

INTERCOMMITTEE WORKING

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Autosegmental Tonology

This paper deals with the representation and behavior of tone in African languages. I shall concentrate in my examples on languages of the Northwest -- in particular, Kwa languages, especially Igbo. Considerable work has been done in this area, and two kinds of questions may be asked: first, what are the appropriate representations for tones at the lexical level, during the derivation, and at the phonetic level? Second, what are possible tonological rules? How do they interact with phonological rules? To my knowledge, there has been no attempt made to see a common system which will serve as a basis for the answer to both of these questions. The point of this paper, then, is to use the system first suggested in "Tonemic Structure" to investigate these issues.

I shall first sketchily outline my proposal, which I have dubbed "autosegmental tonology", because the tones are not "suprasegmental", as Leben has suggested, but they rather compose their own sequence of segments, parallel to, but not reduced to, the sequence of phonological segments.

Then I shall give a formal account of what this "two-tier" or "two-dimensional" description is, and how tonological rules are written.

Next I shall discuss the question of tone representation, dealing with downstep and its concurrent multiplication of surface

itches, and the issue of how tone melodies are represented underlyingly.

Examples of tone rules which autosegmental tonology rules out as impossible are discussed next, though throughout, certain solutions are explicitly rejected as inconsistent with the general theory.

Finally I shall consider several problems in Igbo tonology in detail from the point of view of this theory.

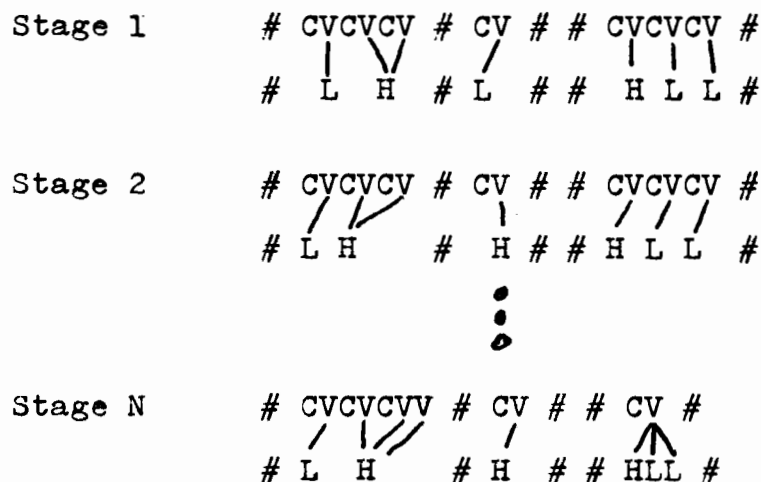
Throughout I shall use "tone" as a systematic term, defined by features. H-tone is $\begin{bmatrix} +\text{High} \\ -\text{Low} \end{bmatrix}$, M is $\begin{bmatrix} -\text{High} \\ -\text{Low} \end{bmatrix}$ and L is $\begin{bmatrix} -\text{High} \\ +\text{Low} \end{bmatrix}$.

Pitch is everywhere a phonetic term.

An informal account of autosegmental phonology

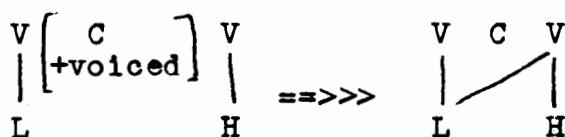
We generally think of a phonological derivation as a sequence of representations, where each representation is a sequence of feature bundles (segments), and each pair of adjacent representations is related by a phonological rule. The first in the sequence is the underlying representation; the last is the final, derived representation.

The only change that the autosegmental tonology makes in this picture is to say that each stage in the derivation is a pair of sequences of feature bundles; one such sequence is the phonological sequence, as in the description above; the other sequence is a sequence of feature bundles (again, segments) describing tone. These two sequences are related to each other -- hooked up to each other -- in a natural way at each level of representation, from the underlying representation to the final derived form, by a set of formal associations with well-formedness conditions. Imagine the following picture:

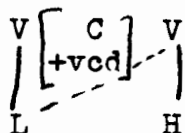


In the interest of clarity, and at the risk of inaccuracy, I have left off the necessary lines of association drawn between corresponding word boundaries.

It must be made clear that this is not just a shorthand for expressing tone features on syllabic segments in the phonological sequence (the upper sequence); it is a full-fledged representation just as it stands. Rules which have either changes to make or conditions involving both tone and non-tone features must likewise be broken up into a tonological and a phonological part. For example, a rule that changes $\grave{a}\acute{b}\acute{a}$ to $\grave{a}\acute{b}\grave{a}$, as in Nupe (see George, 1970), is written like this:



So, for short:



where the broken line indicates the change.

There are several immediate consequences of this approach. Since tonemes and phonemes are throughout the derivation separate entities, deletion of a vowel will never delete the tone associated with it. Likewise, feature assimilation of a vowel will never include tone because a vowel's features do not include its tone specification. Further consequences will be seen throughout this paper.

Formal Representation in Autosegmental Notation

The autosegmental representation of tone is a two-dimensional affair. There are toneless phonological segments (P_1) and tonological segments (T_1), both of which are arranged to form a string. There is a pair of relations "<" and ">" defined on the union of these two sets with the following properties (read "<" as "is to the left of or identical to"):

Definition is not quite right. It implies that <, > are absolute relations on $\{T_1\} \cup \{P_1\}$, whereas the intended meaning is relative to given strings. I.e., it could be that $a < b$ in one string, $\neg a < b$ in another, but this is inconsistent with the relation defined. Also, you really mean $a \leq b$, not $a < b$.

- (1) $a < b$ implies either (i) a and b are both tonological segments; or
(ii) a and b are both phonological segments.
- (2) For all $a, b \in \{T_1\}$ and for all $c, d \in \{P_1\}$
 $a < b$ or $b < a$ (or both); and
 $c < d$ or $d < c$ (or both).
- (3) For all $a \in \{T_1, P_1\}$, $a < a$
- (4) $a < b$ and $b < a$ implies $a = b$.
- (5) $a < b$ and $b < c$ implies $a < c$.
- (6) $a < b$ iff $b > a$.

