Tonal Complexes and Tonal Alignment

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1. Introduction

1.1 The phenomenon
In the Benue Congo languages of West Africa, we often see a process in which the transition from one tonal level to another is delayed so as to create a salient tonal contour on the syllable beginning the new level. In a notation in which vowels are tagged as "High", "Low", "Rising", "Falling", etc., this leads to the creation of rises and falls, as in the examples below from Yoruba1 and Edo

(1) (a) Yoruba rising example
àlá (LH) → àlā (L LH) 'dream'

(b) Yoruba falling example
rárà (HL) → rará (H HL) 'elegy'

(c) Edo (Bini) falling example
čkpó (HL) → čkpó (H HL) 'bag'

In pronunciation, F0 transitions are always contours, not step functions; however, the contours exemplified in (1) are not just the necessary phonetic consequence of tonal co-articulation. The evidence for this is of two kinds: first, the same language may form contours for some tonal sequences and not others; and second, some languages may never form such contours at all. Thus Edo does not form such tonal contours in Low High sequences; and Yoruba does not do so in any case where Mid tone precedes or follows High or Low. The difference between the Yoruba H L and M L cases can be seen in the pitch tracks in (2):

1 Note that in Yoruba, the standard orthography shows the input to this process, not the output, so that the resulting contours are not normally indicated in the written forms; therefore the examples in (1) are written as in the left hand column.
For the past few decades, phonologists have generally followed Hyman and Schuh (1974:88) in treating this process of tonal contour formation as "tone spreading."

(2) *HL plot*                           *ML plot*

(3)a    ma         b   mama       c   mama  
       / \ | | | / |
       H L H L H L

1.2 The Problem
As Hyman and Schuh observed in 1974, there is a general pattern to be accounted for. Such tone contour formation is common, but by no means universal. When it happens, the change is always in the direction of a delay rather than an advance of the F0 transition.

In a phonological theory where rules or constraints formalize universal tendencies, so that phonological processes should have outputs that are formally more highly valued than their inputs, we need more. What specific properties of the representations make it better for perseveratory contour formation to occur, as compared to anticipatory contour formation or no change?

Ironically, we will show that the only well-known constraint in the literature that bears on the question points in exactly the wrong direction, at least for Yoruba (i.e. Goldsmith’s Well Formedness Conditions).

As we look more closely at the phonetic details, we will also want answers to some other questions: why is contour formation (apparently) associated with target exaggeration, and why does it also seem to have a special relationship to downdrift?
1.3 Our Solution

Our solution to the problem posed by Hyman and Schuh (1974) has two parts. First, we propose that tones naturally form binary prosodic complexes, so that tonal rises and falls are natural and universally valued combinations of tones, roughly in the way that syllables are natural and universally valued combinations of segments, or diphthongs are natural and universally valued combinations of vowels. Second, we observe that the normal alignment of (simple) tonal and segmental spans, in the absence of any contour formation, places each F0 target at the end (rather than the beginning) of the corresponding segment. Perseveratory contour formation preserves this endwise alignment, since it affects the beginning rather than the end of the affected segment.

Thus contour formation by tone spreading is a natural process, since it creates a tonal complex that is more highly valued than an isolated tone is. However, anticipatory spreading is avoided because it would violate the normal endwise phonetic alignment of (underlyingly associated) tones and segments.

First, we argue that our proposed tonal complexes are already familiar to phonologists, under the name of "pitch accents." We will discuss some unexpected similarities between Japanese and Yoruba in order to underline this point. Second, we suggest that several other tonal/accentual phenomena may be clarified by analysis in terms of tonal complexes and the edgewise alignment of tonal and segmental spans.

2. Yoruba

Yoruba has three phonemically distinctive tones-H(igh), M(id), and L(ow). H occurs in word-initial position only in (marked) consonant-initial words, which reveal an implicit initial vowel when preceded by another word in genitive construction.

