \cdot\\ \cdot\\ \cdot\end{bmatrix} \end{array}$$

The collapsed segment that results from the application of this rule - the nasalized vowel - has inherited the +vocalic feature of the V, the +nasal feature of the N, thus is a compromise between the underlying segments V and N.

A more familiar example to which Leben's compromise convention would apply is the contraction of ai to æ in Sanskrit where the collapsed segment keeps the lowness of the first vowel and the backness of the second vowel.

Xhosa is cited as an example of a tone language where tone behaves segmentally according to his first criterion. Leben (1973b, 23) gives the following description of a phonological rule: "a high tone is realized as rising when preceded by a depressor consonant, such as bɦ, mbɦ, mɦ, v, ɦ, but not when preceded by consonants like p, ph, t, ɓ, m, f, h...a falling tone...is realized as rising-falling...when preceded by a number of this same class of depressor consonants".

Siamese is cited as an example of a tone language where tone behaves segmentally according to the second criterion. Before looking at the particular rule Leben proposes, however, let us first consider the data and assumptions on which the rule depends.

Leben's data, taken from Henderson (1949), includes so-called 'compound' forms pronounced in a slow deliberate speech style and a fast casual speech style. They are listed below - the (a) forms occurring in slow speech, the (b) forms occurring in fast speech (examples taken from Leben 1971a).

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1. | (a) | thîi HL | nǎy LH | 'where?' | (b) | thi M | nǎy LH |
| | 2. | (a) | sǐi LH | khǎaw LH | 'white' | (b) | si M | khǎaw LH |
| | 3. | (a) | wâaŋ HL | wâaŋ HL | 'at your leisure' | (b) | waŋ M | wâaŋ HL |
| | 4. | (a) | sǎaw LH | sǎaw LH | 'young girls' | (b) | saw M | sǎaw LH |
| | 5. | (a) | náam H | chaa M | 'tea' | (b) | nám H | chaa M |
| but | 6. | (a) | tôŋ HL | kaan M | 'want' | (b) | tôŋ HL | kàan L |
| | 7. | (a) | thâw HL | ray M | 'how much' | (b) | thâw HL | rày L |

A few remarks must be made about these data. First, even though Leben (1973b: 20) acknowledges that some length is retained on vowels not followed by a consonant or glide in forms (1b) and (2b) as indicated in the original phonetic transcription (Henderson 1949: 97), he goes on to assume without any justification that the vowel is simply equivalent to a short vowel. Secondly, the indicated change from a M to L tone in forms (6b) and (7b) should probably be attributed to phrase final lowering of MID. A final LOW tone is also lowered. The presence of a falling tone preceding is not required for the lowering to occur. Thirdly, these data are incorrect as shown by the results of acoustical measurements of tones in fast casual speech (cf. Section 2.3).

Nonetheless, it is still instructive to consider the type of argument he presents. Leben's assumptions include :

(a) tone features are assigned to individual voiced segments in the syllable,

(b) long vowels are represented as sequences of two identical vowels,

(c) contour tones are represented as a sequence of level tone features,

(d) phonological tones are M L HL H LH for tone numbers 1 2 3 4 5, respectively (cf. Section 1), and

(e) the (a) forms above are underlying, the (b) forms are derived.

With this set of assumptions and the above set of data, Leben formulates a phonological rule that effects a compromise between a HL or LH sequence of tones when they occur on short vowels in fast casual speech.

(Vowel shortening) VV → V

This rule simply reduces a double vowel to a single vowel. Implicit to its operation, however, is a 'compromise convention' that produces a MID tone as the 'normal' result of a collapsing of a sequence of HL or LH tones.

$$\begin{array}{lccccc} \text{segments} & V & + & V & \rightarrow & V \\ \text{features} & \left\{\begin{matrix} \begin{bmatrix} +H \\ -L \\ \cdot \\ \cdot \\ \cdot \end{bmatrix} & \begin{bmatrix} -H \\ +L \\ \cdot \\ \cdot \\ \cdot \end{bmatrix} \\ \begin{bmatrix} -H \\ +L \\ \cdot \\ \cdot \\ \cdot \end{bmatrix} & \begin{bmatrix} +H \\ -L \\ \cdot \\ \cdot \\ \cdot \end{bmatrix} \end{matrix}\right\} & & & \Rightarrow & \begin{bmatrix} -H \\ -L \\ \cdot \\ \cdot \\ \cdot \end{bmatrix} \\ \text{(or)} & & & & & \end{array}$$

Consider now how the rule applies to forms (1) through (7). It simplifies the underlying contour tones to MID in derived forms (1b), (2b), (3b), and (4b). Because the underlying tone is level, no simplification occurs in derived form (5b). The underlying contour tones do not simplify in derived forms (6b) and (7b) because they do not occur on double vowels. If tones are assigned to segments and if the normal result of compromise between a sequence of HL or LH is M, then the simplification of contour tones follows automatically from the reduction of a double vowel to a single vowel. Even assuming the correctness of Leben's data, his explanation is still unsatisfactory.

First, there is evidence from other tone languages (cf. Maddieson 1972) as well as Siamese that the result of a compromise of a LH or HL sequence of vowels is more often H or L than M. In Siamese, a common variant pronunciation of the question particle rɨ̌ɨ is rɨ́, not *rɨ.

The normally unstressed personal pronouns chǎn 'I', phǒm 'I (male)', and khǎw '3rd person' are pronounced chán, phóm, and kháw, respectively. The word for 'city hall,' however, would conform to Leben's compromise convention for sequences of level tone features. It is written in the Siamese alphabet with a RISING tone on the first syllable sǎalaaklaaŋ but normally pronounced with a MID tone on the first syllable [sələklaaŋ]. In this case, it does appear that a LH sequence has been restructured as a MID according to Leben's convention. But what about the word for 'book'? It is written in the Siamese alphabet as nǎŋsɨ̌ɨ, but pronounced as either [náŋsɨ̌ɨ] or [naŋsɨ̌ɨ].

Second, no formal definition of the compromise convention is provided by Leben, a conspicuous omission in view of his emphasis on formalism in grammar (Leben 1973b: 19). What are the constraints on its application? What types of segments and features may be compromised? How many features may be compromised?...

As stated, the compromise convention does not make a unique prediction. For example, in Ogoja Yala, a West African tone language, the compromise between a high tone followed by a low tone separated by a word boundary is a high tone, not a mid tone as Leben's convention would predict (data taken from Maddieson 1972: 958).

H # L (H) → H (H) e.g., má ɔ̀chí mɔ́chí 'see tree'

Maddieson (1972) gives numerous examples like the one from Ogaja Yala that strongly suggest that tones are arranged in a hierarchy of dominance. The dominance relationship between tones then determines which tone will appear in the contracted syllable. Until Leben states some such principles to motivate the output of his convention, it is not of any theoretical interest.

As extralinguistic evidence in favor of a segmental analysis, Leben (1973a, 1973b) cites one example taken from Haas (1969) from the Siamese word game khamphuǎn 'word-reversal,' in which the syllable finals of adjacent words or syllables are interchanged.

| | | | |
|---|---|---|---|
| regular form: | k → [ôn] | y → [ày] | 'big bottom' |
| game form: | k → [ày] | y → [ôn] | |

In this particular example, note that the tones move along with the segments. This is just what we would expect, according to Leben, if tone is a property of segments in Siamese.

Unfortunately, the one example cited by Leben is not representative of the game rules. Many examples can be found where the tone does *not* move with the shifted syllable-final segments (cf. Gandour, 1974c). For more examples from khamphǔan where the tone does not move along with the shifted syllable-final segments, see Surintramont (1973).

So, the word game data from Siamese is inconclusive. It neither argues for nor against a segmental analysis of tone. The cases where the segments shift independently of the tone demonstrate that tone features may behave differently from other segmental features. But it does not necessarily follow that just because tone features exhibit properties not shared by some of the other segmental features that tone must be established as a suprasegmental phenomenon.

Next let us consider the arguments advanced by Hiranburana (1971) in support of a segmental analysis of tone in Siamese. Based on data obtained from her own instrumental study of the phonetic shapes of tones in non-phrase-final positions (including initial syllables of bisyllabic noun compounds) in fast casual speech, Hiranburana, like Leben, cites putative neutralizations of contour tones as evidence is support of a segmental representation of tone in Siamese. Unlike Leben, however, she claims that the FALLING contour tone simplifies to HIGH level tone and the RISING contour tone simplifies to a HIGH or LOW level tone depending on the syllable-initial consonant.

Unfortunately, the results of her instrumental study are at best inconclusive. Six supposed examples illustrating the simplification of FALLING to HIGH (Hiranburana 1971: 181-84) are given. In 5 out of the 6 examples, the oscillograms do not support her point; the falling contour is clearly evident. The remaining example is the negative morpheme mây that is often realized phonetically as máy in unstressed positions. This is correct, but in no way represents an example of a regular productive phonological rule of the language. Eight supposed examples illustrating the simplification of RISING to either HIGH or LOW level tones (Hiranburana 1971: 185-89) are given. None, however, are instances of a regular rule. Two of her examples are náŋsɨ̌ɨ 'book' and the 3rd person pronoun kháw (cf. above). Another example náaw naǎw yùu 'I'm cold' is an instance of an emphatic reduplication rule (cf. Abramson 1962: 16), not a regular tone simplification rule. In 3 of the 8 examples, the oscillograms fail to support her point; the rising contour is clearly present.