This amounts to saying that the phonological segments form a well-ordered sequence, and so do the tonological segments; they both participate in the "<" relation, but they are not ordered with respect to each other.

The association procedure sets up a ^{symmetric} relation consisting of pairs with one toneme and one phoneme, noted $a \sim A$. I shall follow the general convention that an expression with both upper and lower case letters uses the lower case to refer ambiguously to either tonemes or phonemes, while the upper case then refers to the other category (phonemes or tonemes, respectively). Throughout the formalism, the role of the tonemes

and the phonemes are entirely parallel.

The association relation thus consists of pairs $a_1 \approx A_1$, which intuitively indicates a link between a toneme and a syllabic phoneme it is associated with.

"<" and " \approx " together induce a derived relation " \leq ", and correspondingly, " \geq ", in the following way:

- (1) $a < b$ implies $a \leq b$
- (2) $a \approx A$ implies $a \leq A$ and $A \leq a$.
- (3) $a \leq b$ iff $b \geq a$.

Before proceeding, I should point out intuitively what is going on. In the situation without any association, there is no sense of a toneme being to the left or to the right of a phoneme. If we put in associations, as below, then a is to the left of A , c and d are to the right of A , a and b are to the left of B , and so on.

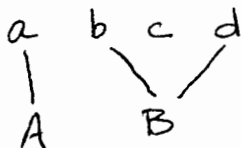


What properties does this extended notion of left/right have? It inherits reflexiveness from "<". We will ~~stipulate~~ ^{transitivity is} that it must be transitive, a necessary property for an ordering to have. We will furthermore stipulate an extended notion of anti-symmetry, which is partly a condition on the " \approx " relation:

Anti-symmetry condition: $a \leq b$ and $b \leq a$ implies

$a \approx b$ or $a = b$ (note that the two are necessarily incompatible).

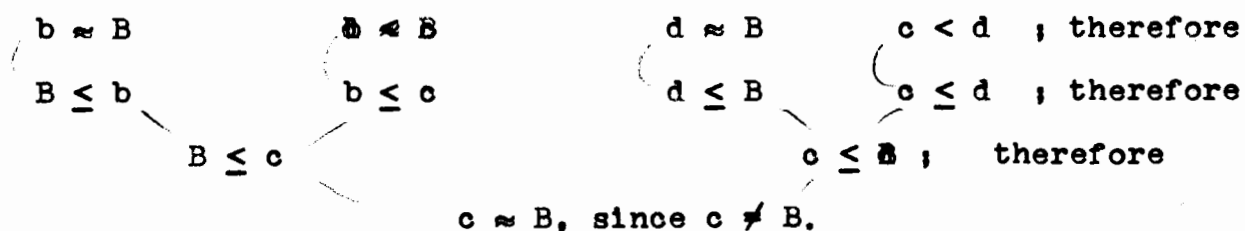
Consider the following situation.



a problem. Thus
consider diagram
below.

$d \leq B$ (since $d \approx B$)
 $B \leq b$ (since $B \approx b$)
 $\therefore d \leq b$ (transitivity)
But $b \leq d$ (since $b \approx d$)
 \therefore by anti-symmetry,
 $b = d$ or $b \approx d$ (false).

Something is wrong



This anti-symmetry property says, in effect, that when an element X is surrounded on both sides by elements associated with some element y , then $X \approx y$.

Note that the anti-symmetry property also rules out association lines crossing (this is a crucial property):



$a \approx Y$ implies $a \geq Y$; $b \approx X$ implies $X \geq b$; therefore $a \geq Y \geq X \geq b$, and thus $a \geq Y \geq X \geq b$, so $a \geq b$. But $a < b$, so $a \leq b$; therefore $a \approx b$ (which is impossible), or $a = b$, which is false. A contradiction arises, proving this is an impossible situation.

To connect this formalism with phonological reality: syllabic phonemes, all tonemes and word boundaries in both the phonological and tonological sequence form the sets $\{T_1\}$ and $\{P_1\}$ in the obvious way. Non-syllabic phonological segments, that is to say, have associations in only a trivial, derivative sense, and we shall not both with these relations (note that this is an empirically testable assumption, and we may ultimately need to modify it, of course).

The Autosegmental Derivation

The phonological-tonological derivation has the following major stages:

(1) The phonological and tonological lexical entries are set out in parallel strings; corresponding word boundaries in each lexical element are associated with each other.

(2)

#	C	V	C	V	#	#	C	V	C	#	C	V	#
#	L	H	#	#	L	H	#	L	H	#	L	H	#

(2) The association rule is applied. This associates the first toneme with the first syllabic segment, the second toneme with the second syllabic segment, and so on. If there are n tonemes and m syllables, this will set up $\min(n,m)$ associations -- that is, the lesser of m and n .

The association rule is written simply

$$a \approx d / \# X \left[\begin{smallmatrix} a \\ +\text{syll} \end{smallmatrix} \right]_{\alpha}$$

where X is a real variable.

We interpret this on a grid where i indexes columns, and j indexes rows.

$i \rightarrow$		C	V	C	V	C	V
$j \downarrow$	α						
	β						
	γ						
	δ						
	ϵ						
	η						

Algorithm: Check the box (i,j) , where i and j are each the smallest valued integers greater than the corresponding (i',j') of any previously checked box, where the phoneme and toneme of box (i,j) meets the structural description of the rule. Continue this process as many times as it is possible to do so. (This is a straightforward application to autosegmental rules of the interpretation of real variables). The rule's

What does
this mean?

2. what change
 change applies to those pairs whose boxes have been checked -- which is to say, in this case, these pairs are formally associated.

