Tone in Mende: A Comparative Analysis of Theoretical Approaches

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Abstract

In this paper, I examine the advantages and shortcomings of two different methods of tonal analysis; Autosegmental Phonology and Simplified Bracketed Grid Theory. Autosegmental Phonology is widely used in American linguistics for tonal analysis, but Simplified Bracketed Grids are still very new and relatively unknown. For this reason, I explain each theory in general, and expound on some key points and key differences between the new and old theories. Each analytic approach is applied to Mende, a member of the Niger-Congo language family, with the aim of determining which of the two approaches, if either, provides the simplest and most elegant analysis. Mende has long been used as an anchor of support for the application of Autosegmental Phonology in representing tone, and it is for this reason, that I am using it as the medium of comparison.

Two separate Mende data sets, which represent two dialects, are analyzed. The first data set, Mende A, is the classic data set used when discussing Mende or tone in Autosegmental Phonology. A supplement to this data set is included, which contains data that fits in with the patterns in Mende A. Mende B doubles the number of possible tones and the number of tonal patterns. SBG theory ends up turning out analyses of Mende tonal patterns that are at least equally as sophisticated as the Autosegmental analyses. They additionally provide some predictions inherent to the structures and created by the analyses about the eventual phonetic output fromthe phonological representations.[1]

[1] I would like to acknowledge the help and support of David Harrison, my thesis advisor, as well as Donna Jo Napoli, Nathaniel Peters, and Jonathan Ference. These people all took the time to read my thesis and give me invaluable comments that lead to its improvement. I would also like to thank; Eric Raimy for helping me extensively with SBG theory, and for fueling my interest in phonology in the first place; Paul Grobstein for emotional support and philosophical discussion; friends and family who offered time and support during the writing process. Without the help and encouragement of all of these people, this thesis would be very, very bad indeed.

1. Introduction

One exceedingly important goal in theoretical linguistics is to come up with the most effective representations to describe linguistic data. Representations can generate or change ideas about how the brain acquires, processes, or creates language. For example, the advancement of X' Theory in syntax created an intermediate level in the hierarchy, providing a needed separation between the phrase and its head. This change in the theoretical representation allowed for more adequately descriptive and predictive analyses than the previous arrangement which had no intermediate structure.

We can find another example of such major advances in the development of Autosegmental Phonology, which was first introduced in John Goldsmith's 1976 dissertation "Autosegmental Phonology". This innovation in non-linear phonological theory viewed phonological processes as separate from the discrete units that they affect (individual phonemes). Goldsmith proposed looking at phonology as a multi-dimensional entity, with different processes on different tiers, a system that can allow a process to affect more than one phoneme simultaneously. Autosegmental Phonology was originally developed to describe the behavior of tone, but it was also found to be useful in describing other phonological phenomena, such as vowel harmony.

Since the initial development of Autosegmental Phonology thirty years ago, the theory has been used almost exclusively to describe the behavior of tone in language. Recently, phonologists have been investigating the possible relationship between tone and metrical structure.

> In the metrical approach to tone, the surface tone melody of a given form is realized by tonal rules which refer to the constituents of metrical structure built on the form. In this approach, the generation of *ad hoc* rules is averted as much

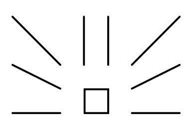
> as possible, and virtually all the processes are achieved with universal principles and the parameters derived from these principles. This metrical approach is different form the traditional tone mapping approach, in that its basic idea is that the underlying representation contains metrical constituents and the metrical component interacts with the tonal component.
>
> (Kim 1999:2-3)

In this paper, I intend to continue this endeavor and explore an alternative to a strictly Autosegmental treatment of tone: Simplified Bracketed Grid (SBG) theory. I will present an overview of the Autosegmental and SBG approaches to tone as well as analyses of tone using both theories and the tone patterns of nouns in a single language in order to compare the two approaches. The language used will be Mende, a Mande language of the Niger-Congo family. This language was chosen precisely because the analysis of data from Mende has been used prominently to support the theory of Autosegmental Phonology. Before the development of this theory, the behavior of tone in Mende had been difficult to accommodate. Autosegmental Phonology provided a remarkably simple and elegant description of this behavior, and since its inception, Mende has been used repeatedly as an example to cite its usefulness. If Autosegmental Phonology has worked so well for Mende, then Mende can provide an excellent test for the usefulness of SBG theory. The goal is to find if there are any significant differences in information provided by the two representations, and, if differences are found, to determine which theory, if either, better accommodates the data. We will look for any descriptive or predictive differences between the purely Autosegmental approach and the SBG approach and discuss the benefits and short-comings of each theory according to these differences.

2. Autosegmental Phonology

In "Autosegmental Phonology", Goldsmith formalized his theory using tone in Igbo, a Niger-Congo language in Africa. The idea behind this development was to separate features and processes from the individual entities they affected so that a feature or process could apply, as a segment unto itself, to more than one segment at a time. The end result was a three-dimensional model of phonology, looking like a paddle wheel, or a book flipped open on a desk with its pages sticking up in the air. The spine of the book is the skeletal-tier, also called the x-tier, which other tiers branch off of, not unlike the following diagram (fig. (1)), in which the box represents the x-tier with secondary tiers branching off:

(1) Depiction of Autosegmental Phonology



Consider the following:

(2) Autosegmental representation of 'phonology':

```
      σ *     σ *     σ *     σ *          (prosodic & metrical tiers)
     /  \|   /  \|   /  \|   /  \|
# → X →X→X→X→X→X→X→X→%                     (x-tier)
    |   |   |   |   |   |   |   |
   [f] [ə] [n] [a] [l] [ə] [dʒ] [i]        (segmental level)
```

In this representation of 'phonology' we have the x-tier, which tells us how many phonemes are in the underlying representation. An arrow (→) signifies "precedes", the number sign (#) signifies the beginning of the structure, and the percent sign (%) signifies the end of the structure. The segmental level holds the phonemes that make up the phonological word. Syllables are represented by the σ symbol on the prosodic tier of the model. On the metrical tier, only vowels are represented by the * symbol.

Let us now look at a representation of tone in Autosegmental Phonology using a hypothetical language, Language Z. Let us say that Language Z has 4 tonal melodies, or patterns of tone that occur in words regardless of the number of syllables, and that these melodies are Low (L), High (H), Low-High (LH), and High-Low-High (HLH)[2]. A simple schema of possible syllable patterns in this hypothetical language follows:

(3) Syllable schema for Language Z:

	Monosyllabic	Disyllabic	Trisyllabic
L	σ̀	σ̀ σ̀	σ̀ σ̀ σ̀
H	σ́	σ́ σ́	σ́ σ́ σ́
LH	σ̌	σ̀ σ́	σ̀σ́σ
HLH	σ́ˇ	σ́σ̌	σ́σ̀σ́

An autosegmental analysis of tone in Language Z might look something like the following :

(4) Autosegmental representation of tone in Z:

```
High tones:  V    V V    V V V      →      V    V V    V V V
                                            |    | /    | / /
             H    H      H                  H    H      H

Low tones:   V    V V    V V V      →      V    V V    V V V
                                            |    | /    | / /
             L    L      L                  L    L      L
```

