THE COMPUTATION OF PROSODY

by

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ABSTRACT

This thesis presents a new theory of metrical representations and computations. This theory emphasizes that the metrical grid is a separate module of the phonology, devoted to the calculation of partitionings of phonological elements. The metrical grid consists of parallel tiers composed of three kinds of elements: grid marks and left and right boundaries. A single boundary serves to define a metrical constituent: a left boundary creates a grouping of the elements to its right, a right boundary creates a grouping of the elements to its left.

The calculation of the metrical grid is accomplished through the use of both rules and constraints. This division of labor accounts for observed properties of stress systems in a succinct manner. Metrical rules apply successively in a derivation, thus modelling the functional character of metrical structure assignment. The constraints prevent the application of metrical rules that would generate universal or language-particular disfavored configurations.

The interface to the metrical grid module is controlled by two parameters of projection, which provide the initial grid marks and boundaries. Further parameterized rules of Edge marking, Iterative constituent construction and Headedness complete the construction of the grid.

This theory allows the derivation of Extrametricality effects through the interaction between Edge marking and Iterative constituent construction. Constraints against particular configurations yield both clash effects and a ternary parsing ability.

Further, the Edge marking parameter provides the requisite formal power to deal with stress introduced by specific morphemes in such languages as Turkish, Macedonian, Polish, Russian, Cayuvava, Shuswap (Salish) and Moses-Columbian (Salish).

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To Jane.

"It's not an explanation," he said, and laughed again. "There ain't any explanations. Not of anything. All you can do is point at the nature of things. If you are smart enough to see 'em."

Robert Penn Warren

All the King's Men

Contents

Chapter 1: Basic mechanisms for constructing metrical grids

1. Introduction

The title of this thesis, *The computation of prosody*, is meant to emphasize two aspects of metrical theory. First, that metrical theory describes a computational procedure which maps phonological representations into other phonological representations, yielding a derivation. Second, that metrical computations are a general method of phonological counting, and can do more than just compute the location of stress. However, almost all of the examples discussed here involve stress, so the title suggested to me by Jay Keyser, *Another essay on stress*, might be more appropriate.

Descriptions of some stress systems are given in (1). These examples are common ones from the literature on stress, especially Hayes (1980, 1991, etc), Hammond (1986, etc) and Halle & Vergnaud (1987).

(1) a. *Koya* — Tyler (1969)
Primary stress on initial syllable. Secondary stress on closed syllables, and syllables with long vowels.

b. *Selkup* — Kuznecova et al (1980)
Stress right-most long vowel, otherwise the initial syllable

c. *Khalkha Mongolian* — Street (1963)
Stress left-most long vowel, otherwise the initial syllable

d. *Weri* — Boxwell & Boxwell (1966)
Stress falls on all odd-numbered syllables counting from the end of the word. Main stress is on the last syllable.

e. *Warao* — Osborn (1966)
Stress falls on even-numbered syllables counting from the end of the word. Main stress is on the penultimate syllable.

The phonological computation of stress placement requires knowledge about two questions: what to count and how to count it. The major insight into the first question is provided by Vergnaud & Halle (1978) and Halle & Vergnaud (1980): only certain elements are *projected*. This captures the fact that some elements are relevant for the count while others are irrelevant. It is this particular device that makes metrical theory a branch of autosegmental phonology (Goldsmith (1976)). The second insight is due to Liberman (1975): stress is relational, hence it is metrical constituency that is computed. This thesis will focus on the second question, and will try to explore the nature of metrical constituency.

The theory developed here will calculate stress by constructing a special phonological plane, the metrical grid, familiar from Prince (1983) and Halle & Vergnaud (1987) (abbreviated here as HV). Metrical constituents will be created by placing boundaries on the metrical grid. The emphasis in this theory is on the placement of these metrical boundaries; the addition of grid marks is limited to rules of projection. The metrical boundaries are the parentheses familiar from HV. I will take a realist position regarding these parentheses: they are elements on the grid, just like the grid marks. However, in this thesis we will abandon some of the "bookkeeping" parentheses of HV. This leads to a somewhat different conception of the meaning of the parentheses. In the current theory, a left parenthesis indicates that the material to its right up to the next parenthesis or the end of the form comprises a constituent; and a right parenthesis indicates that the material to its left comprises a constituent. In this way, the parentheses partition the form into constituents; they act as junctures. Possible formal representations for metrical constituent structure are compared in Chapter 5. In addition to rules inserting metrical boundaries, there will be constraints on the application of these rules. The possible sets of rules and constraints a language may have is further narrowed by limiting the choice available to the child to particular parameter settings. That is, the parameters limit the kinds of rules and constraints a child will consider in learning a language. Not all rules or constraints that can be described in the formalism are actual or possible rules or constraints of human languages.

The basic idea for this thesis occurred in a conversation with Morris Halle. It occurred to us that if metrical theory includes the placement of metrical parentheses then it does not also need to include the direct placement of line 1 marks. This thesis is a working out of the consequences of this observation. The theory presented here is therefore most similar to HV. However, in many ways a better comparison is Prince (1983). The present theory is very nearly Prince (1983) with line 0 boundaries rather than line 1 marks; constituency in place of prominence. Like Prince (1983), the current theory has (1) a simple, direct manifestation of "heaviness" in metrical elements, (2) operations targeting string-terminal elements, (3) a method of iterating across the form and (4) constraints on the application of these processes.

The best way to get practical experience with the devices of metrical grid construction is to consider how they are used to account for the stress pattern of words in various languages, such as those in (1). We will begin by examining how we can deal with "unbounded" systems with devices for projection, edge marking and head marking.

2. *Koya*

The stress system of Koya (Tyler 1969, Hayes 1980) is described in (2). The stress-bearing elements are the syllable heads.

(2) Stress falls on the head of every closed or long syllable as well as on the head of the initial syllable. Main stress is on the initial syllable.

According to (2) a typical Koya word will have the stress contour shown in (3).

(3)
```
line 2 x
       |
line 1 x   x       x
       |   |       |
line 0 x x x x x x x x x
```

In the following abstract examples, C stands for a consonant, V for a vowel and X for a post-vocalic element which contributes to syllable weight. A word, that is a string of phonemes organized into syllables, will therefore appear as in (4), where the square brackets represent syllable boundaries.

(4) `[cv] [cv] [cvx] [cv] [cv] [cv] [cvx] [cv] [cv]`

First, we need to get our playing field. We need to build a structure in which elements are linked to the phonemes that can bear stress. That is, languages need to define an interface between the strings of phonemes and the metrical grid. The mechanism for implementing this interface is *projection*. Projection adds an element to the grid and links it to the element which is "projected". The parameter in (5) governs this computation.

(5) *Line 0 element projection*
Project a line 0 element for each *element that can bear stress*

Languages are subject to variation in which elements are capable of bearing stress. We will not try to catalog the various possibilities here. We will assume that the italicized phrase is actually a set of syllabic environments for stressable elements that a language can choose from. For example, in a moraic theory of syllabic phonology this might be a choice between "left-most mora" or "all moras" in a syllable. In other theories of syllabification similar sets of environments would be required.

Now we need to formally represent the statement about long vowels and closed syllables. Since the grid only has two kinds of items, elements and parentheses, and we have projected up the elements, we are left with projecting some parentheses, or perhaps none at all. In particular, (6) is the parameter governing this aspect of the line 0 interface.

(6) *Line 0 parenthesis projection*

Project the $\left\{ \begin{array}{c} \text{left} \\ \text{right} \end{array} \right\}$ boundary of *certain syllables* onto line 0

The italicized phrase will also be a set of syllabic environments to choose from. Again taking moraic phonology as an example, one choice might be to project a parenthesis for each two-mora syllable.

The two parameters (5) and (6) govern the interface between syllabification and stress. Some syllables contribute only a grid element while others contribute both a grid element and a parenthesis. Some languages fail to invoke any form of (6) so that differences in syllable structure have no effect on stress. Languages have further variation in what kind of syllables are subject to (6), but the effect of (6) on line 0 is always the same: it projects parentheses onto line 0. Likewise, some languages use a variation of (5) to project more than one grid mark for some syllables. Again, however, the effect on the grid side of the interface is the same: the presence of grid elements.

Increased prominence is always the manifestation of constituent structure. Heavy syllables in Koya have increased prominence, therefore they must correspond to a constituent edge. To account for the stress on heavy syllables in Koya we project a left parenthesis for heavy syllables, that is, we set (5) and (6) as in (7):

(7) Project a line 0 element for each syllable head
Project the LEFT boundary of [...VX] syllables

The operation of (7) will contribute a left parenthesis to the left of each x linked to the head of a heavy syllable, as shown in (8):

(8)
```
 x     x   ( x      x     x     x   ( x      x     x
 |     |   | |      |     |     |   | |      |     |
[cv]  [cv] [cvx]  [cv]  [cv]  [cv]  [cvx]  [cv]  [cv]
```

Since we assume that the operation of Projection includes creating a link back to the item projected, we have links between metrical boundaries and syllable boundaries in (8). As we will see in a moment, we can also add parentheses to the grid via other parameter settings. Parentheses introduced by the other parameters will not be projected, and thus will not be linked to other phonological elements. Thus, the different parametrical operations create two different kinds of metrical parentheses: anchored (those linked to other elements) and unanchored. It is as yet unclear the extent to which this linking distinction plays an active role in metrical theory. It will not play a substantial role in this thesis.

To get an output grid compatible with (3) we also require stress on the first element. That is, the first syllable, like heavy syllables, has increased prominence. Therefore the first syllable must also correspond to a constituent edge. To achieve this we need to place a left parenthesis before the left-most element. To do this, I propose that Universal Grammar provides a parameter which allows us to place a parenthesis at an edge of a form. This is the Edge Marking Parameter, given in (9):

(9) *Edge Marking Parameter*

Place a $\left\{\begin{matrix}\text{left}\\ \text{right}\end{matrix}\right\}$ boundary to the $\left\{\begin{matrix}\text{left}\\ \text{right}\end{matrix}\right\}$ of the $\left\{\begin{matrix}\text{left}\\ \text{right}\end{matrix}\right\}$-most element

Koya sets Edge:LLL, that is, it places a LEFT boundary to the LEFT of the LEFT-most element, producing the grid in (10).

(10)
```
(x     x   ( x      x     x     x   ( x      x     x
 |     |   | |      |     |     |   | |      |     |
[cv]  [cv] [cvx]  [cv]  [cv]  [cv]  [cvx]  [cv]  [cv]
```

It is also possible for a grammar to not include any form of Edge marking, that is to have no setting for this parameter. This could leave a language with words that lack metrical structure entirely. Seneca, discussed in Chapter 3, is one example of this. This may also be a way of handling certain kinds of toneless words in metrical tone languages (Sietsema (1989), Meredith (1990)).

The Edge Marking Parameter actually governs the choice from the set of available rules shown in (11):

(11)

Edge:LLL = $\emptyset \rightarrow (\ /\ \#\ \_\ x$	Edge:RRR = $\emptyset \rightarrow)\ /\ x\ \_\ \#$
Edge:LRL = $\emptyset \rightarrow (\ /\ \#\ x\ \_$	Edge:RLR = $\emptyset \rightarrow)\ /\ \_\ x\ \#$
Edge:LLR = $\emptyset \rightarrow (\ /\ \_\ x\ \#$	Edge:RRL = $\emptyset \rightarrow)\ /\ \#\ x\ \_$
Edge:LRR = $\emptyset \rightarrow (\ /\ x\ \_\ \#$	Edge:RLL = $\emptyset \rightarrow)\ /\ \#\ \_\ x$

Thus, under this theory it is then possible for Edge marking to fail to apply to a form because the environment is not met. As an example, if a bracket is already present before the first mark, due say to an initial heavy syllable, then the first mark is no longer adjacent to the left edge of the form. In this case, any Edge:XXL setting will be unable to apply.

Now we need to add prominence to the first element in each constituent. This is controlled by the Headedness Parameter, (12):

(12) *Headedness parameter*

Project the $\begin{Bmatrix}\text{left}\\ \text{right}\end{Bmatrix}$-most element of each constituent (onto the next higher line of the grid)

Koya sets the Headedness parameter on line 0 to Head:L, generating (13).

(13)

```
  x         x                    x
  |         |                    |
 (x    x  ( x     x    x    x  ( x     x    x
  |    |  | |     |    |    |  | |     |    |
[cv] [cv] [cvx] [cv] [cv] [cv] [cvx] [cv] [cv]
```

The Headedness parameter is the grid-internal interface between the layers of the grid. That is, Headedness is Projection within the grid. Universal Grammar constrains the grid-internal interface to the operation of the Headedness parameter, thus restricting each constituent to a single projected element, which must be constituent terminal. In this, we depart from HV, who allowed non-head terminal constituents in the case of ternary constituents. For the treatment of ternary languages within this framework, see Chapter 2.

Now we need to apply Edge marking and Headedness to line 1. In Koya the line 1 settings are the same as those of line 0. That is, the settings are Edge:LLL, and Head:L. These parameter settings yield the grid in (14):

(14)

```
  x
  |
 (x          x                           x
  |          |                           |
 (x    x   ( x    x     x     x        ( x     x     x
  |    |   | |    |     |     |        | |     |     |
[cv] [cv] [cvx]  [cv]  [cv]  [cv]     [cvx]  [cv]  [cv]
```

We review the action of the various parametric computations in Koya in (15). To reduce the clutter in the diagrams, we will suppress the association lines and adopt the typographical convention that H will stand for a heavy syllable in the language (one subject to (6)), and L will stand for a light syllable in the language (one not subject to (6)).

```
(15)  Line 0  Project:L    x  x (x  x  x  x (x  x  x
                           L  L  H  L  L  L  H  L  L

              Edge:LLL    (x  x (x  x  x  x (x  x  x
                           L  L  H  L  L  L  H  L  L

              Head:L       x     x           x
                          (x  x (x  x  x  x (x  x  x
                           L  L  H  L  L  L  H  L  L

      Line 1  Edge:LLL    (x     x           x
                          (x  x (x  x  x  x (x  x  x
                           L  L  H  L  L  L  H  L  L

              Head:L       x
                          (x     x           x
                          (x  x (x  x  x  x (x  x  x
                           L  L  H  L  L  L  H  L  L
```

We should ask ourselves at this point whether the devices of Projection, Edge marking and Heads offer a unique solution for Koya. For example, we should ask, "Could Koya be right-headed on line 0?" That is, could we obtain the skeleton grid (3) by means of right-headed constituents. Indeed, we could. This would, of course, require changes in the other parameters. In particular, Koya would have to project the RIGHT boundary of heavy syllables instead of the left one. Likewise, the Edge parameter would have to be set to put a RIGHT parenthesis to the RIGHT of the LEFT-most mark on line 0, to ensure that the initial element gets stress. The derivation for this alternative is shown in (16):

(16)

```
Line 0  Project:R   x  x  x) x  x  x  x) x  x
                    L  L  H  L  L  L  H  L  L

        Edge:RRL    x) x  x) x  x  x  x) x  x
                    L  L  H  L  L  L  H  L  L

        Head:R      x     x           x
                    x) x  x) x  x  x  x) x  x
                    L  L  H  L  L  L  H  L  L

Line 1  Edge:RRL    x)    x           x
                    x) x  x) x  x  x  x) x  x
                    L  L  H  L  L  L  H  L  L

        Head:R      x
                    x)    x           x
                    x) x  x) x  x  x  x) x  x
                    L  L  H  L  L  L  H  L  L
```

For the facts of Koya stress both systems will work. So which one does the child actually have? As Blevins (1992) points out, many kinds of other evidence could bear on this issue. Various morphological processes such as reduplication could give evidence for foot structure. Likewise, phonological processes can be sensitive to metrical structure, and can affect metrical structure. For example, the second analysis predicts that a string of unmetrified material exists at the right edge of the form. We might be able to find rules sensitive to this difference. Another potential difference could arise if we found out that some vowels were deleted. If a vowel in a stressed syllable happened to be deleted what would happen to its stress? The two sets of parameter settings differ in their predictions of where the stress would migrate. As we see in (17), left-headed feet would predict right-ward shift, right-headed feet left-ward shift.

(17)

	Head:L	Head:R
Project Deletion	x (x x ... V ... V ... V	x x) x ... V ... V ... V
Deletion	x (x ... V V	x) x ... V V
Head	x (x ... V V	x) x ... V V

But what if no such evidence is available? As pointed out, above, the right-headed analysis predicts a string of unmetrified elements at the right edge of the word. We might expect that systems which generate complete (exhaustive) metrification are preferred over those that do not. This metric would prefer the left-headed system for Koya.

In the examination of learning procedures for parameterized models of metrical theory, Dresher & Kaye (1990), and Dresher (1992) offer compelling evidence that for a child to learn a grammar, the child must be pre-equipped with default settings for the parameters. We might then expect that certain parameter settings are more accessible to the child than others. In particular, I propose that homogeneous parameter settings are preferred over heterogeneous settings. The left-headed analysis of Koya is homogeneous, having all the parameters set to "L". The right-headed analysis is heterogeneous. Thus, this metric would also prefer the left-headed analysis of Koya. However, languages are not restricted to being homogeneous. One example of a heterogeneous language is Winnebago (discussed in Chapter 2).

3. *Warao and Weri*

Languages are not limited to placing stresses only on elements near an edge or on elements with special properties. Languages also can construct a sequence of constituents over a line of grid marks. In all known cases these constituents are either binary or ternary. The stress systems of Weri and Warao are repeated in (18).

(18)	*Warao*	Stress falls on even-numbered syllables counting from the end of the word. Main stress is on the penultimate syllable.
	Weri	Stress falls on all odd-numbered syllables counting from the end of the word. Main stress is on the last syllable.

Examples are shown in (19).

(19)		*Odd*	*Even*
	Warao	yiwàranáe	yàpurùkitàneháse
	Weri	àkunètepál	ulùamít

Notice that the stress system of Maranungku, (20), is the mirror image of Weri's.

(20) *Maranungku* Stress falls on all odd-numbered syllables counting from the beginning of the word. Main stress is on the initial syllable.

Clearly in Warao and Weri, constituency is assigned starting from the right-most element, grouping two elements at a time. In Maranungku elements are instead grouped left to right. Languages achieve such systems by including settings of the Iterative Constituent Construction parameter, (21).

(21) *Iterative constituent construction parameter*
Insert a parenthesis every two elements starting from
the $\left\{\begin{matrix}\text{left}\\\text{right}\end{matrix}\right\}$-most element.

Constituents are constructed by inserting the "far" parenthesis. That is, right parentheses are inserted when going left to right; and left parentheses when going right to left. Following the suggestion of Howard (1972) on the directional application of rules, the metrical rules have no "look-ahead". This means that the ICC parameter governs the choice between the rules given in (22).

(22) *Rules of iterative constituent construction*

ICC:R =	$\emptyset \rightarrow ($ / _ x x	(right to left)
ICC:L =	$\emptyset \rightarrow)$ / x x _	(left to right)

The application of these rules yields a sequence of binary constituents. The Iterative Constituent Construction rules do not have the option of generating constituents with less than two marks. As a result, in a string with an odd number of syllables the application of an Iterative Constituent Construction rule will leave the far terminal element unmetrified. This inability to exhaustively parse all words stands in contrast to the view of HV where the Exhaustivity Condition caused all such items to form constituents. As a result in a string with an odd number of syllables the application of some forms of the Iterative Constituent Construction rules will leave the far terminal element unmetrified.

A further consequence of the formulation of the Iterative Constituent Construction is that no ICC rule can apply to monosyllabic words. This result is compatible with theories of minimality like those of McCarthy & Prince (1986, etc) and Hayes (1991). This theory predicts both kinds of languages: those with minimality effects and those without. Those without minimality set the line 0 Edge parameter, those with minimality do not set the line 0 edge. Hayes (1991) indicates that Warao allows monomoraic feet, offering evidence that Edge:RRR is a line 0 component of the stress system, as we must construct a constituent even in monomoraic words.

The Warao parameters are given in (23):

(23)	Line 0:	Edge:RRR	ICC: R	Head:L
	Line 1:	Edge:RRR		Head:R

These parameters will yield the derivations in (24).

(24)

```
              | Even                | Odd
--------------+---------------------+------------
Project       |  x x x x x x x x)   |  x x x xx)
Edge:RRR      | yapurukitanehase    | yawiranae
--------------+---------------------+------------
ICC:LR        | (x x(x x(x x(x x)   | x(x x(xx)
              | yapurukitanehase    | yawiranae
--------------+---------------------+------------
Head:L        |                x    |         x
Line 1        |  x   x   x     x)   |    x    x)
              | (x x(x x(x x(x x)   | x(x x(xx)
              | yapurukitanehase    | yawiranae
```

Notice that in placing the far parenthesis the Iterative Constituent Construction rules do not have the option of generating constituents with less than two marks. In the Odd case this leaves an unmetrified initial mark.

However, in Weri, words with an odd number of syllables must have a constituent with a single element. To achieve this, Weri sets the Edge parameter to LLL. The full set of parameters for Weri is given in (25):

(25)

Line 0:	Edge:LLL	ICC: R	Head:R
Line 1:	Edge:RRR		Head:R

These parameter settings yield the derivations in (26).

(26)

```
              | Even           | Odd
--------------+----------------+--------------
Project       | (x xx x        | (x x x x x
Edge:LLL      |  uluamit       |  akunetepal
--------------+----------------+--------------
ICC:R         | (x x(x x       | (x(x x(x x
              | ulu amit       |  akunetepal
--------------+----------------+--------------
Head:R        |         x      |           x
Line 1        |    x    x)     |  x    x   x)
              | (x x(x x       | (x(x x(x x
              |  ulu amit      |  akunetepal
```

Like Koya, there is another possible parameter setting that will generate the stress patterns of Weri, shown in (27).

(27)

Line 0:	Edge:LLR	ICC: R	Head:L
Line 1:	Edge:RRR		Head:R

The parameters in (27) yield the derivations in (28).

(28)

	Even	*Odd*
Project Edge:LLR	x xx(x uluamit	x x x x(x akunetepal
ICC:R	x(xx(x uluamit	(x x(x x(x akunetepal
Head:L Line 1	x x x(xx(x uluamit	x x x (x x(x x(x akunetepal

So the two possible systems for line 0 in Weri are [Edge:LLL ICC:R Head:R] and [Edge:LLR ICC:R Head:L]. Neither of these systems is completely homogeneous. However, the Edge marking of the first system is homogeneous whereas that of the second is not. Further, the second system generates some unmetrified elements, whereas the first does not. And, though both systems generate single element (degenerate) constituents the first system does so only with odd words, whereas the second system does this with all words. Finally, even words in the second system have both a degenerate feet and an unmetrified element, whereas in the first system, even words have homogeneous constituents, each constituent consisting of exactly two elements. Therefore, the first analysis of Weri is the preferred one.

Prince (1985) has suggested that unbounded feet can be eliminated by building binary feet and then using stray adjunction to add material to the binary feet. Such a view makes little sense in the present theory. Unbounded stress systems are simpler than binary systems. Binary systems contain some version of the ICC, whereas unbounded systems simply lack any form of the ICC. The stray adjunction analysis would necessarily involve further complications of non-iterative or sparse constituent construction to be able to handle all of the unbounded systems. Thus, given the theory of metrical constituent structure developed here, it is much simpler to derive binary systems as an enrichment of unbounded systems.

4. *Tubatulabal*

Tubatulabal (Voegelin 1935, Hayes 1980) is a language which projects parentheses as well as marks, like Koya. In addition, Tubatulabal sets the ICC, creating binary constituents. Further, Tubatulabal demonstrates an interesting singleton footing. In Tubatulabal, stress falls on final vowels, long vowels and any syllable two to the left of a stressed vowel. Examples are shown in (29):

(29)	táaháwiláap	*in the summer*
	pïtḯpïtḯïdinát	*he is turning it over repeatedly*
	ḯïˀḯïˀáanicá	*he will meat-fast*
	pốnihwḯn	*of his own skunk*

Clearly constituents are being constructed right to left. But which kind of parentheses are inserted? The two possibilities are shown in (30).

(30)	Analysis 1	Project: R		ICC: R	Head: R
	Analysis 2	Project: L	Edge:LLR	ICC: R	Head:L

The clue to figure out which of these is correct comes in considering a span of syllables HLLH. Derivations under the two analyses are shown in (31):

(31)

	Analysis 1	*Analysis 2*

Project	`x)  x  x  x)`
	`taahawilaap`
	`H   L  L  H`
		`(x   x  x(x`
		`taahawilaap`
		`H   L  L  H`

Edge		
ICC	`x)  x(x  x)` `taahawilaap`	`(x  (x  x(x` `taahawilaap`

Head	`x         x`
	`x)  x(x  x)`
	`*taahawilaap`
		`x    x    x`
		`(x  (x  x(x`
		`taahawilaap`

In Analysis 1, applying Project:R to HLLH leaves a span of three marks: H)LLH). Since single elements do not constitute enough material to form a constituent, the ICC groups these three marks into only one binary constituent, plus a left-over mark, H)L(LH). The left-over mark is not in any constituent, and thus does not gain stress. This parsing produces one stress too few in these words.

In Analysis 2, Project:L also leaves a span of three marks, (HLL(H. However, this time the parenthesis at the far end will cause the left-over mark to form a constituent by itself. The crucial difference is the nature of the three mark span. In Analysis 1 this span is LLH, and the left-over mark is in an L syllable, which does not provide its own constituent. In Analysis 2, the span is HLL, and the left-over mark is in an H syllable, which provides its own parenthesis, (H(LL(H. Because of this, only Analysis 2 does produce the correct stress patterns for Tubatulabal.

5. *Macedonian I*

Macedonian word stress is predominantly antepenultimate (Franks (1987, 1989, 1991), HV, Hammond (1989a)). However, there are exceptions to this, which we will examine at the end of this chapter. Examples of a normal stem are shown in (32).

(32)

Stem	Stem + V	Stem + VCV	
vodéničar	vodeníčari	vodeničárite	*miller*

The parameter settings in (33) achieve antepenultimate stress.

(33)

Line 0:	Edge:RLR	ICC:R	Head:L
Line 1:	Edge:RRR		Head:R

Derivations are shown in (34).

(34)

	Stem	*Stem + V*	*Stem + VCV*
Project Edge	x x x)x vodeničar	x x x x)x vodeničari	x x x x x)x vodeničarite
ICC	x(x x)x vodeničar	(x x(x x)x vodeničari	x(x x(x x)x vodeničarite
Head Line 1	x x) x(x x)x vodeničar	x x x) (x x(x x)x vodeničari	x x x) x(x x(x x)x vodeničarite

Notice that as a consequence of the fact that the Iterative Constituent Construction requires two adjacent marks to insert a parenthesis, the last element is systematically precluded from being part of a constituent due the parenthesis placed by the Edge parameter. Since the last mark will effectively be "frozen out" it acts for stress placement as if it is not there. Previous metrical theories invoked a special device of Extrametricality to skip such elements. We are able to capture this extrametricality effect as a specific manifestion of the general edge marking.

In addition to main stress, however, the parameter settings also generate secondary stresses, which are not present in the speech of Macedonian speakers. We shall postulate that unlike the preceding languages, Macedonian is subject to a special rule of Conflation which eliminates all but the main stress in the word. For the present, we will follow Halle & Kenstowicz (1991) in defining conflation as the elimination of all metrification except that of the stressed foot. The formal mechanism for this is examined in Chapter 3. The grids resulting from the application of Conflation to the grids in (34) are shown in (35).

(35)

Conflation	x x(x x)x vodeničar	x x x(x x)x vodeničari	x x x x(x x)x vodeničarite

A parameter of iterativity has been proposed as a replacement for Conflation. Under this view, Macedonain has no secondary stresses because it is non-iterative, that is, it only constructs a single constituent. This theory is difficult to maintain given the facts of exceptional items in Macedonain, discussed below. The general question of a parameter for iterativity is considered along with formal mechanisms for Conflation, in Chapter 3.

6. *Selkup and Khalkha Mongolian*

Koya, Selkup (Kuznecova et al (1980)) and Khalkha Mongolian (Street (1963)) each have some words with initial stress. The descriptions of these languages are repeated in (36).

(36)	*Koya*	Primary stress on initial syllable. Secondary stress on closed syllables, and syllables with long vowels.
	Selkup	Stress right-most long vowel, otherwise the initial vowel.
	Khalkha	Stress left-most long vowel, otherwise the initial vowel.

Recall the parameter settings for Koya, repeated in (37):

(37)	Line 0:	Project:L	Edge:LLL	Head:L
	Line 1:		Edge:LLL	Head:L

In (38) we see the application of the Koya parameters to two abstract words, one all light, the other with two heavy syllables.

(38)	Line 0	Project:L	x x x x x L L L L L	x (x x x (x x L H L L H L
		Edge:LLL	(x x x x x L L L L L	(x (x x x (x x L H L L H L
		Head:L	x (x x x x x L L L L L	x x x (x (x x x (x x L H L L H L
	Line 1	Edge:LLL Head:L	x (x (x x x x x L L L L L	x (x x x (x (x x x (x x L H L L H L

The parameter settings in (39) capture the Selkup facts.

(39)	Line 0:	Project:L	Edge:LLL	Head:L
	Line 1:		Edge:RRR	Head:R

Selkup and Koya have the same line 0 parameters, but differ in the line 1 parameters. The derivation for the two kinds of words in Selkup is shown in (40).

(40)	Line 0	Project:L	x x x x x L L L L L	x (x x x (x x L H L L H L
		Edge:LLL	(x x x x x L L L L L	(x (x x x (x x L H L L H L
		Head:L	x (x x x x x L L L L L	x x x (x (x x x (x x L H L L H L
	Line 1	Edge:RRR Head:R	x x) (x x x x x L L L L L	x x x x) (x (x x x (x x L H L L H L

As shown in (41), the settings in (39) locate main stress on the rightmost long vowel, but in words without long vowels, stress is located on the first syllable. Like Macedonian, Selkup eliminates secondary stresses through Conflation.