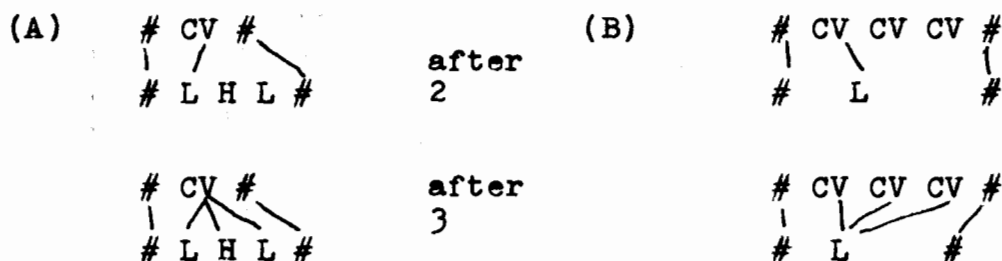
It is worthy of note that the association rule is, formally, literally the simplest possible tone rule that makes sense. Parenthetically, we would expect to find languages with a tone association rule working from the right -- i.e.,

$$a \approx a / \left[\begin{smallmatrix} a \\ \text{syll} \end{smallmatrix} \right] \chi \#$$

(3) The well-formedness condition then comes into effect. This stipulates that

all tonemes must be associated with a syllabic segment, and all syllabic segments must be assigned a toneme, if this is possible without violating the formal constraints of the theory (among which, it will be recalled, is the prohibition of the crossing of association lines).

An immediate consequence is that (A) if there were extra unassigned tonemes, they are automatically assigned to the final syllabic unit; (B) if there were too few tones, the final tone is assigned to the toneless syllabic segments.



These additional associations are due to the uniqueness of the additional possible associations that can (and therefore must) be made in compliance with the well-formedness condition.

(4) The derivation thus begins, with the well-formedness condition in effect at all points.

Consider a derivation with a cliticizing preposition, as in Igbo. The sole preposition, toneless, na cliticizes to its object. If its object begins with a vowel, the vowel quality of na may assimilate to that of the initial vowel. In any event, na adopts the tone of the following word.

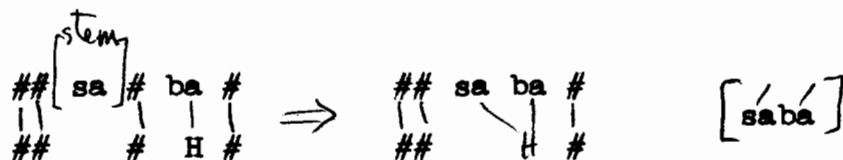
\acute{o} $\grave{n}\acute{o}$ $\acute{n}\acute{a}$ $\acute{u}\grave{l}\acute{o}$ 'he is in the house'
 \acute{o} $\grave{n}\acute{o}$ $\acute{n}\acute{a}$ $\acute{a}\grave{l}\acute{a}$ 'it is on the ground'

Consider the autosegmental derivation:

- (1) $\begin{array}{c} \#\#\ \text{na}\ \#\ \text{ulo}\ \#\# \\ \#\#\ \quad\quad \# \text{H L} \#\# \end{array}$ after the association rule
- (11) $\begin{array}{c} \#\#\ \text{NA}\ \text{ULO}\ \#\# \\ \#\#\ \quad\quad \text{H L} \#\# \end{array}$ cliticization
- (111) $\begin{array}{c} \#\#\ \text{na}\ \text{ulo}\ \#\# \\ \#\#\ \quad\quad \text{H L} \#\# \end{array}$ after unambiguous correction

Such a tonological derivation is an important type of counterexample to Hyman and Schuh's claim that "the spreading of tone takes place always to the right and apparently never (or almost never) to the left" (p.86) or again (89) "the major contention, then, is that tones spread to the right." Toneless proclitics should always, to the contrary, "pull" the tone leftward.

A parallel example is reported by Williams (1971), though I have not investigated the data from Margi further. Margi, in contrast to Igbo, has not only toneless suffixes but toneless verb-stems. However, as we would expect from the well-formedness conditions above, the tone of the suffix spreads leftward onto the verb stem.



This type of derivation demonstrates that the apparent leftward movement of the tone is not merely a fact about procliticization, but is rather a general structural fact about autosegmental tones.

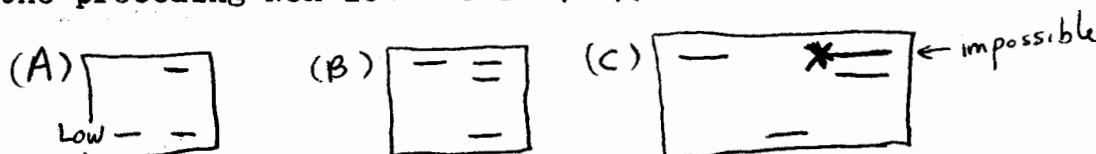
Downstep and Terrace Tone Languages

Igbo is a standard terrace-tone language. This means

(A) following (non-phrase final) low, two pitches are possible: a tone at the same pitch (i.e., a low tone) ~~and~~ a non-low tone;

(B) a non-low tone may be followed by three possible pitches: (1) the same pitch; (2) a slightly lower pitch; or (3) a low pitch.

(C) Crucial, too, is the fact that a tone following a [Non-low] [Low]ⁿ sequence will be in the same "downstep" relation to the preceding Non-low as in (B2). In short:



The problematic case is the High (V̌) followed by Downstepped High (V̌̌). It occurs (1) in a fairly small class of nouns (e.g., éǵó 'money', óǵó 'length', óǵí 'yam'); (2) its only uniform occurrence at the beginning of a word is with ǵányí 'us', in object position (recall that the combination V̌V̌̌ indicates level pitches, not rising); (3) the 'mutated' forms of three (and possibly four) of the four main classes of nouns contain downstep.

