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In Aspects of the Theory of Syntax, Chomsky argued that the "critical factor in the development of a fully adequate theory [of language] is the limitation of the class of possible grammars." (p. 61) "For the construction of a reasonable acquisition model, it is necessary to reduce the class of attainable grammars compatible with given primary linguistic data to the point where selection among them can be made by a formal evaluation measure [the Simplicity Metric]." (p. 35) In this paper, I will apply Chomsky's criterion to just one part of the theory of language -- the theory of tone.[1] In the first part of the paper, I will argue that the Autosegmental Theory of tone as developed by Goldsmith (1979), Leben (1979), Williams (1976), Haraguchi (1977), Clements and Ford (1979) and others fails to meet Chomsky's criterion for a fully adequate theory because it allows multiple alternative analyses which cannot be distinguished from one another by means of the Evaluation Metric. I will then show that the Dynamic-tone Theory which I proposed in Clark (1978) is much more restrictive in its descriptive power; thus by Chomsky's criterion it is a more explanatory theory than the Autosegmental Theory. In the final section of the paper, I will discuss the nature of tone rules in a Dynamic-tone Theory, pointing out some ways in which these rules can and should be further constrained.

Both the theories which I will discuss here represent tone suprasegmentally, by means of tonal units which are independent of the phonological segments. The fundamental difference between the two theories is in the nature of the tonal units which they assume. In the Autosegmental Theory, these units represent tone levels such as "high", "mid", and "low". The tone segments are arranged in an ordered string which is mapped onto the phonological string by means of association lines which link each tone segment with one or more tone-bearing units. For example, in Igbo, where the basic tone-bearing unit is the syllable, a word like ọkụkọ 'chicken' is represented as shown in (1), with the first tone segment, L(ow), attached to the first syllable of the word, the second tone segment, H(igh), attached to the second syllable, and the third tone segment, L(ow) again, attached to the third syllable:[2]

(1)

o	ku	ko
σ	σ	σ
L	H	L

Besides the tone segments and the association lines, there is another notational device, the feature "star", which enters into the representation of lexical tone contours in "pitch-accent" languages such as Japanese. The star, which is a feature on tone-bearing units, plays its primary role in the positioning of the lexical tone melody with respect to the phonological string. For example, in Tokyo Japanese, which has the lexical tone melody HL (see Haraguchi (1975)), this melody is mapped onto individual words by means of a rule which associates the high tone with the last syllable which is not preceded by a starred syllable (where the starred syllable is the syllable traditionally known as the "accented" syllable.) The application of the tone-association rule to three-syllable words is illustrated in (2):

```
           *                              *
(2) a.   ?inoti    'life'       b.   kokoro    'heart'
          |                               |
          H L                             H L

               *
    c.   ?atama    'head'       d.   miyako    'city'
              /                          /
             H L                        H L
```

Once the rightmost association of the high tone has been established by the tone-association rule, the tone melody is distributed over the remainder of the word in accordance with universal tone-mapping conventions which insure (among other things) that every tone segment is associated with at least one tone-bearing unit, and vice-versa. The exact statement of the conventions is somewhat controversial, and I will not go into them here, but will simply assume that there is some statement which will produce the desired output, which in this case is the completed tone-mapping shown in (3):

```
           *                 *                 *
(3) a.   ?inoti     b.   kokoro     c.   ?atama      d.   miyako
          H L                 H L               H L               H L
```

The tone-association process does not complete the derivation; there are additional rules which adjust the lexical tone contour in response to internal properties of the word or its external environment. For example (still following Haraguchi (1975)), there is a rule which deletes the L of a HL contour on an unstarred syllable. This rule applies to (3d) above, as shown below:

```
(4)  miyako    ==>    miyako
        H L               H
```

A HL contour on a short <u>starred</u> syllable (as in (3c)) also simplifies to H, but not in all contexts. Thus the feature "star" plays a role not just in the association of the lexical tone melody, but also in determining the applicability of subsequent contour-simplification rules.

