ALIGNMENT AND ADJACENCY

IN

OPTIMALITY THEORY:

Evidence from Warlpiri and Arrernte

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ABBREVIATIONS

()/F	=	foot
[ ]/PW	=	prosodic word
σ	=	syllable
μ	=	mora
		=	stem edge
{	=	intonational phrase edge
*	=	constraint violation
!	=	fatal violation
<>	=	unparsed.

- morpheme boundary *(Sometimes glosses are not given to individual morphemes. This is because some morphemes are considered to be bipartite eg =rna=lu 1peS. In addition, there are a number of frozen complex words, in which the morphemes are discernible but no glosses are assigned to them)*

= clitic boundary

1/2/3	first/second/third person
S	subject
NS	non-subject
s	singular
d	dual
p	plural
i	inclusive
e	exclusive
3DAT	3rd dative
ALL	allative
BEN	benefactive
CAUS	causative
CHARAC	characteristic
COMIT	comitative
DAT	dative
DENIZ	denizen
ELAT	elative
ERG	ergative
FUT	future
IDENT	identified information
IMP	imperative
IMPF	past imperfect
INCEP	inceptive verb formative
INCH	inchoative
INF	infinitive
IRR	irrealis
LOC	locative
NOMIC	agentive
NPST	non-past verb inflection
PART	participle
PL	plural number
PST	past verb inflection
POSS	possessive
PROP	proprietive
PURP	purposive complementiser
RECIP	reciprocal
SERCOMP	preceding event
SEQCOMP	directional purposive

CHAPTER 1

OPTIMALITY THEORY

1.1 Introduction

The aim of this thesis is to assess and account for phonological and morphological data by providing explanations and revealing generalisations not previously noted or not sufficiently reflected in analyses. This is a departure from most theses written in Australia which focus on previously undescribed Australian languages or particular grammatical aspects of Australian languages. These theses often bring to light data which challenges current theoretical models. Within the domain of phonology, this thesis attempts to take the next step and show how a broad selection of data can be incorporated into theoretical models of phonology, and what changes to the theory are needed to make this possible. Optimality Theory (McCarthy & Prince 1993a; Prince & Smolensky 1993) seems well suited to this enterprise since it allows for fluid interaction between phonological and morphological entities, not adequately captured in other or previous theories, and such interaction is particularly evident in Australian languages. The benefit to be gained is a better understanding of the interaction, the patterns of interaction, as well as improved theoretical models with greater empirical coverage which contain clearer and more relevant representations, and more constrained analyses.

In general, phonological descriptions of Australian languages use a version of Chomsky and Halle's (1968) generative phonology. The problem with such generative models and earlier item-and-process accounts is that two kinds of rules are required: phonological rules and morpheme structure constraints. The main role of phonological rules was to account for alternations such as that seen in vowel harmony, where the alternants are related to each other via underlying representations. Morpheme structure constraints are generalisations such as those defined on a language's segment inventory, combinations of features and phonotactic constraints on sequences of sounds.

The early generative model is a linear one which conceives of phonemes as a string of positions not grouped into any higher order constituents. Problems with this conception were revealed in processes which required reference to syllable structure and in accounts of stress. With reference to stress, Chomsky and Halle (1968) used a binary [+/- stress] distinction to show that the distribution of stress in a word could be predicted by simple rules. The binary distinction faced much the same problem that the structuralists (Trager & Smith 1951, Newman 1946, among others) encountered with their interpretation of stress as four stress phonemes. The problem is that stress is very different from segmental phonemes because stress has no invariant phonetic cues, has long distance effects, can be realised only in certain positions in a word, and can be lexical.

To better capture the qualities of stress, a metrical grid was introduced which represented different levels of prominence, and syllables were associated with positions on the grid (Liberman 1975). Thus a syllable would have primary stress by virtue of the fact that it was associated to a grid position which had the highest level of grid marks. Stress alternations, for instance, where a stress moves when adjacent to another, could be easily accounted for by moving grid marks that are adjacent on some level.

It became evident that the grid could be used to establish parameters. These parameters are based on whether at a word edge there was a stressed (peak) or unstressed syllable (trough) and on the direction for stress assignment, eg peak first right-to-left, trough first right-to-left. Among some proponents of the theory, there was no characterisation of metrical grouping. However, an alternative was to do just this, that is, group stressed and unstressed syllables into metrical units known as feet. A grouping which contains an initial stressed syllable is a trochaic foot, and one where a stressed syllable is final is an iambic foot. This led to a move away from purely linear representations to hierarchical structures in phonology.

Because syllables could be grouped into feet some interesting patterns were discovered relating to syllable weight. For instance, Hayes (1985) found that an asymmetry existed in stress patterns, which is that quantity insensitive systems (no distinctions in syllable weight) tend to be trochaic while iambic parses do not permit a heavy syllable to be in an unstressed position preceding a stressed light syllable, eg (HL′). The motivation for the asymmetry comes from human perception of rhythmic groupings. In experimental psychology it was found that when quantity distinctions are to be made an iambic grouping is favoured, but a trochaic grouping is favoured when distinctions of intensity are made (Bell 1977). The grouping principle is evident when English speakers demonstrate the difference between iambic and trochaic verse, eg iambic grouping is shown as: ta taa ta taa ta taa; while the trochaic grouping is TA ta TA ta TA ta.

Given that grouping syllables into feet revealed previously unnoticed patterns, a number of metrical theorists came to accept a hierarchy of phonological or prosodic constituents.[1] Such groupings were useful to account for a number of processes. In early linear models, morphophonological processes such as reduplication or infixation were accounted for with unconstrained rules potentially producing operations that did not occur. For instance, a phonological representation consisted of a string of phonemes, where there were no points or units that could be referred to. With the notion of prosodic constituents, eg syllable, foot and prosodic word, phonological and morphological operations could refer to such groupings.

Since it has been acknowledged that particular groupings exist, it has been possible to show what similarities exist across very diverse languages, revealing that little variation exists in certain properties. This moves in the direction of finding what common elements are shared amongst languages and thus what is part of Universal Grammar. The differences in languages then occur because of different choices of settings/parameters/options/constraint orderings.

Despite the variability evidenced across languages in stress patterns and reduplication, it was found that a small set of constituents could account for these processes. What undermined this benefit was how the patterns were derived and once derived whether any further changes were required. Rules derived outputs, but often morpheme structure constraints or wellformedness conditions, and not rules, determined the form of an output. Furthermore, wellformedness conditions could be overridden at various points during a derivation, for instance, certain elements may be assigned monosyllabic feet (σ) during a derivation, even though such feet do not occur in outputs. In addition, some wellformedness conditions were more important than others, but there was no systematic way to encode this.

[1] Note that the use of 'prosodic' differs from the term used by the Firthian school of phonology named after J R Firth (see Sommerstein 1977). The main thrust of this theory was that a speech stream could not suitably be analysed into discrete units. In an analysis of vowel harmony, features involved in the harmony like rounding and fronting are represented as ‘prosodies’ of a word which can affect intervening consonants. The harmonising vowels do not have any markings but take on a prosody. For instance, in Turkish **ulusum** ‘my arm’ would have the following representation /^{w}VlVsVm/. Prosodies are written as superscript symbols.

Essentially, the problem, known as the Duplication Problem as discussed by Kenstowicz and Kisseberth (1977), is that two separate mechanisms, the morpheme structure constraints and phonological rules, are required to account for the phonological generalisations of a language.

To avoid this disadvantage, the aim is to develop ways to account for processes which do not require unmotivated constituents, to develop a system of priorities leading to a much more constrained theory, to enhance our understanding of the various phenomena and to have better representations. Optimality Theory has made much ground in this direction. Here rules and constraints are both characterised in terms of constraints contained in a single grammar and these constraints interact just once, simultaneously, when evaluating the well-formedness of an output. The emphasis is on the output and constraints that ensure the well-formedness of an output.

In this thesis I examine the processes of stress, reduplication and vowel harmony in a number of Australian languages. The analysis of these processes is carried out within the theoretical framework of Optimality Theory (OT), incorporating the theory of Prosodic Morphology (McCarthy and Prince 1986,et seq), which is a theory of the interaction between prosodic constituents and morphological processes. OT builds on this theory, introducing a system of constraints based on well-formedness conditions which determine the well-formedness of surface forms. This chapter outlines the operation and principles of OT.

As will be shown in the thesis, one of the benefits of OT is a straightforward account of operations occurring at the interface between phonology and morphology. This contrasts with rule-based analyses which are restricted in providing explanatory accounts for such operations, often invoking uninsightful mechanisms. As I show in Chapter 2, accounting for the behaviour of monosyllabic morphemes under stress requires that the morpheme structure of the word and the size of individual morphemes within this word are ‘known’ in order to derive optimal outputs. The failing with rule-based analyses is that they cannot know and are forced to introduce purely mechanical devices which are often subsequently obliterated before an output is finally generated.

The value then in accounting for processes in OT is to reveal patterns and phenomena previously obscured by the constructs of a rule-based analysis and to do so in a constrained fashion. The contribution this thesis makes in this regard is an explicit characterisation, for the first time, of the interaction between morphology and rhythm in both isolated words and casual speech, allowing for binary and ternary rhythm which is constrained by binary feet. This is achieved by aligning feet to an edge (the range of edges is expanded here), by requiring adjacency of feet, by ruling out sequences of unfooted syllables, and by allowing constraint relaxation in some contexts (the latter features independently introduced here). Support for adjacency is found in vowel harmony where adjacency accounts, in contrast with other analyses, for harmony and blocking without needing unusual feature specifications and representations and the consequence is finding three main characteristics in harmony processes. Finally, I introduce a theory to account for onset sensitivity in various phenomena which is based on syllable prominence, thereby enhancing our concept of prominence and rhythm. The overall finding is that prosodic constraints dominate constraints on the interaction between phonology and morphology.

The structure of this chapter is as follows. Section 1.2 discusses stress patterns of a few languages and shows how and why OT is preferred in accounting for these patterns. In 1.3 the concept of alignment is introduced and in 1.4 the notion of adjacency is discussed. As much of the data examined in this thesis is of Warlpiri, a brief outline of the grammatical structure of Warlpiri is presented in 1.5. The organisation of the remainder of the thesis is given in 1.6.

1.2 Theoretical Introduction

In this section, some basic stress patterns are presented and I show how these can be accounted for in OT. This is followed by discussion of the principles governing OT.

1.2.1 Stress patterns

In many languages, stress alternates on syllables across a word. A rhythmic pattern is created by the alternation of stressed and unstressed syllables. This is illustrated in Pintupi (Hansen and Hansen 1969,1978) where stress falls on the word-initial syllable and every other odd-numbered syllable. Odd-numbered syllables in word-final position are not stressed.

(1)	tjúrtaya	'many'
	márlawàna	'through from behind'
	púrlingkàlatju	'we (sat) on the hill'
	tjámulìmpatjùngku	'our relation'
	rtírlirdìngulàmpatju	'the fire for our benefit flared up'
	yúrdanjùlulìmpatjùrra	'because of mother-in-law'[2]

The alternation of stress is due to the assignment of feet across a word. Two syllables are grouped into a foot and one of these syllables receives stress, as in (márla)(wàna) 'through from behind', where "()" indicates a foot. Feet must consist of two syllables in Pintupi. Foot size accounts for the fact that adjacent syllables are not stressed, *(má)(rlàwa)na 'through from behind', and for the fact that word-final odd-numbered syllables are not stressed, *(tjúrta)(yà) 'many'.

In general feet are binary (σσ); monosyllabic (σ) and ternary feet (σσσ) are not well-attested crosslinguistically. Some languages allow for monosyllabic feet in some contexts, but there is very little support for ternary feet. Languages with ternary alternation (eg Estonian and Warlpiri discussed in Chapter 4), where stress occurs on every third stress bearing unit, can be accounted for with binary feet.

The presence of an odd number of syllables in a word suggests that foot assignment is directional; that feet are parsed commencing from one edge of a word and moving to the other edge. In Pintupi, word-final odd-numbered syllables are unstressed indicating that feet are assigned from the left edge of the word.

In contrast to Pintupi, feet in Warao (Osborn 1966) are assigned from the right edge of the word, as is evident in (2a), where the initial odd-numbered syllable is unfooted:

(2) a. e.(nà.ho.)(rò.a.)(hà.ku.)(tá.i)
'the one who caused him to eat'
b. (nà.ho.)(rò.a.)(hà.ku.)(tá.i)
'the one who ate'

The location of feet indicates that the alternation of feet is oriented with respect to word edges. In previous accounts within metrical phonology (including Liberman and Prince 1977; Hayes 1981; Prince 1983; Hammond 1984; Selkirk 1984; Halle and Vergnaud 1987; Kager 1989)

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[2] No morpheme-by-morpheme glosses are given.

such directional effects are derived by constructing feet from either the left or right edge of a word. This gives the following patterns in (3). σ=syllable

(3)	Left-to-right (Pintupi)	Right-to-left (Warao)
	(σσ)(σσ)σ	σ(σσ)(σσ)
	(σσ)(σσ)(σσ)	(σσ)(σσ)(σσ)

The fact that a syllable is unfooted at the right edge in Pintupi indicates that feet are oriented to the left word edge, while in Warao the unfooted syllable word-initially shows feet are oriented to the right.

In languages with alternating stress, as many syllables as possible are parsed into feet. This is interpreted as exhaustive parsing[3]. However, when there are an odd number of syllables, one syllable is not incorporated into a foot, as exhibited by Pintupi and Warao. This means that exhaustive parsing is not satisfied. On the other hand, if exhaustive parsing was satisfied, all syllables would be parsed into feet, thus giving rise to a foot consisting of a single syllable: (σσ)(σσ)(σ)[4], or a ternary foot: (σσ)(σσσ). A foot with a single syllable or monosyllabic foot would not satisfy the foot binarity requirement. This conflict between the two requirements can be resolved by a statement such as 'syllables are parsed into feet except final odd numbered syllables'. A better solution is to say that one requirement has priority over another. This is the solution offered by OT.

In Pintupi and Warao, foot binarity has priority over exhaustive parsing which means that satisfying foot binarity is more important than satisfying exhaustive parsing. In some languages the reverse is true; exhaustive parsing has priority over foot binarity. This is shown in Ono (Phinnemore 1985, Hayes 1991):

(4)	(déne)	'my eye'
	(ári)(lè)	'I went'
	(lólot)(nè)	'many'
	(mési)(kène)	'you will sit'

Word-final odd numbered syllables in Ono are parsed into feet, which is contrary to the requirement on foot size, but satisfactory for the requirement on exhaustive parsing. These requirements or conditions on parsing are expressed in OT as constraints. Where there are conflicts between constraints one of these constraints is given priority over the other. Priority is characterised in terms of ranking. If one constraint is ranked over the other the higher ranked constraint must be satisfied. Ranking is discussed in 1.2.2. The requirements on foot size and exhaustive parsing are expressed in the following constraints (McCarthy & Prince 1993a, henceforth M&P):

(5) **FOOT BINARITY (FtBin):** Feet are binary at a syllable or moraic analysis.

(6) **PARSEσ:** syllables must be parsed into feet.

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[3] This could also be interpreted as iterative footing – an unfooted syllable at the edge of a word is left stray.

[4] In some analyses, an odd-numbered syllable at the end of a word is regarded as extraprosodic or invisible to feet.

In Pintupi and Warao, FtBin is ranked above (or is dominant over) PARSEσ which ensures that syllables can only be parsed into binary, and not monosyllabic, feet. The form (σσ)(σσ)σ is well-formed by FtBin. In Ono, PARSEσ is ranked above FtBin which ensures that all syllables are parsed into feet, binary or monosyllabic. The form (σσ)(σσ)(σ) is well-formed by PARSEσ.

In OT, the directionality in foot parsing is captured in a constraint requiring all feet to be as close as possible to the edge of a word. This is Align Foot (AlignFt) (M&P 1993b; Kirchner 1993):

(7) **AlignFt:** A foot is aligned to the left/right edge of a prosodic word.

The location of feet with respect to the edge of a word is specified for each language. Thus, for Pintupi, it is AlignFt-Left, and for Warao, it is AlignFt-Right. As previously discussed, the evidence that feet are oriented to one edge comes from the location of unfooted syllables at the edge of a word. For instance, an unfooted syllable at the right edge can mean foot alignment is to the left edge.

Under AlignFt, every foot is assessed in relation to its distance from the edge of a prosodic word. For Pintupi, the location of feet is assessed in relation to the left edge of the word. To assess the distance from the left edge, the number of syllables are counted. In (8a), the second foot (F2) is two syllables from the left edge and satisfies AlignFt better than (8b,c) where the second foot is three syllables from the edge.

(8) a. (púrling)(kála)tju F2:σσ
b. pu(rlíngka)(làtju) F1: σ;F2: σσσ
c. (púrling)ka(làtju) F2: σσσ

AlignFt ensures that the best output is where one foot is aligned to the edge of a word. Other feet in the word do not satisfy the requirement. When AlignFt has priority over PARSEσ, this will account for languages with one stress per word, as in French **amicalemént** 'friendly', or Turkish **adam-lar-á** ‘to the men’.

To account for languages with alternating stress, PARSEσ must have priority over AlignFt. PARSEσ ensures that as many syllables as possible are parsed into feet. The form in (9a) satisfies this requirement better than (9b) because it has more syllables incorporated into feet.

(9) a. (σσ)(σσ)σ - satisfies PARSEσ but not AlignFt (1 foot is not aligned)
b. (σσ)σσσ - satisfies AlignFt but not PARSEσ (3 syllables are unfooted)

The alignment of feet with prosodic word edges can account for the stress patterns of many languages. In previous metrical (or rule-based) accounts of stress, a stress rule, eg parse stress left-to-right, is stated along with well-formedness conditions, like FtBin. In many cases, the conditions on stress assignment determined the outcome of the rule, and some of these conditions had priority over others, for instance the priority of FtBin over PARSEσ for which a specific statement is required. This conflict between the rules for stress assignment and the conditions on stress assignment, as well as conflict between the conditions themselves, is given a straightforward account in OT. In OT, the motivation for the rule and the conditions on the rule are interpreted as constraints and ranked in a system giving priority to some constraints.

Constraints operate on inputs producing a surface form without the need for step-by-step derivations. In situations where rules are overridden by wellformedness conditions, the necessity for such rules diminishes and given that in many cases the structural description of a process, where A becomes B, follows from general well-formedness constraints on the language, rules become redundant.

In rule-based accounts, rules are sometimes over-ridden by an 'except when' type of statement. This is the case for Pintupi, where the statement for parsing is: syllables are parsed into feet except when the final syllable is an odd-numbered one. Given that feet are universally binary, why would such a statement be necessary? The fact that feet are binary should account for unfooted syllables in Pintupi. However, since there are languages such as Ono, where feet can be monosyllabic word-finally, an 'except when' statement seems necessary. In Ono, an 'except when' statement is not required, but the condition that feet are binary has to be relaxed.

'Except when' statements are necessary to account for the inadequacies of rules which provide no reason for why rules are over-ridden. Nor is there an explanation in rule-based systems for why conditions can be relaxed in some instances. The existence of rules, well-formedness conditions or 'except when' statements obscure priorities exhibited by languages and the differences between languages.

In OT, well-formed outputs are a result of satisfying the constraints that have priority. This contrasts with similar theories where the output is the one that satisifies all constraints. Approaches that incorporate constraint satisfaction include Kisseberth (1970), Haiman (1972), Stampe (1973), Sommerstein (1974), Bird (1990), Bosch and Wiltshire (1993), Goldsmith (1991), Kaye, Lowenstamm and Vergnaud (1985,et seq.), Paradis (1988), Scobbie (1991), Singh (1987).

In OT, well-formedness constraints are ranked on a scale of most to least important. If higher ranked constraints cannot be obeyed, the next best thing is obeying the next condition down the scale. Violation of constraints is possible, but least violation will generate the most well-formed or optimal output.

Constraints that account for the stress patterns of a number of languages are AlignFt, PARSEσ and FtBin. A constraint on the type of foot, iambic (σσ´) or trochaic (σ´σ), is also required. Differences in priority or ranking of these constraints account for the different patterns exhibited by the various languages. The notion of ranking is discussed below.

1.2.2 Ranking

In OT, constraints replace rules in determining the well-formedness of outputs in prosodic processes. Constraints are ranked on a language-particular basis and may be violated. This is in contrast to other constraint-based systems, which do not allow for constraint violation (Goldsmith 1990, 1991, among others). Candidates are evaluated in 'constraint tableau'. Following M&P (1993a) the following representations used in tableaux are adopted (with some modification):

% = optimal candidate (instead of a pointing hand in M&P).
* = violation of constraint.
! = fatal violation; the constraint that is responsible for the non-optimality of a candidate.

A blank box indicates that a constraint is satisfied. In the OT literature, a shaded box in a tableau indicates that a constraint is irrelevant to the fate of the candidate. Shading is not a crucial aspect in tableaux and is not included here.

In the constraint tableaux, constraints are ranked in descending order from left to right. The highest constraint is at the very left of the table, while the lowest is on the right. Ranking order is indicated as A >> B, which is interpreted as: A is ranked higher than B, or A is preferred over B. This is illustrated in the following tableau:

(10) candidate A B

candidate	A	B
% X1		*
X2	*!	

The optimal candidate is the one which does not violate the highest ranked constraint, in this case X1.

If both outputs violate constraint A, then the decision as to which is most optimal falls on B, as shown in (11).

(11) candidate A B

candidate	A	B
% Z1	*	
Z2	*	*!

When there is no violation of A, as in (12) below, B will make the decision on the optimal candidate.

(12) candidate A B

candidate	A	B
% P1		
P2		*!

In many cases, a candidate will violate more than one constraint. This is an instance where constraints conflict. If the conflict is between a specific constraint and a more general constraint, then the specific constraint must be ranked higher than the general one. This ranking is necessary if the specific constraint is to have some effect or seen to be active in the tableau. Prince and Smolensky (1993) term this ranking logic 'Panini's Theorem' (also known as the 'Elsewhere Condition'; see Kiparsky 1973 et seq).

The differences between the stress patterns of the languages discussed above are characterised by the following rankings.

(13) Pintupi, Warao: FtBin >> PARSEσ >> AlignFt
Ono: PARSEσ >> FtBin >> AlignFt
French: FtBin >> AlignFt >> PARSEσ

The fact that monosyllabic feet occur in Ono is due to the ranking of PARSEσ over FtBin, and the fact that only one foot occurs in French is due to the ranking of AlignFt over PARSEσ. This ranking provides a way of explaining why some constraints but not others are violated and thus, the differences between languages in the realisation of outputs.

In rule-based accounts, no straightforward account of these differences is available, nor is there an explanation for why rules can be overridden by constraints. Constraints are turned on and off at particular points in a derivation without motivation for this apart from ensuring that the right output could be derived. Further, we find that some constraints are overridden during a derivation, but cannot be overridden in outputs. One consequence is the introduction of additional principles or rules which complicate the analysis and contribute no insights to the process. These deficiencies are detailed in Chapter 2.

Another advantage of constraints is that language typologies can be constructed and different languages can easily be compared. With the different rankings of the constraints in the languages in (13) we are able to see what gives rise to the differences in stress patterns.

Underlying the system of constraints are the Principles of OT discussed below.

1.2.3 Principles

There are five basic principles of Optimality Theory. These are listed below, followed by discussion of these principles.

(14) Principles of Optimality Theory

a. Universality

Universal Grammar provides a set CON of constraints that are universal and universally present in all grammars.

b. Violability

Constraints are violable; but violation is minimal.

c. Ranking

Constraints of CON are ranked on a language-particular basis; the notion of minimal violation is defined in terms of this ranking. A grammar is a ranking of the constraint set.

d. Inclusiveness

The constraint hierarchy evaluates a set of candidate analyses that are admitted by very general considerations of structural well-formedness. There are no specific rules or repair strategies.

e. Parallelism

Best-satisfaction of the constraint hierarchy is computed over the whole hierarchy and the whole candidate set. There is no serial derivation.

Constraints are said to be universal, such as the requirement for feet to be binary and for feet to align to the edge of a word, and these constraints are contained in the grammars of all languages. Violation of constraints is possible, and languages vary as to which constraints may be violated; for instance, violation of FtBin is allowed in Ono, but not in Pintupi. This variation reflects a difference in importance of some constraints and is expressed through constraint ranking.

As previously mentioned, there are no rules to derive surface forms. Surface forms are selected from a large number of forms on the basis as to how well they satisfy constraints. The constraints assess forms simultaneously which means that prosodic structure is not constructed gradually as in derivational analyses, but that this structure is constructed at the same time.

These principles enable a number of significant changes to the ways output forms are derived. The constraints together with their ranking determine wellformed outputs without the need for step-by-step derivation. In other words, evaluation by the constraints of various outputs is simultaneous.

According to the theory, a Universal grammar must provide the following:

CON.	The set of constraints out of which grammars are constructed.
GEN.	A function where an input string is associated with a potentially infinite set of outputs in line with that string.
EVAL.	A function that comparatively evaluates sets of forms with respect to a given constraint hierarchy, a ranking of CON.

The constraints that form the grammar of a particular language are given by CON. The set of constraints is specified by Universal Grammar and individual languages impose a different ranking on these constraints. There are three broad categories of constraint families which are discussed below. Variation between languages may result from the different ranking of the Universal constraints.

EVAL's role is to assess output candidates and sort them as to how best they satisfy the constraints of the language in question. The candidate that best satisfies the constraints is the one which minimally violates the constraints.

The tableau in (15) illustrates the generation of outputs from an input. From the input /tjurtaya/ 'many', from Pintupi, a number of outputs are produced which are assessed by constraints ranked as FtBin >> PARSEσ >> AlignFt. Many other outputs are possible, but would be ruled out by higher ranked constraints on parsing segments and syllable structure.

(15) /tjurtaya/	FtBin	PARSEσ	AlignFt
a. (tjúrta)(yà)	*!		F2:σσ
b. tjurtaya		σσσ!	
c. tju(rtáya)		σ	F1:σ!
%d. (tjúrta)ya		σ	F1:#

In (15a) the higher ranked constraint FtBin is violated, and because of this violation to lower ranked constraints is irrelevant. PARSEσ rules out (15b) because it has more violations than (15c,d). The decision as to the optimal output is left to AlignFt. As the foot in (15d) is at the left edge of the word and is not in (c), (d) is the optimal candidate.

As shown in (15), EVAL determines the wellformedness of each member of the candidate set through the system of ranked constraints. A candidate is evaluated by how it best satisfies the constraint system. A candidate that least violates the constraints is the optimal candidate, as (15d).

Since constraints evaluate outputs, it is necessary to provide a large set of candidate outputs. GEN produces a set of outputs from a given input. This set is evaluated by the constraints in tableaux from which the best output is selected. Two features are incorporated into Gen: (1) representational primitives of linguistic form, for instance, features; (2) inviolable constraints on linguistic structure, such as the properties of feature geometry (eg root nodes dominate features) and prosodic structure (eg syllables dominate moras, feet dominate syllables etc). While Gen is constrained by these principles when it produces outputs from the input, it has some freedom to improvise for instance, with syllabification, features, deletion of structure, and ordering segments.

M&P (1995) introduce the Correspondence theory of faithfulness in OT which has different consequences for the interpretation of GEN compared to earlier work in OT (Prince & Smolensky 1993; M&P 1993a,b). The essential difference is that GEN is given a correspondence function where outputs are dependent on the input. Part of the motivation for this change came from reduplication where the reduplicant (the copy) is dependent on the base for its phonological interpretation. Here there is a correspondence relation between the base in the output and the reduplicant, the reduplicant occurring only in outputs. In addition, there is the input-output relationship in phonology which looks at whether the identity of the output is the same as that in the input. In both kinds of relationship, a comparison between two forms is made. The formal statement for Correspondence is given as:

(16) Correspondence (McCarthy & Prince 1995)

Given two related strings S_1 and S_2, Correspondence is a relation $\Re$ from the elements of S_1 to those of S_2. An element $\alpha \in S_1$ and any element $\beta \in S_2$ are referred to as *correspondents* of one another when $\alpha \Re \beta$.

The correspondence relation between S_1 and S_2 can vary, but the choice as to the optimal output is determined by the constraints which make up CON. The three main constraint families of CON are: markedness constraints, faithfulness constraints and alignment constraints. Markedness constraints look at how well-formed linguistic structures are, such as segments and syllables. For instance, syllables typically have onsets, and thus a markedness constraint would state that all syllables have onsets.

Faithfulness constraints look at the correspondence between two strings and any variations from the original string, such as reordering of segments, deletions and insertions of features and segments, are penalised. Three general constraint groups occur in the set of faithfulness constraints: MAX, DEP and IDENT. These are briefly described below (M&P 1995):

(17a) **The MAX Constraint family**

General Schema

Every segment of S_1 has a correspondent in S_2.

Specific Instantiations

MAX-BR

Every segment of the base has a correspondent in the reduplicant.
(Reduplication is total)

MAX-IO

Every segment of the input has a correspondent in the output.
(No phonological deletion)

(b) **The DEP Constraint Family**

General Schema

Every segment of S_2 has a correspondent in S_1.
(S_2 is ‘dependent on’ S_1)

Specific Instantiations

DEP-BR

Every segment of the reduplicant has a correspondent in the base.
(Prohibits fixed default segmentism in the reduplicant)

DEP-IO

Every segment of the output has a correspondent in the input.
(Prohibits phonological epenthesis)

(c) **The IDENT(F) Constraint Family**

General Schema

IDENT(F)

Let α be a segment in S_1 and β be any correspondent in S_2.
If α is [γF], then β is [γ F]
(Correspondent segments are identical in feature F)

Specific Instantiations

IDENT-BR(F)

Reduplicant correspondents of a base [γF] segment are also [γF].

IDENT-IO(F)

Output correspondents of an input [γF] are also [γF]

In sum, these constraints regulate the amount of deletion, insertion that occurs in an output string, as well as regulate the identity of features. In the next section the Alignment constraint family of CON is introduced.

1.3 Alignment

Prosodic processes, such as stress assignment discussed above, often make reference to an edge, morphological or syntactic. Theories of the syntax-phonology interface (including Chen 1987, Selkirk 1986) are primarily concerned with the edges of syntactic constituents. In these theories, the edges of syntactic constituents form the basis for constructing phonological representations. The edge of a lexical category may correspond to the edge of a phonological word or phrase.

M&P (1993b) propose to extend the theory to incorporate not only syntactic edges, but also morphological and prosodic edges. They claim that a theory which incorporates all such edges is better equipped to deal with the diverse range of prosodic processes exhibited by languages. Coincidence of the edges of prosodic constituents with other prosodic constituents and morphological ones is interpreted through alignment constraints, where the edge of one constituent is required to align/coincide with another. The relationship between edges is expressed in terms of alignment.

Alignment of prosodic and grammatical constituents is grouped under one family of well-formedness constraints known as Generalized Alignment (M&P 1993b). Coinciding edges may be of a PCat, prosodic category, or of a GCat, grammatical category. The range of alignments are PCat to Gcat, PCat to PCat, or GCat to PCat.

According to M&P, the technical interpretation of the term "edge" is relational, meaning something like "sharing an edge". When two categories share an edge they are aligned.

(18) General Schema for ALIGN (M&P 1993a): In ALIGN(GCat, GEdge, PCat, PEdge), the GEdge of any GCat must coincide with PEdge of some PCat, where GCat = Grammatical Category, among which are the morphological categories, MCat = Root,Stem,Morphological Word,Prefix,Suffix etc, PCat = Prosodic Category = σ, Ft, PW, PhPhrase, etc, MEdge,PEdge = Left, Right.

Under this schema, the edges of grammatical constituents (morphological and syntactic) map onto or align with the edges of prosodic constituents, and the edges of prosodic constituents align with the edges of other prosodic constituents. The alignment of such edges can account for a wide range of processes, including affixation to prosodic constituents, alignment of stress to word edges and augmentation.

The prosodic constituents that are well established are the syllable, foot and prosodic word, shown in (19).

(19) Prosodic Hierarchy PW (prosodic word)
|
F (foot)
|
σ (syllable)

According to the hierarchy, syllables are incorporated into feet and feet are incorporated into prosodic words. Segments are not considered to be prosodic constituents and are therefore not included in the prosodic hierarchy, but they are grouped into syllables which are combined into feet and prosodic words. A prosodic word corresponds to a lexical or grammatical word.

Alignment accounts for the interaction of morphology and phonology at the edges of domains, such as the alignment of foot and prosodic word, or prosodic word and stem. Alignment between prosodic and morphological categories is referred to as 'interface' alignment. Alignment constraints are crucial in accounting for the stress patterns of the languages examined in this thesis, Warlpiri, Wambaya, Dyirbal, Diyari, and Martuthunira. I propose to extend the range to include the alignment of feet with word-internal morpheme edges (Chapter 2), specific morphemes or lexically marked morphemes (Chapter 3), and alignment to intonation phrases (Chapter 4).

In comparison to previous edge-based theories, alignment does not involve rules for constructing representations step-by-step. Instead, alignment operates within a system where prosodic structure is constructed simultaneously. Thus, syllables, feet and prosodic word constituents are all present for simultaneous assessment by constraints.

The benefit of alignment constraints is shown in Chapters 2 and 3, where the interaction of morphemes and feet can be directly accounted for. In previous analyses, this was difficult and was accomplished indirectly through a combination of rules and principles which could not always derive the correct forms and, as a consequence, additional mechanisms were required. Alignment provides an explanation for the stress patterns that is lacking in previous analyses.

1.4 Adjacency

In some of the data examined in this thesis, stress may be binary or ternary alternating, (σ´σ)(σ´σ)(σ´σ) or (σ´σ)σ(σ´σ)σ. The ternary pattern referred to here is not dependent on ternary feet, but on a binary foot followed by an unfooted syllable. In the binary pattern, stress alternates on every second syllable, and in the ternary pattern, stress alternates on every third syllable. The ternary pattern is a variant on the binary one or arises from requirements of stress on initial syllables of word-internal morphemes; for instance, a string of trisyllabic morphemes with stress on the first syllable of each morpheme will generate a ternary alternating pattern (σ´σ)σ-(σ´σ)σ. Only a binary pattern best satisfies both AlignFt and PARSEσ.

AlignFt indirectly ensures that feet are adjacent within a word by requiring all feet to align to the edge of the prosodic word. Any foot not aligned to this edge will violate the constraint. However, outputs where all feet are as close as possible to the prosodic word edge, that is, where they are adjacent, will be preferred, eg (σσ)(σσ)(σσ).

In some cases, though, we want optimal outputs where feet are not adjacent. Feet are not adjacent in ternary alternating systems (except of course if feet are ternary) and they are not always adjacent in languages where word-internal morphology determines the placement of stress, eg (σσ)σ(σσ)σ, (σσ)σ-(σσ)σ.

This raises the issue of how feet can be non-adjacent. If feet can be non-adjacent what determines the distance between feet. I propose that this distance can be determined by notions of adjacency, where adjacency is based on the issue of locality.

It is generally acknowledged in generative grammar that featural processes are typically local. In other words, processes apply between segments or syllables that are adjacent. In theories such as prosodic phonology/morphology, it is believed that locality is a property governing all areas of phonology. This is based on observations that prosodic processes do not count more than two, which means a unit and an adjacent unit. Under this view, locality is used to constrain rules to apply within particular domains.

Processes that involve adjacent elements essentially involve two elements. This underlies the claim that phonological processes count up to two, or rather do not actually count but instead assess elements with regards to adjacency.

When parsing syllables into feet, one syllable is examined with respect to adjacency with another. In both representations in (20), there is one unfooted syllable. In (20a) this is the final syllable, and in (20b) this is the medial syllable. In (20b) the syllables incorporated into the foot are not adjacent. (20a,b) each incur one violation of PARSEσ. <σ> = unfooted syllable.

```
(20)  a.  (σ σ) <σ>        b.  (σ  <σ>  σ)
           |  |                  |        |
           X  Y                  X        Y
```

The syllables X and Y are adjacent in (a) but not in (b). Under notions of adjacency, structures like (σ<σ>σ) are not possible because the syllables in the foot are not adjacent. Such gapped configurations contradict linearity.

If the syllables parsed into a foot are not adjacent, this implies that the foot is not binary and any number of syllables could intervene between the two footed syllables. The result would be overlapping constituents.

I argue that the adjacency rather than alignment can better account for prosodic processes such as vowel harmony and for rhythmic patterns. I show that a constraint is necessary to align one foot to the edge of a word, but that the location of feet within words is dependent on other factors. In some cases, ternary rhythm is a result of requirements for feet to align with morpheme edges or specific syllables in a word. However, in other cases, ternary rhythm is due to a preference for such rhythm over a binary one. To account for ternary rhythm, I argue that some feet must be assessed with regards to adjacency. Under adjacency, feet are assessed as to whether they are adjacent or not.

Some featural phonology involving long distance processes, such as assimilation and dissimilation, are held to be best treated as local phenomena (Archangeli and Pulleyblank 1986, Clements 1985, Sagey 1990, Steriade 1987, among others). Following on from this view, vowel harmony in Warlpiri is analysed (in Chapter 5) as motivated by adjacency. When certain features are adjacent, vowel harmony applies.

Alignment generalises across a constituent, concerned completely with the edges of that constituent. This misses some details occurring within those edges (as discussed in Chapters 4 and 5). In such cases, one-to-one alignment, where one foot aligns to an edge, is preferred over many-to-one alignment, where all feet are required to align to an edge. I argue that one-to-one alignment constraints combined with adjacency constraints are more successful in dealing with some rhythmic phenomena.

In sum, this thesis shows that foot alignment is not just restricted to word edge and alternate syllables, but applies to word-internal morpheme boundaries and lexically specified morphemes. In addition, the location of feet within a word can be governed by adjacency constraints, and such constraints are further supported by vowel harmony. An additional finding is that foot alignment can be affected by the absence of onsets or by the featural quality of onsets leading to an expanded theory of syllable prominence.

Much of the thesis is concerned with the interaction between morphology and phonology in Warlpiri, and for this reason, I briefly discuss some of the morphological features in Warlpiri in the following section.

1.5 Warlpiri

Warlpiri is a Pama-Nyungan language of the Ngumbin-Yapa language group spoken in Central Australia by over 3,000 people. There are four main dialect groups and all dialects are mutually comprehensible. The main distinguishing features of the dialects are pronunciation and vocabulary. Pama-Nyungan languages are commonly referred to as suffixing languages, due to the use of suffixes to mark verbal categories and nominal cases, although there are some exceptions to this general tendency. In contrast, a group of languages called the non-Pama-Nyungan languages tend to use prefixes as well as suffixes.

Warlpiri has an ergative-absolutive case-marking system. Predicate-argument relations are carried by the morphology rather than the syntax. Pragmatic considerations generally determine word order. Tense, case and person number information is carried by suffixes. Verb roots are required to be inflected, (with the exception of the first conjugation verbs where non-past may be indicated by zero or **-mi**) while nominals stems can occur uninflected.

To acquaint readers with the orthography used for Warlpiri an inventory is presented in (21). The corresponding IPA symbol is given in brackets.

(21)	bilabial	apico-alveolar	apico-domal	lamino-palatal	dorso-velar
stops	p (p)	t (t)	rt (⊞)	j (c)	k (k)
nasals	m (m)	n (t)	rn (⬋)	ny (⬊)	ng (☠)
laterals		l (l)	rl (⇧)	ly (⍰)	
flaps		rr (r)	rd (“)		
glides	w (w)		r (☐)	y (y)	

Vowels i, ii, u, uu, a, aa

The parts of speech categories in Warlpiri are nominals, verbs, preverbs, and particles. Nominals includes words which translate into English as adjectives or verbs (eg **want, know**). Preverbs are adverbial elements which combine with a verb forming a complex verb. 'Preverbs add meaning components such as manner, direction and result, quantification, means, or further specification of some property of the object or subject,' (Simpson 1991:34). Included as particles are propositional particles, sentential particles, interjections and conjunctions.

The following are the morphological categories required for word formation: nominal roots, verbal roots, preverb roots, clitics, particles, nominal and verbal suffixes. Clitics may attach to any morphological category without changing categories and, like suffixes, are phonologically subordinated to the word they are attached to. Another similarity to suffixes is that clitic boundaries are equal to suffix boundaries in stress assignment. For further details regarding the morphosyntax of Warlpiri I refer the reader to (Hale 1981,1982,1983), Laughren (1982), Nash (1986), Simpson (1991), Hale, Laughren & Simpson (1996) and references therein.

In Warlpiri, words must consist minimally of a foot and end in a vowel. Well-formedness conditions on the size of words can be stated and incorporated into the constraint system. Languages typically have grammatical requirements by which certain morphological units must correspond to certain prosodic constituents. A number of morphological categories in Warlpiri are required to correspond or align with prosodic words. The words in these categories may occur as phonologically independent words. The requirement for Warlpiri is given in the following constraint (M&P 1991a, 1993a):

(22) MCat = PW, where MCat = root, stem, preverb, particle.

By the Prosodic Hierarchy, in conjunction with FtBin, the minimal form of a prosodic word will be equivalent to a foot. The constraint ensures that roots, stems, preverbs and particles consist minimally of a foot. The constraint excludes other morphological categories, such as suffixes and clitics, which will not surface as prosodic words, as they are not required to correspond to prosodic words. The categories requiring correspondence will differ to some degree across languages.

There is no evidence from phonology for different levels of word-formation. I assume therefore, that after all word-formation occurs, words are subjected to prosodic phonology/morphology. Word-formation produces well-formed morphological and grammatical words. These serve as the inputs to the constraint tableaux where they are assessed by the constraints. In addition, I assume that sentence formation also occurs prior to the application of phonological processes. The model of the grammar is given in (23).

(23) Model of the grammar

Lexicon (underlying representations)

↓

Word formation
Sentence formation

↓

Prosodic phonology/
morphology;
fast speech processes

↓

phonetic implementation

Optimal outputs of the tableaux at the word level are submitted to a phonetic level. The outputs of the phonetic level are phonetic realisations.

1.6 Outline of Thesis

The remainder of this thesis is outlined as follows. Chapter 2 presents an analysis of the stress patterns of Warlpiri which is extended to account for the stress patterns of Wambaya, Diyari and Dyirbal. Polymorphemic words pose particular problems for the alignment of feet to word edges and for parsing syllables into feet. Alignment and adjacency constraints are introduced to account for the pattern of stress in these words. The adjacency constraint is a determining factor in the rhythmic organisation of words where both a binary and ternary pattern are evident. This constraint is also active in phrasal stress. An interesting pattern in the relationship between feet and morphemes is found with variations across the languages investigated.

Chapter 3 examines variation in the stress patterns of specific morphemes in Warlpiri. I show that under the notion of alignment, the means to explain the variation is possible. The data contrasts with that from Martuthunira, which is dealt with through a difference in constraint ranking. I also examine how lexical stress can be interpreted in Optimality Theory.

Chapter 4 examines the nature of rhythmicity in casual speech contexts in Warlpiri. I argue that the alternation of stress within and across words is best accounted for by adjacency requirements on feet. I propose that the theory be modified to allow for one foot rather than all feet in a word to align to a word or intonational phrase edge which, firstly, enables a more straightforward assessment and, secondly, allows for binary and ternary rhythm. The analysis is extended to account for rhythmic alternation within words in Estonian. To account for differences in stress patterns between isolated words and those in phrases, as well as those that exhibit variation in canonical forms, I propose that constraints can be relaxed, thus introducing a novel conception of constraint ranking.

Vowel harmony in Warlpiri is analysed in Chapter 5. I argue that adjacency of features better captures the operation of vowel harmony than an alignment requirement. Requiring adjacency can explain why harmony occurs and why potential harmonising segments are not skipped over. In addition, constraints on identity of features are adopted which accounts for where harmony occurs, what blocks harmony and how. Constraints on identity throw a different light on harmony and can explicitly characterise the commonly observed factor that affixes and not roots undergo harmony. In addition, the constraints allow for a distinction between morphological and phonological harmony. The analysis reveals three main characteristics of harmony: motivation (does harmony require adjacency or not), feature dependency (what feature, if any, is the harmonising feature dependent on) and domain identity (does harmony apply to affixes and/or roots).

Warlpiri is typical of many languages where prosodic words align with feet on their left-edges. In Arrernte, a neighbouring language, misalignment of these prosodic constituents occurs when the word-initial syllable is onsetless. Alignment and adjacency requirements are unable to deal with the facts. I introduce a theory on left edge syllable prominence to account for onset sensitivity which is extended to other languages, enabling an analysis of stress in Arrernte, Spanish, Pirahã and Ngalakan, reduplication in Arrernte and Nunggubuyu, and patterns of allomorphy in Arrernte and Kayteye. The benefit of this theory is that a range of diverse prosodic phenomenon can be accounted for in this theory. An additional benefit is the discovery of another rhythmic dimension.

CHAPTER 2

FOOT ALIGNMENT

2.1 Introduction

One of the basic tenets of Optimality Theory is that there is no serial derivation, that prosodic operations on inputs apply simultaneously (M&P 1993,1994). This is the principle of Parallelism. Parallelism is examined in this chapter in relation to stress assignment in Warlpiri. It will be shown that the analysis of stress supports the theory.

Stress patterns in Warlpiri vary depending on the morphological organisation of a word. In monomorphemic words, stress alternates on every odd numbered syllable. The pattern in polymorphemic words is dependent on the presence of morphemes and the number of syllables in each morpheme. The patterns show that stress is sensitive to morpheme boundaries. To account for these patterns, I assume that each morpheme is a domain for stress assignment. For instance in **(máli)ki-(kìrla)ngu** 'dog-POSS' and **(yápa)rla-(ngùrlu)** 'father's mother-ELAT', stress is on the first syllable of each morpheme. If stress was not sensitive to the presence of morphemes then stress would alternate on every odd numbered syllable.

Not all morphemes receive initial stress. In some cases monosyllabic morphemes are stressed as in **(wáti)ya-(rlà-rlu)**. However in other cases, they are not stressed, as in **(wángka)-ja=(jàna)**. The challenge is to account for these patterns.

Previous accounts of this data have also acknowledged that morphemes constitute stress domains. Nash (1986) formulates a rule that assigns stress to all polysyllabic morphemes. In a modified cyclic analysis, as suggested in Poser (1989), each morpheme constitutes a cycle for stress assignment. The analysis I present in this chapter builds on these insights.

I will depart from previous models in one significant respect. This departure will be in the way the domains of the phonology and morphology are treated. These domains are inextricably linked in Warlpiri and I argue that a successful analysis must treat them simultaneously. In OT, constraints on the interaction between phonology and morphology are simultaneous. In this system, simultaneous interaction provides an explanation for the stress patterns in Warlpiri.

The organisation of this chapter is as follows. The stress patterns in monomorphemic words are presented in 2.2 with discussion of the constraints required to account for these patterns. In 2.3, the stress patterns in polymorphemic words are given. To account for these patterns I propose an alignment constraint to ensure correspondence of morpheme edges with foot edges. The analysis is compared to noncyclic and cyclic models in 2.4. In 2.5, the analysis and constraints introduced are extended to Wambaya, Diyari and Dyirbal. The constraints on parsing syllables into feet are discussed in 2.6. The chapter closes with a summary of the constraints.