[2] The melodies for this language are: all low tones, all high tones, a low tone/high tone contour or rising tone, and a high tone/low tone/high tone contour, or falling-rising tone.

```
Low-High:        V       V V    V V V        →      V       V V     V V V
                                                    /\      |  |    |  |
                 LH      L  H   L  H                LH      L  H    L  H

High-Low-High:      V       V V      V V V      →       V       V V     V V V
                                                       / | \    |  | \   |  |  |
                 HLH     H LH    H L H                HLH     H LH    H L H
```

According to the tonal melody of a word, the tonal tier contains a number of high or low tones which need to be attached to a vowel (V). Let us say that the tones attach from left to right until each tone on the tier is associated with some V. For both the low and high tone groups, the tone is attached, and then tone spreading occurs in order to cover all of the syllables of the word (the third pattern, Low-High, presents an exception which will be discussed momentarily). Every tone must be associated with a V. In those cases where there are more tones than there are Vs, such as the monosyllabic word in the Low-High group or the mono- or disyllabic words in the High-Low-High group, the extra tones are associated with the final V. In the High-Low-High group, the H L and H are all assigned to the same V in the monosyllabic word, the H attaches to the first V and the L and H to the second V in the disyllabic word. In the trisyllabic word each V receives one tone according to the pattern.

The exception of the Low-High group to which we now return is an important one to note. In this group, the Low and High tones are attached to the only syllable in the monosyllabic word, and one to each syllable in the disyllabic word. This behavior is not unlike the unremarkable pattern in the fourth group. The unusual distinction appears in the trisyllabic word, when we have more syllables than we do tones: one tone each to the first two syllables and the last syllable left with no tone. We could say that there are only two tones on the tier and that for this group there is no rule for spreading, preventing the

High tone from being spread to any further syllables. Unlike the words with all High tones and all Low tones, using tone spreading in order to cover all syllables, this group exhibits only two tones per word, regardless of the number of syllables.

An instance of an actual language that exemplifies such behavior can be found in "Problem Book in Phonology" (Clements and Halle 1983) in Ogori, another Niger-Congo language. There are words in this language that have more syllables than they do tones, as well as words that have tones on every syllable:

(5) Ogori data:

ɛsá	'cloth'	ɔ̀kɛ̆̀ka	'big'
ɔ̀nɛ	'this'	úwó	'dog'
òkeke	'small'	óbòrò	'good'

Because these patterns are attested in actual languages, we need to have a system that can accommodate differences similar to those between the Low-High group and the rest of the patterns from our hypothetical Language Z. Autosegmental Phonology can, in fact, accommodate the data. As suggested earlier, we could sort words into different groups according to tonal melody, and for the Low-High Group say that there is only one Low tone and one High tone on the tier, and that no spreading occurs. This gets us the grammatical results. However, not much is done for us on a theoretical level. Autosegmental Phonology is very general, which makes it very easy to apply and manipulate in order to get the correct output, but in this case it doesn't predict anything new. To form the rules, one need only look at a pattern, and spit that pattern back out, along with a few stipulations set by the theory. This is effective, but theoretically weak.

Looking at tone through metrical structure may provide new and interesting insights into how it is processed, or how tone systems change.

3. Metrical Grids

Metrical Grids were introduced in Mark Liberman's 1975 dissertation "The Intonational System of English" as a representational system for stress. Michael Kenstowiscz in "Phonology in Generative Grammar" says of them, "…stress is defined in terms of an abstract two-dimensional array that plots metrical positions for levels of prominence. Syllabic nuclei 'bear' a stress by autosegmentally associating with one of these metrical positions" (1994:553-554). In Autosegmental Phonology, a unit that carries a tone is called a tone bearing unit, or TBU. For a metrical grid, a syllable is a unit that can bear different levels of stress. The level of stress is determined by universal and language specific parameters that interact to build up the grid. Consider the following example:

(5) Metrical grid for 'metricality'[3]

(Diagram from SIL Online Linguistics Glossary: Metrical Phonology)

[3] It should be noted that 'ty' in 'metricality' is a heavy syllable, however, the SIL did not factor this into their representation. Because this is not immediately relevant to the larger issue, the author will leave the example alone – it still serves to provide a useful illustration of grid-building.

The relative prominence of stress is determined by how many marks are projected on the grid for each syllable. For ‘metricality’, ‘ca’ has primary stress with three marks, ‘me’ has secondary stress with two marks, and the rest of the syllables are ‘unstressed’.

Parentheses are put in the grid by way of rules to create constituents. Consider figure (6):

(6) Grids for ‘metricality’ and ‘supercalifragilistic’

```
                         *
          *             (*              *)
(*        *)            (*       *)   (*       *)
(*   * ) (*  *) *       (*   *) (*  *)(*   *)(*   *)
me tri  ca  li ty       su per ca li fra gil is tic
```

At the lowest level of the grid, a mark is projected for each stress-bearing element. For these examples, the marks are then gathered into feet (constituents made up of two or three grid marks). The head of the constituent (the leftmost mark, in English) projects a mark onto the next line of the grid. Feet are formed on this line, and heads are again projected one line up. The process is repeated until there is only one mark in the top line of the grid.[4] In these two examples, the parentheses create binary constituents. Originally in the metrical grid approach, one could only have closed constituents, meaning that for every left bracket there needed to be a complementary right bracket and vice versa. Marks were most often grouped into binary feet, or groups of two marks. It is also possible to have ternary feet (constituents containing three grid marks), as well as extrametrical elements. One of the simplifications of Simplified Bracketed Grid Theory,

[4] For ‘metricality’, the extrametrical element discussed earlier causes the appearance of a right-headed constituent, causing stress to fall on the medial syllable.

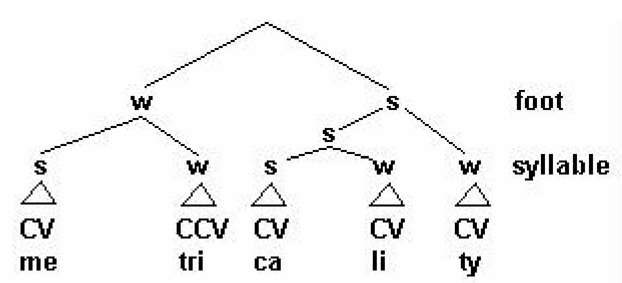
to be discussed in more depth later, allows a constituent the possibility to be formed by only one bracket.

In the first line for the grid for ‘metricality’, the syllables are paired into feet, with one syllable leftover. (This leftover mark is an extrametrical element.) Within these constituents, the left-most mark is projected up to another line in the grid, which ends up having two marks. In this line of the grid, the right-most mark is projected to the next line, creating a terminal line with only one element. In the grid for ‘supercalifragilistic’, the syllables are, again, paired into feet, and for each foot the left-most element is projected to the next line on the grid. Binary constituents are created on this second line, and again the left-most element is projected one line up. On this third line, there are enough marks to create another binary foot, and the left-most mark is projected, giving the syllable ‘su’ the strongest stress, followed by ‘fra’ with secondary stress. The syllables ‘ca’ and ‘is’ have the next level of stress after ‘fra’, followed by ‘per’, ‘li’, ‘gil’, and ‘ic’ with the weakest stress.