A word which lies at the beginning of a phrase in Tokyo Japanese is subject to an additional rule, Initial Lowering, which introduces a low tone at the beginning of the word, as shown in (5):

(5) $_{\text{PHRASE}}[$ kok*oro (H L) $\Longrightarrow$ $_{\text{PHRASE}}[$ kok*oro[3] (L H L)

Words like ?*inoti (2a), in which the H-tone is associated with the first syllable only, are exceptions to this rule. Probably the best account of this exception is that proposed by Ostler (1978), who allows the low tone to be introduced in the usual way, but deletes it in this case by a contour-simplification rule which may be stated as shown in (6a). The effect of the rule is shown in (6b).

(6) a.

$L \rightarrow \emptyset \;/\; \underline{\;\;}\,\sigma\, H$

b. ?*inoti (H L) $\xRightarrow{\text{Initial Lowering}}$?*inoti (L H L) $\xRightarrow{\text{rule (6a)}}$?*inoti (H L)

Having used this informal analysis of part of the tonal system of Japanese to review the major features of the Autosegmental Theory, we are now ready to consider whether this theory comes at all close to meeting Chomsky's criterion that the set of descriptions of primary data should be so limited that selection among them can be made by means of the Evaluation Metric. The answer is that it does not. What causes the trouble is the fact that the theory provides so many levels of tonal structure: the feature "star", the tone segments, and the association lines. If all these structural levels can be affected by rule, then all the following sorts of rules are possible: (i) rules inserting, deleting, or changing the feature composition of tone segments, (ii) rules inserting, deleting, or moving a star, and (iii) rules adding or erasing association lines.[4]

With such a variety of rule-types to choose from, we fail to obtain a unique "best" analysis, or even to narrow the choice very much, in a great many cases. To see that this is so, consider a hypothetical dialect of Japanese with the tone-association and contour-simplification rules which were motivated above for Tokyo Japanese. Now suppose that in this dialect, penultimately-starred words (i.e., words of the form [...CV*CV]) have high tone throughout in some environment rather than the ...CV\CV contour which we would expect by the normal derivation.[5] There are at least seven accounts of this exceptional case within the autosegmental framework which we have set up:

(7) a. There may be a rule which deletes a penultimate star in this environment, giving us the derivation

```
    *
...CVCV  ⟹  ...CVCV  ⟹  ...CVCV  ⟹  ...CVCV
                           H L          H
```

b. There may be an association rule which associates the H-tone with the next syllable after tone-mapping is completed. The rule of HL-simplification (4) then deletes the L-tone:

```
           *            *           *
L-tone:  ...CVCV  ⟹  ...CVCV  ⟹.....CVCV
            H L          H L          H
```

c. There may be an association rule which associates the L-tone with the penultimate syllable after tone-mapping is completed. The rule of HL-simplification (4) then completes the derivation:

```
            *          *           *          *
vation:  ...CVCV  ⟹  ...CVCV  ⟹  ...CVCV  ⟹  ...CVCV
            H L        H L          H            H
```

d. There may be a deletion rule which deletes a final L-tone in this environment. The universal tone-mapping conventions complete the derivation by associating the H-tone with the now toneless final syllable:

```
                                  *          *          *
the now toneless final syllable: ...CVCV ⟹ ...CVCV ⟹...CVCV
                                    H L        H          H
```

e. There may be a rule of the form L → H which applies in this environment, so that

```
                   *          *
environment, so that ...CVCV ⟹ ...CVCV
                    H L        H H
```

f. There may be a rule of the form ∅ → H which inserts a H-tone between the H and L of the tone melody in this environment, attaching it to the righthand syllable. The rule of HL-simplification (4) then deletes the L, so that

```
  *          *             *
...CVCV  ⟹  ...CVCV  ⟹  ...CVCV
   H L        H H L        H H
```

g. There may be a rule of the form ∅ → H which inserts a H-tone at the end of the word in this environment. The H-tone associates with the final syllable, creating a LH-contour which is simplified to H by rule (6a):

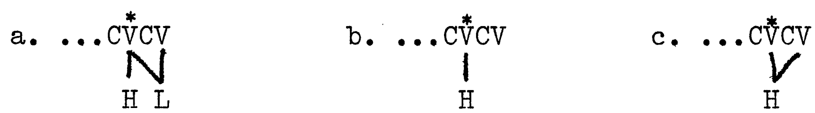
```
  *          *             *
...CVCV  ⟹  ...CVCV  ⟹  ...CVCV
   H L        H L H        H H
```

Notice that it is not possible to decide among these competing analyses by means of the Simplicity Metric, for there is no way to know which is "simpler" -- a star-deletion rule, as in (a), a re-association rule as in (b) or (c), a tone-deletion rule as in (d), a tone-insertion rule as in (f) or (g), or a rule which changes an L into an H as in (e). Clearly the theory so far does not limit the class of attainable grammars in the way Chomsky envisioned.