The data for the analysis of word stress come from a variety of sources including Nash (1986;indicated by [DGN:page number]) and tape recordings from Berry (1992;[LB]), Breen (1980;[GB]), Laughren (1987;[ML]).

2.2 Stress patterns in monomorphemic words

In this section the stress pattern for monomorphemic words is presented, followed by discussion of the constraints required to account for these patterns. These are general constraints proposed by M&P (1993a,b).

In monomorphemic words, stress falls on the first syllable and on every following odd-numbered syllable. Main stress is on the first syllable.

(1) a. mánangkàrra 'spinifex plain' [DGN:102]
b. kúruwàrri 'variegated' [GB]
c. wápurnùngku 'ghost gum' [GB]
d. kárlarnjìrri 'lizard' [GB]
e. wíjipìrtirli 'hospital' (loan) [GB]

Stress on word-final syllables is not permitted. This means that in trisyllabic words there is only one stress.

(2) a. wúrlampi 'stone knife' [GB]
b. wátiya 'tree' [DGN:102]
c. yújuku 'humpy' [GB]
d. ngípiri 'egg' [GB]

The majority of words in Warlpiri consist of monomoraic syllables; however, some words have syllables with long vowels. According to Nash (1986:65), long vowels occur in the first syllable of nominal and verbal roots, with a few exceptions. Exceptions are when a preverb with a long vowel is reduplicated (3c) and when glide coalescence occurs (3a). Long vowels are always stressed as shown in the following examples:

(3) a. yárdijìinypà-rlu 'black ant sp.'
black ant sp.-ERG [DGN:101]
b. tíirl-pì-nyi 'split down the middle'
(PVB)-bite,hit,kill-NPST [LB]
c. wúurr-wùurr-wàngka-mi 'howling..of wind'
RED- whirr-speak-NPST [GB]

A number of monosyllabic preverbs are of the form CVV, but these are always prefixed to the verb root and never occur finally, eg **jaa-karri-mi** ‘to be agape’.

The account for these patterns is straightforward. Feet are assigned across the word. Syllables are parsed into feet and these feet are binary. The necessary constraints for these facts are introduced below. I will not be concerned with the different levels of stress, that is, primary versus secondary stress levels, in this chapter. This aspect of the analysis is addressed in Chapter 4.

The general observation that feet are binary is captured in FtBin introduced in Chapter 1 and repeated here:

(4) **FOOT BINARITY (FtBin):** Feet are binary under some level of analysis (syllable or mora).

FtBin is a dominant constraint which ensures that only binary feet occur in well-formed outputs. I assume that stress on word-final syllables in words with an odd number of syllables is ruled out by FtBin. Word-final stress could also be ruled out by NON-FINALITY, a constraint introduced by P&S (1993) which has the same effect as extrametricality (see 6.2.2 for discussion) in ruling out prominence on word-final syllables[1].

The type of foot required to parse words is a moraic trochee foot, ie a foot containing two moras where the leftmost one is stressed. (3) shows that the trochaic foot in Warlpiri counts moras. A long vowel contributes two moras. Moras rather than syllables are the minimum stress bearing units in Warlpiri. CVV syllables are heavy, while CV and CVC syllables are light. The relevant foot in Warlpiri is the moraic trochee, which could be:

(5) a. F (σ σ / μ μ)   b. F (σ / μ μ)

```
(5)   a.  F          b.  F
         / \             |
        σ   σ            σ
        μ   μ           μ μ
```

As a constraint this can be stated simply as:

(6) **FOOT FORM (FtForm):** The moraic trochee is the foot form: (μ⇔μ)

In the majority of forms, the syllable is equivalent to the mora. FtForm rules out feet where the head is the rightmost syllable, ie an iambic foot.

The requirement that syllables are parsed into feet is captured in the constraint PARSE-SYLL, introduced in Chapter 1.

(7) **PARSE-SYLL (PARSEσ):** all syllables must be parsed by feet.

PARSEσ expresses the requirement in rule-based metrical phonology that parsing of syllables into feet be exhaustive. In OT, violation of this constraint is possible. In examples such as **(yúju)ku**, the final syllable is not parsed into a foot. This indicates that parsing syllables into feet is dominated by FtBin, and that PARSEσ can be violated. This ensures that syllables are not forced into larger or smaller feet at the expense of binarity. Parsing syllables into feet will be exhaustive in well-formed outputs only if FtBin is also satisfied.

FtForm may not be violated and is therefore a dominant constraint. It thus rules out instances where a single monomoraic syllable is parsed into a foot. FtBin and FtForm are dominant constraints which are not ranked with respect to each other, but are ranked above PARSEσ. The ranking is given in (8).

(8) FtBin, FtForm >> PARSEσ

The effect of the constraint ranking is shown in (9). ( )=foot

[1] Final stresslessness is preferred rhythmically (P&S 1993; Hung 1993) because as pointed out by Hyman (1977) stress is more natural when realised as falling prominence over two syllables.

(9) /yujuku/

	FtBin	FtForm	PARSEσ
%a. (yúju)ku			*
b. (yujú)ku		*!	*
c. (yújuku)	*!	*	
d. (yúju)(kù)	*!	*	

(9a) is the optimal candidate even though it records a PARSEσ violation. This is because all other candidates in the tableau violate the higher ranked constraints FtBin and FtForm. (9b) has an iambic foot which violates FtForm. (9c,d) are ruled out by FtBin because they have non-binary feet. When stress is on the final syllable, as in (9d), both FtBin and FtForm record a violation.

Stress occurs on the initial syllable of a word indicating that feet align to the left edge of a word rather than the right edge. Recall from Chapter 1 that this constraint specifies that the left edge of any foot and the left edge of a prosodic word must be aligned.

(10) **Align Ft,L PW,L (AlignFt):** the left edge of a foot is aligned to the left edge of a prosodic word.

AlignFt is a constraint that assesses violations in a gradient manner. All feet in an output are assessed in terms of their distance from the left edge of a prosodic word. If more than one foot is present in an output, there will always be violations of AlignFt since only one foot can logically align to the left edge of a prosodic word. The closer feet are to the prosodic word edge the more optimal the form is. The number of syllables indicates the distance from the designated edge. Each foot is assessed in this way.

To ensure that as many syllables as possible are parsed into feet, PARSEσ must be dominant over AlignFt. If AlignFt was dominant this would generate optimal candidates with only one foot. The effect of the ranking PARSEσ >> AlignFt is shown in the following tableau. F=foot; #=aligned; []=prosodic word.

(11) /wijipitirli/

	PARSEσ	AlignFt
a. [(wíji)pitirli]	***!	F1:#
b. [wi(jípi)(tìrli)]	*	F1:σ! F2: σσσ!
%c. [(wíji)(pìti)rli]	*	F1:# F2: σσ

(11a) is the least preferred output, as it violates the higher ranked PARSEσ. Both (11b,c) have the same number of violations of PARSEσ. The decision on the optimal candidate falls to AlignFt. In (11b), both feet are further away from the left edge of the prosodic word in comparison to the feet in (11c). (11c) is the optimal candidate; it has one foot aligned to the left prosodic word edge and the second foot is only two syllables from the edge.

AlignFt ensures the alignment of the prosodic categories, foot and prosodic word. For this constraint to be completely effective, that is, to be certain that feet are parsed from the leftmost syllable in a word, it is necessary to ensure that the edge of the prosodic word is in fact at the edge of the word. In **wa[(tíya)]** the first syllable of the stem is not parsed into a prosodic word, although the left edges of the foot and prosodic word are aligned. If segments are not parsed into a prosodic word they have no phonetic content and effectively delete.

Alignment of a prosodic word with a stem is achieved by the interface constraint, AlignL (M&P 1993b).

(12) **AlignL:** the left edge of a stem corresponds to the left edge of a prosodic word.

A stem is a word consisting of a root and any number of suffixes. If the left edge of a prosodic word is aligned at a morpheme boundary within a stem this would violate AlignL, since this boundary is not at the leftmost edge of the stem. AlignL is a dominating constraint which may not be violated and is therefore included in the set of undominated constraints.

(13) AlignL, FtBin, FtForm >> PARSEσ >> AlignFt

In the following tableau '|' indicates a stem edge.

(14) /watiya/	AlignL	PARSEσ	AlignFt
%a. |[(wáti)ya]		*	
b. |wa[(tíya)]	*!	*	
c. |[wa(tíya)]		*	1: σ!

All candidates violate PARSEσ. (14a) is the optimal candidate because it violates no other constraints. In (14b), the stem and prosodic word are not aligned which violates the higher ranked AlignL constraint. The left edge of the foot is not aligned with the left edge of the prosodic word in (14c).

In (14) I have not included outputs which would violate the constraints FtBin and FtForm. The outputs in a given tableau have survived evaluation by higher ranked constraints. The practice of restricting the number of outputs considered in any one tableau will be continued throughout this thesis. Those outputs not included are irrelevant since they incur more violations than the ones considered.

The constraints which account for stress in monomorphemic words have been outlined in this section. In the following section, the stress patterns in polymorphemic words which differ from those of monomorphemic words are discussed.

2.3 Stress in Polymorphemic Words

In polymorphemic words, the first syllable of a polysyllabic morpheme is stressed. If there is a string of monosyllabic morphemes, the first suffix is stressed. I account for these patterns in terms of the alignment of feet with morphemes.

The difference in stress patterns between (15) and (16) is due to the number of syllables in the root, as well as the presence of following polysyllabic morphemes. Where the first morpheme in the word is disyllabic, stress is on the first and third syllable.

(15) a. yápa-rlàngu-rlu 'a person for example'
person-for example-ERG [DGN:101]
b. pírli-ngìrli 'from the hill'
stone,hill-ELAT [LB]
c. jílja-wàrdingki 'sandhill resident'
sandhill-DENIZ [LB]

If, on the other hand, the first morpheme is trisyllabic, stress is on the first and fourth syllable.

(16) a. yáparla-ngùrlu 'from the father's mother'
father's mother-ELAT [DGN:101]
b. yúwarli-ngìrli 'from the house'
house-ELAT [LB]

The following examples show that monosyllabic morphemes do not behave like polysyllabic morphemes. Monosyllabic suffixes cannot make a foot on their own. '=' are clitic boundaries.

(17) a. málikì-rla-kùrlu 'with (something) on a dog'
dog-LOC-PROP [ML]
b. jírramà-rlu=kìrli=pàla 'they two precisely (did something)'
two-ERG=precisely=3dS [LB]
c. wángka-ja=jàna '(someone) spoke to them'
speak-PST=3pNS [ML]
d. mánangkàrra-rla 'in the spinifex'
spinifex-LOC [DGN:102]

When there are strings of monosyllabic suffixes or clitics the first one in the string is stressed, as in:

(18) a. yáma-ngkà=rna 'in the shade I (did...)'
shade-LOC=1sS [LB]
b. pálya-ngkù=rna=lu 'with an adze we (did...)'
adze-ERG=1peS [LB]
c. mánangkàrra-rlà-rlu 'in the spinifex (modifying an Ergative subject)'
spinifex-LOC-ERG [DGN:102]
d. wángka-jà=rna=jàna 'I spoke to them'
speak-PST=1peS=3pNS [ML]
e. wángka-mì=rra=lku=jàla [ML]
speak-NPST=tothere=then=obviously
'obviously (someone) is speaking in that direction now'

(19) a. wátiya-rlà-rlu 'in the tree (modifying an Ergative subject)'
tree-LOC-ERG [DGN:102]
b. máliki-rlì=lki 'the dog (doing...) now'
dog-ERG-now [DGN:115]
c. ngájulu-rlù=lpa=rna 'I was (doing...)'
I-ERG=IMPF=1sS [LB]

The stress patterns in (18) and (19) are like those of words consisting of polysyllabic morphemes in (15) and (16). The second stress is on the third syllable following a disyllabic morpheme, or on the fourth syllable following a trisyllabic morpheme. A sequence of monosyllabic suffixes are treated as if they were one morpheme.

When there is a single monosyllabic suffix attached to a trisyllabic root, the pattern of stress is like that of monomorphemic words.

(20) a. wátiyà-rla 'in the tree'
tree-LOC [DGN:102]
b. wírnpirlì-mi 'whistle'
whistle-NPST [DGN:113]

Trisyllabic suffixes pattern like trisyllabic roots. Stress may or may not be on final syllables depending on the number of syllables in the following suffix, as shown in (21):

(21) a. wárlu-ngàwurrpà-rlu 'fire dwellers'
fire-DENIZ-ERG [ML]
b. wárlu-ngàwurrpa-kùrlu 'with fire dwellers'
fire-DENIZ-PROP [ML]

Since stress is not always located on every alternating syllable, the constraints given in section 2.3 will not derive the attested stress patterns for many inflected words. The following facts must be accounted for:

1. The first syllable of polysyllabic morphemes is always stressed, (σ´σ)σ-(σ`σ)
2. The first monosyllabic suffix in a string of such suffixes is stressed, (σ´σ)σ-(σ`-σ). A monosyllabic suffix is not stressed if there is an immediately following polysyllabic morpheme, (σ´σ)- σ-(σ`σ).

2.3.1 Foot and morpheme alignment

To account for the stress patterns in polymorphemic words, I introduce specific constraints[2]. As noted above, stress is always on the first syllable of a polysyllabic morpheme, **(yápa)rla-(ngùrlu)** 'father's mother-ELAT'. When a monosyllabic and a polysyllabic suffix are present, it is the polysyllabic suffix that is stressed, **(wángka)-ja=(jàna)** 'speak-PST=3pNS'. When there are a number of monosyllabic suffixes, they behave as if they constitute a polysyllabic morpheme in terms of stress, **(wáti)ya-(rlà-rlu)** 'tree-LOC-ERG'. Two facts are evident from these patterns. Firstly, stress is sensitive to morpheme boundaries and secondly, preference is given to parsing the syllables of polysyllabic morphemes into feet over parsing of monosyllabic morphemes. The second fact can be interpreted as a restriction on footing across morpheme boundaries. However, footing across morpheme boundaries must be permitted if strings of unfooted syllables arise.

The pattern of stress is interrupted by the presence of morpheme boundaries. This is particularly noticeable where morphemes consist of an odd number of syllables. A final odd-numbered syllable will not be parsed into a foot if there is a following polysyllabic morpheme. This

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[2] These constraints were first introduced in Berry (1993) and account for the range of Warlpiri data presented in this thesis, some of which have not previously been accounted for in either OT or rule-based analyses.

results in unfooted syllables at the right edge of morphemes. The presence of unfooted syllables suggests that parsing syllables into feet is not exhaustive.

The constraints that capture these observations are:

(22) **Left Edge (LE):** Align the left edge of a morpheme with the left edge of a foot.

(23) **Tautomorphemic Foot (Taut-F):** Feet are tautomorphemic.

(24) **Rhythmic Alternation (RA):** Unfooted syllables must not be adjacent. *σσ.

These constraints are discussed in order, commencing with Left Edge.

2.3.2 Left Edge

Left Edge (LE) demands alignment of feet with morpheme edges and will account for stress on the initial syllables of polysyllabic morphemes, such as in **(yúwa)rli-(ngìrli)** 'from the house'. Where feet are not aligned with respect to morpheme boundaries, a violation to LE will be incurred. For example, in the hypothetical form ***(yúwa)(rlì-ngi)rli**, the left edge of the second morpheme is not aligned with a foot.

In the well-formed example, eg **(yúwa)rli-(ngìrli)**, a foot is aligned with the morpheme, which indicates that LE has priority over AlignFt. Ranking LE above AlignFt will resolve the conflict over constraint satisfaction.

In words where all morphemes have an odd number of syllables, a number of unfooted syllables may occur. In **(máli)ki-(kírla)ngu**, LE is satified but there are two unparsed syllables. This indicates that LE has priority over parsing syllables into feet. LE is ranked above PARSEσ. The ranking so far discussed is:

(25) LE >> PARSEσ >> AlignFt

The tableau in (26) shows the effect of this ranking for the form **yaparla-ngurlu** ' dog-POSS' [yápa⇧♋☠◆👓⇧u][3]. The number 2 or 3 represents the second or third foot in the word.

(26)

	LE	PARSEσ	AlignFt
%a. [(yápa)rla-(ngùrlu)]		*	2: σσσ
b. [(yápa)(rlà-ngu)rlu]	*!	*	2: σσ

(26a) is the optimal candidate even though its second foot is further away from the edge of the prosodic word. In (26b), a foot is not aligned with a morpheme edge and this violates the higher ranked constraint LE. Consequently, this candidate is judged as least optimal.

LE is an interface constraint which accounts for the alignment of feet with morpheme edges. LE differs from the other interface constraint, AlignL, which requires alignment of the left edge of the prosodic word with the left edge of the stem.

[3] IPA symbols are not used in tableaux.

LE demands alignment with morpheme edges but this is not always possible when monosyllabic morphemes are present. The output with the least violations of LE will emerge as optimal. This is shown in (27) for the form **watiya-rla-rlu** `tree-LOC-ERG' [wátiya⇧♋👓⇧◆].

(27)	LE	PARSEσ	AlignFt
%a. [(wáti)ya-(rlà-rlu)]	*	*	2: σσσ
b. [(wáti)(yà-rla)-rlu]	**!	*	2: σσ

In the optimal form (27a), there are fewer violations of LE because a foot is aligned to the edge of a suffix compared to (27b), where there is no alignment of suffixes with feet. LE is a crucial constraint in accounting for stress at morpheme boundaries.

In words with a number of monosyllabic suffixes, feet are always located at the leftmost suffix in the string, as in [(ngáju)lu-(rlù=lpa)=rna]. This footing could suggest that there are two prosodic word structures within the word, eg [(ngáju)lu]-[(rlù=lpa)=rna], where the first suffix following the root was the head of a prosodic word. Consequently, we would expect this to be consistent across all words. However, in [(máli)(kì-rla)-(kùrlu)], the monosyllabic suffix is not stressed, which indicates that it is not in a different prosodic word from the root.

LE demands foot alignment with morphemes, and for this reason, a string of monosyllabic suffixes gives the appearance of being prosodic words. This appearance is superficial, since when only one monosyllabic suffix is present, it is unfooted.

2.3.3 Tautomorphemic Foot

In candidates with monosyllabic morphemes, feet cannot always align to morpheme edges. For example, in **(wángka)-ja=(jàna)** speak-PST=3pNS '(someone) spoke to them', the monosyllabic suffix is not aligned with a foot edge. Preference is given to the alignment of feet with polysyllabic morphemes over alignment with monosyllabic morphemes.

Where a foot is aligned to a monosyllabic suffix as in ***(wángka)-(jà=ja)na**, LE is violated once. LE is also violated once in **(wángka)-ja=(jàna)**. However, in the latter form, feet do not cross morpheme boundaries. To ensure that the edges of feet are kept as much as possible at morpheme edges, Tautomorphemic Foot (Taut-F) is required. This constraint notes when feet cross morpheme boundaries.

Taut-F has priority over PARSEσ and AlignFt, but not with respect to LE. Taut-F and LE do not compete with each other over candidates. This ranking is:

(28) LE, Taut-F >> PARSEσ >> AlignFt

In the following tableau, because there are equal numbers of violations to LE, Taut-F makes the decision on the optimal candidate.

(29) ngajulu-rlu=lpa=rna	LE	Taut-F	PARSEσ
%a.[(ngáju)lu-(rlù=lpa)=rna]	**	*	**
b.[(ngáju)(lù-rlu)=(lpà=rna)]	**	**!	

(29a) incurs fewest violations of Taut-F and is therefore the optimal candidate. PARSEσ has two violations in (29a) but, because it is ranked below Taut-F, it cannot make any decision on these forms. If the ranking of PARSEσ and Taut-F was reversed this would make (29b) optimal. Another possible output is where the last two syllables are unfooted; the fate of such outputs is discussed in section 2.3.4.

In order to be an active constraint Taut-F must be ranked above AlignFt. The effect of this ranking is demonstrated in (30). The form **wangka-ja=jana** 'speak-PST=3pNS' [wá☠kacacàna] is assessed where Taut-F decides on the optimal candidate.

(30)	FtBin	LE	Taut-F	PARSEσ	AlignFt
%a.[(wángka)-ja=(jàna)]		*		*	2: σσσ
b.[(wángka)-(jà)=(jàna)]	*!				2: σσ
c.[(wángka)-(jà=ja)na]		*	*!	*	2: σσ

(30a) least violates the higher ranked constraints and is the optimal candidate. When the monosyllabic suffix is incorporated into a degenerate foot, FtBin is violated as in (30b). When a binary foot is aligned to the left edge of the monosyllabic suffix as in (30c), Taut-F is violated.

Taut-F is not an alignment constraint like LE. Taut-F rules out feet straddling morpheme boundaries. When a foot crosses a morpheme boundary, the syllables in the foot are not in the same morpheme. Adjacent syllables are in different morphemes, (σ-σ). In -(σσ)- , the syllables in the foot are in the same morpheme. Syllables in feet must be tautomorphemic which in turn means that feet must be tautomorphemic.

When there are combinations of polysyllabic morphemes with monosyllabic ones, the Taut-F constraint ensures that feet are aligned with polysyllabic morphemes. This avoids non-aligned feet and morphemes. In some cases, misalignment must occur in order to parse the syllables of monosyllabic suffixes into feet. As long as foot and morpheme misalignment is kept to a minimum, well-formed outputs will be produced.

2.3.3.1 LE and Taut-F

LE and Taut-F overlap in their roles of maintaining alignment. For instance, whenever there is a Taut-F violation, there will also be a LE violation, as shown in ***(wángka)-(jà=ja)na**. The reverse does not have to apply, as for example in **(wángka)-ja=(jàna)**, where there is an LE violation but not a Taut-F violation. Significantly, Taut-F is crucial in these examples where there are the same number of violations to LE. The significance of LE is validated when the same number of Taut-F violations occur, as shown in (31).

(31)	LE	Taut-F	PARSEσ	AlignFt
%a.[(wáti)ya-(rlà-rlu)]	*	*	*	2: σσσ
b.[(wáti)(yà-rla)-rlu]	**!	*	*	2: σσ

Both outputs incur the same number of violations to Taut-F, in which case LE is necessary to rule out (31b).

The outputs ruled out by either Taut-F or LE have one element in common, and this is: a foot straddling the boundary of a polysyllabic morpheme and any other morpheme. These non-optimal outputs are:

(32) *(wángka)-(jà=ja)na
*(yápa)(rlà-ngu)rlu
*(wáti)(yà-rla)-rlu
*(ngáju)(lù-rlu)=(lpà=rna)

Compare these with outputs which, although violate Taut-F and LE, violate them minimally, and are therefore not ruled out.

(33) (pálya)-(ngkù=rna)=lu
(wángka)-(jà=rna)=(jàna)
(ngáju)lu-(rlù=lpa)=rna

Parsing two monosyllabic morphemes into a foot as in (33) is well-formed. In contrast, parsing a monosyllabic suffix into a foot with a syllable from another morpheme is not well-formed. As will be discussed in 2.3.4, such parsing may be forced by higher ranked constraints.

Given that LE and Taut-F share a common element, one solution to the overlapping problem is to combine them into a single constraint. We want to rule out foot parsings such as (σσ)(σ-σ) and (σσ)-(σ-σ)σ, but not (σσ)-(σ-σ). The generalisation that captures this is: morphemes may not be split between feet. I will refer to this generalisation as No Split.

No Split would allow monosyllabic morphemes to be combined into a single foot, eg -(σ-σ)-, since they comprise a single syllable. However, No Split would not allow a syllable of a polysyllabic morpheme to be parsed into a foot with the syllable of another morpheme, eg *(σσ)(σ-σ), since this splits a morpheme. No Split could be interpreted as a constraint, replacing LE and Taut-F.

LE is an alignment constraint requiring alignment with morphemes. Taut-F ensures that this alignment is with polysyllabic morphemes. In words consisting solely of polysyllabic morphemes, either LE or Taut-F would be sufficient to guarantee alignment. However, when there are monosyllabic morphemes which require alignment, both LE and Taut-F or No Split are necessary.

In languages with similar stress patterns, such as Diyari and Dyirbal (discussed in 2.5), No Split is unable to account for the range of facts. In these cases, No Split is either too specific or not specific enough.

In Diyari, strings of monosyllabic feet cannot be parsed into feet *-(σ-σ)-. No Split is unable to rule out such instances of foot parsing. In Dyirbal, while root and suffix cannot be split between feet, other morphemes can be. However, No Split would rule out all instances of morpheme splitting.

LE and Taut-F can account for a larger range of stress patterns and would have wider universal application than No Split. It is on these grounds that I reject the No Split generalisation.

An alternative analysis to Taut-F would be to require recursive prosodic word boundaries (Kager pc). The right edge of the prosodic word could then align with the right edge of stems, as in [(pa.lya)]-ng.(ku.=rna.)]=lu.] 'with an adze we (did..)'. However, as is evident, syllabification across prosodic word boundaries occurs, eg **.lya)]-ng.**, resulting in overlapping prosodic constituents. As discussed in 2.3.2.1, harmony does not cross prosodic word boundaries and requiring recursive prosodic word would fail to account for this fact. An additional disadvantage is that verb stems would require a different explanation which is not justified given the data.

2.3.4 Rhythmic Alternation

The ranking of Taut-F above PARSEσ is necessary to ensure that alignment of feet with morphemes occurs in preference to parsing syllables into feet. One consequence of this ranking is the possible lack of foot parsing. The nonparsing of syllables into feet, particularly when there are monosyllabic suffixes, is an effect of Taut-F.

The solution to the non-parsing problem is to introduce a more specific parsing constraint and rank it above Taut-F. This is Rhythmic Alternation (RA), which requires one of two adjacent syllables to be parsed into a foot. Where there is a sequence of two syllables, eg σσ, one of these syllables must be in a foot, eg σ)σ or σ (σ.

RA is concerned with adjacency. It assesses whether one of two adjacent syllables is parsed into a foot.

(34)

	RA
(σσ)	
σ)σ	
σσ	*

This constraint is similar to a constraint called Parse-Syllable-2 which Kager (1994) independently introduces to account for ternary alternating systems exhibited by languages such as Estonian and Chugach. I show in Chapter 4 that RA is a motivating constraint in the rhythmic organisation of the language.

In a word with a monosyllabic suffix, for example, **(wáti)(yà-rla)**, Taut-F is violated. Taut-F is not violated if the final two syllables are unfooted, as in ***(wáti)ya-rla**. PARSEσ cannot rule out the latter form because it is ranked below Taut-F. It is in these cases that Rhythmic Alternation makes a crucial contribution. By RA, a form with adjacent unfooted syllables is ill-formed. In order to rule out such ill-formed outputs RA needs to have priority over Taut-F. This will entail ranking RA above Taut-F.

(35) RA >> LE,Taut-F >> PARSEσ >> AlignFt

Consider the following tableau showing the word **watiya-rla** `tree-LOC' [wátiyà⇧a]:

(36)

	RA	LE	Taut-F	PARSEσ
%a. [(wáti)(yà-rla)]		*	*	
b. [(wáti)ya-rla]	*!	*		**

(36a) is the optimal output because it does not violate the higher ranked RA. PARSEσ is ranked below LE and Taut-F and, consequently, has no say in determining the optimal candidate. Without RA, (36b) would be optimal.

If LE and Taut-F were not required to align feet with morpheme edges, PARSEσ would ensure that syllables are parsed into feet. As I have argued, LE and Taut-F are crucial constraints accounting for morpheme and foot alignment.

In outputs where there are no violations to Taut-F, RA is essential as shown in (37) with the word **jirrama-rlu=kirli** `two-ERG=precisely' [círamà⇧ukì⇧i]:

(37)

	RA	Taut-F	PARSEσ	AlignFt
%a. [(jírra)(mà-rlu)=(kìrli)]		*		2: σσ
b. [(jírra)ma-(rlù=ki)rli]		*	**!	2: σσσ
c. [(jírra)ma-rlu=(kìrli)]	*!		**	2: σσσσ

(37c) violates the higher ranking constraint RA and thus, is judged as the least preferred output in this tableau. There are two PARSEσ violations in (37b), it is therefore ruled out in favour of (37a). Without RA, (37c) would be the optimal candidate since it does not violate Taut-F.

In (37) RA and AlignFt make the crucial decisions on outputs. This is also evident in the next tableau with the word **palya-ngku=rna=lu** 'adze-ERG=1peS' [pá◈a☠kù✐alu].

(38)

	RA	LE Taut-F	PARSEσ	AlignFt
%a.(pálya)-(ngkù=rna)=lu		** *	*	2:σσ
b.(pálya)-ngku=(rnà=lu)		** *	*	2: σσσ!
c.(pálya)-ngku=rna=lu	**!	***	***	

In (38), AlignFt has the final say. (38a) is the optimal candidate as the second foot in the word is closer to the word edge than the same foot in (b). (38c) is ruled out by the higher ranked RA.

In some cases the conflict is between Taut-F and AlignFt. This is shown in (39) with the word **ngajulu-rlu=lpa=rna** 'I-ERG=IMPF=1sS' [náculu⇧ùlpa✐a].

(39)

	RA	LE Taut-F	PARSEσ	AlignFt
%a. [(ngáju)lu-(rlù=lpa)=rna]		** *	**	2: σσσ
b. [(ngáju)(lù-rlu)=(lpà=rna)]		** **!		2: σσ
c. [(ngáju)lu-rlu=(lpà=rna)]	*!	** *	**	2: σσσσ

Once RA rules out (39c), the decision on the optimal output is left to Taut-F and AlignFt. (39b) incurs more violations of Taut-F than (39a) and thus (a) emerges as the optimal output.

PARSEσ is not able to rule out an adjacent sequence of unparsed syllables in preference to nonadjacent unparsed syllables. RA, on the other hand, notes instances of unfooted adjacent syllables. PARSEσ simply notes how many syllables have not been parsed into feet. It is not concerned with the location of unparsed syllables, whether or not they are next to each other, as for example in (40).

(40) ngajulu-rlu=lpa=rna

	PARSEσ
a. [(ngáju)lu-(rlù=lpa)=rna]	**
b. [(ngáju)lu-rlu=(lpà=rna)]	**

RA is a more specific constraint on parsing and rules out candidates such as those in (40b), where unfooted syllables are adjacent. PARSEσ cannot decide on either candidate. RA cannot be violated and must be a dominant constraint. The fact that not all syllables are parsed into feet indicates that exhaustive parsing is not an absolute requirement in Warlpiri.

Unfooted syllables between feet create ternary rhythmic patterns, while adjacent feet create a binary rhythm. In Warlpiri, both patterns are attested. RA predicts the existence of ternary patterns, while PARSEσ predicts that only binary patterns are possible. FtBin and RA ensure that rhythm is restricted to binary and ternary alternations. Rhythmic patterns in Warlpiri are discussed in more detail in Chapter 4.

2.3.5 Other Polymorphemic Words

The stress pattern for reduplicated and compound words is consistent with that of other polymorphemic words. Stress is regularly located on the initial syllable of polysyllabic morphemes and prosodic words. RED=reduplicated portion.

(41) Reduplicated Words

a.	yárli-yàrli-ni	'wetting'
	RED -wet -NPST [DGN:139]	
b.	wúurr-wùurr-wàngka-mi	'howling..of wind'
	RED- whirr-speak-NPST [GB]	
c.	pírilyi-pìrilyi	'black beetle;pupil of eye'
	RED -charcoal [GB]	
d.	ngáti-nyànu-ngàti-nyànu-rlu	'their mothers'
	RED-mother-POSS-ERG' [DGN:134]	

(42) Compounds

a.	púnju-ngà-rnu	'drank the whole lot'
	PREVERB-eat,drink-PST [GB]	
b.	máarrpà-rni-mà-ni-nja-yà-ni	
	flash-hither-INF-go-NPST [LB]	'coming flashing (lightening)'
c.	wápa-njà-ngu-wàpa-njà-ngu	'from walking'
	RED- walk-INF-NOMIC [DGN:135]	

There are also a large number of unproductive reduplications and compounds in Warlpiri. The stress pattern of these forms will be addressed in the next chapter.

2.3.6 Summary

As shown throughout this section, in accounting for the patterns of stress in polymorphemic words, the presence of morphemes and the number of syllables in these morphemes must be acknowledged. The patterns are straightforward: stress is on the first syllable of every polysyllabic morpheme or on the first monosyllabic suffix in a string of monosyllabic suffixes. In the absence of morpheme boundaries, stress alternates on every other syllable. I have proposed specific constraints that account for the stress patterns LE, Taut-F, and RA.

These constraints are ranked above AlignFt and PARSEσ and ensure foot alignment with a suffix, as in **(yápa)rla-(ngùrlu)**, rather than the iterative footing demanded by AlignFt.

Monomorphemic words have no internal morpheme boundaries and as long as the left edge of the word is aligned with a foot, they will always satisfy LE and Taut-F.

In some cases we can see that LE and Taut-F reflect something of the morphological structure of a word. For instance, in a word consisting of two polysyllabic morphemes, such as **(máli)ki-(kìrla)ngu** dog-POSS, the two morphological domains are clearly delineated by stress. This delineation is overridden by RA, however, if otherwise adjacent unfooted syllables arise, as in ***(wáti)ya-rla.**

In some cases it will be impossible to satisfy LE completely, in which case ensuring that feet do not straddle morpheme boundaries of any kind is imperative. For instance, **(wángka)-ja=(jàna)** is well-formed but ***(wángka)-(jà=ja)na** is not.

Taut-F does not discriminate against the kinds of morpheme boundary that feet may straddle, but demonstrates that morphemes are domains for stress assignment. All morphemes are word-like in this respect, including a sequence of monosyllabic suffixes. Such a sequence is parsed into a foot in words such as **(wáti)ya-(rlà-rlu)**, rather than ***(wáti)(yà-rla)-rlu**. Priority is given to parsing the monosyllabic suffixes into feet.

Other languages, such as Diyari (discussed in 2.5), do not tolerate feet which straddle morpheme boundaries, even if that means having adjacent unfooted syllables.

The crucial constraints for Warlpiri are RA, LE and Taut-F. Their ranking with regard to the more general constraints is:

(43) FtBin, AlignL, FtForm, RA >> LE, Taut-F >> PARSEσ >> AlignFt

The crucial constraints are necessary to account for the more specific cases of morpheme and foot alignment and foot parsing. The inter-relationship between the morphology and phonology is expressed in LE and Taut-F. This inter-relationship is successfully captured in a system that allows for consideration of outputs in parallel and for minimal violations of constraints. As I argue below it is these aspects which provide the most convincing analysis of the stress patterns in Warlpiri.

2.4 Comparison with Alternative Analyses

In this section I consider how other accounts compare with OT. The focus is on derivational analyses.

2.4.1 A Noncyclic Analysis

One of the benefits of OT is that all prosodic structure is built simultaneously. In a serial derivation approach prosodic structure is built gradually. For instance, segments are parsed into syllables, then syllables are combined into feet, and feet are then grouped into a prosodic word. This step-by-step approach of building prosodic structure puts the analysis at a disadvantage, as I will show.

We will consider a serial derivation assuming the constraints given in the analysis presented in 2.3. In a derivational analysis, prosodic word structure is not present at the time that feet are parsed. Consequently, constraints such as AlignL and AlignFt are not applicable at this stage. AlignFt ensures that feet are parsed as close as possible to the edge of the prosodic word, which effectively ensures that feet are iteratively parsed. AlignFt can only apply when prosodic word structure is present. Thus, in a derivational analysis iterative foot parsing must be generated by rule. This rule is given below.

(44) Rule 1: within morphemes, syllables are parsed into trochaic feet left-to-right.

The rule must specify the domain of parsing to ensure that feet are sensitive to morpheme boundaries, as in (45).

(45) /maliki-kurlangu/ dog-POSS
Rule 1: (máli)ki-(kìrla)ngu

By Rule 1, a monosyllabic morpheme cannot be parsed into a foot on its own. Thus, to ensure that a string of monosyllabic morphemes are parsed into feet, an additional rule is required stating that unfooted syllables are parsed into feet.

(46) Rule 2: Parse unfooted syllables into feet left-to-right.

(47) /yama-ngka=rna/ shade-LOC=1sS
Rule 1: (yáma)-ngka=rna
Rule 2: (yáma)-(ngkà=rna)

Problems arise when there are a number of monosyllabic suffixes following a morpheme with an odd number of syllables. For instance, by Rules 1 and 2, /watiya-rla-rlu/ would be parsed as ***(wáti)(yà-rla)-rlu** rather than **(wáti)ya-(rlà-rlu)**. The solution to this problem is to ensure that syllables within a morphological domain are exhaustively parsed into prosodic structure. This can be achieved by Stray Syllable Adjunction (Liberman and Prince 1977, Hayes 1981, among others) where a stray (unfooted) syllable is adjoined to preceding foot.[4]

(48) Stray Syllable Adjunction: A stray syllable within a morpheme domain is adjoined to a preceding foot in the morpheme.

(49) /watiya-rla-rlu/ tree-LOC-ERG
Rule 1: (wáti)ya-rla-rlu
Stray Adjunction: (wátiya)-rla-rlu
Rule 2: (wátiya)-(rlà-rlu)

A consequence of adjoining stray syllables is having to reassociate a stray adjoined syllable to a foot via a kind of rhythmic principle, as suggested in Berry (1991). This means that some feet have to undergo restructuring, as shown in (50).

(50) /watiya-rla/ tree-LOC
Rule 1: (wáti)ya-rla
Stray Adjunction: (wátiya)-rla
Rule 2: n/a
Restructure: (wáti)(yà-rla)

---

[4] Another solution following Hewitt (1991) is to parse stray syllables into a maximal minimum word (ie a minimum word plus a single light syllable), as proposed in Berry (1991). This solution avoids the creation of ternary feet.

The form after stray adjunction is an ill-formed rhythmic structure. The final syllable cannot stray adjoin to the preceding foot, since this foot already consists of three syllables. As a result, re-footing is forced.

The output in (50) is what would result from a general stress rule. The processes of stray adjoining and restructuring, while superficial and non-explanatory, are necessary steps in a derivational analysis. In (50) it is only after stray adjunction that we can see when restructuring is required, because it is only then that the other unfooted syllables are considered. If there is more than one syllable, these will be parsed into feet, as in (49) **(wátiya)-(rlà-rlu);** if there is only one syllable; then restructuring is required, as in (50). If it was possible to see the number of syllables in a morpheme or the number of monosyllabic suffixes in a string, this would avoid the need for adjunction and restructuring.

This is possible in OT, where the output in (50) is achieved in a single simultaneous application of constraints, without the need for readjustments. In addition, the observation that stress is dependent on morpheme boundaries is captured and not obscured in OT, a point also noted by Kager (1993b). Another disadvantage is that ternary feet are created and are only required to ensure all syllables are exhaustively parsed into feet.

Additional problems are encountered with certain monosyllabic morphemes. These are monosyllabic verb roots, and a few monosyllabic suffixes (discussed in Chapter 3) which attract stress in certain contexts. In previous accounts (such as Nash 1986) these forms were assigned monosyllabic feet, because as monosyllables they will not be parsed by Rule 1. Assigning monosyllabic feet to them will therefore ensure that they are stressed. Monosyllabic feet never surface in outputs and thus an additional mechanism would be needed to ensure that monosyllabic feet delete or adjoin to other feet.

Monosyllabic feet also violate FtBin. We might consider that such violation is permitted prior to foot deletion or adjunction. In sum, FtBin is violated to ensure that domains are exhaustively parsed and specific morphemes are assigned stress. However, there is no evidence to suggest that ternary or monosyllabic feet are prosodic constituents in Warlpiri.

In a derivational analysis, Stray Adjunction, foot restructuring, ternary and monosyllabic feet are the only ways to account for the behaviour of monosyllabic morphemes. Sometimes these morphemes constitute a domain for stress assignment (eg specific morphemes or a string of morphemes) and sometimes they do not (eg on their own).

Stray Adjunction, foot restructuring and assigning degenerate feet to monosyllabic verb roots are conditions on parsing, and can be characterised in the following statements: If an unfooted syllable occurs within a domain, then adjoin it to a preceding foot; If stray adjunction were to create a quaternary foot, then restructure the foot; If a monosyllabic verb root is not parsed, assign it a degenerate foot.

As noted by Prince & Smolensky (1993) 'if..then' conditions are characteristic of systems which combine well-formedness conditions with rules. A rule may say to do X, but if a condition would be violated, then do not do X, or do something else. Here two conditions are considered relative to each other, but not relative to other conditions in the analysis. This obscures the priorities between all the conditions and forces the analysis to proceed step-by-step. For instance, stray adjunction is not considered in relation to foot restructuring, since restructuring is a consequence of stray adjunction. Stray adjunction would not need to happen if it was known when adjunction was unnecessary, and if that could apply then restructuring would also be unnecessary.

In OT, priorities are explicitly interpreted as dominance of some conditions over others. Conflict between all conditions is resolved through ranking. Since in OT, all constraints assess simultaneously, the interaction between a number of conflicting constraints can be captured.

The disadvantage of a derivational analysis is that conditions and non-binary feet have to be introduced which do not contribute to our understanding of the process of stress assignment. They are stop-gap measures needed during the derivational process. In OT, in contrast, these conditions are unnecessary since it achieves what no other model can, that is, a virtual 'look-ahead' system. For instance, the number of syllables in morphemes and the number of monosyllabic suffixes can be ascertained through the simultaneous operation of constraints on fully formed words.

2.4.2 Cyclic Analysis

In a standard cyclic analysis, morphological and phonological operations are interwoven. After each morphological operation, a form is submitted to the phonology and then resubmitted back to the morphology. Each cycle of affixation constitutes a phonological domain and on each cycle phonological rules are reapplied. In this system, an input such as watiya-rla 'tree-LOC' would go through two cycles[5].

(51) cycle 1 (wáti)ya
cycle 2 (wáti)(yà-rla)

In other morpheme combinations, where some morphemes have an odd number of syllables, the cyclic model is unable to generate the attested stress patterns, as shown in (52).

(52)	UR	/watiya-rla-rlu/	/yaparla-ngurlu/
	cycle 1	(wáti)ya	(yápa)rla
	cycle 2	(wáti)(yà-rla)	(yápa)(rlà-ngu)rlu
	cycle 3	(wáti)(yà-rla)-rlu	
		*wátiyàrlarlu	*yáparlàngurlu

One solution to this problem is to carry over stress assigned on a previous cycle, and stipulate that each new morpheme is subject to phonological rules, rather than the entire string (as in Poser 1990). This will mean that rules apply only to the morpheme added at each cycle. Parsing monosyllabic morphemes would require additional specifications. This applies whether they are to be parsed into degenerate feet or left until all morphology is completed. Once again problems with monosyllabic suffixes and morphemes with an odd number of syllables are encountered.[6] Very much the same 'if..then' conditions required for the noncyclic analysis would be necessary.

The drawback with a standard cyclic analysis, is that the morphological organisation of the whole word is only known after the final cycle. To overcome this, the analysis would have to be modified to ensure that each morpheme is a domain for stress assignment. Such a move undermines the essence of a cyclic analysis.

In derivational analyses, monosyllabic suffixes are left to be dealt with by additional rules after polysyllabic morphemes have been parsed. In OT, the conflict between the phonological and morphological requirements of the stress system are addressed at the same time. This is essentially

[5] Here the root constitutes a cycle, although not all cyclic analyses have a root cycle.

[6] Poser's analysis would not work for words in Warlpiri consisting of a root with an even number of syllables and an uneven number of monosyllabic suffixes ie σσ-σ-σ-σ. His analysis assigns monosyllabic feet to these suffixes which then are formed into binary feet by joining them together right-to-left. Any remaining monosyllabic feet form a ternary foot with a preceding foot which would produce the unattested pattern *σ´σ-σ-σ`-σ

what makes the OT analysis successful and also the superficial structures (monosyllabic feet or ternary feet) and rules are not required. Once we know what the constraints are on the stress patterns, the priority of each constraint is then established. All the constraints assess an output simultaneously and the output that best satisfies these constraints will be the preferred output.
In cyclic and noncyclic analyses, stress assignment occurs by the application of rules step-by-step. If rules are interpreted as conditions on outputs, a more satisfactory account of the stress patterns is provided. OT provides such an account.

The constraint system OT provides allows for effective comparison with other languages. This is shown in the following discussion of the stress patterns in a number of languages.

2.5 Constraint Application in Other Languages

LE, Taut-F and RA are crucial constraints in generating the attested stress patterns in Warlpiri. Other languages submit to a similar analysis. Many other Australian Aboriginal languages display sensitivity to morphological edges in the location of stress. Analyses of the stress patterns of some Australian languages, for example, Diyari (Austin 1981), Dyirbal (Dixon 1972) and Wambaya (Nordlinger 1993) show that feet are sensitive to morpheme boundaries. In this section, the constraints-based analysis proposed here is extended to these languages. We will see that the languages vary as to whether morpheme boundaries may be crossed or not.

2.5.1 Wambaya

Wambaya (Nordlinger 1993) is a non-Pama Nyungan language and a member of the West Barkly language group spoken in north central Australia. The stress patterns in Wambaya are similar to those of Warlpiri, with the exception that monomoraic roots are stressed and long vowels arising from glide deletion are not stressed.

In monomorphemic words with short vowels, stress falls on the initial syllable and every following alternate syllable. Main stress falls on the first syllable of a word and word-final stress is not permitted. The initial syllable of a polysyllabic morpheme and the first suffix in a string of monosyllabic suffixes receive stress. These patterns are shown in the following examples:

(53)	a. gáguwi-nì-ni	'fish-I:nAbs-LOC'[7]
	b. búgayì-rna	'big-II:Abs'
	c. náyida	'woman'
	d. gályurrìngi-ni-nmànji	'water-I:nAbs-ALL'
	e. dágumaj-bàrli	'hit-Agnt:I:Abs'

The constraints introduced for Warlpiri will account for the forms in (53), but additional constraints are required to account for the words in (54).

(54)	Long vowels and verb roots	
	a. galáa	‘bone’
	b. gardáala	‘gidgee tree’
	c. jány-bu`lu	‘dog-DU’

[7] Abbreviations are: I = class I (masculine gender); II = class II (feminine gender); Abs = absolutive gender suffix; nAbs = non-absolutive gender suffix; ALL= allative case; Agnt= agentive nominaliser; DU=Dual.

Long vowels in Wambaya can be located anywhere in the word, in contrast with those in Warlpiri which are typically located in the initial syllable of the word. This requires the constraint Weight-to-Stress (P&S 1993) which demands that heavy syllables are parsed into feet. Ranked above LE and AlignFt, Weight-to-Stress will ensure the optimal forms are those with stressed heavy syllables.

To account for the monosyllabic roots, an additional constraint is required to ensure they are assigned monomoraic feet. This can be achieved by demanding that the edges of one foot and the edges of a root are aligned as stated in the following constraint.

(55) **Align Root (AlignRt$_{\sigma}$)**: The left and right edges of a monosyllabic root correspond to the left and right edges of the same foot.