Her claim that the RISING tone is realized as LOW after voiceless consonants and HIGH after voiced consonants is immediately suspect based on results of instrumental investigations of the effect of preceding consonant types on pitch which indicate that voiceless and voiced consonants tend to raise and lower pitch, respectively (Lehiste and Peterson 1961, Lea 1973, Gandour 1974b). In particular, the first part of the RISING tone becomes higher not lower after voiceless consonants in Siamese (Gandour 1974b). Furthermore, the examples cited occur in totally different syntactic and prosodic contexts.

More examples of deficiencies in her experimental design could be pointed out, but suffice it to say that no conclusions can be drawn from her data.

Next consider her analysis itself. The notion 'optional pitch height' plays a crucial role. Optional pitch heights are "those which do not apply when the lexical item concerned does not contain the maximum number of sonorant segments" (Hiranburana 1971: 149). This is the way she tries to account for the restrictions on the distribution of MID, LOW, FALLING, HIGH, RISING tones (cf. Section 1.1). Her lexical tones for Siamese are shown in Table IV below. The distinctive features for tone are adopted from Woo (1969); the optional pitch heights are enclosed in parentheses.

| | MID | LOW | FALLING | HIGH | RISING |
|---|---|---|---|---|---|
| HIGH | - - - | - (-) - | (+) + - | (+) (+) + | - - + |
| LOW | - - - | + (+) + | (-) - + | (-) (-) - | + + - |
| MODIFY | - - - | - (-) - | (-) - - | (-) (-) - | - - - |

Table IV. Lexical tones in Siamese (Hiranburana 1971)

The optional pitch heights are supposed to explain why the FALLING tone occurs on syllables that contain either 2 or 3 sonorant segments, but not on syllables that contain only 1 sonorant segment (for example, khâa 'to kill,' khâaw 'rice,' but not *khâp), and similarly why LOW or or HIGH tones occur on syllables containing 1, 2, or 3 sonorant segments (for example, phàk 'vegetable', màak 'betel', khàaw 'news', nók 'bird', máa 'horse', and cháaŋ 'elephant'). For the MID and RISING tones, on the other hand, all 3 pitch heights are obligatory. This is necessary in order to rule out the possibility of a MID or RISING tone occurring on a long checked syllable.

Such an analysis has undesirable consequences, however. It forces one to represent 2-sonorant segment syllables carrying a MID or RISING tone with an underlying string of 3 sonorant segments since all 3 pitch heights are obligatory for the MID and RISING tones, resulting in hypothetical lexical entries that never surface phonetically.

| | | |
|---|---|---|
| /*khaaa/<br>MMM | 'a kind of grass' | [kha:] |
| /*khaaa/<br>LLH | 'leg' | [khǎ:] |
| /*khaww/<br>LLH | 'mountain' | [khǎu] |
| /khaaw/<br>LLH | 'white' | [khǎ:u] |

Implicit in this analysis is a contrast between long and short glides as well as long and short vowels. This is clearly an unnecessary artifact of the segmental analysis.

Neither of the two earlier proposed segmental analyses of tone in Siamese can be accepted. Both fail to reach even the level of observational adequacy and both crucially depend on an ad-hoc contrivance - the "compromise convention" for Leben, the "optional pitch height" for Hiranburana. Despite their failure to do so, it is still possible to justify a segmental representation of tone in Siamese (cf. Section 3.2).

## 3.2 On the segmental nature of tone in Siamese

This section deals primarily with the question of whether tone features in Siamese are to be assigned to the segment or to some larger linguistic unit, such as the syllable, morpheme, word, etc.

Restrictions on the distribution of tones in Siamese indicate that tone is a property of the segment. If the domain of phonological tone is the segment and if the FALLING and RISING contour tones are analyzed as sequences of level tones, then we have a principled reason for excluding contour tones on syllables containing a single vowel followed by a voiceless stop p t k ?. A summary of the distribution of tones on various types of syllable structures in Siamese is presented in Table V. below. An 'X' indicates that the lexical tone at the top of the column may occur on the syllable structure in that same row; a 'O' indicates that the tone may not occur. Syllable structures (1) and (2) are the smooth syllables, (3) and (4) the checked syllables (cf. Section 1.1).

| SYLLABLE STRUCTURES | | | LEXICAL TONES: MID | LOW | HIGH | FALLING | RISING |
|---|---|---|---|---|---|---|---|
| (1) | CVV | | X | X | X | X | X |
| (2) | CV(V)$C_f$ | $C_f$= mnŋwy | X | X | X | X | X |
| (3) | CVV$C_f$ | $C_f$= ptk | 0 | X | 0 | X | 0 |
| (4) | CV$C_f$ | $C_f$= ptkʔ | 0 | X | X | 0 | 0 |

Table V. Distribution of lexical tones in different types of syllable structures in Siamese.

The absence of a RISING tone on long checked syllables (3) is considered to be a language-specific fact about Siamese. But this is not surprising. Statistically, falling tones outnumber rising tones (Ohala 1973: 3). A higher incidence of falling tones over rising tones is reported for Chinese (Cheng 1973). Furthermore, it has been suggested (Ohala and Ewan 1973) that more physiological effort is required for the production of RISING tones as compared to FALLING tones. They report that for a given pitch interval a subject could execute a falling pitch faster than a rising pitch. Accordingly, the absence of a RISING tone does not argue against a segmental analysis of tone in Siamese. On the other hand, if tones in Siamese are assigned to a larger unit than the segment (the only plausible candidate is the syllable), then the absence of a FALLING contour tone on short checked syllables (4) appears to be purely accidental.

In the Indic (Pali-Sanskrit) portion (approx. 60%) of the Siamese lexicon, a noninitial syllable (in polysyllabic morphemes) beginning with a sonorant segment and following a short checked syllable carrying LOW tone, carries LOW tone if it ends in a stop, otherwise RISING tone. This generalization has to be stated at the lexical level of representation because HIGH and LOW tones on short checked syllables are neutralized to MID tone in this position in everyday speech (cf. Section 4).

| | | | |
|---|---|---|---|
| sàʔwǎn | 'heaven' | sàʔmùt | 'ocean' |
| sàʔmǎy | 'period, age' | sàʔlèet | 'phlegm' |
| khàʔnǒm | 'candy' | khàʔnòt | 'coils (of a snake)' |
| thàʔnǒn | 'road' | càʔrìt | 'conduct' |
| thàʔnɔ̌ɔm | 'to cherish' | càʔrùat | 'rocket' |
| chàʔlɔ̌ɔn | 'to celebrate' | sàʔnùk | 'to be amusing' |
| chàʔləə̌y | 'to answer' | sàʔràʔ | 'vowel' |

| | | |
|---|---|---|
| <u>but</u> | sàʔtaaŋ | 'Thai monetary unit' |
| | sàʔkun | 'family line' |
| | sàʔphaa | 'assembly, congress' |
| | pháʔlaŋ | 'power' |
| | kháʔnɛɛn | 'grade, vote' |
| | cháʔləəy | 'prisoner of war' |

These polysyllabic morphemes clearly show that tone in Siamese is sensitive to surrounding segments (Leben's (1) criterion for segmental tone, cf. Section 3.1), thus evidence in support of a segmental representation of tone in Siamese.

There is additional evidence for Leben's (1) criterion for segmental tone in Siamese. No HIGH or RISING tone occurs on syllables that begin with p t c k ʔ. Thus, syllables like *páa *kǎa *táam *ʔǎaw are not permitted, once again illustrating the close interaction between tones and segments in Siamese. The only exceptions that I know of are non-Indic loanwords, onomatopoeic words, exclamatory expressions, and a few intensifying 'particles', egs. pǔy 'fertilizer (Chinese)', ʔóok 'oak (English)', kúuk 'call of a nightbird' báa 'bah!', dampǐi 'coal-black'.

As shown above in Table V (cf. Section 3.1), a syllable in Siamese may consist of 1, 2, or 3 tone-bearing segments. If tones are assigned to segments, then it is necessary to state restrictions on the permitted sequences of tones. This can be done easily for syllables containing 1 or 2 sonorant segments, but not for syllables containing 3 sonorant segments.

I know of no crucial evidence that would force us to choose between a solution (a) that required identity between the first and second segments or a solution (b) that required identity between the second and third segments in a string of 3 sonorant segments (the underlined tones are considered to be redundant)

| | | | |
|---|---|---|---|
| (a) | $\underline{M}$ M M | (b) | M M $\underline{M}$ |
| | $\underline{L}$ L L | | L L $\underline{L}$ |
| | $\underline{H}$ H H | | H H $\underline{H}$ |
| | $\underline{H}$ H L | | H L $\underline{L}$ |
| | $\underline{L}$ L H | | L H $\underline{H}$ |

Perhaps in favor of solution (a) is the fact that the phonetic pitch change on contour tones is concentrated at the end. Whether solution (a) or (b) turns out to be correct, we can see that it would be relatively easy to state permitted tone sequences in a segmental analysis of tone in Siamese without resorting to an ad-hoc contrivance like "optional pitch height" (cf. Section 3.1).