Let us now consider whether the descriptive power of the Autosegmental Theory can be reduced in some plausible way by means of constraints which either eliminate some rule-types altogether or else limit their use to particular (identifiable) sorts of tonal phenomena.

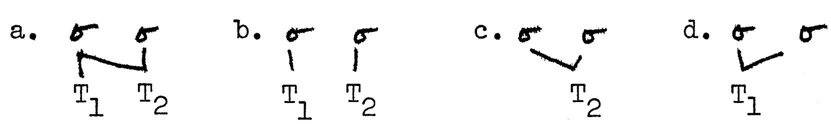
One of the least attractive derivations of (7) is that of (7c), which uses the HL-simplification rule (4) to convert the intermediate form (8a) to (8b). The universal tone-mapping conventions then convert (8b) to (8c):

(8)



We could eliminate this derivation by limiting the class of contour-simplification rules in such a way as to prevent them from deleting a tone-segment which is associated with more than one tone-bearing unit. In other words, we could require that a string of the form (9a) be simplified to (9b) or (9c), never to (9d):

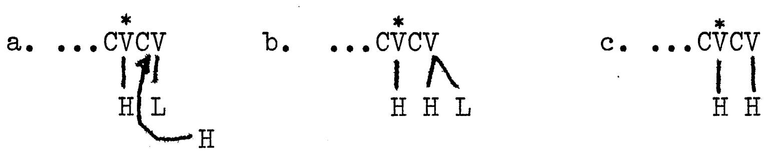
(9)



Such a constraint would block derivation (7c), reducing the number of competing analyses for our hypothetical Japanese dialect to six.

It may also be possible to eliminate derivation (6f), which inserts an H between the two segments of the tone melody, as shown in (10a). The resulting (10b) is then simplified to (10c) by means of the HL-simplification rule (4):

(10)



This derivation could be ruled out by a constraint which Ostler (1978) proposed in his paper "Autosegmental Theory and Japanese Tone Spread." Ostler's constraint limits tone-insertion to word-boundaries; no rule may insert a tone segment into the middle of a tone melody, as in (10a). If Ostler's constraint can be maintained (and I know of no counter-examples to it) then derivation (6f) is impossible, and we are down to five alternative analyses.

Unfortunately, I do not know of any way to pare the list down further. Ostler (1978) proposed other changes in Autosegmental theory, but they do not reduce its descriptive power. For example, consider Ostler's proposal (p. 149) that rules of tone-deletion should be replaced by rules of tone dissociation. An argument for allowing such rules was given by Leben (1978) in a paper delivered to the Linguistic Society of America Convention. Leben showed that by using a dissociation rule, we obtain an elegant analysis of the "downstep" phenomenon whereby a string of the form (11a) is converted to (11b) in many African languages:

(11) a. $\begin{array}{ccc} CV & CV & CV \\ | & | & | \\ H_1 & L & H_2 \end{array}$ b. $\begin{array}{ccc} CV & CV & CV \\ | & \backslash & / \\ H & & {}^{\prime}H_2 \end{array}$

The symbol "'" in (11b) indicates a lowering of the high pitch register; in other words, the pitch level of H_2 is lower than that of H_1.

Leben's proposal is this: Suppose that the rule which converts the underlying string (11a) to (11b) does not delete the low tone, but simply dissociates it, as shown in (12), where the "°" under the "L" indicates that it has become a non-associable (or "floating") tone:

(12) $\begin{array}{ccc} CV & CV & CV \\ | & \backslash & / \\ H_1 & \underset{\circ}{L} & H_2 \end{array}$ [6]

The $\underset{\circ}{L}$-tone can now be used to account for the lowering of the high tone register between H_1 and H_2, for languages which undergo this process are commonly also subject to a "downdrift" rule which lowers the high tone register whenever H follows L. If the $\underset{\circ}{L}$-tone is allowed to remain in the surface form and to exert the usual effect of a low tone on the high pitch register, then the relatively low pitch of H_2 follows automatically. Since the downdrift rule is usually assumed to be one of the last rules of the phonological component, its use in accounting for the lowering of H_2 depends on the fact that the L-tone has simply been dissociated rather than deleted altogether.