This constraint is specific to monomoraic roots to avoid the possibility of ternary feet, where the edges of a trimoraic root would align with those of a ternary foot (σσσ), occurring in optimal outputs. It is similar to a constraint introduced by Kager (1993b) to account for stress patterns in Dyirbal (see section 2.5.3), except that in Dyirbal it is not specific to monomoraic roots.

AlignRt$_{\sigma}$ is not ranked with respect to FtBin and consequently other constraints decide on well-formed outputs allowing for monomoraic feet but ensuring that these are confined to verb roots. The constraints and ranking order is as follows:

(56) Weight-to-Stress, RA >> AlignRt$_{\sigma}$, FtBin >> LE,Taut-F >> AlignFt

Some polymorphemic words in Wambaya undergo glide deletion at a morpheme boundary producing a long vowel which, however, is not stressed like underlying long vowels. Instead, it appears that the long vowel is recognised as a sequence of short vowels with an intervening morpheme boundary because stress occurs on the vowel at left edge of the morpheme, as shown in (57).

(57) darranggu-wulu ‘tree-DU’
dá.rrang.gu.u`.lu

I assume that the vowels in the vowel sequence seen in (57) are syllabified into different syllables, and LE will ensure that stress aligns to the left edge of the morpheme. An Identity constraint will ensure that underlying long vowels surface as such in well-formed outputs and accounts for the behavioural difference between these vowels and those that arise from glide deletion.

With some exceptions, almost the same constraints and ranking order proposed for Warlpiri are also required by Wambaya, eg RA >> (AlignRt$_{\sigma}$, FtBin) >> LE,Taut-F >> AlignFt. The additional constraints are the exceptions and the only ranking difference is that FtBin is ranked below RA. This means that many stress patterns are accounted for by the same constraints as those for Warlpiri, as shown in the next tableau.

(58) gáguwi-nì-ni	RA	LE	Taut-F	AlignFt
%a. (gágu)wi-(nì-ni)		*	*	F2:σσσ
b. (gágu)wi-ni-ni	*!	**		
c. (gágu)(wì-ni)-ni		**!	*	F2: σσ
d. ga(gu´wi)-(nì-ni)		**!	*	F1: σ; F2:σσσ

RA and LE decide on the candidates ensuring that (58a) is the optimal output. In the next tableau, the operation of AlignRt$_\sigma$ is demonstrated.

(59) jany-bulu	RA	FtBin	AlignRt$_\sigma$,	LE	Taut-F
%a. (jány)-(bu`lu)		*			
b. (jány-bu)lu			*	*!	*
c. jany-(bu´lu)			**!	*	
d. jany-bulu	**!		**	**	

The same number of violations are incurred by (59a) and (59b) for FtBin and AlignRt$_\sigma$ and the decision is left to LE. If a verb root is not aligned at the left and right edges two violations are incurred as for (59c).

Since AlignRt$_\sigma$ is specific to monomoraic roots it has no effect on longer roots such as dágumaj-bàrli, as shown in the following tableau.

(60)	RA	FtBin	AlignRt$_\sigma$	LE	Taut-F
%a. (dágu)maj-(bàrli)					
b. (dágu)(màj)-(bàrli)		*!			
c. (dágu)(màj-ba)rli				*!	*
d. (dágumaj)-(bàrli)		*!			
e. (dá)gumaj-(bàrli)	**!				

As (60a) incurs no constraint violations it is the optimal output.

2.5.2 Diyari

The data from Diyari, originally given in Austin (1981), have been previously analysed by a number of linguists (including Poser 1990, Halle and Kenstowicz 1991, Idsardi 1992). A recent analysis of Diyari, Dyirbal and Gooniyandi by Crowhurst (1994) has, independently, proposed an analysis along similar lines to the one presented here. With the exception of RA, the constraints and ranking are the same in both Crowhurst and my analysis. In Crowhurst, Morpheme-Foot-Left: Align(Morpheme,L, Foot, L) corresponds to my LE. As will be shown, Taut-F is ranked higher than LE in Diyari.

Diyari has very similar stress patterns to Warlpiri with one exception, which is that monosyllabic suffixes are not incorporated into feet. In (61) we see examples of words whose stress patterns are the same as those for Warlpiri[8].

(61)	a. (pína)du-(wàrda)	'old man-PL'
	b. (ngánda)(wàlka)	'to close'
	c. (kánha)-(wàra)-ngu	'man-PL-LOC'
	d. (kárna)-nhi-(màtha)	'man-LOC-IDENT'
	e. (yákal)ka-(yìrpa)-(màli)-rna	'ask-BEN-RECIP-PART

[8] Diyari has an additional place series, the lamino-dentals. These are orthographically indicated as th,nh,lh.

The following examples show that monosyllabic suffixes are not parsed into feet in contrast to Warlpiri.

(62) a. (púlyu)du-nhi 'mud-LOC'
b. (máda)-la-nthu 'hill-CHARAC-PROP'

From these examples it is clear that the constraint RA is not a dominating constraint in Diyari, as adjacent unfooted syllables are permitted in polymorphemic words. Given that feet are aligned with polysyllabic morphemes, Taut-F must be ranked above AlignFt and RA (here we can replace RA with PARSEσ). Taut-F must also be ranked above LE to ensure that outputs where monosyllabic suffixes are parsed into feet are not optimal.

(63) Constraint Ranking for Diyari
Taut-F >> LE >> RA >> AlignFt

The effect of this ranking is shown in (64).

(64) mada-la-nthu	Taut-F	LE	RA	AlignFt
%a. (máda)-la-nthu		**	*	
b. (máda)-(là-nthu)	*!	*		2:σσ

A foot which crosses morpheme boundaries is not tolerated in Diyari. Unfortunately, there are no monosyllabic roots in Diyari which might prove an exception to this prohibition. (64a) is the optimal output even though there are violations of LE and RA. (64b) violates the higher ranked Taut-F and is thus the non-optimal output.

The hypothetical constraint No Split (feet may not be split by morphemes), introduced in section 2.3.3.1, would not rule out (64b). While such forms are acceptable in Warlpiri, they are not acceptable in Diyari. Taut-F is crucial in ruling out all instances of feet crossing morpheme boundaries in Diyari. This is the situation in the next tableau, where parsing a monosyllabic suffix into a foot violates Taut-F.

(65) karna-nhi-matha	Taut-F	LE	RA
%a. (kárna)-nhi-(màtha)		*	
b. (kárna)-(nhì-ma)tha	*!	*	

Taut-F makes the decision on the optimal candidate, ensuring that (65a) is the preferred output.

In Diyari, feet must not cross morpheme boundaries, while, in Warlpiri and Wambaya, this prohibition is relaxed if otherwise adjacent unfooted syllables occur. Differences in the stress patterns exhibited by various languages can be expressed by differences in constraint ranking. In Diyari, the constraint Taut-F is dominant, that is, it cannot be violated, in contrast with Warlpiri and Wambaya. Violation of the constraint RA is permitted in Diyari and must be a lower ranked constraint.

Kager (1993b) proposes an analysis for Diyari, where prosodic word structure is recursive and a constraint aligns the right edge of the stem with the right edge of the prosodic word. In

Diyari, this accounts for the fact that monosyllabic suffixes are not parsed into feet. As pointed out in 2.3.3, a right-edge alignment constraint on stem and prosodic word cannot account for the facts of Warlpiri. Given this, I adopt Taut-F for the analysis of Diyari on the basis that the constraint has application to other languages.

2.5.3 Dyirbal

In Dyirbal, feet are permitted to cross morphological boundaries, with the exception of root and suffix boundaries and, to account for this, a more specific Taut-F constraint is required. The data are from Dixon (1972) and Crowhurst (1994)[9]. My analysis of the Dyirbal facts differs from that of Crowhurst, and is slightly different from Kager (1993b), as discussed in the latter part of this section.

The stress patterns in the data in (66-68) of monomorphemic and polymorphemic words respectively are the same as those found in Warlpiri. Examples from Crowhurst are indicated by MC.

(66)	a. múlumíyan	'whale' [MC]
	b. dyúgumbil	'woman'
	c. balan yímalímal	'welcome swallow'

(67)	a. búyba-rrí-nyu	'hide-REFL-PRES/PST'
	b. wáydyi-ngú-gu	'motion uphill-rel.cl.-DAT'
	c. núdil-mál-dya-nyu	'cut-COMIT-LOC-PRES/PST'
	d. bánagay-mbá-rri-nyu	'return-REFL-COMIT-PRES/PST'
	e. wáyndyi-ngu	'motion uphill-rel.cl.'
	f. búrgurúm-bu	'jumping ant-ERG'[10]

Differences between Warlpiri and Dyirbal are evident in the following examples:

(68)	a. (dyángga)-(ná-mbi)la	'eat-pron-with'
	b. (mánda)lay-(mbál-bi)la	'play-COMIT-lest' [MC]

In contrast to Warlpiri, non-initial polysyllabic morphemes in Dyirbal do not always have stress on the first syllable. Feet align with the first suffix following the root regardless of whether the suffix is monosyllabic or polysyllabic. Feet are not permitted to cross over root and suffix boundaries, except when the suffix is monosyllabic. This observation requires a more specific constraint than Taut-F. Such a constraint would prohibit feet from straddling the boundary between a root and suffix, but still allow other boundaries to be straddled. This constraint is proposed in Kager (1993b) and is:

(69) **Align Root (AlignRt)**: Align (Root, Left/Right, PW, Left/Right).

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[9] The data in Crowhurst is from Dixon (1972) and from personal communication with Dixon.

[10] There is conflicting information about the stress pattern of words with trisyllabic roots followed by a monosyllabic suffix. Dixon (1972) states that there is a strong tendency for stress to regularly alternate. This is confirmed by Dixon (pc) for words of the form σσσ-σ. In Crowhurst and Kager, these forms have the stress pattern (σ⇔σ)σ-σ.

AlignRt is more specific than Taut-F and consequently renders Taut-F inactive. AlignRt is ranked below RA to ensure that syllables across root and suffix boundaries are parsed into feet. The ranking is:

(70) RA >> LE >> AlignRt >> AlignFt

In Kager (1993b) and Crowhurst (1994) there is no RA constraint. Kager ranks AlignRt above PARSEσ to account for (búrgu)rum-bu.

LE must be ranked above AlignRt to ensure foot alignment with the left edges of roots, as shown in the following tableau.

(71) burgurum-bu	RA	LE	AlignRt	AlignFt
a. [(búrgu)rum-bu]	*!	*		1:#
b. [bur(gúrum)-bu]		**!		1:σ
%c. [(búrgu)(rúm-bu)]		*	*	1:# 2:σσ

Adjacent unfooted syllables are ruled out by RA in (71a). Neither of the morphemes in (71b) are aligned with a foot, incurring more violations of LE. If LE was ranked below AlignRt, (71b) would be the optimal output, rather than (71c).

In words with a number of monosyllabic suffixes, AlignRt makes the crucial decision, as shown in (72). (72a) is the optimal candidate, least violating the constraints.

(72) banagay-mba-rri-dyu	RA	LE	AlignRt	AlignFt
%a. [(bána)gay-(mbá-rri)-dyu]		**		2: σσσ
b. [(bána)(gáy-mba)-(rrí-dyu)]		**	*!	2: σσ
c. [(bána)gay-mba-(rrí-dyu)]	*!	**		2: σσσσ!
d. [(bána)gay-mba-rri-dyu]	**!	***!		

As the following tableau demonstrates, it is not essential that preference be given to the alignment of feet with polysyllabic morphemes, as long as the root and suffix boundaries are not crossed.

(73) mandalay-mbal-bila	RA	LE	AlignRt	AlignFt
%a. [(mánda)lay]-(mbál-bi)la]		*		2: σσσ
b. [(mánda)(láy]-mbal)-(bíla)]		*	*!	2: σσ
c. [(mánda)lay]-mbal-(bíla)]	*!	*		2: σσσσ!

In (73) the decision on the optimal candidate is left to RA and AlignRt.

AlignRt is a more specific constraint than Taut-F, as AlignRt is concerned only with feet crossing root and suffix boundaries, rather than any boundaries. This contrasts with the other languages discussed here, Warlpiri and Diyari.

In an alternative analysis of Dyirbal by Crowhurst, a constraint on the alignment of feet and morphemes on the right edge is introduced. This is Morpheme-Foot-Right (MFR). This constraint, in addition to FtBin, LE, Taut-F, AlignFt and PARSEσ, is ranked as:

(74) FtBin >> LE >> PARSEσ, AlignFt >> Taut-F >> MFR

Due to the equal ranking of PARSEσ and AlignFt, where AlignFt assesses violations in a non-gradient fashion, MFR is crucial as shown in (75) involving a monomorphemic word.

(75) mulumiyan	LE	PARSEσ AlignFt	Taut-F	MFR
%a. [(múlu)(míyan)]		**		
b. [(múlu)miyan]		**		*!

Both (75a,b) have an equal number of violations to the equally ranked PARSEσ and AlignFt. In such cases, MFR decides on the optimal candidate.

While the constraints are able to generate the optimal forms, a problem arises with the equal ranking of PARSEσ and AlignFt. PARSEσ assesses violations in an outright fashion, while AlignFt assesses violations gradiently. Given this difference in assessment, equal ranking of the constraints results in an imbalanced assessment.

Under Crowhurst's analysis, the total number of violations incurred by both PARSEσ and AlignFt count against a candidate. This is shown in the following tableau with the input /banagay-mba-ri-dyu/ where PARSEσ and AlignFt decide on the optimal candidate.

(76)	LE	PARSEσ AlignFt	Taut-F
a. (bána)(gày-mba)-(rì-dyu)	**	** ****!	**
%b. (bána)gay-(mbà-ri)-dyu	**	** ***	*
c. (bána)gay-mba-(rì-dyu)	**	** ****!	*

All outputs have an equal number of violations to LE and it is left to PARSEσ and AlignFt to decide on the optimal candidate. (76a,c) have 6 violations, and since (76b) only has 5, it is the optimal candidate (each syllable under AlignFt counts as a violation).

Under AlignFt, the location of a foot with respect to a prosodic word edge is calculated in terms of the number of syllables, if any, that intervene between the edges of the two constituents. If the constraint assessed violations outright, feet that did not align to the prosodic word edge would incur a violation. Gradient assessment is able to make subtle distinctions in comparison to outright assessment, as shown in (77).

(77)	AlignFt (outright)	AlignFt (gradient)
a. (σσ)σ(σσ)	*	2: σσσ!
b. (σσ)(σσ)σ	*	2: σσ

Due to gradient assessment, only AlignFt (gradient) can make a decision as to the optimal output, which demonstrates the benefit of a gradient-assessing constraint.

I In general, counting all outright and gradient violations together will often give the wrong result. For instance, the more feet in a word the more violations there will be. As shown in a hypothetical example, candidates with a smaller number of feet will be better off than candidates with more feet.

(78)

	PARSEσ	AlignFt
a. (σσ)σ(σσ)σ	**	***
b. (σσ)(σσ)(σσ)		** ****!

(78a) is the optimal candidate, since it has only five violations compared to the six violations in (78b). If PARSEσ was ranked above AlignFt, (b) would be the optimal output.

Counting violations in this way loses the generalisation of AlignFt, because each foot is not assessed with respect to the same foot in other outputs. Instead, the total number of violations incurred by all feet counts against an output, as illustrated in (79).

(79)

	AlignFt	
a. (σσ)(σσ)(σσ)	** ****!	6 violations
b. (σσ)σ(σσ)σ	***	3 violations
c. (σσ)σσ(σσ)	****	4 violations

Under AlignFt the same syllables may be counted a number of times. For instance, in the assessment of F3 and F2 in (79) the first two syllables in the string are counted twice. PARSEσ counts syllables once; if a syllable is not parsed PARSEσ is violated and syllables are not counted again.

Given that assessment is unequal, a gradient-assessing constraint cannot be ranked equally with a constraint which assesses outright. Such ranking is inequitable. This can be stated in a principle of ranking.

(80) Ranking Equity
Two constraints may be ranked equally iff they assess in a non-gradient fashion.

Crowhurst and Hewitt (to appear) discuss an alternative to the equal ranking of PARSEσ and AlignFt in their account of the Diyari facts (Crowhurst pc). They propose using a conjunction of constraints. A conjunction of two constraints will be satisfied if there are no violations to either constraint.

In my analysis of the stress patterns in Dyirbal, the specific constraints, RA and AlignRt, and their ranking above AlignFt account for the patterns. AlignRt accounts for the fact that root and suffix boundaries cannot be straddled by feet.

2.5.4 Summary

In contrast to Warlpiri, Wambaya and Dyirbal, stress alternation in Diyari is not restricted to a binary and ternary pattern. Sequences of unfooted syllables are permitted. In all the languages discussed here the rhythmic pattern is constrained by the morphology. However, in Warlpiri and Wambaya the rhythmic pattern is constrained to a lesser extent than in Diyari. Morpheme boundaries in Warlpiri and Wambaya may be crossed, just in those cases where a pattern other than binary or ternary may emerge. RA is the constraint governing the overall rhythmic organisation of these languages.

RA enables characterisation of rhythmic patterns in various languages, while Warlpiri, Wambaya and Dyirbal do not allow violation of RA. This is not captured by PARSEσ. PARSEσ is not a crucial constraint given its ranking below the more specific RA. The crucial constraints and their ranking for the languages discussed are:

(81) Diyari: Taut-F >> LE >> RA >> AlignFt
Warlpiri/
Wambaya: RA >> AlignRt$_{\sigma}$ >> LE, Taut-F >> AlignFt
Dyirbal: RA >> LE >> AlignRt >> AlignFt

The sensitivity to foot and morpheme alignment is expressed in the following typology.

(82) a. Foot and morpheme alignment, adjacent unfooted syllables allowed:
Taut-F >> LE >> RA >> AlignFt (Diyari)
b. Non-alignment of foot and morpheme allowed in order to incorporate unfooted syllables:
RA >> LE, Taut-F/AlignRt >> AlignFt (Warlpiri,Wambaya,Dyirbal)
c. No word-internal foot and morpheme alignment:
RA >> AlignFt >> LE, Taut-F (Pintupi, see Ch1)

In sum, there is a strong tendency for feet to avoid crossing morpheme boundaries, particularly the root/stem and suffix boundary. This division confirms that feet do regulate stress and that feet are useful in discovering patterns not previously noticed. What is also interesting about the division between root/stem and suffixes is that a similar divide is found in the pattern of vowel harmony (discussed in Ch5), where, in general, only suffixes undergo harmony.

2.6 Concluding Remarks

This chapter has revealed that Warlpiri exhibits a mix of two stress systems, morphological and rhythmic (or prosodic). Stress is consistently located on the first syllable of a polysyllabic morpheme. This pattern, where stress marks out morphological boundaries, indicates that the prosodic system is conditioned by the morphology. On the other hand, the regularly alternating stress pattern in monomorphemic words shows evidence of a rhythmic system. I have shown that in a language like Warlpiri, which displays morphologically conditioned stress as well as rhythmic stress, the morphological system constrains the rhythmic system in particular ways. The inter-relationship between the morphology and the rhythmic system conflicts in certain contexts. This inter-relationship can only be captured in a system that deals with them simultaneously rather than one at a time. OT provides such a system in which constraints and their ranking prioritise demands and resolve conflicts.

I have shown that an adjacency constraint on syllables, RA, accounts for the stress data in a number of languages better than PARSEσ. Where there are conflicts over alignment, RA, but not PARSEσ, is able to resolve these. RA ensures that, at most, one unfooted syllable occurs between feet. PARSEσ is not able to do this. Thus RA is an important constraint in determining rhythmic patterns. In Chapter 4, this is given further support where we will see that RA is crucial in restricting rhythmic patterns in languages.

The constraints for Warlpiri are summarised in the following table:

(83) Table of constraint ranking

RA >> LE,Taut-F	*ensures that a sequence of adjacent unfooted syllables are parsed into feet with minimal violation of Taut-F and LE.*
LE,Taut-F >> AlignFt	*ensures alignment of feet with morpheme edges at the expense of iterative feet.*
RA >> AlignFt	*ensures iterative foot parsing over non-iterative parsing.*

Note that the interface constraints on stress, LE and Taut-F, are ranked above the prosodic constraint AlignFt. The interface constraints, LE and Taut-F, are in turn dominated by another prosodic constraint, RA. This ranking can be schematised as prosodic >> interface >> prosodic, and characterises the interaction between the morphological and prosodic domains. The interface constraints are specific constraints for word-internal alignment. They are a subset of the constraints that hold for prosodic word alignment.

A large number of words exist which do not have a pattern of binary alternating stress. Some inflected and compound words contribute to these groups of words displaying both binary and ternary alternation. Underlying these patterns is an overriding sensitivity to morphological edges. In the absence of these edges, a binary rhythmic stress pattern is the dominant pattern. However, ternary alternation is an option. This is discussed in Chapter 4.

Despite the appearance of irregularity in the stress patterns in a large number of words in Warlpiri, the stress patterns investigated so far are actually very regular considering the alignment conditions on feet and morpheme edges. There are some stress patterns, however, which do not conform to any of the patterns discussed. These are addressed in Chapter 3.

CHAPTER 3

LEXICALISED STRESS PATTERNS

3.1 Introduction

The previous chapter established that stress in Warlpiri is on the first syllable of a polysyllabic morpheme and on the first monosyllabic morpheme in a string of such morphemes. These facts are complicated by a few monosyllabic morphemes which do not conform to this pattern.

Three monosyllabic morphemes in Warlpiri attract stress in certain contexts. These are the infinitive **-nja,** the inceptive **-nji**, and the aspect clitic **ka**. The stress patterns involving these forms are dependent on the context. For instance, in a string of monosyllabic morphemes, the infinitive, inceptive or the aspect clitic will be stressed in preference to the first monosyllabic morpheme. This is shown in **(páka)-rni-(njà-rla)** 'hit-NPST-INF-SERCOMP', where the infinitive is stressed. However, these morphemes are not stressed if a polysyllabic morpheme follows.

The problem is to account for stress on the infinitive, inceptive and aspect clitic in contexts involving monosyllabic suffixes. The constraints introduced in Chapter 2 would ensure that in words such as **paka-rni-nja-rla**, the first monosyllabic suffix is stressed and not the infinitive suffix **-nja**.

Since they attract stress in certain cases, I introduce a specific constraint requiring that they align with the left edge of feet. The constraint is incorporated into the system of constraint interaction which allows us to see what determines stress placement in well-formed outputs. In this system, the attraction of stress to these forms in certain contexts can be explained.

I show that an advantage of OT over other theories is a straightforward explanation for the contextual variability exhibited by such forms. This variability in OT can be said to result from priorities in the language expressed as constraint ranking.

The chapter is outlined as follows. In 3.2 the data on the infinitive and inceptive are presented. I provide an account of these patterns in 3.2.1. In 3.3 the discussion focuses on the patterns involving the aspect clitic which give the appearance of the clitic being a separate phonological entity from the stem to which it attaches. I consider whether words with once productive morpheme boundaries should be analysed as having lexical stress in 3.4, and in 3.5 the behaviour of a particular morpheme with regard to stress is examined in Martuthunira. In 3.6 some alternatives are considered, followed by concluding remarks in 3.7.

3.2 The Infinitive and Inceptive

The infinitive **-nja**[11] and inceptive **-nji** morphemes attract stress. If they were polysyllabic this would be expected; however, these suffixes are monosyllabic. Recall from Chapter 2, that in a string of monosyllabic suffixes, the first in the string is stressed. However, if there is an infinitive or inceptive suffix present in the string, it will always be stressed regardless where it occurs; for example, **(páka)-rni-(njà-rla)** hit-NPST-INF-SERCOMP, ‘after hitting (it)’; **(wála)(pàrri)-rni-(njì-ni)** test it-NPST-INCEP-NPST ‘began testing (it)’[12]. In contrast, when there is a following

[11] The infinitive suffix is analysed as distinct from tense morphemes which may cooccur with the infinitive.

[12] Unless otherwise indicated data are from Nash (1986).

polysyllabic suffix, the infinitive and inceptive are not stressed, behaving in the same way as other monosyllabic suffixes in such contexts. This is shown in **(páka)-(rnì-nja)-(kùrra)** hit-NPST-INF-SEQCOMP ‘(doing something) while hitting’.

The patterns for the infinitive are given below, followed by those for the inceptive.

3.2.1 Infinitive

An infinitive is a nominalised verb with an infinitive suffix **-nja**. Infinitives cannot appear as independent lexical items but must be inflected as in **paka-rni-nja-kurra** 'hit-NPST-INF-SEQCOMP', **parnti-nya-nja-kurlangu** smell-perceive-INF-instrument ‘instrument for smelling ie nose’. They may be compounded with the verb **ya-ni** 'go-NPST' to form a verb, as in [maarrpa-rni-ma-ni-nja-ya-ni] flash-hither-CAUS-INF-go-NPST ‘cause to go flashing here’.

The stress pattern of verbs with the infinitive is presented in the following paradigm for the infinitive-SERCOMP, **-nja-rla,** taken from Nash (1986:113). The interpretation given to these forms is 'after X-ing (it)':

(1)	INF-SERCOMP	Verb class	NONPAST
	a. wángka-njà-rla	V1	wángka/wángka-mi
	speak		
	b. wírnpirli-njà-rla	V1	wírnpirli/wírnpirli`-mi
	whistle		
	c. pí-nja-rla	V3	pí-nyi
	hit		
	d. páka-rni-njà-rla	V2	páka-rni
	strike		
	e. wálapàrri-rni-njà-rla	V2	wálapàrri-rni
	test		
	f. ngá-rni-njà-rla	V4	ngá-rni
	eat		
	g. yá-ni-njà-rla	V5	yá-ni
	go		

With the exception of (1c), stress is consistently located on the infinitive suffix **-nja**. As previously discussed, the first in a string of monosyllabic suffixes is stressed following a polysyllabic morpheme. This pattern is exemplified in examples (1a,b). Note, however, that in (1d,e) there is a tense suffix (underlined) in between the root and the infinitive suffix, and yet the infinitive, rather than the tense suffix, is marked for stress. When the infinitive is suffixed to a monosyllabic verb root of the third conjugation (1c), there is no stress on the infinitive. In these situations, stressing the verb root, which is at the left edge of the word, has priority over stressing the infinitive.

Verbs in the first conjugation can appear without overt marking for tense, in which case the verb is interpreted as a non-past form, eg V1 **wángka/wángka-mi**. When the first and third conjugation verbs (1a,b,c) are marked for the infinitive, none of the tense morphemes are permitted, as they are in the other conjugations (1d-g). Thus, a first conjugation verb is illformed if any tense suffix is present ***wangka-mi-nja-rla** 'speak-NPST-INF-SERCOMP' or ***pi-nyi-nja-rla** 'hit-NPST-INF-SERCOMP'.

As the examples in (2) show, the infinitive suffix is not stressed when a polysyllabic morpheme, or a compounded verb, follows.

(2) a. páka-rnì-nja-kùrra '(doing something) while hitting'
hit-NPST-INF-SEQCOMP [DGN:113]

b. máarrpà-rni-mà-ni-nja-yà-ni
flash-hither-CAUS-NPST-INF-go-NPST
'cause to go flashing here' [LB]

c. wírnpirlì-nja-yà-ni 'going along whistling'
whistle-INF-go-NPST [LB]

3.2.2 The Inceptive

The inceptive **-nji** behaves similarly to the infinitive with regards to stress. The inceptive is classed as a V5 stem (Nash 1986) and therefore takes an appropriate tense suffix. However, in contrast to other verb stems, the inceptive is not morphologically independent and must be suffixed to a verb stem. Nash claims that the inceptive has some historical connection with the verb **ya-ni** 'go' which is a member of the same conjugation class. The inceptive is a combination of **-nji** and a tense suffix. As with the infinitive, there are the same conditions on tense suffixes for verbs of the first and third conjugations, that is, tense morphemes of the first and third conjugation verbs cannot be present.

In the following paradigms, the inceptive suffix is consistently stressed. The gloss for the inceptive is 'begin X-ing'; data are from Nash (1986:113).

(3)	INCEP-NPST	INCEP-INF-SERCOMP	
	a. wángka-njì-ni speak	wángka-njì-ni-njà-rla	V1
	b. wírnpirli-njì-ni whistle	wírnpirli-njì-ni-njà-rla	V1
	c. pí-nja-ni pí-nja-njì-ni hit	pí-nja-ni-njà-rla pí-nja-njì-ni-njà-rla	V3
	d. páka-rni-njì-ni strike	páka-rni-njì-ni-njà-rla	V2
	e. wálapàrri-rni-njì-ni test		V2
	f. ngá-rni-njì-ni eat	ngá-rni-njì-ni-njà-rla	V4
	g. yá-ni-njì-ni go	yá-ni-njì-ni-njà-rla	V5

The monosyllabic verbs of the V3 conjugation are the only verbs which have the alternative inceptive form, as seen in (3c), where the inceptive suffix may be absent.

The analysis proposed in Chapter 2 will not be able to generate all the attested forms involving the infinitive or the inceptive suffixes. For instance, in **paka-rni-nji-ni**, the optimal output would be one where stress was on the first suffix in the string, that is **-rni**. I will argue below that the infinitive and inceptive require a specific constraint.

3.2.3 An Account

From the stress patterns involving the derivational suffixes, it appears that there are conflicting morphological and prosodic requirements. As particular morphemes, the infinitive and the inceptive attract stress. This is evident when they are surrounded on either side by monosyllabic suffixes. However, when a polysyllabic suffix is adjacent, it will be stressed in preference to any monosyllabic morpheme.

In previous analyses, Nash (1986), Poser (1990), the infinitive and the inceptive are assigned monosyllabic feet by a rule prior to other stress rules. Monosyllabic feet do not actually surface in outputs. In their analyses, these feet may become binary by incorporating a following syllable into the foot, or, if that does not happen, they delete.

Since monosyllabic feet do not occur in outputs there would be no point positing them in underlying representation. Such feet violate the dominant constraint FtBin and would be ruled out in favour of binary feet.

In underlying representation, a monosyllabic foot would be a diacritic, since it is debatable whether there is phonological structure present at this level. A diacritic is necessary in underlying representation when stress is unpredictable. The element marked with the diacritic will surface as stressed. Thus diacritics tell us that a particular form is unusual, and that, when diacritics are present in underlying representation, some general constraints will be overridden.

The stress patterns involving the infinitive and inceptive are variable. These suffixes are stressed except when a polysyllabic suffix follows. Given the contextual variability, these facts indicate that the infinite and inceptive are not prosodic word final. The suffixes override the general pattern of stress assignment to strings of monosyllabic suffixes. In this sense, the stress patterns are unpredictable and require a specific statement. The suffixes do not override the general pattern of stress to polysyllabic morphemes, and here the patterns are predictable. The stress patterns are not fixed and thus lexical marking is not required.

These patterns indicate that there are priorities in the alignment of feet. Feet align to morpheme edges and prefer alignment with the edges of polysyllabic suffixes rather than with monosyllabic suffixes. Of the monosyllabic suffixes, the infinitive and inceptive have priority in foot alignment. To ensure that the infinitive and inceptive suffixes have priority over other monosyllabic suffixes a specific constraint is needed. This is given as:

(4) **LEXSTRESS:** The left edge of a foot is aligned with the left edges of the infinitive **-nja** and the inceptive **-nji** suffixes.

The infinitive and inceptive suffixes never occur immediately adjacent to one another and thus no conflict involving LEXSTRESS occurs.

If the placement of stress on the infinitive and inceptive is interpreted as a constraint, interaction with the other constraints is possible. Once integrated into the constraint system, variation in stress placement can be captured.

When a polysyllabic suffix follows an infinitive or inceptive suffix, the polysyllabic suffix is stressed, as in **(páka)-(rnì-nja)-(kùrra)** 'strike-NPST-INF-SEQCOMP'. This indicates that alignment of feet with polysyllabic morphemes has priority over alignment of feet with the infinitive and inceptive suffixes. LEXSTRESS is ranked below LE and Taut-F, ensuring that polysyllabic suffixes align with the edges of feet.

Where there are strings of monosyllabic suffixes, the leftmost suffix is typically aligned with a foot, this is **-rli** in **(máli)ki-(rlì-rna)=lu** 'dog-ERG=1peS'. When LE and Taut-F cannot decide on a candidate, AlignFt ensures that alignment is with the first suffix in the string and not the second one. AlignFt is overridden when an infinitive or inceptive suffix occurs in the string: **(wála)(pàrri)-rni-(njì-ni)**, 'test-NPST-INCEP-NPST'. This indicates that LEXSTRESS has priority over AlignFt and, to ensure that LEXSTRESS is active, it must be ranked above AlignFt.

The ranking discussed is:

(5) LE,Taut-F >> LEXSTRESS >> AlignFt

The ranking of LEXSTRESS above AlignFt is crucial, as the following tableau shows with the form **paka-rni-nja-rla** 'hit-NPST-INF-SERCOMP' [(páka) |i(ncà〉a)].

(6)

	LE Taut-F	LEXSTRESS	AlignFt
a. (páka)-(rnì-nja)-rla	** *	*!	2:σσ
%b. (páka)-rni-(njà-rla)	** *		2: σσσ

In (6a), the infinitive is not stressed, violating LEXSTRESS. If the ranking between LEXSTRESS and AlignFt was reversed, (6a) would be optimal, as its second foot is closer to the left-edge of the prosodic word than the second foot in (6b).

When a polysyllabic suffix follows the infinitive in the word **paka-rni-njá-kurra** 'hit-NPST-INF-SEQCOMP' [páka |ncakùra], LE and Taut-F make the decision on the optimal candidate. This is shown in (7) where (7a) is the optimal output, since it least violates the higher ranked LE and Taut-F.

(7)

	LE Taut-F	LEXSTRESS	AlignFt
%a.(páka)-(rnì-nja)-(kùrra)	* *	*	2: σσ
b.(páka)-rni-(njà-ku)rra	**! *		2: σσσ

An inceptive form is considered in the following tableau. The input is **paka-rni-njí-ni** 'hit-NPST-INCEP-NPST' [páka |ncìni]. LEXSTRESS makes the decision on the optimal candidate, ruling out (8b).

(8) paka-rni-njí-ni

	LE Taut-F	LEXSTRESS	AlignFt
%a. (páka)-rni-(njì-ni)	** *		2: σσσ
b. (páka)-(rnì-nji)-ni	** *	*!	2: σσσ

For other words, LE and Taut-F decide on the optimal candidate, as shown in (9) with the form **wirnpirli-njí-ni** 'whistle-INCEP-NPST' [wí |pi〉incìni].

(9)

	LE Taut-F	LEXSTRESS	AlignFt
%a. (wírnpi)rli-(njì-ni)	* *		2: σσσ
b. (wírnpi)(rlì-nji)-ni	** *!	*	2: σσ

In (9) the inceptive immediately follows a trisyllabic morpheme. As long as there is a following monosyllabic morpheme, the inceptive, like any other monosyllabic suffix in this position, receives stress. If this does not occur, LE and Taut-F will incur more violations, as in (9b). Alignment of a foot to the inceptive is a result of LE and Taut-F in these contexts. In other contexts, such as the word in the previous tableau (8), LEXSTRESS will be crucial in ensuring that these suffixes are stressed.

LEXSTRESS is a more specific LE constraint, as it specifies which morphemes align with feet. Unlike other specific constraints, LEXSTRESS is ranked below the less specific constraint. This is due to the fact that alignment with polysyllabic suffixes has priority over alignment with specific morphemes.

3.2.3.1 LEXSTRESS and Prosodic Word Alignment

As discussed above, LEXSTRESS has priority over AlignFt. This ranking poses problems for words consisting of strings of monosyllabic morphemes. For example, when an infinitive suffix follows a monosyllabic verb root, LEXSTRESS will ensure that the suffix rather than the verb root will be stressed, as in *[pi-(njá-rla)] 'hit-INF-SERCOMP'. AlignFt cannot ensure that a foot is aligned to the left edge of the prosodic word, since it is ranked below LEXSTRESS. However, the conflict between these two constraints cannot be resolved by reversing their ranking.

To ensure that one foot is aligned to the left edge of a prosodic word, the constraint AlignPW (M&P 1993b) is adopted. AlignPW assesses whether just one foot is aligned to the left edge of the prosodic word. In contrast, AlignFt assesses all feet in an output.

(10) **AlignPW:** The left edge of a prosodic word is aligned with the left edge of a foot.

It is evident from examples, such as **(pí-nja)-rla**, that AlignPW has priority over LEXSTRESS. The ranking of AlignPW above LEXSTRESS is crucial in ensuring foot alignment to the prosodic word edge and not to the infinitive or inceptive.

The effect of the ranking AlignPW >> LE,Taut-F >> LEXSTRESS is demonstrated in **pi-nja-rla** 'hit-INF-SERCOMP' where the verb root **pi-** is stressed in preference to the infinitive. This is shown in the following tableau.

(11)	AlignPW	LE Taut-F	LEXSTRESS
%a. [(pí-nja)-rla]		** *	*
b. [pi-(njá-rla)]	*!	** *	

LE and Taut-F are unable to make a decision on the optimal candidate, since both outputs have an equal number of violations of these constraints. AlignPW is crucial in these words in deciding on the optimal candidate, which in this case is (11a). Without AlignPW, alignment of feet to prosodic word edge could not always be guaranteed.

Ranking AlignPW above LEXSTRESS ensures that the conflict over alignment is resolved. The verb root is at the edge of a prosodic word and must therefore be given preference. AlignL requires stem and prosodic word alignment and plays no role in foot and prosodic word alignment.

The fact that the infinitive and inceptive suffix are stressed in some contexts may be due to their verb/root-like behaviour. Like verbs, both suffixes have to be inflected; they cannot occur word-finally. The verb-like behaviour of the inceptive is possibly because it was once a root, as suggested by Nash (1986). Stress may be a reflection of this previous role.

In the next section, the stress patterns involving the aspect clitic **ka** are examined.

3.3 The Aspect Clitic

The present imperfect aspect clitic **ka** (IMPF), has similar stress patterns to the infinitive and inceptive suffixes. Compare the following examples below. '=' represents clitic boundaries.

(12) a. wángka-mi=kà=rna 'I am speaking'
speak-NPST=IMPF=1sS [DGN:102] [ML]
b. wángka-mi=kà=lu=jàna 'They are speaking to them'
speak-NPST=IMPF=3pS=3pNS [ML]
c. ngájulu=kà=rna 'I am ....'
I=IMPF=1sS [LB]
d. ngárnangàrna-nya=kà=rna=lu 'as for the claypans, we (did something)'
claypans-TOP=IMPF=1peS [LB]

The patterns in (12) are the same as those for the infinitive and inceptive suffixes shown repeated below:

(13) a. páka-rni-njà-rla 'after hitting (it)'
hit-NPST-INF-SERCOMP
b. wálapàrri-rni-njà-rla 'after testing (it)'
test-NPST-INF-SERCOMP
c. páka-rni-njì-ni 'began hitting (it)'
hit-NPST-INCEP-NPST
d. wálapàrri-rni-njì-ni 'began testing (it)'
test-NPST-INCEP-NPST

ka is not stressed when followed by a polysyllabic morpheme, as is the case for the infinitive and inceptive suffixes.

(14) a. wángka-mì=ka=pàla 'they two are speaking'
speak-NPST=IMPF=3dS [ML]
b. Wárlpirì=ka=rlìpa[13] 'we .... Warlpiri'
Warlpiri=IMPF=1piS [LB]
c. páka-rnì-nja-kùrra '(doing something) while hitting'
hit-NPST-INF-SEQCOMP

The other aspect clitic, the past imperfect **lpa** (IMPF), is stressed depending on its position in the word, in contrast to /ka/ but like other monosyllabic morphemes, as shown in (15).

[13] **rlipa** is analysed as a single morpheme, however historically it is a complex morpheme **rli-pa**.

(15) a. wángka-jà=lpa=rna 'I was speaking'
speak-PST=IMPF=1sS [ML]
b. yá-nu=lpà=rna 'I was going'
go-PST=IMPF=1sS [ML]
c. kúrdu-kùrdu-rlù=lpa=lu 'The children, they were (doing something)'
children-ERG=IMPF=3pS [LB]
d. ngájulu-rlù=lpa=rna 'As for me, I was (doing something)'
I-ERG=IMPF=1sS [LB]

The patterns in (15) are the same as those in (16) below, where the first monosyllabic suffix in a string is stressed (repeated from Chapter 2).

(16) a. pálya-ngkù=rna=lu 'with an adze, we (did something)'
adze-ERG=1peS
b. máliki-rlì=rna=lu 'with a dog, we (did something)'
dog-ERG=1peS
c. wángka-mì=rra=lku=jàla
speak-NPST=thither=then=obviously
'obviously (someone) is speaking in that direction now'

In line with all other monosyllabic morphemes, **lpa** is not stressed when followed by a polysyllabic morpheme, as (17) shows.

(17) a. wírnpirli-jà=lpa=jàna '(someone) was whistling to them'
whistle-PST=IMPF=3pNS [DGN:110]
b. máliki-kìrli=lpa=pàlangu 'with a dog they two were (doing something)'
dog-PROP=IMPF=3dNS [LB]
c. kárnta-jàrra-rlù=lpa=pàla 'the two women, they two were (doing something)'
woman-two-ERG=IMPF=3dS [LB]

There are two possible analyses of this data. Firstly, the analysis for the infinitive and inceptive suffixes could be extended to **ka.** The second possibility involves parsing **ka** as a prosodic word. **ka** could be parsed as a prosodic word because it is a member of a morphological category, ie particle, which is required to be parsed into a prosodic word. Since the former analysis has been outlined in section 3.2, I will consider the latter one in the following discussion.

Aspect morphemes are in the part-of-speech category of 'particle' (Laughren 1982); and particles, like nominals and verbs, occur as independent words. Independent words are parsed as prosodic words which ensures that they consist minimally of a foot. Any morpheme which is in the particle category would be parsed as a prosodic word.

As discussed in Chapter 1, certain grammatical categories are required to correspond to certain prosodic categories. The items in these grammatical categories occur as independent phonological words. Nouns, verbs, preverbs and particles in Warlpiri correspond to prosodic words.

Since the aspect clitics are members of the particle category, we might expect that they too are parsed as prosodic words. The patterning of **ka** gives some indication that this is possible. For example, in **(wángka)-mi=(kà=rna)** 'speak-NPST=IMPF=1sS', **ka** and not the first monosyllabic morpheme **mi** is stressed. This would suggest that **ka** is in a separate prosodic constituent from the verb stem. As discussed in Hale (1976 et seq. also Laughren 1982, Nash 1986, Simpson 1991), aspect particles and following clitics form an 'auxiliary word'. An auxiliary word is a single complex of morphemes, which has no morphological head and has a flat structure.

If **ka** was parsed as a prosodic word, then we should expect that it always heads a prosodic word like the monosyllabic verb roots. As previously discussed, the monosyllabic verb roots are always stressed regardless of the size of the following morpheme. However, **ka** is not always stressed, as, for instance, when **ka** precedes a disyllabic suffix, in **(wángka)-(mì-ka)=(pàla)** 'speak-NPST-IMPF=3dS'. Since verbs have a requirement that they must be parsed as a prosodic word, no other parsings are possible without violating highly ranked constraints. Whether verb roots are mono- or polysyllabic, they will always be parsed as prosodic words.

Given these facts, I assume that, because the monosyllabic aspect particles are clitics and are thus phonologically subordinate to prosodic words, they cannot themselves be a prosodic word. I propose to include **ka** in the LEXSTRESS constraint. This will ensure that it will be stressed in preference to other monosyllabic suffixes. LEXSTRESS is revised to:

(18) **LEXSTRESS (revised):** The left edges of a foot aligns with the left edges of the infinitive **-nja**, inceptive **-nji** and aspect **ka** morphemes.

We do not need to say anything about the other monosyllabic aspect clitic **lpa**, since it behaves like other monosyllabic suffixes.

The word **wangka-mi=ka=rna** 'speak-NPST=IMPF=1sS' is considered in the following tableau.

(19)	LEXSTRESS	AlignFt
%a. (wángka)-mi=(kà=rna)		2: σσσ
b. (wángka)-(mì=ka)=rna	*!	2: σσ

(19a) is the optimal candidate because it does not violate LEXSTRESS. In the next tableau, **ka** is suffixed by a polysyllabic pronominal clitic **pala** 'they two'.

(20) wangka-mi=ka=pala	LE	Taut-F	LEXSTRESS
%a.[(wángka)-(mì=ka)=(pàla)]	*	*	*
b.[(wángka)-mi=(ká=pa)la]	**	*!	

Since there are less violations of LE and Taut-F in (20a), it is the optimal candidate.

If the ranking between Taut-F and LEXSTRESS was reversed, stress would always occur on the morphemes specified in LEXSTRESS. **ka** is not stressed when word-final which could occur if it was parsed into a monosyllabic foot or parsed into an iambic foot. Each of these possibilities is ruled out by FtBin and FootForm respectively.

Requiring a specific constraint for the infinitive, inceptive and aspect clitic is motivated by the observations of their role with regard to stress. The challenge for the analysis is to capture the fact that they are stressed in contexts involving strings of monosyllabic suffixes but not when a polysyllabic suffix follows. They have alignment priority when surrounded by monosyllabic suffixes, but not when they precede polysyllabic suffixes. The challenge is met by the constraint ranking system which ensures the appropriate alignment priority.

3.4 Lexical Stress in Warlpiri

A large number of words in Warlpiri have historically been formed by reduplication, and the reduplication process of these words is no longer productive. Since there is no unreduplicated counterpart, the words may be referred to as frozen reduplications. In the stress patterns of frozen reduplications, stress is always located on the initial syllable of the reduplicated portion. These patterns are given below:

(21)	a. míjilijìli	'navel' [DGN:121]
	b. púyukuyùku	'mist,fog;haze' [DGN:121]
	c. jákurdukùrdu	'novice taken on journey'[DGN:121]
	d. kályakàlya	'wife's br, sister's husband' [GB]
	e. kírlilkìrlilpa	'galah' [GB]
	f. mánjarnmànjarnpa	'irritation' [GB]
	g. yínkardàkurdàku	'owlet nightjar'[14] [DGN:1136]

In these examples, the final two syllables have been copied and suffixed to the root. In (21e,f) **pa** occurs at the end of the words to ensure that they are vowel-final. In (21a-c), stress is on the first and fourth syllables, in contrast to the usual pattern for monomorphemic words where stress is on the first and third syllables. In the data, two words have stress patterns similar to some of the frozen reduplications:

(22)	a. járnamiljàrnpa	'generation moiety term' [DGN:68]
	b. yúwayikìrdi	'babbler, bird sp.' [DGN:68]

These words are either borrowings like (22a) (Mary Laughren pc) or have been formed historically by compounding as in (22b) where **–kirdi** constituted a morpheme perhaps related to **kurdu** ‘child’.