As far as I know, there are no tone sandhi rules in Siamese that require information about surrounding segments. Mohr (1973) uses the absence of such rules as a criterion for establishing tone as a suprasegmental phenomenon in a particular language. But this appears to be a pseudo-issue regarding the segmental or suprasegmental nature of tone. Other things being equal, one could just as easily formulate conventions for application of phonological rules that ignore extraneous intervening material in the domain of the rule.

## 3.3 On the sequential nature of contour tones in Siamese

This section is concerned with the phonological representation of the FALLING and RISING contour tones. Are they best represented with unit contour tone features or sequences of level tone features?

If the domain of phonological tone is the segment, the absence of FALLING and RISING contour tones in short checked syllables is automatically accounted for if they are represented as sequences of level tones (cf. also Section 3.2). This generalization is missed if they are represented with unit contour tone features. Only if we assign tones to segments do we have a principled reason for excluding contour tones on syllables containing a single vowel. For instance, syllables like *phǎk or *phâk are excluded because RISING (=LH) and FALLING (=HL) tones require a sequence of 2 vowels on the phonological level of representation. If tones are not assigned to segments in Siamese, we are left with no principled explanation for the distributional restrictions on contour tones. Other minor points that might be made in favor of a sequential analysis of contour tones are given below.

Other things being equal, a solution that makes use of fewer features is to be preferred. If the FALLING and RISING contour tones are analyzed as sequences of independently-motivated level tone features HL and LH, respectively, then there is no need to introduce additional unit contour tone features.

I know of no productive phonological *rules* in Siamese that require decomposition of the FALLING and RISING contour tones into sequences of level tone features. In particular, there are no tone copying rules of the kind reported for numerous African tone languages (Leben 1973, Fromkin 1972, Hyman and Schuh 1972) where the sequential nature of the contour tones becomes immediately apparent.

A few shreds of morphological evidence suggest a sequential analysis of contour tones: níi 'this' / nîi 'this one,' nán 'that' / nân 'that one,' nóon 'that farther away' / nôon 'that one farther away'.

I know of no cases where contour tones cross a morpheme or even a syllable boundary. Some might argue that this testifies to the unitary nature of the contour tones. To the contrary, it is exactly what one might expect in a language that has no derivational morphology and no vowel-initial syllables. Again, *lack* of evidence neither argues for or against a sequential analysis of contour tones in Siamese.

## 4. A case of tone neutralization in Siamese

The HIGH and LOW tones are neutralized to MID on unstressed short checked syllables (those ending in a glottal stop only)

| underlying form | | citation form | derived form |
|---|---|---|---|
| thá?hǎan | 'soldier' | thá?hǎan | thəhǎan |
| thà?nǒn | 'road' | thà?nǒn | thənǒn |

In this section, arguments are presented against Whitaker's (1969) solution. Another solution is proposed based on Fromkin's (1972) set of tone features.

Adopting Wang's (1967) set of tone features - *High Mid Central Falling Rising Convex Contour* - Whitaker (1969: 194-5) argues for (1) as the optimal representation of lexical tones in Siamese on the basis of the formal statements (irrelevant details omitted) of the tone neutralization rules (2) and (3)

(1)

| | MID | LOW | FALLING | HIGH | RISING |
|---|---|---|---|---|---|
| high | - | - | + | + | - |
| rise | - | - | + | + | + |
| fall | - | + | + | - | - |

$$(2)\ [+\text{fall}] \rightarrow [-\text{fall}] \quad / \text{env.}$$

$$(3)\ \begin{bmatrix}+\text{high}\\+\text{rise}\end{bmatrix} \rightarrow \begin{bmatrix}-\text{high}\\-\text{rise}\end{bmatrix} \quad / \text{env.}$$

The two separate rules (2) and (3) fail to reveal what is actually a single phonological generalization. Note what happens when we try to collapse (2) and (3) into a single rule:

$$(4)\ \begin{bmatrix} \alpha\text{high} \\ \alpha\text{rise} \\ -\alpha\text{fall} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{high} \\ -\text{rise} \\ -\text{fall} \end{bmatrix} \Big/ \text{ env.}$$

In the structural change of the rule, [-high] and [-rise] are required just in case the input tone is HIGH, [-fall] just in case the input tone is LOW. A collapsed rule for (2) and (3), then, cannot be written without including *redundant* features in the structural change of the rule.

Implicit also in (1) is the claim that Siamese has 4 underlying contour tones - LOW, FALLING, HIGH, RISING and 1 underlying level tone - MID. Such an analysis gives us no principled reason for permitting LOW and HIGH but not FALLING and RISING tones on short checked syllables.

I propose an alternative solution based on Fromkin's (1972) set of tone features - *High Mid Low.* Using this set of features, the level lexical tones of Siamese could be represented as either.

(5)

| | HIGH | MID | LOW |
|---|---|---|---|
| high | + | - | - |
| low | - | - | + |

or (6)

| | HIGH | MID | LOW |
|---|---|---|---|
| high | + | - | - |
| mid | - | + | - |

Formal statements of the tone neutralization rules (7) and (8), based on (5) and (6), respectively, indicate that (6) is to be preferred.

$$(7)\ \begin{bmatrix} \alpha\text{high} \\ -\alpha\text{low} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{high} \\ -\text{low} \end{bmatrix} \Big/ \text{ env.}$$

$$(8)\ [-\text{mid}] \rightarrow [+\text{mid}] \Big/ \text{ env.}$$

Rule (7) abbreviates the two subrules (9a) and (9b) (parenthesized features in structural change of rule are redundant):

$$(9)\ \begin{array}{ll} \text{(a)} & \begin{bmatrix} +\text{high} \\ -\text{low} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{high} \\ (-\text{low}) \end{bmatrix} \\ \text{(b)} & \begin{bmatrix} -\text{high} \\ +\text{low} \end{bmatrix} \rightarrow \begin{bmatrix} (-\text{high}) \\ -\text{low} \end{bmatrix} \end{array} \Big/ \text{ env.}$$

The fact that one cannot write the tone neutralization rule based on (5), without specifying redundant features in the structural change of the rule, leads us to choose (6).

Note, however, that (6) implies that the MID tone is closer to LOW than HIGH, MID differs from LOW by 1 feature, from HIGH by 2 features. I do not know of any phonological evidence to support this claim. Note also that (8) requires the application of the sequence structure condition - IF [+mid] THEN [-high] - in order to derive the correct surface forms. Nonetheless, this solution is to be preferrred because it permits us to state a single phonological generalization in a single rule.

Optimal solutions constructed with other sets of distinctive features for tones - Wang 1967, Woo 1969, Maddieson 1970, Halle and Stevens 1971 - would also require that a lexical redundancy reapply to the output of the tone neutralization rule.

## 5. Summary

An argument that has been advanced in favor of analyzing tone segmentally in Siamese - namely, the neutralization of contour tones in fast, casual speech - is untenable. A systematic acoustic investigation of these putative cases of tone neutralization shows that RISING and FALLING contour tones are not neutralized to level tones in fast, casual speech. Other arguments, however, can be given in favor of assigning tones to segments on the phonological level of representation as well as analyzing contour tones as sequences of level tones. Further, a solution is proposed for a real case of tone neutralization - HIGH and LOW tones neutralize to MID on short checked syllables - and this is shown to be preferred over competing alternative solutions.

## References

Abramson, A.S. 1962. *The Vowels and Tones of Standard Thai: Acoustic Measurement and Experiments. IJAL Publication* 20.

Benedict, P.K. 1948. "Tonal Systems in Southeast Asia." *Journal of American Oriental Society*. 68.4:184-191.

Cheng, C.C. 1973. "A Quantitative Study of Chinese Tones." *Journal of Linguistics*. 1:93-110.

Fromkin, V.A. 1972. "Tone Features and Tone Rules." *Studies in African Linguistics*. 3.1:47-75. UCLA.

Gandour, J. 1974a. "The Glottal Stop in Siamese: Predictability in Phonological Description." In this volume.

Gandour, J. 1974b. "Consonant Types and Tone in Siamese." In this volume.

Gandour, J. 1974c. "Some Remarks on Siamese Word Games." Unpublished paper, UCLA.

Gay, T. 1968. "Effect of Speaking Rate on Diphthong Formant Movements." *Journal of the Acoustical Society of America.* 44.6: 1570-1573.

Gedney, W.J. 1969. "A Checklist for Determining Tones in Tai Dialects." *Studies in Linguistics in Honor of George L. Trager,* edited by M. Estellie Smith, 423-437. Mouton: The Hague.

Gillette, J.A. 1955. *Prosodic Features of Bangkok Thai.* Unpublished MA thesis, Georgetown University.

Haas, M.R. 1956. *The Thai Systems of Writing.* American Council of Learned Societies. Washington, D.C.