Tone Group I	I HH ≥ HM	I shall indicate downstepped high by M
	II LH > MH (i.e., level)	
Tone Group II	III HL > HM	(recall that there is only one non-low pitch that can follow low; H and M are neutralized there)
	IV LHL > LH or LM	

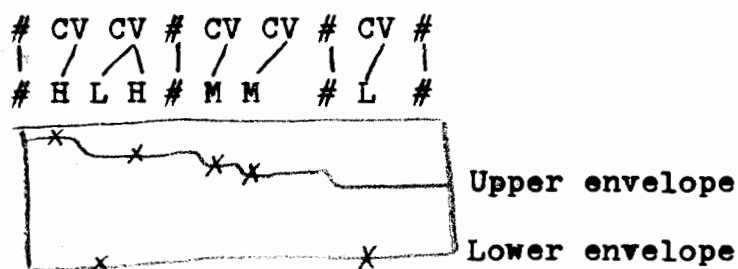
The changes in Tone Group I and II are two separate phenomena.

(4) Downstep occurs in other positions in indicating tense,

mood, and several other grammatical functions.

There are an indefinite number of pitch levels in Igbo, as in any terrace-tone language, since the M tones can in theory be strung out indefinitely one after another, and H tones can be separated repeatedly by Ls. However, we can describe the origin of the many surface pitches in terms of three underlying tones and a downstep/downdrift rule.

Consider a tone phrase such as the one below. Its tonemic representation contains the sequence HLHML. A late process transfers the information contained in this sequence to a formal, graphical representation as below. The graphical representation is made up of two envelopes, an upper and a lower, which represents the pitch registers within which the utterance is spoken. When H, M and L have the features as indicated on p.2, the feature ± Low determines which envelope that toneme is situated on.



A downstep, we observe phonetically, occurs with every M or H following a M or H and a sequence of Ls -- i.e. / [-Low] [+Low]₁ⁿ --. A downstep also occurs on a M following a M or H -- i.e., / [-Low] --. In short,

$$\left[\begin{array}{c} <-High> \\ -Lo \end{array} \right] \rightarrow ?? / [-Low] < [+Low]_1^n > -$$

↑
it
downsteps

I hasten to add that this is not the appropriate way to state the generalization, though modulo some notation changes, this is the standard formal description of downstep. Lurking behind this rule is the assumption that downstep "occurs" when we first hear the downstepped pitch. However, if we consider spoken pitches as resident on a pitch envelope, the effect of downstep is not to change the phonetic features on a segment, but rather to change the height of the upper pitch envelope. The condition for downstep then is simply $[-\text{Low}][-\text{High}]$ -- that is, a H or M followed by a M or L. M and H therefore merge phrase-initially and after a low.* Downstep, then, is a suprasegmental phenomenon in the strict sense. It is a lowering of the suprasegmental pitch envelope, conditioned by a sequence $[-\text{low}][-\text{High}]$.

I shall say little more about what processes occur after downstep. As Hyman and Schuh (1974) suggest, there is probably an assimilatory effect which pulls up the lower envelope when a low pitch is surrounded by two high pitches (cf. also Redden (1963) for similar facts in Twi). Ultimately the graphical representation becomes segmental and interacts with consonantal laryngeal features. I can say nothing about the details of this now.

*The standard orthography obscures this, since it is based on the incorrect assumption that M can only be defined immediately following a H.

Lexical representation of "tone melodies"

I shall be accepting, throughout this paper, the basic idea that has been developing for quite some time that tone contours or melodies are lexically associated with entire morphemes, and are composed of sequences of level tones. Contour tones are the result of two or more level tones associated with one syllabic segment.

This idea has been suggested for Etung (Edmundson and Bendor-Samuel, 1966) and Mende (Leben, 1972) on the basis of "possible contours" for lexical items, and for Tiv (Arnott, McCawley, Leben) for its verb "tenses". Leben's system is perhaps the best articulated general theory, and for this reason I shall argue against it in particular. On the point where it is most controversially different from the approach taken by all the other writers, I must disagree with Leben.

Leben ~~proposes~~^{ment} that prior to the assignation of tones to the syllabic segments, LL and HH sequences in the melody to be mapped are collapsed respectively to L and H units. I do not know why he holds this so strongly; it appears to make his system more complicated. I shall return to this in detail below.

The system described by Edmundson and Bendor-Samuel demonstrates that melodies may be of the form LLH and HHL. Under Leben's convention, these should be reduced first to LH and HL before mapping; after tone mapping, these melodies will be realized phonetically as LHH and HLL on 3-syllable words. But the fact is that both of these types of melodies do occur on 3-syllable

words.

Etung's system is shown to consist of three tonemes: L, H and a M which downsteps precisely like Igbo's. The M tone does not occur very often, a general fact about terrace-tone languages which deserves a diachronic rather than a synchronic explanation. Of the 27 possible combinations of three of these tonemes, only 12 are in fact found. This simplification in the task of describing possible tone contours is above and beyond the simplification achieved by recognizing contour tones to be the realization of dissimilar tones on the same "syllable". (Edmundson and Bender-Samuel make the now-characteristic observation that "in examining the occurrence of the rising and falling tones it is found that these usually occur on the final syllable of the phonological word. In addition these tones very rarely occur on three syllable words, but rather on words of one or two syllables. Thus, the rising and falling tones are generally found on the final syllables of one or two syllable words." They further suggest that the exceptions are for independent reasons to be morphologically analyzed with multiple tone melodies.)

Another case where two identical tonemes do not (contra Leben's suggestion) collapse is in the well-known Tiv conjugation system. Arnott gathered the information together systematically; McCawley tried to show that the use of subscripts (like L_0) in tone formulae was useful, and that underlying downstep tonemes were really L tonemes. Leben in turn devoted 30 pages of his thesis to fitting the data into his system. Insofar as our

systems differ, I shall try to show that the present account is more satisfactory.

We agree that preceding and following floating downstep tonemes are indeed L tonemes. As is indicated elsewhere, in the formal discussion of floating tonemes, only "interword" floating tones are permitted within the autosegmental system. Intra-word floating tonemes are explicitly forbidden (note that Leben has no system at all for handling floating tones, despite his claim to the contrary¹).