In general, when stress is unpredictable, it has to be lexically marked. The location of stress in the frozen reduplications is predictable. Stress is always on the first syllable of the reduplicated element. The reduplicated element is polysyllabic and patterns in the same way as the polysyllabic morphemes with respect to stress. The reduplicated element is clearly identifiable with or without a morpheme boundary.

The question is whether lexical stress is necessary for these forms? If morphological boundaries were marked in frozen compounds and reduplicated words (as, for instance **mijili-jili**), then lexical stress would be unnecessary. LE would ensure that feet aligned to the left edge of morphemes. Marking morpheme boundaries in frozen word forms operates like lexical stress, but avoids the need to mark syllables with diacritics underlyingly.

The monosyllabic suffixes **-nja**, **-nji** and **ka** are always stressed when monosyllabic, but not polysyllabic, morphemes follow. Since they are monosyllabic, different contexts can have consequences for the stress patterns of these forms. Variation in the stress patterns of the stress-attracting morphemes occurs because they are monosyllabic and because of the priority polysyllabic morphemes have. In contrast, the stress patterns in frozen words do not change and are not affected by changing morpheme concatentations which occur in the infinitive, inceptive and aspect clitic forms and therefore LE will ensure stress occurs on unproductive morphemes.

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[14] Nash (1986) notes another stress pattern for this word ie **yínkardakùrdaku**. This will be discussed in Chapter 4.

In sum, LEXSTRESS is required for monosyllabic morphemes, while LE will account for stress in frozen reduplications and compounds. LEXSTRESS has application for a number of languages with lexical stress and can be included in the set of universal constraints.

In Warlpiri, there are patterns of stress involving lexically specified stress as well as those generated by the constraints. Constraints assess all outputs regardless of how stress is assigned. In Warlpiri the relevant constraints are:

(23) AlignPW, RA >> LE,Taut-F >> LEXSTRESS >> AlignFt

These constraints and ranking will ensure that stress is assigned in order of priority. Note that this is achieved by simultaneous application of the constraints and not step-by-step. A priority scale is illustrated in (24), where '>' = in preference to.

(24) Word-initial,
polysyllabic morpheme >
specific morpheme >
monosyllabic morpheme >
adjacent feet

This scale reads: stress is word-initial in preference to morpheme initial, in preference to specific morphemes (that is the infinitive, inceptive and aspect clitic), in preference to monosyllabic morphemes, in preference to adjacent feet. Outputs exhibiting all these priorities are possible.

In the next section we consider a derivational suffix in Martuthunira which attracts stress.

3.5 The Causative in Martuthunira

Martuthunira is a Pama-Nyungan language of the Ngayarda group, spoken in the north-west of Western Australia, described by Dench (1987, 1995). In this language the causative suffix **-ma**[15] attracts stress in much the same manner as the infinitive and inceptive suffixes in Warlpiri. One main difference is that stress is always present on the causative suffix regardless of the number of syllables in following suffixes. Recall that in Warlpiri, whenever a polysyllabic suffix follows the infinitive, the infinitive does not receive stress. In general, the causative attaches to a nominal stem and derives a transitive verb.

The stress patterns in Martuthunira are similar to those of Warlpiri. Stress occurs on the first syllable of polysyllabic morphemes, and the first monosyllabic suffix in a string of monosyllabic suffixes is stressed.

(25)	a.	pátha-rrngùli-nyìla-a	'throw-FUT-PrREL-ACC'
	b.	kányara-ngàra-la	'man-PL-LOC'
	c.	kányarà-la-ngùru	'man-LOC-ABL'
	d.	wángkarnu-màrri-lhà-rru	'talk-DerSFX-PST-now'
	e.	pányu-rrì-rra-rru	'good-INCH-CTEMP-now'

[15] This is probably a cognate of the **-ma-** causative in Warlpiri, historically derived from a transitive verb root ***ma** 'get'(Jane Simpson pc).

Dench provides a small amount of data on the effects of vowel length on stress. The generalisation is that stress cannot occur on a syllable following a long vowel, even if the long vowel is not stressed.

(26)	a.	tháapuwa	'rotten mouth'
	b.	tháapuwa-ngàra	'rotten mouthed fellows-PL'
	c.	tháapuwa-là-rru	'rotten mouth-LOC-now'
	d.	kápun-wìrraa-npa-lhà-rru	'body-PRIV-INCH-PST-now'
	e.	ngúrra-arta-npà-rra	'camp-ALL-INCH-CTEMP'

In examples such as (26d), stress does not occur on the suffix following a long vowel. In contrast, when the causative suffix follows a suffix with a final long vowel, stress occurs on the causative, as shown in (27a).

(27)	a.	ngúyirri-wìrraa-mà-rninyji	'asleep-PRIV-CAUS-FUT'
	b.	mírru-ngka-mà-lalhà-rru	'spear thrower-LOC-CAUS-PST-now'
	c.	wántharni-mà-rninyjì-rru	'how-CAUS-FUT-now'

When the causative morpheme is present, stress does not occur on the first syllable of a following polysyllabic suffix. The causative is always stressed regardless of the surrounding context. If there is no preceding causative morpheme, polysyllabic suffixes are stressed on the first syllable. In this way, the causative is similar to the monosyllabic verb roots in Warlpiri which are always stressed even when a polysyllabic suffix follows.

Stress is consistently located on the causative suffix. This is unlike the variable stress patterns involving the infinitive, inceptive and aspect clitic in Warlpiri. We can assume that the stress associated with the causative is part of its morphological specification and is captured by LEXSTRESS. We can also assume that Martuthunira has the same constraints as Warlpiri, which account for the general stress patterns.

In Martuthunira, the constraints on foot structure, that feet are trochaic and binary, are not violated; the alignment of the stem and prosodic word is not violated. On the other hand, alignment of feet with the prosodic word (AlignFt) and with polysyllabic morphemes (Taut-F) is violated. The lexical stress is assessed in relation to the other constraints. It does not override all the constraints, only some of them. These facts indicate that the assessment of lexical stress must occur in constraint tableaux.

The constraint LEXSTRESS specifies that a foot aligns to **-ma** and must be ranked above LE and Taut-F (in contrast to the ranking in Warlpiri where LEXSTRESS is ranked between LE and AlignFt). The tableau in (28) considers the form mirru-ngka-má-lalha-rru 'spear thrower-LOC-CAUS-PST-now' [míruNkamàlal5àru].

(28)

	LEXSTRESS	LE Taut-F	AlignFt
%a.(mírru)-ngka-(mà-la)(lhà-rru)		*** *	2: σσσ
b.(mírru)-(ngkà-ma)-(làlha)-rru	*!	** *	2: σσ

The output in (28a) incurs more violations of LE and Taut-F. However, since it does not violate the higher ranked constraint LEXSTRESS, as does (28b), it emerges as the optimal candidate.

There are no well-formed outputs that violate FtBin, FtForm, AlignL or LEXSTRESS. The fact that LEXSTRESS is a dominant constraint does not have to be stipulated as a separate statement involving lexical stress, but follows from the ranking and interaction of the constraints.

3.5.1 A note on long vowels and stress in Martuthunira

As noted, long vowels in Martuthunira exhibit unusual behaviour. Some syllables have long vowels which, although they are not stressed, can inhibit stress on a following syllable. Word-initial syllables are always stressed whether they have long vowels or not. In the following examples (repeated from (26)), stress is on the syllable with the long vowel. Stress on this syllable is expected since it is word-initial.

(29)	a.	tháapuwa	'rotten mouth'
	b.	tháapuwa-ngàra	'rotten mouthed fellows'
		rotten mouth-PL	

The stress patterns in (29) are like those of other trisyllabic morphemes. Stress is not sensitive to syllable weight in Martuthunira. If stress was sensitive to syllable weight, we would expect the following foot parsing ***(tháa)(pùwa)** rather than **(tháapu)wa** 'rotten mouth'. Thus feet are syllabic. In other contexts, syllables with long vowels are not stressed, as in (30).

(30)	a.	(kápun)-(wìrraa)-npa-(lhà-rru)	'body-PRIV-INCH-PST-now'
	b.	(ngúrra-a)rta-(npà-rra)	'camp-ALL-INCH-CTEMP'

In (30a), the syllable following the long vowel is not stressed, although this would be expected, since the long vowel is incorporated into the preceding foot.

The patterns indicate that syllables with long vowels pattern with light syllables for the purposes of stress. This information would be relatively uninteresting except for one fact. A syllable following one with a long vowel does not, except when the causative is present, get stressed. This fact suggests that a syllable with a long vowel suppresses stress on a following syllable, unless overridden by a more dominant requirement.

The general pattern is that stress is located on every odd-numbered syllable within a morpheme. However, two things throw this pattern out: the presence of a long vowel and the presence of the causative suffix. When these are adjacent in a word the stress of the causative suffix is maintained.

Syllables with long vowels exhibit a kind of prominence which is different from that of stressed syllables, and it appears that a following syllable can be included in this prominential domain. It would be worthwhile conducting further investigation into the phenomenon, but until then I sugggest the following informal constraint.

(31) **NOSTRESS**: A sequence $\sigma_{\mu\mu}\sigma_{\mu}$ is unstressed in outputs

This requirement is overridden when the causative is present which indicates that LEXSTRESS is dominant over NOSTRESS. The dominance of LEXSTRESS ensures the causative is stressed, as shown in (32).

(32) FtBin LEXSTRESS NOSTRESS

%a.(ngúyi)rri-(wìraa)-(mà-rniny)ji			*
b.(ngúyi)(rrì-wi)(ráa)-(mà-rniny)ji	*!		*
c.(ngúyi)rri-(wìraa)-ma-(rnìnyji)		*!	

The optimal output is when the causative is stressed, as in (32a).

NOSTRESS is crucial in deciding against outputs with an equal number of violations to LE, as shown in the following tableau. It also must be ranked above AlignFt to ensure that forms like (33a) do not emerge as optimal.

(33) kapun-wirraa-npa-lha-rru	LE	NOSTRESS
a. (kápun)-(wìrraa)-(npà-lha)-rru	**	*!
%b. (kápun)-(wìrraa)-npa-(lhà-rru)	**	
c. (kápun)-wi(rràa-npa)-(lhà-rru)	***!	

(33a) is least optimal because the syllable following a long vowel is stressed, violating NOSTRESS. The decision on the other outputs is made by LE. (33b) has less violations of LE than (33c) and so (b) is the best output.

The unusual stress patterns involving long vowels in Martuthunira are accounted for by assuming that long vowels suppress stress on following syllables.

Instances where stress is suppressed on particular morphemes have been documented for Turkish. In this language, stress generally occurs on the word-final syllable, but not if particular suffixes occur. Compare the data (34a & b) with (34c) cited from Halle & Vergnaud (1987):

(34)	a.	adám	'man'
	b.	adam-lar-á	'to the man'
	c.	adám-im	'I am a man'

The final suffix in (34c) cannot bear stress and so stress occurs on the preceding syllable. Such suffixes behave in the opposite way to morphemes or particular syllables which receive lexical stress. These latter items demand to be stressed, while the Turkish suffix demands no stress. The similarity in both types is that a lexical specification is required to capture their respective behaviour, which is unpredictable. Both require lexical faithfulness. Thus, just as it is necessary to specify foot alignment with specific morphemes, so too it is necessary to specify that feet do not align with specific morphemes.

Given these facts, we can assume that LEXSTRESS and NOSTRESS are of the same constraint family requiring faithfulness in the alignment interaction between lexical elements and prosodic structure. The constraints ensure that in outputs particular items have a particular metrical or prosodic identity which cannot otherwise be obtained.

3.6 Alternative analysis

In derivational analyses, assigning degenerate feet would be the only way to ensure that certain monosyllabic suffixes get stress. However, the analysis then has to explain why stress is not always assigned to these forms, and why monosyllabic feet do not surface in outputs. Such analysis faces the dilemma of being able to account for the unpredictable stress patterns, ie stress on specific monosyllabic morphemes, but not for the predictable ones, ie stress on polysyllabic morphemes or the first monosyllabic morpheme in a string.

Dench (1987, 1995) provides a rule-based analysis for the stress patterns of Martuthunira where most morphemes except for the majority of monosyllabic suffixes are assigned lexical stress. In some cases, stress is lexically assigned to syllables which never surface with stress, eg syllables with long vowels. A rule deleting stresses is required for contexts where the causative suffix, which is always stressed, precedes a polysyllabic morpheme with initial stress. The stress deletion rule ensures that adjacent stresses do not occur.

Given that stress is largely predictable, except for the causative suffix it is unnecessary to lexically assign stress. When morphemes have lexical stress, the influence of the causative on following morphemes is obscured, that is, if morphemes have lexical stress, it is not clear why some lose it. In my analysis, only the causative receives lexical stress and this stress is maintained when adjacent to polysyllabic morphemes. It is recognised that this priority is separate from that of other morphemes and this priority can be ranked. In other words, the causative is treated differently from other morphemes as reflected by the way it behaves. This is better than treating a morpheme which happens to occur adjacent to the causative as different. In my analysis, morphemes which behave unpredictably with regard to stress are given a status which sets them apart from other morphemes and is in line with most other analyses involving lexical stress.

3.7 Summary

LEXSTRESS accounts for stress on specific morphemes and can be construed as a universal constraint. Those elements that require foot alignment are indicated in the constraint. The ranking of the constraint is subject to individual language requirements.

LEXSTRESS, along with LE and Taut-F, are interface constraints. These constraints dictate the role of morphology in the phonology. In order to be active, that is, to make decisions on well-formed outputs, they must be ranked above AlignFt. Constraint ranking systematically accounts for the order of priority is the assignment of stress. This priority was obscured in rule-based theories.

In other models, the fact that specific monosyllabic morphemes are stressed in preference to other monosyllabic morphemes cannot be expressed in a straightforward manner. Lexically marked stress would predict that stress is obligatory, that stress is always on morphemes that it marks. However, such marking is useful only in one context and, as a consequence, such accounts have difficulty with variable stress.

I have shown that lexically specified stress must be assessed by constraints, since lexical stress may affect the stress patterns generated by constraints. Alignment of feet with lexically specified stress or with specific morphemes accounts for the data in a straightforward way.

Constraints and their ranking for the languages discussed in this chapter are summarised below:

Warlpiri: RA, AlignPW >> LE, Taut-F >> LEXSTRESS >> AlignFt
Martuthunira: RA, LEXSTRESS >> LE, Taut-F >> NOSTRESS >> AlignFt

CHAPTER 4

CHAPTER 4

RHYTHMIC ALTERNATION

4.1 Introduction

4.1 Introduction

The constraints required to account for the stress patterns of words in Warlpiri are given in Chapters 2 and 3. These constraints generate well-formed outputs such as [(máli)ki(lìlki)] from an input **maliki-rli-lki** 'dog-ERG-then'. In casual speech, a variation to the stress pattern of this output may occur, as in [(máli)(kìli)lki]. This variation in stress patterns is an option available in casual speech. Stress patterns in monomorphemic words may also vary, for example, from **(yínka)(rdàku)(rdàku)** 'owlet nightjar' to **(yínka)rda(kùrda)ku**. This is a context-free variation. Both kinds of variation result in a binary or ternary alternating rhythm.

This chapter is concerned with variant stress patterns in Warlpiri and with characterising these rhythmic patterns. By focussing on this issue an attempt is made to advance our understanding of rhythm within the theoretical paradigm of Optimality. I show that rhythmic patterns are constrained by the constraints RA and FtBin, generating binary and ternary patterns. As a consequence, it can be argued that rhythm is a result of foot adjacency and not necessarily foot alignment to the edge of a prosodic constituent. I argue that rhythmic variants can be generated at the same level as other forms, if it is assumed that some constraints are relaxed under specific conditions. The benefit of this approach is that an additional derivational level is not required and thus, is consistent with the principles of OT.

The structure of this chapter is as follows. The theoretical characterisation of rhythm is discussed in 4.2. This is followed by presentation of the data on stress variation in casual speech in Warlpiri. In 4.4, an account of the variation is given, where I argue for constraint relaxation. Alternatives to the analysis are considered in 4.5, and the role of AlignFt is considered in 4.6. Concluding remarks are given in 4.7.

4.2. Theoretical Characterisation of Rhythm

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In this section, I briefly outline the treatment of rhythm prior to OT, and then suggest how this may be interpreted in OT.

4.2.1 Previous accounts of rhythm

4.2.1 Previous accounts of rhythm

Prior to OT, one of the concerns in Metrical Theory was to characterise the observations regarding manifestations of rhythm in languages (Hayes 1984, Prince 1983, Selkirk 1984). In many languages, rhythm tends to be generated by the alternation of stressed and unstressed syllables.

A rhythmic pattern, where stress is on every alternate syllable, may not always be adhered to. For instance, there may be unfooted syllables or even adjacent stressed syllables. Rhythm may be defined by what it should avoid, as shown by the following statement from Hayes (1984):

(1) Eurhythmy Principle

A process is evaluated higher to the extent that it minimizes rhythmic ill-formedness.

Rhythmic ill-formedness is defined by two notions, they are Clash and Lapse (Prince 1983, Selkirk 1984). A clash is when there are two adjacent stressed elements (syllables or moras), eg, σ́σ́. A lapse is defined by the presence of two adjacent stressless elements, eg, σσ.

In metrical theory, if a word in a phrase had a different stress pattern from its pattern in isolation this was accounted for by a stress movement rule. Stress movement might occur to avoid stress clashes or lapses when words combine together.

Previous metrical theories rely on the representation of stress in the metrical grid to characterise rhythm. A metrical grid indicated the location of stress, as well as the degree of stress. (2) has examples of metrical grids, where 'x' indicates stress; the greater the number of x's the greater the degree of stress.

```
(2)     a.     x         b.   x
             x x              x
            sixteen          bees
```

When the two words in (2) combine, the stress pattern on one of the word alters. Under Metrical theory, it is argued that the stronger stress in **sixteen** moves to the left, as shown in (3).

```
(3)        x   x             x     x
         x x   x             x x   x
        sixteen bees   >   sixteen bees
```

One of the primary questions in Metrical theory was to determine what principles made one grid more eurhythmic than another. The metrical grid sees rhythm in terms of a linear sequence of strong, ie those with more x's, and weak positions. Here the concept of eurhythmy is based on the number of positions that occur between other positions.

The metrical grid is mostly concerned with prominence relations and less concerned with constituency, which means that stress is seen to move independently of prosodic constituent structure.

It is currently acknowledged (including Hayes 1991, Kager 1990, McCarthy and Prince 1990) that rhythmic patterns are better accounted for by foot constituency, rather than by a string of positions. Establishing the constraints on foot constituency has been of more current concern. In OT, foot size is constrained by FtBin, which accounts for the lack of stress clash and degenerate feet.

A sequence of strong and weak positions can be generated by parsing feet. This does not necessarily mean that rhythm is binary alternating only. As we will see in this chapter, foot size alone does not determine rhythmic alternation, as stress patterns may be binary or ternary, where the ternary patterns are not determined by morphological edges.

4.2.2 Rhythmicity

4.2.2 Rhythmicity

In Chapter 2, I noted that the rhythmic pattern in Warlpiri is ternary and binary. Binary alternation is a result of the constraints FtBin, RA and AlignFt which together ensure that stress alternates on odd-numbered syllables, as in **(kúru)(wàrri)** 'variegated'. The binary pattern of alternation may be disrupted by the presence of morphological boundaries, which are aligned with foot edges under the interface constraints Taut-F, LE and LEXSTRESS. Where there is an odd number of syllables in morphemes, a ternary pattern of alternation may emerge, for example **(máli)ki-(kìrla)ngu** 'dog-POSS'. This ternary pattern is not because feet are ternary, but is a result of the conflict between AlignFt and the interface constraints. These constraints require morpheme and foot alignment which interrupts the alternation of stress, as, for example, in **(wángka)-ja-(jána)**. As a consequence, unfooted or trapped syllables may be found word-internally like the syllable **ja** in **(wángka)ja(jàna)**. By the constraint RA, optimal outputs will have only one unfooted syllable between feet. An unfooted syllable together with a preceding foot creates a ternary pattern. While the trapped syllable is not incorporated into the preceding foot (due to FtBin), the presence of such syllables is nonetheless responsible for a ternary rhythmic pattern.

In Warlpiri, RA allows for a single unfooted syllable adjacent to a foot, ie (σσ)σ. FtBin bans ternary feet *(σσσ), but has nothing to say about the form (σσ)σ. Together (σσ) and (σσ)σ underlie the organisation of rhythm in Warlpiri.

The tendency for binary and ternary alternation, but not for other alternating patterns such as quaternary, is, according to Selkirk (1984), a reflection of a general rhythmic principle, the Principle of Rhythmic Alternation (ibid:52). According to this Principle, stress clash *σ´σ´ should be avoided and the spaces between stresses should be no more than two weak positions σ´σσσ´σ. This is interpreted as allowing binary and ternary alternation.

As I show in this Chapter, binary and ternary alternation occurs not because of principles operating to ensure clash and lapse are avoided, but through a combination of constraints on the location of feet. Adjacent feet are preferred in monomorphemic words (due to AlignFt) in Warlpiri, but non-adjacent feet may be generated in polymorphemic words. The extent to which feet may be non-adjacent is constrained by RA. RA contrasts with Parseσ in this sense as Parseσ simply notes how many syllables have not been parsed and not their location with respect to other unfooted syllables. For instance, the outputs (σσ)σ-σ-(σ-σ) and (σσ)σ-(σ-σ)-σ score an equal number of violations to Parseσ because both have two unfooted syllables, but RA ensures that the latter is the optimal output, because in the former two unfooted syllables are adjacent. RA and FtBin are the constraints which allow for rhythmic alternation:

(4) Constraints on Rhythmic Alternation
FtBin: feet are binary (σσ)
RA: no adjacent unfooted syllables *σσ

FtBin rules out feet other than binary ones, *(σσσ) *(σ). Adjacent unfooted syllables *(σσ)σσ, which would generate a quaternary alternation, are ruled out by RA. FtBin constrains foot size and RA constrains the distance between feet. Thus, while ternary feet are not possible, ternary alternation is.

Rhythm is essentially based on adjacency; non-adjacent feet create a ternary rhythm and adjacent feet create a binary rhythm. Foot size is constrained by FtBin and nonadjacent feet by RA. The constraints allow for both ternary and binary alternation.

In other languages, such as Estonian (Hint 1973, Prince 1980, Kager 1994, Hayes 1991), ternary alternation is an option along with a binary alternating pattern. Syllables are parsed into binary feet and stress may be binary or ternary alternating. Some examples of these patterns are given in (5).

(5) Estonian Binary and Ternary patterns (Hayes 1991)

Ternary	Binary	
pímestavàle	pímestàvale	'blinding,ill.sg.'

ósavamàleki	ósavàmalèki	'also more skillful abl.sg'
hílisemàtele	hílisèmatèle	'later,all.pl'

Hayes (1991) cites other languages with reported binary and ternary rhythmic patterns. In Karelian (Leskinen 1984), secondary stress can sometimes occur on the third rather than the fourth syllable, and so on. Both binary and ternary patterns are also possible for Hungarian (Balassa 1890 cited in Kerek 1971 and Hall 1938; Sovijarvi 1956, Szinnyei 1912, Lotz 1939).

Some analyses of ternary stress patterns have proposed that such patterns arise by constructing ternary feet (including Levin 1988, Dresher and Lahiri 1991, Rice 1992). Others have argued that Weak Local Parsing (Hayes 1991, Kager 1993a) where binary feet are separated by unparsed syllables gives rise to ternary patterns. The advantage of Weak Local Parsing is that ternary feet are not postulated as a prosodic constituent. Unlike binary feet, the ternary foot is not well-supported cross-linguistically. The foot inventory is thus restricted to binary feet in the Weak Local Parsing analysis.

I have shown in Chapter 2 that ternary alternation is possible even when a constraint on foot size, ie FtBin, is dominant. This has also been demonstrated by Kager (1994) for languages with ternary alternations such as Cayuvava and Estonian. Ternary alternation does not have to be generated by parsing ternary feet. Thus, the notion of a ternary foot *(σσσ) is rejected here (following Hayes 1994, Kager 1993a, M&P 1990, among others).

4.2.3 The data

The data on phrasal stress comes from a number of sources and informants. The primary data are from a tape-recording (archive tape 430A) made by Ken Hale (1966) of Paddy Stuart Jupurrula (Lanta River Warlpiri). A copy of the tape is provided with the thesis. The tape is approximately 50 minutes in length and consists of a number of stories about the old days, all of which are monologues. Hale made hand-written transcriptions of the recording. These were later typed up by Nash (1982) and the typed version was used in the analysis of stress.

Another recording (archive tape 4545a) made by Hale (1959-60) is of Mickey Connell (from Yuendumu) telling a number of short stories. A total length of 30 minutes was analysed. Hale's hand-written transcriptions, which included words marked for a single stress, of the recording assisted in the analysis. No translations of either of these Hale texts are available. The translations given for each example here are my own and I am therefore responsible for any errors.

A more recent recording of connected speech is of Mary O'Keefe Napurrula, recorded at Alekurenge in 1990 by Mary Laughren. The recording is of a short story, approximately 15 minutes long, titled 'Yapuntakurlu' transcribed and translated by Peggy Rockman Napaljarri and Lee Cataldi.

Throughout this chapter any example taken from Hale's tape recording is labelled with the page and line number corresponding to the typed transcription (Nash 1982) accompanying the tape. The page number corresponding to Hale's (1966) notes is also given and is indicated by 'HN'. Some pages of the transcription are provided in Appendix 2. Samples from the recording of Mickey Connell will be indicated by 'MC/HN', and for Paddy Stuart 'PC/HN'. Examples taken from the Mary Laughren recording will be indicated by 'MOK'.

4.3 Stress Patterns in Casual Speech

Casual speech is defined following Browman & Goldstein (1990:359) as ‘that subset of casual speech in which reductions typically occur.’ This definition is based on the frequent observation that there is often a difference in the pronunciation of words in isolation compared to their realisation in casual speech. In the data presented here, the stress patterns of words in casual speech may differ somewhat from those patterns found in the citation form of words. This may be a result of a number of phonological processes that occur in casual speech. These include word-final vowel deletion and glide vocalization. In some cases, stress patterns are affected by vowel deletion. While stress variation may be a consequence of vowel deletion, there are other instances where the motivation for variant stress patterns is not obvious.

In casual speech, feet may cross word boundaries resulting in a rhythmic pattern different from that when words are in isolation and this pattern may be either a binary or ternary one. In this section, examples of stress variation, including those resulting from word-final vowel deletion, are given. It will be shown that neither morphological boundaries nor prosodic word boundaries constrain stress patterns in casual speech.

Ternary alternation is generated by alignment constraints. A variant to this pattern is binary alternation. Binary variants are discussed in 4.3.1. In some cases where a binary pattern is generated by alignment constraints, a ternary variant on this pattern may arise as discussed in 4.3.2. This is followed by an examination of the rhythmic patterns that result when word-final vowels are not parsed.

4.3.1 Binary Variants

4.3.1 Binary Variants

In the texts spoken by Paddy Stuart (Lanta River Warlpiri), there are numerous instances of variant stress patterns (approximately 2.4% of the data) which do not cooccur with vowel deletion. I did not find this in the speech of the other two speakers[1].

In the following examples, there is no foot alignment with the left edge of the second word in the string. Instead, the first syllable of the second word is incorporated into a foot with a syllable from a preceding word. Such non-alignment violates a number of the constraints introduced in Chapter 2. The non-aligned syllables are underlined. Segments in '<>' are unparsed; only foot structure is indicated.

Some examples were analysed using Waves software and printouts of rms, F0, waveforms and spectrograms are given in Appendix 2. If a given example is in the Appendix it is indicated with a corresponding Figure number in italics.

(6) a. ka-nyi=rni kuyu > (kanyi)(rnu <u>k</u>u)yu [&♋✍⬂✋⬃✞✍&✞⍓✞☸
carry-NPST=HITHER meat [p2.13:HN1103] 'the meat is carried here'

b. ngula=juku=lpa nga-rnu > (ngula)(jukul)(pa <u>ng</u>arn)<u>
that one-still=IMPF eat-PST [☠✞✍●♋♍✞✍&✞■♋✍☠♋⬃]
'still that one was eating' [p20.12:HN1158]

c. manyu-karra-rlu nga-rni-yi > (manyu)(karra)(rlu <u>ng</u>a)rni<yi>
play-SUBJCOMP-ERG eat-NPST [❍♋✍⬂✞&♋✍▫❒⇧✞✍☠♋⬃♏✋]

[1] This may be because Paddy Stuart is of a different dialect from the other speakers and/or because Hale was much more familiar with Warlpiri at this time (the tape is later than the one made with Mickey Connell and thus Paddy Stuart may have paid less attention to his speech). The recording of Mary O'Keefe Napurrula was made in 1990 and contains a number of English words and probably shows features of modern spoken Warlpiri said to be quite different from traditional Warlpiri as noted by Bavin and Shopen (1987).

'....eating and playing' [p3.3:HN1105]

d. wali=lpa ngaka=lku > (walil)(pa <u>nga</u>)kal<ku> [⬥✐♒●★●✎✞♒✌♋⁺⬃✌●]
well-IMPF soon-then [p8.9:HN1122]
'well then soon (something happened)' *(see Appendix 2,Fig1)*

In (6a), word-final vowel assimilation occurs changing **rni** to **rnu** before **kuyu**.

From the constraints already introduced, binary and ternary patterns are expected. However, in some cases in casual speech, ternary patterns emerge where binary patterns are expected, or binary patterns emerge where ternary patterns are expected.

A number of words show variable stress patterns. Nash (1986) notes that there are some words which may have two slightly different stress patterns. For example:

(7) a. (máli)ki-(rlì=lki) ~ (máli)(kìrli)lki [❍♋♒●♓♑♓⇧♓♒●♑♓] ~ [❍♋♒●♓♑♓♒⇧♓●♑♓]
dog-ERG=then 'then the dog (did something)'
[DGN:115,116]

b. (míji)li(jìli) ~ (míji)(lìji)li [❍♓♒♍♓●♓♍♓♒●♓] ~ [❍♓♒♍♓●♓♒♍♓●♓]
'navel' [DGN:125]

I verified similar variations after listening to data I had recorded:

(8) a. (ngáju)lu-(ngùrlu) ~ (ngáju)(lù-ngu)rlu [♌♋♒♍◆●◆♌◆♒⇧◆] ~[♌♋♒♍◆●◆♒♌◆⇧◆]
I-ELAT [LB]
'I (came) from (somewhere)..' *(see Appendix 2, Fig 2)*

b. (pí-nja)-ni-(njàrla) ~ (pínja)(nìnja) [◻♓♒⬁♍♋■♓⬁♍♋♒●♋] ~ [◻♓♒⬁♍♋■♓♒⬁♍♋●♋]
hit-INCEP-INF-SEQCOMP [LB]
'(somebody) is hitting, while...' *(see Appendix 2, Fig 3a)*

c. (kúja)rni-(rlì-ji) ~ (kúja)(rnìrli)ji [♑◆♒♍♋⬀♓⇧♓♒♍♓] ~ [♑◆♒♍♋⬀♓♒⇧♓♍♓]
on other side-ERG-TOP [LB]
'(something) on the other side...'

d. (járna)mil(jàrnpa) ~ (járna)(mìljarn)pa [♍♋♒⬀♋❍♏●♍♋♒⬀◻✐] ~[♍♋♒⬀♋❍♏♒●♍♋⬀◻✐]
generation moiety term [LB] *(see Appendix 2, Fig 4)*

e. (júwa)yi(kìrdi) ~ (júwa)(yìki)rdi [♍◆♒⬩♋⌸♓♑♓♒❝♓] ~[♍◆♒⬩♋⌸♓♒♑♓❝♓]
'babbler bird sp.' [LB]

The stress patterns in the words in the left-hand column are those generated by the constraints introduced in Chapters 2 and 3. Those in the right-hand column are variations to the pattern generated by the constraints. Stress variation is an option on the general patterns. In the data examined, this option is not frequently taken; further work of a socio-linguistic nature may clarify the cause.

4.3.2 Ternary Variants

4.3.2 Ternary Variants

In previous accounts, stress variation in phrasal contexts is said to be due to stress movement and that stress movement is a result of Eurhythmic Principles (Hayes 1984). These principles state that the ideal rhythmic structure is one where stress alternates on every odd-numbered syllable. An unfooted single syllable between two feet would be ill-formed by the Eurhythmic Principles because a break occurs in the regularly alternating pattern of stress. The breaks or lapses arise in Warlpiri in words comprised of morphemes consisting of an odd number of syllables or moras. Stress movement applying to eliminate a lapse in the rhythmic pattern could be attributed to principles of eurhythmy. However, this is not always the case, as the data in (9) show. The optimal output generated by the constraints would be binary, but these forms show that ternary variants are a possibility. Such variants are not very common occurring much less frequently than binary variants.

(9) a. ngapa=ka=lu nguna > (ngapa)ka(lu ngun)<a> [☠♋✍♌①⬋♋●★✍☠■]
water=IMPF=3pS lying down *(see Appendix 2, Fig 5)*
'they are all lying down (near) the water' [p5.2:HN1111]

b. wurna=lku=lpa ya-nu > (wurnal)kul(pa ya)nu [⬩✆✍⬃⮰●♑✞●❑♋✍⍓⮰■◆]
travel=then=IMPF go-PST
'we were travelling then' [p17.2:HN1148]

c. ngarirliparla ngapa nyampu nya-nyi >
foliage;tea leaves water this see-NPST
(nga<ri>rli)(parla) nga(pi nyam)(pi nyany)i
'see this tea/leaf water' [p6.3:HN1116]
(*see Appendix 2, Fig's 6 & 7)*
[☠♋✍⇧★♌♋✍⇧⮰☠★♌☜✍⬂♋❍❑♓✍⬂✈⬂⮰]

In (9c), word-final vowels in **ngapa** and **nyampu** have fronted before **ny**. Consonant lenition is illustrated in (a) where /k/ is realised as [⬋]. Vowel deletion is frequent.

Under the constraints, we would expect a binary pattern but these examples show that a ternary pattern is possible. It is less common to find a ternary pattern where a binary one is expected. Ken Hale (cited in Nash 1986:136) noted stress variation in the following example where the variant (on the right) occurred in casual speech:

(10) (yínka)(rdàku)(rdàku) ~ (yínka)rda(kùrda)ku
'owlet nightjar'

While a binary pattern is expected in the examples in (9,10), variant ternary patterns occur. This ternary pattern is not common in monomorphemic words, which suggests that ternary variants on expected binary patterns is not as preferable, or does not exist at all as an option for some speakers or dialects.

4.3.3 Vowel deletion

4.3.3 Vowel deletion

Word-final vowel deletion, or non-parsing of final vowels, commonly occurs in casual speech[2]. When it occurs it has a direct effect on the rhythmic structure of an utterance. Final vowels may delete within an utterance as in (11a,b) or at the end of an utterance as in (11c,d).

(11) vowel deletion in trisyllabic words

a. ka-nyi=rni yangka > (kanyi)(rn<i y>angka) [&♋⬂♉✋⬀☼♋⬂☠&✌]
carry-NPST=HITHER that one [p3.2:HN1105]
'carrying that one over here'

b. ngakalu pina > (ngakal)<u> (pina) [☠♋⬂&♋●◻♓⬂■✌]
soon wise;experienced [MC/HN20]
'soon (someone) will be wise/knowledgeable'

c. pangurnu > (pangurn)<u> [◻♋⬂☠✞⬀]
'wooden scoop' [MOK/p3.15]

d. rdarri-marda-rnu > (rdarri)(mardarn)<u> [❝♋⬂❒♓❍♋⬂❝♋⬀]
hold;have-PST '(someone) held (something)' [MOK/p4.9]

Where final vowels are not parsed, a consonant may syllabify into the onset syllable of a following word when the syllable is glide initial, as, for example in (11a), where **rn** resyllabifies into the onset of the following word and the glide vocalises. Alternatively, a consonant syllabifies into coda of the preceding syllable as in (b,c,d).

Bavin (1986) reports that it is common to find final syllable deletion in casual speech in Warlpiri, citing the example, **karntaku** ‘woman’, which can be realised as **karntak**.

When a vowel is not parsed in a word with an even number of syllables, a ternary pattern arises as shown in (12):

(12) a. ngurrju-manu > (ngurrju)-man<u> [☠◆⬂❒♍◆❍♋■]
make/fix-PST [MOK/p8.12]
'made (something)'

b. manta yangka > (mant<a y>ang)ka [❍♋⬂■⧫♋☠&♋]
take;get-IMPER that one [MC/HN25]
'take that one!'

c. yankirri-ki yani > (yanki)rri(k<i> ian)<i> [✋♏⬂★■⬁⍓✋❒♏⬃✋⬂⍓♋■]
emu-DAT go-NPST [p6.3:HN1115]
'the emu (meat) is going' *(see Appendix 2, Fig 8)*

[2] The figures for vowel deletion evident in the data are: Paddy Stuart 15%; MC 10%; MOK 6%; with the overall rate at 12%. These figures were obtained by counting the number of words as transcribed in the texts and dividing that by the number of word-final vowel deletions.

d. pu-ngu kala > (pung<u> ka)la [✌□①✎☠⬥□♋●♋]
hit;kill-PST but [p10.1:HN1126]
'killed, but..' *(see Appendix 2, Fig 9)*

e. kapalarla yi-nyi > (kapa)la(rl<a> i:ny) [&♋✎□♋●♋"♓✎▫⬂]
give-NPST [p3.12:HN1106]

In (12c and e), the initial glide in the second word vocalises upon syllabification of a consonant from the preceding word.

In the following example, the final vowels of the first two words fail to be parsed, effecting the alignment of feet with word boundaries.

(13) ngari=lpa=lu yangka yanu > (ngaril)(pal<u> yang)(k<a y>anu)
=IMPF=3pS that one go-PST [☠♋✎□✋●□✆✎⬦♋☠&✆✎■◆]
'they all go to that (place)' [p4.5:HN1108]

The glide of the second word **yangka** forms a palatal with the lateral that syllabifies from the preceding word. The glide **y** of the third word in the string **yanu** deletes when **k** from the preceding word syllabifies into onset.

As shown in the above examples, syllabification may occur across word boundaries, violating AlignL and the requirement that words are vowel-final. Failure to parse word-final vowels violates PARSE-SEG.

Word-final vowel deletion may apply to a word in any position in a string, internal or final. The response to vowel deletion may be other segment deletions, lenition, or fewer feet than expected. Word boundaries do not block phonological processes applying in casual speech, and constraints that hold for the prosodic word, do not necessarily hold in casual speech. It appears that there is some independence between foot formation and vowel deletion, since we find that a final vowel in a disyllabic word may delete, just as we find vowel deletion in trisyllabic words. However, while foot formation is dependent on vowels, vowels are not dependent on feet.

When vowels are not parsed, a different rhythmic pattern may arise contrasting with the rhythmic pattern where all vowels have been parsed. Vowel deletion occurs regardless of what effect it may have on rhythmic structure. There is no evidence to suggest that vowel deletion occurs in a trisyllabic form in order to generate a binary rhythm. If one particular rhythmic alternation pattern was preferred over another, vowel deletions such as /σσσσ/ > (σσ)σ<σ>, where final vowels are not parsed, giving rise to a ternary pattern, would not be expected.

Effects on stress patterns as a result of phonological processes have been described in other languages. Halle and Vergnaud (1987) cite stress shift in Russian, and Tiberian Hebrew as due to deletion, glide formation in Sanskrit, and vowel insertion in Winnebago. In Tokyo Japanese, which is a pitch accent language, high vowel devoicing affects the accent patterns.

4.3.4 The Domain of Stress Variation

When speaking, phrases, including single word phrases, are associated with an intonation contour. Intonation contours have particular characteristic shapes which are assigned to a phrase or an utterance (Selkirk 1984, Nespor and Vogel 1986, Pierrehumbert 1980, Beckman 1986). An utterance may consist of a single word or a string of words.

Some brief comments are made here on intonation in Warlpiri, which are based on monologic speech, in particular that of story-telling style. There has so far been no systematic study of Warlpiri intonation patterns[3].

In an intonation phrase only one main stress is heard in an utterance of one or many words. Based on my perceptual interpretation, primary stress is not present in all words. Stress is perceived on all words, but this stress is heard as relatively equivalent to all other stresses in the utterance. The exception to this is prominence located in initial or final position in an utterance.

When a word appears in isolation, the syllable with primary stress is the initial syllable. When a word is combined into a sentence, there may be no primary stress on its initial syllable depending on its position in the sentence. In non-initial position in a sentence, a word has no distinction between the stresses it carries. That is, there is no significant differentiation between stresses present on the first, third or other moras of a word. Perceptually, all stresses are relatively similar.

On the other hand, a word at the beginning of a sentence or after a pause will carry a main prominence on its initial syllable. This main prominence is generally the most salient compared to the stresses which follow.

Two main types of intonation patterns were noted in the data, a declarative type and a listing type. In a declarative type intonation pattern, the more prominent tone is that located on the first syllable of the initial word in the utterance. The end of the utterance is marked by a low boundary tone, as shown in (14)[4].

(14) Nyampu-rla=lku yi=rna purra-mi [p2.5:HN1102]
here-LOC=now RELCOMP=1sS cook-NPST
'I am here now to cook'

The pitch range is small; the beginning of the utterance is at around F0 200 and the end at around F0 150. In a listing-type pattern where a number of items are listed, each listed item except for the final one ends with a high tone (around F0 250). Examples of this pattern are given in (15).

(15) a. Ngaka ngarni yankirri pakuru mala jajina.
by-and-by ingest;move emu bandicoot rat-kangaroo mouse.
'by-and-by they move the emu, the bandicoot, the rat kangaroo and the marsupial mouse'
[p11.19:HN1131]

b. pakarninjarla [LB] *(see Appendix 2, Fig 3c)*
strike-NPST-INF-SERCOMP
'while striking'

The high and low tones mark the boundaries of an utterance (or an intonation phrase). Following a pause, an utterance is always aligned with the beginning of an intonation contour. The beginning of an utterance is defined as coinciding with a pause. In the following examples the full stop coincides with a pause and following the pause is the beginning of an intonational phrase. Note also that the intonation pattern is similar whether for a single or a multi-word phrase.

[3] Heather King (University of Edinburgh) is currently undertaking a study of intonation in Warlpiri.

[4] The intonation contours are the F0 contours as interpreted by the Waves acoustic program. The contours here approximate with those generated by the program, except that I have not included voiceless consonant breaks in the contour.

(16) a. Kapi miyi yarla warru-karla. Nyampurlalku yirna
FUT food yam around-dig for. Here-LOC=now RELCOMP=1sS

purrami.   Yamangka. [p2.5:HN1102]
cook-NPST   shade-ERG
'dig around for yams. I also continue to cook here in the shade'

b. Pirrarnirli ngularna   pakarnu.   Ngulalku.
yesterday-ERG that one=1sS strike-PST that one=then

Ngarninjarla yantarli nyinanjarla yarda nguna.
eat-NPST-INF-SERCOMP staying at home again lying down

Yantarlilki. [p2.17:HN1104]
at home then
'Yesterday, I killed that one and I ate it, after staying at home lying around.'

The nature of IP, that is, whether it is a prosodic or semantic constituent, or both, is uncertain. Therefore, the relationship of IP with the prosodic constituents, PW, F and σ is not clear. What is certain is that the IP serves as a domain for the alternation of rhythmic units. This domain is delimited by the edges of intonational phrases, which coincide with pauses.

Prosodic constituents do not straddle IP boundaries. Based on this observation, I propose a constraint requiring the left edge of the foot to align with the left-edge of the IP. The IP edge is indicated by '{'.

(17) **AlignIP:** the left edge of a foot aligns to the left edge of an intonational phrase.

The edges of the IP constrain the alternation of the feet. For instance, within an IP, a foot or syllable may straddle word boundaries but not intonational boundaries. For instance, *(σ{σ)....} is not possible. Only one foot is required to align to an IP in contrast to AlignFt which requires all feet to align to a PW edge. I argue later that edge alignment is required for one foot, but the location of other feet is not determined by alignment, but rather by adjacency.

It would be expected that IPs align with morphosyntactic structure, rather like the alignment of the left edge of a stem with the left edge of a prosodic word. Thus, the left edge of an utterance, a morphosyntactic category, aligns with the left edge of an intonational phrase. In examples (15-16), the edges of the IP are where breaks occur in the contour due to slight pauses in speaking. This may mean, as in the example in (15), that each word in a sentence is aligned with its own intonation contour.

A string of words in an intonational phrase is like a single word. Word boundaries are blurred and main stress occurs only at the beginning of the intonational phrase. This main stress would appear to be the combination of stress and a high intonation tone. The notion of prosodic word in intonational phrases may be somewhat flexible, but further research is required to investigate this.

When words are in phrases, the edges of these phrases or strings are the crucial edges for alignment. This is the case whether speech is slow or fast. It appears that word or morpheme edges are less important under casual speech conditions than intonational phrase edges. The higher the constituent on the prosodic scale, ie an IP, the more relevant its edges are for alignment, in comparison to lower constituents, ie a prosodic word.

There is little data on phrasal rhythmic patterns in other languages apart from some Indo-European languages. Bruce (1984) reports that in Swedish stress movement occurs across word boundaries in phrasal contexts. Schutz (1985) gives a small amount of information regarding stress movement across words in Fijian.

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4.3.5 Summary

As the data shows, word boundaries are not always relevant in casual speech, as evidenced by stress placement (examples (8) & (9)) and by syllabification across word boundaries (eg (13)). The requirement that prosodic words are bimoraic and vowel-final does not always hold when word-final vowel deletion occurs.

Non-parsing of word-final vowels may mean that unsyllabifiable elements delete (or are not parsed) (examples (11) & (12)), and that consonants syllabify across word boundaries resulting in word-initial glides vocalizing (examples (13) & (12e)). Foot structure is adhered to as there are no degenerate feet or stress clashes.

While feet and syllables may cross word and word-internal morpheme boundaries, they do not cross intonational phrase boundaries.

The align constraints that are violated in casual speech are AlignL, AlignPW, Taut-F, LE, LEXSTRESS, AlignFt. PARSE-SEG is also violated. The constraints that hold are FtBin, RA and FtForm.

In the next section, I develop an account of the stress patterns in casual speech.

4.4 An Account4.4 An Account

Variation in stress patterns across morpheme boundaries in Warlpiri can be considered a connected/casual speech phenomenon which is sensitive to pause and insensitive to morphological structure (Kaisse 1985). This contrasts with other connected speech processes, such as sandhi, which are sensitive to morphosyntactic contexts. Processes that occur under casual speech conditions are optional.

As noted, word boundaries do not always restrict the rhythmic organisation of an utterance. This is exemplified in (22), where, if prosodic word boundaries were present, a foot straddles prosodic word boundaries.

(18) a. [(ká-nyi)-rni] [(kúyu)]
b. [(ká-nyi)(rnù][ku)yu]

(18a) is the optimal word generated by the constraints and contrasts with (18b), where the final syllable in the first prosodic word is stressed and the second prosodic word lacks stress.