Haas, M.R. 1969. "Burmese Disguised Speech." *Bulletin of the Institute of History and Philology, Academia Sinica* , 277-285.

Halle, M. and K. Stevens, 1971. "A Note on Laryngeal Features. *M.I.T. Research Lab. of Electronics, Quarterly Progress Report.*101: 198-213.

Haudricourt, A.G. 1961. "Bipartition et Tripartition des systèmes de tons dans quelques langues d'Extrême-Orient." *Bulletin de la Société de linguistique de Paris.* 56:163-180.

Henderson, E.J.A. "Prosodies in Siamese, A Study in Synthesis." *Asia Major* (New Series) 1:189-215. Reprinted in *Prosodic Analysis* edited by F.R. Palmer, Oxford Univ. Press, London (1970): 27-53.

Hiranburana, S. 1971. *The Role of Accent in Thai Grammar.* Unpublished doctoral dissertation, University of London.

Hyman, L. and R. Schuh. 1974. "Universals of Tone Rules." *Linguistic Inquiry* 5.1:81-115.

Ladefoged, P. 1973. "Features of the Larynx." *Journal of Phonetics* 1.1: 73-83.

Lea, W.A. 1973. "Segmental and Suprasegmental Influence on Fundamental Frequency Contours." in *Consonant Types and Tone. Southern Calif. Occasional Papers in Ling.* 1. Edited by Larry M. Hyman 15-70. Linguistic Program of University of Southern Calif. Los Angeles.

Leben, W.R. 1971a. "On the Segmental Nature of Tone in Thai." *M.I.T. Res. Lab. of Electronics, Quarterly Progress Report.* 101:221-224.

Leben, W.R. 1971b. "Suprasegmental and Segmental Representation of Tone." *Studies in African Linguistics.* Supplement 2.

Leben, W.R. 1973a. "The Role of Tone in Segmental Phonology." in *Consonant Types and Tone, Southern California Occasional Papers in Linguistics* 1. Edited by Larry Hyman: 115-149. Linguistics Program. University of Southern California. Los Angeles.

Leben, W.R. 1973b. *Suprasegmental Phonology.* Unpublished doctoral dissertation, M.I.T.

Maddieson, I. 1970. "The Inventory of Features." *Research Notes* 3:2. 3-18. Ibadan, University of Ibadan.

Maddieson, I. 1972. "Tone System Typology and Distinctive Features." *Proceedings of the 7th International Congress of Phonetic Sciences.* Edited by A. Rigault and R. Charbonneau, 957-961. Mouton; The Hague.

Matisoff, J. 1973. "Tonogenesis in Southeast Asia." in *Consonant Types and Tone. Southern California Occasional Papers in Linguistics* 1. Edited by Larry Hyman, 71-95. Linguistics Program of the University of Southern California. Los Angeles.

Mohr, B. 1973. "Tone Rules and the Phonological Representation of Tones." Paper presented to the *6th International Conference on Sino-Tibetan Languages and Linguistics.* University of California at San Diego.

Noss, R.B. 1964. *Thai Reference Grammar.* U.S. Government Printing Office. Washington, D.C.

Ohala, J. 1973. "The Physiology of Tone." in *Consonant Types and Tone. Southern California Occasional Papers in Linguistics* 1. Edited by Larry Hyman, 1-14. Linguistics Program of University of Southern California. Los Angeles.

Ohala, J. and W. Ewan. 1973. "Speed of Pitch Change." (Abstract) *Journal of the Acoustical Society of America* 53:345.

Palmer, A. 1969. "Thai Tone Variants and the Language Teachers." *Language Learning* 19.3-4:287-299.

Surintramont, A. 1973. "Some Aspects of Underlying Syllable Structure in Thai: Evidence from KHAMPHUAN -- A Thai Word Game." *Studies in the Linguistic Sciences* 3.1:121-142.

Wang, W. S-Y. 1957. "The Phonological Features of Tone." *International Journal of American Linguistics* 33:93-105.

Warotamasikkhadit, U. 1967. "Some Phonological Rules in Thai." *Journal of the American Oriental Society* 87.4:541-574.

Whitaker, H.A. 1969. "Stylistic Tone-Changing Rules in Thai." *Glossa* 3.2:191-197.

Woo, N. 1969. *Prosody and Phonology*. Unpublished doctoral dissertation. M.I.T.

# *The Features of the Larynx: N-ary or Binary?*

Jack Gandour

[Paper presented at the Fourth California Linguistics Conference, University of Southern California]

## 0. Introduction

According to the theory of generative phonology as presented in *The Sound Pattern of English* (Chomsky and Halle 1968), all phonetic features are binary on the classificatory level of representation. Only on the phonetic level of representation may these features be specified with more than two values. In this paper, I will attempt to show that phonological theory must necessarily permit n-ary features on the classificatory level of representation as well.

As to whether some classificatory features are n-ary or not, it is important to keep in mind what the empirical issues are. Ladefoged (1971; 98) has said:

> "The issue of whether classificatory features should be binary...or multivalued...is not in itself very relevant to a choice between feature systems. Any multivalued feature can be reinterpreted in terms of a number of binary features; and any binary system can be supplied with marking conventions so that it acts as if it contained multivalued features.

* Many thanks to the Tone Group - especially Peter Ladefoged, Ian Maddieson, and Vicki Fromkin - for helpful comments and suggestions on this paper. I also want to thank Dr. William J. Gedney (University of Michigan) for helpful discussions on tonal development in the Tai language family during the summer of 1973. The work for this paper was supported by grant NSF GS 37235X.

> What is far more relevant to a comparison is the difference in the claims that each system makes both about the phonological relations between sounds and the phonetic facts."

An exclusively binary system makes the claim that linearly-ordered sets of speech sounds along a single continuum do not exist in language. Much evidence (Ladefoged 1971), however, has already been given that points to the need for multivalued classificatory features for 'vowel height' and 'place of articulation' for consonants. Evidence will be given in this paper that points to the need for a multivalued classificatory feature for 'width of the glottal aperture.'

The evidence has to do with the historical development of tone in languages and dialects of the Tai language family of Southeast Asia - in particular, tonal splitting conditioned by the phonation type of initial consonants. Two earlier proposed sets of laryngeal features - one by Halle and Stevens (1971), the other by Ladefoged (1973) - will be tested against this evidence and shown to be inadequate. Two new laryngeal features will be proposed that enable us to provide a descriptively adequate account of the Tai data. One, a feature *vibrating* with two values; the other, a multivalued feature *glottal width*. Moreover, these features will be justified by phonetic principles independent of the data in question.

## 1. Overview of tonal development in the Tai language family

First, let us begin with an overview of the historical development of tone in the Tai language family.

The parent language, Proto-Tai, has been commonly assumed to have had three tones on non-stopped syllables and a fourth noncontrastive tone on stopped syllables. The three tones on nonstopped syllables have been reconstructed simply as the tonal categories A,B, and C; similarly, the fourth tone on stopped syllables is reconstructed simply as the tonal category D. As of yet, none of the phonetic or phonological shapes for these tonal categories have been reconstructed. The D tonal category is not relevant to the questions dealt with in this paper and will be omitted from further discussion.

The sound changes that are believed to have taken place from Proto-Tai to the modern Tai languages and dialects are described by Gedney (1969: 428):

> "At some time after the period of Proto-Tai unity... a wave of drastic sound changes...swept most of Southeast Asia...In tonal languages such as those of the Tai family, these sound changes involved splits in the tonal system, with the splits conditioned by the phonetic nature of initial consonants of the syllables...in general what happened was that each of the original tones...split into two or more tones..."

The phonetic classes of reconstructed initial consonants that are commonly assumed (Haas 1958, Li 1966, Gedney 1969, Sarawit 1973) to be necessary to account for the different kinds of tone splits are given below.

| | consonant class | mnemonic symbol |
|---|---|---|
| (1) | voiceless aspirated stops + h | ph |
| (2) | voiceless fricatives and voiceless sonorants | f |
| (3) | voiceless unaspirated stops | p |
| (4) | glottal stop + preglottalized stops and preglottalized glides | ? |
| (5) | voiced obstruents and sonorants | b |

When they are arranged in this particular order, it will be shown that the classes of consonants needed to account for the tone splits consist of only adjacent subclasses. The phonetic principles that appear to motivate this linear order will be taken up later in the paper.

## 2. Tone splits in Tai

Tone splits reported for the Tai language family (Brown 1965, Li 1966, Gedney 1970, Sarawit 1973) include three cases involving a split of the original Proto-Tai tone(s) into two tones (hereafter called 'binary splits'), two cases involving a split of the original Proto-Tai tone(s) into three tones (hereafter called 'ternary splits'). No cases of tone splits have yet been reported in which four or more tonal reflexes result from the splitting of the Proto-Tai tones. One representative Tai language or dialect has been selected to illustrate each case.

White Tai, a Tai dialect spoken in the western part of North Vietnam, illustrates the most common binary split. The historical sources of the White Tai tonal reflexes and the classes of initial consonants that figured in the tone split are given below (data taken from Sarawit 1973).