The General Past "tense" has the following tonal formula:

- (1) 1 syll 2 syll 3 syll
 L#B# L#BL# L#BLL#

where the word boundaries (#) surround the stem. Thus the L to the left is a floating (downstep) toneme. "B" stands for L or H depending on whether the verb is a L or H-toned verb underlyingly.

Leben suggests the correct general formula is L#BL# along with a rule (following my notation)

(2)
$$\begin{array}{c} V \\ \wedge \\ H \quad L \end{array} \Rightarrow \begin{array}{c} V \\ | \\ H \end{array} \quad \text{OR} \quad L \rightarrow \emptyset / \begin{array}{c} \wedge \\ H \quad - \end{array}$$

¹ Leben has a rule simplifying contour tones in Tiv to H, which is clearly post-mapping, a segmental rule; only a segmental rule can be conditioned by whether two tones are "on the same vowel". This must, by Leben, precede downstep. Thus downstep is a segmental rule. But Leben's floating tones trigger downstep; therefore the floating tones have undergone tone-mapping; but they are not mapped onto any segments. A flat paradox.

tri-syllabic form, and it is posited as the underlying form for the mono- and bi-syllabic forms, the simplification convention forces us to a different formula for the 3-syllable forms: #BH#L. This is "BH" as the stem contour, with a L-floating tone on the right end. This floating tone must later get affixed to the last syllable and (N.B.) displace the final H, not turn it into a falling tone. Incorporating the low-toned verbs in this formula is easy, now: Leben's ultimate solution is the following.

Imperative (Leben): 1,2 syll: #BHL#
 3 syll: ~~#BH#~~L + a rule "docking" the floating tone

If we abandon the simplification convention, but still retain rule 2, what solution can we find? The tri-syllabic forms clearly suggest that the correct formula is #BHL#, and with this the tri-syllabic forms work straight-forwardly.

Monosyllabic forms are underlyingly LHL and HHL, which simplify by rule 2 to LH and HH respectively. The former still needs to be simplified to a non-contour tone; for the moment I will accept the same device to do this as did Leben, but ultimately will find another solution (see discussion of Subjunctive, below). This settles the mono-syllable case.

Bi-syllabic L-tone verbs are no problem: BHL = LHL \rightarrow $\begin{smallmatrix} \backslash & \wedge \\ cv & cv \end{smallmatrix}$
 which becomes $\begin{smallmatrix} \backslash & / \\ cv & cv \end{smallmatrix}$ by rule 2.

The problematic case is H-toned bi-syllabic forms. BHL = HHL which must become $\begin{smallmatrix} / & \backslash \\ cv & cv \end{smallmatrix}$. Rule 2, as it stands, would simplify it to $\begin{smallmatrix} / & / \\ cv & cv \end{smallmatrix}$. The only solution I can see is to posit a special ad hoc rule (3) for this form. In its favor can be added that

$$(3) \quad H \begin{smallmatrix} \wedge \\ HL \end{smallmatrix} \rightarrow H L$$

it is a naturally-appearing absorption rule (compare Leben's rule for Mende: $[\alpha][\bar{\alpha}][\alpha] \rightarrow H[\alpha]$), and that it makes possible an explanation of the coherence of the six imperative forms, and avoids the surprising case of opacity that is generated by deriving the surface BHL of the 3-syllable forms from something other than the BHL formula of the 1 and 2-syllable forms.

The same issue arises in the Recent Past A form:

<u>1 syll</u>	<u>2 syll</u>	<u>3syll</u>
L#H#	L#BH#	L#BHL#

Leben's solution is L#BH#L -- that is, a left-end floating tone (that is not controversial), a base form BH, and a right-end floating tone L, which is "docked" in tri-syllabic forms. This can't be quite right, because there is no floating downstep on the right in the mono- and bi-syllabic cases, in point of fact. Leben's "corrected" solution, then, must be L#BH#(L)₃, where we use the parenthesis and subscript notation to indicate the floating tone appears only in the tri-syllabic form.

The revised solution I would offer is simply L#BHL#. This is the same formula as above for the imperative except for a left-end floating tone. Note that the single place where Leben's simplification did work -- in the bisyllabic H-form of the imperative -- is paralleled by a case where the simplification ~~main~~ convention makes the wrong prediction. That is, bi-syllabic H-verb forms are H-H here, rather than H-L. And in the 3-syllable forms here as in the imperative, abandoning the simplification convention leads to subsuming the three different forms under the same formula.

This form further lends support to an approach which claims the simplification of HL through rule 4 is exceptional rather than normal.

I shall not discuss the several tonal formulae that Leben and I treat the same (Continuous, General Past, Habitual 2, Habitual 3, Past Habitual).

The Habitual 1 has the following forms:

<u>1 syll</u>	<u>2 syll</u>	<u>3 syll</u>
L#H#	L#BH#	#BHL# (sic)

Again Leben's simplification convention makes it impossible to write BHL as the formula for the 3-syllable H-verbs, so he suggests they don't exist -- those that have been classified here are just Habitual 4 (see below). He cannot deny the LHL L-tone Habitual 1 3-syllable form, however. This form strongly suggests that the formula is BHL, as I will ultimately conclude, thus accounting for both H and L-toned verbs. Leben agrees that BHL is a leading candidate for the tonal formula, and this would account automatically for the L-toned bisyllabic forms. But once again his simplification convention blocks this possibility for H-toned bi-syllabics, because if B is H, BHL = HHL = HL, which is the wrong solution. So Leben posits two formulae:

1,2 syll:	L#BH#	
3 syll:	L#BH#L	+ the rule that "docks" right end floating tones in tri-syllabic forms.

The proposed revised solution is:

1,2 (L)#BHL# where the floating tone is marked as occurring in the 1 and 2 syllable forms. This cost is to be measured against Leben's denial of the form altogether. I could, of course, take that tack too and eliminate

the subscripts and parentheses.

In the Future form, we find:

<u>1 syll</u>	<u>2 syll</u>	<u>3syll</u>
L#B#	#BL#	#BLL#

Leben's solution is: 1 syll: L#BL#

2,3 syll: #BL#

These two collapse to become the formula: $_1(L)\#BL\#$, where the floating tone is present only in monosyllabic verbs.