Despite the attractiveness of Leben's analysis, it is clear that the substitution of dissociation rules for deletion rules does not help to reduce the descriptive power of the theory; for example, it does not reduce the number of competing analyses in (7). Instead, it is likely that the addition of this new sort of rule will increase the descriptive power of the theory, for there are some tone-deletion rules which cannot be replaced by dissociation rules. For example, consider the following facts from Igbo:

A cardinal numeral in Igbo loses its initial low tone when the

N'-phrase which it modifies ends on a high tone level, as in

(13) oce atọ ⟹ oce ato 'three chairs'

H H L H   H H 'H (lit., 'chairs three')

Since the loss of the low tone in this environment produces a downstep, we may want to analyze it along the lines suggested by Leben, dissociating the low tone rather than deleting it, so that the surface form of (13) is really

(14) oce ato

H H L H

This analysis assumes that the independently-motivated downdrift rule of Igbo lowers the high pitch register after any low tone, even one which is not associated with a tone-bearing unit.

But there are other instances of low-tone deletion in Igbo which cannot be analyzed in the same way. For example, consider the rapid-speech rule pointed out by Welmers (1973), which converts (15a) below to (15b):

(15) a. ogaghi Aba   b. ogaghi Aba 'He didn't go to Aba.'

L H 'H L H   L H 'H H

This rule, which deletes a word-initial low tone after a high tone in rapid speech, must be a real deletion rule, for if the low tone of <u>Aba</u> were simply dissociated it would, by the assumption we made above, make its presence felt in the form of a downstep. Thus there must be both tone-dissociation <u>and</u> tone-deletion rules.

This, of course, adds to the descriptive power of the theory. In particular, if we assume (as we would probably want to do) that a floating low tone in Japanese does not create a downstep, then there is another possible analysis of our hypothetical Japanese dialect of (7), for along with derivation (7d), which deletes a low tone segment in the given environment, we must allow for a dissociation analysis in which the low tone segment is simply converted to a floating tone. But the addition of the class of tone-dissociation rules contributes even further to the indeterminacy of the analysis, for now there are two possible ways of stating the contour-simplification rules which participate in most of the derivations of (7). Here we see how indeterminacy at one point in the analysis multiplies itself throughout the grammar.

Having shown that the Autosegmental Theory in its present form has far too much descriptive power, I now turn to a second theory of tone, the Dynamic-tone Theory which I proposed in Clark (1978). What makes this theory fundamentally different from the Autosegmental Theory is the fact that the basic tonal units (called "pitch-change markers" or "pcm's") represent pitch changes (rise or fall) rather than pitch levels (such as high, mid, low). The pcm's are interspersed with the basic tone-bearing units of the language. For example, in this system, the Japanese word ko↑ko↓ro 'heart' is represented as shown in (16), with a ↓ (representing a drop in pitch) at the first and third syllable boundaries, and a ↑ (representing a rise in pitch) at the second:

(16) ↓ σ ↑ σ ↓ σ 'heart' (↓ko↑ko↓ro)
ko ko ro

The parenthesized representation on the right is a more graphic, abbreviated notation which I will use when the prosodic structure is irrelevant or can be assumed. The dotted lines have no theoretical status, but are there simply to make the contour more readable.

Now consider how we are to express the regularities of Japanese lexical tone in a system of this sort. We can begin by comparing the (abbreviated) representations of the four three-syllable words which were discussed above in (2)-(5):

(17) a. ↑?i↓noti b. ↓ko↑ko↓ro c. ↓?a↑tamà↓

d. ↓mi↑yako

A special realization convention will be needed to account for the fact that a ↓ at the end of a word (as in (c)) is realized as a falling glide on the final syllable rather than (in the usual way) as a sharp drop in pitch at the syllable boundary. For some speakers, a word-final ↓ is deleted at the end of a phrase, so that in this position the accented word ↓?a↑tamà↓ has the same tone contour as the unaccented word ↓mi↑yako .