Khalkha stresses the first heavy syllable, or when there are no heavy syllables, the first syllable. Khalkha, like Selkup and Macedonian, must end up eliminating secondary stresses through Conflation. Further, Khalkha must be the line 1 mirror image of Selkup, placing word stress on the *first* constituent. Notice that if the Edge parameter were set to LLL on line 0 this would produce a pattern of uniform initial stress. The presence of heavy syllables disallows the initial syllable from heading a line 0 constituent. This can be accomplished by setting the line 0 Edge parameter to Edge:RRR. The parameter settings for Khalkha are given in (41).

(41)	Line 0:	Project:L	Edge:RRR	Head:L
	Line 1:		Edge:LLL	Head:L

In placing a right boundary to the right of the right-most element we will again get initial stress in all light words. However, in words with heavy syllables, the elements before the first heavy syllable will remain unmetrified. This will prevent the unwanted placement of stress on the initial syllable in such words, as illustrated by the derivations in (42).

```
(42)  Line 0  Project:L    x x x x x        x (x  x  x (x  x
                           L L L L L        L  H  L  L  H  L

              Edge:RRR     x x x x x)       x (x  x  x (x  x)
                           L L L L L        L  H  L  L  H  L

              Head:L       x                   x        x
                           x x x x x)       x (x  x  x (x  x)
                           L L L L L        L  H  L  L  H  L

      Line 1  Edge:LLL     x                   x
              Head:L      (x                  (x        x
                           x x x x x)       x (x  x  x (x  x)
                           L L L L L        L  H  L  L  H  L
```

Khalkha thus differs from Koya in the setting of the line 0 Edge parameter. In words without heavy syllables, this difference will have no effect; both settings yield the same results. As shown in (43), in words with heavy syllables, in Khalkha the initial string of light syllables will not form a constituent, but in Koya they *will*.

(43)

Koya	Khalkha
x	x
(x x x	(x x
(x (x x x (x x	x (x x x (x x)
L H L L H L	L H L L H L

In HV, the stress system of Khalkha caused some formal problems. The lack of initial stress in words with heavy syllables was handled by not constructing constituents on line 0. To get stress in words without heavy syllables, the line 1 parameters were allowed to apply to line 0. However, facts of stress shift in the essentially similar languages Russian and Sanskrit showed that there must indeed be line 0 constituents. To handle, constituents were constructed only when they could be inferred from line 1 marks. The shortcomings of this account are that constituent construction can have different orderings with head placement, and that parameters intended to apply on one line can apply instead to other lines The analysis provided here solves these problems. The construction of constituents always precedes Head projection, and parameters only apply to the intended line.

7. *Turkish*

The behavior of stress in exceptional items in Turkish has attracted a great deal of attention, and has been analyzed by Sezer (1983), Poser (1984), Kaisse (1985), HV, Barker (1989), Halle & Kenstowicz (1991) and van der Hulst & van de Weijer (1991). In this analysis we will consider only the correct placement of the main stress. For a discussion of the facts of Turkish secondary stresses see van der Hulst & van de Weijer (1991). Poser's description of the main stress facts is given in (44).

(44) In Turkish stress generally falls on the last syllable of the word. ... Exceptions are of two kinds. First, there are a number of words with inherent stress on some non-final syllable. In this case, stress does not shift when suffixes are added ... [Second,] there are a number of suffixes that never bear stress.

Some examples are given in (45).

(45)	a. adám	*man*	adam-lár	*men*	adam-lar-á	*to the men*
	b. mása	*table*	mása-lar	*tables*	mása-lar-a	*to the tables*
	c. yorgún	*tired*	yorgun-lár	*tired (pl)*	yorgún-dur-lar	*they are tired*

The stress pattern of *adam* is readily generated by setting the line 0 parameters to [Edge:RRR, Head:R]. The derivation for *adamlará* is shown in (46).

(46) Line 0 Project

```
x x   x  x
adam-lar-a
```

Edge:RRR

```
x x   x  x)
adam-lar-a
```

Head: R

```
         x
x x   x  x)
adam-lar-a
```

The formal problem that arises at this point is how to represent the morphemes that generate the exceptional patterns in (b) and (c). We note that these are of two kinds. The stem morpheme, *mása* takes stress on the penultimate syllable whereas the exceptional suffix morpheme *-́dur* places stress on the immediately preceding vowel. We can achieve this by postulating that some morphemes have an extra right boundary before their final line 0 mark. That is, these two morphemes have the representations in (47).

(47)

```
x)x        )x
masa      -dur
```

In other words, Turkish morphemes can be exceptional with respect to their final vowel. There are two possible ways to lexically represent additional idiosyncratic parentheses: lexical specification of line 0, or lexical specification of some parameter settings.

The lexical specification of line 0 is the most straightforward translation of the lexical line 1 marks of HV. Individual morphemes could stipulate various aspects of prosodic structure (cf. Inkelas (1989)). In particular, they could include extra line 0 parentheses. Under this theory morphemes simply carry a partial line 0 specification, and all tiers are concatenated together when morphemes are concatenated. Therefore, an individual morpheme could have several lexical parentheses. Almost all languages seem to require a maximum of only one parenthesis per morpheme. The exceptions to this that I am aware of are Moses-Columbian (examined in Chapter 4), and Shingazidja (Cassimjee and Kisseberth (1989, 1992)).

Thus, it is compelling to try to offer an account of why most morphemes can only have one exceptional parenthesis. A way to achieve this result is to combine the insights of Tsay (1990) and Barker (1989) and constrain them further. Tsay suggests that lexical exceptionality is lexical parameter setting on morphemes. Barker suggests that the Turkish exceptionality is the triggering of applications of extrametricality. Since in this study extrametricality is an Edge setting (see Macedonian, above), the logical combination of these two ideas is to have lexically marked morphemes trigger applications of a specific Edge marking.

If morphemes were limited to a single Edge marking, this would reduce the number of possible exceptional morphemes to nine. There are eight settings for positive Edge marking, and the specification of a null Edge marking, which will be employed in Macedonian exceptional items, below. The number of exceptional items might be further restricted by restricting the kind or location of exceptional parentheses. For example, the language might only allow left parentheses. Or, the language might only allow exceptional parentheses at the right edge, as is the case in Polish (below).

Pursuing the lexical Edge marking theory of lexical stress, if the exceptional morphemes of Turkish are subject to an extra Edge marking, either in the lexicon, or as part of a special cycle, this will achieve the desired result. Specifically, the Turkish exceptional morphemes will be marked Edge:RLR. Giving the morphemes this extra parenthesis, and setting the line 1 parameters to [Edge:LLL, Head:L] correctly locates the main stress, as shown in (48):

```
(48)  Line 0  Project         | x)x  x    | x  x  )x   x      |
              Lexical Edges   | masa-lar  | yorgun-dur-lar    |
              Edge:RRR        | x)x  x)   | x  x  )x   x)     |
                              | masa-lar  | yorgun-dur-lar    |
              Head: R         | x    x    |    x       x      |
                              | x)x  x)   | x  x  )x   x)     |
                              | masa-lar  | yorgun-dur-lar    |
      Line 1  Edge:LLL        | x         |    x              |
              Head:L          |(x    x    |   (x       x      |
                              | x)x  x)   | x  x  )x   x)     |
                              | masa-lar  | yorgun-dur-lar    |
```

In (49) we see a derivation for a form with two exceptional morphemes. Again, main stress is correctly located on the first exceptional stress by the line 1 parameters.

```
(49)  Line 0  Project         | x x)x )x   x     |
              Lexical Edges   | kenedi-dir-ler   |
              Edge:RRR        | x x)x )x   x)    |
                              | kenedi-dir-ler   |
              Head: R         |   x x      x     |
                              | x x)x )x   x)    |
                              | kenedi-dir-ler   |
      Line 1  Edge:LLL        |   x              |
              Head: L         |  (x x      x     |
                              | x x)x )x   x)    |
                              | kenedi-dir-ler   |
                              | they're the Kennedys |
```

Turkish also has a few types of words which are not covered by the analysis so far. The first case is the behavior of toponyms. The various cases are summarized in (50).

(50)	a.	L Ĺ X #	O dí pus	Ke né di
	b.	L H́ X #	Sa mu él son	Va šínk ton
	c.	H́ L X #	Án ka ra	Šév ro le
	d.	H H́ X #	Men dél son	Kam čát ka

The words in (50c) cannot be handled by the rules so far, having stress one syllable further to the left than expected.

Words in *-en* behave similarly. Examples are given in (51).

(51)	a.	Ĺ L en #	ay rí ye ten	*separately*
	b.	L H́ en #	e sáa sen	*basically*
	c.	H́ L en #	ha kíi ka ten	*in truth*

Again, the cases in (51c) have stress one syllable further to the left than expected. However, (51a) also has stress an extra syllable to the left, unlike (50a).

The exceptional disyllabic suffixes fall into two classes. One behaves as expected, conforming to Edge:RLR, generating pre-final stress (52a). The other case has stress one syllable further to the left, (52b).

(52)	a.	yap-árak	*by doing*
	b.	akšám-leyin	*at evening*

All of these problematic cases can be handled by a extra rule of parenthesis insertion, which has the basic form shown in (53).

(53) $\varnothing \rightarrow)\ /\ \ x \_\ x)$

To derive (50c) and (51c), (53) can be restricted to the form in (54), effectively retracting main stress off a light syllable onto a heavy syllable.

(54) $\varnothing \rightarrow) \; / \; \underset{H}{x} \; \_ \; \underset{L}{x})$

However, we must generalize (54) at least to (55) in order to account for the *-en* cases.

(55) $\varnothing \rightarrow) \; / \; x \; \_ \; \underset{L}{x})$

Thus, certain stems and suffixes trigger some form of a special rule which adds an extra metrical boundary. The effect is to cause a leftward shift in main stress. This rule seems to have a complicated set of lexical, morphological and phonological conditions. Getxo Basque (Hualde & Bilbao (1992)) has a stress system very similar to Turkish. Getxo Basque even has a similar system of lexical stress, including a set of pre-pre-stressing morphemes, which trigger a rule essentially the same as (53).

8. *Polish*

We should expect to find languages in which morphemes can carry the same sort of lexical exceptionality displayed in Turkish, but in which the Iterative Constituent Construction parameter is set. Polish is an example of this. The Polish data in this section comes from HV, Hammond (1989b) and Franks (1991). In this analysis we will consider only the correct placement of the main stress. For a discussion of the facts regarding secondary stresses in Polish see Rubach & Booij (1985).

Polish words generally have penultimate stress. However, some words have antepenultimate stress and others have final stress. Specifically, Polish has four kinds of stems, illustrated in (56). The P stems represent the unmarked case, having penultimate stress in all forms. The P/A stems, like the normal stems, have penultimate stress when they appear alone. But when a single vowel is added the resulting form has antepenultimate stress. When two or more vowels are added, the word again has penultimate stress.

The A/P stems have antepenultimate stress alone, penultimate stress with endings. Lastly, the F/P stems have final stress alone, and penultimate stress with endings.

(56)

	Stem	*Stem + V*	*Stem + VCV*	
P	hipopótam	hipopotámu	hipopotamámi	*hipopotamus*
P/A	repúblik	repúblika	republikámi	*republic*
A/P	uniwérsytet	uniwersytétu	uniwersytetámi	*university*
F/P	režím	režímu	režimámi	*regime*

Notice that, as shown in the right-most column of (56), once two syllables are added after any stem the resulting word will have the normal penultimate stress.

Beginning with the normal (P) stems, in order to get stress on the second syllable from the end, Polish has the parameter settings in (57):

(57)

Line 0:	Edge:LLL	ICC:R	Head:L
Line 1:	Edge:RRR		Head:R

The line 0 Edge:LLL setting accounts for the fact that Polish monosyllabic words are stressed. (58) shows the derivations for the P stems.

(58)

```
              Stem          Stem + V        Stem + VCV
Project     | x x x x      | x x x x x     | x x x x x x
            | hipopotam    | hipopotamu    | hipopotamami
Edge        | (x x(x x     | (x(x x(x x    | (x x(x x(x x
ICC         | hipopotam    | hipopotamu    | hipopotamami
Head        |     x        |       x       |           x
Line 1      | x   x)       | x x   x)      | x   x   x)
            | (x x(x x     | (x(x x(x x    | (x x(x x(x x
            | hipopotam    | hipopotamu    | hipopotamami
```

To capture the exceptional stress patterns in Polish, the stems of nouns with exceptional stress carry a lexical Edge specification. Specifically, the exceptional noun stems have the edge parameter settings in (59):

(59) P/A = Edge:RRR   A/P = Edge:RLR   F/P = Edge:LLR

```
 x x  x)          x x x  x)x          x(x
republik         uniwersytet         režim
```

Polish does not have post-stressing stems, though such stems do occur in Russian, for example *korol'* 'king'. Post-stressing stems would be marked Edge:LRR. The Russian stress system is examined in Chapter 4.

Derivations for the P/A stems are given in (60).

(60)

	Stem	*Stem + V*	*Stem + VCV*
Project Lex Edge	`x x  x)` `republik`	`x x  x)x` `republika`	`x x  x)x x` `republikami`
Edge ICC	`(x(x  x)` `republik`	`(x(x  x)x` `republika`	`(x(x  x)(x x` `republik ami`

Head Line 1	`  x`
	`x x)`
	`(x(x  x)`
	`republik`
		`  x`
		`x x)`
		`(x(x  x)x`
		`republika`
			`          x`
			`x x       x)`
			`(x(x  x)(x x`
			`republik ami`

The P/A stems dictate that the stem-final vowel must always be the right-most element of a constituent. Since constituent construction takes place from the right-most element, this means that these stems will always have the same constituent structure. When there is a single line 0 element following the stem, it remains unmetrified. Antepenultimate stress results. This is the same effect shown with the general antepenultimate stress in Macedonian, above. When there are two syllables following the stem, however, there is always enough material to build a constituent, so these forms have penultimate stress.

The derivations for the A/P stems, are given in (61).

(61)

	Stem	*Stem + V*	*Stem + VCV*
Project Lex Edge	x x x x)x uniwersytet	x x x x)x x uniwersytetu	x x x x)x x x uniwersytetami
Edge ICC	(x x(x x)x uniwersytet	(x x(x x)(x x uniwersy tetu	(x x(x x)x(x x uniwersytetami
Head Line 1	x x x) (x x(x x)x uniwersytet	x x x x) (x x(x x)(x x uniwersy tetu	x x x x) (x x(x x)x(x x uniwersytetami

In an A/P form without a suffix the final mark is isolated due to its lexical Edge marking. Therefore, the Iterative Constituent Construction cannot form a constituent with it, and it remains unmetrified, giving antepenultimate stress. Whenever there is one or more syllables following the stem there will be enough material to build a constituent, and penultimate stress will result.

Finally, the derivations for the F/P stems are given in (62).

(62)

	Stem	*Stem + V*	*Stem + VCV*
Project Lex Edge	x(x režim	x(x x režimu	x(x x x režimami
Edge ICC	(x(x režim	(x(x x režimu	(x(x(x x režimami
Head Line 1	x x x) (x(x režim	x x x) (x(x x režimu	x x x x) (x(x(x x režimami

The F/P stems are Edge:LLR, forcing the last vowel of the stem to be the left-most element of a constituent. Thus, when there is no following material, this will form a constituent with a single element, yielding final stress. When suffixes occur with the word enough material for a full constituent is always available, and penultimate stress occurs. Thus, we can account for the various exceptional stem types in Polish with lexical Edge marking, with all words subject to the same grammatical stress parameters.

9. *Macedonian II*

Recall that Macedonian word stress is predominantly antepenultimate, with the parameter settings in (63).

(63)				
	Line 0:	Edge:RLR	ICC:R	Head:L
	Line 1:	Edge:RRR		Head:R
	Conflation			

Macedonian has two kinds of exceptions to the normal stress patterns: stems with penultimate (P) and final (F) stress (HV, Franks (1987, 1991), Hammond (1989)). Examples of each kind are shown in (64).

(64)	*Stem*	*Stem + V*	*Stem + VCV*	
P	televízor	televízori	televizórite	*television*
F	kandidát	kandidáti	kandidátite	*candidate*

The P stems have penultimate stress alone, and antepenultimate stress with endings. The F stems have final stress alone, penultimate stress when a single syllable follows, and antepenultimate stress when two or more syllables follow.

Recall that we have limited our lexical stress capacity to giving a morpheme a special Edge setting. The representation for an F stem is given in (65).

(65) Edge:LLR

```
x  x(x
kandidat
```

The F stems behave similarly to their Polish counterparts, receiving stress when there are too few subsequent marks to construct a constituent. Thus, the final vowel of the stem will have stress in all of these forms. The derivations are given in (66).

(66)

```
                  Stem            Stem + V        Stem + VCV
Project         | x   x(x       | x   x(x x     | x   x(x x x
Lex Edges       | kandidat      | kandidati     | kandidatite
Edge            |               | x   x(x)x     | x   x(x x)x
                |               | kandidati     | kandidatite
ICC             | (x  x(x       | (x  x(x)x     | (x  x(x x)x
                | kandidat      | kandidati     | kandidatite
Head            |       x       |       x       |       x
Line 1          | x     x)      | x     x)      | x     x)
                | (x  x(x       | (x  x(x)x     | (x  x(x x)x
                | kandidat      | kandidati     | kandidatite
```

The grammatical Edge marking is not allowed to apply to the stem by itself. If it were to apply, it would create a vacous constituent, as shown in (67).

(67)

```
Project      | x   x(x
Lex Edges    | kandidat
Edge         |  x   x()x
             | *kandi dat
```

The other interpretation that could be given in this case is that the Edge marking creates a legitimate pair of parentheses before the last mark, as in (68).

(68)

```
Project      | x   x(x
Lex Edges    | kandidat
Edge         |  x   x)(x
             |  kandi dat
```

This would yield an acceptable result for Macedonian, but it is not the right solution for two reasons. The first is that this does not follow the statement of the Edge marking rule, repeated in (69).

(69) Edge:RLR = $\varnothing \rightarrow)\ /\ \_\_\ x\ \#$

The rule in (69) says that the right parenthesis is inserted immediately before the final grid mark. This produces the grid in (67), not the one in (68). We could simply stipulate the () is always converted to)(, but this also appears to be wrong. For an empirical argument regarding this point, see the analysis of Cayuvava in Chapter 2. For the present, we will simply stipulate that the Edge marking does not occur in this form. The formal mechanism blocking its application is discussed in Chapter 2.

The P/A stems, could achieve penultimate stress when the stem occurs alone with the lexical Edge setting in (70).

```
(70)    Edge:RRR     x x x x)
                    televizor
```

For the stem alone, the Iterative Constituent Construction will form a binary constituent at the right edge of the word, yielding penultimate stress. When a single vowel follows, any subsequent grammatical Edge marking is vacuous, and we get the normal antepenultimate stress. However, we run into a problem when two vowels follow, as the derivations in (71) show.

```
(71)                 Stem          Stem + V        Stem + VCV

Project            x x x x)       x x x x)x       x x x x)x x
Lex Edges         televizor      televizori      televizorite

Edge                                              x x x x)x)x
                                                 televizorite

ICC               (x x(x x)      (x x(x x)x      (x x(x x)x)x
                  televizor      televizori      televizorite

Head                   x              x                    x
Line 1             x   x)         x   x)          x   x    x)
                  (x x(x x)      (x x(x x)x       (x x(x x)x)x
                  televizor      televizori      *televizorite
```

The analysis predicts the wrong stress in *televizórite*. One solution would be to add a rule of bracket deletion, as shown in (72).

(72)

	Stem + VCV
Project	x x x x)x x televizorite
Edge	x x x x)x)x televizorite
) → Ø / __ x)	x x x x x)x televizorite
ICC	x(x x(x x)x televizorite
Head Line 1	x x x) x(x x(x x)x televizorite

Invoking this bracket deletion rule has the undesirable consequence of having to allow language particular rules to occur between the application of two parameters on a single line.

The other option is to say that the penultimately stressed stems lexically stipulate that *no* Edge be applied to them. The derivations in (73) show the result of the requirement that P strems receive no Edge marking on their own.

(73)

	Stem	*Stem + V*	*Stem + VCV*
Project	x x x x televizor	x x x x x televizori	x x x x x x televizorite
Edge	*lexically* *blocked*	x x x x)x televizori	x x x x x)x televizorite
ICC	(x x(x x televizor	(x x(x x)x televizori	x(x x(x x)x televizorite
Head Line 1	x x x) (x x(x x televizor	x x x) (x x(x x)x televizori	x x x) x(x x(x x)x televizorite

This analysis requires particular interpretations of what Edge:Ø on a stem is taken to mean. The setting of Edge:Ø prevents the application of Edge marking to that form. It does not prevent Edge marking in derived forms. In (73) Edge:RLR does apply when suffixes are added, as shown in the last two columns.

Further evidence for this analysis of the P stems comes from another interesting area of Macedonian stress, the enclitic stress, discussed in Franks (1989), Halle & Kenstowicz (1991) and Kenstowicz (1991). Examples of enclitic stress patterns are shown in (74).

(74)	3 + 1	okolú + rid	*around a hill*
	2 + 2	prekú + zima	*through the winter*
	2 + 1	prekú + rid	*over the hill*
	2 + 1 alternate	préku + rid	
	1 + 2	stár + čovek	*old man*

Let us assume, following Halle & Kenstowicz that the metrical structure of the second word is deleted upon cliticization and the stress parameters are reapplied to the entire form. An example derivation is shown in (75).

(75)

Cliticize	`(x x)x    x` ` okolu + rid`
Edge	`(x x)x)   x` ` okolu + rid`
ICC	

Head
Line 1
	`      x`
	` x    x)`
	`(x x)x)   x`
	` okolu + rid`

Main stress falls on the former "extrametrical" syllable in these forms. Recall that the location of secondary stresses are irrelevant, because in Macedonian Conflation eliminates the secondary stresses. We have no need to "revoke extrametricality", the concatenation of forms suffices, as no mark was made "invisible". Rather, the mark was simply in a position where the ICC could not construct a constituent with it. As we know some words allow the edge marking RLR to take place and others do not (the P stems). Notice that we would have to prevent the bracket deletion rule considered in (72) from applying in (75). This is more evidence that the bracket deletion rule is the wrong solution.

Further, in word stress two syllable words will be ambiguous as to whether or not they allow Edge:RLR to apply. Whether or not it applies they will get initial stress, though the metrical structures differ. This is shown in (76):

(76)

	No Edge	*Normal Edge*
Project	x x preku	x x preku
Edge	*lexically blocked*	x) x preku
ICC	(x x preku	
Head Line 1	x x) (x x preku	x x) x) x preku

Thus two syllable words have two possible representations. In the enlarged stress domains, all combinations for the 2 + 2 cases yield the right results, as shown in (77).

(77)

	No Edge stem	*Normal Edge stem*
Cliticize	(x x x x preku + zima	x) x x x preku + zima
Edge	(x x x) x preku + zima	x) x x) x preku + zima
ICC	(x (x x) x preku + zima	x) (x x) x pre ku + zima
Head Line 1	x x x) (x (x x) x preku + zima	x x x) x) (x x) x pre ku + zima

Thus, either represntation for *preku* yields the correct stress placement. Because the two syllable stems have two possible lexical stress representations, they yield an ambiguity that is observed in the 2 + 1 enclitic stress cases, as shown in (78).

(78)

	No Edge stem	*Normal Edge stem*
Cliticize	(x x x preku + rid	x)x x preku + rid
Edge	(x x)x preku + rid	x)x)x preku + rid
ICC		
Head Line 1	x x) (x x)x preku + rid	x x x) x)x)x preku + rid

However, according to the descriptions of Macedonian, no stress ambiguity is present in the 1 + 2 cases. And with 1 + 2 cases no ambiguity results under this analysis. The possibility of multiple enclictic stress patterns is due to lexical stress ambiguity of two syllable forms. Since the hypothesis is that the metrical structure of the second element is *eliminated* upon cliticization, any difference in the second element is neutralized. The derivation is shown in (79).

(79)

Cliticize	x x x star + čovek
Edge	x x)x star + čovek
ICC	(x x)x star + čovek
Head Line 1	x x) (x x)x star + čovek

Thus, Macedonian provides further evidence for the Edge marking theory of lexical stress, along with evidence that an Edge:Ø lexical setting can *prevent* the application of a grammatical Edge marking in certain circumstances.

Chapter 2: Constraints on the construction of metrical grids

1. *Clash avoidance*

Prince (1983) formulated clash avoidance as a prohibition against generating prominence on adjacent syllables. We will translate this insight into the present framework as constraints barring the placement of certain constituent boundaries. Typically, this will prevent parentheses being inserted too close to pre-exisiting parentheses. Thus, this is a "first wins" constraint theory. Since the parameterized operations apply in the fixed sequence Projection, Edge marking, Iterative Constituent Construction and Headedness, this sequence also determines which parenthesis will surface in the case of a constraint violation. Similarly, because the ICC iterates across the form, applications of it can be bled by constraints. In such cases, the direction of the ICC determines which parenthesis will actually occur. Because the constraints refer to parentheses and not line 1 marks, they are somewhat more abstract than the constraints in Prince (1983), because, for instance, the configuration (x(xx could be prohibited even in languages that have the parameter setting Head:R.

Such a theory is to be constrasted with the view expressed in HV where clash resolution is a clean-up rule deleting certain unwanted constituents or marks. The constraint theory never allows these constituents to be generated in the first place. There are, however, some languages where a HV style deletion must be employed. Such cases are discussed at the end of this chapter.

1.1. *Malayalam and Wolof*

Malayalam (Mohanan (1985), Hayes (1991)) and Wolof (Ka (1988)) have essentially the same stress pattern as Koya. Stress usually falls on heavy syllables and the initial syllable. The parameters for such systems are repeated in (1):

(1)	Line 0:	Project:L	Edge:LLL	Head:L
	Line 1:		Edge:LLL	Head:L

There are differences among these languages, however, when the initial syllable is light, and the second heavy, or when there are two adjacent heavies. The facts regarding initial sequences for the various languages are given in (2):

(2)	Koya	Malayalam	Wolof
	# ĹH̀	# L H́	# L H́
	# ĹL H̀	# ĹL H̀	# ĹL H̀

We can see that an initial LH sequence has main stress on the initial syllable in Koya, but on the second syllable in both Malayalam and Wolof. We can handle this pattern by giving Malayalam and Wolof the Koya stress system with one addition: a constraint against forming certain line 0 configurations. The appropriate constraint is given in (3):

(3) Avoid (x (

Since projection applies before Edge marking, projection will be allowed to put in a bracket before the second syllable. Then when Edge:LLL applies in a language with Avoid (x(it will be prevented from adding the Edge bracket. This blocking of the application of a rule is the same as McCarthy's "active" formulation of the OCP, (4) (McCarthy (1986)), in which the OCP *prevents* the application of rules which would produce violations.

(4) ... the OCP operates not only in a passive way, on the lexical listing of morphemes, but also actively in the course of the phonological derivation. Its function in the derivation, I claim, is not that sporadically assumed in the tonal literature (a process that fuses adjacent identical tones into a single one), but rather is more typical of other principles of grammar, accounting for a hitherto unnoticed constraint, called antigemination, which prohibits syncope rules from creating clusters of identical consonants. (p208)

We will adopt this view of constraints: that they prevent the creation of disfavored structures. This view is very different from the HV treatment of clash resolution. In HV, the full metrical constituency was constructed, and at the end disfavored configurations were modified to make them acceptable, specifically by deleting line 1 marks. Under such a view, the origin of the constituent structure can play no role in the clash resolution. Parentheses are parentheses, no matter what parameter licensed their occurence. Under the avoidance view of constraints, the function of the derivation is extremely important. Since disfavored configurations are not allowed to come about, the origin of each parenthesis is very much at issue. Simply put, parentheses that get placed first preclude the introduction of later parentheses that would result in a disfavored configuaration. As a result, in avoiding a configuration like (x(, the presence of a parenthesis will prevent the introduction of a parenthesis both to the left and to the right. Under the HV view, clash resolution is always in favor of a particular direction. Wolof provides evidence that the avoidance analysis is the correct one.

In the case of the avoidance of certain metrical configurations, constraints are a language particular matter. This provides further evidence that Projection precedes Edge marking, as we have cases where projected parentheses prevent the insertion of an Edge parenthesis. But could one application of Projection bleed another? That also appears to be possible, as Malayalam and Wolof treat HH sequences differently. Malayalam behaves like Koya, stressing both syllables. Wolof does not stress the second one. The patterns are given in (5):

(5)

	Koya	Malayalam	Wolof
	# H́ H̀ L	# H́ H̀ L	# H́ H L
	# Ĺ H̀ H̀	# L H́ H̀	# L H́ H
	... H̀ H̀ ...	... H̀ H̀ ...	... H̀ H ...
	... H̀ H̀ H̀ ...	... H̀ H̀ H̀ ...	... H̀ H H̀ ...

Notice that crucially Wolof does not resolve clash in favor of a single direction. In the #LHH... form, the projected parenthesis associated with the second syllable precludes both the preceding syllable and the following syllable from obtaining parentheses. Furthermore, the #LHH span of three syllables behaves differently from the HHH span of three syllables. If we simply put in all the parentheses and then try to remove some of them, we will not be able to handle both of these cases, as they will have the same line 0 representation: (x(x(x. The Avoid (x(constraint will yield the correct results because the metrical structure is assigned through a derivation consisting of a universally ordered application of metrical rules.

This is one place where the idea of anchored and unanchored parentheses might be useful. Since projection by hypothesis creates parentheses that are linked to other phonological elementes, we could ascribe the failure of Edge in these circumstances to an Avoidance constraint plus a universal statement that anchored parentheses are "stronger" than unachored ones. Then Malayalam would tolerate disfavored configurations with both parentheses of the same strength. Wolof, on the other hand, would include a statement about how to resolve disfavored configurations involving parentheses of the same strength.

However, a simpler solution is available. By applying parenthesis projection in Wolof iteratively from left to right across the form, the Avoid (x(constraint will yield the correct results, as shown in (6). However, in Malayalam, both syllables get stress, and hence left parentheses. To capture this fact we will project two grid marks for each heavy syllable in Malayalam.