<u>White Tai</u>

| Initials At Time Of Tone Splits | Proto-Tai Tones: A | B | C |
|---|---|---|---|
| (1) ph (2) f (3) p (4) ? | 22 ˨˨ | 45 ˦˥ | 23 ˨˧ |
| (5) b | 44 ˦˦ | 343 ˧˦˧ | 31 ˧˩ |

These diagrams (developed by Gedney 1969) provide a convenient way of organizing the data on tone splits. At the head of each column are given the Proto-Tai tonal categories A,B, and C; to the left of each row are given the numbered subclasses of initial consonants that lead to the series of tonal reflexes appearing in that row; at the intersection of a given row and column, then, is the tonal reflex that developed from the Proto-Tai tonal category when preceded by that particular class of initial consonants. The tonal reflexes themselves are represented in the Chao (1930) tone-letter notation, in which the normal pitch range of a speaker's voice is plotted on the vertical axis from 5 (the highest pitch) to 1 (the lowest pitch); the changes in pitch level throughout the duration of the tone are plotted on the horizontal axis.

Note that in White Tai one of the classes of consonants that leads to the same series of tonal reflexes is composed of the phonetic subclasses represented by the symbols ph, f, p, and ?.

The Tai dialect, Lung Ming - spoken in the southwestern part of Kwangsi province, China - illustrates another way the original Proto-Tai tones split into two modern tonal reflexes. The historical sources of the Lung Ming tones are given below (data taken from Sarawit 1973).

Lung Ming

| Initials At Time Of Tone Splits | Proto-Tai Tones A | B | C |
|---|---|---|---|
| (1) ph (2) f (3) p | 55 ˥ | 45 ˦˥ | 33 ˧ |
| (4) ? | 21 ˨˩ | | |
| (5) b | | 11 ˩ | 212 ˨˩˨ |

Of special interest here is the binary split of the A tone. Note that the subclasses represented by ph, f, and p fall into one class, whereas the subclasses represented by ? and b fall into another. The binary split of the B and C tones, on the other hand, is based on the same classes of initials as in White Tai. Again, the linear order of these classes of initials is confirmed; under the A tone, phonetic subclasses (1)-(3) yield one tonal reflex and subclasses (4) and (5) another.

Siamese, the national language of Thailand, illustrates yet another kind of binary split. The historical sources of the Siamese tones are given below (data taken from Sarawit 1973).

Siamese

| Initials At Time Of Tone Splits | Proto-Tai Tones A | B | C |
|---|---|---|---|
| (1) ph (2) f | 24 ˨˦ | 22 ˨ | 41 ˦˩ |
| (3) p (4) ? | 33 ˧ | | |
| (5) b | | 41 ˦˩ | 453 ˦˥˧ |

Under the A tone, the phonetic subclasses represented by ph and f fall together into one class; those represented by p, ?, and b fall into another. The binary split of the B and C tones is based on the same class of initials as in White Tai and Lung Ming. Again, the linear order of the initials is confirmed; under the A tone, phonetic subclasses (1) and (2) make up one class, subclasses (3) - (5) another.

Under the A tone, the phonetic subclasses represented by ph and f fall together into one class; those represented by p, ?, and b fall into another. The binary split of the B and C tones is based on the same class of initials as in White Tai and Lung Ming. Again, the linear order of the initials is confirmed; under the A tone, phonetic subclasses (1) and (2) make up one class, subclasses (3) - (5) another.

Ternary splits, although less common than binary splits, have occurred frequently throughout the Tai-speaking domain, particularly among those Tai dialects spoken in the southern peninsula of Thailand. The Songkhla dialect of southern Thailand illustrates a common ternary split across all tonal categories. The historical sources of the Songkhla tones are given below (data taken from Brown 1965).

<u>Songkhla</u>

| Initials At Time Of Tone Splits | | Proto-Tai Tones A | B | C |
|---|---|---|---|---|
| | (1) ph (2) f | 45 ˦˥ | 45 ˦˥ | 43 ˦˧ |
| | (3) p (4) ? | 24 ˨˦ | 24 ˨˦ | 32 ˧˨ |
| | (5) b | 31 ˧˩ | 22 ˨˨ | 21 ˨˩ |

Here we find it necessary to set up the same classes of initial consonants as in Siamese, the difference being that each class leads to different tonal reflexes under each of the Proto-Tai tones A, B, and C. Once again the linear order of the phonetic classes of initials is confirmed.

The Tai dialect of Nung, spoken at the village of Bac Va in north-eastern North Vietnam, illustrates another kind of ternary split. The historical sources of the Nung tones are given below (data taken from Gedney 1970).

Nung, Bac Va

Proto-Tai Tones

| Initials At Time Of Tone Splits | A | B | C |
|---|---|---|---|
| (1) ph | low rising | No description of tones provided in reference source | |
| (2) f (3) p (4) ? | high rising | | |
| (5) b | mid level | | |

Under the A tone, we can see that it is now necessary to treat the voiceless aspirated stops and h as a separate class and those phonetic subclasses represented by f, p, and ? as another class. The binary split of the B and C tones is again based on the same classes of initials as found in White Tai. Of particular interest is the fact that the linear order of the phonetic classes yet remains intact.

A description of tone splitting in Tai, then, must reveal the generalization that the classes of initial consonants that conditioned the tone splits form a linearly-ordered set. Let us next test earlier proposed sets of laryngeal features against the Tai data.

## 3. Halle and Stevens' (1971) proposal

Halle and Stevens (1971) have proposed four binary laryngeal features, shown below, that represent two variables - (1) degree of stiffness of the vocal cords, and (2) degree of constriction of the glottis, with a convention that neither [+stiff, +slack] nor [+spread, +constricted] can occur.

(1) [±stiff]  (2) [±spread]

[±slack]  [±constricted]

The same pair of features - *stiff* and *slack* - are claimed to govern both pitch levels in vowels and voicing in obstruents. Accordingly, three types of obstruents are claimed to occur in language: "voiceless, voiced, and intermediate; the first corresponding to the high pitch vowels, the second to the low pitch vowels, and the third to vowels with mid pitch" (Halle 1972: 181). Vowels and obstruents, then, would be specified as shown below.

| | VOWELS | | | OBSTRUENTS | | |
|---|---|---|---|---|---|---|
| | V́ | V̀ | V | Voiceless | Voiced | Intermediate |
| stiff | + | – | – | + | – | – |
| slack | – | + | – | – | + | – |

In favor of their features, Halle (1972: 182-3) points to historical development of tonal systems in Far Eastern languages which purportedly shows a direct correlation between pitch levels in vowels and voicing in obstruents. This correlation, however, is not as straightforward as Halle would lead us to believe. True, one can find numerous cases among these languages where a low pitch is the reflex of earlier voiced consonants and a high pitch is the reflex of earlier voiceless consonants. But, for the Tai language family at least, one can find just as many cases where this prediction is not borne out (Brown 1965, Li 1966, Sarawit 1973). Tonal reflexes like we find in Siamese and Nung are not at all uncommon. To the extent that tonal systems do not reflect the correspondence of voiceless, voiced and intermediate obstruents with high, low and mid tones Halle's (1972 182) characterization of tonal development as an instance of assimilation in which the feature *stiff* or *slack* in the consonant is assimilated by the following vowel is inadequate.

Somewhat puzzling, too, is Halle's (1972: 183) reference to Haudricourt's oft-cited paper on tone splitting in Far Eastern languages, in which Halle claims to have found considerable support for his framework. My own inspection of Haudricourt's data would lead me to just the opposite conclusion.

Another claim made by their feature framework, that is not borne out by historical development of tonal systems in the Tai family, is that the features *spread* and *constricted* are irrelevant to tonal processes. Take the case of tone-splitting in Nung under the A tone where it becomes necessary to separate out the class (1) initials. As shown below, the only way this can be done in Halle and Stevens' theoretical framework is to refer to the feature *spread*. But their system predicts that the feature *spread* is irrelevant to tonal phenomena.

| | ph | f | p | ? | b |
|---|---|---|---|---|---|
| spread | + | – | – | – | – |
| stiff | + | + | + | + | – |

Indeed, of all the cases of tone splitting in the Tai language family, the features *stiff* and *slack* can divide the classes of initials correctly only for the simplest case - that exemplified in White Tai. Notice, however, that even here the correlation between tonal reflexes and consonant types is opposite to Halle and Stevens' prediction.

In addition, and more significantly for the Tai data under discussion, the generalization that the classes of initials form a linearly-ordered set is, in principle, ruled out in Halle and Stevens' binary system.

Other serious problems with Halle and Stevens' set of laryngeal features - both phonetic and phonological - have already been pointed out (Lisker and Abramson 1971, Fromkin 1972, Ladefoged 1973). For the purposes of this paper, suffice it to say that tonal development in Far Eastern languages cannot be used to support their features.

## 4. Ladefoged's (1973) proposal

Ladefoged (1973) has proposed a set of laryngeal features that includes 3 n-ary features - *glottalicness, voice onset,* and *glottal stricture,* and additional pitch features. Of these laryngeal features, it is the n-ary feature *glottal stricture* that we are mainly interested in.