<u>Metrical Trees</u>

Around the same time as the establishment of metrical grids, metrical trees were also considered as a method to represent stress. In a metrical tree (see fig. (7)), there is binary branching with possible designations of ‘strong’ (s) or ‘weak’ (w):

(7) Metrical tree for “metricality”:



(Diagram from SIL Online Linguistics Glossary: Metrical Phonology)

The relative amount of stress per syllable depends on the number of 's' nodes that dominate it. The strongest stress is on the node that is dominated only by 's' nodes, so for metricality, the syllable 'ca'. The question, then, is how do we distinguish between 'me' and 'ty', which are each dominated by one 's' node, but in different places along the hierarchy? It turns out that 'me' has more stress, so we could say that the closer the 's' node is to the terminal node, the stronger its effect is on the syllable, or that if the terminal node is mothered by a weak node that this somehow detracts from the syllable's stress. In a metrical grid representation, this point is obvious. The strength of stress on a syllable is determined by how many marks are projected on the grid. Another difference between trees and grids is that stress retraction rules are simply stated in a grid structure: a mark needed only to be moved leftward to the closest available column. In a tree structure, however, there is no simple way to show stress retraction. For these and for similar reasons, soon after their initial use, trees were abandoned in favor of grids.

Simplified Bracketed Grids

After the emergence of metrical grids, three key works developed and elaborated the theory of Simplified Bracketed Grids; Halle and Vergnaud's 1987 paper "An Essay on Stress", Idsardi's 1992 paper "The Computation of Prosody", and the current seminal work on SBGs, Halle and Idsardi's 1995 paper "General Properties of Stress and Metrical Structure". SBGs are just what they sound like: a simplified and stream-lined version of metrical grids. They are constructed using only three symbols, and four different tools unique to the system:

Symbols

- *) (

Tools

- Projection**:** Marks are projected from one line of the grid to another depending on rules, such as Idsardi's Line 0 Projection Principle:

  Line 0 Projection
  Project a line 0 element for each *element that can bear stress*.
  (Idsardi 1992:2)

- Edge-Marking**:** Parentheses are placed at either or both ends of the grid according to rules. There are 6 possible combinations[5]:

RRR	* * * *)	- Right bracket to the Right of the Right-most element
RLR	* * *) *	- Right bracket to the Left of the Right-most element
RRL	*) * * *	- Right bracket to the Right of the Left-most element
LLL	(* * * *	- Left bracket to the Left of the Left-most element
LRL	* (* * *	- Left bracket to the Right of the Left-most element
LLR	* * * (*	- Left bracket to the Left of the Right-most element

- Headedness**:** L or R – the left or right-most element is chosen as the head of the constituent

- Iterative Constituent Construction (ICC): Binary parameter: ICC or no ICC. Distributes parentheses across the grid according to rules that trigger their use

SBGs differ in several important ways from the original conceptualization of metrical grids. Some are best stated by the theory's originators:

> The most significant innovation of the present theory is in the representations of bracketed grids. By eliminating superfluous parentheses, we change the meaning of parentheses themselves. A single parenthesis is now sufficient to define a metrical constituent. This has the important consequence that metrical constituents can be open-ended. This, in turn, means that constituency can be modified while still respecting the already assigned structure in the sense of Halle (1990). The addition of new elements can augment constituents and the (re)application of parameter settings can subdivide constituents. Operations that must destroy previously built structure in tree theory can be formulated in the present theory so that they only add structure. Thus this theory gives a whole new meaning to constituent structure and Free Elements.

[5] It should be noted that it is also logically possible to have the combinations RLL and LRR, but we don't see these because output is not well-formed. RLL would give us:)****, while LRR would give us: ****(meaning that the tones resulting from these algorithms could be associated with marks in an outside string, but introduces no phonological material for the x-tier with which it is connected.

> We also deviate from previous metrical theories by not requiring exhaustive parsing of the sequence of elements, that is we do not require that every element belong to some constituent, thus also denying the fundamental basis of Prosodic Licensing.
>
> (Halle and Idsardi 1995: 440)

Annother development (part of the move away from necessitating closed constituents) was the idea that feet are an artifact of metrical structure and not part of a universal taxonomy. Instead, Edge-Marking and Iterative Constituent Construction Parameters are a part of Universal Grammar, and a language simply selects from the options available in order to establish its prosodic patterns (Kim 1999). Since their establishment as a method for describing metrical structure in language, Simplified Bracketed Grids have been found to accommodate many phonological phenomena besides stress, such as vowel harmony, reduplication, and tone.

4. Tone in Mende

This paper will address two sets of Mende data; the first, Mende A, is the classic data set that has been used as a stalwart example of the Autosegmental approach to tone, and the second, Mende B, comes from a 1935 dissertation, "A Grammar of the Mende Language", that compiles a grammar of Mende. In the grammar, author Ethel Aginsky provides a different set of data which will be treated as entirely separate from Mende A, and will be called Mende B. In Aginsky's grammar, nouns exhibit not two, but four levels of tone: High, Mid-High, Mid-Low, and Low. Not only does she claim more levels of tone than are found in Mende A, but certain words in both data sets have different reported melodies. For example, 'bɛ̀lɛ̀' (*trousers*), in Mende A is reported to be in the lexical class 'B' (discussed below) with all Low tones. Aginsky, however, places it in a group with a Mid-Low tone followed by a High tone, or, 'bε_2lε_4'. It is not unusual for tone systems to change, causing the formation of different dialects. As such, it will be assumed in this paper that these two data sets are representative of two different dialects of Mende. They will both be treated separately in an Autosegmental framework and an SBG framework.

Mende A

Mende A is the classic Mende data set that is used to provide support for Autosegmental Phonology. It can be found in Kenstowicz's "Phonology in Generative Grammar" (1994: 386), and follows below.

(8) Mende A Nouns:

Monosyllables		Disyllables		Trisyllables	
kɔ́	'war'	pɛ́lɛ́	'house'	háwámá	'waist'
kpà	'debt'	bɛ̀lɛ̀	'pants'	kpàkàlì	'three-legged chair'
mbǎ	'rice'	fàndé	'cotton'	ndàvúlá	'sling'
mbû	'owl'	ngîlà	'dog'	félàmà	'junction'
mbǎ̂	'companion'	nyàhǎ̂	'woman'	nìkîlì	'peanut'

(9) Mende A Noun + clitic:

Noun	Noun + ma 'on'	Noun	Noun + ma 'on'
kɔ́	kɔ́-má	mbû	mbú-mà
pɛ́lɛ́	pɛ́lɛ́-má	ngîlà	ngîlà-mà
bɛ̀lɛ̀	bɛ̀lɛ̀-mà	nyàhâ	nyàhá-mà
mbǎ	mbà-má		

In this data set, we find mono-, di-, and tri- syllabic words in (8), and mono- and di-syllabic polymorphemic words in (9). There are high and low tones, and these are found in 5 main patterns across nouns, as illustrated in (10):

(10) Simplified schema of tonal melodies for Mende A nouns:

	Monosyllables	Disyllables	Trisyllables
Class A	σ́	σ́ σ́	σ́ σ́ σ́
Class B	σ̀	σ̀ σ̀	σ̀ σ̀ σ̀
Class C	σ̌	σ̀ σ́	σ̀ σ́ σ́
Class D	σ̂	σ́ σ̀	σ́ σ̀ σ̀
Class E	σ̌̂	σ̀ σ̂	σ̀ σ́ σ̀

In this schema, we have separated the different tonal melodies and placed them accordingly into classes. Class A contains High tones, B Low tones, C a Low-High(-High) pattern, D a High-Low(-Low) pattern, and E a Low-High-Low pattern. The melodies are manifested without regard to the number of syllables in the word. This supports the autosegmental view that tone is represented on a different tier from the units with which it is associated. The tone pattern is not dependent on the word, but rather exists as its own component.