(4) Lexical tone contrast:

<table>
<thead>
<tr>
<th>ra H</th>
<th>ra M</th>
<th>ra L</th>
</tr>
</thead>
<tbody>
<tr>
<td>'to disappear'</td>
<td>'to rub'</td>
<td>'to buy'</td>
</tr>
<tr>
<td>ọkọ MH</td>
<td>ọkọ MM</td>
<td>ọkọ ML</td>
</tr>
<tr>
<td>'hoe'</td>
<td>'husband'</td>
<td>'vehicle'</td>
</tr>
<tr>
<td>ilu LH</td>
<td>ilu LM</td>
<td>ilu LL</td>
</tr>
<tr>
<td>'town'</td>
<td>'opener'</td>
<td>'drum'</td>
</tr>
<tr>
<td>pako HH</td>
<td>kese HM</td>
<td>pako HL</td>
</tr>
<tr>
<td>'plank'</td>
<td>mythological place name</td>
<td>'chewing stick'</td>
</tr>
</tbody>
</table>

2.1 **Mid tone Un(der)specification**

There are several reasons to believe that Yoruba 'mid' tone is underlingly just the absence of tonal features (Akinlabi 1985, Pulleyblank 1986).
2.1.1 Tonal Stability

Low and High tones generally remain and re-attach when their lexically-associated vowels delete; lexical Mid does not. Thus vowel deletion processes treat Mid as if it were not there.

In some cases the tone of the deleted vowel remains, and may appear alone or in a glide on one of the remaining vowels; in other cases the tone of the deleted vowel also seems to disappear. The output of tone sequences in the following examples is straightforward to calculate if Mid is just the name for lack of tone. The crucial cases are exemplified below.

(5) **H verb + L initial noun**

(a) wa (H) + ękọ (LH) → wękọ (H LH)
look (for) education look for education

(b) mu (H) + iwe (L H) → muwe (H LH)
take book take a book

(c) wa (H) + ọnọ (L L) → wọnọ (H L)
look (for) way look for a way

(d) wa (H) + imọ (L L) → wamọ (H L)
look (for) knowledge look for knowledge

(e) ji (H) + ọbẹ (L M) → jọbẹ (H (L) M)
steal knife steal a knife

(f) fe (H) + iwo (L M) → fẹwo (H (L) M)
want horn want a horn

**H verb + M initial noun**

(g) wa (H) + ọwọ (MH) → wowo (H H)
look (for) money look for money

(h) wa (H) + ile (MH) → wale (H H)
look (for) house look for a house

**M verb + L initial noun**

(i) jọ (M) + ajẹ (L H) → jajẹ(L H)
resemble witch resemble a witch

(j) sin (M) + oku (L H) → sinku (L H)
bury dead (body) bury the dead
2.1.2 "Tonal Spreading" treats Mid as nonexistent

In Yoruba, the sequence L H is realized as L LH and the sequence H L is realized as H HL, that is adjacent H and L tones always spread (rightwards) onto each other, creating LH and HL contours. On the contrary, an M L sequence does not become *M ML and an M H sequence does not become *M MH. That is, there are no MX contours, as indeed there could not be if mid does not exist.

(6)a. ala (LH) → ala (L LH) 'dream'
    rara (HL) → rara (H HL) 'elegy'

(6)b. ole (ML) 'thief'
    ile (MH) 'house'

When H or L spread to M, M is usually completely erased:

(7a) MLL LLL / MLL
    erìrà → ëèrà / èèrà 'ants'
    erùpè → ëèpè / èèpè 'sand'

(7b) MHH HHH / MHH
    egùngún → ëégún / ëègún 'maquarade'
    orúkọ → óókọ / óókọ 'name'

2.2 The paradox of Yoruba tone (non-)spreading and (non-)relinking

The Yoruba cases of tone non-spreading and non-relinking present a paradox. In configurations (8a) and (8b) below (illustrated in 9a), where each syllable has its own tone, the first syllable's tone insists on crowding onto the second syllable. In configurations (8c) and (8d), where the second syllable is unspecified for tone, the first syllable's tone stays home, leaving its neighbor tonally empty (i.e. Mid). (See examples in (9b))

(8) a. \( \sigma \ \sigma \) b. \( \sigma \ \sigma \) c. \( \sigma \ \sigma \) d. \( \sigma \ \sigma \)
    H L L H H L L

(9)a. ala (LH) → ala (L LH) 'dream'
    rara (HL) → rara (H HL) 'elegy'

(9)b. kese (HØ) → kese (HØ) 'mythological place name'
    ilu (LØ) → ilu (LØ) 'opener'
Furthermore, in vowel deletion a Low tone “relinks” if the final syllable has a high tone (10a), but again not if the final syllable is tonally empty (10b). Examples are in (11a) and (11b) respectively.