Syllabification may occur across prosodic word boundaries (if present) when a word-final vowel is not parsed, as shown in (19).

(19) σ σ σ σ σ σ σ σ σ
/\ /\ /\ /|\ /\ /\ /\ / \\ /\
[(ká.nyi.)rni.][(.yáng.ka.)] > [(yá.nyi.)(.rn<i>][ang.)ka.]

The problem is to account for the variant forms that arise under casual speech conditions. Constraints govern well-formedness of outputs, but outputs generated under casual speech conditions are not always well-formed by the constraints. There are a number of possibilities that may provide an explanation for the problem. Before these are addressed, it is necessary to discuss prosodic constituent structure under casual speech conditions.

4.4.1 Prosodic word in casual speech

Since word boundaries are ignored in both stress placement and syllabification in casual speech, the issue of prosodic word structure is relevant. Within an IP, internal prosodic word structure appears non-existent or irrelevant. To account for this, two main alternatives are considered. The first is that in casual speech the presence of prosodic word structure is optional, and the second is that prosodic word structure is present, but it is irrelevant to other prosodic constituent structure. The former possibility is discussed first.

As mentioned in the section on intonation, a string of words bounded on either side by a pause resembles a single word. Main stress occurs on the initial syllable in the string and no other differentiation between main and secondary stress is made. This observation, together with the fact that feet and syllables may straddle word boundaries, indicates that prosodic word structure internal to an IP is not present. In such cases, we could say that generating prosodic word structure is optional under casual speech conditions, that alignment of stems with prosodic word edges is not always required. Under this analysis, there is the option of viewing phrases as consisting of one prosodic word or of a number of prosodic words. Furthermore, if we say that it is optional, we account for the cases where prosodic word structure is present. This means that from an input /σσσ//σσ/ the prosodic word structure may be [σσσ][σσ] or [σσσ σσ].

If generating prosodic word structure is optional, there will be violation to the requirement that particular morphological categories, ie stems and roots, correspond to prosodic words. Having some constraints as optional is explored further in the following section.

The other alternative is that the prosodic word is generated, but is irrelevant. This will mean that feet straddle prosodic word boundaries, and that syllabification occurs across such boundaries. Such structures are not permitted by the Prosodic Hierarchy. The question is why would prosodic word structure be generated if it was subsequently ignored? An answer may lie in the notion of mismatched representations.

McCarthy (1986) and Blevins (1995) argue that mismatches between phonological representations and phonetics in the phonetic interpretive component are possible. In other words, changes that occur in the phonetic component do not effect the phonological representation. For instance, where vowel deletion has occurred, the phonological representation of the syllable is not affected, as represented in (20). In such cases, the phonetic target is not quite reached.

(20) σ σ

/\ /\
[(C V C <V>)]

Consider the possibilities if syllable structure, which affects foot and prosodic word constituents, did not alter. If a final vowel in a disyllabic word was not parsed, as in (20), we would expect stress clashes in the phonetic interpretive component when adjacent to another word, shown in (21).

(21) σ́ σ σ́ σ
/\ /\ /\ /\
[(C V C <V>)] [C V C V]

In the mismatch analysis, resyllabification of the stranded consonant should not occur if the syllable node remained after deletion. However, in the data presented here resyllabification does occur (see (12) b, c and e). Furthermore we would expect stress clashes in (21) because the second syllable is only representational, but since we do not find these, we can assume that non-parsing of vowels simply means that no mismatch between phonological and phonetic representations exists, or that it cannot be characterised in this way.

An alternative to the mismatch analysis is to say that the phonological component is 'hidden' under phonetic implementation. This is based on claims by Browman & Goldstein (1990) that the gestures or articulation of segments can be reduced and/or overlap resulting in hidden or blended gestures. Phonetic and phonological variation can be a result of overlapping gestures. Thus, if segmental gestures overlap, this would mean syllables do as well and that, at word edges, prosodic word boundaries are overlapped or blurred. Under these conditions, prosodic words are no longer distinct entities. Hidden and blended gestures are discussed more in 4.4.4.

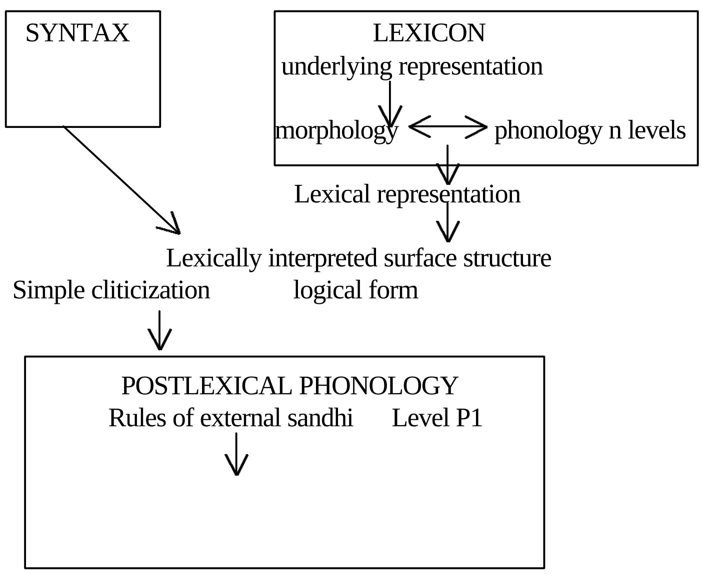
In conclusion, the solution where prosodic words are optionally parsed is preferable to the alternative of parsing prosodic words and allowing violation to the Prosodic Hierarchy.

Now that the nature of prosodic word in casual speech is established, we need to ascertain whether these forms are generated on a different level or on the same level as the optimal forms in the tableaux presented in Chapters 2 and 3.

4.4.2 Constraint Relaxation

In previous derivational accounts, casual speech processes applied to outputs from a word level. This is characterised in a model (simplified) from Kaisse (1985:20):

(22)



Pause insertion
↓
Rules of casual speech   Level P2
↓
Connected speech

In this model, derived outputs from the lexicon are submitted to postlexical phonology. In the postlexical component, outputs may undergo two types of rules, P1 and P2 rules (Kaisse 1985). P1 rules are rules of external sandhi which apply in specific morpho-syntactic environments, while P2 rules are connected/casual speech rules which are sensitive to notions of adjacency, in particular, the absence of pause between segments or constituents.

In OT outputs are generated from underlying representations through a constraint system avoiding the need for derivation from one level or component to another. However, since the variant forms in the data violate many of the constraints, positing another level may be necessary. One reason why we might want to generate variant forms on a different level is to allow Bracket Erasure (Pesetsky 1979, Kiparsky 1982, Mohanan 1982, Inkelas 1989) of internal structure. Bracket Erasure (BE) occurs at the interface between different levels in the grammar. As discussed above, feet may cross word boundaries and if prosodic word brackets were present this would violate AlignPW and AlignFt. If there were no internal prosodic brackets present, then prosodic constituents straddling the boundaries of other prosodic constituents would not occur and would not be a problem.

However, Bracket Erasure would be the only reason why we would want different levels, as no other motivation exists. Since the processes that occur under casual speech are optional and infrequent, positing a different level is unnecessary. Additionally, BE is not required if prosodic word structure is not constructed in the first place.

It has been argued that variant forms can be generated through one set of constraints at one level (including Kager 1994, Anttila 1995). This analysis has been applied to languages where there is a high frequency of variation, which is not dependent on speech rate or sociolinguistic factors, as shown by Kager and Anttila for Estonian and Finnish respectively. Re-ranking or the partial ranking of two constraints is able to generate the variant forms (discussed in 4.5.2).

Following a similar line of investigation, I propose that the casual speech variants in Warlpiri can likewise be generated at the one level. However, in contrast to re-ranking or partially ranking constraints, I propose that some constraints are 'relaxed'[5] or 'by-passed' under casual speech conditions.

Constraint re-ranking does not occur under specific conditions; where two constraints, X,Y, are unranked in the grammar of a language, X is dominant over Y in one tableau, and in the other tableau the ranking is reversed Y > X. Re-ranking accounts for a high frequency of variation and is suited to cases involving two constraints.

In contrast, variant forms are produced under casual speech conditions and are less frequent and may violate a larger number of constraints, than non-casual speech variants. In addition, variants under casual speech occur across word strings and are not confined within words. Casual speech conditions are determined by rate of speech and context. Variants produced under casual speech conditions tend to show more changes to phonological structure, including lenition and glide vocalisation, than other (non-casual speech) variants.

In derivational accounts of phonology, casual speech rules are optional and apply to outputs from another level. If the OT principle of simultaniety is pursued, casual speech variants

[5] This terminological suggestion was made to me by Avery Andrews.

can be generated at the same level as other forms without invoking an additional level. Relaxed constraints are like optional rules; we can equate optional rules with constraint violation which may or may not be ignored. Hence, where constraint violations can be ignored, we can say the constraint is relaxed. Since constraints not rules generate outputs, it must be the status of violations to constraints that is fundamental to the generation of casual speech variants.

Determining how and when constraints can be relaxed is then a necessary step. I propose a principle governing the relaxation of constraints where specific conditions determine when relaxation is upheld.

(23) Constraint Relaxation[6]
Under casual speech conditions, constraint(s) can be nominated as relaxed in tableaux.

Where constraints are relaxed, more than one optimal output will arise in tableaux. This contrasts with the standard view in OT, whereby a single optimal form is generated in tableaux. There may be two possible outputs as a result of casual speech conditions[7].

Since casual speech is produced under specific conditions, tableaux will be specific to such conditions and contrast with tableaux where constraints are not relaxed. Thus, there will be two tableaux: one which generates the optimal forms according to all the constraints in the grammar and another in which the relaxed constraints have been de-activated.

In the model I am proposing, all outputs are generated at the one level, but it is the conditions that determine whether all constraints apply or not. This model is schematised as:

(24) /input/ > ┌── all constraints apply
└── constraints are relaxed

Under casual speech conditions, a number of constraints are nominated as optional. Since feet may cross morpheme and word boundaries, the constraints AlignL, AlignPW, AlignFt, LE, Taut-F are nominated as optional. These constraints involve prosodic word and foot alignment. Feet optionally align with lexically marked syllables and with specific morphemes, and thus LEXSTRESS is also nominated as optional. In contrast, the dominant constraints AlignIP, RA and FtBin are not optional and cannot be violated. As RA is dominant, Parseσ is also an optional constraint.

The optional constraints operate as a set, although it is possible that constraints requiring alignment to prosodic word, ie AlignL, AlignPW and AlignFt function independently of the foot and morpheme alignment constraints, as discussed in 4.6.

In the tableaux in this section, I consider only those words which have variant stress patterns unaffected by vowel deletion.

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[6] This constraint was originally introduced in a paper presented at the Australian Linguistics Conference 1995.

[7] Avery Andrews has suggested an alternative ranking possibility. At a particular point on the ranking scale, the scale divides into a fork and the choice is to take either the top or bottom path, eg —<>—. The top path road may be taken under casual speech conditions. However, there needs to be a number of these forks on the ranking scale for Warlpiri, since the constraints that are relaxed under casual speech conditions are at various points along the scale. The question to be resolved is whether this is more complicated than relaxing certain constraints. My present view is that it is.

When all constraints are obligatory, there is a single optimal output, as the following tableau illustrates:

(25) ka-nyi-rni kuyu	AlignPW	LE	Taut-F	AlignFt
%a. [(kányi)rni][(kúyu)]		**	*	
b. [(kányi)(rnì][ku)yu]	*!	**	**	2:σσ

If violations against the constraints in (25) were ignored then there would be two optimal outputs, as in the following tableau where the relaxed constraints are omitted.

(26) ka-nyi-rni kuyu	AlignIP	FtBin	RA
%a. {[(kányi)rni][(kúyu)]			
%b. {[(kányi)(rnì ku)yu]			

Another possible output is {[ka-(nyí-rni)][(kúyu)]}, which violates AlignIP because a foot is non-aligned with the left edge of the IP.

Since the dominant constraints AlignIP, FtBin and RA cannot be violated, they restrict the range of possible variation. This is the case in the following tableau involving a word located at the beginning of an intonational phrase.

(27) ngajulu-ngurlu	AlignIP	FtBin	RA
%a. {[(ngáju)(lù-ngu)rlu]			
%b. {[(ngáju)lu-(ngùrlu)]			
c. {[nga(júlu)-(ngùrlu)]	*!		
d. {[(ngáju)lu-ngurlu]			***!

(31a,b) are the optimal candidates. (31c,d) are ruled out by AlignIP and RA. Ternary variants can likewise be generated under constraint relaxation, as in the following tableau.

(28) wurna=lku=lpa ya-nu	AlignIP	FtBin	RA
%a. {[(wúrna)=(lkù=lpa)][(yá-nu)]			
%b. {[(wúrna)=lku=(lpà ya)-nu]			
c. {[(wúrna)=lku=lpa][(yá-nu)]			*!
d. {[wu(rná=lku)=lpa][(yá-nu)]	*!		

In monomorphemic words, it is necessary to ensure that AlignFt is relaxed to account for the variant ternary patterns.

(29) yinkardakurdaku	AlignIP	RA	FtBin
%a. (yínka)(rdàku)(rdàku)			
%b. (yínka)rda(kùrda)ku			

The constraints that account for the stress patterns in Warlpiri are part of the grammar. Under casual speech conditions some constraints do not always hold. What is interesting is that the dominant rhythmic constraints hold and we should expect a similar situation in other rhythmic languages displaying binary and ternary patterns. This is in fact the case with Estonian, discussed in section 4.5.2.

Instead of nominating constraints to be relaxed, it may be preferable to regard morphological boundaries as not present or irrelevant. However, this would mean accounting for instances where alignment has occurred with morphological boundaries at certain locations throughout a word or strings of words. Recall that the morphological structure of a word determines binary and ternary patterns when constraints are obligatory, eg (σσ)σ-(σσ)σ-(σσ), (σσ)(σ-σ)-(σσ). Given that ternary patterns arise from morphological alignment, such patterns would be difficult to explain in the absence of boundaries, particularly since ternary variants are much less frequent than binary variants.

In casual speech, morphological boundaries have less relevance and the interface constraints AlignL, LE, Taut-F, LEXSTRESS play a lesser role in the assessment of outputs under these conditions. The conflict between morphological and prosodic dominance is somewhat alleviated under casual speech, generating a range of variant forms. The advantage of the analysis presented here is that casual speech variants can be accounted for without introducing an additional level in the grammar, and is thus consistent with the principles of OT. In addition, with the proposed model, it is possible to account for different speech styles.

4.4.3 PARSEs and RA

In 2.3 I argued that the specific parsing constraint, RA, is required to account for stress patterns in Warlpiri. The analysis of rhythmic alternation in this chapter further supports this constraint. Under PARSEσ, ternary patterns could not be generated, since they would incur more violations of PARSEσ, as shown in (30).

(30)	RA	PARSEσ
(σσ)σ(σσ)σ		**!
(σσ)(σσ)(σσ)		
(σσ)σσ(σσ)	**!	**

RA says nothing about (σσ)σ, but prevents sequences of adjacent unfooted syllables. RA is a more sophisticated parsing constraint which also ensures rhythmic alternation and this may be a reason to abandon Parseσ in favour of RA.

4.4.4 Segments in Outputs

Under casual speech conditions, changes occur to segments in outputs which would violate the

Correspondence constraints requiring exact identity between inputs and outputs. This prompts us to consider the kinds of identities acceptable in casual speech. We can think of segmental alterations in terms of the gestural model of Browman & Goldstein (1989, 1990). In this model, gestures are described as a combination of inherent spatial and temporal aspects. The spatial aspect is the constriction formed by the articulators and this action occurs within some inherent time. Browman and Goldstein propose the segment deletions, insertions, assimilations and weakenings that occur in casual speech can be explained as resulting from two kinds of changes: (1) a reduction in the magnitude of articulation; (2) an increase in overlapping of articulations. As a result of these changes segments can be hidden or blended.

An example of a hidden gesture is the /t/ in '**perfect memory**' which is present when the word **perfect** is said in isolation, but in the phrase it is not heard, eg [◘★❐♐★&❍☜✍:❍★❐❒♓]. When Browman & Goldstein examined the articulation data, they found that an alveolar closure was produced, but it was completely overlapped by preceding and following closures. Thus in articulation terms the gesture is present, but due to overlapping, the /t/ is acoustically hidden. The same explanation is given for other segmental changes.

Given these facts, there is the sense that segments are not deleted or altered, at least in articulation terms. This would mean that the Correspondence constraints, ie MAX-IO, DEP-IO and IDENT(F), could be fine-tuned to account for articulatory and acoustic dimensions in casual speech. When speech is carefully pronounced, both dimensions would be evenly matched, but in casual speech we can expect the articulatory dimension to compromise the acoustic one. The details on how either dimension would function as constraints in casual speech require more space than is available here, and research on whether all languages support the hidden segment theory is needed.

We should note that the gestural explanation will not let us off the hook when word-final vowel deletion occurs at the end of an utterance, since it is not overlapped by a following consonant, although it could conceivably be overlapped by a preceding one. To account for final-vowel deletion, a constraint requiring words to end in vowels would be relaxed. Final vowels are not parsed in the variant in (31b):

(31) a. [(yán.ki.)(rri.ki.)][(yá.ni)]
b. [(yán.ki.)rri.(k<i>][ían.)<i>]

In sum, in casual speech gestures are modified so as to produce overlapping articulations. The gestures may be modified because a speaker is paying less attention to what he/she is saying (Dressler & Wodak 1982; Barry 1984) or because the speaker is articulating faster. In either case, gestural modifications result in relative variations.

4.4.5 Binary vs ternary alternation

As shown by the data, ternary alternation as an option is not as common as binary alternation. While ternary alternation is generated by the constraints, it is less common as a variant on binary patterns. One possible reason for this imbalance may be because binary patterns tend to be easier to generate. Binary patterns are generated by ensuring feet are adjacent to each other. Generating ternary patterns may be slightly more difficult as it is necessary to ensure that one syllable intervenes between feet. However, it is interesting to note that in Martuthunira phrasal stress patterns (Dench 1987), ternary alternation occurs contrary to the expected binary pattern as in the examples below (no glosses given).

(32)	*word stress*	*phrasal stress*
	pátha-rrálha-rru	pátharralhárru
	máni-ngká-npa-rra	máningkanpárra
	yákarrángu-la	yákarrangúla
	kányará-npa-rrá-rru	kányaranpárrarru

Dench notes that in words with five syllables, stress often occurs on the penultimate syllable showing a preference for a ternary+binary pattern over a binary+ternary pattern. Sometimes the stress pattern of a word is altered so that it is similar to that of other words in a phrase.

The examples of ternary alternation suggest that there is a greater control over such patterns than what was previously thought and that generating such patterns may not be related to ease of production.

4.4.6 Summary of analysis

In the analysis presented in this section, I have argued that under casual speech conditions certain constraints can be relaxed. The variants produced are constrained by the rhythmic constraints.

The constraints and their ranking allow for both binary and ternary rhythm. If only binary was permitted, then we would expect ternary rhythm to be eliminated by vowel deletion and we would not expect ternary alternation where binary was expected. Word-final deletion applies to a word of any size, disyllabic or trisyllabic, etc. Vowel deletion is unconstrained by the prosodic structure of an utterance and can be interpreted as a way of ensuring a particular kind of rhythmic pattern.

In Warlpiri, there is tension between the rhythmic organisation and the morphological organisation of an utterance. Under casual speech conditions, this tension is eased, giving rise to variation, eg $(\sigma\sigma)\sigma(\sigma\sigma) \sim (\sigma\sigma)(\sigma\sigma)\sigma$. The prosodic word is not a crucial player in the rhythmic organisation of texts, nor is it crucially relevant as a constituent in connected speech. This is evident in cases involving syllabification across word boundaries and word-final vowel deletion.

The advantages of the analysis are, firstly, that it avoids positing an additional level for derivations. An additional level would suggest that differences in stress patterns were due to obligatory rather than relaxed constraints. Secondly, the variants can be explained as a different style of speech and that different speech styles require a different system of constraint ranking. Casual speech requires a ranking system involving constraint relaxation. As will be discussed in section 4.5.2, a further advantage is that an additional constraint to generate ternary patterns is not required.

4.5 Alternative Analyses

As previously mentioned, stress variation under casual speech conditions is accounted for in rule-based analyses derivationally. Consequently, the difference in stress patterns is described as stress movement and rules to account for the movement of stress are required. Hayes (1991) lists commonly found phrasal stress operations:

(33) a. End rules - prominence among phrases
b. Move stress under clash
c. Destressing under clash

d. Eurhythmy

Adjustment or deletion of stress operates in line with rhythmic principles, which include the avoidance of stress clash and regular spacing of stresses. These operations would be required in a derivational analysis of the Warlpiri data. For instance, to derive a ternary variant from a binary form of **(yinka)(rdaku)(rdaku)**, a stress deletion rule must first apply followed by a stress movement rule. This process is shown below:

(34)	input:	/yinkardakurdaku/
	output from word level stress rules and input to next level:	(yínka)(rdàku)(rdàku)
	1. delete the second stress:	(yínka)rdaku(rdàku)
	2. move stress one syllable to the left:	(yínka)rda(kùrda)ku

Stress is assigned at the word level, but is optionally altered at the next level by deletion and movement rules. The stress movement rule captures the observation that stress typically moves to the left. However, the deletion rule is more arbitrary in terms of which stress to delete. The rule requires a particular stress to delete to enable stress movement to the left, but the deleting stress could be anywhere in a string and there may be more than one stress deleting. Thus, movement is dependent on deletion. The phrase in (35) would be the output from the word level and may be altered in casual speech (see (36)):

(35) (ngári)rli(pàrla) (ngápa) (nyámpu) (nyányi)
foliage:tea leaves water this see-NPST

To achieve the altered output, the fourth and fifth stress have to be deleted and stress movement to the left then applies twice, as shown in (36):

(36) (ngári)rli(pàrla) nga(pà nyam)(pù nyany<i>)

Stress deletion can apply anywhere in a string, but the stress deletion rule is unable to capture this. Particular stresses have to be nominated, and while the tendency (evident in the data) is for second stresses in a string to delete, this is not always the case.

In a derivational analysis, variations to rhythmic patterns in casual speech contexts are accounted for by rules which operate on outputs from the word level. However, one of these rules, the stress deletion rule, is unexplanatory and unable to indicate which stress deletes. Furthermore, it appears that stress movement can only occur because of stress deletion but there is no reason why it cannot occur independently.

The benefit of an OT analysis is that stress is assigned to outputs without the need to posit different levels of stress assignment. This avoids the need for unmotivated rules, for assignment, deletion, and reassignment steps. With the constraints on IP alignment and RA, the prediction is that the stress patterns will be binary and ternary.

4.5.1 Levels

As previously mentioned, casual speech processes have been typically assigned to a separate level in derivational accounts of phonology. Casual speech processes apply to derived forms. In the theory of Lexical Phonology/Morphology (Kiparsky 1982, Mohanan 1982), the output of one level is the input to another level. At the interface between levels, Bracket Erasure applies to eliminate boundary information and is necessary to avoid violating well-formedness conditions, when additional structure is added to a derived form.

M&P (1993a) claim that the grammar of Axininca Campa has three levels: prefix, suffix and word. At each level, there are different constraint rankings, and outputs are selected on the basis of best satisfying the constraints at that level. At the interface between the suffix level and word level in Axininca Campa, M&P argue that BE occurs eliminating word-internal prosodic structure. Inputs to the word level contain only the outermost prosodic word brackets. This accounts for the difference in stress patterns between suffix level and word level outputs. This difference is shown in the following example where constraints at the suffix level generate (37a) but the observed output (37b) is that generated at the word level.

(37) a. [[[(nomà) na]-(pit à)(Cáa)]-ri
b. [(nomà)(napì)(t aCáa)ri] [M&P 1993a:147]

At the suffix-level, suffixes are required by the constraint SFX-TO-PW to attach to prosodic words. If the syllable **na** in (37a) was parsed into a foot, a foot would straddle prosodic word boundaries which is not permitted by the Prosodic Hierarchy. The solution is to eliminate all feet and internal prosodic word structure at the interface between levels. At the word level, SFX-TO-PW is ranked below the stress constraints and is consequently unable to rule out attested forms such as (37b).

If a levels analysis was adopted, we could say there are two levels, word level and a postlexical level where casual speech processes apply. For instance, the optimal form of /ngajulu-ngurlu/ at the word level is [(ngáju)lu-(ngùrlu)]. Bracket Erasure occurs at the interface between levels resulting in [ngajulungurlu]. This output then serves as the input to the postlexical level, as shown in (38).

(38) [ngajulungurlu]	FtBin	RA
a . [(ngáju)(lùngu)rlu]		
b. [(ngáju)lu(ngùrlu)]		

However, the alignment constraints involving prosodic words, ie AlignFt, would still need to be relaxed to account for variants. As in the tableau above, (38b) would incur more violations to AlignFt than (38a). Furthermore, without boundaries we would expect one particular rhythmic pattern, rather than a combination of binary and ternary which arise from the presence of prosodic or morphological boundaries.

If Bracket Erasure and levels were introduced, constraints would still need to be relaxed. Bracket Erasure only adds complexity to the model proposed here and contributes little to our understanding of the stress patterns in outputs. The rationale behind different levels is to explain prosodic or morphological structure on one level that would not be permitted at another level. However, we are trying to explain permissible variations to forms whose phonological structure violates constraints.

4.5.2 Re-ranking

Under the notion of re-ranking, constraints may be re-ranked with respect to each other to achieve a variant form. Re-ranking has been considered by Kager (1994) for Estonian. In this analysis two constraints are involved in re-ranking.

As discussed in section 4.2, Estonian may have a binary or ternary rhythmic pattern. The examples from (5) are repeated in (39).

(39) Estonian Binary and Ternary patterns

Ternary	Binary	
pímestavàle	pímestàvale	'blinding,ill.sg.'
ósavamàleki	ósavàmalèki	'also more skillful abl.sg'
hílisemàtele	hílisèmatèle	'later,all.pl'

There is a three-way distinction of syllable weight: light, heavy and overlong. I will discuss words with overlong syllables after presenting Kager's analysis of the binary and ternary patterns. The ternary pattern is constrained by the presence of heavy syllables, CVC and CVV. In word-final position, CVC is light and CVCC is heavy. To account for CVC syllables being light in this position, I suggest that a consonant in word-final position is not mora-bearing, and therefore does not contribute to the weight of a syllable.

(40)

kávalàtt	'cunning,part.sg.'	*kávalatt
párimàttelt	'the best,abl.pl.'	*párimattèlt
pímestàttuse	'blinding,ill.sg.'	*pímestattùse
úsaltàttavàmattèks	'...'	*úsaltattàvamattèks

The third syllable in the examples in (40) is a heavy syllable and must be stressed. However, stressed syllables cannot be adjacent. The following patterns are not possible ***párimàttèlt**, ***pímestàttùse**. To account for the stress patterns, Kager proposes the following constraints:

(41) FtForm: Feet are Trochaic
*Clash: No adjacent stressed syllables
Parse-2: One of two adjacent stress units (syllable or mora) must be parsed by a foot[8].
*FtFt: Feet must not be adjacent.
AlignFt: The left edge of a foot aligns to the left edge of a prosodic word.
Align-L: Every prosodic word begins with the main stress foot.

Ternary alternation is guaranteed by *FtFt which demands feet to be non-adjacent. The ranking of these constraints is:

(42) FtBin, *Clash, Parse-2, FtForm, AlignL >> AlignFt, *FtFt

In Kager, the binary alternating pattern is derived by ranking AlignFt above *FtFt. The ternary pattern is generated by reversing the ranking of these two constraints.

(43) pimestavasse	AlignFt	*FtFt
a. (pímes)ta(vàsse)	2:σσσ!	

[8] This constraint operates similarly to RA.

% b. (pímes)(tàvas)se	2:σσ	*

	*FtFt	AlignFt
% a. (pímes)ta(vàsse)		2:σσσ
b. (pímes)(tàs)se	*!	2:σσ

Under AlignFt, binary alternation is achieved by assessment to the prosodic word edge, and every non-initial foot incurs a (gradient) violation. In contrast, under *FtFt, ternary alternation is achieved by assessing foot adjacency rather than by assessment to the prosodic word edge. Violation to *FtFt is not gradient, but is outright. Given the way each constraint assesses violations, they must be ranked with respect to each other. Consequently, to derive a binary or ternary rhythmic pattern the ranking of AlignFt and *FtFt must change.

Heavy syllables must be parsed into feet, and, when heavy syllables are adjacent, Parse-2 and *Clash ensure that the alternating pattern is primarily binary. This is shown below:

(44) usaltattavamatteks	Parse-2	*Clash
a. (úsal)tat(tàva)(màtteks)	*!	
b. (úsal)(tàtta)va(màt)(tèks)		*!
%c. (úsal)(tátta)va(màtteks)		
%d. (úsal)(tàtta)(vàmat)(tèks)		

Binary and ternary patterns of alternation are also present in words with overlong syllables. Overlong syllables are heavy syllables with additional length, CVV:, CVVC:, CVCC:.

(45) a. káu:kèle káu:kele 'far away'
b. jál:kètest jál:ketèst 'trick,el.pl.'
c. toos:tùsele tóos:tusèle 'industry,ill.pl.'
d. téot:tàttuttèlt téot:tattùttelt 'backer,abl.pl.'

In the binary patterns, adjacent stressed syllables are permitted and, in the ternary patterns, heavy syllables may remain unfooted. This suggests that there is no ranking between *Clash and RA, as shown in (46).

(46) /teot:tattuttelt/	*Clash	RA
%a.(téot:)(tàttut)(télt)	*	
%b.(téot:)tat(tùttelt)		*
c.(téot:)(tát)(tùttelt)	**!	
d.(téot:)tattut(tèlt)		**!

Another possible pattern is **(téot:tat)(tùttelt),** where a heavy syllable is parsed into the same foot as an overlong syllable. This would be ruled out if the maximum number of moras in a foot was three.

In Warlpiri, re-ranking may explain variant stress patterns in frozen reduplication words which appear to be undergoing some regularisation (Nash 1986). To explain the stress patterns of words such as **(míji)li-(jìli)**, the constraint LE was introduced (Chapter 2). A variation to this pattern is **(míji)(lìji)li**. Variation in the stress patterns may be accounted for by re-ranking the constraints LE and AlignFt. However, re-ranking will only account for a small percentage of the variation evident in the data and introduces complexities in the ranking system. To give one example, LE, Taut-F, LEXSTRESS dominate AlignFt and as a result many polymorphemic words have ternary alternating patterns. To achieve binary alternation, AlignFt would have to be re-ranked with each one of these more dominant constraints. Recall that the ranking of the constraints is:

(47) FtBin, RA, AlignL, FtForm, AlignPW >> LE,Taut-F >> LEXSTRESS >> AlignFt

The relationship of AlignFt with these constraints varies because these constraints are ranked differently with respect to each other and with AlignFt. Re-ranking between one of the constraints and AlignFt will involve consideration of the ranking of the other constraints. For instance, when AlignFt is ranked above LE, it is important to ensure that AlignFt is also ranked above LEXSTRESS and Taut-F. Thus, the re-ranking analysis involves not just two constraints, but also the other constraints that are not directly involved in re-ranking. And because other differently ranked constraints are involved, re-ranked constraints would have to 'jump' over other constraints, thereby weakening the ranking system.

Given the re-ranking scenario above, it would be simpler, more constrained and more economical to compute the dominant rhythmic constraints (ie FtBin, RA, AlignIP) as always obligatory and other constraints as relaxed, than to compute a number of re-rankings in certain contexts.

One question which has not been considered in re-ranking analyses is the relationship between non-ranked constraints. It is assumed that unranked constraints can be ranked with respect to each other to generate variant forms. This suggests that any set of unranked constraints can be re-ranked, which undermines the stability of the system.

Note that there is no ranking between the constraints LE and Taut-F due to the fact that there is no conflict between the two constraints. If one of the constraints was ranked above the other, there would be no effect on outputs. Under the re-ranking analysis, generating two tableaux with different constraint ranking, ie LE >> Taut-F or Taut-F >> LE, would be automatic. However, this process would be unnecessary given that exactly the same output would occur in the tableaux.

In conclusion, relaxation of constraints allows for a straightforward and constrained analysis of casual speech.

4.5.3 Non-ranking

Another alternative is to consider non-ranking of the alignment constraints under casual speech conditions. For instance, we could say that there is no ranking between LEXSTRESS, LE, Taut-F and AlignFt. However, as argued in Chapter 2, under Ranking Equity, non-ranking of crucial constraints is not possible between gradient and non-gradient constraints. Since AlignFt is a gradient constraint, non-ranking between it and the other constraints is not permitted.

4.5.4 An alternative to the Estonian analysis

In the analysis given for Warlpiri, binary and ternary patterns are generated without the constraints

AlignFt and *FtFt. This analysis could be extended to account for similar rhythmic patterns in Estonian. In fact, the analysis could account for other languages with reported binary and ternary patterns such as Hungarian and Karelian mentioned in 4.2.

Without AlignFt and *FtFt in tableaux, either a binary or ternary pattern can be generated. The dominant constraints rule out any other ungrammatical patterns, as shown for Estonian in the tableau below.

(48) pimestavasse	AlignL	FtBin	*Clash	RA
%a. (pímes)(tàvas)se				
%b. (pímes)ta(vàsse)				
c. (pímes)tavasse				**!

The dominant constraints decide against outputs other than (48a,b). AlignL ensures that the main stress foot is located at the left edge of the word. RA and FtBin constrain alternation to binary and ternary. The rhythmic alternation pattern is further constrained by *Clash. With these dominant constraints, AlignFt and *FtFt are unnecessary.

If AlignFt is present in tableaux, and none of the dominant constraints are in a conflicting relationship with AlignFt, then a constraint that conflicts with AlignFt is needed. Thus *FtFt is forced into service.

Since RA allows either binary or ternary alternation, AlignFt is superfluous in languages showing equal frequency of either pattern. The question of AlignFt is addressed in the following section.

4.6 AlignFt

As discussed in 4.2 our notion of rhythm is based on adjacency. Syllables within a foot are adjacent; adjacent feet create binary rhythm; non-adjacent feet, constrained by RA, create ternary rhythm. Rhythmic patterns can be generated without alignment constraints on all feet as shown for the Warlpiri (casual speech) and Estonian data. If rhythm is an adjacency phenomenon, then what of the constraint AlignFt?

Under Kager's analysis the rhythmic patterns are determined by AlignFt and *FtFt. These constraints assess the location of feet differently, AlignFt by alignment to the prosodic word edge, and *FtFt by adjacency with other feet. Under this analysis, rhythm is achieved by both alignment and adjacency; binary by alignment and ternary by adjacency. As a consequence, there is some inconsistency in generating rhythmic patterns. We would expect the generation of both patterns under the same type of constraints, particularly since rhythmic patterns are not confined to speech or morphological edge alignment.

AlignFt could be replaced by a constraint requiring feet to be adjacent, such a constraint, call it BINARY, would reflect the notion that rhythm is an adjacency phenomenon. BINARY predicts a binary rhythm and does not rely on an edge to ensure this.

In languages which exhibit high frequency in both binary and ternary patterns, constraints such as AlignFt or *FtFt are not required. Where the tendency is for binary patterns a constraint like BINARY is necessary. In such cases the rhythmic patterns are more constrained. This would give us the following typology:

(49) binary and ternary FtBin RA Align(foot to edge)

(50) binary only FtBin RA Align(foot to edge) BINARY

There are some languages with reported ternary only patterns of alternation, such as Cayuvava (Key 1961). As analysed by Kager (1994) the constraints AlignFt and *FtFt are crucial to derive ternary alternation. AlignFt ensures that at least one foot is located close to a prosodic word edge, while *FtFt ensures ternary rhythm.

In Chapter 1, the stress patterns of Pintupi, Warao and Ono are accounted for by the constraints FtBin, AlignFt and PARSEσ. These patterns can also be derived by FtBin, RA, Align(foot to an edge) and BINARY, where Align and BINARY replace AlignFt. The question is which is the most appropriate set of constraints?

The most appropriate would be those that account for the widest possible range of data. AlignFt and PARSEσ overly constrain rhythmic alternation, thereby not allowing ternary variation. Nor does this set of constraints allow for alignment to anything other than prosodic word edges. We need to allow for alignment to other prosodic structures, such as intonational phrases, as we have seen from the data examined here that the IP, the higher prosodic constituent, constrains feet at IP edges.

Constraints on the adjacency of feet determine rhythmic patterns. If rhythm is computed through adjacency we can say that rhythm is adjacent dependent. In contrast, alignment is required to locate one foot with respect to one prosodic word edge and/or intonational phrase edge. Thus, feet are adjacent dependent as well as alignment dependent. In languages with a single foot per word, a foot is aligned to one particular edge. This contrasts with rhythmic languages, where one foot is aligned to an edge, and rhythmic alternation is in relation to this and other feet.

In conclusion, rhythm should be interpreted as an adjacency phenomenon, rather than only an alignment phenomenon and constraints should reflect this.

4.7 Concluding Remarks4.8 Concluding Remarks

The rhythmic constraints are defined in terms of adjacency, and these constraints ensure binary and ternary rhythmic patterns. To achieve this I have proposed that certain constraints, interface constraints and foot alignment to prosodic word can be relaxed under specific conditions. This means that an additional level for derivations on derived forms is not required, thus simplifying the grammar as a whole. Constraint Relaxation accounts for variant rhythmic patterns, and could be extended to account for other speech styles.

Rhythmic alternation in casual speech is confined within an IP, and to account for this I have introduced a new alignment constraint, AlignIP, which demands that the left edge of a foot align with the left edge of an IP. This accounts for the absence of non-aligned constituents at the edges of intonation phrases.

CHAPTER 5

ADJACENCY IN VOWEL HARMONY

5.1 Introduction

Warlpiri has been described as a language with two vowel harmony processes, progressive and regressive (Nash 1986). In both types of harmony high vowels undergo harmony. In progressive harmony, high vowels in suffixes and clitics attached to stems ending in /i/ become /i/. Unless otherwise indicated, examples are from Nash.

(1) maliki-kirli-rli=lki=ji=li 'as for the dogs, they are with me'
dog- PROP-ERG=now=1sNS=3pS
(cf. minija-kurlu-rlu=lku=ju=lu 'as for the cats, they are with me'
cat- PROP-ERG=now=1sNS=3pS)

wanti-mi=jiki '(something) is still falling'
fall-NPST=still
(cf. wanti-ja=juku '(something) still fell'
fall-PST=still)

Regressive harmony is morphologically restricted, only applying in the presence of a verbal suffix containing /u/ causing preceding /i/ vowels to become /u/.

(2) pangu-rnu dig-PST 'dug (something)'
(cf.pangi-ka dig-IMP 'dig!')
kuju-rnu throw-PST 'threw (something)'
(cf.kiji-ka throw-IMP 'throw!')

Previous to OT, vowel harmony has been analysed in the theory of autosegmental phonology. Autosegmental analyses of vowel harmony in Warlpiri include Nash (1979,1986), Steriade (1979), Sagey (1990), Cole (1991), van der Hulst and Smith (1985), Kiparsky (ms). Many autosegmental analyses of vowel harmony advocate some form of underspecification where one value for a feature may be filled in by spreading. If this does not occur, then the default value for the feature may be inserted by redundancy rules.

Following the principles of OT, the emphasis here is on the output form and the constraints that determine well-formedness of outputs rather than on the representation of the input form. The analysis does not rely on underspecified segments where correspondence constraints assessing the relationship between inputs and outputs is required, but rather argues that harmony is an output phenomenon where exactness is required of particular vowels in outputs.

In an underspecification analysis, vowel harmony is viewed as a feature filling process. A feature spreads because of the lack of full feature specification in surrounding vowels (discussed in 5.5.1). A contrary view is to suppose that vowel harmony is a consequence of adjacency requirements on certain features in outputs and not a consequence of underlying representations. In the analysis presented here, segments are fully specified in underlying representations. Whether all underlying features are parsed or not depends on higher ranking identity constraints. A constraint on adjacent high vowels ensures that they harmonise for a particular place feature, and this place feature is determined by other constraints. Harmony is then a result of adjacency requirements.

This outcome underlies one of the goals of the chapter, which is to show that harmony is achieved under adjacency rather than alignment. Another goal is to provide explanations for harmony and the blocking of harmony which are expressed through general constraints.

The data on vowel harmony presented in this chapter are largely from Nash (1986), supplemented with examples from the Warlpiri dictionary (1990;DIC), Laughren (ML) and Simpson (1991;JS).

The chapter is outlined as follows. Section 5.2 discusses the role of the OCP in OT and notions of adjacency. I introduce a constraint on the adjacency of features and propose that this constraint can adequately account for many processes of assimilation. The vowel harmony data from Warlpiri is presented in 5.3. In 5.4, I provide an analysis of the data. An account for the blocking behaviour of labial consonants is given in 5.4.1. In progressive harmony, labial consonants block the spread of /i/, but they do not block the spread of /u/ in regressive harmony. I argue that the blocking behaviour is best understood as an identity and homorganicity requirement on adjacent labial consonants and vowels which overrides vowel assimilation. In this section I also argue that vowel harmony is a simultaneous not derivational process given the interaction of reduplication and vowel harmony. In 5.5, I consider alternative analyses. This is followed by a discussion in 5.6 of transparency and opacity in OT and I argue that under feature identity these can receive a different interpretation compared to previous analyses. Some concluding remarks are given in 5.7.

5.2 Theoretical Issues

In stress systems, it is fairly straightforward to establish the parameters which contribute to the range of stress patterns. For instance, there are two basic foot types which may or may not be quantity sensitive, and generally feet align to the left or right of a word. However, establishing the parameters in vowel harmony appears not to be as clear cut. For instance, elements that undergo harmony such as the kinds of vowels and morphemes vary widely, as well as the elements that trigger harmony. In addition, the direction of harmony and the number of elements that undergo harmony vary across languages.

Despite the number of elements involved in vowel harmony, two factors have been well-established; these are iteration and direction. Iteration is the extent of feature spreading, whether it is unbounded across a domain or confined to a single adjacent element. Harmony is directional, spreading either left or right, or in some instances bidirectionally. I agree with Beckman (1998) in the main that spreading and the direction of spreading are characteristics of harmony which can be generated through identity constraints. Under the notion of identity, directionality is a result of suffixes or prefixes, but not roots, to undergo feature alternation. However, I also find that some notion of directionality must be captured in constraints to avoid regressive suffix-to-suffix harmony.

Iterative harmony and the constraints on identity are discussed below.

5.2.1 Adjacency

An uncontroversial view in phonology is that phonological processes are local. The ramifications of this view are reflected in various principles and processes. One of these is a principle on the formal representation of features, known as the OCP (Obligatory Contour Principle), originally due to

Leben (1973). The OCP prohibits adjacent identical elements. For instance, if there is a sequence of high vowels then by the OCP they must both be linked to a single instance of [high].

In OT, the effects of the OCP can be achieved by featural markedness constraints which value multiply linked features over singly linked ones. Featural markedness constraints are those which rule out parsing of features, eg *[COR] which says do not parse [COR]. Thus the representation in (a) involving multiple linking is better than (b) with singly linked features.

(3) a. [COR]

V V

b. [COR] [COR]

V V

In vowel harmony, an adjacency constraint on particular features is required. I assume that vowels in adjacent syllables are adjacent and vowels in non-adjacent syllables are not adjacent. This is expressed in the following statement.

(4) Adjacency: vowels are structurally adjacent iff they are associated with syllables which are adjacent.

The notion of adjacency captures the fact that, in vowel harmony, consonants are generally transparent to the process. In section 5.6 the issue of transparency is discussed with relevance to adjacency as not only consonants can be transparent but also vowels.

As previously mentioned, it is acknowledged in generative phonology that rules are local in application (including Sagey 1990, Clements 1991, Archangeli and Pulleyblank 1986,1994, among others). In other words, the operation of rules is dependent on the elements involved being adjacent; some elements are close enough for operations, while others are not.

The processes of assimilation and dissimilation involve features that are adjacent on some tier and are not expected to 'skip over' the features involved in these processes. Instances of skipping, shown in (5a), are not possible. Assimilation of a feature (F) is acceptable when those elements undergoing the process are adjacent, as in (5b).

(5) a. * F

x x x

b. F

x x

In vowel harmony in Warlpiri, adjacent high vowels must have the same place of articulation. This accounts for the fact that high vowels undergo harmony in either frontness or roundness when adjacent to vowels with these features, as seen in (6).

(6) kiwinyi-rli=ji (cf minija-rlu-ju 'cat-ERG=1sNS)
'mosquito-ERG=1sNS'
yurrpu-rnu (cf yirrpi-rni 'insert-NPST')
'insert-PST'

I will assume the place features [LAB] and [COR] for the corresponding features [+round] and [-back]. A sequence of vowel-place features [COR] and [LAB] is not permitted. I propose a constraint, called Harmonic Adjacency, to ensure that adjacent vowels share the same place feature.

(7) **Harmonic Adjacency (HA):** Adjacent high vowels share the same place feature.

HA is an identity constraint on features in outputs, an output-output constraint (like MAX_{BR} which requires exactness between the reduplicant and the base) rather than a constraint comparing exactness of outputs with inputs. This constraint builds on previous analyses, such as Cole (1991), that harmony requires adjacency. However, HA differs from this analysis in that spreading is dependent on the presence of the feature [high], as proposed in Nash (1980).

Under Harmonic Adjacency, if adjacent vowels have the same height feature then they must also have the same place feature. The preference is for particular cooccurrence of features when adjacent, as shown in the representations below.

(8) a. COR b. LAB

H H

V V V V

HA expresses an interdependency between place and height. This contrasts with the featural markedness constraints which prefer that adjacent identical features are multiply linked. The representation in (9) is not well-formed by HA (as specified for Warlpiri).

(9) * COR LAB

V V

H

HA builds on observations on coarticulation effects in vowels in adjacent syllables, as noted for instance in English (Bell-Berti and Harris 1976), Russian (Purcell 1979) and Catalan (Recasans 1984). In a sequence V_1 C V_2, the articulation of either vowel can be affected by the other. However, if the vowels are the same or similar, there are less coarticulation effects, and if there are less coarticulation effects, then the identification of the vowels would tend to be faster. Thus when a sequence of high vowels occurs, they are easier to identify if they share the same features. This eliminates coarticulatory effects and potential perceptual confusion.

HA does not apply to features across word boundaries and in a previous analysis (Berry 1994,1996) this was accounted for by restricting adjacency to features within a prosodic word. In the analysis presented here Identity constraints restrict feature alternation to suffixes, thereby constraining alternation in roots. HA is an identity constraint requiring the same place features of high vowels in outputs.

5.2.2 Vowel features

Following Sagey (1990), I assume a theory of features where binary features like [+/- high] are combined with unary place features such as [labial]. The place features are marked with * in the table below, which indicates that a vowel is specified for that feature. I assume that vowels have the same place features as consonants, following Clements (1992), Ni Chiosáin and Padgett (1993), Selkirk (1988, 1991) among others[1].