After the first use of Igbo for exemplification of the theory by Goldsmith in 1976, Mende became the key support case for the Autosegmental representation of tone, mainly because of the simplicity of the analysis. This analysis follows:

<u>Classic Autosegmental Analysis of Mende Data Set A</u>

```
High tones:   X     XX    XXX
              |     |/    |/ /
              H     H     H

Low tones:    X     XX    XXX
              |     |/    |/ /
              L     L     L
```

```
Low-High contour:       X      XX     XXX
                        /\     | |    | |/
                        L H    L H    L  H

High-Low contour:       X      XX     XXX
                        /\     | |    | |/
                        H L    H L    H  L

Low-High-Low contour:   X      XX     XXX
                       /|\     | /\   | | |
                      L H L    L HL   L H L
```

The clitic (see fig. (9)) is assimilated with a spreading rule, making it interchangeable with any of the di- or trisyllabic representations listed above. The only shortcoming seems to be that there isn't much predictive force behind this analysis. It doesn't really tell us why things are the way they are: it just splits words into tone patterns and shows how tone is associated with TBUs.

Simplified Bracketed Grid Analysis of Mende Data Set A

(11) Order of Operations:

Morphology	→	Lexical Classes (for different tonal patterns) • Edge Parameters • Readjustment Rules
Phonology	→	Iterative Constituent Construction Tone Insertion Tone Spreading
Phonetics	→	Tone Interpretation

(Method follows the adaptations of Purnell 1997, and Kim 1999 to SBG theory in order to encompass tone.)

In the SBG approach, the nouns are separated into five different lexical classes based on tonal melody (see also: fig. (10)). This occurs in the morphology, before phonological processing takes place. The lexical classes differ in their edge parameter settings and readjustment rules:

Class A → Edge: RLR
Class B → Edge: LLL
Class C → Edge: RLR, Edge: LLL
Class D → Edge: RRL, Edge: LLR
Class E → Edge:LLR, Edge: LLL
'ternary closure' (*** → (***)
'unary closure' (** → (*)*

Each syllable projects two marks onto the grid (used in Bao, 1999). The marks here are the equivalent of a TBU in the Autosegmental approach. The use of two marks per syllable allows the rising-falling pattern found in class E, as well as the contrasting contours found in classes C (rising) and D (falling). One benefit of this analysis that we can see already is that the edge markings from classes A and B combine to form the edge markings for class C (RLR + LLL). This is a notable occurrence, and it seems appropriate that a third class would combine rules already established in two other classes. This effect occurs again for class E. An edge parameter setting from D (LLR) is used in conjunction with the edge marking from B (LLL).

The readjustment rules in class E provide the medial high tone in the rising-falling pattern. These rules create closed constituents and are governed by the Elsewhere Condition[6], meaning that anywhere the ternary closure rule (which is the more specific

[6] Elsewhere Condition:
Rules A, B in the same component apply disjunctively to a form Φ iff
(i) The structural description of A (the special rule) property includes the structural description of B (the general rule).
(ii) The result of applying A to Φ is distinct from the result of applying B to Φ.
In that case, A is applied first, and if it takes effect, then B is not applied.
(Kiparsky 1982:136-137)
For our analysis, ternary closure is rule A whereas unary closure is rule B. (** is contained within (***.

rule) has a chance to apply, it will apply instead of the rule for unary closure (the more general rule). These rules apply in the morphology, meaning that they are restricted to class E. Because of this, the only place a unary closure will ever occur in class E is the only place we ever need it: in a monosyllabic word.

After the morphological processing comes the phonology, in which we have Iterative Constituent Construction (ICC), Tone Insertion, and Tone Spreading. It has been suggested that within SBG theory there is an intrinsic ordering of these functions according to UG, so that the ICC precedes tone insertion which precedes tone spreading (Purnell 1997). Mende has two Iterative Constituent Construction rules, which we will call Right bracket ICC and Left bracket ICC. They both apply from right to left (they start at the rightmost element and run to the left) and form binary feet through the insertion of right or left brackets. The Right bracket ICC creates boundaries which with Tone Insertion and Spreading produce high tones across the desired sections of words in classes A and C. The Left bracket ICC enables the existence of low tones across all needed sections in class D.

Iterative Constituent Construction (ICC):

- Right bracket ICC: R→L ***) → *)**) Avoid (*)**)
- Left bracket ICC: R→L ***(→ *(**(

In this analysis I have used, in conjunction with the ICC, an avoidance constraint which prevents the right bracket ICC from making unary closures.[7] This constraint is separate from the unary closure rule found in class E. The rule forming unary closures happens in the morphology for one class, and creates the medial high tone in monosyllabic words for

[7] The left bracket ICC does not appear to have occasion to make unary closures, thus an avoidance constraint for left bracket ICC is not needed.

the rising falling pattern. This avoidance constraint stops the ICC, which happens in the phonology, from making unary closures in all classes containing right brackets. We see the effects of this constraint in the polysyllabic words in classes C and E. The effects of the ICC will be shown in more detail in the tables that follow which map out the application of the rules, and show the phonological output for the different classes.

High tones are inserted on marks next to right brackets, and low tones are inserted onto marks next to left brackets:

Tone Insertion:

```
        H                  L
*) →    |        (* →      |
        *)                 (*
```

Tone spreading occurs for both high and low tones. Low tones spread iteratively to the right until another bracket or tone is encountered. High tones spread, at most, once across a bracket.

Tone Spreading

- Low tone spread – iterative

```
L              L
|       →      |\\ …
(* * *         (* * *
```

- High tone spread (as in Purnell, 1997, for Serbo-Croatian)

```
H              H
|       →      |\
*)**           *)**
```

Tones will only spread to empty marks. A mark with which a tone has already been associated will not support tone spread. Two tones being associated with the same mark, however, is not precluded. This can occur through insertion and yields contour tone syllables. The last step is the phonetic interpretation of tone. This step turns out to produce some exciting predictions which will be discussed later on.

Now that we have set up all rules occurring in the morphology and the phonology, we can take a look at how they apply and interact in each class. The following tables present line 0 of the grid after it has run through all rules in the morphology (edge-marking and readjustment rules) and show each step taken in the phonology, ending with the final phonological output.

(12) Class A 'High' - RLR

<table>
<tr><th></th><th>σ</th><th>σ σ</th><th>σ σ σ</th></tr>
<tr><td>Morphology</td><td>*)*</td><td>***)*</td><td>*****)*</td></tr>
<tr><td>RB-ICC</td><td>---</td><td>*)**)*</td><td>*)**)**)*</td></tr>
<tr><td>LB-ICC</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>Tone Insertion</td><td>H
|
)</td><td>H H
| |
*)**)*</td><td>H H H
| | |
*)**)**)*</td></tr>
<tr><td>Tone Spreading</td><td>H
|\
)</td><td>H H
|\ |\
*)**)*</td><td>H H H
|\ |\ |\
*)**)**)*</td></tr>
<tr><td>Phonology Output</td><td>H
|\
)</td><td>H H
|\ |\
*)**)*</td><td>H H H
|\ |\ |\
*)**)**)*</td></tr>
</table>

The phonological output for Class A produces exactly what we would expect for a class containing High tones on all syllables. Through the ICC and tone spreading, high tones appear on each mark of the grid.