So far we have seen that the right-end floating tones occur precisely when they must undergo his docking rule (Recent Past β , Subjunctive, Habitual 1, Recent Past A, Imperative); they, in effect, are a notational device to overcome the inability of his system to describe what's happening on the right end of a word tonally. His constraint that the docking rule operates on tri-syllabic words is the reflex of the fact that his theory is capable of handling mono- and bi-syllabic forms.

Consider below a summary of the forms, with Leben's formulae

and the proposed reanalysis. Notice that all the forms we agree about have the property that their tone formulae are collapsible using parenthesis notation. This is a striking property and explains the coherence of the verb forms in general. The 1,2 and 3 syllable forms are not as different as Leben's formalism requires them to seem.

	<u>Leben</u>		<u>Reanalysis</u>	
General Past	L#BL#	same	L#BL#	
Future	1,2(L)#BL#	same	1,2(L)#BL#	
Imperative	1,2:#BHL# 3:#BH#L	diff	#BHL# + Rule 4	
Habitual 1	1,2(L)#BH#(L)3	diff	1,2(L)#BHL#	
Habitual 2	L#BH#(L)1,2	same	L#BH#(L)1,2	
Habitual 3	L#BH#	same	L#BH#	
Habitual 4	#H+L#	same	#H+L#	
Past Habit	L#BH+L#	same	L#BH+L#	
Continuous	#HL#	same	#HL#	
Recent Past A	L#BH#(L)3	diff	L#BHL#	
Recent Past B	1,2: #HB#H 3: #H#L	diff	#HHL#	See text
Subjunctive	1,2: #HB#H 3: #H#L	diff	#HHL#	

We now come to the final bizarre forms which have caused the most trouble. The Recent Past B and the subjunctive have the same tonal forms:

	<u>1 syll</u>	<u>2 syll</u>	<u>3 syll</u>
L verbs	H	H [•] H	HHL
H verbs	H	H H	HHL

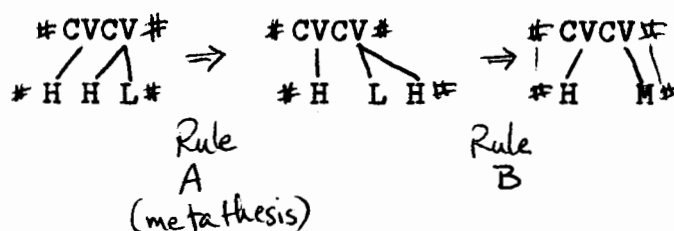
McCawley's solution was: 1-syll: H
 2-syll: H BH
 3-syll: H H L

Leben's solution was: 1,2-syll: #HB#H + plus a new docking rule
 for bi-syllabics after
 downstep (unformulated)
 3-syll: #H#L + the old docking rule

Notice that all of the formulas in the chart on the preceding page have B in them as the first tone in the stem formula if it occurs at all. This, I believe, is a real universal generalization to be pursued. I cannot support it strongly now, but Leben's solution unchallenged would be strong disconfirming evidence. A reanalysis which revises it is of more than just its intrinsic interest for that reason.

This form also seems to potentially hold trouble for the position that there are no floating tones in the middle of words -- that non-appearing floating tones can only occur inter-word, not intra-word. I believe, however, that the autosegmental approach not only can be supported, but is able to come up with the best analysis tendered so far, while also held to the tightest general theoretical constraints.

Note first that five of the six forms of the subjunctive are automatically accounted for with the formula HHL. (Note too that this is an illegal formula in Leben's system.) The only trouble-maker is the low-toned bisyllabic form, H-downstepped H. I would like to suggest that this is the result of metathesis on the final two tones of the second syllable:



Merger rule B:
$$\begin{array}{c} V \\ \swarrow \searrow \\ L \quad H \end{array} \Rightarrow \begin{array}{c} V \\ | \\ M \end{array}$$
 (Fed by Rule A, metathesis;
Precedes downstep, as do all
rules)

The "rising" contour tone then is merged to a Mid tone (or downstep), a general terrace-tone language principle. If we go back and look at the other occurrences of LH on a single syllable, we notice a very interesting fact. This can occur only in the monosyllabic forms of tenses with a B in the formula and followed by H (as noted above, B is always the first in the stem formula if it occurs). Further, a preceding downstep floating toneme occurs in exactly these cases (except Imperative: see below). The absence of the downstep floating toneme suggests once again that there is no B in the Subjunctive tone formula.

But the crucial point is this: that LH sequence on a single vowel always occurs after a L-toneme -- or in the Imperative. I must infer that the Imperative occurs without a subject and is thus preceded by a phrase boundary. In all cases, then, \widehat{LH} occurs in the position where M and H are neutralized in terrace-tone languages. Thus I conclude that \widehat{LH} does not simplify, as \widehat{HL} does, to H; rather, it simplifies, in Tiv as it does in Igbo, to M. (Leben suggests implicitly that the neutralization of both \widehat{HL} and \widehat{LH} to H is a natural fact in his system, though he doesn't explain why. I must explicitly admit that there is no way that these two rules could be collapsed in the autosegmental system.)

Impossible Tone Rules

We have seen how an autosegmental approach deals with tone representation, and in a few cases seen how it handles tone rules. The sense of the system may be made clearer with a few examples of tone rules which seem plausible on first sight and which probably are plausible in a phonological theory of tones, which nevertheless are ruled out as impossible in an autosegmental framework.

(A) Floating-tone epenthesis: "Insert an /i/ to support all floating high tones." Segmentally, this would be written:

$$(1) \emptyset \rightarrow i / \left[\begin{array}{c} \text{—} \end{array} \right]$$

Written in an autosegmental notation, the rule becomes:

$$(2) \emptyset \rightarrow i / \left[\begin{array}{c} \text{—} \\ | \\ \# \# \# \end{array} \right]$$

which is impossible because ill-defined. It does not say where to put the epenthetic vowel. All the information that a floating tone (or tones in general) can provide is where it is in relation to other tones and autosegmental word boundaries.