(10) a. σ σ σ \rightarrow σ σ  
   H L H \rightarrow H LH  

b. σ σ σ \rightarrow σ σ  
   H L \rightarrow HL  

(11)a Input \rightarrow Output  (11)b Input \rightarrow Output  
\text{Input:} \quad m u + i w e \quad \quad \text{Output:} \quad m u w e  
\text{H L H} \quad \quad \text{H L H}  
\text{Output:} \quad f e + i wo \quad \quad \text{Output:} \quad f e w o  
\text{H L} \quad \quad \text{H L}  

Yoruba thus presents a case ironically antithetical to Williams/Goldsmith's original Well-Formedness Condition: the rule seems to be that a tone “spreads” or “relinks” if and only if the target syllable already has its own tone!

-- Another three tone language with similar facts to Yoruba is Ghotuo (Elugbe 1985, 1995).

2.3. **Proposed Analysis:**

We propose that Yoruba tones do not “spread” or “relink” in order to fill tonally unspecified vowels, rather they “spread” or “relink” in order to join with other tones to form tonal complexes, HL or LH units.

Such units, long postulated as underlying elements in accentual systems, also play a crucial role in tonal phonology more generally.

3.0 **Comparison to Japanese pitch accent**

These tonal complexes have some phonetic similarities to (underlying) pitch accents in pitch accent languages, the canonical example of which is Japanese.

(12) a. Tones associated with multiple tone-bearing-units have just one F0 target; this is a sort of "phonetic OCP" (Akinlabi and Liberman 1995).

\text{Input:} \quad ó wà là ní rò run 'he drove Alani to heaven'  
\text{H ( L) H L M}  
\text{Output:} \quad ó wà là ní rò run  
\text{H L H M}  
\text{cf. Kubozono (1993:76ff) arguments that the terminal point of accentual fall has a certain value”}.

b. In HL and LH sequences, a tonal glide is formed on the second syllable, while this does not happen in HM, MH, LM, or ML sequences (Ward 1952). On the phonological surface each of these syllables is associated with a (HL) unit which functions phonetically much like a pitch accent.  
Cf. Japanese accent is interpreted (Pierrehumbert and Beckman 1989) as a metrical HL group that functions as a unit.
c. Downdrift occurs in HLHL sequences which are adjacent but not in HMMH or MLML (LaVelle 1974). Catathesis is triggered only by accents in Japanese (Poser 1985); each accentless “minor phrase” has (ungrouped) H and L tone pair, but accentless sequences rise and fall with only a small amount of declination. Yoruba downdrift = catathesis.

d. H is raised before L as compared to before M (Akinlabi and Laniran 1987, Connell and Ladd 1990, Laniran 1992); L is lowered before H as compared to before M (Akinlabi and Liberman 1995). Accentual H's are higher than non-accentual H's ("accentual boost," Kubozono 1993), even though Japanese accent is not stress-like, does not cause greater segment durations, and is not considered a strong position for alignment with music.

4.0 Comparison to Mawukakan tonal accent

There are also similarities to the characteristics of tonal accent noted for the Manding language Mawukakan (Bamba 1991): accentual H is raised compared to non-accentual H; downdrift is only caused by accentual HL, not other (non-metrically joined) H L sequences.

5.0 Conclusion: Arguments for Tonal Complexes

A successful account of tonal phonology in terms of universal constraints requires enriching tonal representations to include some simple kinds of structures, such as a tonal unit consisting of paired HL or LH tones, which organize tones in somewhat the same way that segments, syllables and feet organize non-tonal features.

--- Constraints mentioning such tonal structures can motivate

(13) (a) spreading
(b) epenthesis (as in tone polarization)
(c) deletion (similar to cluster simplification)
(d) (re-)ordering of tonal features

just as constraints on syllable or foot structure may motivate such processes in well-known cases of segmental phonology.

--- Restrictions

(14) (a) Restriction on types of contours
Some languages allow certain types of contours but not others
(e.g. Nupe allows only LH contour tones but no HL contours, on the contrary Edo (Bini) allows only HL contours but no LH contours).

(b) Restriction to positions
Some languages allow contour tones through spreading only at edges of domains.
References