Other languages which project two grids marks for heavy syllables include Cairene Arabic (Halle (1990)), Winnebago, Chugach, and Cayuvava (all discussed below).

(6)

	Koya	Malayalam	Wolof
Project elements	x x x x x L H H H L	x xx xx xx x L H H H L	x x x x x L H H H L
Project:L syllable 1			
syllable 2	x (x x x x L H H H L	x (xx xx xx x L H H H L	x (x x x x L H H H L
syllable 3	x (x (x x x L H H H L	x (xx (xx xx x L H H H L	*avoided*
syllable 4	x (x (x (x x L H H H L	x (xx (xx (xx x L H H H L	x (x x (x x L H H H L
syllable 5			
Edge:LLL	(x (x (x (x x L H H H L	*avoided*	*avoided*
Head:L	x x x x (x (x (x (x x L H H H L	x x x x (xx (xx (xx x L H H H L	x x x (x x (x x L H H H L

Thus by adding a constraint which prevents the occurrence of certain grid configurations and the ability to project more than one mark for some syllables we are able to capture these stress systems.

We have seen in the case of the other iterative rule, the ICC, that the ICC places a particular kind of parenthesis based on the direction of iteration across the form. Specifically, it places the far parenthesis: putting in left parentheses in right-to-left iteration and right parentheses in left-to-right iteration. We can see that this generalization does not apply to Wolof, as it inserts left parentheses, but must iterate from left-to-right. One difference between these rules is that the ICC is a rule that operates wholly within a single line of the grid. Projection is a rule mediating between lines of the grid, that is, it is an interface. Further, it only considers a single position on the "target" grid, hence there is no question of a "minimal quantity" of grid marks required to form a valid constituent. The ICC does care about such consituent minimality requirements, in fact, that is the essence of the ICC. The iterativity and directionality of parenthesis projection is very likely not a random choice. Sloan (1991) shows that syllabification must be an iterative, directional procedure. If line 0 Projection applies as soon as possible, then its iterativity and directionality would be a simple consequence of the iterativity and directionality of syllabification.

There is another way to capture the Malayalam/Wolof distinction. This is to allow the constraints to apply only to particular operations. Under this view, in Malayalam, Avoid (x(would *not* apply to Projection but would apply to Edge marking. In Wolof it would apply to both Projection and Edge marking, as shown above. This view would still require that parenthesis projection be iterative and directional.

It is not possible to always avoid creating disfavored metrical configurations. Specifically, morpheme concatenation, can create disfavored configurations because each morpheme may be assigned some metrical structure separately. The OCP has a similar character.

We have seen that not all languages avoid clash. Koya and Tubatulabal *do* allow adjacent stressed syllables, indicating that the specification of avoidance constraints is a language particular and potentially rule particular matter.

1.2. Garawa

The avoidance constraints predict that applications of the ICC could be blocked in some configurations. In particular, the avoidance theory predicts that later bracket placement can be bled by the presence of brackets placed by earlier rules. Since the operations of Projection, Edge Marking and ICC proceed in that order, we should find that projected brackets can bleed instances of Edge marking (as in Malayalam and Wolof, above) and instances of ICC. Likewise, brackets placed by Edge marking should bleed instances of ICC.

The stress system of Garawa (Furby 1974), summarized in (7), yields just such a case.

(7) Stress falls on even-numbered syllables counting from the end of the word, and on the first syllable, but never on the second.

Two examples, one even and one odd, are given in (8):

(8) wátjimpàŋu nářiŋinmùkunjìnamìřa

The even case is handled simply by assuming that line 0 has the parmater settings [ICC:R Head:L], as shown in (9).

(9)

Project	x x x x watjimpaŋu	x x x x x x x x x nařiŋinmukunjinamiřa
ICC	(x x (x x watjimpaŋu	x(x x (x x (x x(x x nařiŋinmukunjinamiřa
Head	x x (x x (x x watjimpaŋu	x x x x x(x x (x x (x x(x x * nařiŋinmukunjinamiřa

However, in the odd case we have two problems: no stres on the first syllable and an unwanted stress on the second syllable. To begin to solve the odd cases in Garawa we need to add Edge:LLL to these parmeters. This will yield stress on all even-numbered syllables counting from the right-most element *and* on the first syllable. This will not change the parsing of even numbered words, but in words with an odd number of syllables this predicts stress on the first *and* second syllables, as shown in (10).

(10)

Project Edge	(x x x x watjimpaŋu	(x x x x x x x x x nařiŋinmukunjinamiřa
ICC	(x x (x x watjimpaŋu	(x(x x (x x (x x(x x nařiŋinmukunjinamiřa
Head	x x (x x (x x watjimpaŋu	x x x x x (x(x x (x x (x x(x x * nařiŋinmukunjinamiřa

Something is still needed to prevent the placement of stress on the second syllable. If we add the same avoidance constraint used in Malayalam and Wolof, giving Garawa the line 0 settings in (11), this will have the effect of bleeding certain application of ICC.

(11) Line 0: Avoid (x (Edge:LLL ICC: LR Head:L

Now we have tools sufficient to place Garawa stress; the derivations are given in (12). Each attempted application of the ICC is shown so that the one prevented by Avoid (x(is evident.

(12)

Project Edge	(x x x x watjimpaŋu	(x x x x x x x x x nařiŋinmukunjinamiřa
ICC	(x x (x x watjimpaŋu	(x x x x x x x(x x nařiŋinmukunjinamiřa
ICC		(x x x x x (x x(x x nařiŋinmukunjinamiřa
ICC		(x x x (x x (x x(x x nařiŋinmukunjinamiřa
ICC		(x (*avoided*
Head	x x (x x (x x watjimpaŋu	x x x x (x x x (x x (x x(x x nařiŋinmukunjinamiřa

Thus, the effect of the clash avoidance is to give words with an odd number of syllables a constituent with three elements at the left edge.

With regard to the higher grid lines, Garawa has primary stress on the initial, secondary stress on the penult and tertiary stresses in between. To generate this pattern we need to allow multiple Edge markings on line 1, namely Edge:LLL and Edge:LLR, and construct constituents on line 2. The settings and a derivation are shown in (13).

(13)

Line 0	Avoid (x(
	Edge:LLL
	ICC:R
	Head:L
		`x      x    x    x`
		`(x x x (x x (x x (x x`
		`nařiŋinmukunjina mir̃a`

LIne 1	Edge:LLL and LLR
	Head:L
		`x                x`
		`(x      x    x    (x`
		`(x x x (x x (x x (x x`
		`nařiŋinmukunjina mir̃a`

Line 2	Edge:LLL
	Head:L
		`x`
		`(x               x`
		`(x      x    x    (x`
		`(x x x (x x (x x (x x`
		`nařiŋinmukunjina mir̃a`

Thus, line 1 in Garawa evidently requires two edge parameters. Later in this chapter we will see that Chugach Alutiiq line 0 requires two ICC parameters. Further cases of languages with multiple stress paramters are examined in Chapter 3.

2. *Edge avoidance*

Just as some languages disfavor configurations where parentheses appear too close together, some languages disfavor configurations where parentheses appear too close to the edge of the form.

2.1. *Latin*

Latin exhibits a very common stress pattern. Stress is assigned to the penultimate syllable if it is heavy, otherwise to the antepenultimate. This system is modelled with the parameter settings in (14):

(14)

Line 0:	Avoid (x #			
	Project: L	Edge: RLR	ICC:R	Head: L
Line 1:		Edge: RRR		Head: R
Conflation				

The derivations for two words are shown in (15):

(15)

```
Project    x   x x x         x   x  (x x
           reprimitur        reprimuntur

Edge       x   x x)x         x   x  (x)x
           reprimitur        reprimuntur

ICC        x  (x x)x        (x   x  (x)x
           reprimitur        reprimuntur

Head             x                  x
Line 1           x)          x      x)
           x  (x x)x        (x   x  (x)x
           reprimitur        reprimuntur
```

As in Macedonian (above), Edge:RLR with ICC:R yields the "extrametricality" effect by freezing out the last element of line 0. In Latin we find that final heavy syllables do not receive stress. Thus, in Latin the avoidance constraint is applying to instances of projection, as in Wolof (above).

HV accounted for the fact that Latin final heavies do not receive stress by ordering their rule of extrametricality before the rule projecting line 1 marks. The equivalent of this option is not available within the present framework. Even if we did apply Edge:RLR before parenthesis projection, this would not prevent the final syllable from projecting a parenthesis, as shown in (16).

(16)

```
Project        x  x   x x
Marks          reprimuntur

Edge           x  x   x)x
               reprimuntur

Project        x  x  (x)(x
Parentheses    reprimun tur
```

In order to prevent the introduction of the parenthesis for the final syllable, we would have to include a constraint, either Avoid (x# as above, or Avoid)(. Furthermore, as we saw in Malayalam and Wolof (above), it is necessary for parenthesis projection to precede Edge marking, as projected parentheses can prevent the occurence of Edge parentheses. Additionally, as argued with respect to Macedonian exceptional stress in Chapter 1, it is conceptually better to have both parameters of Projection apply together, as they together form the interface between line 0 and the rest of the phonology. By specifying the order of application of the parameters in Universal Grammar, we also reduce the amount of information that the child must learn regarding the construction of metrical structure. Finally, the theory is more constrained if we do not allow language particular orderings of the application of metrical parameters.

Another possible solution to Latin final heavies is to project the left boundaries of all heavy syllables, including finals and then to blindly apply Edge:RLR to the result, as shown in (17).

```
(17)  Project   x   x x(x
                reprimitur

      Edge      x   x x()x
                reprimi tur

      ICC       x  (x x()x
                reprimi tur

      Head          x
      Line 1        x)
                x  (x x()x
                reprimi tur
```

This analysis uses vacuous constituents to prevent constituents from spanning certain strings of elements. However, Macedonian has generally antepenultimate stress but exceptional forms *can* have final stress. Therefore, at least in Macedonian the vacuous constituent configuration, (), is being avoided. If vacuous constituents are universally avoided then Latin *must* include Avoid (x#.

The parameter setting of Edge:RLR predicts that monosyllables will be given a structure in which they have a left parenthesis "dangling" off the left edge. This configuration might generally be disfavored. The behavior of Latin monosyllables is quire complex and interesting, see Mester (1991) for some proposals regarding their treatment.

Further evidence for the Avoid (x# constraint would be provided by a language where the application of this constraint allowed the element in question to then form part of a constituent created by the application of a subsequent parameter. Western Aranda provides just this sort of evidence.

2.2. *Western Aranda*

The generalizations regarding stress in Western Aranda (Davis (1984), HV) are given in (18):

(18) ... the Western Aranda stress rule for trisyllabic words or longer is that primary stress falls on the first syllable containing an onset. Secondary stress is usually on every other syllable after the one with main stress. Final syllables never receive any stress ... Davis (1984)

Examples of Western Aranda words are given in (19):

(19)	# C		# V	
	káma	*to cut*	ílba	*ear*
	túkura	*ulcer*	erɡúma	*to seize*
	kútunùla	*ceremonial assistant*		

This behaviour can be captured by basing Edge marking on the phonological properties of the word. Normally, no Edge marking applies. However, with vowel intial words an Edge marking of Edge:LRL is supplied. The full set of parameters for Western Aranda is given in (20).

(20) Line 0: Avoid (x #
Edge:LRL for #V ICC:L Head:L
Line 1: Edge:LLL Head:L

The absence of final stresses (achieved with extrametricality in HV) results from the ICC's inability to create a constituent with a single left-over element. Further, the initial stress on bisyllabic vowel initial words results from Avoid (x#. Avoid (x# will bleed Edge marking in bisyllabic vowel-initial words, which will then allow the ICC to pick up the pair as a constituent. Derivations are given in (21):

(21)

Project	x x x x kutunula	x x x tukura	x x x erguma	x x ilba
Edge			x (x x erguma	*avoided*
ICC	x x) x x) kutunula	x x) x tukura	x (x x) erguma	x x) ilba
Head Line 1	x (x x x x) x x) kutunula	x (x x x) x tukura	x (x x (x x) erguma	x (x x x) ilba

The facts of Western Aranda show that the judicious application of simple constraints on parenthesis placement can allow these elements to become parts of constituents that they otherwise could not. If we allow Edge:LRL to apply to *ilba* then we would have to have some way to ensure that the first syllable will form a constituent, *and* to remove the stress from the second syllable. By simply constraining the Edge marking so that it cannot apply in this case, the ICC then is able to construct a constituent from the pair of elements, and generate the correct stress.

3. *Ternary Constituents*

The analysis of systems with stress patterns in which every third element is stressed remains a contentious issue in metrical theory. Two approaches within the current framework are possible: use an avoidance constraint to block certain applications of the ICC or add some other parenthesis insertion rule to work in tandem with the ICC.

Haraguchi (1991) formulates a general theory of clash resolution. He allows clash resolution in cases where stresses are not strictly adjacent. The translation of this idea can be employed to model ternary parsing, for instance, by using Avoid)xx). Obviously, Avoid)xx) is more complicated than Avoid)x). We therefore expect that avoiding non-adjacent parenthesis configurations should be more marked.

The application of ICC:L subject to Avoid)xx) is shown in (22).

(22)

Input	x x x x x x x x x
ICC @ 1	
2	x x) x x x x x x x
3	
4	) x x) *avoided*
5	x x) x x x) x x x x
6	
7	) x x) *avoided*
8	x x) x x x) x x x) x
9	
Output	x x) x x x) x x x) x

The avoidance constraint yields a ternary parsing ability without changing the ICC nor Headedness. Thus we can eliminate the [-HT +BND] foot type from HV. In fact, we can construct only head terminal feet, thus in ternary constituents we derive only dactyls (Head:L) and anapests (Head:R), but never amphibrachs. In this the present theory also agrees with Haraguchi (1991), contra HV. Given this derivation of a ternary parsing ability through the use of Avoid)xx) or Avoid (xx(, one might try to replace the ICC with a more general rule of parenthesis insertion and Avoid)x) or Avoid (x(. This idea is considered at length in Chapter 5. It will not work, as it predicts that no binary language allows clash, but Tubatulabal (Chapter 1) does, and, further, it predicts languages with stress on almost every vowel.

There has recently been quite a lot of interest generated by proposals to limit constituents to binary size (see for example Hayes (1991), McCarthy & Prince (1986), Kager (1989, 1992), etc). Under this proposal, Hayes has modelled ternary alternations by constructing a binary constituent and then skipping an element (termed "weak local parsing"). It is not clear, however, that Hayes's conception of bracketed grid theory is compatible with the view presented here. Despite this major caveat, we can formalize the necessary additions to the ICC to produce the effects of "weak local parsing". These additions are shown in (23).

(23) *Weak local parsing*

Ø →) / _ x (	+ ICC:R	(right to left)
Ø → (/) x _	+ ICC:L	(left to right)

In (24) we see the operation of left to right weak local parsing on the same abstract grid.

(24)

Input		x x x x x x x x x
ICC/WLP @	1	
	2 ICC	x x) x x x x x x x
	3 WLP	x x) x (x x x x x x
	4	
	5 ICC	x x) x (x x) x x x x
	6 WLP	x x) x (x x) x (x x x
	7	
	8	x x) x (x x) x (x x) x
	9	x x) x (x x) x (x x) x (
Output		x x) x (x x) x (x x) x (

Notice that it is necessary to interleave the application of the WLP addition with the application of the normal ICC rule. That is, the WLP operations must apply in lock-step with the normal ICC operations. Notice also that the bracketing generated by WLP does not agree in detail with the Avoidance bracketing. WLP, like Avoidance, does not affect the Head parameter, so we are again prevented from creating amphibrachs.

The Avoidance theory is to be preferred on both conceptual and empirical grounds. The system is conceptually simpler than WLP. It adds no new formal mechanisms, whereas the WLP analysis requires that two fundamentally different rules operate in tandem. The Avoidance theory also provides better analyses of the two well-known ternary languges: Cayuvava and Chugach Alutiiq.

3.1. *Cayuvava*

In Cayuvava (Key (1961, 1967), Levin (1985, 1988b), HV, Hayes (1991)) stress falls on every third mora counting from the end of the word, and on the initial in shorter words. Examples are given in (25):

(25)	3n	cáadiróbcβurúruce	*ninety-nice*
		ráibirínapu	*dampened manioc flour*
	3n+1	maráhahaéiki	*their blankets*
		kihíβere	*I ran*
	3n+2	ikitáparerépeha	*the water is clean*
		βariékimi	*seed of squash*
		rúca	*wine*

Cayuvava projects a line 0 grid mark for every vowel. Key only notes two levels of stress in Cayuvava: stressed and stressless. Accordingly, no assumptions about line 1 will be made here. Using an avoidance constraint, Cayuvava can be modelled with the the line 0 parameters in (26).

(26) Avoid (x x(Edge:RLR ICC:R Head:L

For words with 3n and 3n+1 moras, (26) yields the derivations in (27).

(27)

	3n	*3n+1*
Project Edge	` xx x x x)x` `raibirinapu`	` x x x xxx)x` `marahahaeiki`
ICC	`(xx x(x x)x` `raibirinapu`	` x(x x x(xx)x` `marahaha eiki`

Head	` x    x`
	`(xx x(x x)x`
	`raibirinapu`
		`   x     x`
		` x(x x x(xx)x`
		`marahaha eiki`

For forms with 2 and 3n+2 syllables, we have the derivations in (28).

(28)

	2	*3n+2*
Project Edge	` x)x` `ruca`	`x x x x x x x)x` `ikitaparerepeha`
ICC		`x x(x x x(x x)x` `ikitaparerepeha`

Head	` x`
	` x)x`
	`ruca`
		`    x     x`
		`x x(x x x(x x)x`
		`ikitaparerepeha`

In addition, Key notes that some morphemes are lexically marked for stress. The two types, stressed (*-pe*) and pre-stressing (*-je*) are shown in (29):

(29) pécaipé — *where is . . .*
jínahaéje — *it really is true*

We can represent these morphemes as in (30).

(30) Edge:LLR `(x` / `-pe` *interrogative*
Edge:RRR ` x)` / `-je` *emphatic*

This generates the derivations in (31):

(31)

Project Lex Edge	x x xx x) jinahaeje	x xx(x pecaipe
Edge		*avoided*
ICC	(x x x(x x) jinaha eje	(x xx(x pecaipe
Head	x x (x x x(x x) jinaha eje	x x (x xx(x pecaipe

The grammatical Edge marking fails to apply in either of these cases. In the Edge:RRR case, since there is now a final bracket, there is no string-final mark for the grammatical Edge marking to apply to. In the Edge:LLR case, the grammatical Edge marking is subject to the universal prohibition against creating vacuous constituents. Empirical evidence for this comes from three mora words with final stress. Such words, for example *aβiró* 'come' do not have an initial stress. If Edge marking did apply in these forms, either creating a vacuous constituent, () or the pair)(, it would yield incorrect stresses, as shown in (32).

(32)

Project Lex Edge	x x(x aBiro	x x(x aBiro	x x(x aBiro
Edge	() *avoided*	x x)(x aBi ro	x x()x aBi ro
ICC	*avoided*	(x x)(x aBi ro	*avoided*
Head	x x x(x aBiro	x x (x x)(x * aBi ro	x x()x * aBi ro

Thus, we have further empirical evidence that vacuous constituents are prohibited. Cayuvava is an example of the maximally simple right to left ternary system under the Avoidance theory of ternary stress.

The parameters in (33) are the first approximation for a weak local parsing analysis of Cayuvava.

(33) Edge: RLR ICC: R/WLP Head: L

This analysis yields the derivations in (34).

(34)

	3n	*3n+1*
Project Edge	xx x x x)x raibirinapu	x x x xxx)x marahahaeiki
WLP	(xx)x(x x)x raibirinapu	)x(x x)x(xx)x marahaha eiki
Head	x x (xx)x(x x)x raibirinapu	x x)x(x x)x(xx)x marahaha eiki

The same representations for the stressed and pre-stressing morphemes, will also work in the WLP analysis, yielding the derivations in (35).

(35)

Project Lex Edge	x x xx x) jinahaeje	x xx(x pecaipe
Edge		() *avoided*
ICC/WLP	(x x)x(x x) jinaha eje	(x x)x(x peca ipe
Head	x x (x x)x(x x) jinaha eje	x x (x x)x(x peca ipe

One amendment is required, however, for the same words that caused problems for HV, those with 3n+2 moras. The analysis for such words so far gives the derivations in (36).

(36)

Project Edge	x)x ruca	x x x x x x x)x ikitaparerepeha
ICC/WLP		x)x(x x)x(x x)x ikitaparerepeha
Head	x x)x ruca	x x x x)x(x x)x(x x)x *ikitaparerepeha

This correctly predicts stress for two syllable words but not for longer examples. In the longer examples an initial stress is incorrectly predicted. One response to this problem is to add the constraint in (37).

(37) Avoid # x)

Though this will prevent the application of WLP to create an initial singleton, the bleeding of the WLP will feed another application of ICC, as shown in (38):

(38)

Project	x x ruca	x x x x x x x x ikitaparerepeha
Edge	*avoided*	x x x x x x x)x ikitaparerepeha
ICC	(x x ruca	x x x x x(x x)x ikitaparerepeha
WLP		x x x x)x(x x)x ikitaparerepeha
ICC		x x(x x)x(x x)x ikitaparerepeha
WLP		*avoided*
ICC		(x x(x x)x(x x)x ikitaparerepeha
Head	x (x x ruca	x x x (x x(x x)x(x x)x * ikitaparerepeha

Again, we get the correct result for 2 syllables, but not for 3n+2. It appears that we also need to have a constraint that will prevent the ICC from applying at the left edge of the form. In other words, we do not want the Avoidance of WLP at the beginning of the form to feed an application of ICC. However, in Chugach Alutiiq (below) this is exactly what we *do* want.

One avoidance constraint which will work when added to the WLP analysis is the one in (39).

(39) Avoid (x x (

The constraints Avoid #x) and Avoid (xx(along with the WLP analysis do yield the correct stresses. But Avoid (xx(is exactly the ICC/avoidance constraint. Therefore, using just Avoid (xx(will get all the facts, without the additional mechanisms of Avoid #x) and WLP. Thus, the avoidance analysis of ternary stress proposed above is clearly simpler for Cayuvava.

3.2. Chugach Alutiiq

The facts of Chugach Alutiiq (Leer (1985, 1989)) are more complicated than those of Cayuvava, and have prompted a number of imaginative analyses by Leer, Rice (1988), Halle (1990), Haraguchi (1991) and Hayes (1991).

As shown by the words in (40), in words with all light syllables, stress falls on the syllables 3n+2 from the left, and initial CVC syllables receive stress.

(40)	a kú tar tu nír tuq	*he stopeed eating akutaq*
	kúm la ci wí li ya qú ta qu ní ki	*if he is going to undertake constructing a freezer for them*

Additionally, long vowels count as bimoraic and always receive stress. The tone associated with stress occurs on the second mora of the long vowel. Following Halle (1990), in this analysis long vowels will project two grid marks and a left parenthesis. Initial closed syllables will project a right parenthesis.

Haraguchi notes that when stress vowels are deleted the stress shifts leftward. This is evidence that Chugach Alutiiq is Head:R.

(41)	tangertuq	*she sees*	/ta.ŋə́x.tuq/	→ [táŋx.tuq]
	kakEglluk	*nasal mucus*	/ka.kə́x.ɬuk/	→ [kákx.ɬuk]

Leer (1989) notes that #LH... words receive stress on both the initial and second syllables. To correctly model this, we will make Chugach Alutiiq Edge:LLL on line 0. Thus, for the ICC/Avoidance analysis of ternary constituents, we will start out with the parameter settings in (42).

(42) Avoid:) x x)
Project: all vowels, L for [...VV...], R for #[...VC]
Edge: LLL
ICC: L
Head:R

This yields the derivation in (43).

(43)

Project Edge	`(x) x   x x x   x x x   x x x` `kumla^ciwili^yaquta^quniki`
ICC	`(x) x   x x)x   x x)x   x x)x` `kumla^ciwili^yaquta^quniki`

Head	`x        x        x        x`
	`(x) x   x x)x   x x)x   x x)x`
	`kúmla^ciwíli^yaqúta^quníki`
	wrong fortition

Interestingly, CA also has a segmental rule that seems sensitive to metrical constituents. A rule of fortition makes the onsets of word-initial and certain other syllables fortis (indicated here with a preceding caret, ^). Leer pointed out that this corresponds generally with constituent initial position and we will use fortition as diagnostic of foot initial position. In (43) the ICC/Avoidance account gets the correct stress placement but does not get the fortition facts correctly. The answer is to apply ICC:R back over the form. This will give the correct constituents, as shown in (44).

(44)

Project Edge	(x) x x x x x x x x x x kumla^ciwili^yaquta^quniki
ICC:L	(x) x x x)x x x)x x x)x kumla^ciwili^yaquta^quniki
ICC:R	(x) x (x x)x (x x)x (x x)x kumla^ciwili^yaquta^quniki
Head	x x x x (x) x (x x)x (x x)x (x x)x kumla^ciwili^yaquta^quniki

This will also solve the problem of HLLH sequences, which would parse (H)LL(H) without the application of ICC:R. The application of ICC from right to left picks up the LL pair, as shown in (45).

(45)

Project Edge	(x)(xx x x (xx x agNua^qutar^tuaNa
ICC:L	(x)(xx) x x (xx)x agNua^qutar^tuaNa
ICC:R	(x)(xx)(x x (xx)x agNua^qutar^tuaNa
Head	x x x x (x)(xx)(x x (xx)x agNua^qutar^tuaNa

Notice that)(xx does not trigger Avoid)xx), and this pair of marks does form a constituent.

The translation into a weak local parsing account (cf. Hayes (1991)) is given in (46).

(46) Project: all vowels, L for [...VV...], R for #[...VC]
Edge:LLL
ICC: L/WLP
Head:R

The derivation for the word in (44) under WLP is shown in (47).

(47)

Project Edge	(x) x x x x x x x x x x kumla^ciwili^yaquta^quniki
ICC/WLP	(x) x (x x)x (x x)x (x x)x kumla^ciwili^yaquta^quniki
Head	x x x x (x) x (x x)x (x x)x (x x)x kumla^ciwili^yaquta^quniki

Notice that the WLP account does correctly predict the location of fortis consonants.

Adding the constraint Avoid (x(to ICC/WLP does the work of disallowing degenerate feet by bleeding an application of WLP. But, when the WLP is blocked, the ICC *does* apply getting the effect that Hayes attributes to "persistent footing". This is shown in (48).

(48)

Project Edge	(x) (xx x x (xx x agNua^qutar^tuaNa
ICC	(x) (xx) x x (xx x agNua^qutar^tuaNa
WLP	(x(*avoided*
ICC	(x) (xx) x x) (xx x agNua^qutar^tuaNa
ICC	(x) (xx) x x) (xx)x agNua^qutar^tuaNa
WLP	(x) (xx) x x) (xx)x(agNua^qutar^tuaNa
Head	x x x x (x) (xx) x x) (xx)x(agNua^qutar^tuaNa

Following the ...*qutar*... portion of the word is a pre-existing left bracket, due to projection. Thus, *tar* cannot receive a left bracket by WLP because this would violate Avoid (x(. If this had applied, the environment for the application of ICC would not exist. However, since WLP was unable to apply, ICC *is* able to apply, providing *tar* with a right parenthesis.

Recall that LH words receive initial stress. WLP and Avoid (x(predicts instead that such words should not have initial stress. Therefore we must modify the constraint to be Avoid x(x(.

The two analyses generate the equivalent parsings shown in (49).

(49)

ICC/WLP	*ICC:L + ICC:R*
(H) L (H)	(H) L (H)
(H) L L) (H)	(H) (L L (H)
(H) L (L L) (H)	(H) L (L L) (H)
(H) L (L L) L (H)	(H) L (L L) L (H)
(H) L (L L) L L) (H)	(H) L (L L) (L L (H)
(H) L (L L) L (L L) (H)	(H) L (L L) L (L L) (H)

Thus, the facts of Chugach Alutiiq stress can be handled by both theories of ternary stress. Because Cayuvava must on either analysis contain the Avoid (xx(constraint, we cannot do without the basic mechanism of the Avoidance analysis. However, we can do without the additional mechanism required by the WLP analysis, as both analyses yield the same metrical structures in Chugach Alutiiq. Therefore, the avoidance analysis of ternary stress is to be preferred.

4. *Parenthesis deletion*

Ternary constituents provide an excellent argument for the existence of avoidance constraints. Ternary parsing crucially relies on the non-application of certain bracket placements by the ICC which then lead to ICC applications which would otherwise be unavailable. That is, it is impossible to get ternary constituents by doing binary parsing and then throwing away some of the parentheses. Rather, it results from the iterative application of the ICC rule, coupled with its non-application in certain configurations. Thus, the mechanism that derives clash effects also derives ternary parsing.

HV had a different view of clash. In their view, clash was resolved by means of a rule deleting certain marks or constituents. These rules could be ordered anywhere in the derivation. We will still require a parenthesis deletion rule for such languages as Diyari and Winnebago, and perhaps others to be discussed in the next chapter. However, we will be able to universally order this rule immediately prior to Headedness. Therefore, one possibility (which I will not pursue here) is that the operation of parenthesis deletion constitutes a furtner parameterization of Headedness.

4.1. Diyari

Poser (1989) points out the relevance of the stress facts of Diyari (Austin (1981)) for metrical theory. The examples in (50) show the stress patterns of several types of Diyari words.

(50)	káṇa	*man*	2
	mánkaṛa	*girl*	3
	ŋándawàlka	*to close*	4
	káṉa + ṉi	*man + loc*	2 + 1
	káṇa + wàra	*man + pl*	2 + 2
	táyi + yàtimàyi	*to eat + opt*	2 + 4
	púḻuru + ṉi	*mud + loc*	3 + 1
	pínadu + wàṛa	*old man + pl*	3 + 2
	ŋándawàlka + tàda	*to close + pass*	4 + 2
	púḻuru + ṉi + máṯa	*mud + loc + ident*	3 + 1 + 2
	yákalka+yìrpa+màli+na	*ask + ben + recip + part*	3 + 2 + 2 + 1

Poser's observations regarding these facts is given in (51).