(10) Surface feature specifications for vowels

	i	u	a
[high]	+	+	
[low]	-	-	+
[LAB]		*	
[COR]	*		
[PHAR]			*

/a/ is specified as [+low] and not also [-high], following information on this vowel from researchers including Schane (1984), van der Hulst (1988), McCarthy (1991), Selkirk (1991a,b).

5.3 Data

As mentioned in the introduction, two kinds of vowel harmony processes, progressive and regressive, exist in Warlpiri involving the high vowels /i,u/. In progressive harmony, suffixes with high vowels attached to a stem ending in /i/ surface with [i], as shown in (11). The vowels in the morphemes bound by '/ /' represent underlying forms.

(11) a. maliki-kirli-rli=lki=ji=li 'as for the dogs they are with me now'
dog -PROP- ERG=now=1sNS=3pS
/maliki-kurlu-rlu=lku=ju=lu/

b. maliki-kirlangu-kari-kirli 'with another's dog'
dog-POSS-another-PROP
/maliki-kurlangu-kari-kurlu/

c. jinta-kari-ki 'at one another'
one-another-DAT
/jinta-kari-ku/

d. kiwinyi-rli=ji 'mosquito (did something) to me'
mosquito-ERG=1sNS
/kiwinyi-rlu-ju/

e. wangka-mi=lki=ka=rna 'I am really speaking now'
speak-NPST=still=IMPF=1sS [ML]
/wangka-mi=lku=ka=rna/
(cf wangka-mi=rra=lku=ka=rla 'he is speaking away to him now'
speak-NPST=still=IMPF=2sS [ML])

[1] This is also proposed in other frameworks such as Dependency Phonology and Particle Phonology and include Anderson and Ewen (1987), van der Hulst (1986,1989), Kaye, Lowenstamm and Vergnaud (1985), Schane (1984,1987).

f. kapi=ji=rla FUT=1sNS=3DAT [JS339]
kapi=ju=rla

g. paji-ki cut-FUT[2] 'will cut'
/paji-ku/ (cf paka-ku strike-FUT 'will strike')

Regressive harmony only involves verb roots with underlying high vowels and contrasts with progressive harmony in that the harmonising feature is [LAB]. Harmony occurs when suffixes with back vowels are attached. These suffixes are the past tense and agentive (nomic) suffixes **-rnu**, **-ngu** and **-nu**.

(12) a. pangu-rnu dig-PST 'dug'
/pangi-rnu/ (cf. pangi-ka dig-IMP 'dig!')

b. kuju-rnu throw-PST 'threw'
/kiji-rnu/ (cf. kiji-ka throw-IMP 'throw!')

c. kupu-rnu winnow-PST '(something) winnowed'
/kipi-rnu/ (cf. kipi-rni winnow-NPST '(something) is winnowing')

d. kuju-rnu-nju-nu '(someone) began to throw (something)'
throw-INCEP-PST
/kiji-rnu-nji-nu/
(cf. kiji-rni-nji-ni throw-INCEP-NPST '(someone) is beginning to throw (something)'

e. miyi-kupu-rnu 'food winnower'
food-winnow-NOMIC
/miyi-kipi-rnu/

Regressive harmony is morphologically restricted, occurring only when verb tense suffixes with back vowels, except for **-ku** FUT, attach to the verb root[3].

In progressive and regressive harmony, the low vowel /a/ does not undergo harmony and harmony does not propagate through it; it is opaque. This is shown in (13).

(13) a. minija-kurlu-rlu=lku=ju=lu 'as for the cats, they are with me now'

[2] The future tense forms are rare and are used by speakers in the west.

[3] There are two verb roots ending in /u/ (the only verb roots to end in /u/) which undergo assimilation to /i/ before lamino-alveolars:

a. pi-nyi ‘hit, kill bite-NPST’
/pu-nyi/ (cf pu-ngka ‘hit, kill, bite-IMP’)
pi-nja ‘hit, kill, bite-INF’
b. yi-nyi ‘give-NPST’
/yu-nyi/

Along with Nash I assume that this latter assimilation process is local in contrast with assimilation of vowels to [u] under the influence of suffixes with /u/ which will be referred to as vowel harmony.

cat-PROP-ERG=now=1sNS=3pS

b. jurdi-ma-nu 'mounted'
mount-CAUS-PST [JS361]

c. yirra-rnu 'put'
put-PST

The folllowing examples show that progressive harmony is blocked by labial consonants:

(14) a. ngamirni-puraji 'your mother's brother'
mother's brother-your

b. milpirri-puru 'during cloud'
cloud-during

c. ngali=wurru 'you and I'
you and I=EMPH

d. miyi-kipurda 'in search of,wanting food'
food-DESIDCOMP

In contrast, the labial consonants are not active in blocking regressive harmony as shown in (15).

(15) a. yurrpu-rnu insert-PST 'inserted'
/yirrpi-rnu/ (cf yirrpi-rni insert-NPST ‘inserting')

b. kupu-rnu winnow-PST 'winnowed'
/kipi-rnu/ (cf kipi-rni winnow-NPST' 'winnowing')

There are some examples where labial harmony spreads to the right. Although it is reported in Nash that this process is restricted to certain dialects of the west and north of the Warlpiri region, data from Simpson (1991) and Laughren (recordings) indicate that it has become more widespread. The spreading of round to the right is confined to the directional clitic **-rni** 'HITHER' and the pronominal agreement clitics -**rli** 2dS, -**rlipa** 1piS, -**rlijarra** 1deS[4].

(16) a. muku=rnu /muku=rni/

[4] Nash (1986) analyses the clitics with initial **rli** as comprising the morpheme **rli** 2dS and thus that 1piS and 1deS clitics are analysed as **rli-pa** and **rli-jarra** respectively.

all=HITHER [JS399]

b. ya-nu=rnu=ju=lu 'they came' /ya-nu=rni=ju=lu/
go-PST=HITHER=1sNS=3pS [JS361]
(cf pina=rni ya-nu 'he came back hither'
transfer back to original location=HITHER go-PST)

c. ya-nu=rlupa=jana=rla 'we went to them for it' /ya-nu=rlipa=jana=rla/
go-PST=1piS=3pNS=DAT [ML]
(cf wangka-ja=rlipa=jana=rla 'we spoke to them for it'
speak-PST=1piS=3pNS=DAT [ML])

Other clitics with /i/ in the initial syllable do not undergo round harmony. This includes **pinki** 'etc', **wiyi** 'prior, first', **mipa** 'only', and **kirli** 'exactly'.

With the exception of verb roots, harmony is restricted to suffixes and clitics, and there is no harmony across compound boundaries. For example, in preverb-verb compounds, vowels in the preverb (PVB) do not agree in backness with the vowels in the verb, as (17b) shows.

(17) a. pirri-kiji-rni 'scatter'
PVB -throw-NPST
b. pirri-kuju-rnu 'scattered'
PVB - throw-NPST
c. miyi-kupu-rnu 'food winnower'
food-winnow-NOMIC

Similarly, in nominal reduplication involving full word reduplication, harmony does not apply across the boundary.

(18) a. yukiri-yukiri 'green'
b. kurdiji-kurdiji 'shoulder blade'

The two harmony processes can be summed up in the following table. Progressive harmony where [COR] is the harmony feature is the most general process, while the other harmony processes are morphologically restricted.

(19)	target	trigger	blockers	domain
progressive u > i	u	i	/a/, labial C's, word & compound boundaries	suffixes, clitics
i > u	specific clitics with /i/	u	as above	clitics
regressive i > u	/i/ in verb roots	u	/a/, word & compound boundaries	verb roots

5.3.1 Distribution of high vowels in roots

Within nominal and verbal roots, adjacent high vowels may occur which do not share the same place feature. While somewhat rare, sequences of iCu, where C=p/w, can be found in nominal roots, as shown in (20). Such sequences are not found in verb roots.

(20)	a.	yirriwu	'Acacia ancistrocarpa (bush)
	b.	kajipu	'inside of bush coconut'
	c.	yuriwurrunyu	'kindling wood'

Some loan words may consist of a sequence of iCu, as in:

(21) miyurlu 'mule (English loan word)' (Hale 1966:764)

The examples in (22) show that in verbs and noun roots, sequences of uCi can be found.

(22)	Verbs		
	a.	ngurntirri-mi	'scold, growl at'
	b.	nyunji-rni	'kiss'
	c.	yurirri-mi	‘move, stir (intrans)'
	d.	yururri-mi	
	Nouns		
	a.	jalurti	'crest-tailed marsupial mouse'
	b.	kurriji	'wife's mother'
	c.	punjungiyingiyi	'incipient beard'
	d.	pukurdi	'pigeon's top-knot; hair-bun'

A sequence uCi suggests that vowel harmony is directional where frontness spreads to the right and roundness to the left. However, as I argue later, this is due to the tendency of suffixes rather than roots to undergo feature alternation.

5.3.2 Discussion

In sum, there are two harmony processes in Warlpiri involving high vowels, progressive front harmony and regressive back harmony. The low vowel blocks both harmony processes, while labial consonants block progressive harmony. Back harmony is morphologically restricted in contrast to front harmony, which applies whenever possible.

It has often been noted that vowel harmony is stem/root controlled (Clements 1980, among others). In other words, harmony typically spreads from stem to affixes rather than from affixes to stems. Warlpiri exhibits the typical pattern in progressive harmony, but an atypical spreading pattern in regressive harmony.

One aim in accounting for segmental harmony is to establish the motivation for its occurrence. As has been noted, when segments are articulated, certain features may be neutralised. Feature neutralisation occurs when changes from a neutral state of the articulators are minimised. In Warlpiri, neutralisation of features is responsible for progressive harmony.

In verbs, a distinction between past and nonpast tense is carried by the high vowels; the past tense suffixes **rnu, nu** have round vowels and the nonpast suffixes **rni**, **ni** have front vowels. The only difference between these two sets of suffixes is the quality of the vowels. Given this fact, it is likely that the motivation for round harmony in verb roots is to maintain this distinction in tenses. We have seen that progressive harmony applies wherever possible. If this occurred in verbs, then the past tense form of the verb **pangi-rnu** dig-PST, would be **pangi-rni**, which is exactly the form for the present tense. Whenever verbal suffixes with round vowels are present, progressive harmony is overridden.

In the absence of the past tense suffixes, high vowels harmonise in frontness. In these contexts, maintaining a distinction between the front and round high vowels is unnecessary. Note that maintaining the vowel distinction is not crucial in the future tense suffix **-ku**, where the vowel is either /u i/ depending on the preceding vowel. Changing the vowel in **-ku** does not change the tense, but it would do in **-rnu** 'PST' or **-rni** 'NPST'.

We could argue that the asymmetry in vowel harmony (round harmony in verbs involving certain suffixes and front harmony elsewhere) is necessary to maintain past and present tense distinctions; that the asymmetry is a result of a morphological requirement overriding a prosodic one. Thus vowel harmony in this context is not neutralising but instead expresses a contrast. Featural agreement is forced if maintaining contrastiveness would otherwise be difficult. On the other hand, progressive harmony is neutralising, as maintaining a contrast is unnecessary.

We might also argue that featural contrasts are neutralised in certain positions, eg affixal, because such contrasts are not crucial in these positions (Steriade 1994). Other morphemes, ie roots, are in positions of prominence and are less likely to undergo featural alternation. This could explain the predominance of stem/root controlled harmony noted by Clements.

In support of the view of positional prominence, note that stems/roots are typically the subject of alignment constraints in prosodic operations such as stress, and the base for reduplication. Thus in terms of these processes, stems/roots have a significant role to play, which suggests that the prosodic status of stems/roots is higher than that of affixes. This status means that they are less likely to undergo vowel harmony, unless a morphological distinction is to be maintained, or there is a phonological distinction that is not crucial.

Previous analyses accounting for positional prominence use the notion of prosodic licensing (Itô 1986, Goldsmith 1990, Itô & Mester 1993, Itô, Mester & Padgett 1994). For a particular contrast to be maintained, the contrast has to be licensed by a prosodic position or category. However, as Steriade (1994) points out, this is problematic because it misses the distributional generalisation that it is the position and not just prosodic structure which ensures the maintenance of a contrast. Steriade cites examples of distributions which are not dependent on prosodic licensing of prosodic structure. For instance, in Klamath a contrast in glottalisation and aspiration is licensed only when a sonorant follows regardless of where syllables boundaries are. Similarly, syllable boundaries are irrelevant for contrastive retroflexion in Australian languages, which is licensed only when a vowel precedes.

In Warlpiri, all featural contrasts within nominal roots are maintained while certain contrasts in suffixes are not. Characterising roots and suffixes is not possible in prosodic terms.

Expanding on Selkirk (1994), who introduced positional Parse(F) constraints, Beckman (1998) proposes to account for positional prominence through identity constraints expressed in terms of position. An Ident-Position(F) constraint is ranked above a general identity constraint and a constraint (call it X) requiring featural alternation. This ranking generates positional asymmetries:

(23) Ident-Position(F) >> X >> IDENT(F)

Beckman argues for an Ident-Position(F) for languages where harmony is triggered by a vowel in a root initial syllable, as in Shona.

(24) **IDENT-σ_1(F)**
Let β be an output segment in the root-initial syllable and α its input correspondent. If β is [γF] then α must be [γF]

This is interpreted as "an output segment in σ_1 and the input correspondent of that segment must have identical feature specification" (1998:56). The ranking of this constraint will ensure alternation of features in everything except those in the root-initial syllable.

To account for the Warlpiri data, identity constraints on roots and verbal suffixes are required to express the fact that feature contrast is essential in roots (unsuffixed nominals are considered roots) and in specific verbal suffixes.

(25) **IDENT-Root(F)**
The output features of a segment in a root must be identical to the input features of that segment.

(26) **IDENT-VSfx(F)**
Features which ensure the syntactico-semantic identity of suffixes must be exact in outputs to those in inputs.

The constraint on suffixes will ensure that the distinction between past tense and non-past tense is maintained, but it will not affect featural alternation in other verbal suffixes, eg **-ku** in **paji-ki** vs **paka-ku,** since this alternation is not distinctive and thus does not change semantic interpretation.

P&S (1993) discuss place features with regard to markedness and based on cross-linguistic evidence claim that the feature [COR] is favoured over other place features. The data from Warlpiri support this claim, as shown in the following section, and motivates separate identity constraints for parsing [COR] and [LAB] in vowels.

(27) **IDENT[COR]**: Correspondent segments in S_1 and S_2 have identical values for [COR]

(28) **IDENT[LAB]**: Correspondent segments in S_1 and S_2 have identical values for [LAB]

Harmony is typically thought of as a process where features are spread across a particular domain. Here the view is that positional prominence and neutralisation determine harmony, which is governed by the Identity constraints. The evident directionality in harmony systems is determined by Identity.

5.4 Analysis

A number of facts are to be accounted for in vowel harmony in Warlpiri. These are:

1. COR harmony occurs freely and spreads to the right
2. LAB harmony occurs only when verbal suffixes with round vowel specification are present and only spreads to the right to certain clitics.
3. Both harmony processes are blocked by the low vowel
4. COR harmony is blocked by labial consonants
5. Harmony only occurs upon suffixation

Following early analyses (including Nash 1979, Steriade 1979), I propose an analysis of vowel harmony in Warlpiri where vowels are fully specified in underlying representations. This analysis better captures the two harmony processes and better accounts for the surface high vowels in the absence of harmony, as discussed in 5.5.1. Cole (1991) also allows harmony to be a feature-changing operation where harmony operates on vowels specified for [round].

Harmony is domain specific: round harmony in verbal roots and front harmony in nominal and verbal suffixed stems, as well as particles. [COR] may spread in a verbal domain, as for example, in **wanti-mi=jiki**, where the clitic surfaces as **juku** in the absence of harmony. In a domain, the vowel that surfaces in the absence of harmony is not the same as the harmonising vowel. The harmony domains can be summarised as follows:

(29) High vowels in harmony domains

Domain	Verbal Roots	Stems
Harmony	LAB	COR (limited LAB)
No harmony	COR	LAB

High vowels in verbal roots surface as [u] under harmony and as [i] in suffixes in stems. Where there is no harmony, high vowels in suffixes surface as [u] and in verbal roots as [i].

As discussed in 5.2.1, Harmonic Adjacency (HA) requires adjacent high vowels to share the same place feature. A violation to HA is incurred if high vowels do not share a place feature, as shown in (30).

(30)	/maliki-kurlu-rlu=lku=ju=lu/	HA
	maliki-kurlu-rlu=lku=ju=lu	*
	maliki-kirli-rlu=lku=ju=lu	*
	maliki-kirli-rli=lki=ju=lu	*
	% maliki-kirli-rli=lki=ji=li	

Harmony is motivated by HA and any sequence of iCu will incur a violation of HA. However, IDENT-Root(F) will ensure that sequences of uCi in monomorphemic roots, eg **jalurti** 'crest-tailed marsupial mouse'; **nyunji**- 'kiss', do not undergo harmony. The ranking is:

(31) IDENT-Root(F) >> HA

(32) jalurti	IDENT-Root(F)	HA
%a. jalurti		*
b. jalirti	*!	

c. jalurtu	*!	

Another output is conceivable where all vowels are parsed as /a/, but this would also violate IDENT-Root(F).

In some words, the number of constraints against HA will determine the optimal candidate, as illustrated in the following tableau, which evaluates the input form **yukiri-rlu** 'green-ERG'.

(33) yukiri-rlu	IDENT-Root(F)	HA
a. yukiri-rlu		**!
b. yikiri-rli	*!	
c. yukuru-rlu	**!	
%d. yukiri-rli		*

The two HA violations to (a) decide in favour of (d) as the optimal output. The featural markedness constraints are ranked below the constraints considered in this section; nonetheless they ensure that features are multiply linked.

HA is ranked above the identity constraints on the features [COR] and [LAB]. IDENT[COR] is ranked above IDENT[LAB]. The evidence for this ranking is in forms where the trigger and target of harmony are high vowels in suffixes. An example is given in the next tableau.

(34) jinta-kari-ku	HA	IDENT[COR]	IDENT[LAB]
%a. jintakariki			*
b. jintakaruku		*!	
c. jintakariku	*!		

The final vowel in the suffix /-kari/ triggers harmony in the following suffix and the optimal form is that in (34a). It is therefore better to parse the input feature [COR] which enables this harmony to occur. Where the input feature [LAB] is parsed, and to avoid violating HA, round harmony occurs as in (34b), but since this means COR is not parsed, it fails as an optimal output. When input features for both the high vowels have been parsed as in (34c), HA is violated.

A small number of clitics with /i/ in the first syllable undergo rounding harmony when attached to roots ending in /u/, as shown in the following tableau, where IDENT-Root(F) and HA determine the optimal candidate:

(35) muku=rni	IDENT-Root(F)	HA	IDENT[COR]
%a. mukurnu			*
b. mukurni		*!	
c. mikirni	**!		

Since other clitics with underlying /i/ do not undergo rounding harmony, we can assume that input and output features must be identical in such clitics and include them in the constraint requiring identity in verbal suffixes. An alternative is to have an identity constraint on these clitics and rank it above HA. This seems unnecessary for a very small number of forms and it would be preferable that they be specified in the IDENT-VSfx(F) constraint.

As discussed in the section on alternatives, underspecifying the clitics that do undergo harmony is not a satisfactory solution since it would be necessary to specify what the surface vowel would be in the absence of harmony and it would also give rise to inconsistencies in the grammar. In other words, if these clitics were underspecified, then all other forms showing feature alternation should be underspecified. The problem with this is that the ‘default’ vowel (the one that surfaces in the absence of harmony) is different in the verb roots, suffixes and clitics that show alternation.

As noted previously, suffixes or clitics may trigger [COR] harmony in following, but not preceding, suffixes. However, harmony in preceding suffixes cannot be ruled out by the constraints introduced so far, since vowels in suffixes may undergo feature alternation. Conditions for a regressive [COR] harmony could arise because there are some clitics, eg **mipa, pinki,** which can follow any grammatical category. Thus, some way to prevent regressive [COR] harmony must be explored.

The fact that [COR] harmony proceeds from left to right is a consequence of suffixes undergoing neutralisation and of feature enhancement across a span of segments. If [COR] harmony is to extend the quality of a particular vowel feature, then conceivably it does so when that vowel feature has been encountered. Thus the [COR] trigger occurs to the left of the target vowels, and not to the right. HA needs to be modified to incorporate the fact that neutralisation is not regressive.

(36) **HA** (modified): Adjacent high vowels following [COR] share [COR].[5]

This constraint also reflects the fact that suffixes, and not just roots or tense suffixes, can trigger harmony in following suffixes. Under Beckman's (1998) model, regressive harmony involving suffixes cannot be ruled out.

5.4.1 [LAB] harmony

So far constraints have assessed nominal forms in which suffixes, but not roots, undergo feature alternation. However, feature alternation within verb roots must be allowed when the harmony triggering suffixes are present. Currently, IDENT-Root(F) rules out any feature change within roots, and IDENT-VSfx(F) will ensure that verbal suffixes with input round vowels surface with these vowels. These constraints will lead to a lack of harmony within roots and violation of HA, eg ***kipi-rnu**, because featural identity is demanded by both Identity constraints. As previously discussed, it is not possible to rank HA above IDENT-Root(F) because feature alternation would occur in nominal roots, which is not attested. The solution is to introduce a specific root harmony constraint allowing for round harmony within roots when suffixes with round vowels are present. This constraint is:

(37) **Root Harmony (RootHA)**: Adjacent high vowels agree in place in verb stems.

To ensure that harmony occurs due to the [LAB] place feature of verbal suffixes, IDENT-VSfx(F) must be ranked above Root Harmony. Compare the optimal outputs in the following two

[5] The general constraint is universal but it allows for specification of the harmonising features in a language, in the same way that alignment constraints allow for specification of certain edges.

tableaux where in (38) harmony occurs in the suffix **-ku**, and in the root in (39) but not in the suffix **-rnu**.

(38) paji-ku	IDENT-VSfx(F)	RootHA	IDENT-Root(F)	HA
%a. paji-ki				
b. paju-ku			*!	
c. paji-ku		*!		*

The identity constraint on verbal suffixes only holds of the suffixes **-rnu**, **-ngu**, and **–nu;** thus vowel alternation in other suffixes is not ruled out. This allows for (38a) to be optimal, violating only the lower ranked feature, identity constraint, IDENT[LAB] (not shown in the tableau). RootHA and IDENT-Root(F) rule out (38b,c) and so force harmony to occur in the suffix. In the next tableau, it is IDENT-VSfx(F) and RootHA that register fatal violations.

(39) kipi-rnu	IDENT-VSfx(F)	RootHA	IDENT-Root(F)	HA
%a. kupu-rnu			*	
b. kipi-rnu		*!		*
c. kipi-rni	*!			

Without RootHA, which ensures that harmony occurs, (39b) would be the optimal output. It is therefore an important constraint and must be ranked above IDENT-Root(F).

The word **kiji-rnu-nji-nu** 'throw-PST-INCEP-PST' contains the inceptive **-nji-.** As discussed in Chapter 3, the inceptive is categorised as a verb root and must be suffixed by a tense marker. The inceptive undergoes harmony as a result of being suffixed by the past tense suffixes. The constraint IDENT-VSfx(F) will ensure that the verbal suffixes are the triggers and not the targets in the harmony process when ranked above IDENT-Root(F).

(40) kiji-rnu-nji-nu	IDENT-VSfx(F)	RootHA	IDENT-Root(F)	HA
%a. kuju-rnu-nju-nu			**	
b. kiji-rnu-nji-nu		***!		***
b. kiji-rni-nji-ni	**!			

(40a) is the optimal candidate, which has no violations of the two higher ranked constraints present in the tableau. Violations to RootHA are incurred in (40b) because the root vowels do not agree in place with the suffixes. In (40c) [COR] has spread rather than the input feature [LAB], violating the requirement that input feature identity must be the same in outputs in verbal suffixes.

In words such as **minija-kurlu** harmony is blocked by the presence of the low vowel between the high vowels. Since the high vowels are not adjacent, there is no violation to HA and thus no motivation for harmony. If the high vowels in the suffix surface as front in the suffix, IDENT[LAB] will rule these forms out. Since the analysis allows for feature changing, an identity constraint for /a/ like that for the other place features is required.

(41) **IDENT[PHAR]**: Correspondent segments in S1 and S2 have identical values for [PHAR].

IDENT[PHAR] must be ranked above Root Harmony to ensure there is no change to the feature [PHAR] in any context including verb roots. The rankings of the constraints introduced so far is:

(42) IDENT[PHAR], IDENT-VSfx(F) >> RootHA >> IDENT-Root(F) >> HA >> IDENT[COR] >> IDENT[LAB]

It is generally agreed that vowel harmony is a device for extending vowel qualities which might otherwise be difficult perceptually (including Steriade 1994, Cole & Kisseberth 1994, Kaun 1995). Thus, it is better that a string containing a mixture of underlying front and back high vowels enhance only one of those vowel types in outputs. However, articulatory factors also play a role in harmony processes; it is easier to maintain articulation for a single vowel type, ie round high, than it is for many, ie round high then front high etc. Thus, harmony also facilitates articulation. The question of articulation arises when considering consonant blocking in Warlpiri, discussed below.

5.4.2 Consonant Opacity

In this section, an explanation for the blocking role of labial consonants is presented. I show that an underlying factor in blocking is the preference for some adjacent consonant and vowel sequences to be homorganic, thus maintaining feature identity.

The blocking behaviour of the low vowel in vowel harmony is explained by adjacency. When the low vowel intervenes between two high vowels, the high vowels are not adjacent and thus harmony cannot occur. Accounting for the blocking behaviour of labial consonants is more difficult. Typically, consonants are invisible or transparent to the spreading of vowel features. The challenge is to determine why consonants block harmony.

In previous accounts of consonantal blocking, blocking is generally held to occur when the blocker is specified for the spreading feature. This analysis would not be possible for Warlpiri because labial consonants block the spread of [COR] and not [LAB].

The fact that labial consonants are opaque to [COR] spreading could mean that adjacent high vowels are in fact not adjacent. This would require a statement such as: high vowels are not adjacent when a labial consonant intervenes; but this would not be effective because labial harmony occurs in such contexts. The statement would have to be more specific, but it would not provide an explanation for blocking.

Given the different role labial consonants play in both harmony processes, it would appear that there is a particular relationship between a labial consonant and an immediately following labial vowel. Under the identity analysis given here, this relationship can be explained as one where maintaining a labial distinction is crucial to morphological distinctiveness. We know that HA is not violated in verbs under suffixation of the suffixes containing /u/ because distinguishing [LAB] is necessary for morphological distinctiveness. If the input feature [LAB] is always parsed in outputs, meaning there is no vowel feature alternation, then it could be assumed that this is to maintain a distinction.

Sequences of iCu where C is a labial are permitted in roots where high ranking IDENT-Root(F) ensures that HA does not win out and, consequently, that labial is parsed. As these sequences are also found in suffixes, we can likewise assume that identity ensures exactness in input and output correspondence of such sequences.

An additional interpretation is one involving something like ‘labial attraction’ evident in Turkish (Lees 1961, Lightner 1972). In Turkish roots, a sequence of aC(C)u occurs but not aC(C)i, when C(C) contains a labial.

(43)	armud	'pear'	kabuk	'rind'
	karpuz	'watermelon'	yavru	'cub,chick'
	samsun	'mastiff'	avlu	'courtyard'

Padgett and Ni Chiosian (1993) argue that some inherent qualities of consonants, such as rounding. play a role in the phonology in some languages like Turkish. They make a distinction between inherent rounding and distinctive rounding. They claim that inherent round of labial consonants is not controlled and is less salient than distinctive round. The inherent quality is supported by acoustic evidence from Stevens, Keyser & Kawasaki (1986), which found that rounding and labial consonants were similar acoustically, and by Goldstein (1992), who found that there is a single invariant articulatory feature of round in languages which is contact between the upper and lower lips at the sides.

P&NC suggest that inherent round could be represented in consonants by attaching it to a vowel place node which is attached to the place node of the consonant. This means that a labial CV sequence shares the same place feature at some level, as follows[6]:

```
(44)   C          V
       place       |
        |    \Vplace
       [LAB]   [LAB]
```

Support for the view that CV sequences can be linked to the same place of articulation features comes from research showing a tendency cross-linguistically for consonant and vowel sequences to be homorganic (Janson 1986; cited in Clements 1991).

The preference for homorganicity is reflected in the various interactions between consonant and vowels. Affinity for homorganicity between adjacent consonants and vowels is discussed in Hyman (1973), Campbell (1974), Sagey (1990), Clements (1991), Selkirk (1988), among others. An example of consonant and vowel interaction is labialisation of vowels in the context of labial consonants. This is illustrated in Tulu, a Dravidian language (Bright 1972). Vowel rounding occurs when high front vowels /i/ following either a round vowel or a labial consonant round to [u] (Campbell 1974).

(45)	a.	■♋✂♎♊i✂	'country'	b.	bolpu	'whitener'
		&♋♦♊♦♊♓✂	'bond'		kappu	'blackness'
		&♋☠☠♓✂	'eye'		po☠☠u	'girl'
		ugar♓✂	'brackish'		uccu	kind of snake
		ari-n-i✂	'rice acc.'		◆✂❐◆-n-u	'country village acc.'

Consonants may be labialised when adjacent to rounded vowels, as attested in Bantu languages (Guthrie 1967-71). In these languages, consonants are labialised when they occur before a high round vowel /u/.

---

[6] The issue of representation is not crucial to the analysis that CV sequences share place features.

(46) *pu,bu,tu,du,ku,gu > fu (Bemba)
*tu > vu,du > fu (Songe)
*ku > fu (Punu, Swahili, Sango)

Janson's research contrasts with Kawasaki (1982), who found that maximal acoustic contrast is preferred in consonant and vowel sequences. Sequences which are least preferred across languages are sequences of palatalized consonant and palatal vocoid, eg Cyi, labialized consonant and labial vocoid, eg Cwu, and homorganic glide and vowel sequences, eg yi,wu. The difference in these research findings is due to the fact that Janson's research is articulator- or gesture-based, while Kawasaki's research is acoustically-based. In summing up these two perspectives, Clements states that the tendency is for consonant and vowel sequences to exhibit acoustic dissimilation but gestural assimilation.

The relevance of homorganicity or affinity for a degree of homorganicity for the Warlpiri data is significant. While research from Kawasaki indicates that sequences such as *yi,wu* are strongly disfavoured cross-linguistically, this is not the case in many Australian languages, including Warlpiri. This would back the gesture-based research by Janson supporting CV homorganic sequences. Thus, the presence of *yi*, *wu* and *pu* sequences, as well as the evident preference to maintain labial consonant and vowel sequences, indicates a preference for labial homorganicity. The interaction between labial consonants and vowels cross-linguistically also supports this research.

Other assimilatory phenomena involving consonants are attested in Warlpiri. We have looked at iterative harmony, but a non-iterative type involving consonants is also attested. Assimilatory phenomena involving consonants typically affect a single immediately adjacent segment; ie assimilation is non-iterative. This phenomenon is shown in preverb-verb compounds in Warlpiri. Regressive nasal assimilation occurs when consonant-final preverbs are prefixed to verbs with initial nasals. Examples are from Laughren (1990).

(47) /puuly-mardarni/ [puuny-mardarni] 'grab'
(cf. puulyparni mardarni [puulyparni])
/puurl-ngarni/ [puurn-ngarni] 'set out'
(cf. puurlparra ngarni [puurlparra])
/yiily-ngarni/ [yiiny-ngarni] 'use up'
(cf. yiilyparra ngarnu [yiilyparra])

Manner assimilation occurs in C1-C2 sequences, where C2 is a nasal. No other assimilation, place or manner, occurs in this context. Nasal assimilation is analogous to the situation where labial consonants prefer homorganicity with following vowels. In each case, a single adjacent segment is affected, which is typical of consonant assimilation. The fact that CV homorganicity is a non-iterative phenomenon indicates that a consonant is a factor in assimilation[7].

The vowel harmony data show, firstly, a requirement that high vowels share the same place feature, and secondly, a requirement that adjacent labial consonants and vowels share the same place feature under input/output identity requirements. When these requirements are in conflict the

[7] Another example of assimilation involving consonants is found in the two verb roots **pu-** and **yu-** whose vowels undergo fronting when the following consonant is palatal (see fn3). Since this does not occur elsewhere, I assume the process is exceptional. I also assume that the process overrides many of the constraints introduced here.

latter requirement wins. A constraint is necessary to ensure harmony is blocked under certain conditions. This will be an Identity constraint requiring that labial CV sequences are exact in outputs, thus blocking of harmony is achieved if a change to features in such sequences is ruled out. This is stated as follows:

(48) **IDENT-σ(F)**: Output features of a syllable containing a labial CV sequence are identical to their corresponding input features.

IDENT-σ(F) is in conflict with HA and is ranked above it to ensure CV labial sequences maintain their input identity.

(49) IDENT-σ(F) >> HA

The effect of this ranking is demonstrated in (50) with the word **ngali-wurru** 'you and I are the ones'.

(50) ngali-wurru	IDENT-σ(F)	HA
%a. ngali-wurru		*
b. ngali-wirri	*!	

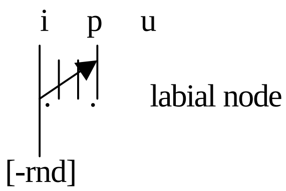
Interestingly, it is less important to parse [LAB] for vowels in contexts other than CV labial sequences, suggesting that the features of labial CV sequences have to be maintained for contrastiveness.

The reason that labial consonants do not block labial harmony in verb roots is because underlyingly they precede a front vowel and vowels in these sequences show alternation, unlike underlying labial CV sequences.

I have claimed that labial CV sequences are homorganic, in which case it is likely that they share the same vowel place feature. Therefore, changing the feature of the vowel could change that of the consonant. A high ranking Identity constraint on features in consonants would rule out any change to consonants in outputs. This analysis relies more or less on representation and, given that the kind of representation is not clear, it would be better to avoid constraints that make reference to it. The bond between labial CV sequences can adequately be captured by an Identity constraint demanding exactness of such sequences.

In their analysis of harmony in Walpiri, both Sagey (1990) and Cole (1991) describe progressive harmony as the spreading of the labial class node which dominates [-round]. It is argued that the labial node of consonants is responsible for blocking the spread of labial, as in (51). | | = blocked

(51)



Sagey and Cole's analyses for the lack of labial blocking of regressive harmony differ. In Sagey, labial consonants do not block regressive harmony, as it is the feature [round] that spreads and [round] is not blocked by labial nodes. In contrast, Cole argues that labials are transparent in regressive harmony because labial spreading occurs from specific morphemes which are on a different tier from roots, as shown below.

```
(52)            +round
                 / /  |
                / /  LAB
               / /    |
          yirrpi  -  rnu
            |
           LAB
```

The analysis involving homorganic blocking does not rely on autosegmental representation, as in Cole, or on feature geometry, as in Sagey, but captures a cross-linguistic preference for consonant/vowel homorganicity, which in Warlpiri is reflected as a high ranking constraint on feature identity. This enables a straightforward explanation for the blocking of harmony by labial consonants and for the asymmetry in blocking in the two harmony processes.

Warlpiri shows a preference for homorganic labial CV sequences above dorsal and coronal sequences. Labial CV sequences are not altered by COR neutralisation. In contrast, coronal CV sequences may be altered by LAB spreading. Round harmony conveys a relevant distinction, while front harmony is a neutralising process eliminating feature differences if they are not relevant. IDENT-σ(F) serves to maintain a distinction in suffixes which would otherwise be overridden. It is an identity constraint, which is different from IDENT-Root because the latter is a requirement on grammatical categories in positions of prominence, while IDENT-σ(F) is a requirement on the identity of certain segment sequences regardless of position.

In sum, CV homorganicity provides an explanation for the blocking of vowel harmony. This is an advantage over analyses which can formally account for blocking, but are unable to explicate why this should be the case.

5.4.3 Reduplication and vowel harmony

In this section, the role of OT to account for the interaction between harmony and reduplication is shown. The analysis of reduplication relies on two crucial constraints, IDENT-VSfx(F) and the reduplicative Identity constraint MAX$_{BR}$[8].

The general reduplicative constraints require correspondence between the reduplicative element and the base. Reduplicated words are indicated as /RED-base/ in underlying representation, where RED is phonologically unspecified. RED is a prefix whose output is determined by constraints on segmental and syllabic well-formedness, in addition to reduplicative constraints. The

[8] There are other constraints on the correspondence between the base and the reduplicant, including ANCHORING and CONTIGUITY. These constraints ensure that segments are not skipped and that segments occur in the same sequence in both the base and the copy. These constraints are discussed in more detail in Chapter 6. Outputs in tableaux do not violate these constraints.

reduplicative constraints are essential as the reduplicative morpheme, RED, has no phonetic specification and anything could serve as RED. An important constraint is MAX_{BR} (M&P 1995) which requires that the elements in RED correspond to the elements in the output base. This is stated as:

(53) MAX_{BR}:Correspondents in RED and the output base are identical.

The base and RED are correspondents which must be phonologically identical. The phonological content of the reduplicative element is dependent on the content of the base. If harmony between two high vowels is required in an input containing RED, we would expect the reduplicant to show vowel harmony effects because of the requirement for RED and the base to be identical.

Verbal reduplication involves copying a foot, in contrast to the nominal reduplication pattern where the full root is copied (Nash 1986). A more specific constraint for verbal reduplication is necessary, requiring verbal RED to be equivalent to a foot. Neither this constraint nor the ones on identity can be violated and therefore they comprise the set of dominating constraints. The set of outputs in the tableau are restricted to those involving reduplication of a foot.

The following tableau evaluates the word **RED-pangi-rnu** 'dig-PST' where MAX_{BR} is ranked above IDENT-Root(F) ensuring that feature identity is the same for the base and the reduplicant rather than ensuring exactness of input and output base. The reduplicant is underlined.

(54) RED-pangi-rnu	IDENT-VSfx	RootHA	MAX_{BR}
%a. <u>pangu</u>-pangu-rnu			
b. <u>pangi</u>-pangi-rnu		*!	
c. <u>pangi</u>-pangu-rnu			*!
d. <u>pangu</u>-pangi-rnu		*!	*
e. <u>pangi</u>-pangi-rni	*!		

Since harmony does not occur between the adjacent high vowels in (b) and (d), RootHA is violated. When there is harmony, but the reduplicated portion does not reflect this, then MAX_{BR} is violated as in (c). (e) violates the IDENT-VSfx. (a) does not violate these constraints and is thus the optimal candidate. (a) violates IDENT-Root because of the vowel change in the output base, but if there was no change then violations to other constraints as shown by the candidates in the tableau would be incurred.

MAX_{BR} effectively ensures that a verb root marked for past tense reflects this marking in the reduplicative element. This maintains the distinction of past tense. Outputs such as ***pangi-pangu-rnu** and ***pangu-pangi-rnu** reflect conflicting tense markings, ie /i/, representing present tense, and /u/, which represents past tense.

Reduplicative examples such as **pangu-pangu-rnu** could suggest that harmony was a result of a domain requirement, ie where harmony is not blocked and not sensitive to adjacency. For instance, it could be that harmony occurs in verb roots not because of adjacency, but because the requirement is for high vowels in the verb domain to agree in place regardless of what intervened between these vowels. The fact that domain harmony does not apply in Warlpiri is illustrated in examples such as **yirra-rnu** ‘put-PST’, which clearly shows that adjacency is required for harmony in verbs.

5.4.4 Summary

In the account of vowel harmony given in this section, I have provided an explanation for the motivation, as well as for the blocking of harmony. Harmony is dependent on the presence of the feature [high] when adjacent. The low vowel blocks harmony and does not undergo harmony due to the fact that it is specified for [low], not [high]. By combining the insights of adjacency and height dependency, iterativity is mirrored in OT by HA.

Iterativity is restricted by the Identity constraints and so accounting for the absence of harmony in nominal roots, verb suffixes and particular clitics. IDENT-Root(F) reflects the universally attested fact that suffixes not roots undergo harmony. The language specific constraints are IDENT-VSfx(F) and RootHA. When morphological aspects are involved in harmony, we would expect these aspects to be language specific. We would also expect this when the vowel inventory is small and that there would be some contexts where distinguishing the two high vowels is crucial. The interesting feature is that maintaining featural identity is absolute in nominal roots, verbal suffixes, some clitics and certain sequences of segments, but not in verb roots, nominal suffixes, certain clitics. This complicates the harmony processes and contrasts with many other languages where all roots are impervious to feature alternation.

The constraints IDENT[COR] and IDENT[LAB], including their ranking with respect to each other are compatible with markedness claims (P&S 1993).

The explanation for blocking by labial consonants is due to homorganicity and identity requirements on underlying labial CV sequences. Evidence for homorganicity rests on cross-linguistic research and observations on consonant and vowel interaction. IDENT-σ(F) requires feature identity of particular segment sequences and is different from IDENT-Root(F), which requires exactness within a particular morpheme.

HA is a universal constraint, which is given further support in 5.6. The specification of the features involved is language specific, although there is little variation in what these features are. HA is similar to universal constraints such as FtForm, where the specification for the kind of foot is language specific. The crucial constraints in Warlpiri are:

(55) IDENT-σ(F), IDENT-VSfx >> RootHA >> MAX_{BR} >> IDENT-Root(F) >> HA >> IDENT[COR] >> IDENT[LAB]

This constraint ranking where HA is ranked between Identity constraints is predicted in languages with harmony. Where there was no Harmony, all the Identity constraints would be ranked higher than HA.

5.5 Alternative Analyses

In this section, alternative analyses are considered. Firstly, an analysis involving feature underspecification is examined, followed by an analysis involving feature alignment.

5.5.1 Underspecification

In vowel harmony, the kinds of constraints and their ranking are dependent on whether harmonising vowels are underspecified or fully specified in underlying representation. In an underspecification analysis, input vowels that undergo harmony may lack a feature value for place, and so, if the underspecified vowel does not undergo harmony, a place feature has to be inserted. In a derivational (rule-based) analysis, vowels surface with place features by a redundancy or default rule.

In an underspecification analysis for Warlpiri, the relationship between feature spreading and insertion would be intertwined. The feature that spreads in one domain cannot also be the default feature in that domain. For instance, the default feature in the [COR] domain (ie nominals) is [LAB], while [LAB] is the spreading feature in the verb domain and [COR] is the default. Thus, features have to be specified as to which domain they can be inserted into if harmony does not occur.

Problems for an underspecification analysis in Warlpiri arise because there are two harmony processes involving different harmonising features, and it is necessary to specify what feature is inserted when harmony does not occur.

Typically, segments that show feature alternation are underspecified and, while this will account for the majority of forms, there are some segments which undergo feature alternation which cannot be underspecified. For instance, the clitics -**rni** and the pronominal clitics with initial **rli**- surface with [i] when adjacent to stems ending in /i/ or /a/, eg **pina=rni** (from 20b), but when attached to stems ending in /u/ they undergo harmony, eg **muku=rnu**. This is almost the reverse compared to all other suffixes which surface with [u] when adjacent to stems ending in /u/ or /a/, but harmonise when adjacent to stem final /i/, eg **minija-rlu** vs **maliki-rli**. If a form of underspecification were used for all these clitics and suffixes, there would be no way to predict whether [i] or [u] would surface. This is because there are two 'default' vowels which surface in the absence of harmony [i] or [u].

These clitics present two problems for the underspecification analysis: (1) the harmonising feature is [LAB] (typical of verb roots) and not [COR] (expected of non-verb root morphemes); (2) the default feature for the clitic is [COR], but the typical default feature outside of verb roots is [LAB]. To account for this either an exceptional constraint is required or the clitics have to be fully specified in underlying representations. The latter option would give rise to an inconsistency as to what is and what is not under- or fully-specified. For instance, the clitics which show harmony are fully specified, but all other forms with vowels that show harmony are underspecified. An exceptional constraint or separating harmonising forms into two representational types, fully or underspecified, provide no explanation for the harmony patterns.

In my analysis, feature change in suffixes is expected as feature identity among high vowels is typically non-distinctive, while in nominal roots input/output feature identity must be exact. The reason for this is that roots, not suffixes, are in positions of prominence. Identity constraints are able to capture this asymmetry as well as account for the instances of round harmony in the clitics and front harmony in some verb roots. While these instances of harmony are not typical, nonetheless they can still be accounted for in a straightforward manner.

An underspecification theory is designed to deal with languages which have a single default feature and this is typically [COR]. In Warlpiri, the 'default' in nominals is [LAB] and the feature in triggering harmony is [COR]. In verbs, on the other hand, the trigger is [LAB] and the 'default' is [COR]. Thus, harmony is either neutralisation or a distinctiveness process. Even if domains were specified for default features this is not a formal expression of the harmony processes in Warlpiri. It relies on representation, which, while it may account for spreading, does not provide an explanation.

Continuing on with this line of argument, another objection to an underspecification analysis is that feature insertion is required, which seems counterintuitive for a neutralisation process such as [COR] harmony. In fact, it would appear that an underspecification analysis cannot appeal to neutralisation because underlyingly there would be no place features to neutralise.

In another alternative analysis, we might consider floating features in underlying representations (eg Kiparsky ms; Archangeli and Pulleyblank 1994). In Kiparsky's analysis of vowel harmony in Warlpiri, he suggests that for suffixes showing vowel alternation, vowels are specified only as high and are associated with a floating [+round] feature in underlying representation. In the absence of [COR] spreading, the floating feature links to high vowels. In the analysis presented here, the featural identity constraints allow for featural change in suffixes in a straightforward manner without the need for unusual representations. Positing a floating feature in underlying representation is similar to underspecification and would require the same constraints, and for this reason has similar disadvantages as well.

5.5.1.2 Summary

I have argued that vowel harmony involves feature adjacency and identity which can be better captured and explained in an analysis with full specification in the underlying representation.

In rule-based theories of vowel harmony using underspecification, the focus is on the form of the input representation. In OT, on the other hand, concern is on the forms of the outputs and not with the issue of whether underspecification or the form of underspecification is justifiable. This difference between rule-based and OT theories is further emphasized by the fact that well-formedness constraints are inviolable in rule-based theories but violable in OT. It is the constraints in OT and not the representational forms of the input that determine the well-formedness of outputs.

In the analysis in this chapter, underspecification is not relied upon to provide explanations for why harmony occurs. This notion is independent of the issue of underspecification. Harmony is motivated by HA which is an adjacency constraint on features and is not predicated on the presence or absence of certain features. However, I have argued that full specification is more successful in capturing the phenomenon of harmony in Warlpiri.

The fact that verb roots and not noun roots undergo labial harmony is due to specific verbal suffixes. These suffixes must be allowed to dominate otherwise coronal harmony would apply across the board. Labial harmony is morphologically restricted; there are no nominal suffixes which trigger labial harmony.

Coronal harmony applies whenever possible, being blocked in specific contexts, morphological and phonological. The direction of coronal spread reflects the suffixation system of the language and the fact that vowels in suffixes are more likely targets for harmony than vowels in roots.