(13) Class B ‘low’ – LLL

<table>
<tr><td></td><td>σ</td><td>σ σ</td><td>σ σ σ</td></tr>
<tr><td>Morphology</td><td>(**</td><td>(****</td><td>(******</td></tr>
<tr><td>RB-ICC</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>LB-ICC</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>Tone Insertion</td><td>L
|
(**</td><td>L
|
(****</td><td>L
|
(******</td></tr>
<tr><td>Tone Spreading</td><td>L
| \
(**</td><td>L
| \ \ \
(****</td><td>L
| \ \ \ \ \
(******</td></tr>
<tr><td>Phonology Output</td><td>L
| \
(**</td><td>L
| \ \ \
(****</td><td>L
| \ \ \ \ \
(******</td></tr>
</table>

Tone spreading causes the Low tone to attach to all grid marks in class B, which is again what we should expect in the class containing words with a low tone on each syllable.

(14) Class C ‘low-high/rising’ – RLR, LLL

<table>
<tr><th></th><th>σ</th><th>σ σ</th><th>σ σ σ</th></tr>
<tr><td>Morphology</td><td>(*)*</td><td>(***)*</td><td>(*****)*</td></tr>
<tr><td>RB-ICC</td><td>---</td><td>---</td><td>(***)**)*</td></tr>
<tr><td>LB-ICC</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>Tone Insertion</td><td>L H
|/
(*)*</td><td>L H
| |
(***)*</td><td>L H H
| | |
(***)**)*</td></tr>
<tr><td>Tone Spreading</td><td>L H
|/\
(*)*</td><td>L H
|\ |\
(***)*</td><td>L H H
|\ |\ |\
(***)**)*</td></tr>
<tr><td>Phonology Output</td><td>L H
|/\
(*)*</td><td>L H
|\ |\
(***)*</td><td>L H H
|\ |\ |\
(***)**)*</td></tr>
</table>

Class C, the rising contour pattern, uses the right bracket ICC in the trisyllabic form. The ICC avoidance constraint is invoked in both the di- and trisyallbic forms. Through tone spreading and the ICC, each mark receives tone. This class is formed from the Edge-Marking rules from our first two classes, A and B.

(15) Class D ‘High-Low/Falling’ – RRL, LLR

<table>
<tr><th></th><th>σ</th><th>σ σ</th><th>σ σ σ</th></tr>
<tr><td>Morphology</td><td>*)(*</td><td>*)**(*</td><td>*)****(*</td></tr>
<tr><td>RB-ICC</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>LB-ICC</td><td>---</td><td>---</td><td>*)**(**(*</td></tr>
<tr><td>Tone Insertion</td><td>H L
| |
)(</td><td>H L
| |
*)**(*</td><td>H L L
| | |
*)**(**(*</td></tr>
<tr><td>Tone Spreading</td><td>H L
| |
)(</td><td>H L
|\ |
*)**(*</td><td>H L L
|\ |\ |
*)**(**(*</td></tr>
<tr><td>Phonology Output</td><td>H L
| |
)(</td><td>H L
|\ |
*)**(*</td><td>H L L
|\ |\ |
*)**(**(*</td></tr>
</table>

The falling tone pattern in class D, the other double contour, undergoes the left bracket ICC. Tones are inserted and spread. In both polysyllabic forms, a grid mark is left underspecified, for which the phonetic implications will be discussed in the next section.

(16) Class E ‘low-high-low/rising-falling’ – LLR, LLL, ternary closure, unary closure

	σ	σ σ	σ σ σ
Morphology	(*)(*	(***)(*	(***)**(*
RB-ICC	---	---	---
LB-ICC	---	---	---
Tone Insertion	LH L |/ | (*)(*	L H L | | | (***)(*	L H L | | | (***)**(*
Tone Spreading	LH L |/ | (*)(*	L H L |\ | | (***)(*	L H L |\\|\ | (***)**(*
Phonology Output	LH L |/ | (*)(*	L H L |\ | | (***)(*	L H L |\\|\ | (***)**(*

In class E, the morphology applies the edge marking, unary closure for the monosyllabic word, and ternary closure for the polysyllabic words. (Again, the application of the closure rules is governed by the Elsewhere Condition, and is a part of the morphology for class E only). Class E also ends up with an underspecified mark in the trisyllabic form, which too will be addressed in the following section.

<u>Phonetic Implementation</u>

The phonological output produces contrast in tone patterns that the phonetics takes and converts into the surface tone patterns.

(17) Class A:

<table>
<tr><td>Phonology Output</td><td>H
|\
)</td><td>H H
|\ |\
*)**)*</td><td>H H H
|\ |\ |\
*)**)**)*</td></tr>
<tr><td>Phonetics</td><td>σ́</td><td>σ́ σ́</td><td>σ́ σ́ σ́</td></tr>
</table>

(18) Class B:

<table>
<tr><td>Phonology Output</td><td>L
|\
(**</td><td>L
|\\\
(****</td><td>L
|\\\\\
(******</td></tr>
<tr><td>Phonetics</td><td>σ̀</td><td>σ̀ σ̀</td><td>σ̀ σ̀ σ̀</td></tr>
</table>

(19) Class C:

<table>
<tr><td>Phonology Output</td><td>L H
|/\
(*)*</td><td>L H
|\ |\
(***)*</td><td>L H H
|\ |\ |\
(***)**)*</td></tr>
<tr><td>Phonetics</td><td>σ̌</td><td>σ̀ σ́</td><td>σ̀ σ́ σ́</td></tr>
</table>

(20) Class D:

<table>
<tr><td>Phonology Output</td><td>H L
| |
)(</td><td>H L
|\ |
*)**(*</td><td>H L L
|\ |\ |
*)**(**(*</td></tr>
<tr><td>Phonetics</td><td>σ̂</td><td>σ́ σ̀</td><td>σ́ σ̀ σ̀</td></tr>
</table>

(21) Class E:

<table>
<tr><td>Phonology Output</td><td>LH L
|/ |
(*)(*</td><td>L H L
|\ | |
(***)(*</td><td>L H L
|\|\ |
(***)**(*</td></tr>
<tr><td>Phonetics</td><td>σ̀̂</td><td>σ̀ σ̂</td><td>σ̀ σ́ σ̀</td></tr>
</table>

In classes A, B, and C, each grid mark receives tone from one function or another, but in classes D and E, some marks go underspecified. However, because a syllable is made from two grid marks (** → σ), it may be possible for the phonetics to interpret a foot where only one mark from the pair is specified according to that solitary specification. This method of phonetic interpretation generates some interesting predictions. For the disyllabic word from class D and the trisyllabic word from class E, we predict that the low tone on the ultimate syllables as well as the high tone on the penultimate syllables should be slightly falling. For the trisyllabic word in class D, the high tone on the first syllable should be slightly falling, as should the low tone on the following syllable. The low tone on the ultimate syllable for this form should be relatively stable.