(51) The facts presented above motivate a simple stress system in which binary quantity insensitive left-dominant feet are constructed from left to right, with a left-dominant word tree, together with some proviso for preventing stress on an odd-numbered final syllable, such as defooting of degenerate feet ... Each morpheme is stressed word-internally just as if it stood alone...
The pattern we have observed may be succintly described. Each morpheme in Diyari is stressed separately. (p119-20)

This analysis translates partially into the system in (52).

(52)	Line 0:	Edge:LLL	ICC:L	Head:L
	Line 1:	Edge:LLL		Head:L

Following Halle & Kenstowicz (1991), we can analyze the requirement that each morpheme is stressed separately as each morpheme contributing a left parenthesis at its left edge. That is, each morpheme is subject to a lexical Edge:LLL marking. A derivation is shown in (53).

(53)

```
Project      (x x   x    (x   x    (x x    (x
Lex Edges    yakalka + yìrpa + mali + na

ICC:LR       (x x) x    (x   x)   (x x)   (x
             yakalka + yìrpa + mali + na

Head:L         x          x         x       x
              (x x) x    (x   x)   (x x)   (x
             *yakalka + yìrpa + mali + na
```

However, the stress is not quite correct. Although it correctly predicts that there is no stress on the third syllable of the stem, it incorrectly still predicts stress on monosyllabic morphemes. The solution is to apply (54) which deletes all unmatched left parentheses.

(54) $(\rightarrow \varnothing \; / \; \_\_ \; x^{*} \left\{ \begin{matrix}) \\ \# \end{matrix} \right\}$

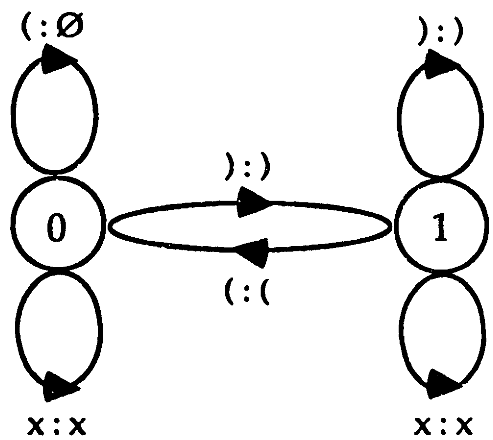
The application of (54) yields the derivation in (55).

(55)

Project Lex Edges	(x x x (x x (x x (x yakalka + yìrpa + mali + na
ICC:LR	(x x) x (x x) (x x) (x yakalka + yìrpa + mali + na
Delete	(x x) x (x x) (x x) x yakalka + yìrpa + mali + na
Head:L	x x x (x x) x (x x) (x x) x yakalka + yìrpa + mali + na

The rule (54) can be formulated as a finite state transducer with two states that scans the form from right to left, shown in (56).

(56)



The state of the machine indicates whether the current mark is in a constituent defined by a right parenthesis. If it is, and a left parenthesis is encountered, it is retained. Any other left parentheses are deleted.

It is not sufficient to simply avoid putting in some of the Edge markings as this would then feed the ICC, as shown in (57).

(57) Project Lex Edges

```
(x x x     x
puɭuru + ŋ̪i
```

ICC:LR

```
(x x)x     x)
puɭuru + ŋ̪i
```

Head:L

```
  x   x
 (x x)x     x)
*puɭuru + ŋ̪i
```

Nor is it possible to delete all unmatched parentheses, as unmatched right parentheses provide stress in four syllable morphemes, as shown in (58).

(58) Project Lex Edges

```
(x   x x  x
ŋandawalka
```

ICC:LR

```
(x   x)x  x)
ŋandawalka
```

Head:L

```
 x    x
(x   x)x  x)
ŋandawalka
```

It would be possible to delete *all* unmatched parentheses if we apply ICC:R after ICC:L, (as in Chugach Alutiiq, above) as this will match up the brackets inserted by ICC:L. Thus, languages can specify that unmatched parentheses of a particular sort be deleted.

4.2. *Winnebago*

The stress system of Winnebago has been very important in the development of metrical theory. Metrical analyses of Winnebago have been presented by Hale & White Eagle (1980), HV, Miner (1989), and Hayes (1991). In particular, Winnebago was the source of the Domino Condition of HV, which sparked a great deal of controversy. The present theory will allow a simple characterization of the Winnebago stress system. The source of the complications in Winnebago stress involves the rule known as Dorsey's Law

(DL), informally stated in (59), which inserts an echo vowel betweeen a consonant and a sonorant in the onset of a syllable.

(59) $\emptyset \rightarrow V_i / C \_ RV_i$

The introduction of new stressable elements through DL can seem to have an effect on the stress assignment in Winnebago words. As discussed by Hale & White Eagle, some words with DL vowels appear to have stress assigned before DL, while others clearly have stress assigned after DL. DL vowels can even themselves bear stress. Some previous accounts (Hale & White Eagle, HV) formulated this difference as a difference in the introduction of new stressable elements into a previously constructed metrical structure. If a new element was added into the middle of a constituent, this caused the metrical structure to be erased. Thus, the invariant effect is that DL vowels occur at a constituent boundary. If a constituent boundary would have been placed there anyway, then it will appear as though stress is assigned before DL. If one would not have been placed there, the effect of DL is to provide a constituent boundary. In most cases then, the appearance of a DL vowel correlates with stress two syllables later. The one case where this is not true is near the right edge of a word, which we will handle with the same avoidance constraint as proposed for Latin.

To capture the stress effect of DL vowels we will project a left parenthesis for CRV syllables, those that will be subject to Dorsey's Law. The standard effect is not present at the end of the word, and we will capture this with Avoid (x#, as in Latin. Like Cayuvava and Chugach Alutiiq, Winnebago projects all vowels onto line 0. The parameters for Winnebago stress assignment are given in (60).

(60) Line 0 Avoid: (x #
Project all vowels
Project:L for CRV syllables
Dorsey's Law
Edge: LRL ICC: RL Head: R
Line 1 Edge: LLL Head: L

In (61) a derivation for a word not subject to Dosey's Law is given.

(61)

Project	`xx x x x` `haakitujik`
DL	
Edge	`x(x x x x` `ha akitujik`
ICC	`x(x x)x x)` `ha akitujik`

Head	`    x   x`
	`x(x x)x x)`
	`ha akitujik`

Line 1	`    x`
	`   (x   x`
	`x(x x)x x)`
	`ha akitujik`

From here on in, we will ignore the line 1 effects. The parameter settings work as is for the bulk of the data. Two and three element words are shown in (62).

(62)

= *Miner*	(15a)	(15b)	(15d)
Project	x kre	(x x krahe	x x hipres
DL	x x kEre	x (x x kArahe	x x x hipEres
Edge	*avoided*		x (x x hipEres
ICC		x (x x) kArahe	x (x x) hipEres
Head	x x x) kEre	x x (x x) kArahe	x x (x x) hipEres

Notice that if Dorsey's Law follows Edge marking, it will generate incorrect forms, as shown in (63).

(63)

= *Miner*	(15d)
Project	x x hip res
Edge	*avoided*
DL	x x x hipEres
ICC	x x) x hipEres
Head	x x x) x *hipEres

Derivations for four element words are shown in (64).

(64) = *Miner*	(15c)	(15e)	(15f)	(15g)
Project	(x x x xrojike	x x x hojisna	xx x boopres	(x x krepna
DL	x(x x x xOrojike	x x x x hojisAna	x x x x bo opEres	x(x x x kErepAna
Edge		x(x x x hojisAna	x(x x x bo opEres	
ICC	x(x x)x xOrojike	x(x x)x hojisAna	x(x x)x bo opEres	x(x x)x kErepAna
Head	x x(x x)x xOrojike	x x(x x)x hojisAna	x x(x x)x bo opEres	x x(x x)x kErepAna

And derivations for two longer words are given in (65).

(65)		
Project	x x (x x x hirakrohoni	x x (x x x x hirakrohonira
DL	x x x(x x x hirakOrohoni	x x x(x x x x hirakOrohonira
Edge	x(x x(x x x hirakOrohoni	x(x x(x x x x hirakOrohonira
ICC	x(x x) (x x)x hirakO rohoni	x(x x) (x x)x x) hirakO rohonira
Head	x x x(x x) (x x)x hirakO rohoni	x x x x(x x) (x x)x x) hirakO rohonira

The derivation in (66) demonstates that lapses of two syllables are possible because the ICC does not create a constituent with a medial single element.

(66)

Project	x x x (x x x harakishrujikshna
DL	x x x x(x x x x harakishUrujikshAna
Edge	x(x x x(x x x x harakishUrujikshAna
ICC	x(x x) x(x x) x x) harakishUrujikshAna
Head	x x x x(x x) x(x x) x x) harakishUrujikshAna

However, there are cases where stress falls on the fourth surface vowel of form, shown in (67).

(67)

= *Miner*	(15h)	(15i)	(15j)
Project	x (x x hikroho	x (x x wakripras	x (x (x x wakripropro
DL	x x(x x hikOroho	x x(x x x wakIripAras	x x(x x(x x x wakIripOropOro
Edge	x(x(x x hikOroho	x(x(x x x wakIripAras	x(x(x x(x x x wakIripOropOro
ICC	x(x(x x) hikOroho	x(x(x x)x wakIripAras	x(x(x x) (x x)x wakIripO ropOro
Head	x x x(x(x x) *hikOroho	x x x(x(x x)x *wakIripAras	x x x x(x(x x) (x x)x *wakIripO ropOro

The account given so far incorrectly predicts that these words should also have a stress on the second syllable. If we now delete all unmatched left parentheses, as in Diyari, we generate the correct stress placements, as shown in (68).

(68) = *Miner*	(15h)	(15i)	(15j)
Project	x (x x hikroho	x (x x wakripras	x (x (x x wakripropro
DL	x x(x x hikOroho	x x(x x x wakIripAras	x x(x x(x x x wakIripOropOro
Edge	x(x(x x hikOroho	x(x(x x x wakIripAras	x(x(x x(x x x wakIripOropOro
ICC	x(x(x x) hikOroho	x(x(x x)x wakIripAras	x(x(x x)(x x)x wakIripO ropOro
Delete	x x(x x) hikOroho	x x(x x)x wakIripAras	x x(x x)(x x)x wakIripO ropOro
Head	x x x(x x) hikOroho	x x x(x x)x wakIripAras	x x x x(x x)(x x)x wakIripO ropOro

Notice that the deletion of unmatched left parentheses cannot do all the work done by Avoid (x#. Avoid (x# can feed the ICC, whereas the left parenthesis deletion follows ICC. Thus, a word like *kere* would receive no constituent structure if we did not have Avoid (x#, as shown in (69).

(69)	
Project	(x kre
DL	x(x kEre
Edge	
ICC	
Delete	x x kEre
Head	

Thus, as Diyari shows, avoidance constraints cannot do all the work of unmatched parenthesis deletion. Nor can unmatched parenthesis deletion do all of the work of avoidance constraints. Thus, both mechanisms are necessary for the construction of metrical grids.

Again, as in Diyari, we cannot delete all unmatched parentheses. Unmatched right parentheses constribute stress to the final syllables of the words in (70).

(70)

Project	x kre	xx x x x haakitujik	x x x (x x x harakishrujikshna
DL	x x kEre		x x x x(x x x x harakishUrujikshAna
Edge	*avoided*	x(x x x x ha akitujik	x(x x x(x x x x harakishUrujikshAna
ICC	x x) kEre	x(x x)x x) ha akitujik	x(x x) x(x x) x x) harakishUrujikshAna
Head	x x x) kEre	x x x(x x)x x) ha akitujik	x x x x(x x) x(x x) x x) harakishUrujikshAna

In addition to providing evidence for unmatched parenthesis deletion, Winnebago also shows (1) that parenthesis projection can be sensitive to things other than rimal weight and (2) that the projection and head parameters do not have to match. By projecting left parentheses for CRV syllables while line 0 is Head:R, this achieves the post-stressing effect of syllables subject to Dorsey's Law.

Chapter 3:
Conflation and multiple metrical parameters

1. Introduction

Languages can have still more complicated rules of stress assignment. As in the analyses of Garawa and Chugach Alutiiq in Chapter 2, some languages invoke more than one setting of a parameter. In Garawa it was two Edge markings on line 1, in Chugach Alutiiq, line 0 had both ICC:L and ICC:R, in that order. The languages examined in this chapter similarly invoke more than one metrification of the grid. We will not consider here cases like Tiberian Hebrew (Rappoport (1985), HV) which require more than one metrical plane. Such a case is examined in the analysis of Shuswap sonorant glottalization in Chapter 4.

2. Bi-directional stress assignment

We have already seen in the case of Macedonian enclitic stress (Chapter 1) that stress rules can apply more than once to a form. In Macedonian, individual words receive stress, and the "enlarged stress domain" of the word with its enclitics is also subject to the same stress parameters. Levin (1988a) and Halle & Kenstowicz (1991) have examined languages with stress patterns that require multiple sets of *different* stress parameters. The divison between the sets of parameters is defined by cyclicity.

2.1. Cahuilla

Cahuilla stress has been discussed by Seiler (1965, 1970, 1977), Fuchs (1970) Levin (1988a), and Hayes (1991). Levin's description of the Cahuilla stress facts is given in (1).

(1) a. Primary stress falls regularly on the first syllable of the root, with few exceptions.

b. Secondary stress falls regularly on alternating moras both preceding and following the primary word stress.

Levin schematically illustrates this as in (2), where the underlined *x* is the first line 0 element of the root.

(2) . . . x̀ x x̀ x $\underline{\acute{x}}$ x x̀ x x̀ . . .

Examples are given in (3).

(3)	a.	pàpentúleqàlevèh	*where I was grinding it*
	b.	cemèynúˀinqàlet	*he is our leader*

As Levin notes, there are minimal pairs in roots showing different stress placements, as illustrated in (4).

(4)	néñukum	*female cousins*
	neñúkum	*male cousins*

To handle this system, we need to mark stems Edge:LLL (Edge:LRL for ***neñúkum***), and, following Levin, apply binary footing in different directions. The stem (cyclic) ICC is left to right, and the word (non-cyclic) ICC is right to left. That is, the parameters are as in (5).

(5) Roots are Edge:LLL (or Edge:LRL)

Cyclic:	Line 0:	Edge:LLL	ICC:L	Head:L
	Line 1:	Edge:LLL		Head:L
Non-cyclic:	Line 0:	Edge:RRR	ICC:R	Head:L

The system in (5) will yield the derivations in (6).

(6)			
	Cyclic	x (x x (x x) x x) x tuleqaleveh	x (x x (x x) x x) nu?inqalet
	Non-cyclic	x x (x x x (x x (x x) (x x) x) papentule qaleveh	x x (x x x (xx (x x) (x x) cemeynu?inqalet

As we can see from *cemèynú?inqàlet,* there is no degenerate constituent created at the left edge of the word.

Halle & Kenstowicz (1991) proposed the Crossover constraint on the application of metrification procedures to grids already containing constituents. They proposed that the subsequent rules of metrical construction operated only until they encountered pre-existing metrical structure. Thus, the procedures could not "cross-over" pre-existing metrical structure. The Crossover condition cannot be maintained in the present theory for two reasons. One reason is that we now have many parameters which provide constituent boundaries, and if the ICC were not allowed to cross over pre-existing metrical boundaries, then, for example it would be restricted in Tubatulabal (Chapter 1) to operating only to the right of the last heavy syllable. However, this is clearly not the case with the HLLH words discussed in the Chapter 1. The same is true of the analysis of Chugach Alutiiq in Chapter 2. Furthermore, the Cahuilla data provides a direct counterexample to the Halle & Kenstowicz claims. Here the prefixes are parsed right to left. Since the ICC is the only means of generating binary constituents, and it is universally constrained to start at a terminal element, it must be crossing over the pre-existing metrical structure. Thus, in the face of such right to left constituent construction over prefixal material we cannot maintain the Crossover condition.

3. *Conflation and circumscription*

In Chapter 1, the operation of conflation was introduced. The function of conflation was to eliminate secondary stresses by demetrifying all but the main constituent. Halle, Harris & Vergnaud (1991) discuss two views of conflation, that of HV and the alternative proposed in Halle (1990).

(7)

```
            | Halle & Vergnaud        | Halle (1990)
------------+-------------------------+-------------------------
Input       |                x        |                x
            | (x      x      x)       | (x      x      x)
            | (x  x) (x  x) (x  x)    | (x  x) (x  x) (x  x)
------------+-------------------------+-------------------------
Conflation  |                x        |
            | (              x)       |                x
            |  x  x   x  x  (x  x)    |  x  x   x  x  (x  x)
```

We could adopt one of these views, or we could ask whether a different view is possible with the present theory. Consider the stress patterns of Macedonian and Latin. Both languages require the elimination of secondary stress, and both have antepenultimate stress (for Latin only in words with a light penult). Thus, in these languages a typical word might have the form in (8).

(8)

```
Line 0: Edge:RLR  ICC:R   Head:L  |              x
Line 1: Edge:RRR          Head:R  |  x     x     x)
                                  | (x x  (x x  (x x) x
```

In examining line 0, we notice that the last constituent is the only one with both a left and a right parenthesis. Thus, if we delete the unmatched left parentheses from line 0 and then apply Head:L, we get the derivation in (9).

(9)

```
Edge:RLR ICC:R  | (x x  (x x  (x x) x
Delete          |  x x   x x  (x x) x
Head:L          |              x
                |  x x   x x  (x x) x
```

This correctly locates main stress without a line 1 calculation, and without generating the unwanted secondary stresses.

Interestingly, Diyari and Winnebago (see Chapter 2) require exactly the same rule deleting unmatched left parentheses. However, in those languages, this does not serve to leave only a single stress, because in these languages the application of ICC:L provides some left parentheses with companion right ones.

The analysis of Macedonian exceptional forms introduces a slight complication for the unmatched parenthesis deletion analysis of the elimination of secondary stress. Recall that Macedonian exceptional words can have final stress, as shown in (10).

(10)

Project	`x   x(x` `kandidat`
Edge	() *avoided*
ICC	`(x   x(x` `kandidat`

Head
Line 1
	`        x`
	`x       x)`
	`(x   x(x`
	`kandidat`

If unmatched left parentheses are deleted in this word, the word would be left without *any* line 0 metrical structure. We could fix up this problem by making these words subject to another exceptional Edge marking of Edge:RRR, providing the final constituent with both parentheses. A similar alternative is to allow the normal Edge marking to create the () vacuous constituent (see also the analysis of Latin in Chapter 1), and then "repair" this by moving the bracket, as shown in (11).

(11) Project

```
x   x(x
kandidat
```

Edge

```
x   x()x
kandi dat
```

"Repair"

```
x   x(x)
kandidat
```

ICC

```
(x   x(x)
kandidat
```

Deletion

```
x   x(x)
kandidat
```

Head

```
         x
x   x(x)
kandidat
```

Interestingly, the parenthesis deletion analysis of secondary stress elimination will also work for Selkup. Recall the facts of Selkup stress, repeated in (12).

(12) *Selkup* Stress right-most long vowel, otherwise the initial syllable

The analysis given in Chapter 1 to account for the Selkup stress pattern is repeated in (13).

(13)				
	Line 0:	Project:L	Edge:LLL	Head:L
	Line 1:		Edge:RRR	Head:R

These parameter settings yield the derivations shown in (14).

(14)	Line 0	Project:L	x x x x x L L L L L	x (x x x (x x L H L L H L
		Edge:LLL	(x x x x x L L L L L	(x (x x x (x x L H L L H L
		Head:L	x (x x x x x L L L L L	x x x (x (x x x (x x L H L L H L
	Line 1	Edge:RRR Head:R	x x) (x x x x x L L L L L	x x x x) (x (x x x (x x L H L L H L

Now consider a minor change to this system, making the line 0 Edge marking Edge:RRR. This yields somewhat different line 0 constituents, as shown in (15).

(15)	Line 0	Project:L	x x x x x L L L L L	x (x x x (x x L H L L H L
		Edge:RRR	x x x x x) L L L L L	x (x x x (x x) L H L L H L

Now if we again delete unmatched left parentheses we get the representations in (16).

(16)	Line 0	Delete	x x x x x) L L L L L	x x x x (x x) L H L L H L

And applying Head:L (17) gives the correct location of stress, without superfluous secondary stresses.

(17)	Line 0	Head:L	x x x x x x) L L L L L	x x x x x (x x) L H L L H L

Obviously the deletion of unmatched parentheses goes a long way toward eliminating the need for a separate operation of conflation. We know that it is independently necessary to have such unmatched parenthesis deletion from Diyari and Winnebago (Chapter 2). However, unmatched parenthesis deletion is not a panacea, as it cannot handle the elimination of secondary stresses in Khalkha Mongolian. Recall that Khalkha stresses the first heavy syllables or if the word has no heavy syllables, the first syllable. This is modelled by the parameters in (18).

(18)				
	Line 0:	Project:L	Edge:RRR	Head:L
	Line 1:		Edge:LLL	Head:L

Notice that the line 0 settings are the same as the modified settings for Selkup. The derivations (sans secondary stress elimination) for typical Khalkha forms are shown in (19).

```
(19) Line 0  Project:L   | x x x x x    | x(x x x(x x   |
                         | L L L L L    | L H L L H L   |
             Edge:RRR    | x x x x x)   | x(x x x(x x)  |
                         | L L L L L    | L H L L H L   |
             Head:L      | x            |   x     x     |
                         | x x x x x)   | x(x x x(x x)  |
                         | L L L L L    | L H L L H L   |
     Line 1  Edge:LLL    |  x           |   x           |
             Head:L      | (x           |  (x     x     |
                         |  x x x x x)  | x(x x x(x x)  |
                         |  L L L L L   | L H L L H L   |
```

Here, we see that the main stress is *not* located on the head of the sole constituent that contains both parentheses. Nevertheless, the description of Khalkha claims that there are only two degrees of stress. Furthermore, we do not have to rely on the facts of Khalkha. Russian (see Chapter 4) has the same parameter settings, and it is clear that secondary stresses are eliminated in Russian. Evidently, we will still require a way of eliminating metrical structure in all but the constituent with main stress.

One way to achieve this is to import a notion from prosodic morphology, which will allow us to break a form into two domains. McCarthy & Prince (1986, 1990, etc) have introduced a powerful operation to prosodic morphology, which they call *circumscription*. The circumscription operation parses a form into two pieces: the base and the residue. Adapting this idea to the present theory, with the insight from the operation of Conflation that main stress is the location of the major break, gives the operation in (20).

(20) *Circumscription*
Divide a form into two domains at the main stress

The formulation in (20) is somewhat more general than that of McCarthy and Prince. They allow only a terminal constituent to be circumscribed. However, the facts of English secondary stress assignment, discussed below, offer an example of a non-terminal circumscription.

Again adapting the terminology of McCarthy and Prince, let us call the portion of the form containing the (former) main stress the base and the other portion the residue. We can now characterize Conflation as Circumscription with deletion of the metrical structure of the residue. Returning to the Latin/Macedonian example, using Circumscription and residue deletion gives the derivation in (21).

```
(21)  Line 0                          x
      Line 1            x     x       x)
                        (x x  (x x    (x x) x

      Circumscription                 |  x        ⎫
                        x     x       |  x)       ⎪
                        (x x  (x x    |  (x x) x  ⎬ Conflation
                                                  ⎪
      Delete residue                  |  x        ⎪
                                      |  x)       ⎪
                        x x   x x     |  (x x) x  ⎭
```

That the division occurs at the location of main stress can be seen more clearly in the case of English words with retracted main stress, for example *oríginàte* (see Hammond (1989b), Halle & Kenstowicz (1991)). These words retain the secondary stress on the final syllable. The English cyclic stress rule is the same as Latin, with the proviso that final heavy syllables in English can get stress. Further, in words like *oríginàte*, the main stress is retracted off the final heavy syllable. The derivation for *oríginàte* is given in (22).

```
(22)  Cyclic      Project:L        (x (x  x (x
                                    originate

                  Edge:RLR         ()  avoided

                  ICC:R            (x (x  x (x
                                    originate

                  Head:L            x  x    x
                                   (x (x  x (x
                                    originate

                  Edge:RRR          x  x    x)
                                   (x (x  x (x
                                    originate

                  Retraction        x  x)   x
                                   (x (x  x (x
                                    orígínate

                  Head:R               x
                                    x  x)   x
                                   (x (x  x (x
                                    originate

      Non-cyclic  Circumscription       |   x
                                    x   |   x)   x
                                   (x   |  (x  x (x
                                    or  |  riginate

                  On Residue            |   x
                  Delete                |   x)   x
                                    x   |  (x  x (x
                                    or  |  riginate

                  On Residue            |   x
                  ICC:L                 |   x)   x
                  Head:L            x   |  (x  x (x
                                    or  |  riginate
```

Notice again that unmatched parenthesis deletion would not accomplish what circumscription accomplishes. The English facts, in conjuction with the Macedonian and Khalkha systems, clearly show that Circumscription is required in addition to unmatched parenthesis deletion.

It has been suggested that instead of Conflation, language have a parameter of iterativity. This parameter would govern how many constituents would be built in a form. In non-iterative languages, only one constituent would be built, in iterative languages constituents would be built across the form. The fact that English words are split at the main stress, even in cases of retracted stress, is a clear counter example to the idea that Conflation is non-iterative constituent construction. As we shall see, the Circumscription operation has utility beyond merely providing a mechanism for Conflation. Thus, it is unnecessary to add a parameter of Iterativity.

The various kinds of pre-tonic secondary stress patterns described by Halle & Kenstowicz can be handled with different values for the Edge marking parameter applied to the residue in the non-cyclic metrification. For example, *orìginálity* is Edge:LRL, *pèregrinátion* is Edge:LLL and *Hàlicàrnássus* is Edge:RRR. The derivations for these words are given in (23).

```
(23) Cyclic |       x       |      x         |       x
            |  x x   x)     |  x     x)      | x   x  x)
            | (x(x x(x x)x  | x(x  x(x)x     | (x x(x (x) x
            |  originality  | peregrination  | Halicarnassus
     -------+---------------+----------------+----------------
     Circ.  |      | x      |       | x      |       | x
            |  x x | x)     |  x    | x)     | x   x | x)
            | (x(x x|(x x)x | x(x  x|(x)x    | (x x(x |(x) x
            |  origi|nality | peregri|nation | Halicar|nassus
     -------+---------------+----------------+----------------
     Delete |      | x      |       | x      |       | x
            |      | x)     |       | x)     |       | x)
            | x x x|(x x)x  | x x  x|(x)x    | x x x |(x) x
            | origi|nality  | peregri|nation | Halicar|nassus
     -------+---------------+----------------+----------------
     Edge   |      | x      |       | x      |       | x
            |      | x)     |       | x)     |       | x)
            | x(x x |(x x)x | (x x  x|(x)x   | x x x)|(x) x
            | origi |nality | peregri|nation | Halicar|nassus
     -------+---------------+----------------+----------------
     ICC    |      | x      |       | x      |       | x
     Head   |  x   | x)     |  x    | x)     | x   x | x)
            | x(x x)|(x x)x | (x x) x|(x)x   | x x)x)|(x) x
            | origi |nality | peregri|nation | Halicar|nassus
```

Halle & Kenstowicz took the fact that the post-tonic material does *not* gain new constituent structure through the application of the ICC in the non-cyclic block as evidence for the Cross-over condition. As we have seen, the Cross-over condition cannot be maintained in the face of the Cahuilla data. The effect of the Cross-over condition in English is handled here by the operation of Circumscription. Since the non-cyclic parameter apply only to the residue of Circumscription, the ICC does not have access to the post-tonic string.

Circumscription also provides another way to characterize other languages with multiple stress parameters, such Lenakel, Auca and Seneca. Circumscription is a powerful device, generating prosodic domains for the application of subsequent rules. In this way, many complicated, unattested stress patterns could be generated. Clearly the operation of circumscription must be constrained. However, at present it is not clear what the limits to the use of circumscription are.

3.1. *Lenakel*

Lenakel stress is described in Lynch (1974, 1978), and has been analyzed by Hammond (1985), and HV. The HV summary of the facts of Lenakel stress is given in (24).

(24) a. In Lenakel, main stress is located on the penultimate syllable in the large majority of words and on the final syllable in a class of specially marked words. As in a great many other languages, in Lenakel the main word stress is preceded by a series of subsidiary stresses.

b. In nouns these fall on every even-numbered syllable *[counting from the right — WJI]* preceding the main stress

c. in verbs they fall on odd-numbered syllables *[counting from the left — WJI]* preceding the main stress, except for the syllable immediately preceding main stress

Examples of stress in nouns are given in (25).

(25)	lɛ̀dubɔ̀lugáluk	*lungs (loc)*
	kayɛ̀lawɛ́law	*kind of dance*

For the nouns, we have the parameter settings in (26).

(26)	Line 0:	Edge:RRR	ICC: R	Head: L
	Line 1:	Edge:RRR		Head:R

These settings yield the derivations in (27).

(27)

Edge:RRR ICC:R	(x x (x x (x x) lE du bɔ lu ga lUk	x (x x (x x) ka yE la wE law
Head:L Line 1	x (x x x) (x x (x x (x x) lE du bɔ lu ga lUk	x (x x) x (x x (x x) ka yE la wE law

Examples of stress in verbs are given in (28).

(28)	kə̀namargə́nim	*they have been pinching it*
	tɨ̀nagàmyasɨnə́vɨn	*you will be copying it*
	nàdyagàmɛdwàdamnímɔn	*why I am about to be shaking*

In order to capture the stress pattern of the verbs and adjectives we will need a subsidiary calculation from the left edge that builds constituents from left to right. Parameter settings to do this are in (29).

(29)	Line 0:	Edge:RRR	ICC: R	
		V and Adj:	Delete unmatched left parentheses	
			ICC:L	
		Head:L		
	Line 1:	Edge:RRR		Head:R

In (30) we see this applied to two verbs, one with an even number of syllables, the other with an odd number of syllables.