5.5.2 Feature Alignment

In this section I consider two analyses of vowel harmony as alignment, one by Kirchner (1993) and another by Cole & Kisseberth (1994). In Kirchner, the motivation behind feature spreading has been interpreted as the alignment of a feature to a particular edge. To align a feature, two processes are involved, spreading and the direction of the spread. In Warlpiri, two alignment constraints on features would be required, Align[COR] and Align[LAB].

(56) Align[COR]: The feature [COR] aligns to the right edge of a prosodic word.

(57) Align[LAB]: The feature [LAB] aligns to the left edge of a prosodic word.

The feature alignment constraints are gradient. Under gradient assessment, a feature is noted for its distance (ie how many syllables or segments) from a particular edge. In contrast, outright assessment indicates whether or not a feature is aligned.

The advantage of HA over constraints on alignment of features is demonstrated in examples such as **maliki-kurlangu-kari-kurlu** 'dog-POSS-other-PROP'. Consider the following outputs:

(58) a. maliki-k**i**rlangu-kari-kirli
b. maliki-kurlangu-kari-kirli

In both (58a) and (b), the feature [COR] is aligned to the right edge of the word. The final suffix in the word **-kurlu** has undergone harmony and thus would satisfy an alignment requirement for [COR] in both examples. In (58b) the initial vowel in the medial suffix **-kurlangu** has not undergone harmony. It is instances such as these that the align constraints are not able to decide upon. As a result, the two outputs in (58) would be optimal candidates under these constraints.

In contrast, HA would rule out (58b), which the alignment constraint Align[COR] is unable to do. The alignment constraint demands that a feature align to an edge and if that feature has aligned to that edge then there is no align violation.

While Cole & Kisseberth (1994) appeal to alignment of features, this alignment is motivated by a constraint requiring certain anchors (segments) in a domain to be 'affiliated' with a particular feature. However, in order to ensure that affiliation occurs up to a certain point or edge, alignment is required. This analysis faces the same criticisms voiced here.

The question of adjacency in harmony is ignored in alignment analyses. HA is an adjacency constraint and as such it provides an explanation for the blocking role of /a/. Whenever /a/ intervenes, high vowels are no longer adjacent. Under the featural alignment constraints, this is given no explanation and would have to be expressed in a separate constraint.

An alignment analysis can guarantee that a particular feature will occur or be aligned at an edge but cannot guarantee that a feature spread elsewhere. This is an instance of where adjacency constraints are more suited to account for word-internal processes.

Consider also an alignment analysis of reduplication. To account for the lack of spreading across prosodic words, feature alignment is confined to prosodic word edges. Recall that vowel harmony does not apply across prosodic words, as for example in [[kurdiji]-[kurdiji]] 'shoulder blade'. Spreading to the copied portion of a reduplicated verb would be blocked because it is in a different prosodic word from the root and suffix, as shown in (59).

(59) [pangi [pangi-rnu]
LAB

Since the default vowel in verb roots is /i/, the output would be [pangi[pangu-rnu] from **RED-pangi-rnu**. In an Identity analysis, the optimal output is due to $\text{MAX}_{BR.}$ This can also be appealed to by an alignment analysis, but the problem would be that harmony is due to alignment as well as a particular identity requirement. A more cohesive analysis considers harmony as an identity phenomenon.

Another problem for an alignment or spreading analysis is fast speech phenomena. In Chapter 4, I argued that the parsing of the prosodic word is an option under fast speech conditions. If prosodic word boundaries are not present, this could entail that features spread unconditionally across word boundaries up to the edges of an IP. Since this is not attested in the data analysed it would appear that prosodic word boundaries do not in fact constrain vowel harmony. An Identity analysis can account for the absence of harmony across words due to IDENT-Root(F). Other arguments against alignment can be found in Beckman (1998) and Kaun (1995).

5.5.3 Vowel Opacity

In some analyses of blocking it is argued that blocking occurs because of incompatibility of the feature spreading with the blocking segment. Cole & Kisseberth (1994) argue that the low vowel /a/ blocks round harmony because of a clash constraint ruling out segments with the features *[Rd,Low]. They claim that this constraint prevents the insertion of features on an inappropriate segment.

The requirement that harmony depends on adjacency can account for the opacity of the low vowel, as well as harmony. Where output features are different from input ones, the identity constraints on features determine whether this is acceptable or not. Clash constraints are not needed to rule out inappropriate combinations of features.

5.6 Other Issues

The remaining issues to be addressed are the universality of HA and transparency. The section closes with a summary on round harmony.

5.6.1 Universality of HA

HA is a constraint where place spreading is dependent on height. Kaun (1995) notes that the preference for rounding harmony is when the trigger and target agree in height. There are numerous languages where such dependency exists. One example is Tiv, where round spreading is reliant on the height of the vowel (Pulleyblank 1988, Archangeli and Pulleyblank 1994). If vowels are specified for [+high] then round spreading occurs.

Another example is Turkish, where [round] spreads rightwards across high vowels and is blocked by the presence of low vowels (Clements and Sezer 1982), as shown in (73). U=high front round; *i*=back unround

(60)	gen.sg.	gen.pl	
	ip-in	ip-ler-in	'rope'
	yUz-Un	yuz-ler-in	'face'
	k*i*z-*i*n	k*i*z-lar-*i*n	'girl'
	pul-un	pul-lar-*i*n	'stamp'

The failure of high vowels to harmonise in the suffix **-in** in the genitive plural is due to adjacency. Non-adjacent high vowels do not harmonise in place. The failure of the low vowel /a/ to harmonise is attributed to the fact that it lacks the feature [high].

Yawelmani is another language where feature spreading is dependent on the presence of other features. [round] spreads rightwards onto vowels of similar height but not onto vowels of different height (Archangeli and Pulleyblank 1994).

HA is formulated in the analysis here to capture the interaction between the place features [COR] and [LAB] and the feature [high]. Essentially, HA is a constraint which expresses a dependency relationship between features, and can be utilised to capture dependency relations in other languages.

In her extensive survey on rounding, Kaun (1995) finds that, in six of the nine rounding patterns, harmony is either unconditioned or dependent on vowel height. In the remaining patterns, harmony is unrestricted among front vowels, but for back vowels the pattern is similar to the other six patterns, that is, the trigger and/or target must be high. Some examples are given in the following table modified from Kaun (1995:61-2).

(61) Rounding Typology

Target must be [+high]	Nawuri (Casali 1993), Southern Paiute (Sapir 1930), Sierra Miwok dialects (Callaghan 1987), Turkish (Clements & Sezer 1982), Tuvan (Krueger 1977)
Trigger and target must both be [-high]	Eastern Mongolian dialects (Svantesson 1985, Rialland & Djamouri 1984),Murut (Prentice 1971), Tungusic languages (Ard 1981, Sunik 1985, Avrorin & Lebedeva 1978), Galab (Steriade 1981)
Trigger and target must both be [+high]	Hixkaryana (Derbyshire 1979), Kachin Khakass (Korn 1969), Tsou (Hsu 1993)
Trigger and target must agree in height or target must be [+high]	Yakut (Kreuger 1962)
Trigger and target must agree in height	Yokuts (Newman 1944, Kuroda 1967, Archangeli 1984, Gamble 1978)
Harmony unrestricted among [-back] vowels; among [+back] vowels, target must be [+high]	Kazakh (Korn 1969), Chulym Tatar (Korn 1969), Karakalpak (Menges 1947)
Harmony unrestricted among [-back] vowels; among [+back] vowels trigger and target must both be [+high]	Kyzyl Khakass (Korn 1969)

Given that a number of languages have a dependency on height features, HA would serve as a height-dependency constraint. The features that are dependent on height are language specific. For those languages where back vowels undergo rounding harmony, then backness will be the dependent feature.

In some languages, certain vowels are transparent to harmony, which means that an adjacency requirement would be too specific. A general harmony constraint with a dependency requirement would be sufficient to account for harmony in such cases. Transparency is discussed in the following section.

HA accounts for the absence of skipping behaviour because it requires adjacency. Other analyses in OT appeal to a constraint called NOGAP (Archangeli & Pulleyblank 1994, Kirchner 1993, Beckman 1995) to prevent features skipping over potential anchors. The constraint is expressed in (62).

(62) NOGAP: * F

X X X

This constraint is more stipulative, and it is less intuitive if harmony, at least some forms, is due to neutralisation. NOGAP will also not guarantee, unlike HA, that in aligning a feature to an edge all targets have not been skipped; compare **maliki-k*i*rlangu-kari-kirli** vs **maliki-ku̲rlangu-kari-kirli** discussed in the section on feature alignment.

In some languages, epenthetic vowels acquire place features from an adjacent root vowel. In such cases, there is no feature dependency relationship and if this was the only instance of harmony in the language, HA would simply require feature agreement of adjacent vowels. This would apply to Klamath where, in prefixes, the vowel is a copy of the stem vowel (Barker 1963, 1964 cited in Padgett and Ni Chiosáin 1993).

(63)	sna-batgal	‘gets someone up from bed’
	sna-♍🕮&🕯a:Wa	‘makes cold’
	sne-l’e:mlem’a	‘makes someone dizzy’
	sne-Ge:j🕮iga	‘makes tired’
	sno-bo:stgi	‘causes something to turn black’
	sni-j🕮 i:qjiq’a	‘makes someone ticklish’
	sni-nklilk’a	‘makes tight’

As the prefix vowel is a copy of the adjacent vowel in the first syllable of the root, the requirement would be that adjacent vowels shared the same features. The Identity constraints on features in roots would ensure that harmony only occurred in the prefix.

5.6.2 Transparency

Segments may be opaque or transparent in harmony processes. Opacity of vowels can be attributed to locality, and as we have seen above, the opacity of consonants can be attributed to homorganicity. In some cases, vowels may be transparent, like consonants, to harmony. They allow harmony to propagate across but do not undergo harmony.

An example is Khalkha Mongolian (Steriade 1979, Kaun 1995), where the high front vowel *i* is transparent to rounding harmony involving non-high vowels. While *i* does not block this spread, the high round vowels do. The vowel inventory is given in (64). U=high back round, -ATR; O=mid back round, -ATR.

(64)	i		u
			U
	e		o
		a	O

The following examples are from Kaun:

(65) Transparent i in rounding harmony

xOt-i:xO:	‘town (REFL GEN)
*xOt-i:xa:	
nOir-i:xO:	‘sleep’ (REFL GEN)

*nOir-i:xa:
tomr-i:xo: ‘iron’ (REFL GEN)
*tomr-i:xe:

(66) Opaque U, u in rounding harmony
Or ‘enter’
Or-O:d ‘enter’ (PERF)
Or-U:l ‘enter’ (CAU)
Or-U:l-a:d ‘enter’ (CAU,PERF)
*Or-U:l-O:d

tor ‘be born’
tor-o:d ‘be born (PERF)’
tor-u:l ‘be born (CAU)’
tor-u:l-e:d ‘be born’ (CAU,PERF)
*tor-u:l-o:d

The generalisation is that [-high] vowels agree in place except when right adjacent to high round vowels. There is no adjacency requirement, but rather harmony is general to the suffixal domain. This can be expressed as:

(67) **Round Harmony**: [-high] vowels agree in place.

(68) **IDENT-Sfx(F)**: When U, u are in a suffixal domain, output features must be identical to input ones in that domain.

An IDENT-Root constraint would ensure that feature changes to inputs in the roots is ruled out, and thus only [-high] vowels in suffixes undergo harmony.

Kaun argues that rounding only occurs between non-high vowels in Mongolian because the distance between these vowels is much less than for the high vowels, harmony would then assist in identifying a vowel quality accurately. Rounding of high vowels occurs if this vowel space is relatively crowded. Building on this claim we could say that rounding harmony is unnecessary when a high round vowels occurs because it is sufficiently distinct from the non-high.

5.6.3 A Rounding Summary

At the beginning of this chapter, I mentioned that the apparent characteristics of harmony, direction and iterativity can be interpreted differently under OT with adjacency and the Identity constraint family. Direction is due to Identity constraints on roots, and iterativity due to feature Identity requirements of certain output segments, which involves adjacency of features. In fact, we can establish with some certainty that there are three characteristics of harmony: the motivation of harmony, the harmony dependency feature and the harmony domain. Each of these characteristics has specific requirements expressed as constraints.

(69) *harmony characteristics*

motivation — Harmonic Adjacency / Domain Identity

——	dependency	Height Height + Backness none
——	domain	Identity-Root(F) Identity-Affix(F) Identity(F) Identity-σ(F)

Concern with the output of certain features motivates harmony in terms of adjacency or within a domain. Just what the feature output is is dependent on another feature, or, in the case of epenthetic vowels, there is no feature dependency. Where the harmony occurs is dependent on what is permitted to undergo feature alternation. The ranking of the constraints will determine whether harmony will occur or not, what will harmonise and where.

(70) Constraint Typology

No harmony:	Identity >> HA
Harmony in affixes:	Identity-Root >> HA >> Identity(F)

It is expected that language specific constraints supplement the general harmony constraints as in Warlpiri, where IDENT-VSfx and a specific Root Harmony constraint is required.

5.7 Concluding Remarks

In this chapter I have argued that vowel harmony can be attributed to adjacency and that adjacency can be expressed as a constraint. While adjacency in vowel harmony is not a novel conception of harmony (Archangeli and Pulleyblank 1986, Sagey 1990, Cole 1991), my contribution is to show how adjacency can be formally expressed in a full specification analysis within OT. In addition, I have expanded on adjacency by combining it with height dependency, which is able to account for the two vowel harmony processes in Warlpiri.

Furthermore, an adjacency analysis supports my claim that some processes are better captured under adjacency rather than under alignment constraints.

CHAPTER 6

LEFT EDGE SYLLABLE PROMINENCE AND FOOT ALIGNMENT

6.0 Introduction

Previous chapters have been concerned with foot alignment and adjacency where foot alignment may be determined by morphological or prosodic edges, by rhythmic considerations or lexical marking. Under examination in this chapter is the influence of prominence at the left edge of a syllable on foot alignment, on stress assignment in prominence driven systems, on reduplication and allomorphy.

I propose a theory of left edge syllable prominence to account for a range of prosodic processes which previously appeared disparate and unrelated within and across languages. The problem has been to account for behaviour influenced by onsets where such influence is not frequently encountered.

One interesting result of the examination into left edge syllable prominence is the discovery of an additional dimension of rhythm, created by left edge syllable prominence which, it is claimed, can be independent from the rhythm patterns created by the alternation of stressed syllables.

In the section that follows, I present a theory for interpreting prominence exhibited at the left edge of the syllable. This is followed by a description of Arrernte,[1] which is the language focussed on in this chapter. This description is lengthy as I present a case for a CV syllable structure analysis rather than the VC structure analysis that has previously been argued for. I provide an analysis of stress in Arrernte in section 6.2.2, followed by analyses of stress in other languages with left edge prominence phenomena such as Spanish, Pirahã and Ngalakan. The analysis is extended to account for other prosodic processes: reduplication in Arrernte and Nunggubuyu in section 6.3, and allomorphy in Kayteye and Arrernte in section 6.4. Alternative analyses are considered in each section. The chapter finishes with some concluding remarks.

6.1 Syllable prominence

A theory for interpreting prominence exhibited by onsets is presented in this section. I propose that prominence as determined by sonority in onset position is accessed by prosodic processes which scan the left edge of a syllable. Following Prince & Smolensky' (1993) (henceforth P&S) account of prominence in rhymes, the prominence at the left edge is determined by syllable position and by the sonority that is harmonic for this position.

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[1] The name Arrernte (Aranda) covers Western, Eastern and Central Arrernte varieties which are members of the Arandic language group. This language group also includes Anmatyerre, Alyawarra and Kaytetye. Central Arrernte is also known as Mparntwe Arrernte. These languages are spoken in central Australia.

In terms of structure it is well known that segments in coda or long vowels can make a syllable heavy and that different segments contribute to weight in different languages. This gives rise to the distinction of heavy and light syllables.

Some languages make a syllable weight distinction for the purposes of stress and reduplication. In such languages, constraints must make reference to syllable weight. These constraints may state something along the lines of: stress heavy syllables; a heavy syllable is the reduplicative template, or the minimum size of a word. An example is reduplication in Mokilese (Harrison & Albert 1976) where heavy syllables (ie CVC) are reduplicated.

(1)	a. podok	pod-podok	'plant'
	b. kaso	kas-kaso	'eat'

In assessing syllable weight, reference is made, not to the segments directly, but to the mora, an intermediate structural level. It is argued that prosodic structure, particularly feet and reduplicative templates, make reference to moras. While this is not disputed, others argue for syllable weight to be enhanced to account for phenomena that cannot be captured by a binary heavy/light weight distinction (including Steriade 1982). For instance, stress may be sensitive to sonority, pitch or tone, in addition to weight/length, in determining prominence. Low vowels, heavy syllables, high toned syllables can sound louder and are thus more perceptually salient, ie prominent. Given such distinctions, Hayes (1991) claims that it is necessary to differentiate weight from prominence (perceptual saliency).

Cited in Hayes (1991) are languages which assign stress to syllables with a high tone, Golin (Bunn & Bunn 1970) and Fore (Nicholson & Nicholson 1962). Such syllables are not bimoraic. In Sanskrit, Russian, Lithuanian (Halle & Kiparsky 1977, 1981; Halle & Vergnaud 1987), strong syllables are those with high tones or accents.

Sonority of the vowel may determine the location of stress. Examples include Mordwin (Mokson dialect), a Finno-Ugric language of Central Russia (Tsygankin & DeBaev 1975) where syllables with the vowels [e,o,✈,a] are strong, those with [i,u,★] are weak (cited in Kenstowicz 1994). Hayes (1991) cites Ashenica (Pichis dialect) as having the following prominence hierarchy CVV > Ca,o,e,iN > Ci.

In previous metrical theory analyses, prominence attributed to sonority was accounted for by marks in a grid structure and these, combined with grid marks for weight, generated stress patterns. Prominence due to sonority has been claimed for both rhyme and onset positions.

In OT, prominence in rhyme is accounted for by assessing the inherent prominence of a segment through a non-binary constraint called Peak-Prominence (P&S). In prominence-driven systems, feet are not required for the assignment of primary stress.

(2) **Peak-Prominence (PK-PROM)**

Peak (x) ≻ Peak (y) if |x| > |y|

This constraint translates as '… the element x is a better peak than y if the intrinsic prominence of x is greater than that of y.' (P&S p39). A peak is the syllable nucleus which contrasts with the margin. This notion of prominence is derived from two phonological scales: the inherent prominence of segments according to sonority and the prominence of positional structure in the syllable. As observed in a wide range of literature (including Clements 1990, Hooper 1976, Jesperson 1904, Kiparsky 1981, Lowenstamm 1981, Saussure 1916, Selkirk 1984, Steriade 1982, Zwicky 1972), the location of segments within a syllable is determined by sonority; the most sonorous segments in peak position and the less sonorous towards the margin. Sonority is a contributing factor to syllabic well-formedness. According to P&S (p67) '…when a segment occurs in a structural position such as nucleus, onset or coda, its intrinsic sonority in combination with the character of its position gives rise to markedness-evaluation constraints …'

If we relate sonority scale to syllable position, the most harmonic nucleus will be one with the most sonorous segment. In contrast, the most harmonic onset or coda will be one which is least sonorous. Compare the two harmony scales below:

(3) Sonority Scale

most sonorous				*least sonorous*
vowels	liquids	nasals	fricatives	stops

nucleus |-------------------------------------<--|
(most harmonic) (least harmonic)

margin |------------------------------------->---|
(least harmonic) (most harmonic)

The sonority of the nucleus and that of the margin are assessed on the sonority scale but in reverse order, depending on syllable position. Given these scales, a syllable is more prominent (perceptually more salient) if the sonority distance between margin and nucleus is big. For instance, *ki* is a more prominent syllable than *wi* because a stop is the least sonorous segment and *i* is in the set of most sonorous segments. In contrast, the sonority distance between *w* and *i* is very small.

6.1.1 Onsets and prominence

It has been claimed that onsets in some languages determine stress placement; the sonority of an onset or the absence of an onset influence where stress is located. In Pirahã (Everett 1988), syllable prominence is dependent on the presence, absence or voicing of an onset, as well as vowel length. Main stress in Pirahã falls on the strongest (or most prominent) of the final three syllables in a word. A hierarchy of syllable prominence (Halle & Vergnaud 1987, Hayes 1991) is given in (4), where C = voiceless consonant; G = voiced consonant.

(4) CVV > GVV > VV > CV > GV

There are no syllables consisting of a single vowel. The hierarchy of syllable prominence accounts for the location of main stress in the following words.

(5) a. ?íbogi 'milk'
b. ?abapá (proper name)
c. soi.oa.gahái 'thread'
d. po:gáihi.ai 'banana'
e. ?apabá:si 'square'

If there are two syllables with voiceless stops, as in (5b), the right-most one is stressed. If there are two heavy syllables, the one with an onset is stressed, as in (5c,d). In terms of sonority, the consonants which are least sonorous are the voiceless consonants. It would appear therefore that the least sonorous onset consonants are preferred in stressed syllables.

In Pirahã, the lower the sonority of the onset, the higher the chance the syllable will have of being stressed. If a syllable has an onset and that onset is low in sonority, then the inherent prominence of the syllable is more than if there were no onset or the onset was higher in sonority. Under these conditions, it is logically better to stress a syllable which has higher inherent prominence than to stress an adjacent syllable which has lower inherent prominence. This would be to avoid adjacent prominent syllables and to ensure that prominence alternation occurred – a stressed syllable adjacent to a syllable with high inherent prominence may be perceived to have a similar level of prominence.

In some previous analyses of the Pirahã stress pattern, direct reference to onsets is avoided by representing prominence as marks on a grid. The syllable with the most marks is the one that receives the stress (Hayes 1991, Levin 1985, Davis 1988).

Other analyses have objected to claims that onsets determine stress placement (argued for by Davis, among others), as it is argued only prosodic categories, ie syllables, rather than segments, can be directly accessed in the assignment of stress. It is also argued that onset consonants do not license a mora (Hayes 1991) and that prominence is typically only read from the rhyme. In systems which are prominence-driven, where stress assignment is scalar, there is typically only one stress in a word. Therefore, it is claimed that prominence, not feet, is responsible for stress. However, in general, feet are responsible for stress assignment when more than one stress occurs in a word. In foot-based systems presumably only a heavy/light distinction is available via moras. Feet read moras, so to speak, and are not able to read at the level of segments.

While it is generally agreed that onsets do not count for weight, the question is how prominence of the onset is read in prominence-driven or foot based stress systems. I advocate that the right edge of the syllable is read for weight/sonority, while the left edge is read for sonority, but not weight. The prominence on the left edge is different from that required on the right edge; there are different sonority requirements for different syllable positions.

In theory, a syllable where the onset has the lowest sonority (ie a voiceless stop) followed by a vowel is robust because of the sonority distance between vowel and onset. Syllables where the onset has a higher sonority will be more marked. Such markedness is reflected in the prominence dimension of Pirahã; syllables with high sonority onsets or edges are the least favoured for stress

If an onset is absent, that is, a vowel is at the left syllable margin, this translates as least prominent syllable on the prominence dimension. Here the left margin has a sonority that is equal to the peak – this fact reflects on structure and an onsetless syllable is the least preferred syllable. It is not only because ONSET is violated, but also because the sonority required by onset is absent, and not just whether an onset is there or not.

Where prominence is interpreted at the left word edge, then the constraints on prosodic words, and syllables interact. This edge is a meeting point of Alignment (F,PW) and Prominence (onset, sonority). We will see that in Arrernte, feet will not align with a PW if onset sonority is equal to nucleus sonority. Likewise, for stress assignment via prominence as in Pirahã, stress is avoided on syllables if there is no sonority distinction between the syllable edge and the nucleus.

I argue that this fine-grained assessment explains the prosodic processes in a number of languages, including Arrernte and Pirahã, and that to generate the patterns a prominence constraint on the left syllable edge is required.

Syllable prominence can depend on sonority of the rhyme (nucleus and coda) and of onset, or a combination of rhyme and onset. The evidence from Piraha) bears this out where the preference is, in addition to weight considerations, to stress syllables containing voiceless stops in onset.

I propose that a dimension[2] exists, which may or may not be accessed depending on the language, which I call Left Edge Syllable Prominence (LESP). LESP evaluates information about the sonority of the onset or of the sonority of the left edge of the syllable. The prominence that may be exhibited by the left edge is not necessarily confined to a segment. We know that information about a preceding consonant can be found in the syllable peak due to coarticulation and that the robustness of the perception of the vowel is due to factors of syllable structure (Strange et al 1976, cited in Clark and Yallop 1990:264). A consonant+vowel sequence is more acoustically salient than vowel+consonant sequences because of the consonant release. There is also evidence that the sonority of the onset affects the pitch/tone of the syllable. According to Baker (1997), geminate stops, analysed as fortis, in Ngalakan, an Australian language, affect surrounding vowels giving phonological prominence to syllables. Baker’s claim is supported by evidence from Butcher (to appear), which finds that fortis stops have a greater maximum of intra-oral pressure, as well as a greater rise than lenis consonants.

The constraint for assessing LESP is based on the sonority scale and Peak Prominence proposed by P&S (1993), but with a crucial difference.

(6) **LESP**: x is better than y if the intrinsic sonority at the left edge of x is less than that of y.

LESP works like PK-PROM in assessing the sonority of segments. The difference is that while PK-PROM looks for segments with high sonority levels, LESP targets syllables with left edges that have low sonority levels.[3] This will account for the pattern of stress in Pirahã which is influenced by syllable weight and LESP, and provides an explanation of the different pattern of stress in words like **?íbogi** and

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[2] I use this term to differentiate the prominence characteristics at different syllable edges.

[3] There have been some proposals to include [COR] as part of the sonority scale (Selkirk 1984, among others), but these have met with some objections (Clements 1990, Rice 1992). Arguments in support of including [COR] on the scale are based on evidence from languages like Madimadi (Hercus 1969, Davis 1985,1988) where it is claimed that coronals in onset attract stress. It is possible that a language determines that a particular feature of segments contributes to prominence of a syllable. I leave this question to further research.

?abapá. In the former example, the syllable with the voiceless stop is stressed, and in the latter example where two syllables have voiceless stops, the one closest to the right edge of the word receives stress. Thus, the sonority of the onset is a significant factor in stress in Pirahã.

I propose that LESP can be used to analyse not only feet or the location of stress, but also other prosodic processes such as reduplication. It provides a way to analyse those languages which distinguish sonority of onset to determine stress placement (Pirahã), and languages which distinguish between absence or presence of onset (Arrernte). LESP can capture behaviour exhibited by the left edge of the syllable evidenced in a range of languages.

6.2 Phonology of Arrernte

The bulk of the data on Arrernte presented here is from Breen (1990), Breen and Henderson (1992), Henderson (1993), Henderson and Dobson (1994), Wilkins (1984;1989) and consists mostly of Central, Western and Eastern Arrernte.

Changes that have occurred in Arandic languages have made it difficult to establish the nature of the relationship with other Pama-Nyungan languages, such as neighbouring Warlpiri or Pintupi (see Koch (1995) for a current reconstruction analysis). These changes include stress reassignment[4], loss of initial consonants and sometimes the first syllable, loss of distinction in word-final vowels, pre-stopping of nasals, and labialised consonants. In additional to the consonant series present in Warlpiri, Arrernte has lamino-dental series prestopped nasals and a series of labialised consonants[5]. The orthography used for Arrernte is consistent with that for Warlpiri, with one exception. The palatal stop written as *j* in Warlpiri, is written as *ty* in Arrernte. Words are written with a final **e** which, as argued in Breen (1990), is not present underlyingly.

The vowels in Arrernte are /u,i,a,e/[6]. The **e** represents a placeless vowel, ie a schwa and according to Henderson and Dobson (1994), it is typically shorter in comparison with the other vowels. Central, Eastern or Western Arrernte have the four vowel system just described. Kaytetye is analysed as having a two vowel system (Koch 1990).

Consonant clusters are frequent and some, such as the nasal-stop clusters, labialised homorganic nasal clusters and lateral-stop clusters, may occur word-initially; **ntange** 'flour seed', **mpenge** 'ripe,cooked' . The smallest words, of which there are few, consist of a consonant which surfaces with an epenthetic vowel. These words are imperatives: **we** 'hit (with a missile) imperative; **me** 'here (take this)!; **mpe** 'come on'; **ngke** 'give it to me'. The greatest number of words have the structure VCe.

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[4] Dixon (1980:fn197) and Hale (1976b:44) note the relationship between word-initial consonant dropping and stress shift from the first to second syllable. Dixon claims that the deletion of the consonant is due to stress shift. As pointed out by Blevins & Marmion (1994), this does not explain languages which underwent initial-dropping, but not stress shift, such as Yaygir (Crowley 1979) (see also Alpher 1976).

[5] Lamino-dentals are written as **th, nh, lh**; prestopped nasals as **pm, kng, tn**, etc and labialised consonants as **Cw**.

[6] There is some debate about whether /u/ is part of the underlying vowel inventory in Arrernte (see Breen 1990). Henderson (1993) gives a 3 vowel inventory /e,a,i/. This is not a relevant issue for the analysis presented in this chapter.

6.2.1 Syllable structure

Breen (1990), Breen & Henderson (1992), Breen & Pensalfini (1999)[7] argue that syllable structure in Arrernte is VC. There are problems with this argument and following Wilkins (1989), I maintain the view that the basic syllable structure in Arrernte is CV: a view consistent with universal patterns of syllable structure. I show that there is little evidence for VC syllable structure, nor is there compelling evidence for **e** in morpheme-initial or final position in the underlying phonological representation of morphemes. This means that I differ from Wilkins, who posits **e** morpheme-finally in underlying representations and that I differ from Breen & Henderson, Breen & Pensalfini, who claim that **e** is underlying morpheme-initial but not word-final. The arguments presented below support my analysis.

In a widely circulated paper, Breen (1990) argues that VC is the underlying syllable type in Arrernte, that there are no onsets, and that a CV structure is not valid in the main because:

(1) there is variability in the number of phonetic syllables.
(2) there is a bond between vowels and following consonants.
(3) CV syllables are not relevant when speakers segment words when helping others to learn the language, eg **utnathete** 'mulga blossom' could be segmented as **utne-athete***;* **arlalperre** 'yellow ochre' could be **arl-al-perr**.
(4) if **e** was final, it would be necessary to have a rule to delete **e** before preceding vowels.
(5) there is a number of bound morphemes with initial vowels and the description of all morphemes would be simpler if all were underlyingly vowel-initial.

Each of these arguments is addressed in turn. With regard to the first claim, variability in the number of phonetic syllables in an output is due to vowel deletion/epenthesis at a morpheme edge. Word-final vowel deletion/epenthesis is very common across languages and does not constitute evidence for a particular syllable structure. In fact, some languages have a constraint requiring words to be consonant-final, eg Final-C: every prosodic word is consonant final (M&P 1994)[8]. This is the requirement in Uradhi (Dixon 1980) /ama/ > **amang** 'person'.

Word-final vowels are optional in Arrernte, probably due to a low level of salience and lack of phonological distinction in this position. Only **e** is permitted in this position, and is thus predictable.

Vowel deletion/epenthesis occurs at morpheme boundaries when syllable constraints would be violated. For instance, when consonants occur across a morpheme boundary, epenthesis occurs to avoid violation of NOCODA or ComplexONS (more than one consonant in onset); vowel coalescence occurs when vowels come together, avoiding violation of ComplexNUC (more than one vowel in nucleus). The operation of such constraints explain variability in syllable numbers of

[7] Pensalfini (1998) has since altered his analysis and argues for CV syllables.
[8] M&P (1993) report that consonant-final words are required in Makassarese and P&S report that the same requirement also exists for Lardil. However, both reports are incorrect as pointed out by Nick Evans (pc). Makassarese requires vowels, the velar nasal, or the glottal stop word finally, and in Lardil many vowel-final words exist, for example, **kurrithu** 'will see', **dibirdi** 'rock cod'.

inputs and outputs. Variability of optimal outputs from the same input do not indicate that there is one kind of preferred syllable structure, rather the lack of variability may do so. Variability is due to other factors.

The second claim Breen makes is that there is a bond between vowels and following tautosyllabic consonants. *i* becomes more like [☜] before apico-alveolars, bilabials and lamino-dentals. However, while **e** is also affected by following consonants, preceding consonants also influence the quality of the vowel. Examples of vowels influenced by following consonants are given in ().

(7)	/amirr/	[am☜✍:r★]	'woomera'
	/artity/	[♋▦♓✍:c★]	'tooth'
	/awey/	[awi✍:★]	'boy'
	/ipert/	[ip★✍▦★]	'deep'

Bonds between a vowel and following consonant are common cross linguistically whether or not they are in the same syllable, for example:

a. In Nisgha reduplication, the vowel in the copy is influenced by adjacent consonants: a low back vowel occurs before uvulars, [u] before rounded consonants, [a] after /?, h/, and [i] elsewhere. (Shaw ms)

b. In Southern Paiute (Sapir 1930, cited in Flemming 1993) unstressed vowels devoice when followed by a voiceless consonant and in word-final position. Sonorants before voiceless vowels also devoice.

&♋⬥⍵♓⍵◻♋✍■⍵♓⍵	'beat me!'
❍⍵♓⍵⧫♓✍⬥⍵♋⍵	'point of a hill'
❍⍵◻⍵⌧◻✍♋⍵	'pubic hair'

c. In Tulu (Bright 1972, cited in Clements 1991) rounding of high front vowels occurs when following either a round vowel or a labial consonant, eg **kappu** 'blackness', ◡✔⏶▯⏶▯● 'bond'.

d. In Yessan-Mayo (Papuan language) (Foreman and Marten 1973 cited in Foley 1986), vowels are influenced by preceding and following consonants. For instance:

/❷/ >	[①]/C^w_	[k^w①k^w①]	'chicken'
	[❈]/_y	[w❈y]	'yam'
	[❷]/elsewhere	[s❷k]	'dry'

As discussed in Chapter 5, local assimilation occurs in Warlpiri in the verb roots **pu-** and **yu-** when a palatal consonant follows, eg **pi-nyi** 'hit, kill bite-NPST', **yi-nyi** 'give-NPST'. In Palestinian Arabic (Herzallah 1990, cited in Clements 1991), the high vowel can be influenced by non-adjacent consonants. For instance, in a/i one of the two ablaut classes, [i] typically surfaces in the imperfective, but if a root contains any of the emphatic consonants /t,s,z,r,✍/ or the back velars /k,x,✍/ in any position, then /i/ is realised as [u].

Segments may be affected by surrounding segments regardless of whether they are in different syllables or not. As noted by Amerman and Daniloff (1977, cited in Clark and Yallop 1990), in CCV sequences the tongue body can start moving toward the vowel during the initial C in the sequence. In VCC sequences, similar anticipatory movements are found where during the vowel there is movement towards the second C.

The bond that Breen discusses is a phonetic phenomenon, but is not evidence necessarily for phonological syllable structure. Evidence from other languages shows bonding with following segments, but this has no effect on, nor does it determine, syllable structure. Vowel harmony shows a bonding between vowels in adjacent syllables which is not determined by the kind of syllable structure present.

The third claim is that speakers segment words not according to a CV structure when helping others to learn the language: eg **utnathete** ‘mulga blossom’ could be segmented as **utne-athete; arlalperre** ‘yellow ochre’ could be **arl-al-perr**. This is an interesting situation and would need to be examined in more detail. A personal observation of segmentation of English words into syllables by non-linguists showed that there was variation. In some cases, segments were placed into coda and the medial syllable began with a vowels, eg **wind.ow., test.ing, in.ter.est**. Some divisions show that speakers tend to be more aware of morphological divisions, as is the case in Warlpiri stress patterns, which would explain syllables divisions such as **test.ing**. If a language has a number of VC morphemes, as in Arrernte, then VC syllable divisions would be expected.[9] It would seem that psychological evidence for syllable structure is somewhat inconsistent and not useful support for phonological structures.

The fourth claim Breen makes is if **e**’s were morpheme-final, it would be necessary to have a rule to delete them before a preceding vowel. As he objects to this rule, he claims the underlying representation of morphemes is with **e** occurring initially rather than finally. According to his final claim, this representation is simpler. However, there is no reason that **e** should be underlyingly present morpheme-initially or finally. Epenthesis occurs at morpheme boundaries to separate consonants and optionally word-finally. Because of the variability of **e**, which is predictable, positing it as underlying at morpheme edges is not warranted. It is true that **e** is present in underlying representations when it occurs within a morpheme (it is consistently present), but not true that it exists underlyingly at morpheme edges. Part of the motivation for VC syllable structure is the representation of morphemes as **e** initial. Since this is unnecessary, the claim for VC syllables is not validated.

Other arguments against VC syllable structure are based on expectations if in fact syllables were of a VC structure. Firstly, there is no reason why epenthesis (if final V is not an underlying segment) would apply word-finally. Consider a form /VCVC/ which has VC syllables; epenthesis in this context would be illogical as there is nothing to syllabify with the epenthetic vowel, [VC.VC.e.]. **e** is not permitted word-initially, suggesting that, amongst other factors, **e** cannot occur as a syllable on its own, unlike other vowels. A form /CC/ which surfaces as [CCe] might be expected under a VC syllable analysis to surface as [CeC], thereby satisfying VC requirement which is not satisfied in [CCe].

Secondly, there is no explanation for word-initial vowel deletion and not word-initial C deletion to achieve VC syllable structure word-initially. We would not expect word-initial vowel deletion if syllables were VC; however, we would expect word-initial C deletion.

Finally, a VC analysis cannot say why some roots are realised as C(C)e and not V(C)C. While **e** cannot occur in word-initial position, there would be no reason why

[9] Thanks to Chris Manning for this insight.

another vowel could not occur here. We would expect to find minimal words of the form VC, which are consonant-final and not CV or VCe.

An additional problem with a VC syllable analysis is that syllable structure constraints would need to be revised, as well as theories on segment sequencing in onset and coda positions. Breen does not suggest how consonant clusters are to be interpreted, nor how a word-initial consonant is syllabified. The pattern of consonant sequencing in Arrernte is compatible with other languages, ie the first consonant is less or just as sonorous as the following consonant and, as is typical, the first consonant is a subset of the other consonants. Codas are coronal sonorants or sonorants which are place-linked to a following onset. If there are no onsets, it is not clear how to interpret C_1 in C_1VC.

If we accept Breen's argument, we would need to introduce constraints on syllable structure specifically for Arrernte, which would weaken the theory. I will show that this is unnecessary as the already existing constraints can account for the data. For prosodic processes, having VC syllable structure would mean language specific constraints and an unsatisfactory, or a lack of, explanation for the patterns.

Arguing for VC syllable structure would be difficult to maintain in the light of the behaviour of stress and reduplication. Stress is assigned to the first syllable following a consonant or consonant cluster, as in **tyélpme** 'two', **alénye** 'tongue'. If VC was the syllable type, then we would expect that stress locates on such syllables word-initially. Since it does not, we assume that somehow VC syllables are faulty word-initially, or that there is no such syllable structure. If stress is not placed on word-initial VC syllables, what would be the explanation for it occurring on a following syllable with the same syllable structure, [aC.áC.]? There would be no explanation for the difference in behaviour between word-initial and non-word-initial VC syllables. Given that stress does occur on word-initial CV or CVC syllables, we would have to say that stress occurs on all syllables except VC word-initially, and that the C_1 in C_1VC_2 has something to do with stress appearing word-initially, but is otherwise ignored elsewhere. I argue that CV(C) syllables have no particular or special status in comparison to other syllables, nor does C_1 have a special status word-initially.

Breen and Pensalfini (1999) claim that all words in Arrernte are underlyingly vowel-initial and that stress is assigned at a level when initial **e** is present. Such an analysis is rejected on the grounds that there is no justification for an additional level of processing, and that it is implausible to posit an underlying word-initial **e** which does not surface,[10] but not a word-final **e** which may. If either is predictable then neither should be underlying.

In their analysis, the output of /emp/ is **mpe** which is unexpected in a VC syllable analysis. The location of the epenthetic vowel is a strong indicator of syllable structure and the facts from Arrernte point to CV syllable structure.

Reduplication provides additional evidence for CV syllable structure. The following examples are of prefixing reduplication where for consonant-initial roots CV is copied, while VCV is copied in vowel-initial roots. Vowels are neutralised to **e**

[10] B&P claim that **e** surfaces in all words that are not phrase-initial. Citation forms are phrase initial and thus do not surface with initial **e**. Given this context dependency, under their analysis, **e** is predictable, behaving as an epenthetic segment and not like the **e** that occurs within morphemes, which is not variable.

morpheme-finally and that **e** morpheme-final is an epenthetic vowel. The words in italics are the representation of morphemes advocated by Breen and Henderson and show a different morphological breakup from the analysis presented here.

(8) a.	tnye-me	*tny-eme*	'falling'
	tnye-lpe-tnye-me	*tnyelpetny-eme*	'staggering' [GB:1991]
b.	mpware-me	*mpwar-eme*	'making'
	mpwe-lpe-mpware-me	*mpwelpempwar-eme*	'making' [GB:1991]
c.	itirre-me	*itirr-eme*	'thinking'
	ite-lp-itirre-me	*itelpitirr-eme*	
d.	atwe-me	*atw-eme*	'hitting'
	atwe-lp-atwe-me	*atwelpatw-eme*	

I argue that word-initial onsetless syllables are prosodically inferior and thus do not satisfy targets in prosodic processes; however, in reduplication they cannot be skipped over and so are included in the reduplicant but not counted. Under a VC syllable analysis, syllable reduplication would entail reduplicating a (C)VC syllable in consonant-initial words, thus generating ***mpware-lpe-mpware-me,** instead of the attested **mpwe-lpe-mpware-me**. Given that (C)VC copying is not attested, I maintain that the pattern is CV.

An alternative would be to argue that prefixing reduplication is consonantal, involving copying the initial consonant of the word, and that the **e** in the reduplicant is a result of epenthesis. As I discuss in 6.3, a consonantal reduplication analysis is faced with accounting for a variable number of segments being copied and, therefore, is unable to construct a generalisation for the pattern which a syllable analysis is able to do.

The suffixing reduplication pattern is to copy a foot and suffix it to a fixed reduplicative segment /-p-/.

(9)	Suffixing reduplication - Iterative		
a.	are-me	*ar-eme*	'looking'
	are-p-are-me	*arepar-eme*	'keeps looking'
b.	atwerre-me	*atwerr-eme*	'fighting'
	atwerre-p-erre-me	*atwerreperr-eme*	'keeps fighting'
c.	mpware-me	*mpwar-eme*	'making'
	mpware-p-are-me	*mpwarepar-eme*	'keeps making'
d.	kemirre-me	*kemirr-eme*	'getting up'
	kemirre-p-irre-me	*kemirrepirr-eme*	'keeps getting up'

This pattern does not support the VC syllable claim simply because the initial syllable in the copied portion has not carried over the onset. The fixed segment in Arrernte provides an onset for the copy effectively overwriting any onset. In partial reduplication, VC copying is well attested; examples are given below.

(10) a. Tzeltal (cited in Broselow & McCarthy 1983).

nit	nititan	'push'
haš	hašašan	'feel with palm'

b. Warumungu (Simpson & Heath 1982)

kartt-l	karttart-l	'keep making'
jarrppi-l	jarrparrpi-l	'keep entering'

c. Yir Yoront (Alpher 1973)

worn	wororn
mom	momloml

d. Nakanai (Williams 1984)

hilo	hililo	'seeing'
baharu	bahararu	'widows'

Both prefixing and suffixing patterns of reduplication are consistent with universal reduplicative patterns. The typical prefixing syllable reduplicant (the copied portion) is of the form CV, while for suffixing it is VC. The difference is that, in Arrernte, onsetless syllables do not meet syllable reduplicative requirement and the reduplicant shape is slightly obscured by the presence of neutralised and epenthetic vowels.

The Arrernte language game, Rabbit Talk, involves moving material up to and including the onset (somewhat like Pig Latin) from one end of the word to another, for example, **war** > **arewe** 'only', **arraty** > **atyarre** 'right'. The aim of a language game is to disguise the original form of the word. In Arrernte, transposition occurs to ensure that disguise forms are vowel-initial, except if this results in word-initial **e** which is not permitted (see Berry ms for a full analysis of this and other language games). While moving segments from one word edge to another will generally achieve effective disguise, in monosyllabic words or words that are underlying consonantal this is not the case, eg **ur** > **ure** which is the output for non-Rabbit Talk forms. Instead, a prefix /y-/ is added to the word, eg **ur** > **yure**, **mp** > **yempe**. Under a VC analysis, we might expect a vowel or VC to be prefixed.[11]

Finally, distribution of **e** requires explanation. If it occurs morpheme-initially, what explanation is there for its absence word-initially? What explanation is there for vowel neutralisation in morpheme-final but not morpheme-initial position, and for variability in word-final vowel epenthesis? I argue that the vowel distribution is due to a requirement for place features morpheme-initial, but not morpheme-final. And that variability in word-final epenthesis is because of the low perceptual salience in this position concurrent with absence of vowel-place features. This correlates with the positional prominence asymmetry noted of word edges, ie neutralisation, or reduction in word-final position, but not word-initial.

The claims Breen makes are not sufficient to warrant positing VC syllables in Arrernte. The essential problems are: the non-universality of VC syllables; the lack of strong evidence for VC syllables; the lack of explanation for the difference between

[11] Breen & Pensalfini (1999) argue that the prefix is /ey-/ which shows up when non-phrase initial. Breen & Pensalfini claim that the problem for a CV analysis in accounting for Rabbit Talk is that it would have to say a word is split after the first onset. Though they cite Pig Latin as doing this as well, they then conclude by saying that language games are not good indicators of phonological parsing. Contrary to their claim, language games show that the same constraints on syllable structure, to name just one feature, are in fact maintained in language game forms. In addition, isolating an onset or splitting a syllable is not uncommon in language games and, where it occurs, concern is with the output not the input.

VC and CVC syllables in prosodic processes; no explanation for the distribution of and the variability of **e** at morpheme edges. I believe my arguments presented decide against VC syllables in Arrernte. Since all prosodic processes can be accounted for using CV syllables, this can be considered better than those advocating VC syllables.

Before moving onto the next section, mention should be made of the claim by Wilkins (1989) that /a/ is epenthetic word-initially in a number of words. I assume along with Breen that /a/ is not epenthetic, but that it is underlying. As discussed in the section on variation, I propose that words with variable initial /a/ indicate that there are two underlying forms, one with /a/ and one without.