A quick glance through the forms of (17) (which illustrate all the possible lexical tone contours for three-syllable words) reveals certain generalizations about lexical tone in Tokyo Japanese. First, a word may or may not have an "accent", which in this system is represented directly as a ↓ , with no recourse to a diacritic feature such as the Autosegmental "star". Every word contains one ↑ , which comes after the first syllable unless, as in (a), that position is already occupied by the "accent" ↓ . Finally, every word has an initial pcm which indicates the pitch level on which the word begins, and which points in the opposite direction from the first internal pcm of the word. These generalizations can be stated formally by means of a lexical structure template such as the following:

(18) A word of Tokyo Japanese takes the form [7]

$$[\ \underset{1}{\text{pcm}}\ \underset{2}{\sigma}\ (\underset{3}{\uparrow}\ \underset{4}{\sigma}\ \underset{5}{\ldots})\ (\underset{6}{\downarrow}\underset{7}{\ldots})\ ]$$

(i) 5 and 7 contain no pcm's
(ii) 1 is not the last pcm of the word
(iii) Successive pcm's within the word point in opposite directions.

Notice that since this system makes no use of the feature "star" or of association lines, the total amount of tonal apparatus is very much less than in the Autosegmental Theory. The result is that from the very beginning we are severely limited in the sorts of tone rules we can posit, for only the following sorts of rules are expressible:

(19) a. rules changing the internal feature composition of pcm's
b. rules deleting pcm's
c. rules inserting pcm's
d. rules changing the position of pcm's within the prosodic structure

These inherent limitations in the system severely restrict its descriptive power, as can be seen from a re-examination of our hypothetical dialect of Japanese. Recall that what we wanted to account for was a case in which nouns which should have the tone contour $\overline{\ldots CV}\backslash\underline{CV}$ were in fact pronounced $\overline{\ldots CVCV}$ in a certain environment. Looking at the data in dynamic-tone terms, we see that what is needed is a rule which will convert the underlying form (20a) to the surface form (20b):

(20) a. $\uparrow\overline{\ldots CV}\downarrow\underline{CV}$ b. $\uparrow\overline{\ldots CVCV}$

Clearly what is needed is a rule which deletes a $\downarrow$ before the final syllable of the word. Other analyses are possible, but they would require the introduction of two or more rules, and would thus be less highly valued by the Simplicity Metric. Thus

in this case the theory does indeed meet Chomsky's criterion that the number of statable analyses of given data should be so limited that the correct analysis can be chosen by means of the Simplicity Metric.

Obviously, one hypothetical set of data does not provide an adequate test for a theory. Even so, this result is important, for if we accept the argument that linguistic theory must be sufficiently restrictive to account for language acquisition, then a theory with the excessive descriptive power of the Autosegmental Theory must be wrong; the Dynamic-tone Theory is thus the only currently-held suprasegmental theory of tone which could be right.

In the remainder of this paper, I will describe some further constraints which I believe should be imposed on tone rules in a dynamic-tone system. I will conclude by describing some data from Igbo whose analysis is ambiguous even in this framework, suggesting that even the Dynamic-tone Theory still has too much descriptive power.

Consider first the class of rules which make changes in the internal feature composition of pcm's. I believe such rules can affect only those features which determine the relative size of a pitch change, and not those which determine its direction. In other words, it is possible for a rule to convert a large ↓ to a small ↓ , or vice-versa, but no rule can change a ↓ to a ↑ or a ↑ to a ↓ . As an example of the former sort of change, consider the rule of Igbo which reduces the size of a pitch drop when the next succeeding pitch change is also a drop. The effect of this rule can be seen in (21), where the ↓ of the negative prefix a↓ is reduced in size before the verb stem tụ↓bha↑ 'throw in':

(21) a tụ↓bhaɣị↑ ya↓[8] 'not to throw in'

However, this same ↓ is realized as a "large" ↓ in (22), where the pcm which most immediately follows it is a ↑ :

(22) a↓zaɣị↑ ya↓ 'not to sweep it'

These examples show that the relative size of a pitch change can be adjusted by rule. However, since I know of no case in which one would want to postulate a rule which reverses the direction of a pcm, it seems plausible to suggest that those features which distinguish a ↓ from a ↑ are immune to alteration by rule.