(30)

	Even	*Odd*
Edge:RRR ICC:R	(x x(x x (x x (x x) nadyagamEdwadamnimɒn	x(x x (x x(x x) tɨnagamyasɨnəvɨn
Delete	x x x x x x (x x) nadyagamEdwadamnimɒn	x x x x x(x x) tɨnagamyasɨnəvɨn
ICC:L	x x)x x) x x)(x x) nadyagamEdwadamnimɒn	x x)x x)x(x x) tɨnagamyasɨnəvɨn
Head:L Line 1	x x x x x) x x)x x) x x)(x x) nadyagamEdwadamnimɒn	x x x x) x x)x x)x(x x) tɨnagamyasɨnəvɨn

As we can see, ICC:L applied to the odd word leaves a left-over mark, which remains unmetrified. When a verb has an even number of syllables, the application of ICC:L yields the same footing as the original application of ICC:R gave. The nouns are not subject to unmatched parenthesis deletion or ICC:L, so they retain their original constituents, as shown in (31).

(31)

	Even	*Odd*
Edge:RRR ICC:R	(x x(x x(x x) lEdubɔlugalUk	x(x x(x x) kayElawElaw
Delete	*not applicable*	*not applicable*
ICC:L	*not applicable*	*not applicable*
Head:L Line 1	x x x x) (x x(x x(x x) lEdubɔlugalUk	x x x) x(x x(x x) kayElawElaw

Instead, we could make only the verbs and adjectives subject to unmatched parenthesis deletion, and also apply ICC:L to the nouns. This will not disrupt the constituent structure already assigned, as shown in (32).

(32)

	Even	*Odd*
Edge:RRR ICC:R	(x x(x x(x x) lEdubɔlugalUk	x(x x(x x) kayElawElaw
Delete	*not applicable*	*not applicable*
ICC:L	(x x) (x x) (x x) lEdu bɔlu galUk	x(x x) (x x) kayEla wElaw
Head:L Line 1	x x x x) (x x) (x x) (x x) lEdu bɔlu galUk	x x x) x(x x) (x x) kayEla wElaw

It is also possible to delete unmatched parentheses in all words, and then parameterize the second ICC. For verbs and adjectives we would apply ICC:L, and for nouns, ICC:R. Under this analysis, the nouns just rebuild their original constituents, as shown in (33).

(33)

	Even	*Odd*
Edge:RRR ICC:R	(x x(x x(x x) lEdubɔlugalUk	x(x x(x x) kayElawElaw
Delete	x x x x(x x) lEdubɔlugalUk	x x x(x x) kayElawElaw
ICC:R	(x x(x x(x x) lEdubɔlugalUk	x(x x(x x) kayElawElaw
Head:L Line 1	x x x x) (x x(x x(x x) lEdubɔlugalUk	x x x) x(x x(x x) kayElawElaw

It is a simple matter to translate this analysis of Lenakel into an analysis employing Circumscription. The parameters in (34) also generate the correct stresses.

(34)

Line 0:	Edge:RRR	ICC: R	Head:L
Line 1:	Edge:RRR		Head:R
V and Adj:	Circumscribe		
	Delete Residue		
	ICC:L	Head:L	

In (35) we see this applied to two verbs one with an even number of syllables, the other with an odd number of syllables.

(35)

	Even	*Odd*
Line 0 Line 1	x x x x x) (x x(x x (x x (x x) nadyagamEdwadamnimɒn	x x x x) x(x x (x x(x x) tɨnagamyasɨnəvɨn
Circ	| x x x x | x) (x x(x x (x x | (x x) nadyagamEdwadam|nimɒn	| x x x | x) x(x x (x x| (x x) tɨnagamyasɨ|nəvɨn
Delete	| x | x) x x x x x x | (x x) nadyagamEdwadam|nimɒn	| x | x) x x x x x| (x x) tɨnagamyasɨ|nəvɨn
ICC:L Head:L	| x x x x | x) x x) x x) x x) | (x x) nadyagamEdwadam|nimɒn	| x x x | x) x x) x x) x| (x x) tɨnagamyasɨ|nəvɨn

Again, variations on this analysis involving deletion and remetrification of nouns are possible. Though the two analyses presented here have many similarities, there is a major difference between them. The unmatched bracket deletion analysis predicts that the "metrification divide" is a function of matched brackets, therefore it is related to the operation of line 0 Edge marking. Because Lenakel is Edge:RRR on line 0, it is the final constituent that will have both parentheses. The circumscription analysis, on the other hand, predicts that the "metrification divide" occurs at the main stress. Put another way, the unmatched bracket deletion analysis is *not* dependent upon the operation of the line 1 parameters. The line 1 parameters operate *after* the form has been re-metrified. Thus, line 1 could just as easily be Edge:LLL Head:L, predicting primary stress on either the initial or second syllable, depending on the category and length of the word.

(38)	Cyclic	(x v	(x v	(x v	(x v
	Non-cyclic	(x x v#v	(x (x x v#v v	(x x (x x v#v v v	(x (x x (x x v#v v v v
	Head:L	x (x x v#v	x x (x (x x v#v v	x x (x x (x x v#v v v	x x x (x (x x (x x v#v v v v

Avoid)# is required to get the proper placement of stress with two syllable stems. Without Avoid)#, the derivations for two syllable stems in (39) would occur.

(39)	Cyclic	(x x) v v	(x x) v v	(x x) v v
	Non-cyclic	(x x) x v v#v	(x x) (x x v v #v v	(x x) x (x x v v#v v v
	Head:L	x * (x x) x v v#v	x x (x x) (x x v v #v v	x x * (x x) x (x x v v#v v v

With Avoid)#, the correct stress patterns are generated for two syllable stems, as shown in (40).

(40)	Cyclic	(x x v v	(x x v v	(x x v v
	Non-cyclic	(x (x x v v#v	(x x (x x v v#v v	(x (x x (x x v v#v v v
	Head:L	x x (x (x x v v#v	x x (x x (x x v v#v v	x x x (x (x x (x x v v#v v v

However, we run into trouble with the derivations for three syllable stems, shown in (41).

(41)

Cyclic	`(x x) x` ` v v v`	`(x x) x` ` v v v`	`(x x) x` ` v v v`
Non-cyclic	`(x x) (x x` ` v v   v#v`	`(x x) x (x x` ` v v v#v v`	`(x x) (x x (x x` ` v v   v#v v v`

Head:L	` x     x`
	`(x x) (x x`
	` v v   v#v`
		` x       x`
		` (x x) x (x x`
		`* v v v#v v`
			` x     x    x`
			`(x x) (x x (x x`
			` v v   v#v v v`

These cases were correctly handled by Halle & Kenstowicz because they assumed exhaustive constituent construction, which constructed degenerate constituents. To gain stress on the middle syllable of the form, we could invoke a rule creating a constituent from a single unmetrified mark, as in (42).

(42) $\varnothing \rightarrow (\; / \;) \_ \; x \; ($

The derivation for the 3 + 2 form including (42) then yields the correct stresses, as shown in (43).

(43)

Cyclic	`(x x) x` ` v v v`
Non-cyclic	`(x x) x (x x` ` v v v#v v`
(42)	`(x x) (x (x x` ` v v   v#v v`

Head:L	` x     x  x`
	`(x x) (x (x x`
	` v v   v#v v`

If we allow such rules picking up single stray unmetrified elements, we effectively add a parameter for exhaustive constituent construction. This would allow us to make Tubatulabal (see Chapter 1) right-headed. This would weaken the theory somewhat, so other alternatives are worth pursuing.

By making use of cyclic and non-cyclic stress rules, along with the operation of Circumscription, we can break the form into two domains near the end of the stem and correctly place the stress, without rules such as (42). The parameters to do this are given in (44).

(44) Cyclic: Edge:RRR ICC:L Head:L
Edge:RRR Head:R
Non-cyclic: Circumscribe & delete base
Base: Edge:LLL ICC:R Head:L

The cyclic portion of the derivations for stems of three to five syllables are shown in (45).

(45)

```
         | x   x       | x   x         | x   x   x
Line 0   | (x  x) x)   | (x  x) x  x)  | (x  x) x  x) x)
         | v   v  v    | v   v  v  v   | v   v  v  v  v
---------+-------------+---------------+-----------------
         |        x    |       x       |              x
Line 1   | x      x)   | x     x)      | x     x      x)
         | (x  x) x)   | (x  x) x  x)  | (x  x) x  x) x)
         | v   v  v    | v   v  v  v   | v   v  v  v  v
```

The cyclic portion of the derivations for one and two syllable stems are shown in (46).

(46)

```
         | x    | x
Line 0   | x)   | x  x)
         | v    | v  v
---------+------+--------
         | x    | x
Line 1   | x)   | x)
         | x)   | x  x)
         | v    | v  v
```

As we can see, the main stress dominates a line 0 constituent of either one or two syllables, depending on the length of the stem. When the stem is odd, the main stress constituent has one element, when the stem is even, it has two. Adding non-cyclic suffixes to an odd base yields the derivations in (47).

(47)

<table>
<tr><td>Suffixes</td><td>x
x x)
(x x) x) x
v v v #v</td><td>x
x x)
(x x) x) x x
v v v #v v</td><td>x
x x)
(x x) x) x x x
v v v #v v v</td></tr>
<tr><td>Circum</td><td>| x
x | x)
(x x) | x) x
v v | v #v</td><td>| x
x | x)
(x x) | x) x x
v v | v #v v</td><td>| x
x | x)
(x x) | x) x x x
v v | v #v v v</td></tr>
<tr><td>Delete</td><td>x |
(x x) | x x
v v | v#v</td><td>x |
(x x) | x x x
v v | v#v v</td><td>x |
(x x) | x x x x
v v | v#v v v</td></tr>
<tr><td>Edge</td><td>x |
(x x) | (x x
v v | v#v</td><td>x |
(x x) | (x x x
v v | v#v v</td><td>x |
(x x) | (x x x x
v v | v#v v v</td></tr>
<tr><td>ICC</td><td>x |
(x x) | (x x
v v | v#v</td><td>x |
(x x) | (x (x x
v v | v#v v</td><td>x |
(x x) | (x x (x x
v v | v#v v v</td></tr>
<tr><td>Head</td><td>x | x
(x x) | (x x
v v | v#v</td><td>x | x x
(x x) | (x (x x
v v | v#v v</td><td>x | x x
(x x) | (x x (x x
v v | v#v v v</td></tr>
</table>

Adding non-cyclic suffixes to an even base yields the derivations in (48).

(48)

<table>
<tr><td>Suffixes</td><td>x
x x)
(x x)x x) x
v v v v #v</td><td>x
x x)
(x x)x x) x x
v v v v #v v</td></tr>
<tr><td>Circum</td><td>|x
x |x)
(x x)|x x) x
v v |v v #v</td><td>|x
x |x)
(x x)|x x) x x
v v |v v #v v</td></tr>
<tr><td>Delete</td><td>x |
(x x)|x x x
v v |v v#v</td><td>x |
(x x)|x x x x
v v |v v#v v</td></tr>
<tr><td>Edge</td><td>x |
(x x)|(x x x
v v | v v#v</td><td>x |
(x x)|(x x x x
v v | v v#v v</td></tr>
<tr><td>ICC</td><td>x |
(x x)|(x(x x
v v | v v#v</td><td>x |
(x x)|(x x(x x
v v | v v#v v</td></tr>
<tr><td>Head</td><td>x | x x
(x x)|(x(x x
v v | v v#v</td><td>x | x x
(x x)|(x x(x x
v v | v v#v v</td></tr>
</table>

Certainly, circumscription would be unjustified if we used it only to avoid using a rule picking up a single stray mark. However, circumscription has a more general utility, most notably the wealth of cases analyzed by McCarthy and Prince. Circumscription is also crucial in the analyses of Shuswap sonorant glottalization in Chapter 4 and for the stress patterns of Klamath and Seneca, which we will now examine.

3.3. *Klamath*

Klamath (Barker (1963,1964), Hammond (1986), HV) has a complicated stress system that involves both unbounded and binary constituents. Hammond's summary of the stress facts of Klamath is given in (49).

(49) a. The rightmost long vowel receives primary stress;
b. otherwise, stress a closed penult;
c. otherwise, stress the antepenult if there is one;
d. otherwise, stress the penult.

Hammond gives examples of each clause in (49), one of each of these is given in (50).

(50)	a.	gawí:napgabli	*is going among again*
	b.	gatbámbli	*returns home*
	c.	cáw̓iga	*is crazy*
	d.	ɩóc̓o	*wild celery*

The statements in (49) are arranged in a particular order. Thus, the calculation for the rightmost long vowel is the primary calculation for word stress. By using it as the basis of circumscription, we can succinctly account for the stress patterns in Klamath words. The parameters in (51) will generate the stress patterns.

(51)	Project:R for syllables with long vowels			
	Line 0:			Head:R
	Line 1:	Edge:RRR		Head:R
	Circumscribe			
	On Residue:			
	Project:L for closed syllables			
	Line 0:	Edge:RLR	ICC:R	Head:L
	Line 1:	Edge:RRR		Head:R

Notice that the initial calculation has no line 0 Edge marking. Then, constituents will be formed only if there are long vowels in the form. Thus, in words without long vowels, the entire form will constitute the residue. In this case, we get a Latin-type system with closed syllables functioning as heavy. This gives the derivations for (50b-d) shown in (52).

(52)

	gatbámbli	*cáⱳiga*	*bóčo*
Line 0 Line 1	x x x gatbambli	x x x caⱳiga	x x bočo
Circum	| x x x |gatbambli	| x x x |caⱳiga	| x x |bočo
On Residue: Project	|(x (x x |gatbambli	| x x x |caⱳiga	| x x |bočo
Line 0 Line 1	| x | x x) |(x (x)x |gatbambli	| x | x) |(x x)x |caⱳiga	| x | x) | x)x |bočo

For words with long vowels, this system will provide additional stresses on the residue, as shown in (53).

(53)

	gawí:napgabli
Line 0 Line 1	x x) x x) x x x gawi:napgabli
Circum	x | x) | x x) | x x x gawi:|napgabli
On Residue: Project	x | x) | x x) |(x (x x gawi:|napgabli
Line 0 Line 1	x | x x) | x x) x x) |(x (x)x gawi:|napgabli

According to Barker, some words, including this one, do receive secondary stress on the penult. However, this phenomenon is not general, being limited to forms where "either the penult or the final syllable [is] closed." The account so far yields equal stresses on both base and residue. In order to correctly put main stress on the base, we will have to parameters for line 2 on the base. Specifically, the base will have the same line 2 parameters as those on line 1, [Edge:RRR Head:R]. Completing the derivation in (53) with the base calculation gives (54).

(54)

```
On Base:         x
Edge:RRR         x)|    x
Head:R           x)| x  x)
                x x)|(x (x )x
              gawi:|napgabli
```

Thus, the ICC rule in Klamath is restricted to operating on the residue of the first calculation. By circumscribing the form, we can account for the existence of both binary and unbounded constituents in the same language. Klamath also has both left- and right-headed line 0 constituents. Steriade (1988) gives an analysis of Greek enclitic accent that also employs constituents with different headedness. Again, by using circumscription we can limit each domain to a single type of constituent. Thus, the circumscription theory provides a way of splitting the word into two domains, and these domains may correspond to differences in metrical parameter settings.

3.4. *Seneca*

Seneca stress has a character similar to that of Klamath. Seneca stress has been described and analyzed by Chafe (1977), Stowell (1979), HV, and Michelson (1988). The HV description of the stress patterns of Seneca is given in (55).

(55) a. Stress the last nonfinal even-numbered syllable (counting from the beginning of the word) that is either closed itself or immediately followed by a closed nonfinal syllable.

b. The syllable bearing main stress is preceded by alternating stresses arranged in an iambic pattern.

Further, Chafe notes if the word contains no closed syllables, then "the word appears with no accent at all" (page 179).

Seneca builds binary constituents from left to right, but this is restricted to the portion of the word before the last non-final closed syllable. The key to the analysis is to apply a metrification to first get a gross cut at the location of the stress and then apply more metrical parameters to locate the stress exactly. For the initial cut, we need to metrify the two kinds of words as in (56), splitting the word at the last non-final closed syllable. In (56) the H stands for a closed syllable.

(56)	with closed syllables	L L H L L H | L H
	without closed syllables	| L L L L L

To do this we need to find the last non-final closed syllable and circumscribe the word at this point. We can then delete the constituents and build new ones. Seneca stress can thus be captured with the settings in (57).

(57) Project: R for closed syllables
Line 0: Avoid)# Head:R
Line 1: Edge:RRR Head:R
Circumscribe
On Base: Delete
Line 0: ICC:L Head:R
Line 1: Edge:RRR Head:R

For words with non-final closed syllables, (58) shows derivations for the two cases: odd and even numbers of syllables before last non-final heavy. The Avoid)# constraint prevents final heavy syllables from receiving a parenthesis.

(58)

<table>
<tr><th></th><th>Odd</th><th>Even</th></tr>
<tr><td>Line 0
Line 1</td><td>x
x x)
x x x)x x)x x
L L H L H L H</td><td>x
x x)
x x x)x x x)x x
L L H L L H L H</td></tr>
<tr><td>Circum</td><td>x |
x x) |
x x x)x x) |x x
L L H L H |L H</td><td>x |
x x) |
x x x)x x x) |x x
L L H L L H |L H</td></tr>
<tr><td>On Base:
Delete</td><td>x x x x x |x x
L L H L H |L H</td><td>x x x x x x |x x
L L H L L H |L H</td></tr>
<tr><td>ICC:L</td><td>x x)x x)x |x x
L L H L H |L H</td><td>x x)x x)x x) |x x
L L H L L H |L H</td></tr>
<tr><td>Head:R
Line 1</td><td>x |
x x) |
x x)x x)x |x x
L L H L H |L H</td><td>x |
x x x) |
x x)x x)x x) |x x
L L H L L H |L H</td></tr>
</table>

This method provides a general invisibility to a portion of the word through a stress-like calculation. In this case, it is the residue that is "invisible". This consists of the material following the last non-final closed syllable. As in Klamath, when there are no non-final long vowels, the entire form constitutes the residue, and the subsequent stress calculation has no marks to operate on, leaving the form without stress, as shown in (59).

(59)

<table>
<tr><td>Line 0
Line 1</td><td>x x x x x x x
L L L L L L L</td></tr>
<tr><td>Circum</td><td>|x x x x x x x
|L L L L L L L</td></tr>
<tr><td>On Base:
Delete</td><td>|x x x x x x x
|L L L L L L L</td></tr>
<tr><td>ICC:L</td><td>|x x x x x x x
|L L L L L L L</td></tr>
<tr><td>Head:R
Line 1</td><td>|x x x x x x x
|L L L L L L L</td></tr>
</table>

Thus, the stress pattern of Seneca is captured by dividing the form into two pieces, based on a calculation that could be a main stress calculation for a language. Seneca does not keep this location of main stress, but rather deletes this metrical structure, and builds new metrical structure. This new metrification is restricted to the base defined by the first calculation and circumscription.

Chapter 4: Case studies in lexical stress

1. Introduction

This chapter will examine three languages with extensive systems of lexical stress. Two of these, Shuwap and Moses-Columbian, are Salish and the other, Russian, is Indo-European.

2. Russian

Russian stress is exceedingly well-studied. I have drawn the material, classification and much of the analysis in the section from Halle (1973), Coats (1976, 1989) and Melvold (1990). Other important works on Russian stress include Dybo (1981), Hartmann (1936), Illič-Svityč (1963) and Zaliznjak (1980, 1985). The Basic Accentuation Principle, (1), (Kiparsky & Halle (1977), Halle & Kiparsky (1981)) describes the location of stress in words in Russian (and, more generally, in Indo-European).

(1) *Basic Accentuation Principle*
If a word has more than one accented vowel, the first of these gets the word accent. If a word has no accented vowel, the first vowel gets the word accent.

Khalkha Mongolian (see Chapter 1) has the same pattern, with the one difference that in Khalkha syllable quantity causes parenthesis projection, and in Russian, morphemes are lexically marked for special parentheses. This lexical introduction of metrical parentheses is accomplished with special applications of Edge parameters. The parameter settings for Russian are given in (2).

(2)	Line 0:	Edge:RRR	Head:L
	Line 1:	Edge: LLL	Head:L
	Conflation		

The morphology of Indo-European inflected words often includes an extra morphological element with no semantic function, called the *theme*. That is, an inflected word, for example, *sidela* 'sat (feminine)' has the structure shown in (3).

(3)	Stem	+	Theme	+	Tense	+	Person/Number
	sid	+	e	+	l	+	a
	sit				*past*		*feminine*

For discussions of the morphology of themes and other similar morphological elements, see Bromberger & Halle (1989), and especially Halle (1991, 1992) and Harris (1991).

The Indo-European stress system has changed in many of the daughter languages, often to fixed initial stress. This change can be modelled in two ways. As Donca Steriade (quoted in HV) has pointed out, if a language with (2) loses lexical stresses, the result will be uniform initial stress. Also, if the Edge marking parameter is changed from Edge:RRR to Edge:LLL, this will also result in initial stress. This change in Edge marking increases the homogeneity of the system, and thus should be a favored development. The loss of lexical stress would be a gradual, idiosyncratic loss, whereas the change in Edge marking would cause total immediate loss of the function of lexical stress. This issue is not a simple one, as the loss of lexical marking in particular morphological forms could have severe consequences for the acquisition of the grammar (on this point see Dresher (1992)).

Russian has three basic classes of stems: unstressed (C), stressed (A) and post-stressing (B). With line 0 being Head:L this classification corresponds to various types of Edge:LXX lexical marking, as shown in (4).

(4)

C	Unstressed	x x x	No Edge
B	Post-stressing	x x x(	Edge:LRR
A	Stressed	(x x x	Edge:LLL
		x(x x	Edge:LRL
		x x(x	Edge:LLR

The vowels normally treated as morphologically "accented" will be treated here as having a left line 0 constituent boundary, provided by a special application of Edge marking. This is not the only method of modelling lexical stress within the general framework adopted here. For a discussion of the different possibilities, see Chapter 5. Lexical Edge marking predicts that A stems can have fixed stress on the first (*séver* 'north'), second (*karákul* 'astrakhan') or last (*kapitán* 'captain') syllable of the stem. This accounts for the overwhelming majority of stems, but there are a handful of exceptions, such as *arxitéktor* 'architect', *ginekólog* 'gynecologist', and *temperáment* 'temperament'. These can be handled by assuming that these words, though borrowed, are poly-morphemic in Russian. Russian has two basic kinds of inflectional suffixes: unstressed and stressed; unstressed suffixes have no Edge marking, and stressed suffixes are Edge:LLR.

2.1. *Noun inflections*

The nominal inflection system is the most complex. Examples of the three basic classes are shown in (5).

(5)

	A		B		C	
I	koróva	*cow*	gospožá	*lady*	borodá	*beard*
IIa	goróx	*pea*	čer'ód	*turn*	véčer	*evening*
IIb	zdánie	*building*	božestvó	*deity*	zérkalo	*mirror*
III	postél'	*bed*	l'ubóv'	*love*	pl'óščad'	*horse*

The A stems have stress fixed on some stem vowel, the B stems have stress fixed on the ending. In (6) we have the derivations for the three basic kinds of stems with a stressed ending. The stressed endings have a lexical Edge marking as well, supplying a left parenthesis for the suffix.

(6)

	A Edge:LLR	B Edge:LRR	C Edge:Ø
Project Lex Edges	x (x (x rabot + a	x x((x gospož + a	x x (x borod + a
Line 0 Line 1	x (x x x (x (x) rabot + a	x (x x x((x) gospož + a	x (x x x (x) borod + a

In (7) we have the same words with an unstressed ending. The unstressed endings, like the unstressed roots, do not carry a lexical Edge marking and thus provide no metrical parentheses.

(7)

	A Edge:LLR	B Edge:LRR	C Edge:Ø
Project Lex Edges	x (x x rabot + y	x x(x gospož + y	x x x borod + y
Line 0 Line 1	x (x x (x x) rabot + y	x (x x x(x) gospož + y	x (x x x x) borod + y

In a limited subclass of the C stems, the accent can appear on a preceding preposition, as in *ná golovu* 'on [the] head'. This can be handled by allowing the cliticization of the preposition to the following noun in such cases. The stressless class (C) also has the distinction of having the largest number of stress paradigms, due to the differing stress properties of the inflectional endings. The endings, with their lexical stresses (adapted from Melvold (1990)) are shown in (8). The letters E and O represent the jer vowels, to be discussed below. As in (6) and (7), stressed endings supply a left parenthesis, and unstressed endings supply no parentheses.

(8)

	Singular				Plural
	I	*IIa*	*IIb*	*III*	
Nom	á	O	o	E	y/ý/i/á
Acc	u				
Gen	ý	a		i	O
Dat	é	u		i	ám
Inst	ój	omO		Eju	ámi
Loc	é	e		i	áxO

The table in (8) glosses over many morphological issues. For a more complete treatment of the morpho-phonology of the Russian case system, see Halle (1991). All class I endings except the accusative are stressed. All oblique plural endings are stressed. Following Halle (1991), we can assume that all forms include a theme vowel, and that the theme vowel in the oblique plural is stressed *-á-* as shown in (9).

(9)

	Plural
Dat	á + m
Instr	á + mi
Loc	á + x

The realizations of the theme vowel are quite complicated. In general, the theme vowel is unstressed *-o-*. Russian has a rule of truncation, deleting the first of an adjacent pair of vowels, as in (10).

(10) $V \rightarrow \emptyset \;/\; \_\_ + V$

Since the theme is usually a single vowel, and the endings are usually vowel-initial, truncation often deletes the theme vowel. In certain morphological circumstances, additional material is added which then prevents the loss of the theme vowel. One example of such an alternation are the different forms of the genative plural. Some words add a /w/ between the theme and the case ending, which then allows the theme *-o-* to be retained, for example *beregov* 'shore'. Others add /y/, for example *stebl'ey* 'stem'. Others add no consonant, leading to the deletion of the theme, for example, *volos* 'hair'.

The case endings are subject to rules of allomorphy, and sometimes this allomorphy is distinctive only with regard to stress. The nominative plural has several allomophs, including stressed and unstressed *-y*. The words *dar* 'gift' and *zub* 'tooth' have the same stress patterns for all forms except the nominative plural: *darý, zúby*. They are C stems (Edge:Ø), taking different allomorphs of the nominative plural: *dar* takes unstressed *-y*, and *zub* takes stressed *-ý*, as shown in (11).

(11)

Project Lex Edges	`x   x` `zub + y`	`x   (x` `dar + y`

Line 0
Line 1
	`x`
	`(x`
	`x   x)`
	`zub + y`
		`x`
		`(x`
		`x   (x)`
		`dar + y`

There is another kind of allomorphy, displayed by the locative singular marker. The stem *plen* 'captivity' is an A stem, with stem stress throughout its paradigm, except for the locative singular, *v plenú*. Instead, with the locative singular, it shows stress on the ending. In order to achieve this result, it is not sufficient for the locative singular to merely be stressed. It must also eliminate the stress on the stem. To do this, we will have to allow morphemes to be able to specify that the metrical parentheses are deleted from the stem that they attach to. We will call such morphemes stress-deleting.

(12)

Project Lex Edges	(x (x plen + a	(x (x plen + u
Stem stress deletion		x (x plen + u
Line 0 Line 1	x (x x ·(x (x) plen + a	x (x x (x) plen + u

We will see other instances of stress-deleting morphemes in the verbal system, and especially in the derivational morphology.

2.2. *Jers and stress shift*

One cannot get very far in Russian phonology without dealing with the class of vowels, known as jers, that alternate with zero. There have been two basic approaches to this problem, deletion and insertion (see Kenstowicz and Rubach (1987), Melvold (1990) and Szpyra (1992) for recent discussions and proposals). The generalization in the modern language is that jers surface when followed by another jer. In many analyses this is captured by two rules, one turning jers into regular vowels before jers (13a) and the other deleting any remaining jers (13b).

(13) a. $V \rightarrow$ [-jer] / __ C_0 [+jer]   b. $\underset{[+jer]}{V} \rightarrow \emptyset$

When a jer vowel deletes so will its projected line 0 grid mark. With Russian being left-headed, this will shift stress rightward in the case of the deletion of a jer vowel that begins a constituent. The first part of the derivations of an unstressed (C) stem, *volos* 'hair' with unstressed (nom sg) and stressed (gen pl) jer endings are shown in (14).

(14)

	Unstressed (vólos)	*Stressed (volós)*
Project Lex Edges	x x x volos + 0	x x (x volos + 0
Jer	x x volos	x x(volos

To get final stress in the genitive plural form, we will need the rule in (15) adding another parenthesis before a final "dangling" one.

(15) $\varnothing \rightarrow (\;/\; \_\, x (\#$

The rest of the derivation is given in (16).

(16)

Doubling	x x volos	x(x(volos
Line 0 Line 1	x (x x x) volos	x (x x(x(volos

Rather than add another parenthesis, we could permute the parenthesis and the mark; there is no empirical evidence that bears on this choice. Rules of bracket insertion are conceptually simpler. The same parenthesis doubling rule applies in the nominative singular with B stems belonging to the IIa declension, such as *čer'od* 'turn', as shown in (17).

(17)

Project Lex Edges	x x(x čer'od + 0
Jer	x x(čer'od
Doubling	x (x(čer'od
Line 0 Line 1	x (x x (x(čer'od

It would also be possible to apply Doubling after the grammatical Edge marking, as it will have no effect here. Applying Doubling before the grammatical Edge marking allows all of the grammatical parameters to apply as a block.

Ideally, we would like to treat the jer stems exactly like the non-jer stems, with only the addition of the jer rules. The derivations in (18) show an unstressed (Edge:Ø C) stemwith a jer vowel, *stebEl'* 'stem'.

(18)

Project Lex Edges	x x x stebEl'+ 0	x x x stebEl'+ a	x x (x (x stebEl'+ ej + 0
Jer	x x stebel'	x x stebl'a	x (x stebl'ej
Line 0 Line 1	x (x x x) stebel'	x (x x x) stebl'a	x (x x (x) stebl'ej

In (19) we have the derivations for an Edge:LRR (A) stem with a jer vowel, *otec* 'father'.