First, it should be pointed out that the lack of a single correlation between pitch in vowels and voicing in obstruents in the development of tonal systems in Far Eastern languages is correctly predicted by Ladefoged's feature framework in which pitch and glottal stricture are set up as independent features - a clear advantage over the Halle-Steven's feature framework. This is not to say that there is no relationship between the degree of stiffness of the vocal cords and pitch, but that other factors are involved as well. Experimentally, it has been shown that a rise in pitch may result from either an increase in the tension of the vocal cords or an increase in the air pressure below them (Ladefoged 1963, 1967, 1971) or an increase of medial compression of the vocal cords (Van den Berg 1960).

Ladefoged's feature that is of immediate relevance - *glottal stricture-* is given below.

Glottal Stricture

1. spread
2. voiceless
3. murmur
4. slack (=lax voice)
5. voice
6. stiff (=tense voice)
7. creaky
8. closed

It is a multivalued scalar feature that consists of a linearly-ordered set of states of the glottis. It is supposed to constitute a single physical scale, making the claim that there is a continuum extending from the most closed position, a glottal stop, to the most open position observed in speech, that in voiceless aspirated sounds.

This feature predicts that sets of speech sounds can be classified by glottal stricture *only* by collapsing adjacent members of the set of terms within this feature. For example, it predicts that natural phonological rules would not refer to a class of speech sounds that included terms 1 and 8 on this scale without including any of the intervening terms if they occurred in the language.

Let us now see how this prediction is borne out by the Tai data. From the cases of tone splitting presented earlier, it is clear that we must be able to arrange the classes of initial consonants in the order shown below, if only adjacent subclasses of initials are to be grouped together:

ph
f
p
ʔ
b

When we do this, however, it becomes immediately apparent that Ladefoged's proposed linear order of the states of the glottis is incorrect. To account for the Tai data, it would be necessary to reverse terms 5 and 8 on Ladefoged's scale.

One obvious attempt to salvage the feature *glottal stricture* would be to simply rearrange the linear order of the states of the glottis so that we obtain the correct results for the Tai data. This could be done, but it would be a purely ad-hoc nonexplanatory solution (cf. Gedney 1970). We would no longer be able to claim that the feature constitutes a single physical scale, i.e. we would no longer have a principled reason for the proposed linear order.

Having shown that neither the Halle-Steven's feature framework nor Ladefoged's can adequately handle the Tai data, let us now consider an alternative hypothesis.

## 5. An alternative proposal

I would like to propose 2 laryngeal features that could easily be incorporated into a theoretical framework that permitted n-ary valued classificatory features - (1) a binary feature *vibrating* and (2) an n-ary feature *glottal width.*

(1) [± vibrating]

(2) Glottal Width

1. spread
2. voiceless
3. tightened
4. closed

These features are hierarchically-ordered. The n-ary feature *glottal width* is relevant only to the nonvibrating state of the vocal cords.

Those speech sounds that have fundamental frequency are classified [+vibrating], those that do not [-vibrating]. For the former set of speech sounds, some portion of the vocal cords is vibrating; for the latter set, no portion of the vocal cords is vibrating. This is an inherently binary distinction and is not open to scalar quantification.

The n-ary feature *glottal width* is a multivalued scalar feature that consists of a linearly-ordered set of terms along a single physical scale. The continuum extends from the widest open position of the glottis, that associated with voiceless aspirated stops (Kim 1970, Ladefoged 1973), to the fully closed position, that associated with the glottal stop. That such a physical continuum exists receives support from photographs that have been taken of various states of the glottis (Ladefoged 1973).

The third term - 'tightened' - on the *glottal width* scale gains independent support from Kim's (1970) cineradiographic study of the three types of Korean stops - unaspirated, slightly aspirated, heavily aspirated. In this study Kim found a direct correlation between degree of glottal opening at time of release and degree of aspiration, i. e. the wider the glottal opening, the greater the amount of aspiration. To account for the three Korean stops, then, it is necessary to specify three degrees of glottal width - the unaspirated stops being specified 'tightened'. The Tai unaspirated stops would be similarly specified.

As presented earlier, the Tai data indicates that it is frequently necessary to divide initials between phonetic subclasses (4) and (5). The binary feature *vibrating* easily accounts for that division, i.e. between speech sounds that are classified [-vibrating] as opposed to those classified [+vibrating].

| (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|
| ph | f | p | ? | b |
| [-vibrating] | | | | [+vibrating] |

When we arrange the classes of initials (1) through (4) along the *glottal width* scale, as shown below, the linear order of the classes, evident in the tone splits, is correctly predicted.

(1) ph - spread
(2) f - voiceless
(3) p - tightened
(4) ? - closed

The feature *glottal width* makes interesting predictions about what to expect in both diachronic and synchronic phonology. To the extent that other evidence confirms the linear order proposed here, it must be taken as support for n-ary features on the classificatory level of representation.

<u>References</u>

Brown, J.M. 1965. *From Ancient Thai to Modern Dialects.* Social Science Foundation Press of Thailand, Bangkok.

Chao, Y.R. 1930. "A System of Tone Letters." *Le Maître phonétique* 45:24-27.

Chomsky, N. and M. Halle. 1968. *The Sound Pattern of English.* Harper and Row. New York.

Fromkin, V. 1972. "Tone Features and Tone Rules." *Studies in African Linguistics.* 3.1: 47-76.

Gedney, W. 1969. "A Checklist for Determining Tones in Tai Dialects." *Studies in Linguistics in Honor of George L. Trager,* ed. by M. Smith, 423-437. Mouton, The Hague.

Gedney, W. 1970. "A Spectrum of Phonological Features in Tai." Paper presented to 3rd Annual Meeting of the Conference on Sino-Tibetan Reconstruction. Cornell University.

Haas, M. 1958. "The Tones of Four Tai Dialects." *Bulletin of the Institute of History and Philology. Academia Sinica,* 29:817-826.

Halle, M. 1957. "In Defense of the Number Two." *Studies Presented to Joshua Whatmough on his Sixtieth Birthday,* ed. by E. Pulgram, 67-72. Mouton: The Hague.

Halle, M. and K.N. Stevens. 1971. "A Note on Laryngeal Features." *Quarterly Progress Report of the Res. Lab. of Electronics.* M.I.T. 101:198-213.

Halle, M. 1972. "Theoretical Issues in Phonology in the 1970's." *Proceedings of the Seventh International Congress of Phonetic Sciences,* ed. by A. Rigault and R. Charbonneau, 179-204. Mouton: The Hague.

Kim, C-W. 1970. "A Theory of Aspiration." *Phonetica* 21:107-116.

Ladefoged, P. 1963. "Some Physiological Parameters in Speech." *Language and Speech.* 6.3:109-119.

Ladefoged, P. 1967. "Research Possibilities in Phonetics." *Annual Bulletin,* Res. Institute of Logopedics and Phoniatrics, University of Tokyo. 1:31-34.

Ladefoged, P. 1971. *Preliminaries to Linguistic Phonetics.* University of Chicago Press.

Ladefoged, P. 1973. "The Features of the Larynx." *Journ. of Phonetics* 1.1:73-83.

Li, F.K. 1966. "The Relationship Between Tones and Initials in Tai." *Indo-Iranian Monographs, Studies in Comparative Austro-asiatic Linguistics.* ed. by N. Zide, 82-88. Mouton: The Hague.

Lisker, L. and A.S. Abramson. 1971. "Distinctive Features and Laryngeal Control." *Language.* 42.4:767-785.

Sarawit, M. 1973. *The Proto-Tai Vowel System.* Unpublished Ph.D. dissertation. Univ. of Michigan.

# *An Experimental Study of Yoruba Tone*[1]

Carl R. La Velle

[Department of Linguistics, University of California, Los Angeles]

## 1. Introduction

This paper reports on the preliminary results of an ongoing experimental study[2] of tonal phenomena in Yoruba[3]. This study provides new information as to how phonological tone is realized phonetically. In the course of the acoustic analysis a number of theoretical questions are posed which relate not only to Yoruba but to more general aspects of tone systems.

One such question concerns the phenomenon of downdrift. Numerous linguists have observed that in many African languages there is a continual lowering of high tones after low tones; it has also been suggested that there is a general lowering of low tones after high. (Schachter and Fromkin 1968, Courtenay 1971, et alia). Others have suggested that in some languages only the high tones show this lowering with the low tones remaining on a relatively fixed pitch.

At the present time there is no agreed on explanation for this phenomenon; one view holds that downdrifting is a universal phonetic phenomenon which requires no preprogrammed commands to the laryngeal muscles; others hold that while this may be a phonetic tendency, the lowering of subsequent tones must be the result of specific motor commands. What is clear, however, is that downdrifting may be phonologized (Hyman 1972) and that in certain languages, rules specifying the pitch lowering must occur prior to other phonological rules like vowel deletion in order to account for the downstep tones which occur in these cases (Schachter and Fromkin 1968).