Our prediction is that, because we have an underspecified mark next to a High tone:

Class D:

```
H    L        H    L  L
|\   |        |\     |\ |
*)**(*        *)**(**(*
```

Class E:

L H   L

| \ | \ |

(***)***(*

the phonetics interprets the foot with the underspecified mark as slightly falling (not as drastic as the High-Low contour in class D, but slightly contoured). Acoustic confirmation is needed to see if this prediction is accurate. Even if it were found to be inaccurate, this would not refute the analysis. It would, however, disprove our phonetic prediction, meaning that we would have to come up with a new way for the phonetics to interpret the underspecified mark.

Supplementary data for Mende A:

Now that we have addressed the classic Mende data set, let us look at some supplementary data that fits with Mende A. This data contains one new noun (nàvó) as well as a new suffix. Unlike /ma/, this suffix, /ngà:/, carries its own Low tone.

Mende A Supplementary Data[8]:

Noun	Noun+ma ('on')	Noun+ngà: (Indef. Plural)
kɔ́	kɔ́má	kɔ́ngà:
pɛ́lɛ́	pɛ́lɛ́má	pɛ́lɛ́ngà:
mbû	mbúmà	mbúngà:
ngîlà	ngîlàmà	ngîlàngà:
mbǎ	mbàmá	mbǎngà:
bɛ̀lɛ̀	bɛ̀lɛ̀mà	bɛ̀lɛ̀ngà:
nyàhâ	nyàhámà	nyàhángà:
nàvó	nàvómá	nàvóngà:
fàndé	fàndémá	fàndéngà:

[8] Included with the data was another suffix carrying its own tone, but during its suffixation processes occur which are not tonal in nature, causing the analysis of the data to get unnecessarily complicated for the original purpose of including this additional data. Therefore, the suffix has been left out.

(Clements & Halle 1983 :)

This new data provides an excellent opportunity to see how our SBG analysis fares when combining two tonal elements. Let us say that ngà: comes with its own lexically stored bracket: (**. This is different from our lexically categorized classes; this suffix comes with a bracket pre-attached whereas a noun from a lexical class must undergo the processes outlined in that class.

Let's take a look at an example or two of how the construction of such a compound might work[9]:

(22)

Class A noun + ngà:

Morphology :

```
***)* + (**   →   ***)*(**
```

Phonology:

```
                  H  H   L
*)**)*(**    →    |\ |\  |
                  *)**)*(*
```

Phonetics:

```
*)**)*(**    →    σ́ σ́ σ̀
```

For most examples, the process works out beautifully, just like it does for pɛ́lɛ́. However, there are a few cases where the analysis does not provide the correct form:

(23)

Class C noun + ngà:

Morphology:

```
*)(* + (**    →    *)(*(**
```

[9] The author is putting the morphological processes for tone ahead of suffixation, meaning that lexical boundaries are already in place for both morphemes when suffixation occurs.

Phonology:

)((** → *)(*(**

Phonetics:

)((** → σ̂ σ̀

We end up with a disyllabic word with a rising contour on the first syllable. However, the data tells us that our output should instead have a High tone on the first syllable and a Low tone on the second syllable. The same occurrence happens for:

nyàhâ → nyàhángà:

Our analysis predicts the pattern : σ̀ σ̂ σ̀, but the data shows the pattern: σ̀ σ́ σ̀. What seems to be happening is that the final Low tone in a high-low contour that falls next to ngà: is conflated with the low tone on that suffix. To remedy this, we could posit the following rule :

(→ **/__ngà:

This would get us the correct patterns for both of the exceptions listed above. We could even make the rule more general :

(→ **/__(*

and we would still end up with the correct results for every form in Mende A and in its Supplementary set.

An autosegmental analysis would have a similar problem:

```
V + V        V  V + V
/ \   |      |  / \   |      →    σ̂ σ̀          σ̀ σ̂ σ̀
H L   L      L  H L   L
```

The easiest way to manipulate the Autosegmental analysis so that it accommodates the data is to just change the tone pattern that is supposed to attach to the TBUs:

```
V + V        V V + V
|   |        | |   |     →     σ́ σ̀          σ̀ σ́ σ̀
H   L        L H   L
```

Such a solution would not be unusual for Autosegmental Phonology. There are known cases in various languages of suffixes that change the tone patterns of the roots to which they attach, whether or not they exhibit their own tone.

<u>Mende B</u>

Let us now turn to Mende B. In her grammar, Aginsky represents tone using the numerals 4 through 1, with 4 corresponding to the highest tone and 1 to the lowest. The numeral 3 represents a Mid-High (Mid.High) tone, and 2 corresponds to a Mid-Low (Mid.Low) tone. A sampling of data from Mende B follows[10]:

<u>Mende B:</u>

<u>High:</u>

kpa$_4$	'a bet'
nu$_4$mu$_4$	'person'
pɛ$_4$lɛ$_4$	'house'
ha$_4$le$_4$	'medicine'
fo$_4$lo$_4$	'sun/day'

<u>Mid.High:</u>

kɛ$_3$	'father'
ha$_3$le$_3$	'medicine'
kpi$_3$ndi$_3$	'night'

[10] It should be noted that the data included in this set is reflective of the frequency of the patterns included in Aginsky's data. The author cannot be sure whether or not that frequency is representative of the distribution of patterns in the language. Aginsky included mostly disyllabic words, and most of these were of the High or High-Mid.Low patterns. Other patterns had very few examples. Any grouping listed in this paper containing only one item cites the only item found in the original source.

Low:

sa_1li_1	‘joke’

Mid.Low:

$m\varepsilon_2m\varepsilon_2$	‘glass’

Mid.Low-High:

hi_2nda_4	‘thing’
$nya_2h\tilde{a}_4$	‘woman’
ku_2la_4	‘clothing’
ma_2li_4	‘palm fiber’

Mid.High-Low:

$ba{:}_{3\text{-}1}$	‘price’

Mid.Low-Mid.High:

$nja_{2\text{-}3}$	‘water’

Mid.Low-Mid.High-Low:

$nja_2he_3le_1$	‘hippopotamus’
$ma_2wa_3li_1$	‘a bet’

High-Mid.Low:

$fo{:}_{4\text{-}2}$	‘year’
ke_4nya_2	‘uncle’
ka_4li_2	‘a hoe’
$ndo_4la{:}_{4\text{-}2}$	‘baby’[12]

Mid.Low-High-Mid.Low:

$nya_{2\text{-}4}po_2$	‘woman’[11]
$nja_2he_4le_2$	‘hippopotamus’
$ma_2wa_4li_2$	‘a bet’
$fa_2ka_4li_2$	‘pawpaw’

(data compiled from Aginsky: 1935)

[11] “$nya_2h\tilde{a}_4$ is often contracted into $nya_{2\text{-}4}$ as in this case” (Aginsky, 1935: 10).

[12] This case, the author has determined through Aginsky’s data, is polymorphemic. /ndo/ means ‘child’, while it is assumed that /la:/ is some sort of diminutive. For this reason, we cannot be sure that a three syllable High-Mid.Low word would follow the pattern 4-4-2. It may very well follow the pattern 4-2-2, which is what we expect from the grid, as will be shown below. This assumption is supported by the polysyllabic word $do_4u_2hi_2na_2$ which follows the pattern 4-2-2-2, however, the use of this word as an archetype is unadvisable because of the rarity of the consonant /d/ - this is one of four words in the entire language (according to Aginsky) that begins with this consonant.