(19)

	jer	*non-jer*
Project Edge	x (x x otEc + 0	x (x x otEc + a
Jer	x (x otec	x (x otca
Line 0 Line 1	x (x x (x) otec	x (x x (x otca

There is another class of cases, however, such as *úgol/uglá* 'angle'. Coats (1976) notes that *ugol* receives prepositional stress: *ná ugol*. This indicates that in this form it is acting as an unstressed (C) stem. We can handle this by making *ugol* an Edge:LRR (B) stem, but one that is not subject to final Doubling. Instead, the dangling parenthesis is subject to (20) which *deletes* a final dangling parenthesis.

(20) (→ Ø / — #

The derivations are shown in (21).

(21)

Project Edge	x x(x ugOl + O	x x(x ugOl + a
Jer	x x(ugol	x (x ugla
(→ Ø / — #	x x ugol	
Line 0 Line 1	x (x x x) ugol	x (x x (x) ugla

This will provide initial stress with jer endings and also account for the prepositional stress. We could now have a general rule deleting dangling parentheses following final doubling.

2.3. *Stress retraction*

There are two additional classes of nouns, termed "shifting" by Melvold (1990), that do not have fixed stress. Examples of the first of these, called D by Halle (1973), and B′ by Melvold, are shown in (22). As pointed out by Melvold, in the singular, D stems are post-stressing, like B stems (Edge:LRR) and in the plural they have stress on the final vowel of the stem.

(22)

	nom. sg.	*gen. sg.*	*nom. pl.*	
I	kolbasá		kolbásy	*sausage*
IIa	kazák	kazaká	kazáky	*Cossack*
IIb	kol'osó		kol'ósa	*wheel*

The genitive singular of *kazak* is included to show that it is not an A stem. Following Melvold, we would like to relate D to B. This is done with the Doubling rule in (23).

(23) $\varnothing \rightarrow (\; / \; \_ \, x \, ($ *morphologically and lexically restricted*

This rule is the general statement of doubling. In these cases it has a particular morphological environment, being limited to a small class of nouns in the plural. The application to a D class noun *koleso* 'wheel' is shown in (24).

(24)

	Nom Sg	*Nom Pl*
Project Lex Edges	x x(x kol'os + o	x x((x kol'os + a
Doubling		x (x((x kol'os + a
Line 0 Line 1	x (x x x(x) kol'os + o	x (x x x (x((x kol'os + a

The second class of nouns with shifting stress, Halle's E class, and Melvold's C' class, have singular patterns like C (unstressed) stems, and again have stem-final stress in the plural. Examples are shown in (25).

(25)

	nom. sg.	*acc. sg.*	*nom. pl.*	
I	vodá	vódu	vódy	*water*
IIa	kólos		kolósja	*ear of grain*
IIb	óz'oro		oz'óra	*lake*

The accusative singular of *voda* is included to show that it is not a D stem. Again following Melvold, we will analyze the class E stems as Edge:Ø (C) stems with Doubling in the plural. Derivations of an example, *ozero* 'lake', are shown in (26).

(26)

	Nom Sg	*Nom Pl*
Project Lex Edges	x x x oz'or + o	x x (x oz'or + a
Doubling		x (x (x oz'or + a
Line 0 Line 1	x (x x x x) oz'or + o	x (x x x (x (x oz'or + a

Since we have both B and C stems with plural doubling we should expect to find A stems with plural Doubling, and in fact such cases exist with jer stems. In (27) derivations for such a case, *polotno* 'linen', are shown.

(27)

	Nom Sg	*Nom Pl*	*Gen Pl*
Project Lex Edge	x x(x x polotEn + o	x x(x (x polotEn + a	x x(x (x polotEn + O
Jer	x x(x polotno	x x((x polotna	x x(x(poloten
Doubling		x(x((x polotna	x(x(x(poloten
Line 0 Line 1	x (x x x(x) polotno	x (x x x(x((x polotna	x (x x x(x(x(poloten

There are stems minimally different from *polotno*, for example *kol'có/kól'ca/kol'éc* 'ring'. These are Edge:LRR (B) jer stems with Doubling in the plural. Derivations are shown in (28).

(28)

	Nom Sg	*Nom Pl*	*Gen Pl*
Project Lex Edge	x x(x kol'Ec + o	x x((x kol'Ec + a	x x((x kol'Ec + O
Jer	x (x kol'co	x (x kol'ca	x x(kol'ec
Doubling		(x (x kol'ca	x (x(kol'ec
Line 0 Line 1	x (x x (x) kol'co	x (x (x (x) kol'ca	x (x x (x(kol'ec

There is another class of stems, exemplified by *zajóm/zájma* 'loan', which show a different stem stress allomorphy. This stem was used in HV as an argument for right-headed feet (the counterpart to *otéc/otcá* 'father' here, see above). Under the present theory Russian cannot have right-headed constituents. In fact, numbers are on the side of the present analysis, as there are more cases like *otec* than like *zajom*. If we tried to do Russian with right-headed constituents, for the unstressed (recessive) stress we would have to add a right parenthesis after the first mark (Edge:RRL). However, if such Edge marking applied generally, we would predict initial stress in all forms. Thus, the analysis of Russian as having right-headed line 0 constituents, common to HV and Melvold (1990), cannot be maintained under the present theory. The Russian stress patterns cannot be generated by any other parameter settings.

The relevant generalization is that stems such as *zajom* have retracted stress before all non-jer endings. This word is an Edge:LRR (B) stem with Doubling extended to apply in *all* forms. Derivations are shown in (29).

(29)

	Nom Sg	*Nom Pl*
Project Lex Edge	`x x(   x` `zajOm + O`	`x x(   (x` `zajOm + a`
Jer	`x x(` `zajOm`	`x  (x` `zajma`
Doubling	`x(x(` `zajOm`	`(x  (x` `zajma`

Line 0
Line 1
	`x`
	`(x`
	`x(x(`
	`zajOm`
		`x`
		`(x`
		`(x  (x`
		`zajma`

The plural Doubling analysis of retraction also accounts for the well-known dialectal facts regarding /o/. Halle's description of the facts is given in (30).

(30) In certain dialects spoken in the region of Rjazan' ... there are two types of *o*-sound in stressed position; one is a mid vowel [ô], as in Fr. *beau*, and the other a low vowel [o], as in Eng. *law*. It has long been known that the mid vowel [ô] in this dialect derives historically from an original [o] under 'acute or neo-acute' accent, whereas the low vowel [o] is the reflex either of original [o] NOT under acute or neo-acute accent, or of an original yer... (Halle 1973:314)

In the present analysis, being "under acute accent" corresponds to being lexically edge marked. Being "under neo-acute accent" means having Doubling apply. The remaining possibility is getting initial ("recessive") stress through the application of the grammatical Edge:RRR. Thus, the rule (31) converts /o/ to [ô] in these dialects.

(31)

```
    o    →   ô  /  (x
 [-jer]             |
                    _
```

Since the rule makes direct reference to the left parenthesis, we predict, correctly, that recessive (Edge:RRR) stress cannot cause this rule to apply. However, the rule (31) must be ordered before the jer rules, as the jer rules do not feed it.

2.4. Verbal inflections

The verbal inflection system in Russian has a major division between thematic and non-thematic stems. As the names suggest, thematic inflections include a theme vowel, whereas athematic ones do not. The basic types of athematic stress (from Halle (1973)) are shown in (32).

(32)

	Fem Past	*Pl Past*	*1sg pres*	*2sg pres*	
A	lézla	lézli	lézu	lézeš'	*climb*
B	vezlá	vezlí	vezú	vez'óš'	*transport*
C	žilá	žíli	živú	živ'óš'	*live*

In the past tense, only the feminine ending is stressed. In the present tense, all person endings are stressed. In addition, the present tense marker is stressed. Using the usual classification of stems we get the right results for the three basic types. The 1 sg forms are cited because they behave differently in some contexts, to be discussed below. Recall that Russian has a truncation rule deleting the first of two vowels, repeated in (33).

(33) $V \rightarrow \varnothing \, / \, \_ + V$

Thus, the present tense vowel is deleted before the first person singular ending. Derivations for an unstressed (C) stem *žit'* 'live' are shown in (34).

(34)

	Fem Past	*Pl Past*	*1sg pres*	*2sg pres*
Project Lex Edge	x (x živ+l+a	x x živ+l+i	x (x (x živ+'o+u	x (x (x živ+'o+ŠE
Truncation Jer	x (x žila	x x žili	x (x živu	x(x(živ'oš
Line 0 Line 1	x (x x (x) žila	x (x x x) žili	x (x x (x) živu	x (x x(x(živ'oš

In addition to the basic types, there are four additional athematic verb types not having fixed stress, shown in (35).

(35)

a.	moglá	moglí	mogú	móžeš'	*can*
b.	poróla	poróli	por'ú	póreš'	*rip*
c.	gnalá	gnáli	gon'ú	góniš'	*drive*
d.	krála	králi	kradú	krad'óš'	*steal*

To account for these stems, we must include a rule of Doubling in the present tense, (36).

(36) $\varnothing \rightarrow (\,/\, \_\_ \; x (x ($

Because the present tense marker is deleted by truncation with the 1 sg marker, the 1 sg forms cannot trigger this rule, provided it is ordered after Truncation. The stem *mog* 'can' is an Edge:LRR (A) stem subject to Doubling in the present, as shown in (37).

(37)

	Fem Past	*Pl Past*	*1sg pres*	*2sg pres*
Project Lex Edge	x((x mog+l+a	x(x mog+l+i	x((x(x mog+'o+u	x((x (x mog+'o+ŠE
Truncation Jer			x(x mogu	x(x(možoš'
Doubling				(x(x(možoš'
Line 0 Line 1	x (x x (x) mogla	x (x x (x) mogli	x (x x(x) mogu	x (x x (x(x(možoš'

The stems in (b) are Edge:LLR (B) stems subject to Doubling in the present. Derivations for *porot'* 'rip' are shown in (38).

(38)

	Fem Past	Pl Past	1sg pres	2sg pres
Project Lex Edge	x(x (x poro+l+a	x(x x poro+l+i	x(x (x(x poro+'o+u	x(x (x (x poro+'o+šE
Truncation Jer			x (x por'u	x (x(por'oš'
Doubling				(x (x(por'oš'
Line 0 Line 1	x (x x x(x(x) porola	x (x x(x x) poroli	x (x x (x) por'u	x (x x (x (x(por'oš'

The stems in (c) are Edge:Ø (C) stems subject to Doubling in the present. Derivations for *gnat'* 'drive' are shown in (39).

(39)

	Fem Past	Pl Past	1sg pres	2sg pres
Project Lex Edge	x x (x gOna+l+a	x x x gOna+l+i	x x (x(x gOna+'o+u	x x (x (x gOna+'o+šE
Truncation Jer	x(x gnala	x x gnali	x (x gon'u	x (x(gon'oš'
Doubling				(x (x(gon'oš'
Line 0 Line 1	x (x x(x) gnala	x (x x x) gnali	x (x x (x) gon'u	x (x x (x (x(gon'oš'

Finally, the (d) stems are A stems subject to parenthesis deletion in the present tense. Thus, they are similar to the stress-deleting locative singular cases, such as *v plenú*, discussed above. Thus, the (d) stems lose their metrical parentheses in the present tense. The derivations for *krast'* 'steal' are shown in (40).

(40)

	Fem Past	*Pl Past*	*1sg pres*	*2sg pres*
Project Lex Edge	`(x    (x` `krad+l+a`	`(x     x` `krad+l+i`	`(x   (x(x` `krad+'o+u`	`(x   (x  (x` `krad+'o+šE`
Stem Stress Deletion			`x   (x(x` `krad+'o+u`	`x   (x  (x` `krad+'o+šE`
Truncation Jer	`x(x` `krala`	`x(x` `krali`	`x(x` `kradu`	`x  (x  (` `krad'o+š`

Line 0
Line 1
	`x`
	`(x  x`
	`(x(x)`
	`krala`
		`x`
		`(x`
		`(x  x)`
		`krali`
			`x`
			`(x`
			`x(x)`
			`kradu`
				`x`
				`(x`
				`x  (x  (`
				`krad'o+š`

The basic thematic verb stress classes (from Halle (1973)) are summarized in (41).

(41)

	Fem Past	*Pl Past*	*1sg pres*	*2sg pres*	
A	délala	délali	délaju	délajoš'	*do*
B/C	sidéla	sidéli	sižú	sidíš'	*sit*

Because the theme vowel is stressed, the post-stressing (Edge:LRR B) stems and the unstressed (Edge:Ø C) stems have the same pattern. The theme vowel frequently does not surface in the present tense due to the truncation rule. There are, in addition, two shifting classes. The first of these is shown in (42).

(42)

Fem Past	*Pl Past*	*1sg pres*	*2sg pres*	
utonúla	utonúli	utonú	utóneš'	*drown*

The stems in (42) are subject to Doubling in the present. The derivations for *utonut'* 'drown' are shown in (43).

(43)

	Fem Past	*1sg pres*	*2sg pres*
Project Lex Edge	x x(x (x uton+u+l+a	x x (x (x x uton+u+'o+u	x x (x (x (x uton+u+'o+šE
Truncation Jer		x x(x utonu	x x (x(uton'oš'
Doubling			x(x (x(uton'oš'
Line 0 Line 1	x (x x x x(x(x) utonula	x (x x x(x) utonu	x (x x(x (x(uton'oš'

The second class of shifting stems is shown in (44).

(44)

Fem Past	*Pl Past*	*1sg pres*	*2sg pres*	
kolebála	kolebáli	koléblu	kolébleš'	*rock*

The stems in (44) are minimally different from those in (43). The stems in (44) have simply generalized the retraction to apply to all forms of the present. Derivations for *kolebat'* 'rock' are shown in (45).

(45)

	Fem Past	*1sg pres*	*2sg pres*
Project Lex Edge	x x(x (x koleb+a+l+a	x x (x (x x koleb+a+'o+u	x x (x (x (x koleb+a+'o+šE
Truncation Jer		x x(x kolebl'u	x x(x(kolebl'oš'
Doubling		x(x(x kolebl'u	x(x(x(kolebl'oš'
Line 0 Line 1	x (x x x x(x (x koleb+a+l+a	x (x x x(x(x kolebl'u	x (x x x(x(x(kolebl'oš'

Thus, the inflectional stress patterns in Russian are a result of lexical Edge marking of stems and suffixes, along with morphologically restricted rules of Doubling and Deletion. These rules also play a part in the stress patterns of the derivational morphology.

2.5. *Stress and derivational morphology*

The derivational morphology of Russian has both stress-deleting and non-stress-deleting morphemes. This distinction is also cross-classified with lexical Edge marking on derivational morphemes. In addition to stressed (Edge:LLR) and post-stressing (Edge:LRR) morphemes, the derivational morphology also has a class of morphemes that produce uniform initial stress. The types of derivational morphemes in Halle (1973) and Melvold (1990) are shown in (46). For lists of the various kinds of morphemes, and their exceptions, see those sources and others cited there.

(46)

	stressed	post-stressing	initial
non-deleting	-ist	-ov, -Ok	-nik
deleting	-jag	-ač	-En′

Examples of the stress-deleting morphemes following stressed (A) and stressless (C) stems are shown in (47).

(47)

	A		C	
stressed	bratán′	*big brother*	golován	*big head*
post-stressing	rifmáč	*rhymster*	borodáč	*bearded one*
initial	óboroten′	*werewolf*	skóvoroden′	*dovetail joint*

In these cases, the stress of the form is completely determined by the derivational suffix. The stress class of the stem has no bearing, so A and C stems behave the same.

Examples of non-stress-deleting morphemes following stressed (A) and stressless (C) strems are shown in (48).

(48)

	A		C	
stressed	glínistyj	*clayey*	gorístyj	*mountainous*
post-stressing	goróxovyj	*of pea*	beregovój	*of shore*
initial	jábednik	*informer*	lágernik	*camp inmate*

With these suffixes, the stress of the form is a combination of the stress properties of the stem and the suffix. Stressed (A) stems retain their stress, and stressless (C) stems gain the stress pattern of the suffix.

The lexical Edge markings for the various kinds of suffixes are shown in (49).

(49)

stressed	post-stressing	initial
`(x` `-ist`	` x(` `-ov`	`  x)` `-nʲk`
Edge:LLR	Edge:LRR	Edge:RRR

Notice that all of these morphemes have lexical Edge marking. There are no Edge:Ø derivational morphemes in Russian. Non-stress deleting Edge:Ø inflectional morphemes (such as the IIb singular nominal ending, *-o*) do exist. Stress-deleting Edge:Ø derivational morphemes are attested in historical Lithuanian (see HV).

The stressed derivational morphemes behave like their inflectional counterparts. They get main stress when there is no preceding stress. In addition, the stress deleting derivational suffixes impose their stress pattern on the stem, regardless of the stress properties of the stem. That is, the lexical Edge marking of the stem does not affect the stress on the derived form. The affixes achieve this by triggering the deletion of the metrical parentheses of the stem. An example of a stress-deleting stressed suffix is the noun forming morpheme *-an*, shown in (50).

(50)

A	brát	*brother*	bratán	*big brother*
B	velík	*great*	velikán	*giant*
C	golová	*head*	golován	*big head*

The derivation for the A stem is shown in (51).

(51)

Project Lex Edge	(x (x (x brat-an-am
Stem Stress Deletion	x (x (x brat-an-am
Line 0 Line 1	x (x x x (x (x) brat-an-am

An example of a non-stress-deleting stressed (Edge:LLR) morpheme is the adjective forming suffix *-ist*, which attaches to nouns. Some examples are given in (52).

(52)

A	glína	*clay*	glínistyj	*clayey*
B	xólm	*hill*	xolmístyj	*hilly*
C	gorá	*mountain*	gorístyj	*mountainous*

When attached to A (stem-stressed) class nouns, the derived noun has stress in the same place as the stem. When attached to Edge:LRR (B) or Edge:Ø (C) nouns, the result is a adjective with stress fixed on *-ist*. Thus, *-ist* is non-deleting with a lexical marking of Edge:LLR, as shown in (53).

(53)

Project Lex Edge	(x (x (x glin-ist-yj	x((x (x xolm-ist-yj	x (x (x gor-ist-yj
Line 0 Line 1	x (x x x (x(x (x) glinistyj	x (x x x(x (x) xolmistyj	x (x x x(x (x) goristyj

There is a suffix that is minimally different from *-ist*, the diminutive suffix *-ik*. It behaves the same with A and C stems, but differently with B stems, as in (54).

(54) B

xvóst	*tail*	xvóstik	*little tail*
stvól	*trunk*	stvólik	*little trunk*
xólm	*hill*	xólmik	*little hill*

To handle this, *-ik* must trigger Doubling with B stems, as in (55).

(55)

<table>
<tr><td>Project
Lex Edge</td><td>x x(x x
korol-ik-a</td></tr>
<tr><td>Doubling</td><td>x(x(x x
korol-ik-a</td></tr>
<tr><td>Line 0
Line 1</td><td>x
(x x
x(x(x x
korol-ik-a</td></tr>
</table>

Post-stressing derivational suffixes supply a left parenthesis after their final mark. In the case of stress-deleting suffixes, this will cause uniform end stress in the resulting forms. There are several examples of this kind of morpheme, including the noun forming *-ač*, shown in (56).

(56)

A	rífma	*rhyme*	rifmáč	*rhymster*
B	trubá	*trumpet*	trubáč	*trumpeter*
C	borodá	*beard*	borodáč	*bearded one*

The genitive singular form will show that the resulting noun is post-stressing, because it is an unstressed ending. A derivation is shown in (57).

(57)

Project Lex Edge	(x x (x sil-ač-a
Delete	x x (x sil-ač-a
Line 0 Line 1	x (x x x (x) sil-ač-a

Examples of the non-stress deleting post-stressing (Edge:LRR) adjective forming suffix *-ov* are given in (58). With *-ov* A stems retain their stress, B (Edge:LRR) stems place stress on *-ov*, and C stems are stressed after *-ov*. This behavior was first noted by Hartmann (1936).

(58)

A	goróx	*pea*	goróxovyj
B	bóbr	*beaver*	bobróvyj
C	béreg	*shore*	beregovój

Derivations for these words are given in (59).

(59)

	Edge:LRL (A)	Edge:LRR (B)	Edge:Ø (C)
Project Lex Edge	x(x x(x gorox-ov-yj	x(x(x bobr-ov-yj	x x x(x bereg-ov-oj
Line 0 Line 1	x (x x x(x x (x) gorox-ov-yj	x (x x x (x (x) bobr-ov-yj	x (x x x x(x) bereg-ov-oj

One could say for these cases that *-ov* is Edge:Ø because the long form endings are all stressed. Unfortunately, we cannot resolve this question with *-ov* because there are relatively few cases of short form adjective in *-ov*, and none of them show mobile (C) stress. There are other patterns, where *-ov* is stress-deleting, and either Edge:LLR (stressed) as in *dubóvyj* 'of oak' or Edge:LRR (post-stressing) as in *snegovój* 'of snow'.

Another suffix like *-ov* which is clearly post-stressing is the noun-forming *-Ok*, shown in (60). In (60) the noun is shown in the nominative plural, which is unstressed, allowing us to distinguish an Edge:LRR suffix from an Edge:Ø one.

(60)

A	goróx	*pea*	goróšky	*small peas*
B	volós	*hair*	voloský	*small hairs*
C	górod	*city*	gorodký	*small towns*

Since the nouns formed from C stems show final stress in the nominative plural, the *-Ok* suffix must be Edge:LRR.

The last case is the most unusual, the morphemes that induce initial stress. Examples with the noun-forming suffix *-En'* are shown in (61).

(61)

A	oborót	*turn*	óboroten'	*werewolf*
B	xvóst	*tail*	príxvosten'	*hanger-on*
C	skovorodá	*frying pan*	skóvoroden'	*dovetail joint*

The initial stress is a result of the Edge marking of the suffixes, Edge:RRR. When such morphemes are stress-deleting, this will produce uniform initial stress by wiping out the stress of the stem, and providing a constituent that spans to the beginning of the word, as the derivation in (62) shows.

(62)

Project Lex Edge	`x x(x  x) (x` `oborot-En'-am`
Stem Stress Deletion	`x x x  x) (x` `oborot-En'-am`
Jer	`x x x ) (x` `oborotn'am`

Line 0
Line 1
	`x`
	`(x        x`
	`x x x ) (x)`
	`oborotn'am`

The suffixes *-ost'* and *-nik* are also Edge:RRR, but they are non-stress-deleting. With these suffixes, A stems retain their stress, and C stems gain fixed initial stress. Examples with *-ost* are shown in (63).

(63)

A	gorbátyj	*humpbacked*	gorbátost'am	*humpbackedness*
C	molodój	*young*	mólodost'am	*youth*

Derivations are shown in (64).

(64)

	Edge:LRL (A)	Edge:Ø (C)
Project Lex Edge	`x (x  x) (x` `gorbat-ost-am`	`x x  x) (x` `molod-ost-am`

Line 0
Line 1
	`   x`
	`  (x      x`
	`x (x  x) (x)`
	`gorbat-ost-am`
		`x`
		`(x        x`
		`x x  x) (x)`
		`molod-ost-am`

I have not been able to find examples of *-ost* attached to a B stem. However, *-nik* is essentially similar and does have examples with B stems, shown in (65).

(65)

A	jábeda	*slander*	jábednik	*informer*
B	l'ubóv'	*love*	l'ubóv'nik	*lover*
C	láger'	*camp*	lágernik	*camp inmate*

In this case since the Edge:LRR stem *l'ubov'* does not place stress on *-nik*, we conclude that *-nik* triggers Doubling with this stem, as in (66).

(66)

Project Lex Edge	`x  x(   x)(x` `l'ubov'-nik-a`
Doubling	`x (x(   x)(x` `l'ubov'-nik-a`

Line 0
Line 1
	`   x`
	`  (x    x  x`
	`x (x(   x)(x`
	`l'ubov'-nik-a`

The stress properties of the derivational suffixes of Russian are a cross between the stress properties of stems and the stress properties of inflectional suffixes. Like the inflectional suffixes, they can be stress-deleting or non-stress-deleting. Like the stems, they can be stressed or post-stressing. In addition, some derivational suffixes show a pattern of initial stress. This is a result of providing a right parenthesis, which will cause the preceding material to form a constituent. Because constituents are left-headed in Russian, these morphemes produce a "long-distance" stress effect.

3. *Stress in Shuswap and Moses-Columbian*

The Salish languages have the rich array of consonants. For example, the consonants of Shuswap (Kuipers (1974)) and Moses-Columbian (Czaykowska-Higgins (1992)) are shown in the following tables. The stops and affricates are shown in (67). The features [CG] and [RTR] are constricted glottis and retracted tongue root.

(67)

		[+CG]	[+RTR]	[+CG +RTR]
[Labial]	p	p'		
[Coronal]	t	t'		
[Coronal Distributed]	c	c'	ç	
[Coronal Lateral]	t'ɬ			
[Dorsal]	k	k'	q	q'
[Dorsal Labial]	k^w	k'^w	q^w	q'^w

Fricatives are shown in (68).

(68)

		[+RTR]
[Labial]		
[Coronal]	s	ṣ
[Coronal Lateral]	ɬ	
[Dorsal]	x	χ
[Dorsal Labial]	x^w	χ^w

Sonorants are shown in (69).

(69)

		[+CG]	[+RTR]	[+CG +RTR]
[Labial]	m	m'		
[Coronal]	n	n'	r	r'
[Coronal Lateral]	l	l'		
[Dorsal]	y	y'	ʕ	ʕ'
[Dorsal] [-back]	ɣ	ɣ'		
[Dorsal Labial]	w	w'	ʕ^w	ʕ'^{w}

Laryngeals are shown in (70).

(70)

[+SG]	[+CG]	[+SG +RTR]	[Labial +SG +RTR]
h	ʔ	ħ	ħ^w

The glottalized resonants, in particular, have been of interest in phonological descriptions of these languages (see also Vogt (1940), Reichard (1939), Cole (1987)). The glottalization of sonorants has been identified with morphological processes, and moves freely about the word. The glottalization of sonorants in Shuswap is sensitive to both stress and syllabification. This problem is addressed, below, using metrical and autosegmental phonology in tandem.

The vowels inventories, (71), are simpler.

(71)

	[-back]	[+back]		
		[-round]	[+round]	
[+high]	i		u	
[-high]	e	ə	o	[-low]
		a		[+low]

The discussion of stress in Interior Salish will translate the account of Idsardi (1991a,b), with certain modifications. Since those papers were written some corrections have been brought to my attention. Anthony Mattina (p.c.) has indicated to me that the description of stress in Colville (Mattina (1973)) was based on a morphological anaylsis that does not now seem to be correct. Accordingly, we will limit the discussion here to just two language types: Shuswap/Spokane and Moses-Columbian.

Stress in Salish is similar to Indo-European in that it is largely determined morphologically and lexically. Descriptively, roots are divided into strong and weak types, and suffixes into strong, variable and weak. Stress placement is often described as a hierarchy with the highest member of the hierarchy in a word receiving the main word stress (Carlson (1989)). The hierarchy in (72) describes the basic stress facts of Salish.

(72) strong suffix > strong root > variable suffix > weak root
(> weak suffix)

The weak suffixes are vowelless, and therefore do not project elements onto the grid. Examples of various combinations in Shuswap (Sh), Spokane (Sp) and Moses-Columbian (Cm) are given below. In the examples, roots are marked with "$\sqrt{\ }$", and strong (=lexically stressed) vowels are marked with acute accents.

Strong suffixes attract stress, even when occuring with a strong root, as in (73).

(73) Strong root + strong suffix

Cm	Sp	Sh
[k'im'xíkn]	[k'ʷl'ncút]	[tχyésxnm']
k-√ʔím'x-íkn	√k'ʷúl'-nt-sút	t-√χéy-ésxn-m
loc-move-back	*make-trans-refl*	*to heat stones*

Similarly, strong suffixes attract stress away from weak roots, as shown in (74).

(74) Weak root + strong suffix

Cm	Sh
[nckckqínn]	[q'mnwéns]
n-√cəkcək-qín-n-t-Ø-n	√q'əm-ṅwént-s
loc-hit rep-top-cntrl-tr-3so-1ss	*he accidently swallowd*

With only variable suffixes strong roots will retain stress, as in the examples in (75).

(75) Strong root + variable suffix

Cm	Sp	Sh
[sac'ím'xxʷ]	[k'ʷúl'ntxʷ]	[píc'ncn]
sac-√ʔím'x-mix	√k'ʷúl'-nt-exʷ	√píc'-nt-ci-en
impf-move-impf	*make-trans-2s*	*I squeeze you*

However, (76) shows that weak roots lose stress to a following variable suffix.

(76) Weak root + variable suffix

Cm	Sp	Sh
[ckncás]	[šlntéxʷ]	[lχntélt]
√cək-n-t-sa-s	√šil-nt-exʷ	√leχ-nt-el-t
hit-cntrl-tr-1so-3s	*chop-trans-2s*	*We were squealed on*

Words having more than one variable suffix (and no strong suffixes) following a weak root are stressed differently in different languages, as the examples in (77) show.

(77) Weak root + variable suffix*

Cm	Sp	Sh
[ckstwás]	[šlncín]	[lχncín]
√cək-n-stu-wa-s	√šil-nt-si-en	√leχ-nt-ci-en
hit-cntrl-caus-TO-3ss	*chop-trans-2obj-1subj*	*I squeal on you*

In Moses-Columbian it is the last weak suffix that gets stress, in Shuswap and Spokane it is the first.

To generate the Shuswap/Spokane stress patterns, we will require the parameter settings in (78).

(78)			
	Line 0:	Edge:LLL	Head:L
	Line 1:	Edge:RRR	Head:R

In addition to the settings in (78), we will also need the line 0 specifications for the various morpheme types shown in (79).