The primary restrictions on rules which delete pcm's concern the environments in which such rules apply. One common environment for deletion is the position at the end of a phrase. We have already seen an example of this sort in the rule of Tokyo Japanese which deletes a word-final ↓ at the end of a phrase, so that in this environment a final-accented word like ?atama has the same tone contour as an unaccented word like miyako.

Another common environment for deletion is the immediate vicinity of another pcm, as in the following example from Igbo, where the insertion of a possessive marker consisting of a ↓ causes the deletion of the pcm which would normally come after the prefix vowel of the possessive noun:

(23) a. isi ↓ Ogu ↑ 'Ogu's head' (cf. O↓gu↑)

b. isi ↓ Adha↓ 'Adha's head' (cf. A↑dha↓)

A third common sort of deletion rule is exemplified by the rule which deletes the ↓ of the copula de↓su in Japanese when the preceding noun has a ↓ as its last pcm. For example, this rule applies in (24a) below, but not in (24b):

(24) a. ↓ko↑ko↓ro + de↓su ⇒[9] ↓ko↑ko↓ro desu 'It's a heart.'

b. ↓mi↑yako + de↓su ⇒ ↓mi↑yako de↓su 'It's a city.'

Rules of this sort, which delete all but the first (or last) of a sequence of identical pcm's, are very common in tone languages; for example, there are similar rules in Mende (see Clark (1977)) and in Igbo.[10] The Igbo rule affects sequences of ↑'s only, and works in the opposite direction from that of Japanese and Mende; that is, it deletes all but the last rather than all but the first of a sequence of identical pitch changes. The application of the Igbo rule is illustrated below in (25):

(25)

o↑khe↓ A↑dha↓ huru↑	underlying form
∅	by a rule which deletes a ↓ at the end of a NP in Comp
∅	by the rule which deletes all but the last of a sequence of ↑'s
okhe A↑dha↓ huru↑	Output: 'the rat (which) Adha saw'

Deletion of pcm's may occur in other environments besides the three I have described here, but these are by far the most frequent environments for deletion.

Rules which move pcm's from one position to another are very common; they take the place of what, in level-tone theories, are called "tone-spreading" rules. We have already seen an historical rule of this type in Tokyo Japanese, where the ↑ which follows the first syllable of a word like ↓mi↑yako 'city' is presumably a formerly word-initial pcm which shifted to the right. (See Clark (1979) for a more detailed discussion of this historical change.) In some dialects the rightward shift of the word-initial pcm (with introduction of a new opposite-direction pcm at the beginning of the word) has apparently occurred more than once, producing a complex up-and-down lexical tone pattern, as in the following example from the Nakamura dialect:

(26) ↑ka↓ra↑ka↓sa 'umbrella'

There are also synchronic movement rules. For example, in Kikuyu certain lexical items are marked with a drop in pitch, called the "downstep", which normally appears at the end of the word, as in the phrase

(27) moa ɣa hi ɲa ↓ + ne moɛ ɣa ⇒ moa ɣa hi ɲa ne moɛ ɣa [11]
'the weakling' 'is good'

However, when the word which follows the "downstep" site has a tone contour of the form , the downstep ↓ shifts to the right, replacing the ↑ , so that

(28) moa ɣa hi ɲa ↓ + na moɣɛra nia ⇒

moa ɣa hi ɲa na moɣɛra nia 'weakling and examiner'

Space prevents me from motivating a careful statement of the rule which creates this change; a fairly complete analysis is given in Clark (forthcoming). I give this example here as an illustration of a synchronic rule of pcm-movement and to show that it is possible for a rule to move a pcm indefinitely far to the right. Such movement is limited, however, by a restriction that one pcm cannot be moved <u>over</u> another.