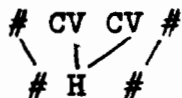
A more complicated rule could be written which specified where to put the epenthetic vowel. I would like to claim that a rule such as (3) is also impossible, on the grounds, less firmly established at this point, that no rule that does not change the tonological sequence or affect existing tone relations can be tonally conditioned.

$$(3) \quad \phi \rightarrow i / \begin{array}{c} V C_0' (\#) [_] \\ | \quad \quad | \\ L \quad (\#) \quad H \end{array}$$

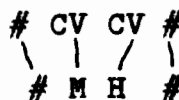
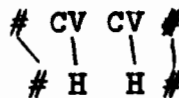
(B) Another rule that should be impossible is a general rule which changes final $\acute{V}C\acute{V}$ sequences to $\acute{V}C\acute{V}$ (i.e., M-H).

$$(4) \quad H \rightarrow M / _ _ H_0 H \#$$

This is impossible, in general, because this phonetic HH can derive from two systematic sources: a single H toneme on the final two syllables, or two tonemes. A single rule, such as (4), cannot apply univocally to both. (There is, of course, the logical possibility that a particular language would have all final HH sequences arising from one source or the other, but that, obviously, is irrelevant to the universal claim). Thus we can have a rule that changes the phonetic form of one but not both.



(4) Cannot apply



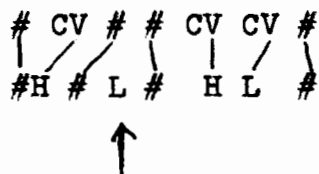
(4) applies

Floating Tones

The twilight existence of floating tones has been banished -- they exist freely on the autosegmental level. Two properties have been imputed to floating tones in the past however: (1) They move from association with one morpheme to another (see the discussion of Igbo verb forms below, for example); (2) "floating" Low tones have also been postulated to account for the conditioning of the downstep of a high after no overt L. This second distinct "property" of floating tones is that they may condition rules and yet not show up on the surface themselves.

This second property of "elusiveness" would be ruled out automatically by the autosegmental theory. Just as one cannot posit a phonological segment which does not appear on the surface without also positing a rule which deletes it, so we cannot have a toneme that is marked not to appear: there is no +Doom feature, so to speak.

The only exception to this principle is a natural one -- a toneme structurally unable to attach itself to a syllabic segment due to the well-formedness conditions must necessarily not be realized phonetically, as in some of the Tiv cases above, e.g.:



Igbo Noun Mutation

The process of noun mutation in Igbo is of interest both for itself and because it yields information about other tone functions in Igbo.

Almost all nouns are bisyllabic, and may be broken up into Tone Group I (High tone) and Tone Group II (Low tone).

Tone Group I: HH
 HH

Tone Group II: HL
 LL

Under certain conditions the Tone Group I nouns mutate to

HH > HM
LH > MH

Under certain quite different conditions, Tone Group II

mutates:(raises): HL > HM
 LL > LM or LH (these are indistinguish-
 able)

The Tone Group II mutation is the result of cliticization of a floating H tone on the right side of the noun. In fact, we apparently find an alternation of H-Rising with HM.

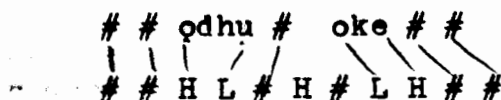
$\begin{array}{l} \text{Igbo} \\ \text{Igbo} \end{array} \left\{ \begin{array}{l} \text{riri} \text{ ji rie ede} \\ \text{riri} \text{ ji rie ede} \end{array} \right.$
'The Igbo people who eat yam and coco yam'

There are two rules: "docking" and LH > M merger. For example:

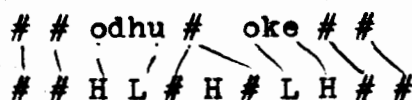
First step of derivation, after word boundary association, but before deletion of superfluous boundaries (this is a genitive noun compound, indicated by the floating H tone inside (cf. Williams):

$\begin{array}{ccccccc} \# & \# & \text{odhu} & \# & \# & \text{oke} & \# & \# \\ | & | & | & | & | & | & | & | \\ \# & \# & \text{H} & \text{L} & \# & \text{H} & \# & \text{L} & \text{H} & \# & \# \end{array}$

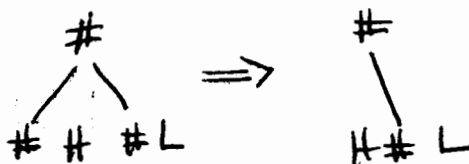
Extraneous #-deletion (note that the phonological sequence provides the conditions for deletion; the tonological does not)



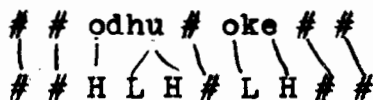
There is only one possible reassociation that will satisfy the well-formedness condition:



The rule of docking is:



which, when applied to the form above, yields



after reassociation by the well-formedness condition.

This then feeds the merger rule (which may in some conditions be optional) $\overline{H} H > M$.

Note that the docking rule for floating tones is another example of tones moving "leftward", not rightward, but one which is not at all obvious on the surface.

Subject Cliticization in Igbo

Igbo has four "inseparable" pronouns: singular first, second, third, and an impersonal. These are the only forms that participate in vowel harmony:

	Separable	Singular	Inseparable	
1 st	mu		m	
2 nd	gi		1/1	
3 rd	ya		o/o	impersonal a/e
		Plural		
1 st	anyi			
2 nd	unu			
3 rd	ha			

Consider the common I Form Main Affirmative, (a verbal "tense".

Inseparable pronouns take H tone.