(79)				
	Roots	strong	(x	Edge:LLL
		weak	x (	Edge:LRR
	Suffixes	strong	(x	Edge:LLL
		weak	x	no Edge

Notice that a metrical boundary is always supplied by any root, strong or weak. Thus for forms with suffixes there is no direct main stress evidence for a grammatical edge marking. However, in the case of a weak root without suffixes the stress falls on the root, indicating that the grammar contains an Edge marking of Edge:LLL. The prefixes never bear stress, and thus are non-cyclic.

Derivations for two Shuswap words with strong roots are shown in (80).

(80)

	√s + s	√s + v + v
Project Lex Edges	(x (x t-√χey-esxn-m	(x x x √pic'-nt-ci-en
Edge:LLL Head:L	x x (x (x t-√χey-esxn-m	x (x x x √pic'-nt-ci-en
Edge:RRRH ead:R	x x x) (x (x t-√χey-esxn-m	x x) (x x x √pic'-nt-ci-en
Syncope	x x) (x t-√χy-esxn-m	x x) (x √pic'-nt-c-n

And derivations for two Shuswap words with weak roots are shown in (81).

(81)

	√w + s	√w + v + v
Project Lex Edges	x ((x √q'əm-nwent-s	x (x x √lex-nt-ci-en
Edge:LLL Head:L	x x (x ((x √q'əm-nwent-s	x x (x (x x √lex-nt-ci-en
Edge:RRRH ead:R	x x x) (x ((x √q'əm-nwent-s	x x x) (x (x x √lex-nt-ci-en
Syncope	x x) (x √q'm-nwent-s	x x) (x √lx-nt-ci-n

Moses-Columbian stress is somewhat more complicated, having a few additional kinds of morphemes. The facts regarding strong and weak roots and strong and variable suffixes are summarized in the table in (82).

(82)	√S + S + Ś	√Ś + V + V	√S + S + Ś + V + V
	√W + S + Ś	√W + V + V́	√W + S + Ś + V + V

As Czaykowska-Higgins points out, the Moses-Columbian stress system is the mirror image of the Khalkha/Indo-European system, and thus has the parameter settings in (83).

(83)	Line 0:	Edge:LLL	Head:R
	Line 1:	Edge:RRR	Head:R

The first approximation for the lexical stress on morphemes would also be the reverse of Indo-European, representing strong morphemes as those having a lexical right parenthesis, as in (84).

(84)	Roots	strong	S	... x)	Edge:RRR
		weak	W	... x ...	no Edge
	Suffixes	strong	D	... x)	Edge:RRR
		variable	R	... x ...	no Edge

Czaykowska-Higgins (1992) recasts the strong/weak classification of roots as strong roots having full vowels, and weak roots having no vowels. Schwas are then inserted into a variety of environments. This schwa insertion serves to complicate the rules assigning stress for words with all weak morphemes, however. Instead, I will assume here that all roots must contain at least one syllable, a reasonable minimality (McCarthy & Prince (1986), etc) assumption. Under this assumption, the distinction between strong and weak roots lies in whether they have (strong) or do not have (weak, variable) an inherent metrical boundary.

However, it turns out that Columbian has extra kinds of roots and suffixes. First, there is a category of suffixes in between strong and variable. In Czaykowska-Higgins's analysis, these are analyzed as non-stress deleting stressed suffixes. The facts regarding the stress placement with these suffixes, are summarized in (85). These suffixes receive stress only when the word contains no strong roots or suffixes. Furthermore, it is the first of these suffixes that receives stress.

(85) Ś + A W + Ś + A W + Á + V W + Á + A

We will obviously need to create additional distinctions to capture this extra kind of suffix. We will change the representations of the suffixes to the system in (86).

(86)	Suffixes	strong	(x)
		A	x)
		variable	x

By adding a rule of unmatched right parenthesis deletion, this will capture the stress patterns with the two kinds of roots and three kinds of suffixes. Notice that the unmatched parenthesis deletion is similar to the analysis of secondary stress elimination in Selkup in Chapter 3.

Derivations with strong suffixes are shown in (87).

(87)

	√s + s	√w + s
Project Lex Edges	x) (x) k-√ʔim' x-ikn	x x (x) n-√cəkcək-qin-n-t-n
Edge:LLL	(x) (x) k-√ʔim' x-ikn	(x x (x) n-√cəkcək-qin-n-t-n
Delete Unmatched)		
Head:R	x x (x) (x) k-√ʔim' x-ikn	x x (x x (x) n-√cəkcək-qin-n-t-n
Edge:RRR Head:R	x x x) (x) (x) k-√ʔim' x-ikn	x x x) (x x (x) n-√cəkcək-qin-n-t-n

And derivations with variable suffixes are shown in (88).

(88)

	√s + v	√w + v + v
Project Lex Edges	x) x sac-√ʔim' x-mix	x x x √cək-n-stu-wa-s
Edge:LLL	(x) x sac-√ʔim' x-mix	(x x x √cək-n-stu-wa-s
Delete Unmatched)		
Head:R	x (x) x sac-√ʔim' x-mix	x (x x x √cək-n-stu-wa-s
Edge:RRR Head:R	x x) (x) x sac-√ʔim' x-mix	x x) (x x x √cək-n-stu-wa-s

And derivations with A suffixes are shown in (89).

(89)

	√s + a	√w + a + v
Project Lex Edges	x) x) √k^{w}uɨn-min-t-n	x x) x √yər-min-stu-m
Edge:LLL	(x) x) √k^{w}uɨn-min-t-n	(x x) x √yər-min-stu-m
Delete Unmatched)	(x) x √k^{w}uɨn-min-t-n	
Head:R	x (x) x √k^{w}uɨn-min-t-n	x (x x) x √yər-min-stu-m
Edge:RRR Head:R	x x) (x) x √k^{w}uɨn-min-t-n	x x) (x x) x √yər-min-stu-m

A word with two A suffixes is shown in (90).

(90)

	√w + a +a
Project Lex Edges	x x) x) √k^{w}uʔɨ-min-xit-n
Edge:LLL	(x x) x) √k^{w}uʔɨ-min-xit-n
Delete Unmatched)	(x x) x √k^{w}uʔɨ-min-xit-n
Head:R	x (x x) x √k^{w}uʔɨ-min-xit-n
Edge:RRR Head:R	x x) (x x) x √k^{w}uʔɨ-min-xit-n

Finally, there are the roots analyzed by Czaykowska-Higgins as "extrametricality assigning". Under this analysis such roots trigger the rule (91).

(91) (→ Ø / Root + __

This rule will feed the deletion of unmatched right parentheses, leading to loss of stress on the following suffix. The application of thie rule is morphologically and lexically restricted. A derivation for a word including this kind of root is shown in (92).

(92)

	$\sqrt{}S_{+ex}$ + S
Project Lex Edges	`x) (x)` `xʷir-akst`
(→ Ø / Root + __	`x)  x)` `xʷir-akst`
Edge:LLL	`(x)  x)` `xʷir-akst`
Delete Unmatched)	`(x)  x` `xʷir-akst`

Head:R	`x`
	`(x)  x`
	`xʷir-akst`

Edge:RRR
Head:R
	`x`
	`x)`
	`(x)  x`
	`xʷir-akst`

It might also be possible to characterize such roots as causing the deletion of a following vowel. Because of the intricate relationship between syllabification, stress, epenthesis and syncope, this alternative will not be examined here.

4. *Shuswap glottalized sonorants*

Morphological glottalization in Shuswap is stress-dependent: it falls only on or after the stressed vowel. To restrict the domain of glottalization, we will circumscribe the word. Recall that following the general tenets of McCarthy

& Prince (1986, 1990), as adapted in Chapter 3, Circumscription divides a word into two domains at the main stress. Recall also, that adapting the terminology from McCarthy & Prince, the portion associated with the main stress is the base and the other portion is the residue. Since the stressed vowel can in some cases bear the glottalization, it is clear that the base is the domain of Shuswap resonant glottalization. But such a circumscription entails that the stressed vowel goes with the *following* material, not with the preceding material. Thus, this is further evidence that line 0 constituents in Shuswap are left-headed. To get the precise location for the association of glottalization, further metrical structure is built on another plane. The glottalization of sonorants is also dependent on syllabification. The analysis of Shuswap glottalization presented here is a translation of Idsardi (1991b) into the present framework.

Shuswap syllabification is similar to that of other Salish systems (see, for example, Bagemihl (1991)). Large consonant clusters occur, and sonorants can function as syllable peaks. Kuipers outlines the situation as in (93).

(93) ... The consonants fall into 22 obstruents (K) and 15 resonants (R). Though the latter can form the peak of an unstressed syllable ... they are classed as consonants because they do not occur as stressed vowels ...

Resonants are syllabic when not adjacent to a vowel. In Kuipers terms, they occur in "vocalic position", defined as in (94).

(94) ... first of all C_C and C_# ... two consecutive resonant neither of which adjoins a vowel the first is consonantal and the second vocalic ...

Only sonorants in certain positions can appear glottalized. Kuipers's summary of the situation is given in (95).

(95) ... a glottalized resonant (symbolized R′) can occur only after a vowel or in vocalic position ...

Specifically, the resonants in VRV, VRCV, and CRC are all potential targets for glottalization, but not the resonant in VCRV. Thus, intervocalic resonants behave like resonants which are clearly nuclear. One way to do this, suggested to me by Glynn Piggott, is to syllabify resonants into the nucleus where possible, and build full nuclei before building onsets.

Pulling all of this together, the maximal syllable in Shuswap is CRVC, sonorants can function as the sole member of a nucleus, and only nuclear elements are appropriate locii for sonorant glottalization. It should be noted that since the maximal syllable is CRVC, it is often the case that words will contain unsyllabified consonants. These consonants are *not* deleted. For a discussion of similar effects in Bella Coola, see Bagemihl (1991).

In Shuswap, glottalization of resonants can be a floating feature listed along with a morpheme. Kuipers statement is shown in (96).

(96) Glottalized resonants can be characteristic of certain morphemes as such.

There are minimal pairs in roots, and the glottalization can "move" when suffixes are added, as shown in (97).

(97)	q′ey	*set up a structure*	q′ey′	*write*
	s-t-q′éy′-qn	*shed*	q′y-ém′	*write-itr*

Glottalization is located in the word according to the hierarchy given in (98).

(98)

post-stress sonorant	v́R'	s-t-q'éy'-qn	*shed*
syllable after	v́CR'	x-sʕχ-n'-s	*he ladles it over*
stress	v́CRV'	ɬkəpépye'	*small dishpan*
stressed vowel	v́'	t-xʷl-xʷl-é'ɬp	*gooseberry bush*

It is evident that the association of [+CG] to sonorants is related to the location of the stress and thus is governed by the prosodic organization of the word.

After the word is circumscribed to restrict SG to the material in the base a separate metrical plane is constructed according to the parameters in (99).

(99) Stress assignment
Circumscribe
On base: Project nuclear sonorants
Edge:LLL ICC:L
Delete unmatched right parentheses
Head:R
Associate [+CG] with the element on line 1'

The glottalization is thus realized on the most prominent element in the sonorant glottalization grid. In (100) a derivation for a weak root with the suffix *-iləp* is shown.

(100)

UR	c'lilχ + iləp
Syll Stress	x x x) (x (x x (c'lil) (χil) (əp)
Syncope Resyll Circum	| x | x) | (x x (c'l) | (χil) (əp)
SG	| x | x) | (x x (c'l) | (χil) (əp) (xx) x x

Because weak roots are Edge:LRR on the stress plane, the following vowel receives the main word stress. Because the root vowel does not bear main stress, it is subject to syncope. The syncope rule is fairly complicated. For example, though the schwa in the suffix is unstressed, it is not subject to syncope. For details on which vowels are subject to syncope, see Kuipers. After the stress has been assigned, the word is separated into two domains at the main stress. Then a second plane of metrical structure is built, projecting nuclear elements of the base. Then, the second nuclear element of the base is located, and this is the locus of glottalization.

The derivation for a word with same suffix, but with a strong root is shown in (101).

(101)

UR	sey + iləp
Syll Stress	x x) (x x x (sey) (il) (əp)
Syncope Resyll Circum	| x | x) | (x x | (sey) (ləp)
SG	| x | x) | (x x | (sey) (ləp) (xx) x x

Notice that the *l* of *-iləp* is no longer a possible target for glottalization due to its resyllabification following the deletion of the preceding unstressed vowel. Further, in this word the entire form constitutes the base, and therefore glottalization falls on the second nuclear element.

Some minor rules of Shuswap phonology are dependent upon sonornant glottalization. In (102), we see a word in which the sonorant glottalization calculation associates [+CG] with a schwa. When *ə* bears glottalization, it is realized as *e'*.

(102)

<table>
<tr><td>UR</td><td>ʔiχ^{w} + iləp</td></tr>
<tr><td>Syll
Stress</td><td>x
x)
(x x x
(ʔi) (χ^{w}il) (əp)</td></tr>
<tr><td>Syncope
Resyll
Circum</td><td>| x
| ẋ)
| (x x
| (ʔiχ^{w}) (ləp)</td></tr>
<tr><td>SG</td><td>| x
| x)
| (x x
| (ʔiχ^{w}) (ləp)
(x x)
x</td></tr>
<tr><td>ə′ → e′</td><td>| x
| x)
| (x x
| (ʔiχ^{w}) (lep)
(x x)
x</td></tr>
</table>

The glottalization in reduplicated forms also conforms to the calculation, with glottalization showing up only on the final sonorant. The derivations in (103) show two such examples.

(103)

UR	mel+mel+ks+n+s	s+t+x^w^ul+x^w^ux^w^l
Syll Stress	x x x) (x (x (mel) (mel) k (sn) s	x x x) (x (x st (x^w^ul) (x^w^u) (x^w^l)
Syncope Resyll Circum	| x | x) | (x (ml) | (mel) k (sn) s	| x | x) | (x st (x^w^l) | (x^w^u) (x^w^l)
SG	| x | x) | (x (ml) | (mel) k (sn) s (xx) x x	| x | x) | (x st (x^w^l) | (x^w^u) (x^w^l) (x x) x

This theory predicts that the stressed vowel should be able to bear glottalization when there is no following sonorant or vowel. An example of sonorant glottalization of the stressed vowel is shown in (104).

(104)

UR	t+x^w^ul+x^w^ul+eɬp
Syll Stress	x x x x) (x (x (x t (x^w^ul) (x^w^ul) (eɬ) p
Syncope Resyll Circum	| x | x) | (x t (x^w^l) (x^w^l) | (eɬ) p
SG	| x | x) | (x t (x^w^l) (x^w^l) | (eɬ) p (x x

Since the stressed vowel can itself bear glottalization, the calculation of glottalization must be restricted to the base.

Thus, sonorant glottalization is calculated metrically, on a subpart of the word demarcated by circumscription based on the stress plane. This system ensures that the glottalization falls near or on the stress. Thus, the limited but mobile distribution of glottalized sonorants in Shuswap can be described through the association of a floating feature to a metrically prominent position. This analysis accounts for the facts of Shuswap stress and sonorant glottalization, and the interaction between them.

Chapter 5: Rules and representations in metrical theory

1. Introduction

In this chapter I will briefly examine two fundamental issues in metrical theory: what the formal representation for bracketed grids is; and whether metrical theories can be formulated using only constraints.

2. Representations of bracketed grids

Since Liberman (1975) and Liberman & Prince (1977) two notations have dominated metrical theory: trees and grids. Subsequent work tried to eliminate one of the representations, either using only trees (Vergnaud & Halle (1978), Hayes (1980), Giegerich (1985), etc) or only grids (Prince (1983), Selkirk (1984), etc). Halle & Vergnaud (1987) managed a reconciliation of the grid/tree dichotomy, combining the virtues of the two systems into a hybrid notation called "bracketed grid" or "constituentized grid" notation. The *notation* has been adopted by both tree and grid proponents alike (Hammond (1989b), Hayes (1991), Kager (1989,1992), etc.). However, it seems that the unifying notation serves more to obscure technical details of the representation. That is, people who share the same notation do not necessarily share the same view of the exact nature of the metrical representation. The bracketed grid notation in practice serves more as a lingua franca than as the theory of metrical representations.

To address this issue I will consider various formalizations of bracketed grids employing mechanisms standard in phonological theory. The various implementations will be tested against abstract properties of metrical systems already observed here and elsewhere. The phonological mechanisms employed are: boundaries, features and autosegments.

The bracketed grid notation contains a fundamental insight into the relationship between tree-like constituency and grid-like prominence. Prominence and constituency are represented separately. Rather than making prominence a labelling convention on trees, more prominence is always represented by more vertical grid marks. In essence, the bracketed grid is a partitioning of the grid marks into constituents. Thus, the search for an adequate formal representation of bracketed grids is the search for an adequate partitioning mechanism. This insight can be represented with a variety of formal devices, though my intuitive reaction is to see it autosegmentally.

For each formal representation for bracketed grids, I will give the representation equivalent to the HV metrical structure in (1).

(1)
```
         x              x        x
   x    (x    x    x)  (x    x)  (x)   x
   |     |    |    |    |    |    |    |
   CV    CV   CV   CV   CV   CV   CV   CV
```

The alternatives considered in this chapter certainly do not exhaust all possible theories of the representation of metrical structure. For example, the grid-only theory of Prince (1983) does not correspond to any of the following models, as it explicitly rejects the use of constituency. All the models considered here include a representation of constituents within the grid. The representations considered do not even exhaust the possibilities for representing bracketed grids, but they do illustrate general properties of methods for representing consituency in metrical theory.

2.1. *Boundary representations*

Implementations of bracketed grids directly employing boundary elements are closest to the typographical character of the HV notation. There are two major variants: one employs two kinds of boundaries (left and right); the other employs only one.

2.1.1. *Left and right parentheses*

First, we can take the HV notation seriously as itself the metrical theory, and allow two kinds of boundaries, indicating the left and right edges of a consituent with the separate entities "(" and ")" in addition to the grid mark "x". For convenience I will refer to this as the parenthesis theory of bracketed grids. The representation in such a system could be equivalent to the HV typographical notation, shown again in (2).

(2)
```
         x                 x        x
   x    (x     x     x)   (x    x)  (x)   x
   |     |     |     |     |    |    |    |
   CV   CV    CV    CV    CV   CV   CV   CV
```

However, in the preceding chapters we have managed to eliminate many of the bookkeeping parentheses of HV, and consequently the representation of the grid in (2) in the present theory is (3).

(3)
```
         x                 x        x
   x    (x     x     x    (x    x   (x)   x
   |     |     |     |     |    |    |    |
   CV   CV    CV    CV    CV   CV   CV   CV
```

Recall that this departure from HV entails a somewhat different meaning for the parentheses. For example, a left parenthesis indicates that all material to its right, up to the next parenthesis or the end of the form, constitutes a constituent. Thus, this kind of partitioning has directionality.

In fact, for many languages it is sufficient for the language to use only one kind of parenthesis. Koya, for example, can be modelled without the use of any right parentheses.

One representational drawback of parentheses marking constituent boundaries is that they can "pile-up", and create vacuous constituents. In order to address this potential inadequacy, we can add statements to the parenthesis theory reducing sequences of boundaries, as in (4).

(4) a. $((\rightarrow ($ b. $)) \rightarrow)$ c. $() \rightarrow \emptyset$

There are three possible alternatives to the statements in (4). The first alternative would be to add universal avoidance constraints, such as those in (5).

(5) a. Avoid ((b. Avoid)) c. Avoid ()

However, the avoidance constraints alone are insufficient. Recall that the effect of the avoidance constraints is to prevent the addition of certain parentheses in the application of certain parameter settings. However, it is possible for disfavored configurations to arise through morpheme concatenation, or through grid mark deletion. The grammar must have some way of dealing with these configurations when they arise through concatenation or deletion. Thus, it is necessary to have universal grid simplification rules, such as in (4), in addition to avoidance constraints as in (5).

The second alternative is to formulate all rules and constraints so that they are insensitive to multiple boundaries. We should not, however, then be able to use the spurious representational distinction between one boundary and several. That is, no rule should be able to refer to the presence of multiple boundaries. It is possible to do this with the view that rules are implemented as finite state transducers (see Sproat (1992) and references cited there).

The third, and most provocative, alternative is to disallow all sequences of multiple parentheses. That is, we would allow only one parenthesis between any pair of grid marks or at any edge. By combining this idea with our "first wins" idea from the avoidance constraints, this would prevent such configurations from arising. In the case of morpheme concatenation this then requires that morpheme concatenation not be viewed as a symmetric operation. Rather, a morpheme is being added *to* another morpheme, which we might call the head. The metrical parentheses of the head would then be morphological prior, and thus have precedence. At the present, this alternative is too restrictive. The analyses of Chugach Alutiiq (Chapter 2) and English secondary stress (Chapter 3) both require that the sequence)(be allowed in certain situations.

Another potential drawback of parentheses marking constituent boundaries occurs with "dangling" parentheses, as in (6)

(6)   #)   (#

In the discussion of Russian in Chapter 4 we proposed two ways of dealing with these configurations. One was to add another parenthesis, as in (7a). The other was to delete the parenthesis, as in (7b).

(7)   a. $\emptyset \rightarrow ($ / __ x (#   b. $(\rightarrow \emptyset$ / __ #

In fact, once (7a) has applied, (7b) can also apply, with no adverse consequences. Therefore, we can make (7b) universal, and mark stems simply for whether they trigger (7a) or not.

Derivations for the two kinds of stems are shown in (8).

(8)

Project	x x(x gospož + O	x x(x ugOl + O
Jer	x x(gospož	x x(ugol
(7a)	x (x(gospož	
(7b)	x (x gospož	x x ugol
Line 0 Line 1	x (x x (x) gospož	x (x x x) ugol

Languages with pre- or post-stressing morphemes have the choice of alternatives in (7), and perhaps others, for the resolution of dangling parentheses. A somewhat stronger claim can be made for languages without pre- or post-stressing morphemes. They can be modelled by using the avoidance constraints in (9).

(9) Avoid #) Avoid (#

2.1.2. *Foot separators*

We could also use a single symbol, "|", to indicate constituent boundaries. This would be similar to the use of "$" to indicate syllable separation in Natural Generative Phonology (Vennemann (1972) and Hopper (1976)). In such a theory, which we will call separator theory, the grid consists of only two atomic symbols, a grid mark "x" and a juncture "|". The separator theory representation for the test grid is given in (10).

(10)
```
          x                 x         x
     x |  x    x      x  |  x    x |  x |  x
     |    |    |      |     |    |    |    |
     CV   CV   CV     CV    CV   CV   CV   CV
```

Separator theory has the same boundary pile-up problem of parenthesis theory, with the same solutions possible. In fact, the separator theory is in essence just another way of limiting a language to a single kind of parenthesis. As discussed in the preceding section, this will work with many languages, such as Koya. However, we know that there are languages which make use of both kinds of parentheses, including Latin, Macedonian, Polish, Khalkha-type languages, Winnebago and Chugach Alutiiq. Thus, separator theory contains a gross inadequacy in being unable to represent such cases. A particularly strong argument against separator theory is provided by Chugach Alutiiq. To get the correct placement of fortition and stress in Chugach Alutiiq words must have unmetrified elements between constituents, a representation that separator theory is incapable of providing.

2.2. *Grid marks as feature matrices*

Another mechanism available in phonological theory is features, both binary and unary. We can augment a plain grid by giving grid marks internal structure, encoding constituency in features.

We can use either binary or unary feature to do this. The main difference between binary and unary features is the familiar one. Binary features are somewhat more powerful, as we can refer to both the positive and negative values, whereas using unary features we can refer only to the presence of a value.

Using binary features inside the grid marks, we can indicate whether the mark serves as the left edge of a constituent [+L] or not [-L] and whether it serves as the right edge of a constituent [+R] or not [-R]. The binary feature representations of the test grid is given in (11).

(11)

$$\begin{array}{cccccccc}
 & \begin{bmatrix}-\mathrm{L}\\-\mathrm{R}\end{bmatrix} & & & \begin{bmatrix}-\mathrm{L}\\-\mathrm{R}\end{bmatrix} & & \begin{bmatrix}-\mathrm{L}\\-\mathrm{R}\end{bmatrix} & \\
\begin{bmatrix}-\mathrm{L}\\-\mathrm{R}\end{bmatrix} & \begin{bmatrix}+\mathrm{L}\\-\mathrm{R}\end{bmatrix} & \begin{bmatrix}-\mathrm{L}\\-\mathrm{R}\end{bmatrix} & \begin{bmatrix}-\mathrm{L}\\+\mathrm{R}\end{bmatrix} & \begin{bmatrix}+\mathrm{L}\\-\mathrm{R}\end{bmatrix} & \begin{bmatrix}-\mathrm{L}\\+\mathrm{R}\end{bmatrix} & \begin{bmatrix}+\mathrm{L}\\+\mathrm{R}\end{bmatrix} & \begin{bmatrix}-\mathrm{L}\\-\mathrm{R}\end{bmatrix} \\
| & | & | & | & | & | & | & | \\
\mathrm{CV} & \mathrm{CV} & \mathrm{CV} & \mathrm{CV} & \mathrm{CV} & \mathrm{CV} & \mathrm{CV} & \mathrm{CV}
\end{array}$$

Constituency can also be encoded using unary features. Further, we do not need to indicate both boundaries for every constituent. A unary feature represenation of the test grid is given in (12).

(12)

$$\begin{array}{cccccccc}
 & [\ ] & & & [\ ] & & [\ ] & \\
[\ ] & [\mathrm{L}] & [\ ] & [\ ] & [\mathrm{L}] & [\ ] & \begin{bmatrix}\mathrm{L}\\\mathrm{R}\end{bmatrix} & [\ ] \\
| & | & | & | & | & | & | & | \\
\mathrm{CV} & \mathrm{CV} & \mathrm{CV} & \mathrm{CV} & \mathrm{CV} & \mathrm{CV} & \mathrm{CV} & \mathrm{CV}
\end{array}$$

The major drawback of the feature theories of metrical constituency is that the marks and constituent information are bound together in a single item. As discussed in detail in HV, the loss of grid marks is associated with stress shift rather than stress loss. Thus, the constituency must have a life separate from the grid mark that it is associated with. The other theories considered in this chapter account for this directly, by representing constituency distinct from the grid marks. The feature theories, without further enhancements, would predict stress loss under deletion rather than stress shift. The feature representations are therefore grossly inadequate as a formal theory of metrical constituency.

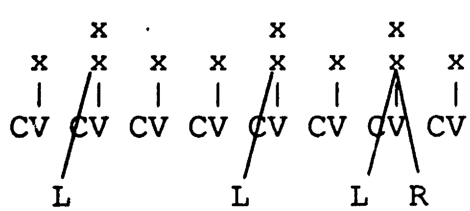
2.3. *Autosegmental representations*

Autosegmental implementations of bracketed grids create layers of planes of consituent structure. The grid marks are associated to three tiers: to the next lower layer; to the next higher layer; and to the autosegments representing constituents. We will consider two variants of such a theory: one where the autosegments mark the left or right edges of a constituent; and one where each autosegment represents the span of a constituent.

2.3.1. *Autosegmental Edges*

Bracketed grids can be represented with autosegments representing the edges of the constituents. We will call this method the autosegmental edge theory. We will use L and R to indicate left and right autosegments respectively. The autosegmental edge representation for the test grid is given in (13).

(13)



It is a basic tenet of metrical theory (though it has been debated) that no grid mark may belong to more than one constituent. The feature and boundary theories account for this directly, being incapable of representing such ambi-pedal elements. However, multiple associations are the hallmark of autosegmental phonology. Therefore, the autosegmental edge theory must include an explicit ban on ambi-pedal elements, as in (14).

(14)
```
* x
 / \
R   L
```

Notice that it is not possible to ban all structures in which grid marks linked to two edges, because some unary constituents, for example the one in (13), have the representation in (15).

(15)
```
  x
 / \
L   R
```

Autosegmental edge theories also have problems similar to bracket pile-up, we must disallow two L's or R's linked to the same element, as in (16).

(16)
```
* x        * x
 / \        / \
L   L      R   R
```

And configurations where autosegmental edges branch must be disallowed, as in (17).

(17)
```
* x   x  * x   x
   \ /      \ /
    L        R
```

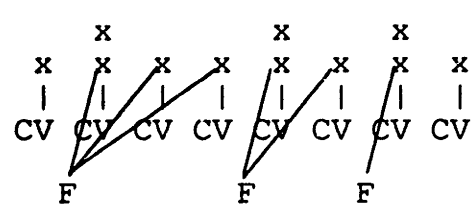
The autosegmental edge theory is a poor use of autosegmental representations since the one to many and many to one mappings are almost all invalid. Thus, the major insight of autosegmental representations plays almost no role when applied in this way to metrical representations.

The autosegmental edge theory also provids no adequate way of handling pre- and post-stressing morphemes. The appropriate device would seem to be floating autosegments. However, the theory offers no obvious constraints on the docking of such floating autosegments. We know, for example, that Russian post-stressing stems cause stress to appear on the immediately following vowel. The parenthesis theory accounts for this kind of stem directly. The parenthesis at the end of the stem will cause the next grid mark to become the left-most element of the constituent. However, if we try to represent this with a floating autosegment on the stem, we must somehow get it to dock to the vowel immediately following the stem. We cannot simply say that it docks to the left-most available element, because the Russian post-stressing stems do not have any other metrical structure, so such a docking would incorrectly predict initial stress. Therefore, the autosegmental edge theory is inadequate for the representation of pre- and post-stressing morphemes.

2.3.2. *Autosegmental feet*

The representation we will call autosegmental feet is probably the most intuitive formalization for bracketed grids. As shown in (18), line 0 is projected from the organizational tier, and the line 0 marks are associated to autosegments (F's) on another tier, representing constituency. The autosegments delimit the domain of the line 0 constituents. Line 1 is then projected from the information contained on the line 0 constituency plane.