(24) Simplified Schema of tonal melodies in Mende B:

	Monosyllables	Disyllables	Trisyllables
High	σ_4	$\sigma_4\sigma_4$	--Not Attested--
Mid.High	σ_3	$\sigma_3\sigma_3$	--Not Attested--
Low	--Not Attested--	$\sigma_1\sigma_1$	--Not Attested--
Mid.Low	--Not Attested--	$\sigma_2\sigma_2$	--Not Attested--
Mid.Low-High	--Not Attested--	$\sigma_2\sigma_4$	--Not Attested--
Mid.Low-Mid.High	$\sigma_{2\text{-}3}$	--Not Attested--	--Not Attested--
High-Mid.Low	$\sigma_{4\text{-}2}$	$\sigma_4\sigma_2$	Undetermined
Mid.High-Low	$\sigma_{3\text{-}1}$	--Not Attested--	--Not Attested--
Mid.Low-Mid.High-Low	--Not Attested--	--Not Attested--	$\sigma_2\sigma_3\sigma_1$
Mid.Low-High-Mid.Low	--Not Attested--	$\sigma_{2\text{-}4}\sigma_2$	$\sigma_2\sigma_4\sigma_2$

Aginsky gives examples of six different tone glides, but only three of these glides are attested in her data for nouns. In the previous SBG analysis, the data presented only two levels of tone to be distinguished. In Aginsky's data, however, we must be able to differentiate between four levels. There may be various ways to achieve this, such as making the different levels of the grid visible to one another, assigning a default tone[13], or using the tools we have in a novel way, such as doubling brackets, i.e.: ((**, or **)). This paper will explore the final option, in an effort to maintain the continuity of the analyses. The option of doubling brackets allows us to keep many of the same rules from Mende A, and offers a simple solution for differentiating between two additional levels of tone.

[13] In a system with a default tone, each syllable has a tone automatically associated with it, and then there need only be differentiation between three levels of tone using brackets. For example, each mark projected could automatically be a mid-low tone, or, ** (σ_2, a closed constituent could be a low tone, or, (**) → σ_1, a left-bracketed constituent could be a mid-high tone, or, (** (σ_3, and a right-bracketed constituent could be a high tone, or, **) → σ_4.

SBG Analysis of Mende B

In Mende B, we follow the order of operations (fig. (11)) established in the presentation of SBG theory:

(11) Order of Operations:

Morphology	→	Lexical Classes (for different tonal patterns) • Edge Parameters • Readjustment Rules
Phonology	→	Iterative Constituent Construction Tone Insertion Tone Spreading
Phonetics	→	Tone Interpretation

The Edge-Marking parameters selected for Mende B closely resemble those selected for Mende A. There are twice as many parameters for this data set, and they have been split up into morphological classes just as was done for Mende A. Two parameters are the same as those that were used in our first data set, those for Class A and Class B. The list below outlines all Edge rules. Classes were named according to their similarity to the classes from Mende A. For example, Class C was not selected, but two classes that behave in an identical way excepting the doubling of certain brackets were selected, and these have been denoted C.i and C.ii. For the E-like classes, we have E-like closure rules. They are similar except for the doubling of brackets, and the stipulation that for the ternary closure there must be four marks following the triggering bracket arrangement as opposed to three, as the rule was in Mende A. The results of these changes will be addressed below.

Edge-Marking and Readjustment Rules:

Class A → Edge: RLR

Class A.i → Edge: RLR, Edge: RLR

Class B → Edge: LLL

Class B.i → Edge: LLL, Edge: LLL

Class C.i → Edge: RLR, Edge: LLL, Edge: LLL

Class C.ii → Edge: RLR, Edge: RLR, Edge: LLL, Edge: LLL

Class D.i → Edge: RRL, Edge: LLR, Edge: LLR

Class D.ii → Edge: RRL, Edge: RRL, Edge: LLR

Class E.i → Edge: LLR, Edge: LLR, Edge: LLL

'ternary closure'	((****	→	((***))*
'unary closure'	((**	→	((*))*

Class E.ii → Edge: LLR, Edge: LLR, Edge: LLL, Edge: LLL

'ternary closure'	((****	→	((***)*
'unary closure'	((**	→	((*)*

For Mende B we have four ICC rules; two for right brackets, and two for left brackets. Both are applied from right to left. Like the Edge-Marking parameters two of the rules are used again, and the new rules mirror these to accommodate double bracketing. We will call them the RRight bracket ICC (RR ICC) and the LLeft bracket ICC (LL ICC).

Iterative Constituent Construction:

- Right bracket ICC: R → L ***) → *)**) Avoid (*)**)
- RRight bracket ICC: R→ L ***)) → *))**)) Avoid (*))**))
- Left bracket ICC: R→ L ***(→ *(**(
- LLeft bracket ICC: R → L ***((→ *((**((

Tone Spreading:

- Low and Mid.Low tone spread – iterative

```
 1              1
 |      →       | \ \ …
(* * *         (* * *
```

- 2 → 2
  | → |\\ …
  ((* * * → ((* * *

- High tone spread (as in Purnell, 1997, for Serbo-Croatian)
  4 → 4
  | → |\
  *)** → *)**

- 3 → 3
  | → |\
  *))** → *))**

This distributes High and Low tones across words, giving us the attested phonological output.

(25) Table of Hypothetical Phonological Outputs for Mende B:

	Monosyllables	Disyllables	Trisyllables
High	*)*	*)**)*	*)**)**)*
Mid.High	*))*	*))**))*	*))**))**))*
Low	(**	(****	(******
Mid.Low	((**	((****	((******
Mid.Low-High	((*)*	((***)*	((***)**)*
Mid.Low-Mid.High	((*))*	((**))*))*	((***))**))*
High-Mid.Low	*)((*	*)**((*	*)**((**((*
Mid.High-Low	*))(*	*))**(*	*))**(**(*
MidLow-MidHigh-Low	((*))(*	((*))**(*/((***))(*	((***))**(*
MidLow-High-MidLow	((*)((*	((*)**((*	((***)**((*

In the Mid.Low-Mid.High-Low group (Class E.i) listed above, we have a choice between two ternary closure readjustment rules. This is because there are no examples within

Aginsky's data to support either choice. We could have: ((**** → ((***))*, or we could have ((*** → ((***)). The difference in outcome is shown in the table (fig. (25)), in the column for disyllables. We could end up with either a contour on the first syllable or a contour on the second syllable. For symmetry's sake (see disyllabic word, class E.ii, (fig. (21), fig. (25)), it would be wise to go with the first rule option, however, there is no data to prove or disprove this selection.