The last of the rule-types which are statable within a dynamic-tone framework is that of pcm-insertion. We have already seen an historical rule of this type, namely the rule which inserted the ↓ at the beginning of words like ↓mi↑yako 'city' in Tokyo Japanese when the ↑ which formerly occupied word-initial position shifted to the right. One would like to confine tone-insertion to cases of this sort, by incorporating Ostler's constraint which prohibits tone-insertion except at the boundaries of words and by requiring that the inserted pcm must point in the opposite direction from the next pcm of the word, as it does in this case. However, there are problems in imposing such a constraint. For example, consider the following data from Igbo:

As was first pointed out by Williams (1976), most verb suffixes in Igbo are toneless and must be given tone by rule. For one large set of verb forms, the rule goes something like this: The string of toneless suffixes at the end of the verb has low tone just in case the last toned morpheme of the verb is low-toned. For example, the toneless suffixes <u>ta</u> and <u>ɣị</u> have low tone in (29a), where they follow the low-toned verb radical <u>bha</u> 'enter', but not in (29b), where the verb radical <u>zụ</u> 'buy' is toneless:

(29) a. abhataɣị 'not to enter' b. azụtaɣị 'not to buy'

In the dynamic-tone analysis of Igbo which is proposed in Clark (1978), the relative tone level of each word is indicated by a pcm (either a ↑ or a ↓) at the end of the word. Thus the verbs of (29) have the surface-level representation shown in (30):

(30) a. a↓bhataɣị↑ b. a↑zụtaɣị↓

Individual morphemes are marked for tone in the same way: low-toned morphemes have a final ↑ , high-toned morphemes have a final ↓ , and toneless morphemes have no pitch-change markers. Thus the verbs of (30) have the <u>underlying</u> representations shown below:

(31) a. a↓ bha↑ ta ɣị b. a↓ zụ ta ɣị

The question is what sort of rule should be posited to convert the underlying forms of (31) to the surface forms of (30). The behavior of verbs made up entirely of toneless morphemes (such verbs are marked with a final ↓ in the verb forms we are concerned with here) suggests that what we want is a sequence of <u>two</u> rules: one to place a ↑ at the end of verbs with the underlying structure of (31a), and the other to place a ↓ at the end of any verb which has not yet been marked with a word-final pcm. The rule which concerns us here is the one which places the ↑ at the end of verbs like (31a).

Clearly, this rule could be stated in either of two ways. On the one hand, we could posit a rule which <u>moves</u> the ↑ of <u>bha↑</u> over the string of toneless suffixes to its right and into word-final position, creating the output form (30a). Alternatively, we could posit a rule which <u>copies</u> the ↑ of <u>bha↑</u> at the end of the verb, creating the intermediate form shown in (32):

(32) a↓ bha↑ ta ɣị↑

The ↑ of <u>bha↑</u> is then deleted by the rule of ↑-Before-↑ Deletion which was illustrated in (25). The output is the same as before, but only this analysis takes us through the intermediate stage (32).

This ambiguity in the analysis would be eliminated if we adopted the constraint on rules of pcm-insertion which was proposed above, whereby the inserted pcm must always point in the opposite direction from the next pcm of the word. Then the pcm-copying rule which produces the intermediate form (32) could not be stated, and we would be forced to choose the analysis which **involves** a rule of pcm-movement.

Unfortunately, there are facts which suggest that this choice is not the right one. The evidence comes from a rather obscure and uncommon verb form which Green and Igwe (1963) call SVF II Negative. This verb form has two unusual tonal properties: First, it has low tone throughout (i.e., in dynamic terms it has a final ↑) even when there is no lexically low-toned morpheme within the verb. Secondly, a normally high-toned noun becomes low-toned in subject position befor a verb in this form. Both these exceptional properties are illustrated in (33):

(33) Ekwe mechiɣi anya 'but Ekwe didn't shut his eyes'

Here the verb is low-toned even though all its constituent morphemes (me 'make', chi 'shut' ɣi (neg)) are toneless. In addition, the normally high-toned noun Ekwe has become low-toned before the verb.

As I argue in Clark (forthcoming), both the peculiar properties of this verb form can be accounted for at once if we assume that there is a prefix of the form "↑" at the beginning of the verb, so that the verb mechiɣi of (33) has the underlying structure ↑+me chi ɣi. The ↑ which appears at the end of the verb in the surface form can then be accounted for in the normal way, by means of the same rule which places the ↑ at the end of a↓bha↑taɣi (31). Furthermore, if we assume a pcm-deletion rule of the form ↓→∅/ __↑ (and there is independent evidence for such a rule in Igbo), then the prefixal ↑ at the beginning of the verb will cause the deletion of the ↓ at the end of Ekwe↓, thereby accounting for its low tone in (33). A complete derivation of this clause is shown below:

(34)