Courtenay (1971) has suggested that in Yoruba downdrift does affect both high and low tones. My acoustical analysis, however, shows that in Yoruba the successive lowering of contiguous low tones is apparently not an unrestricted process. Therefore, it may be that some constraint operates to alter the natural processes of tone lowering in Yoruba. Thus, if downdrift is caused solely by phonetic factors, this may be countered phonologically to prevent the lowering of low tones in certain phonological environments.

## 2. Low tone behavior

There has been little discussion in the literature concerning the lowering of a low tone after a low tone. In Yoruba, however, my data[4] show that this does occur in two identifiable positions. The pitch of a low differs from an immediately preceding low in:

(1)
a. phrase final position, and
b. when the first low tone is immediately preceded by a contrastively higher tone

In other words, given a sequence of contiguous low tones which is not preceded by a non-low tone, a lowered low tone will always occur in phrase final position, and, given a contiguous sequence of two lows which is immediately preceded by a contrastive non-low level tone, the second low is realized on a lower pitch level. In addition, the third and subsequent of any occurring contiguous lows may also differ in pitch with one another. The pitch of the first low after a non-low tone is always realized higher than that of the second low. It might be more plausible to view (b) as resulting from the phonetic assimilation of the first low tone to the immediately preceding non-low. Viewed in this more concrete fashion, (b) predicts that a low tone is raised when immediately preceded by a contrastive higher tone.

## 3. Phonetic data

Evidence is offered in 2 and 3 for claim 1a.

| | | L | L | H | |
|---|---|---|---|---|---|
| (2) | ìyàwó | 94Hz | 92Hz | rise | 'wife' |
| | ìròlɛ́ | 89Hz | 81Hz | rise | 'evening' |
| | òšùkpá | 78Hz | 77Hz | rise | 'moon' |

| | L | L | H | |
|---|---|---|---|---|
| òyìbó | 84Hz | 81Hz | rise | 'European' |
| ìyàwó | 83Hz | 80Hz | rise | 'wife' |
| òdòdó | 84Hz | 92Hz | rise | 'flower' |
| fèrèsé | 102Hz | 102Hz | rise | 'window' |
| Average | 88Hz | 86Hz | | |

In (2) the data show the average pitch[5] of two contiguous low tones immediately preceding a final high tone. The data show that the two low tones are more or less equal in fundamental frequency.

(3)

| | L | L | L | |
|---|---|---|---|---|
| àìsã̀ | 106Hz | 102Hz | 105Hz→93Hz→85Hz | 'illness' |
| òòyà | 94Hz | 91Hz | 92Hz 81Hz 72Hz | 'comb' |
| ààbɔ̀ | 83Hz | 85Hz | 95Hz 90Hz 72Hz | 'half' |
| èèyà | 92Hz | 91Hz | 90Hz 88Hz 73Hz | 'parson' |
| ɔ̀gɛ̀dɛ̀ | 93Hz | 90Hz | 92Hz 90Hz 72Hz | 'banana' |
| ìsàlɛ̀ | 95Hz | 92Hz | 91Hz 85Hz 68Hz | 'lower part' |
| ìràwɔ̀ | 92Hz | 92Hz | 91Hz 91Hz 71Hz | 'star' |
| ìkòkò | 90Hz | 90Hz | 91Hz 91Hz 71Hz | 'pot' |
| ìbàdã̀ | 88Hz | 90Hz | 90Hz 91Hz 70Hz | 'Ibadan' |
| ìròhĩ̀ | 96Hz | 100Hz | 99Hz 90Hz 67Hz | 'news' |
| àgũ̀tã̀ | 88Hz | 94Hz | 100Hz 90Hz 70Hz | 'sheep' |
| Average | 92Hz | 92Hz | | |

In (3) it is shown that the pitch of two contiguous lows immediately preceding a final low tone is stable, whereas, the low tone in final position shows a lowering.

The data in (4) show that in addition to the claim of 1b, a mid tone may also be lower than the end point of an immediately preceding low tone, which has been realized as a falling glide due to the preceding high tone. To my knowledge this surprising information has never been pointed out in the literature. I am currently evaluating more data on this point to determine the generality of this phenomenon. In (4) and (5), the pitch difference column, which expresses the difference between the end point of the fall and average pitch of the following tone, is important.

(4) L M preceded by H

| | | L | M | Pitch Diff. |
|---|---|---|---|---|
| a. | omiòdʒó sɔ̀ lɔ ... | 134Hz→81Hz | 87Hz | +6Hz |
| b. | àrà náà ma kpa... | 126Hz 101Hz | 96Hz | -5Hz |
| c. | a máa borí àwɔ̃... | 124Hz 91Hz | 80Hz | -11Hz |
| d. | ǹdʒɛ́ ǹka tó... | 139Hz 111Hz | 97Hz | -14Hz |
| e. | išɛ́ náà ma kpa... | 135Hz 101Hz | 100Hz | -1Hz |
| f. | ...ɛ̀gbɛ́ òkũ... | 100Hz 91Hz | 86Hz | -5Hz |

Given the data in 4, it is obvious that the low tone relationship expressed by claim 1b is most crucial when the contrastively higher tone is high.

(5) L L preceded by H

| | | L | L | Pitch Diff. |
|---|---|---|---|---|
| a. | ...fṹ ìyàwó ɛ̂ | 120Hz→90Hz | 73Hz | -17Hz |
| b. | ...àárɔ̀ ɔ̀la | 142Hz 100Hz | 80Hz | -20Hz |
| c. | àwɔ̃ iléìkàwé... | 168Hz 147Hz | 89Hz | -58Hz |
| d. | ...lásìkò yɛ̃̂ | 140Hz 127Hz | 93Hz | -34Hz |
| e. | ...sí iléìkàwé | 160Hz 130Hz | 70Hz | -60Hz |
| f. | kílèdèbàdà | 124Hz 102Hz | 74Hz | -28Hz |

As the data of 5 show, the pitch difference between the contiguous lows is quite substantial by comparison to the low-mid tone pitch relationship in 4. If this were not the case, perceptual difficulties could arise in distinguishing /H L M/ from /H L L/ utterances.

4. Phrase final lowering

The fact that one finds a lowering of a low tone in phrase final position (as shown in 3) may be related to the phenomenon observed in both tone and non-tone languages of a pitch fall at the end of utterances. (Lieberman 1967). It has long been observed that words uttered in citation form reveal intonation contours similar to full phrases and sentences. One would therefore expect that the pitch fall observed in sentences would also occur in words uttered in isolation. This study therefore has relevance to the universality of this intonation phenomenon.

The instrumental analysis of Yoruba minimal pairs distinguished by tone alone (e.g., /L L/ vs. /M M/) provides some interesting data. It was found that in the low tone words (i.e., words in which both the first and last syllables are phonologically low tone) the average pitch difference between the initial and final low tone syllable was about 12Hz, while in the mid tone words, the pitch difference was on the average less than 5Hz. If the lowering of the final low tone is the result of the natural tendency to lower the pitch in phrase final position, then we must explain why mid and high tones do not undergo a similar process.

It should be pointed out that, while an all low tone utterance shows phrase final lowering of low tone as a phonetic fall, it is not clear whether it is the contour itself or the end point of the contour that is the important perceptual cue. However, for the present, I will continue to assume that, perceptually, the importance of the final low resides primarily in the fact that it is lowered.

Each table, 6, 7, and 8, contains the data from one recording session by a Yoruba speaker. The structure of the examples cited is V C V. The column, tone bearing segments, shows the tone of the initial and final segments of the disyllabic nouns. The column, number, refers to the number of utterances analyzed. Under, average fundamental frequency, the 3rd column refers to the pitch difference between the average reading of the initial and final tone bearing segments. As the data of these tables show, a final low tone is significantly lower when preceded by an identical tone. No such comparable relation is evident among disyllabic mid or high tone forms.

(6)

| Tone Bearing Segments Initial | Tone Bearing Segments Final | Nbr. | Average Fundamental Frequency Initial | Average Fundamental Frequency Final | Pitch Difference |
|---|---|---|---|---|---|
| L | L | 3 | 104Hz | 89Hz | -15Hz |
| M | M | 5 | 138Hz | 140Hz | +2Hz |

(7)

| Tone Bearing Segments Initial | Tone Bearing Segments Final | Nbr. | Average Fundamental Frequency Initial | Average Fundamental Frequency Final | Pitch Difference |
|---|---|---|---|---|---|
| L | L | 26 | 98Hz | 89Hz | -9Hz |
| H | H | 4 | 156Hz | 155Hz | -1Hz |

(8)

| Tone Bearing Segments Initial | Tone Bearing Segments Final | Nbr. | Average Fundamental Frequency Initial | Average Fundamental Frequency Final | Pitch Difference |
|---|---|---|---|---|---|
| L | L | 8 | 114Hz | 94Hz | -20Hz |
| M | M | 6 | 116Hz | 113Hz | -3Hz |

I would like to suggest that this asymmetry may be accounted for by a linguistic constraint which applies to maintain maximal perceptual distinctiveness. If such a constraint on lowering of a second high or mid tone did not operate then a /H H/ realized as high downstepped-high, as shown in (9), could lead to perceptual confusion between /H H/ and /H M/ utterances.