(26) High

Phonology Output	4 |\\ *)*	4 4 |\\ |\\ *)**)*	4 4 4 |\\ |\\ |\\ *)**)**)*
Phonetics	σ_4	$\sigma_4\sigma_4$	$\sigma_4\sigma_4\sigma_4$

(27) Mid-High

Phonology Output	3 |\\ *))*	3 3 |\\ |\\ *))**))*	3 3 3 |\\ |\\ |\\ *))**))**))*
Phonetics	σ_3	$\sigma_3\sigma_3$	$\sigma_3\sigma_3\sigma_3$

(28) Low

Phonology Output	1 |\\ (**	1 |\\\\\\ (****	1 |\\\\\\\\\\ (******
Phonetics	σ_1	$\sigma_1\sigma_1$	$\sigma_1\sigma_1\sigma_1$

(29) Mid-Low

<table>
<tr><td>Phonology Output</td><td>2
| \
((**</td><td>2
| \ \ \
((****</td><td>2
| \ \ \ \ \
((******</td></tr>
<tr><td>Phonetics</td><td>σ_2</td><td>$\sigma_2\sigma_2$</td><td>$\sigma_2\sigma_2\sigma_2$</td></tr>
</table>

(30) Mid.Low-High

<table>
<tr><td>Phonology Output</td><td>2 4
| / \
((*)*</td><td>2 4
| \ | \
((***)*</td><td>2 4 4
| \ | \ | \
((***)**)*</td></tr>
<tr><td>Phonetics</td><td>σ_{2-4}</td><td>$\sigma_2\sigma_4$</td><td>$\sigma_2\sigma_4\sigma_4$</td></tr>
</table>

(31) Mid.Low-Mid.High

<table>
<tr><td>Phonology Output</td><td>2 3
| / \
((*))*</td><td>2 3
| \ | \
((***))*</td><td>2 3 3
| \ | \ | \
((***))**))*</td></tr>
<tr><td>Phonetics</td><td>σ_{2-3}</td><td>$\sigma_2\sigma_3$</td><td>$\sigma_2\sigma_3\sigma_3$</td></tr>
</table>

(32) High-Mid.Low

<table>
<tr><td>Phonology Output</td><td>4 2
| |
)((</td><td>4 2
| \ |
*)**((*</td><td>4 2 2
| \ | \ |
*)**((**((*</td></tr>
<tr><td>Phonetics</td><td>σ_{4-2}</td><td>$\sigma_4\sigma_2$</td><td>$\sigma_4\sigma_2\sigma_2$</td></tr>
</table>

(33) Mid.High-Low

<table>
<tr><td>Phonology Output</td><td>3 1
| |
))(</td><td>3 1
|\ |
*))**(*</td><td>3 1 1
|\ |\ |
*))**(**(*</td></tr>
<tr><td>Phonetics</td><td>σ_{3-1}</td><td>$\sigma_3\sigma_1$</td><td>$\sigma_3\sigma_1\sigma_1$</td></tr>
</table>

(34) Mid.Low-Mid.High-Low

<table>
<tr><td>Phonology Output</td><td>2 3 1
\/ |
((*))(*</td><td>2 3 1
\/\ |
((*))**(*</td><td>2 3 1
| |\ |
((***))**(*</td></tr>
<tr><td>Phonetics</td><td>σ_{2-3-1}</td><td>$\sigma_{2-3}\sigma_1$</td><td>$\sigma_2\sigma_3\sigma_1$</td></tr>
</table>

(35) Mid.Low-High-Mid.Low

<table>
<tr><td>Phonology Output</td><td>2 4 2
\/ |
((*)((*</td><td>2 4 2
\/\ |
((*)**((*</td><td>2 4 2
| |\ |
((***)**((*</td></tr>
<tr><td>Phonetics</td><td>σ_{2-4-2}</td><td>$\sigma_{2-4}\sigma_2$</td><td>$\sigma_2\sigma_4\sigma_2$</td></tr>
</table>

In Mende B, we see phonetic predictions very similar to those we found in our analysis of Mende A. In Mende A, our analysis produced underspecified marks in classes D and E. In Mende B, our analysis produces underspecified marks in D.i, D.ii, E.i, and E.ii, which we must remember were named so because of the similarity in their parameterized rules to the original classes D and E in Mende A.

Class D.i:

```
4      2        4      2   2
|\     |        |\     |\  |
*)**((*         *)**((**((*
```

Class D.ii:

```
3      1        3      1   1
 |\    |         |\    |\  |
*))**(*         *))**(**(*
```

Class E.i:

```
 2 3    1          2 3      1
  \/    |          |\|\     |
((*))**(*       ((***))**(*
```

Class E.ii:

```
 2 4    2          2 4      2
  \/\   |          |\|\     |
((*)**((*       ((***)**((*
```

Again, like in Mende A, the phonetics interprets the foot with the underspecified mark as slightly falling because of the preceding high or mid-high tone, and, as for Mende A, acoustic confirmation is needed to see if this prediction is accurate. We should note that for both of our data sets, underspecified marks occur only and always in classes where there is a higher tone preceding a lower tone: Mende A in classes D and E, and Mende B in classes D.i; D.ii; E.i; and E.ii.

<u>Autosegmental Analysis of Mende B:</u>

```
High tones:     X      XX      XXX
                |       |/      |//
                4       4       4
```

```
Mid.High tones:   X      XX     XXX
                  |      |/     |/ /
                  3      3      3

Low tones:        X      XX     XXX
                  |      |/     |/ /
                  1      1      1

Mid.Low tones:    X      XX     XXX
                  |      |/     |/ /
                  2      2      2

Mid.Low-High contour:     X      XX      XXX
                          /\     | |     | |/
                          2 4    2 4     2 4

Mid.Low-Mid.High contour:     X      XX      XXX
                              /\     | |     | |/
                              2 3    2 3     2 3

High-Mid.Low contour:     X      XX      XXX
                          /\     | |     | |/
                          4 2    4 2     4 2


Mid.High-Low contour:     X      XX      XXX
                          /\     | |     | |/
                          3 2    3 2     3 2

Mid.Low-Mid.High-Low:         X       XX       XXX
                             /|\      | /\     | | |
                             2 3 1    2 3 1    2 3 1

Mid.Low-High-Mid.Low:         X       X X      XXX
                             /|\      |\ |     | | |
                             2 4 2    2 4 2    2 4 2
```

The last group, Mid.Low-High-Mid.Low, would need a special rule to cause the medial High tone to attach to the left instead of to the final V, as tone always did in our previous autosegmental analysis. It should also be noted for the Mid.Low-Mid.High-Low group, that the current analysis would not allow the structure:

```
Mid.Low-Mid.High-Low:     X      X  X   XXX
                         /|\     |\ |   | | |
                         2 3 1   2 3 1  2 3 1
```

without the same rule needed for the Mid.Low-High-Mid.Low group stated above. This pattern would create the output: $\sigma_{2\text{-}3}\sigma_{1}$, which is the symmetrical output we hypothesized in our SBG analysis. It seems that the SBG analysis is better able to explain the data than the Autosegmental analysis.

5. Conclusions and Implications

It seems that the basic action of Autosegmental Phonology in this case is to look at the Phonetic Output, and assign a correspondingly descriptive phonological pattern. SBG theory proposes that we look at tone in terms of metrical structure. This creates a deeper level of representation and explains why we end up with the patterns that we get. It also generates new phonetic predictions for several words in both data sets.

The most pragmatic step to take now is to test the phonetic predictions against the outputs and judgments of a native speaker. If the predictions fail, then it is possible that either an SBG framework is not as well-suited in this case as an Autosegmental framework, or that we need to come up with a new set of rules within the SBG system to better accommodate the data. If the phonetic predictions succeed, this would lend huge support to the use of SBGs in analyzing tone in language.

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