Ekwe↓ ↑+mechiɣi anya↓	Underlying representation
↑	↑-Copying
∅	↓-Deletion
∅	↑-Before-↑ Deletion
Ekwe mechiɣi↑ anya↓	Output

Unfortunately, since one assumes that rules which apply <u>within</u> a word must precede those which apply <u>between</u> words, this analysis of the SVF II Negative form forces us to use a copying rule rather than a movement rule to account for the verb-final ↑ , for if the prefixal ↑ were moved to the end of the verb in (34), it would not be available to cause the deletion of the ↓ at the end of the subject. Apparently then, we cannot maintain the constraint proposed above, which would require a pcm inserted at the boundary of a word to point in the opposite direction from the next pcm of the word. The relaxing of this constraint introduces an unfortunate indeterminacy into the grammar, for it is hard to believe that the child learning Igbo must, when faced with the facts of (29)-(31), refrain from deciding between a movement analysis and a copying analysis until she encounters the one (rather obscure) verb form which provides a basis for the choice. I do not know how to solve this puzzle. I mention it here in order to show that although it is the Autosegmental Theory which suffers most grievously from excessive descriptive power and the indeterminacy which goes with it, this same criticism also applies to some extent to the Dynamic-tone Theory. No current theory of tone fully meets Chomsky's criterion of reducing the class of statable analyses of primary data to the point where selection can be made among them by means of the Evaluation Metric.

<u>Footnotes</u>

1. Chomsky was, of course, concerned with the whole grammars of languages, leaving open the question of "the extent to which particular parts of the grammar can be selected independently of others." My argument in this paper depends on the assumption that information from other components of the grammar will not help in deciding among competing analyses of tonal phenomena, except, of course, with regard to questions concerning the <u>domains</u> of tone rules.

2. There is an alternative version of the theory in which the tone segments are associated directly with sonorant segments.

3. Presumably there is an intermediate stage with a rising glide on the first syllable.

4. There might also be rules transposing tone segments with one another. I have not listed this class of rules, because to my knowledge, no one has proposed such a rule in an actual analysis.

5. These facts are not entirely hypothetical; <u>no</u>-phrases in Tokyo Japanese are exceptional in just this way. In particular, when the (toneless) possessive particle <u>no</u> is affixed to a final-accented multi-syllable noun, the resulting <u>no</u>-form ends on a high tone level, rather than with the HL which we would expect by the usual derivation. Two examples from Haraguchi (1975) are given below:

(i) ka wa + no ⟹ ka wa-no 'of the river'

a tama + no ⟹ a tama-no 'of the head'

Haraguchi uses a star-deletion rule to account for this exception, but does not say on what grounds he chooses this analysis over the various alternatives which I have listed in (7).

6. In this version of the theory, a tone has no realization unless it is associated with a tone-bearing unit. Thus the L of (12) makes its presence felt only through its effect on the high tone register.

7. Neither the Autosegmental analysis given earlier in this paper nor the lexical structure template proposed here includes a correct account of words whose first syllables are long. See Clark (1979) for a dynamic-tone analysis which includes the special behavior of words with long syllables. An Autosegmental account of these cases is given in Haraguchi (1979).

8. Notice that lexical tone representations in Igbo differ from those of Japanese in that the relative pitch level of one word with respect to another is indicated by a pcm at the <u>end</u> of the word, rather than at the beginning. Some consequences of this difference in lexical representation in the two languages are pointed out in Clark (1978), Chapter II.

9. "Non-lexical" items like de↓su lack the usual word-initial pcm. It is just the fact, of course, which makes their accent ↓'s susceptible to deletion by the rule which is illustrated in (24).

10. These rules serve a tendency in human languages to prefer "alternating" tone contours, in which pitch rises follow pitch drops, and vice-versa. This same tendency often manifests itself in lexical structure templates such as that which was stated in (18) above for Tokyo Japanese. It is easy to see why languages should prefer alternating tone contours, for a sequence of pitch changes in the same direction must be very small in size (and therefore hard to hear) if it is to be accommodated within the comfortable pitch range of the speaking voice.

11. The Kikuyu data in this paper is taken from Clements and Ford (1977).

12. But see Solan (forthcoming) for discussion of some cases which really do seem to involve some indeterminacy in the grammar.

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