(18)



As with the autosegmental edge theory, we must severely limit the use of multiple associations within autosegmental foot theory. Again, we must prevent ambi-pedal elements, as in (19).

```
(19)    *   x
           / \
          F   F
```

A similar shortcoming of autosegmental feet is that they allow another sort of unmetrified elements: discontinuous constituents. In a discontinuous constituent, an unlinked element is surrounded by linked elements. Such configurations must be excluded, as in (20).

```
(20)    *  x  x  x
            \   /
              F
```

Discontinuous constituents can only generated by the autosegmental foot theory; all the other theories considered here cannot represent such structures. Therefore, only in autosegmental foot theory is it necessary to construct an explicit ban on such structures, such as (20).

Notice that the constraints (19) and (20) are not general properties of autosegmental representations. Indeed, many to one and one to many mappings are a crucial part of autosegmental theories of subsegmental features. If we claim that the same representations and operations are used for subsegmental features and prosodic constituency we run into an immediate quandary. To the extent that metrical constituency is not like the subsegmental representations and processes modelled using autosegmental representations and operations, we have to conclude that metrical theories employing the same autosegmental devices are less than ideal.

The autosegmental edge theory, the parenthesis theories and the feature theories all can represent grids with unmatched parentheses, such as those in (21).

```
(21)  x x x      (x x x      |x x x      [L] [ ] [ ]
      |
      L
```

In such theories, the Maximality principle of HV is directly encoded by the representation. A single edge serves to define the existence of a constituent and thus the constituent will have the largest extent possible. Because autosegmental feet lack this property we must instead allow feet to spread. In fact, feet must be able to spread in different directions in the same language in order to correctly capture the Khalkha type systems. That is, the direction of spreading cannot always be a language-wide parameter. Thus, in languages like Khalkha the foot autosegments must be annotated for their spreading direction.

Again, as with autosegmental edge theory, the autosegmental foot theory offers no adequate representations for pre- and post-stressing morphemes. In addition, the autosegmental foot theory has problems with morpheme concatenation. When two morphemes with lexical stress are concatenated the parenthesis and autosegmental feet theories can differ in the number of constituents generated. Recall the case in Russian of an Edge:LRL stem, *gorbat*, with an Edge:RRR suffix, *-ost*, shown in (22).

(22)

Parenthesis	*Autosegmental Feet*
x (x x) gorbat-ost	F F | | x x x gorbat-ost

The prediction made by parenthesis theory in this case is that only one constituent results from this combination. The autosegmental edge theory will predict two foot autosegments, and thus two constituents.

Perhaps surprisingly, the HV notation itself seems to be the most adequate formal representation of bracketed grids. By having a discrete calculus over the three elements "(", ")" and "x" on the grid we can capture the environments necessary for the metrical operations, constraints and morpheme types found in the languages we have examined.

The separator theory is inadequate because it does not allow for the representation of unmetrified elements between constituents, as is required in Chugach Alutiiq.

All of the other theories examined above are inadequate because they lack the representational capacity to express pre- and post-stressing morphemes, especially the variety of such morphemes encountered in Russian.

The feature theories are also inadequate because they do not preserve constituent structure when grid marks are deleted, predicting stress loss rather than stress shift.

Finally, the autosegmental theories require a battery of constraints against the use of one to many and many to one associations which are legitimate in subsegmental uses of autosegmental phonology. This leads us to conclude that metrical theory is not well-served by a formalization employing strictly autosegmental devices.

Finally, there is an argument for the parenthesis theory over the autosegmental theories based on simplicity of projection. The parenthesis theory compresses the constituency information onto the same tier as the grid marks. This means that we can reduce the number of tiers examined in constructing metrical structures. If the syllabification is similarly represented with x-tier parentheses, it would then be possible to do line 0 projection from an examination of only two tiers: the x-tier and line 0. In the autosegmental theories metrical constituency is represented on two tiers: line 0 and the constituent autosegment tier. Likewise, the representation of syllabification is also spread across two (or more) tiers; for example, in moraic phonology, the root tier, the μ-tier and the σ-tier. Thus, the projection of line 0 under an autosegmental system coupled with moraic syllabic phonology would involve the simultaneous examination of five tiers.

3. *Constraints versus rules*

Recall that ternary parsing has been derived as binary parsing subject to an avoidance constraint. Could we get binary parsing as a consequence of some more general parenthesis insertion subject to avoidance constraints? In a sense this would merely shift the burden from one component (rules) to another (constraints). There are two variations on this theme. The less radical alternative preserves a rule of bracket insertion, keeping bracket insertion as an iterative rule with a direction, placing a left or a right bracket. The second, more radical variant, would dispense with the iterative rule entirely. Instead, all possible metrical grids are considered, and constraints rule out the incorrect ones. The radical variant is presumably what is meant by a "rule-free" phonology.

3.1. *Iterative parenthesis insertion*

One might try to do all iterative parsing by just trying to stick in parentheses anywhere with the appropriate additional avoidance constraints. Under this account we will go across the form, either left to right or right to left, placing a left or a right parenthesis. One possible formulation of this idea is given in (23).

(23) *Iterative parenthesis insertion parameter*
Insert a parenthesis at every element starting from
the $\left\{\begin{matrix}\text{left}\\ \text{right}\end{matrix}\right\}$-most element.

We will again restrict the operation of (23) as with the ICC. Iterative parenthesis insertion will insert left parentheses when going right to left and right parentheses when going left to right.

Let's re-examine some of the stress patterns of the languages that we examined in the first two chapters. The line 0 parameter settings for the basic binary systems of interest are repeated in (24).

(24)	*Warao*		ICC:R	Head:L
	Weri	Edge:LLL	ICC:R	Head:R
	Garawa	Avoid (x(		
		Edge:LLL	ICC:R	Head:L

In the present discussion, we will assume that dangling parentheses are universally prohibited, by the constraints in (25).

(25)

Avoid #)
Avoid (#

Warao can then be modelled by the rules and constraints in (26).

(26) Avoid (x # Avoid (x (IPI:R Head:L

Derivations for abstract odd and even words of Warao are shown in (27).

(27)

		x x x x x	x x x x x x
IPI:R at	0	*avoid* (#	*avoid* (#
	1	*avoid* (x#	*avoid* (x#
	2	x x x (x x	x x x x (x x
	3	*avoid* (x (	*avoid* (x (
	4	x (x x (x x	x x (x x (x x
	5	*avoid* (x (	*avoid* (x (
	6		(x x (x x (x x
Head:L		x x x (x x (x x	x x x (x x (x x (x x

The immediate problem is that there are languages like Weri which generally have binary constituents but which do not obey Avoid (x(entirely. One analysis for Weri is shown in (28).

(28) Avoid (x # Avoid x (x (IPI:R Head:R

Avoid x(x(will cause non-initial degenerate constituents to be prohibited, but will allow initial degenerate constituents. Derivations for odd and even abstract words of Weri are shown in (29).

(29)

		x x x x x	x x x x x x
IPI:R at	0	*avoid* (#	*avoid* (#
	1	*avoid* (x#	*avoid* (x#
	2	x x x (x x	x x x x (x x
	3	*avoid* x (x (	*avoid* x (x (
	4	x (x x (x x	x x (x x (x x
	5	(x (x x (x x	*avoid* x (x (
	6		(x x (x x (x x
Head:R		x x x (x (x x (x x	x x x (x x (x x (x x

It is also possible to analyze Weri as left-headed, with the degenerate foot at the right edge. The system for this is shown in (30).

(30) Avoid (x (IPI:R Head:R

And the derivations for odd and even abstract words of Weri under (30) are shown in (31).

(31)

		x x x x x	x x x x x x
IPI:R at	0	*avoid* (#	*avoid* (#
	1	x x x x (x	x x x x x (x
	2	*avoid* (x (	*avoid* (x (
	3	x x (x x (x	x x x (x x (x
	4	*avoid* (x (	*avoid* (x (
	5	(x x (x x (x	x (x x (x x (x
	6		*avoid* (x.(
Head:L		x x x (x x (x x (x	x x x x (x x (x x (x

The second analysis involves fewer and simpler avoidance constraints. However, as discussed in Chapter 1, the metrical structures produced by the second analysis make more use of degenerate constituents, and also use unmetrified elements. In particular, this analysis of even words seems much worse. Under (30) even words have both a degenerate constituent and an unmetrified element, whereas under (28) even words are assigned a homogeneous sequence of binary constituents. Thus, the evaluation of the markedness of the two IPI systems makes the wrong prediction. IPI theory says that (30) is simpler than (28), because it contains one less constraint, and the constraint is simpler. However, the system in (30) is not the preferable analysis.

Garawa was analyzed in Chapter 1 as [Edge:LLL ICC:R] subject to Avoid (x(. We can replace ICC:R with IPI:R as long as we also include Avoid (x#. However, since we are trying to maximize the use of constraints, it would be more interesting if we could eliminate Edge marking in favor of constraints. This can be done for Garawa with the settings in (32).

(32) Avoid (x (Avoid (x # Avoid # x (IPI:R Head:R

Derivations for odd and even abstract words are shown in (33).

(33)

		x x x x x	x x x x x x
IPI:R at	0	*avoid* (#	*avoid* (#
	1	*avoid* (x#	*avoid* (x#
	2	x x x(x x	x x x x(x x
	3	*avoid* (x(	*avoid* (x(
	4	*avoid* #x(	x x(x x(x x
	5	(x x x(x x	*avoid* (x(
	6		(x x(x x(x x
Head:R		x x (x x x(x x	x x x (x x(x x(x x

Further, one might try modelling extrametricality effects with (34) rather than through the interaction of Edge:RLR and constituent construction.

(34) Avoid (x x #

However, unbounded systems also use Edge marking to get stress. If we replace Edge marking in unbounded systems with IPI, we will have to prevent the insertion of parentheses in a bewildering array of environments. Eliminating Edge marking also eliminates our theory of lexical stress.

In the analyses of Warao, Weri and Garawa it seems that the adoption of IPI is merely a trade off: more avoidances for a "simpler" parenthesis insertion rule. However, these analyses all include some form of Avoid (x(. We know, however, from the stress patterns of Koya that Avoid (x(is not universal. Therefore, we predict a language with IPI:R but without Avoid (x(. In such a language IPI will put in parentheses before almost every grid mark, predicting stress on practically every syllable. Further, by using Avoid (x(to get binary parsing we predict that no binary language should allow clash, but Tubatulabal (Chapter 1) is just such a language.

3.2. *Contraint-only metrical theory*

By constraining parenthesis insertion to operate iteratively and try to apply in each position, we only had to keep certain brackets out. Let's now consider the more radical alternative where we allow all possible grid structures to be generated. Now, we not only need to keep parentheses out of certain positions, we also have to ensure that do occur in particular positions. Thus, we will need to add constraints to prevent lapses, and constraints to get "left-to-right" versus "right-to-left" effects.

We will again assume the universal constraints in (35).

(35)

`Avoid #)`
`Avoid (#`

We will also assume that most languages can specify that they use only one kind of parenthesis. Under this assumption, simple constraints to prevent degerate constituents can be formulated, as in (36).

(36)

Left	Right
`Avoid (x(`	`Avoid )x)`
`Avoid (x#`	`Avoid #x)`

All of the systems examined in this section can stipulate that they use only left parentheses.

The iterative construction of constituents is replaced with lapse constraints, for example, the one in (37).

(37)

`Avoid xxx`

Notice that this makes use of the fact that adjacency of marks indicates the lack of a parenthesis. In this way the lack of a parenthesis is positively specified.

Again, we will examine some of the basic systems explored in the first two chapters. The line 0 parameter settings for the basic binary systems of interest are repeated in (38).

(38)	*Warao*		ICC:R	Head:L
	Weri	Edge:LLL	ICC:R	Head:R
	Garawa	Avoid (x(Edge:LLL	ICC:R	Head:L

Assuming that Warao does not employ right parentheses and that Avoid (# is universal, the constraints in (39) produce a complete model of the line 0 constituents of Warao.

(39)

a.	Avoid (x(
b.	Avoid (x#
c.	Avoid xxx
d.	Avoid #xx

The application of the constraints in (39) to the set of possible three mark grids is shown in (40).

(40)

		a.	b.	c.	d.
1	x x x			*	*
2	(x x x			*	
3	x (x x				
4	x x (x		*		*
5	(x (x x	*			
6	(x x (x		*		
7	x (x (x	*	*		
8	(x (x (x	*	*		

All of the grids except (40-3) are ruled out, deriving the correct constituent structure for this case. The application of the same constraints to the set of possible four mark grids is shown in (41).

(41)

		a.	b.	c.	d.
1	x x x x			*	*
2	(x x x x			*	
3	x (x x x			*	
4	x x (x x				*
5	x x x (x		*	*	*
6	(x (x x x	*		*	
7	(x x (x x				
8	(x x x (x		*	*	
9	x (x (x x	*			
10	x (x x (x		*		
11	x x (x (x	*	*		*
12	(x (x (x x	*			
13	(x (x x (x	*	*		
14	(x x (x (x	*	*		
15	x (x (x (x	*	*		
16	(x (x (x (x	*	*		

Again, the correct structure, (41-7), is the only one that does not violate any constraint.

So if we assume that Warao does not use right parentheses, we can generate the correct line 0 constituents using only constraints. Now we must consider the operation of projection, which was also a rule in the preceding chapters. The simplest kind of projection that we have is Headedness. So, how would headedness be done in an constraint-only theory? Obviously, we assume that line 1 elements with links to line 0 are freely generated. For three-element words of Warao, freely generating line 1 marks over the correct constituency yields the eight grids in (42). Since Warao is left-headed, the correct grid is (42-3).

(42)

```
1 | x (x  x
--+----------
2 | x
  | x (x  x
--+----------
3 |    x
  | x (x  x
--+----------
4 |       x
  | x (x  x
--+----------
5 | x  x
  | x (x  x
--+----------
6 | x     x
  | x (x  x
--+----------
7 |    x  x
  | x (x  x
--+----------
8 | x  x  x
  | x (x  x
```

Now we have to find constraints to rule out all grids in (42) except (42-3). In part, this corresponds to the constraints in (43).

(43)

```
a. | Avoid    x
   |        x x
---+------------
b. | Avoid    x
   |        # x
```

The constraint in (a) says that a line 0 mark cannot be associated with a line 1 mark if the line 0 mark is adjacent to another line 0 mark to its left. This rules out some but not all of the incorrect grids. To rule out most of the others, we require the constraint (b). This constraint prevents unmetrified initial elements from receiving a line 1 mark. The effects of (a) and (b) on the three element grids of (42) are shown in (44).

(44)

		a.	b.
1	x (x x		
2	x x (x x		*
3	x x (x x		
4	x x (x x	*	
5	x x x (x x		*
6	x x x (x x	*	*
7	x x x (x x	*	
8	x x x x (x x	*	*

This almost does it. We are left with two grids, (44-3), the correct one, and (44-1), a grid without any line 1 marks. Since we claimed that line 1 was freely generated, it is certainly possible to simply fail to generate any line 1 marks.

This shows one aspect of the non-functional nature of constraint-only theories. The constraints may be insufficient to uniquely identify the correct structure. That is, several structures may be consistent with the entire set of constraints. The complementary case also exists: where the set of constraints rule out all possible structures, that is, no structure meets all the constraints. We will see cases of this below. The problem of no consistent structures can be handled by organizing the constraints into a hierarchy. Then, when no structures meet all constraints, the constraints can be successively relaxed, until a "nearly-consistent" structure is found. However, the problem of too many consistent structures is not helped by a hierarchy of constraints. And, the relaxation of constraints may yield multiple "nearly-consistent" structures, also observed below.

Thus, we require something like (45).

(45)

```
Avoid    .
        (x
```

However, the constraint in (45) makes specific reference to the absence of a line 1 mark. It is a tenet of privative feature theory (alluded to in the discussion of unary feature representation for bracketed grids) that privative features are more constrained, and hence more desirable, because no reference to the absence of a specification is possible. Certainly, bracketed grid theory is a privative theory of stress. However, the constraint in (45) refers to the absence of a grid mark.

Thus, if no better formulation of a constraint yielding the effect of (45) can be found, then the theory will also require some sort of ranking device, which will arrange the consistent structures according to some metric of preference. For the case at hand, one such metric would be to maximize the number of line 1 marks. This would not "rule out" the case without line 1 marks, rather it would render it a "less dersirable" outcome.

Leaving this problem for a moment, let's examine the other binary systems. We know that the ban on degenerate feet cannot be absolute in Weri. Weri allows a degenerate foot, but only in initial position. We also know that Weri does not allow any unmetrified elements. The Weri line 0 constituent system is completely modelled by the constraints in (46).

(46)

Avoid x(x(
Avoid (x#
Avoid xxx
Avoid #x

By changing the ban on degenerate feet from Avoid (x(to Avoid x(x(this will allow an initial degenerate foot. By changing the requirement on initial lapses to prevent them altogether, this disallows an initial unmetrified element, which is possible in Warao. The table in (47) compares the line 0 constituency constraints of Warao and Weri.

(47)

	Warao	*Weri*
Avoid	(x (	x (x (
Avoid	(x#	(x#
Avoid	xxx	xxx
Avoid	#xx	#x

We can see from (47) that the languages have two constraints in common, and four constraints are unique to one of these languages. Thus, to this point languages have a choice among six constraints. Consider instead the system in (48), which combines the two systems in (47), picking the simpler constraint in the case of disagreement between the two systems.

(48)

a.	Avoid (x(
b.	Avoid (x#
c.	Avoid xxx
d.	Avoid #x

Notice that grids with an even number of elements are solvable under the system in (48). For example the grid of six elements in (49) violates none of the constraints, and no other grid of six elements is consistent with all of the constraints.

(49) (x x(x x(x x

Further, the structure (49) is the correct line 0 structure for even words in Warao, Weri and Garawa. Grids with an odd number of elements are inconsistent with the entire set of parameters in (48). The system, however, will work for odd words in Warao and Weri provided that we arrange the constraints in a hierarchy. Consider, for example, the possible metrical constituent structures for a grid with three elements, shown in (50).

(50)

		a.	b.	c.	d.	
1	x x x			*	*	
2	(x x x			*		*Garawa*
3	x (x x				*	*Warao*
4	x x (x		*		*	
5	(x (x x	*				*Weri*
6	(x x (x		*			
7	x (x (x	*	*		*	
8	(x (x (x	*	*			

Each constituent structure violates at least one of the constraints. This is where the hierarchy comes in. In this situation, in order to get the correct metrical structures, we must allow each language to settle on the "least of the evils" for that language. That is, each language may relax one of the constraints. If Warao relaxes (d), then (50-3) is correctly picked as the right structure for three element grids in Warao. Likewise, Weri relaxes (a), correctly picking out (50-5). We can also obtain the structure appropriate for Garawa in this case. In Garawa the correct form for three mark grids is (49-2), and this is the relaxation of (c).

That is, Garawa prefers a ternary constituent over clash or an initial unmetrified element. But, we know more about the location of the ternary constituent in Garawa: it must be the first constituent of the word. We must now consider longer words. For seven mark grids, for example, there are three structure with only a single violation of (c), shown in (51).

(51)

		a.	b.	c.	d.	
1	(x x x (x x (x x			*		*Correct grid*
2	(x x (x x x (x x			*		
3	(x x (x x (x x x			*		

The only thing common to the two unwanted structures is that they contain an initial binary foot. Thus, Garawa will require the extra constraint in (52).

(52)

e.	Avoid #(xx(

This then allows the correct prediction that relaxing (c) in Garawa odd words yields the correct constituent structure. Therefore, (e)>(c) in Garawa. Unfortunately, the Avoid #(xx(constraint will render all even grids larger than two marks inconsistent. In even words, obviously (e) must be the constraint that is being relaxed, as we were generating the correct grids without it. In particular, we do not want to relax Avoid #x, which would then allow an initial lapse of two syllables in even words. Thus, for Garawa that we require the hierarchy (d)>(e)>(c).

The question that arises at this point is why Garawa requires (e) at all. Could there be a language like Garawa, but without (e)? In such a case, we would be able, with the constraints also required by Warao and Weri, to accurately characterize even grids and grids of three marks. However, in odd words of greater length, we would only partially characterize the metrical structure. Thus, we would predict that such words would have variable stress patterns. The prediction is not for total chaos, in fact, the predictions are precise. For example, we predict only the three alternatives for grids of seven marks shown in (51), out of a total 128 possible constituent structures for seven marks. However, stress systems in human languages do not appear to work in this fashion. Rather, for each grid length there is one particular stress pattern. Thus, because of their non-functional nature, constraint-only theories must be augmented with other devices to preserve the observed functional character of metrical structure assignment. Thus, like the unsuitability of autosegmental representations for the formal representation of bracketed grids, it is not the case that constraints are not part of the system, they simply do not offer a suitably complete characterization of the system. Indeed, I have argued in the preceding chapters that Avoidance constraints play an important role in the assignment of metrical structure. The argument here is that there are other players on the stage as well.

Moreover, the constraint-only theory does not provide a satisfying account of cases that were handled by applying constraints in conjunction with the rules of constituent structure assignment. Recall the basic stress facts of Koya, repeated in (53).

(53) *Koya* Stress on initial syllable and all heavy syllables.

In the no-rules framework being examined, to capture quantity sensitivity marks associated with heavy syllables must not be adjacent to other marks. This constraint is fomulated in (54).

(54)

```
Avoid   x x
          H
```

As before, avoiding adjacency entails the presence of a parenthesis. The stress patterns of Koya can be generated with the constraints in (55).

(55)

a.	Avoid # x
b.	Avoid x x H (under the second x)
c.	Avoid (x L (under x)
a > c	

The constraint (a) ensures that initial elements are metrified. The constraint (b) ensures that non-initial heavy syllables will start constituents. Notice that it is (a) rather than (b) that covers the case of a heavy initial. Finally, the constraint (c) states that light syllables may not begin a constituent. Only words with heavy initial syllables can be consistent with all of the constraints. Specifically, (a) and (c) are in conflict with initial light syllables. We know that such syllables have stress in Koya, therefore (c) must be relaxed in these words, showing that it is lower on the hierarchy than (a). Notice, also, that this system requires direct reference to both heavy and light syllables. The Projection parameter of Chapter 1 needs to be sensitive only to heavy syllables. Light syllables do not receive parentheses there because no rule gives them one. Because the constraint-only framework is not constrained to put parentheses only where rules would, it requires the extra statement that light syllables do not receive parentheses in addition to the statement about heavy syllables.

Now recall the systems of Malayalam and Wolof, discussed in Chapter 2, that differ minimally from Koya. The relevant stress patterns are shown in (56).

(56)	Koya	Malayalam	Wolof
	# Ĺ H̀	# L H́	# L H́
	# Ĺ L H̀	# Ĺ L H̀	# Ĺ L H̀
	# H́ H̀ L	# H́ H̀ L	# H́ H L
	# Ĺ H̀ H̀	# L H́ H̀	# L H́ H
	... H̀ H̀ ...	... H̀ H̀ ...	... H̀ H ...
	... H̀ H̀ H̀ ...	... H̀ H̀ H̀ ...	... H̀ H H̀ ...

The stress pattern of Malayalam differ minimally from Koya. The only difference is that initial light syllables do not receive stress when the second syllable is heavy. The obvious constraint to add to the Koya system is Avoid (x(, yielding (57).

(57)

a.	Avoid	# x
b.	Avoid	x x H
c.	Avoid	(x L
d.	Avoid	(x (
b > d a > c		

In order to get initial stress in an all-light word, (a) must be more important than (c). However, when a heavy syllable is in second position, an initial light does not get stress. Therefore, (d) must be more important than (a). Thus, (d)>(a)>(c). When two heavy syllables occur together, they both receive stress, thus, (b) is more important than (d). Therefore, Malyalam has a total ordering of the constraints, (b)>(d)>(a)>(c). This correctly works for all words except those with the first two syllables both heavy. Recall that it is (a) that provides a heavy initial with a parenthesis in Koya. Thus, to get #HH... words correct in Malayalam we will have to add another constraint, and make it greater in the hierarchy than (d). Such a system is shown in (58).

(58)

a.	Avoid # x
b.	Avoid x x H
c.	Avoid (x L
d.	Avoid (x(
e.	Avoid # x H
b e > d > a > c	

Certainly, Wolof will have essentially the same constraints as Koya and Malayalam. The difference in Wolof is that adjacent heavy syllables do not both get stress. This was handled in Chapter 2 by applying Project:L iteratively from left to right, subject to Avoid (x(. In the constraint-only theory, it is clear that for Wolof, the constraint against clash, (d) must be more important than the heavy syllable constraint (b). We can handle an initial string of heavy syllables properly in Wolof with the same constraints but a different hierarchy, shown in (59).

(59)

a.	Avoid # x
b.	Avoid x x H
c.	Avoid (x L
d.	Avoid (x (
e.	Avoid # x H
e > d > b > a > c	

However, now consider a Wolof word of the form #LHHHL#. In such a word stress falls on the second and fourth syllables. The structures for such a word consistent with (d) are shown in (60).

(60)

		a.	b.	c.	
1	(x x(x x(x L H H H L		2	2	
2	(x x(x x x L H H H L		2	1	
3	(x x x(x x L H H H L		2	1	
4	(x x x x(x L H H H L		3	2	
5	x(x x(x x L H H H L	1	1		*Correct structure*
6	x(x x x(x L H H H L	1	2	1	
7	x x(x x(x L H H H L	1	2	1	
8	(x x x x x L H H H L		3	1	
9	x(x x x x L H H H L	1	2		
10	x x(x x x L H H H L	1	2		
11	x x x(x x L H H H L	1	2		
12	x x x x(x L H H H L	1	3	1	
13	x x x x x L H H H L	1	3		

In the table in (61), the columns for (d) and (e) are not shown because the structures are all consistent with (d) and (e). Further, the table shows the number of violations of each constraint. Notice that (a) can only be violated once, as there is only one initial mark.

We know that the constraints (a) and (c) are hierarchical ordered, (a) > (c) because all-light words have initial stress, and therefore all-light words observe (a) rather than (c). However, none of the structures in (61) that obey (a) are correct. What does seem to be a proper metric is either the total number of violations, or the number of violations of (b). The correct structure, (60-5), has the fewest total number of violations (2) and the fewest number of (b) violations (1). Obviously, whatever ranking theory actually implements this, it must be able to record the number of violations of particular constraints, and relate them to the hierarchy of constraints.

Thus, there are significant conceptual reasons for adopting the view that metrical theory contains both rules and constraints. Constraint-only theories are inherently non-functional. That is, a set of constraints can be consistent with more than one metrical structure or with no metrical structures. In order to model the functional character of metrical structure assignment, constraint-only theories must be further enriched with hierarchical ordering of constraints and complex structure evaluations metrics. The ranking of consistent structures (or "nearly-consistent" structures when no consistent ones exist) must evidently have the power to count the number of violations of each constraint.

By having both constraints and rules we can keep each component maximally simple. From the rules, we gain the functional determination of metrical structure. From the constraints we gain a principled theory of rule-structure interactions. Thus, it is the interaction of rules and constraints that yields the best characterization of the construction of metrical grids.

Chapter 6: Conclusions

To conclude, I would like to review the major aspects of the theory of metrical representations and derivations developed in this thesis. I have attempted to develop and describe a discrete calculus that formally captures the fundamental insight of Liberman (1975) that stress is a reflection of the partitioning of sequences of linguistic elements into metrical constituents.

Following Prince (1983), I have suggested that Universal Grammar provides a special plane for metrical structure: the metrical grid. Following Halle & Vergnaud (1987), the grid consists of a number of parallel lines composed of marks and boundaries. However, in the present theory, a single parenthesis is sufficient to define a constituent. A left parenthesis groups material to its right as a constituent, and a right parenthesis groups material to its left.

I have proposed that the grid is a separate module of the phonology, and that there is a strict separation between the grid and the rest of the components of the phonology. The interface between the grid and the rest of the phonology is controlled by two parameters, whose operation is restricted to the projection of marks and boundaries. This can be extended in a natural way to other areas of prosodic phonology. In particular, the end-based theories of the syntax-phonology interface (for example Selkirk (1986)) involve the same sort of boundary projection as found in the line 0 interface.

This view is to be contrasted with theories such as Prince (1990) and Hayes (1991) which do not enforce modularity. Rather, they allow all principles of metrification to have direct access to aspects of syllable structure. Similarly, theories that require generalizations across both feet and syllables, like the Obligatory Branching parameter (Vergnaud & Halle (1978), Hayes (1980), Hammond (1984,1986)) also violate the modular separation of the grid from the syllable structure.

Within the grid, the projection of elements onto higher lines in the grid is strictly limited to the operation of the Head parameter. This framework therefore lacks the capability of increasing an element's prominence directly. As a consequence, any element with increased prominence must always be constituent-terminal.

The major innnovation of the present theory is the Edge Marking Parameter. This simple device solves a number of puzzles in generative stress theory. For example, the differences in stress patterns between Koya and Khalkha are elegantly characterized by different settings of the Edge parameter. This represents an advance in our theorizing about stress since previous theories were able to characterize the stress pattern of languages like Khalkha only with the help of special ad hoc devices. In particular, parameters for higher level constituents were allowed to apply to lower level constituents, violating the Prosodic Hierarchy (McCarthy & Prince (1986)) and the Strict Layer Hypothesis (Selkirk (1986)).

The construction of iterative constituents deviates from the procedure in Halle & Vergnaud (1987) by being universally restricted to construct only full constituents. That is, the ICC cannot itself construct degenerate constituents. In conjunction with the Edge marking parameter this restriction derive the effects previously ascribed to Extrametricality.

Further, the Edge marking parameter provides the requisite formal power to deal with stress introduced by specific morphemes in such languages as Turkish, Macedonian, Polish, Russian, Cayuvava, Shuswap and Moses-Columbian.

The other major facet of this theory is the role played by constraints. Avoidance constraints are statements of universal or language-particular disfavored configurations. The constraints do not cause repair strategies to be invoked, rather they actively prevent the application of metrical rules. This interaction between rules and constraints allows for each component to be made maximally simple, and yet for the system to generate complex results. Among the results achieved in this way is the derivation of a ternary parsing ability.

Finally, by eliminating many of the devices of Halle & Vergnaud (1987), especially the bookkeeping parentheses, many of the conditions imposed there can be dispensed with, including Faithfulness, Recoverability, Peripherality, Maximality and the Domino Condition.

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