(9) /H H/ → *[‾ -] could be confused with /H M/ → [‾ - ]. Also, if /M M/ were realized as mid followed by a lowered-mid, as shown in 10, then /M M/ and /M L/ utterances could be confused.

(10) /M M/ → * [- _] could be confused with /M L/ → [- _]

Alternatively, it is possible that were the second mid tone lowered, a /M M/ realized as a mid lowered-mid could be confused with a /L L/ realized as a low lowered-low as shown in (11). (In the summary, I will elaborate on these conflicting explanations).

(11) /M M/ → *[- _] could be confused with /L L/ → [_ _]

In other words I am claiming that the force working to maintain contrast in the language imposed a constraint on the expected lowering of a tone in phrase final position. If this explanation is correct, then it should be the case that given a pitch value on a word such as is shown in (12), where the second low is not lowered, a native Yoruba would perceive it as the /M M/ disyllabic noun meaning 'husband', or reject it as a possible Yoruba utterance.

(12) [_ _] as the pitch value of ɔkɔ

## 5. Perceptual experiment

To test this hypothesis, the following pretest[7] was conducted: A native Yoruba speaker was asked to give the English gloss for each word presented in (13), with the indicated phonetic representations in the column, stimuli.

(13)

| | Stimuli | Responses | | |
|---|---|---|---|---|
| a. | ɔkɔ [- -] | /M M/ | noun | 'husband' |
| b. | ɔkɔ [- _] | /L L/ | " | 'spear' |
| c. | ɔkɔ [_ _] | /M M/ | " | 'husband' |
| d. | ago [_ _] | /M M/ | " | 'cup' |
| e. | ago [- _] | /L L/ | " | 'fowl-coop' |
| f. | ago [- -] | /M M/ | " | 'cup' |

As shown in the response column in 13, (a) and (f) were identified as /M M/ nouns; (b) and (e) as /L L/ nouns. But what is interesting is that (c) and (d) were identified as /M M/ nouns. This evidence suggests that the phonetic tendency of final lowering has become phonologized in final low tones in Yoruba. Additionally, this pilot experiment provides tentative support for the explanation of why /H H/ and /M M/ sequences do not undergo phrase final lowering.

(6) Summary

At this point it seems reasonable to ask which of the two explanations are to be adopted to account for the constraints on final high and mid tones. Clearly, it is the case that in one sense the proposed explanations do conflict, in the sense that one predicts that if the natural tendency of lowering were realized in, say, /M M/ nouns, the resulting pitch configuration would be confused with /M L/; while the other says that /M M/ would be confused with /L L/.

I have argued that it is the natural tendency to lower in final position that is constrained in high and mid tones. Therefore, if it is assumed that the only phonetic difference between the tonal pattern of /L L/ and /M L/ utterances is one of degree of pitch difference then one would be forced to conclude that/M M/ realized as mid lowered-mid would be confused with /L L/ tone patterns. The final mid tone would be undergoing the natural tendency to lower. Therefore, it seems correct that a naturally lowered final mid tone, of a /M M/ utterance, would result in an overall pitch configuration closely resembling the pattern /L L/, where the final low undergoes the natural tendency to lower. Although we may correctly expect that the natural tendency would produce a pitch pattern in the final mid, similar to that in the final low, there might always be some overall pitch difference. Nevertheless, I feel that most such differences would tend to be negated by the perceptual similarity of such phonetic manifestations. I.e., if speakers of tone languages rely primarily on pitch context to process pitch phenomena, then it is more likely that mid lowered-mid would be confused with low lowered-low. If the lowering process continued in the final tone of /M M/, only then would it become likely that the resulting pitch pattern would be confused with /M L/.

However, the data show that other than a mere pitch difference exists between /L L/ and /M L/ phonetic representations. The relevant evidence is that initial mid tones show an average rise in pitch from voice onset to end point of production, as shown in (14).

(14) M $\rightarrow$ [131 $\rightarrow$ 146] /__L 5 utterances

M $\rightarrow$ [111 $\rightarrow$ 123] /__L 21 "

M $\rightarrow$ [119 $\rightarrow$ 126] /__L 6 "

Normally, initial low tones fall in pitch as in (15).

(15) L $\rightarrow$ [110 $\rightarrow$ 96] /__L 3 utterances

L $\rightarrow$ [120 $\rightarrow$ 109] /__L 8 "

Those lows which do rise in initial position as shown in 16, do so only under abnormal conditions.

(16) L $\rightarrow$ [95 $\rightarrow$ 101] /__L 26 utterances

The /L L/ nouns of 16 were grouped together for the recording, and, consequently, the additional strategy of initial low-fall, which is used in 15, was not needed to avoid possible confusion. Therefore, I conclude that if /M M/ were realized as mid lowered-mid, the likely result would be a loss of distinctiveness brought about by the phonetic merger of /M M/ and /M L/ tone manifestations.

## (7) Conclusions

In the first part of this paper, I suggested that the final low of a /H L L/ sequence undergoes lowering. However, as mentioned, the correct generalization may be that the end point of the first low tone is raised. While either explanation accounts for the data, I prefer the latter because it is simpler.

I have also presented evidence showing that while the expected phrase final pitch lowering occurs with a sequence of two or three low tones, this does not occur with a sequence of two high or mid tones. To account for this difference I suggested that to avoid or prevent perceptual confusion, the 2nd of two high or mid tones are constrained from the phonetically conditioned lowering. A pretest was conducted which supports this hypothesis.

I wish to point out that the two types of low tone behavior, as predicted by claims 1a and 1b are phonetically quite dissimilar. The former is adequately characterized as resulting from a natural tendency, while the latter predicts an output which is satisfactorily accounted for by a progressive assimilation rule. Apparently, these rules share nothing structurally. However, by not showing the relationship between these rules, the nature and fact of their functional similarity will not be expressed.

In an article, Kisseberth (1970) discusses phonological rules which share a functional similarity. It seems that this is the case in Yoruba. The two rules and the proposed linguistic constraint conspire against low-mid tone confusion. However, this rule conspiracy is, functionally, unlike the one in Yawelmani. In Yoruba, the functional nature of the tonal conspiracy is perceptual. It appears to operate to avoid confusion which could arise from the phonetic merger of low and mid tones.

Clearly, further experimentation is required to substantiate the importance of perceptual constraints and tonal conspiracies as influences in the grammar.

## Footnotes

[1]This study began under the guidance of Breyne Moskowitz. I initiated this tone study as a special project for her Introduction to General Phonetics Class in Fall 1972. Without the aid and encouragement of both Victoria Fromkin and Breyne Moskowitz, this paper would not have been written. I would like to thank them both for helping me revise versions of this paper. In addition, I want to thank Ron Carlson, Willie Martin and Lloyd Rice for their help and understanding.

[2]The data presented in this report were recorded in three separate sessions at the UCLA phonetics lab. They were produced in a soundproof booth using an Ampex recorder at 7.5ips. The subjects are native speakers of Yoruba. Two recordings were made by Yemisi Olusola in November and December of 1972. One recording was made by Andrew Medugbon in January 1973. In order to obtain hard copies of the fundamental frequency, a pitch extractor and oscillomink were utilized. The former extracted the fundamental frequency from the recorded data and the latter provided a printed record of the wave form. Immediately upon completion, a calibration of various frequencies was performed in order to provide a means by which to measure the pitch wave form.

[3]The Yoruba language is spoken mainly in the Western Region of Nigeria. It belongs to the Kwa branch of the Niger Kordofanian family. It is a tone language with three level tones: low, mid and high. At the phonetic level,

allotones of low and high tones occur in certain environments. A low tone is realized as a high falling glide when immediately preceded by a high tone. It falls from the level of high towards the level of low tone. A high tone has rising pitch when a low tone immediately precedes. It rises from the level of low towards the level of high tone.

[4]In this report L or v̀ = low tone; M or v = mid tone; H or v́ = high tone, and v̚ = lowered mid tone.

[5]In the data a series of figures connected by arrows represents the pitch of one tone. E.g., 105Hz→93Hz→85Hz represents the pitch of voice onset, mid and end positions of tone production. 124Hz→102Hz represents the pitch of voice onset and end positions of tone production. 94Hz represents the average pitch of voice onset, mid and end positions of the tone.

[6]This explanation was suggested to me by Theo Vennemann.

[7]Only one subject was used in this perceptual test. The stimuli were produced by the author. The subject gave his indicated responses to oral stimuli.

## References


Courtenay, K.R. (1971) "Yoruba: A 'Terraced-Level' Language with Three Tonemes." *Studies in African Linguistics* 2.239-255.

Hyman, L.M. (1972) "Nasals and Nasalization in Kwa." *Studies in African Linguistics* 3.167-206.

Kisseberth, C.W. (1970) "On the Functional Unity of Phonological Rules." *Linguistic Inquiry* 1.291-306.

Lieberman, P. (1967) Intonation, Perception, and Language. M.I.T. *Research Monograph* 38. Cambridge, Massachusetts. The M.I.T. Press.

Schachter, P. and V. Fromkin (1968) A Phonology of Akan. *Working Papers in Phonetics* 9. UCLA.