- (1) ó vù ábò 'he is carrying a basket'
- (2) á dī m mma 'I am well' lit., "it is me beautiful"
- (3) m cì anù 'I am carrying meat'

Full NP subjects, however, retain their isolation tone patterns with one change: if their final syllable is H, it becomes HL (falling). Thus:

- (4) Adhá (people's names) eze
Ekwe uwa isolation tones
- (5) Adhá
Ekwe
Eze
Uwa } cì akwa ' --- is carrying eggs'
- (6) [Ndí nọ n'ahya] huru ugbo elu. 'The people who were in
N^o the market saw an airplane.'
'people...market' /ahya/

Plural subject pronouns obey the same principle, as we can see from the third person, which is H:

(7) $\tilde{H}\hat{a}$ oi anu 'they are carrying meat'

The explanation for this, I would suggest, is a floating L tone on the left of the verb in the form, clearly indicated by examples in (5) and (6). The singular subject pronouns escape its tonal effect by encliticizing, which consists of movement of the subject pronoun with its tone inside the verb's word boundary.

(8) $\begin{array}{c} \# \text{ o } \# \\ \# \text{ H } \# \end{array} \left[\begin{array}{c} \# \text{ vu } \# \\ \# \text{ L } \# \end{array} \right] \Rightarrow \begin{array}{c} \# \# \\ \# \text{ o } \text{ vu } \# \\ \# \text{ L } \# \text{ H } \text{ L } \# \end{array}$

(9) $\begin{array}{c} \# \text{ Adha } \# \\ \# \text{ L H } \# \end{array} \begin{array}{c} \# \text{ oi } \# \\ \# \text{ L } \# \end{array}$

"docking" rule: tonal cliticization, in effect

$\begin{array}{c} \# \text{ Adha } \# \\ \# \text{ LH L } \# \end{array} \begin{array}{c} \# \text{ oi } \# \\ \# \text{ L } \# \end{array}$

I have saved the most extraordinary derivation for last.

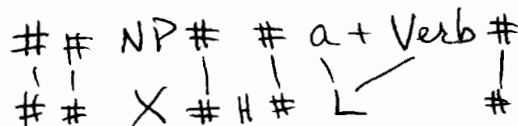
My source for most of the Igbo data is the outstanding grammar of Green and Igwe. They classify two separate forms, the II Form Relative B Affirmative and the II Form Subordinate Conditional with very similar properties, yet which differ by a slight twist. A generative autosegmental analysis of these two forms is most revealing.

Both consist of a L verb stem with a L-toned prefix /à/. Non-cliticizing pronoun subjects are H, and Tone Group II subjects undergo mutation (raising). This is triggered by a floating H tone to the left of the verb form, as first hypothesized by Williams. Neither form triggers Tone Group II mutation in the object (a distinctive characteristic).

Examples:

- (10) anyí egbuo éghu 'lest we kill the goat'
 éghu anyí egbuo 'the goat we killed'
- (11) úze ataa yá 'lest the squirrel eat them'
 /úze/ jí úze ataa 'yams the squirrel ate'

In short, (12)



The relative form, like all relatives with an /à/ prefix, can optionally (preferably) take a /ná/ prefix. In fact, under our analysis, the /na/ is the phonological counterpart of the floating H tone. With the /na/ present, the form looks like this:

- (13)
- | | | | | | | | | |
|----|----|----|----|---|---|---|------|---|
| ## | NP | ## | Na | # | a | × | Verb | # |
| ## | X | ## | H | # | L | | | # |

Immediate consequences of this follow: in particular, the cliticization rule for the subject, cannot apply, thus predicting that the singular pronoun subjects will retain the H tone that the other pronouns have, and that the /a/ will not delete, as it normally does when preceded by cliticized subjects. These predictions are correct.

Furthermore, the tone encliticization rule -- what I've called "docking" -- no longer finds its structural description met. This predicts that Tone Group II subjects will not mutate in front of /na/. This is correct. E.g.:

- (14)
- | | | | | | | |
|------|---|------|---|-------|------|-----------------------------|
| Ahya | { | oso | } | naala | eci. | 'the market the pepper |
| | | *oso | | | | should have left yesterday' |
| | | | | | | |
| | | | | | | |
- 'market' 'pepper'

These two forms -- the relative and the conditional -- differ in another way besides the na, which is functionally

their inherent ~~alone~~ in these forms (just as in most forms). This can be seen by checking the plural bisyllabic pronouns. When 'unu' and 'anyi' are level tone, that indicates that the tone has been imposed by the verb form they appear in. In the I form Main Affirmative, on the other hand, 'anyi' and 'unu' are both H L.

When the subject pronouns cliticize, then, the the II Form Conditional and Relative B, they absorb (or participate in) the tone of the verb stem, through the graces of the well-formedness convention. This would put a L tone on them, in both cases.

Derived form after cliticization:

(15)

o + a + verb

H # L

In order to solve the mystery that still faces us -- which, it will be recalled, is how does the cliticized subject pronoun in the conditional get a Falling contour but the relative a L tone -- in order to solve this, we must become syntacticians. momentarily. A search through the examples of these two forms leads to the conclusion that the only difference between them is that the conditional always appears with a phrase boundary before it, while the relative never does. The relative, indeed, can be used in a "conditional" sense.

What is happening is now clear. When the floating tone has a heavy boundary on its left -- 勢, presumably -- it encliticizes rightward, causing a HL, or Falling tone.

Examples: Relative used as "conditional"

ihye o zuo 'whatever he buys'
mgbe m zula anu 'whenever I buy meat'

One more question must be asked. The claim has been made that these "two separate" forms are in fact the same form, and the only difference (the subject tone in clitics) is a derived property due to the presence of a phrase boundary which reflects the floating tone rightward. We have also seen the floating tone attach to non-cliticized subjects. What happens when a subject pronoun cliticizes, thus hopping over the floating H, in the case when there isn't a phrase boundary to the left of the floating tone? Can such a case occur?

Such cases do occur, when this clause is the complement of the "conjunctions" nà , kà , mà and khámà . As we would expect -- the floating H encliticizes onto these conjunctions, thus forming a LH contour which is then simplified to M, deriving nà , kà , mà and khámà .

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