6.2.1.1 Syllable structure in OT

On the basis of universal evidence into the structures of syllables, it is accepted that CV is the basic syllable shape. Some languages may have CVC and/or V syllables, but no language has only V or only CVC. All languages have CV syllables. To account for basic syllable structure, (P&S 1993, M&P 1993) introduce the following constraints:

(11) **ONSET**: A syllable must have an onset.
NOCODA: Syllables must not have codas
***COMPLEX**: No more than one consonant or vowel may associate to any syllable node position

ONSET requires all syllables to have onsets. Syllables with onsets are universally unmarked syllables, while syllables without onsets are marked. If ONSET is undominated in the grammar of a particular language, it will ensure that only unmarked syllables emerge as optimal, ie CV. *Complex rules out a sequence of vowels or more than one segment syllabified into onset, nucleus or coda.
A difference in ranking generates the following scales:

ONSET >> NOCODA - CV > CVC > V > VC
NOCODA >> ONSET - CV > V > CVC > VC

Segmental epenthesis and deletion are governed in OT by the faithfulness constraints FILL and PARSE (they are also known as DEP and MAX respectively (M&P 1995)). These constraints ensure that input representations are parsed.

(12) **FILL:** Epenthetic structure is prohibited.
PARSE: Unsyllabified structure is prohibited.

In order to satisfy syllabic requirements, epenthesis or deletion may occur, which will thus violate FILL or PARSE. Segments which are not parsed into syllabic structure receive no phonetic interpretation, which means they are deleted. The constraints thus far discussed are ranked as follows for Arrernte: PARSE, NOCODA >> ONSET, FILL. Segments in '< >' have not been parsed.

(13a) therr 'two'	PARSE	NOCODA	ONSET	FILL
%a. the.rre				*

b. therr		*!		
c. <th>e.rre	*!		*	*

(13b) aleny 'tongue'

%a. a.le.nye			*	*
b. a.leny		*!	*	
c. <a>le.nye	*!			*

Variation of outputs occurs in Arrernte; I will assume that the standard citation form is that where initial vowels are parsed and where epenthesis occurs word-finally and between consonants at morpheme boundaries. The issue of variation warrants discussion and I leave this until section 6.2.5. Where **e** occurs morpheme-finally, I assume that it is epenthetic.

I assume that epenthesis can only occur at morpheme boundaries and not within a morpheme, such as between medial consonants clusters. Thus an input /CC/ can only be syllabified as [CCe]. This output violates *COMPLEX, in that two segments are parsed into onset. However, a higher ranked correspondence constraint, such as O-CONTIG (M&P 1995:310), would rule out [CeC]. O-CONTIG rules out internal epenthesis. This explains why epenthesis does not occur within morphemes to separate consonant clusters, but does occur at morpheme boundaries. Epenthesis is forced in these locations by NOCODA, but elsewhere NOCODA is overridden by constraints like O-CONTIG.

e is not permitted word-initially, presumably because it is a placeless vowel. All other vowels occur word-initially. A constraint requiring place features at the left edge of a morpheme is necessary. This contrasts with the right edge of the prosodic word which does not require vowel place at this edge.

(14) LE-Place: -V
|
μ
|
place

To account for the pattern of vowel neutralisation at the right edge of morpheme boundaries, as evidenced in reduplication, a constraint barring vowel place is required. As consonants can be found at this edge, place in this position cannot be ruled out altogether.

(15) RE-NoPlace: V- (At the right edge of a morpheme, vowels are placeless)
|
μ

LE-Place and RE-NoPlace account for the fact that morphemes cannot consist only of a vowel; for instance, a full vowel would violate RE-NoPlace and a schwa would violate LE-Place. The fact that such constraints are required indicates that word-initial onsetless syllables are not invisible to prosodic constraints and that they are parsed into the prosodic word.

6.2.1.2 Onsetless syllables

With regard to phonological processes, some morphological edges behave differently depending on whether they are word-internal or word-edge. Typically, word-internal morphological edges tolerate segmental epenthesis and deletion, but word edges do not. This may mean that onsetless syllables are found only in word-initial position.

The fact that onsetless syllables may occur word-initially and nowhere else is attributed to the relationship between the stem and prosodic word. This is argued by M&P (1993a) for Axininca Campa where epenthesis occurs word-internally, but not word-initially. T = epenthetic consonant

(16) a. /i-N-koma-i/ ingkomaTi 'he will paddle'
b. /i-N-koma-ako-i/ ingkomaTakoTi 'he will paddle for'

Onsetless syllables cannot occur within words but may occur at the left edge of a word. Under the constraint AlignL (introduced in Chapter 2), the left edges of a stem and prosodic word are required to correspond. Any attempt to satisfy syllabic well-formedness at the left edge, either by epenthesis or non-parsing, would incur violations of AlignL. A conflict between AlignL and the syllabic constraint ONSET is evident word-initially.

(17) **AlignL:** The left edge of the stem aligns with the left edge of the prosodic word.

An onsetless syllable may be found at the left edge of words in some languages. However, if a consonant is inserted to fill the onset of a syllable in word-initial position, this would de-align the stem with respect to the prosodic word. While the epenthetic consonant would be part of the prosodic word, it is not part of the underlying representation of the stem, and thus the edges of the prosodic word and stem would not correspond.

The dominance of AlignL over ONSET accounts for a large number of languages where epenthesis or deletion in word-initial position is not permitted, but where both epenthesis and deletion may be found word-internally and finally.

Consonantal epenthesis does not occur in Arrernte, although it is noted that vowel deletion may occur in words commencing with /a/. Wilkins (1989) mentions that the presence or absence of /a/ is restricted to certain words and that not all /a/ initial words undergo /a/ deletion. I analyse words which may or may not surface with initial /a/ as having two variants underlyingly and that word-initial vowel deletion does not occur for reasons discussed in section 6.2.5. I assume that the general pattern is where word-initial vowels are parsed, indicating that AlignL and PARSE are dominant over ONSET. The operation of the constraints is illustrated below in an example from Arrernte **atwerr** 'to fight'. |=stem edge; <>=unparsed

(18) atwerr	AlignL	PARSE	ONSET
%a. [|atwerre]			*
b. |<a>[twerre]	*!	*	

The optimal output is where the stem and prosodic word are aligned in (18a). In (18b) the initial vowel is not parsed, which avoids violation of ONSET, but violates AlignL and PARSE. Note that if a word-initial consonant was not parsed both AlignL and ONSET would be violated.

This section outlines the explanation under OT for onsetless syllables in word-initial position. Any attempt to generate a syllable with an onset will violate the higher ranked AlignL.

6.2.2 Stress

Main stress in Arrernte is on the first syllable with an onset. The exception is when the word is disyllabic and vowel initial, in which case stress can be either on the initial onsetless syllable or the final syllable. Stress alternates on every other syllable. The examples presented in this section are mostly from Mparntwe Arrernte (Wilkins 1989). Some examples are from Henderson & Dobson (1994) indicated by the initials H&D.[12]

The difference in stress patterns between vowel-initial and consonant-initial words is shown in (19).

(19)	a. inárlenge	'echidna'
	b. alénye	'tongue'
	c. ulpmérnte	'dust storm'
	d. arrérnelhéme	'sit yourself down' (H&D)
	e. urrtyálthe	'liar' (H&D)
	a. yéparènye	'k.o.caterpillar'
	b. téngkwelknge	'snot; a cold'
	c. márteme	'is closing'
	d. thérre	'two'
	e. tyélpme	'chips'

When the word is vowel-initial, stress is on the second syllable. In quadrisyllabic words this means only one syllable is stressed. In contrast, when the word is consonant-initial, stress is on the first syllable, as well as the third syllable. The rhythmic pattern of words is affected by the structure of the word-initial syllable.

There is some variation in stress placement in vowel-initial disyllabic words. Stress may be located only on the initial syllable as in the word (20), or only on the final syllable as in (21).[13]

(20)	a. ámpwe	'old'
	b. írlpe	'ear'

---

[12] Wilkins' may represent vowels differently compared to those in the dictionary and in Breen and Henderson due to differences in perception and analysis.

[13] According to Breen (1990), Eastern Arrernte speakers and older speakers of other varieties of Arrernte tend to stress the final vowel in vowel-initial disyllabic words. Breen does not clarify whether this tendency is subject to contextual conditions or whether there is free variation. The different patterns of stress for vowel-initial disyllabic words may represent a change in progress, or the existence of words with lexically marked stress. This area requires further investigation.

	c. álknge	'eye'
(21)	a. arltwé	'empty'
	b. ankwé	'asleep'

Stress on word-final syllables only occurs in vowel-initial disyllabic words, while stress on onsetless syllables appears to be lexically conditioned.

The stress pattern may also vary in words, depending on vowel quality. According to Wilkins (1989), if the initial segment is /a/ and the second vowel is a schwa **e**, then some words may have stress on either the first or second syllable.

(22) árrernte ~ arrérnte 'Arrernte'

Breen reports that, in some words with a word-initial full vowel, followed by a schwa in the next syllable, stress on the first vowel in such words is more likely for younger speakers. He gives **árrernte, úrreke** 'wait on' and **írretetye** 'support,frame' as examples, noting that in all cases the consonant following the vowel is /rr/, but that it is a doubtful conditioning factor.

Henderson & Dobson note that some other disyllabic words also show free variation, eg **urrpmé** ~ **úrrpme** 'chest scar', **ámpe** ~ **ampé** 'child, but in **ampéke** 'for a child' there is no variation. The variation in disyllables perhaps reflects preferences dependent on speaker age and/or dialect.

Words of four or more syllables in Arrernte are typically polymorphemic or frozen reduplications, and follow the general stress pattern described above.

(23)	a.	knwenge-ipere	knwéngipére
		2sgDAT-AFTER	'after you; from you'
	b.	iperte-iperte	ipértipérte
		hole-hole	'rough; bumpy'
	c.	atere-althe	atéralthe
		afraid-BadCHAR	'coward'
	d.	atne-iwe-me	atníweme
		guts-throw away-NPP	'gutting an animal'

In sum, the following observations can be made regarding the stress patterns in Arrernte:
(a) Stress is on the first syllable with an onset.
(b) Onsetless syllables may be stressed if the word is disyllabic or is of the form [VCe…]. In other environments they are ignored.
(c) Stress alternates on every other syllable, but not on the final syllable, except when the word is both disyllabic and vowel-initial.

6.2.2.1 An Analysis

The location of feet within words depends on whether the word-initial syllable has a consonant or not. If the initial syllable has a consonant, then a foot will be aligned to the left edge of the word, eg **(téngkwel)knge** 'snot;a cold'. If, on the other hand, the initial syllable is without an onset, a foot is aligned with the second syllable, and not the initial one, as in **a(lénye)** 'tongue'.

In previous metrical accounts of Arrernte (including Levin 1985, Archangeli 1986, Halle & Vergnaud 1987), initial onsetless syllables are analysed as extrametrical.[14] Extrametrical syllables are marked by rule, and are ignored or are invisible to prosodic processes. When syllables are parsed into feet, the extrametrical syllable is left out because it is invisible. Marking an onsetless syllable as extrametrical can account for stress appearing on the second syllable in words commencing with a vowel.

The marking of certain prosodic constituents as extrametrical is confined to the edges of words. A segment, syllable or a foot at the left or right edge of a word may be marked as extrametrical. For the Arrernte facts, not just any syllable at the left edge of a word can be extrametrical; only onsetless syllables can be extrametrical.

While marking an onsetless syllable as extrametrical prevents it being incorporated into a foot, it does not explain why this should be the case. There is also no evidence from other prosodic processes in the language to indicate that onsetless syllables are extrametrical.

Given that stress is not located on vowel-initial syllables, at least in words longer than two syllables, it is reasonable to assume that there is a particular relationship between the structure of syllables and the foot. If the initial syllable in the word does not have an onset, the foot will align to the next syllable that does.

We may suppose that onsetless syllables are ignored because they are the least well-formed or least harmonic syllable available. In general, prosodic processes target or attempt to achieve the most well-formed or optimal constituent. This is particularly evident in reduplication, where in syllable reduplication, a reduplicated syllable must satisfy syllabic well-formedness conditions, or the complete output best satisfies these conditions. Satisfaction of the conditions is ensured by various means in different languages. For example, in Timugon Murut reduplication (Prentice 1971), initial onsetless syllables are ignored and the first CV syllable is copied.

(24) Timugon Murut reduplication

a. bulud	bu-bulud	'hill/ridge'
b. limo	li-limo	'five/about five'
c. ompodon	om-po-podon	'flatter/always flatter'
d. abalan	a-ba-balan	'bathes/often bathes'
e. ulampoy	u-la-lampoy	no gloss

In consonant-initial words the initial syllable is copied and prefixed to the root. However, in vowel-initial words the first syllable is ignored and the next syllable is copied instead. In words with closed syllables such as (24e), only the onset and nucleus are copied. These facts indicate that reduplication targets the least marked syllable, ie CV. V syllables are ignored and in CVC syllables only CV is copied.

[14] Extrametricality is formally proposed in Hayes (1979) and subsequently developed in numerous works, including Hayes (1981), Harris (1983), Archangeli (1984), Inkelas (1989). The term 'invisibility' (Poser 1984) is often used to cover phenomena which are variously referred to as 'extrametricality' (Liberman and Prince 1977; Hayes 1981), 'extratonality' (for tone, Pulleyblank 1986), and 'extraprosodicity' (for vowel harmony, Kiparsky ms). Idsardi (1992) adopts a different approach to extrametricality through the use of boundary markers. Word edges are marked with boundaries by rule. In his analysis for Arrernte, a rule places a left boundary to the right of the left-most element where the left-most element is a vowel, ie V(CVCV.

As pointed out by M&P (1993a), if onsetless syllables were copied in Timugon Murut, there would be two syllables without onsets, ie ***a-abalan**, which would incur more violations to ONSET than the output **a-ba-balan**. Reduplicating the least marked syllable avoids violation to ONSET and the well-formed output contains one marked syllable rather than two.

In reduplication the segmental content of the copied portion is manipulated to ensure best-satisfaction of well-formedness constraints. This contrasts with stress assignment where there is no operation available to ensure that syllables are structurally the most harmonic. Operations which occur under stress, such as segmental lengthening or affects on segmental quality, do not enhance the well-formedness of a stressed syllable.

In addition, the conflict between ONSET and AlignL means that operations to improve the harmony of initial onsetless syllables are not possible. Consequently, one option for languages is to ignore the least harmonic syllable and target the most optimal syllable, as in Arrernte. I argue below that the optimal syllable is construed along the dimension of prominence.

6.2.2.2 Feet and Prominence

As noted above, in disyllabic vowel-initial words there is variable stressing, in that either the first or second syllable may be stressed. This suggests that footing is responsible for stress assignment. This is because if only prominence was significant then stress would never appear on the onsetless syllable. If stress was due to prominence only, syllables with onsets would be stressed.

The left-most foot carries primary stress and as there is variability in disyllabic vowel-initial words in the location of stress, this primary stress is a result of foot assignment and prominence.

Trochaic feet are responsible for assigning stress, but if a syllable has no onset and the word is disyllabic, a conflict occurs which can optionally result in a change in foot type to satisfy prominence requirement. The change in foot type from trochaic to iambic is referred to as Rhythmic Reversal (P&S 1993:54) and occurs in Southern Paiute (Sapir 1930) due to a constraint against word-final stress (NonFin), shown in the tableau below with the example /puNpuNku☠◆⬀♦♋☠◆♋/ ‘our (incl) horses owned severally’.

(25)

	NonFin	FtForm
%a. (pumpu✍☠)(ku☠◆⬀👓)(ta👓☠wa)		*
b. (pumpú☠)(ku☠w⬀👓)(ta☠wa👓)	*!	

These two cases of Rhythmic Reversal have one thing in common which is that phenomena at a word edge trigger the reversal, either because final stress is not permitted or a stress on an onsetless syllable is not permitted.

The foot type is not variable in any other word sizes. In quadrisyllabic vowel-initial words, there is one stress (**inárlenge** 'echidna'). If stress was assigned by iambic feet, we would expect stress to occur on the final syllable in such forms, eg ***(iná)(rlengé)**. The absence of word-final stress in these kinds of forms cannot be because word-final stress is not permitted, as it is permitted in disyllabic vowel-initial words. The conclusion is that trochaic feet are responsible for assigning feet, but that the foot is sensitive to LESP, which results in second syllable stress because of Prominence.

The left edge of the word is also the position of prominence. If a non-prominent syllable is in this position, stress is forced to locate on another syllable. Also note that the placeless vowel **e** in Arrernte is not permitted word-initially, suggesting that a certain degree of prominence is required in this position. It is possible that prominence is a factor in the variability in stress location when an onsetless syllable is followed by a syllable with **e**.

The most prominent syllables in Arrernte are those with an onset. This generates the following scale: CV (C) > V(C). Note that this prominence scale is significant only word-initially as onsetless syllables elsewhere are not permitted.

(26) LESP: prominence hierarchy
CV (C) > V(C)

The constraint based on this hierarchy is LESP.
(27) **LESP**: Assign stress to prominent syllables.

The other constraints required are:

(28) **FootForm**: SyllableTrochee
AlignPW: Align a foot to the left edge of the prosodic word
RA: Unfooted syllables must not be adjacent

The ranking is: RA, LESP >> FtForm, AlignPW

LESP must be ranked above AlignPW to have any effect, and is also ranked above FtForm to ensure that iambic feet cannot be generated in optimal outputs other than disyllables as a result of LESP. LESP evaluates syllables according to the hierarchy. To avoid confusion only the first two syllables are presented in the tableau; other syllables do not compete.

(29) inarleng	LESP	FootForm	AlignPW
%a. i(nárle)nge	i, ná		*
b. (ína)(rlènge)	í!,na		
c. (iná)(rlènge)	i, ná	*!	

(29a) is the optimal output, even though the foot is not aligned to the left edge of the prosodic word and two syllables are not parsed into feet. Any outputs with a sequence of unfooted syllables would be ruled out by RA. Violation to ONSET has no effect on the outputs as the following tableau shows:

(30) inarleng ONSET LESP AlignPW

%a.[i(nárle)nge]	* i, ná	*
b.[(ína)(rlènge)]	* í! na	

All outputs violate ONSET, but because (30a) does not violate LESP, it is the optimal output.

In consonant-initial words, LESP has no effect since all syllables are prominent and so the decision on the optimal output will be determined by FtForm and AlignPW. In disyllabic words, the LESP will ensure that final syllables are stressed, as shown below with the word **urrpme** 'chest scar'.

(31)	LESP	FtForm
a. (úrrpme)	úrr!, pme	
%b. (urrpmé)	urr, pmé	*

Note that reversal is not an option in longer words as seen in (29) where the optimal output does not violate either LESP or FootForm.

As previously discussed, some dialects or age groups allow stress variation in disyllabic vowel-initial words and words with initial onsetless syllables followed by Ce. To account for this a specific additional ranking needs to be added to the Prominence Hierarchy. Under the current Prominence Hierarchy, this variation could not occur since any CV syllable is better than V syllables. The variability in [VCe…] contexts is context dependent, that is, it is only in this context that either V or Ce can be stressed. Thus V and Ce are equivalent in terms of prominence in this context. Since Ce syllables would be assessed as better than V syllables in the general hierarchy, a specific ranking where V is better than Ce is needed. This is shown in (33), where the ranking is linked to a dialect:

(32) Prominence Hierarchy: CV(C) > V(C);
Dialect (a): in [VCe…], V(C) > Ce

Dialect (a) can represent any group or individual that shows variation and we can say that variation occurs when a speaker uses Dialect (a). For our purposes this simplifies the issues surrounding variation, such as the degree of frequency of variants. In (33) and (34), the optimal output is determined by LESP's Dialect (a) condition.

(33) Dialect (a)	LESP	FtForm
%a. (úrrpme)	úrr, pme	
b. (urrpmé)	urr, pmé!	*

(34) /arrernt/ LESP AlignPW

a. a(rrérnte)	a, rré!	*
%b. (árrern)te	á, rre	

It is debatable as to whether V and Ce syllables should be equivalent or ranked in Dialect (a). If there is no ranking of these syllables, the output will be determined by FtForm in disyllables or by AlignPW in longer forms, in which case the optimal output will have initial stress. Thus the same output is generated regardless of whether V and Ce syllables are ranked or are equivalent. FtForm decides on the optimal form in (35).

(35)

	LESP	FtForm
%a. (úrrpme)	úrr, pme	
b. (urrpmé)	urr, pmé	* !

For the moment I will assume that in Dialect (a), V is ranked above Ce syllables. The benefit is that prominence is determined by LESP rather than FootForm or AlignPW.

6.2.2.3 Discussion

Arrernte is an example of where prominence and foot alignment interact at a word edge. This phenomenon may have arisen as a result of sound changes in the language which affected the structure of word-initial syllables. When syllable structure cannot be changed or improved then prominence requirements attached to the left edge of the prosodic word may come into play. Feet align with edges and such edges are prominent because of that, particularly if the head of the foot is at the edge. The edge may be less prominent if stress is on the second syllable, but in Arrernte this is better than stressing an onsetless syllable.

The evidence that prominence influences the stress patterns in Arrernte includes the distribution of vowels (**e** morpheme-final and not morpheme-initial), avoidance of stress on onsetless syllables, stress on word-final syllables in VCV words, variation in vowel-initial words when the second syllable contains **e**.

Prominence is relevant not only for position in a syllable but also for position in a word. Much evidence exists for the prominence of syllables in word-initial position (see Beckman 1998 for a survey of psycholinguistic and phonological evidence). According to Steriade (1994, cited in Beckman 1998) there are some linguistic positions which are privileged in that phonological contrasts which are perceptually difficult are maintained and such positions are less likely to be subjected to phonological processes such as neutralisation. Word-initial position is a position of prominence and contrasts with word-final position where neutralisation is commonly found.

Stress is commonly found at word edges and Hyman (1977:41) reports that stress on an initial or final syllable involves less calculation for both speaker and hearer. According to Prince (1983:90), word edges are salient positions receiving enhancement from a relationship with the intonation contour which starts high then gradually drops.

Morpheme-final position in Arrernte is not a privileged position as it is susceptible to neutralisation. For instance, when a CV syllable is reduplicated the vowel neutralises to **e**, as in **mpwe-lpe-mpware-me** from **RED-lp-mpwar-m**. This contrasts with morpheme-initial position.

The tendency for vowel neutralisation or deletion may explain why some languages have a requirement that words are consonant final. This tendency is reflected in the constraint previously mentioned, ie Align-C. P&S (1993) claim that such a constraint is required to account for the prosodic weakness of final open syllables evidenced by instances of destressing, devoicing, shortening.

It is interesting to consider why word-initial segment deletion occurred in Arrernte if the edge is indeed prominent. Blevins and Marmion (1994) offer a proposal for Nhanta, a Kartu language of Western Australia, which underwent initial bilabial deletion leaving many words vowel-initial. They claim that onsets of stressed syllables underwent shortening, which affected consonants with a short VOT and weak bursts, ie bilabials. These, as a consequence, weakened gradually to the point where place of articulation cues were no longer auditorily significant, effectively deleting.

6.2.3 LESP in other languages

Other languages with similar conditions to stress assignment as Arrernte are Banawa⇔ (Buller, Buller & Everett 1993) and Iowa-Oto (Robinson 1975) as cited in Downing (1996). While stress is placed on word-initial CV syllables, stress on word-initial onsetless syllables is avoided. Examples from Iowa-Oto are **páxoce** ‘Iowa’ and **aháta** ‘outside’. Languages related to Arrernte show a similar pattern, for instance Alyawarra (Yallop 1977), but where only CV syllables are stressed, as in **kwátja** ‘water’, **ilípa** ‘axe’ and **athá** ‘I (ERG)’; and Andegerebenha (Breen 1977) **káge** ‘bit’, **atwákay** ‘wild orange’. Other Australian languages include Uradhi (Hale 1976b), which shows the following patterns, **yúkuk**, ‘tree’, **amáng** ‘person, as well as some Yolngu languages, such as Djapu, where stress is typically on word-initial syllables but may occur on a second syllable if that syllable has an apical consonant in onset (Evans 1995). In this section, other languages showing LESP, Spanish, Pirahã and Ngalakan are examined.

6.2.3.1 Spanish

The interaction of prominence and the left edge of the prosodic word can be seen in Spanish. In Spanish, word-initial **e** which is epenthetic before sC clusters cannot be stressed (Harris 1983, Alderete 1995)[15]. Epenthesis occurs in the following loan words:

(36)	/sfera/	esfera	‘sphere’
	/slavo/	eslavo	‘slavic’
	/spirar/	espirar	‘to breathe’

The typical stress pattern is stress on the penultimate syllable, but this pattern is disrupted when **e** is initial. This is illustrated in the verb **estar** where stress may occur

[15] The claim that **e** is epenthetic in roots is based on the fact that there are no word-initial sC clusters in Spanish.

on the final syllable and this contrasts with the patterns for the verb **hablar**. Examples are from Alderete (1995).

(37) a. indicative / subjunctive

a. indicative		subjunctive		
estóy	háblo	esté	háble	1perSG
estás	háblas	estés	hábles	2perSG
está	hábla	esté	háble	3perSG
estámos	hablámos	estémos	hablémos	1perPL
estáis	habláis	estéis	habléis	2perPL
están	háblan	estén	háblen	3perPL

The only exception to this pattern of avoiding stress on word-initial **e** are the demonstratives, eg éste. In non-initial position **e** can be stressed:

(38) /aBr-to/ aBjérto 'open'

Other vowels can be stressed word-initially. Examples from Halle & Vergnaud (1990:94):

(39) el áma 'the mistress'
el álma 'the soul'

I propose that **e** word-initially cannot be stressed because its inherent prominence is less than that for other vowels and because there is no onset. Thus, preference is given to more prominent syllables. Given that it can be stressed elsewhere then there is a case for LESP at the left edge of the prosodic word.

In an analysis of the stress transparency of **e** word-initially, Alderete (1995) advocates that an initial stressed **e** is ruled out by a constraint (HEAD-DEP) which only allows input segments to be included in a metrically prominent category, such as in the main stress foot of the prosodic word. He argues that in disyllabic words with initial **e**, this constraint forces monosyllabic feet, such as in **es(tás),** thereby avoiding inclusion of **e** into the main stress foot and violating the higher ranked HEAD-DEP.

It is clear that a relationship exists between syllable prominence and prosodic word prominence, hinted at in Alderete's constraint. A combination of factors seem responsible; lack of an onset, a prominent word edge in disyllables (due to penultimate stress), a non-prominent vowel at this edge. I propose that a prominence hierarchy, such as CV(C), V_{place}(C) >> e(C), is referred to by the LESP constraint, and this will generate the optimal output in disyllabic words. CV syllables include any vowel, but for VC syllables it is necessary to distinguish between vowels with place features and the epenthetic vowel, which by its nature lacks place. In longer words, LESP combined with a constraint on word-final stress (NONFIN) will generate optimal outputs.

(40)

	LESP	NONFIN
% a. está	es, tá	*
b. ésta	és!, ta	

% a. estámos	es, tá , mos	
b. éstamos	és!, ta, mos	
c. estamós	es, ta, mós	*!

Under a prominence analysis, it would not matter if **e** was underlying or epenthetic, as, in either case, in onsetless syllables **e** is the least preferred syllable.

6.2.3.2 Pirahã

In Pirahã, stress is sensitive to syllable weight and to LESP. Voiceless consonants are less sonorous, but more prominent than their voiced counterparts and syllables with voiceless onsets are preferred over voiced onsets. The hierarchy of prominence can be represented on a single scale, but LESP assesses left edge prominence, while PK-PROM assesses syllable weight.

(41) CVV >> GVV >> VV >> CV >> GV

Since weight is more important than onset prominence, PK-PROM is ranked above LESP. These are ranked above a requirement to align stress to the right.

(42) soioagahai ‘thread’	PK-PROM	LESP
%a. soi.oa.ga.hái	ái, a, oa	h, g
b. soi. óa.ga.hai	óa, ai, a	o!, g, h,
c. soi.oa.gá.hai	oa, ai, á!	h, g

The two prominence dimensions interact ensuring that optimal stressed syllables are heavy syllables with an onset of the lowest sonority which is thus maximally distant from the sonority of vowels. Interaction between heavy syllables and syllables with a particular onset occurs in Ngalakan discussed in the next section.

6.2.3.3 Ngalakan

Another language where voiceless consonants have some influence over stress patterns is Ngalakan, a Non-Pama-Nyungan Australian language of the Gunwinjguan family. According to Baker (1997a), heavy syllables are those with heterorganic codas, but not those with homorganic codas, including geminates. This geminate behaviour has been noted by Tranel (1991), who reports that geminates are non-weight bearing in languages where CVV is heavy, such as in Selkup and Malayalam.

Geminates are analysed as fortis and are longer than the corresponding lenis stop. It would seem that this factor influences some of the stress patterns. For instance, when a glide is in onset of the word-initial syllable and there is a geminate, stress goes on to the second syllable, shown in (43).

(43) wukká□a ‘frog sp.’
yippú⍂ca ‘a long time ago’
yukkácih ‘for a long time’
wakkéna ‘return.FUT’
akká▦ah ‘late’

However, if a geminate is present and the word-initial consonant is not a glide, stress is on the first syllable, shown in (44):

(44) pícciri ‘file snake’
káppuci ‘old person’
káppu⇧a ‘old, blind person’

When the first syllable is heavy and the next syllable commences with a geminate, there is variation in the stress pattern.

(45) mi□ppára/mí□ppara ‘child’
palppá□a?/pálppa□a? ‘friend’
palccú▦a?/pálccu▦a? ‘lizard sp.’
purkkáci/púrkkaci ‘real’

In some words there is no variation, as shown in (46). Baker suggests that this may be because the final syllable is closed by a sonorant.

(46) káykkupu□? ‘early’
wúrkki⇧i⍂ ‘macropod sp.’

There is no variation in stress assignment when a light syllable procedes one with a fortis onset, as the words in (44) show. If these syllables were heavy, we would expect stress consistently on the first syllable and not on the second syllable, as in the words in (43) and (45). We may suppose along with Baker (1997b) that prominence is a factor in assigning stress, although how this is formalised differs. I propose that stress is assigned according to LESP and PK-PROM considerations.

The data indicate a LESP prominence hierarchy where syllables with glide onsets are least preferred, and a PK-PROM hierarchy where heavy syllables are preferred. In one of these hierarchies it is necessary to combine the two prominences because of the variation between heavy syllables and syllables with an initial fortis consonant. This can be interpreted as a conflict between LESP and PK-PROM, ie different kinds of prominence, but needs to be expressed in a single prominence hierarchy, PROM. I assume that this conflict expressed as variation is dealt with in the same way as for Arrernte, that is, through a dialect/variant ranking.

(47) PK-PROM: CVC > CV($C_{\text{no place}}$);
Dialect (b): In [CVCC_{fortis}V…], C_{fortis}V > CVC
LESP: In [C_{glide}V C_{fortis}V…], C_{fortis}V > C_{glide}V

Homorganic consonants in coda position have no independent place specification (the details of which I will not formalise here) in contrast to heterorganic codas. Alternatively, homorganic consonants and a geminate are not syllabified into coda. Both options are feasible; however, there is not the space here to debate the benefits of one over the other. For the moment I will indicate homorganic consonants as having ‘no place’.

With PK-PROM and LESP ranked over AlignFt, prominence takes precedence, but is constrained so that stress is as close as possible to the left edge of the prosodic word. The tableaux below show the operation of the constraints.

(48) wukkara	LESP	AlignFt
%a. wukkára	wu, kká	σ
b. wúkkara	wú!, kka	

(49) /kaykkupu	PROM	AlignFt
%a.káykkupu	káy, kku	
b.kaykkúpu	kay, kkú !	σ

(50) Dialect (b)	PROM	AlignFt
%a. palppára?	pal, ppá	σ
b. pálppara?	pál!, ppa	

Under conditions for Dialect (b), a syllable with a fortis onset will be stressed over a heavy syllable and thus (50a) is the optimal candidate in the tableau above.

In many languages, prominence is expressed either through LESP or PK-PROM, with PK-PROM being the more frequently attested prominence type. Arrernte provides evidence that an LESP requirement is needed, separate from PK-PROM. In Ngalakan, we see that both types of prominences are merged together into a single hierarchy in Dialect (b) to account for variation.

Evidence that fortis consonants are recognised as prominent comes from their distribution in suffixal domains. In these domains, the distribution of fortis consonants is dependent on the distance of fortis consonants from each other. If they are within two syllables, degemination of a morpheme initial fortis consonant occurs. Degemination also occurs if there is a glottal-obstruent cluster in the root or if the fortis consonant is adjacent to a stop.

(51)	cangku-cci	‘no meat’
	ku-we?-ci	‘no water’
	mi□ppara-ci	‘no children
	⬃u-kaykka-pulu	‘[those] uncles’
	NC-MoBr-PL[16]	
	kaykka-☠ini-ppulu	‘my uncles’
	MoBr-1SGPOSS-PL	

Baker (1997a) analyses this as a requirement for alternation of prominence with a constraint similar to RA, where prominent syllables are those with geminates and stressed syllables.

[16] Abbreviations: NC: noun class prefixes; MoBr: mother’s brother; PL: plural; POSS: possessive; SG: singular.

6.2.3.4 Discussion

In the analysis presented here, a prominence distinction is made between the different edges of syllables. LESP is sensitive to prominence at the left edge, in contrast to PK-PROM, which is sensitive to the right edge. The right and left edges show different prominence. This asymmetry is observed in what contrasts are available in onsets and codas, and in what undergoes phonological processes. For instance, onsets typically have a greater range of featural contrasts than codas, and onsets typically fail to undergo phonological processes like assimilation, unlike codas.

An asymmetry is also observed in word edges. Typically the right edges of word undergo phonological reduction or deletion processes, while the left edges are resistant to such processes.

Additional support for syllable edge asymmetry in terms of prominence, where different kinds of prominence are required for different edges is illustrated in Koniag Alutiiq (Leer 1985). In this language, consonants in foot-initial position or the left edge of iambic feet (σσ⌧⌧) undergo fortition. The crucial facts are that word-initial consonants strengthen, but there is no strengthening (lengthening) of vowels in an onsetless syllable word-initially. Note that the alternation of fortis consonants is similar to that in Ngalakan. Examples are from Hewitt (ms) and do not have glosses[17].

(51) /-quta-/ 'be going to V'

[**p**i.sú:.qu.**t**a.qú:.ni]	/pi-su-quta-quni/
[**m**a.ngár.su.**g**u.tá:.**g**u.ní]	/mangar-su-quta-quni/
[át.sar.**s**u.qú:.**g**u.ní]	/atsar-su-quta-quni/
[**p**i.sú:.qu.**t**a.qú:.ni]	/pi-su-quta-quni/
[**m**a.ngár.su.**g**u.tá:.**g**u.ní]	/mangar-su-quta-quni/
[a.gá:.**y**u.tém.máng]	/agayute-maang/
[a.gá:.yu.**t**e.lég.mek]	/agayute-leq-mek/
[a.kú:.**t**a.tún.nir.túq]	/akutaq-tu-nnir-tuq/

The data highlights the difference between prominence due to weight and left edge syllable prominence. Strengthening a vowel would result in a long vowel and in this language only stressed vowels are long. Strengthening an onset consonant has no effect on the weight of the syllable, but it does, however, contribute to the prominence of the syllable.

These facts suggest that stress prominence and LESP are different entities. The rhythm based on stressed syllables is different from that created by LESP, particularly when fortis consonants are in onset. Languages with geminates have distinctive rhythmic patterns compared to languages which do not have geminates. And after listening to languages as diverse as Finnish and Djambarrpuyngu (Wilkinson 1991), both with geminates/fortis consonants, it seems that such languages have similar rhythmic characteristics. Another observation is that in Italian, the words **capélli** 'hair'

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[17] e=schwa, g=voiced velar fricative, x=voiceless velar fricative, X=voiceless uvular fricative, R=voiced uvular fricative, L=voiceless lateral, **C**=fortis C, :=lengthened short vowel, VV=underlying long vowel

versus **cappélli** ‘hats’, and **capellíno** ‘hair (DIM)’ versus **cappellíno** ‘hat (DIM)’ have almost exactly the same segmental structure and the same stress pattern, yet have a different rhythmic pattern. From this we can conclude that there are different kinds of rhythmic patterns, LESP, PK-PROM or both. Tone is another rhythmic dimension and quite possibly other rhythmic dimensions exist which are expressed in different ways and in different combinations of patterns. LESP has expanded our understanding of rhythm and opens up an avenue for further investigation.

6.2.4 Alternative stress analyses

Previous rule-based analyses of Arrernte have assumed that onsetless syllables are invisible and use extrametricality to achieve this. Extrametricality is a mechanical device carrying no explanation for the invisibility of units so marked. I have argued that evidence from syllable structure constraints, and from variation in stress placement, that such syllables are not invisible, although they are prosodically inferior.

In a rule-based analysis of Arrernte stress, Davis (1988) argues that stress is sensitive to the presence of onsets. His rule states that main stress falls on the first syllable with a syllable node that branches (into an onset). As the rule refers to syllable branchingness (not nucleus branching), Davis argues that no direct reference to onsets is required.

A more current rule-based analysis is that of Breen & Pensalfini (1999); although no rules are actually stated, stress is assigned at the level where word-initial **e** is still present. If, as Pensalfini (pc) claims, feet are iambic, refooting would have to apply after **e** deletion, for instance, eCeCeC > (eCé)CeC > (Cé)CeC > (CéCeC). The resulting foot is trochaic. A simpler analysis would be to assign trochaic feet from the outset since refooting would not be required as a result of **e** deletion, but because Breen & Pensalfini argue for VC syllables they are virtually forced into a rule-based analysis which will allow a series of derivations where a word-initial syllable can start out as eC but ends up being CVC.

Onset sensitivity in OT analyses of Arrernte include those by Goedemans (1996), Downing (1996) and Takahashi (1994).

Goedemans (1996) proposes a constraint that requires feet to align to onsets. This constraint avoids mention of segments and captures the fact that prosodic processes involve prosodic constituents, ie, syllable, foot, prosodic word.

Downing (1996) proposes that onsetless syllables are excluded from the prosodic word domain, but are syllabified into an M-domain, a concept due to Inkelas (1993). This exclusion is achieved through constraint conjunction of ONSET and Alignσ (the left edge of each syllable must align with the left edge of the prosodic word). To satisfy a constraint conjunction neither constraint in the conjunction can be violated. An independent ONSET constraint occurs, as well as the one in the conjunction. Based on my knowledge of Arrernte, introducing a different domain just to account for the stress patterns seems an unnecessary complication and does not contribute to our understanding of the behaviour of onsetless syllables. In addition, a constraint conjunction is not in keeping with the goals of OT.

Takahashi (1994) uses the notion of licensing to account for stress. It is argued that the head of a prosodic domain must license a prehead, ie an onset, and thus if a prehead is absent, stress is not licensed and a violation is incurred. Stress on a syllable with a prehead will be preferred. This analysis is similar to Goedemans', in that stress can only occur on syllables with onsets.

These analyses end up with a language specific constraint. The advantage of my analysis is that an account of onset sensitivity evident in a number of languages is formally accounted for through the LESP constraint, although the details vary from language to language. This constraint is responsible for determining the location of stress. Constraints which require foot alignment with onsets, or exclude onsetless syllables from prosodic words are not entirely explanatory and are not able to account for other prosodic processes in the language such as reduplication and allomorphy discussed in later sections.

With reference to analyses by Goedemans and Takahashi, the issue is not just whether onsets are present but rather what they contribute in terms of sonority/prominence to the syllable, which is what is evident in Spanish, Piraha) and Ngalakan. If onsets are absent, then nothing additional is contributed to syllable prominence, but if onsets are present, the level of syllable prominence can be affected, depending on the sonority of the onset. The prominence of the syllable is contributed to by the prominence dimension of the margin.

A further advantage of my analysis is that by recognising that prominence is relevant an asymmetry in Arrernte is uncovered, that is, prominence at left edges where full vowels are allowed, but non-prominence at right edges where vowel neutralisation occurs; prominence at the left edge of the word and non-prominence at the right edge. In addition, the hierarchy of LESP prominence correlates with the preferred syllable structure. The only position onsetless syllables are found in is word-initially, which indicates that CV is the preferred syllable structure. The preferred syllable structure is also the preferred stressed syllable. An onsetless syllable is the least preferred syllable and stress avoids such syllables. Given that prominence is associated with word-initial position, the preferrred syllable will be targetted in this position. If an onsetless syllable is in this position, the next best move is to stress the second syllable.

A prominence analysis enables us to understand that stressing an onsetless syllable is not an optimal option; it is the least preferred syllable and the least prominent.

6.2.5 Variation

As discussed in section 6.2.1, variation in outputs frequently occurs in Arrernte. Breen (1990) suggests that there is a change in progress from rounded onset (anticipatory rounding) found in the speech of older speakers to rounded release for younger speakers. Such a change appears evident in the deletion and epenthesis of vowels and in the stress patterns of certain words, which accounts for the variation. It is possible that four acceptable outputs are generated from a single input. An input /akem/ may be realised as: **akeme, akem, kem, keme,** where deletion of the initial vowel is possible if it is /a/ (John Henderson,pc). However, in a tableau only **akeme** would be the optimal candidate.

(53) /akem/	PARSE	AlignL	NOCODA	ONSET	FILL
%a. |[akeme]				*	*
b. |[akem]			*!	*	

c. |<a>[keme]	*! *		*
d. |<a>[kem]	*! *	*	

Note that (c,d) violate more constraints than the other outputs and are the least preferred.

Accounting for variation can be achieved through partial ranking where certain constraints are reranked as argued for by Anttila (1994). This is possible when there is competition between two constraints X and Y in generating an optimal output. If X and Y are not ranked with respect to each other, two optimal outputs would be generated. This, according to Anttila, should not be permitted because allowing more than one output does not capture the fact that, in Finnish at least, some variant outputs are less frequent than others. This latter point regarding frequency of variants is relevant and it may be that future research on variation in Arrernte concentrates on what the frequency of variants is. This information would allow for a better analysis.

If for the moment we assume that all variants are equal in frequency, because sufficient data is not available to do otherwise, then the problem is how to account for them. If the solution put forward by Anttila was adopted, then a number of rerankings would be required because three rankings would be involved. From the base ranking in (54a) the other rankings are shown in (b-d):

(54) *Base and rerankings*

(a) PARSE, AlignL >> NOCODA >> ONSET, FILL
(b) ONSET, FILL >> PARSE, AlignL >> NOCODA
(c) NOCODA >> ONSET, FILL >> PARSE, AlignL
(d) PARSE, AlignL >> ONSET, FILL >> NOCODA

The reranking of constraints (54b-d) are shown in the following three tableaux.

(55)

	ONSET	FILL	PARSE	AlignL	NOCODA
a. |[akeme]	*!	*			
b. |[akem]	*!				*
c. |<a>[keme]		*!	*	*	
%d. |<a>[kem]			*	*	

	NOCODA	ONSET	FILL	PARSE	AlignL
a. |[akeme]		*	*!		
b. |[akem]	*!	*			
%c. |<a>[keme]			*	*	*
d. |<a>[kem]	*!				

	PARSE	AlignL	ONSET	FILL	NOCODA
a. |[akeme]			*	*!	
%b. |[akem]			*		*
c. |<a>[keme]	*!	*		*	
d. |<a>[kem]	*!	*			

To generate all the variants, four tableaux are required. Another option is to drop the rankings altogether, as shown in (56), but not all the variants can be generated.

(56)	PARSE	AlignL	NOCODA	ONSET	FILL
a. <a>[kame]	*	*			*
b. <a>[kam]	*	*	*		
c. akame				*	*
d. akam			*	*	

If the violations for each output are counted, then (a,b) would be ruled out as they have more violations than the other two outputs.

Still another option is to say that violations incurred by a particular set of constraints are rendered irrelevant. The only problem with this option is that an output may incur four violations of one constraint and yet still be generated as an optimal output.

Reranking constraints or dropping the rankings are not satisfactory solutions since they can be unconstrained. A better solution is to deal with the problem outside of the ranking system. We might consider whether the underlying representation of morphemes can be revised. Given that only some words with initial /a/ undergo /a/ deletion, we could assume that two variants for these words are present underlyingly. Thus, **akem** has an underlying variant **kem**. This would effectively mean that there is no /a/ deletion, which then simplifies the analysis as only NOCODA and FILL would be involved in assessing candidates. Given the current ranking of NOCODA over FILL, optimal outputs are those with a final vowel. This is desirable and is consistent with claims that isolated words are pronounced more frequently with final vowels. However, another way to account for variants without final vowels is required.

Note that it is the syllable and faithfulness constraints determining the outputs. But what if we assumed that prominence played a role here. Vowels are required to satisfy NOCODA, although not always word-finally. Vowels are not distinctive at this edge; their feature value in this position is predictable. This contrasts with vowels in word-initial position whose features are not predictable. Feature contrast is not required of word-final vowels, which reflects the fact that word-final position is less prominent.

Because it is less prominent, it allows variation and because it is an edge phenomenon, an independent constraint is needed. This constraint is similar to Align-C, mentioned in 6.1.1. I propose to modify it so that it ranks consonant-final words and vowel-final words according to whatever variant a speaker is using. The variant requiring consonant-final words will be referred to as Dialect (a) and has this constraint ranked above NOCODA, ensuring that vowels do not occur word-finally.

(57) **RE Align**: The right edge of a prosodic word aligns with a vowel or a consonant.
Dialect (a): The right edge of a prosodic word aligns with a consonant.

Under typical circumstances, NOCODA will decide on outputs, even if ranked below RE Align. But if Dialect (a) is in use then RE Align ensures final vowels do not occur.

I have shown that variation can be accounted for by assuming particular morphological representations underlyingly and by incorporating hierarchies within a constraint. This avoids complicated rerankings which can destabilise a grammar.

In the following section prominence in reduplication in Arrernte and Nunggubuyu is examined.

6.3 Reduplication

In this section the role of onsetless syllables in reduplication and the effect they have on the reduplicative template is examined. The analysis for prefixing reduplication in Arrernte is given first, followed by analysis of the suffixing reduplication pattern where I show that the template is the same as that for the prefixing pattern. The analysis is compared to reduplication patterns in other languages involving onsetless syllables. Finally, the prominence analysis is applied to reduplication data in Nunggubuyu in section 6.3.4.

The prefixing pattern of reduplication varies, depending on whether the root initial syllable has an onset or not. If the root is consonant-initial, a single syllable is copied, as in (58a), but if the root is vowel-initial, two syllables are reduplicated, as in (58b). Vowels neutralise to **e** morpheme-finally.

(58)	a.	kutye-me	'is gathering'
		ke-lpe-kutye-me	
	b.	itirre-me	'is thinking'
		ite-lp-itirre-me	[DW 1989]

These patterns suggest that the reduplicative template targets a prominent syllable and that onsetless syllables do not meet this template requirement. However, onsetless syllables must be reduplicated to avoid violating a constraint on skipping. This shows that onsetless syllables are visible to prosodic processes. In this section I am concerned with constraints on the size of the reduplicant.

Reduplication applies in both nominals and verbals. The most common pattern of reduplication for nominals is total reduplication.

(59)	a.	ahiye	'breath'	
		ahiye-ahiye	'fontanelle'	
	b.	kwatye	'water'	
		kwatye-kwatye	'a clear translucent appearance'	[DW 1984]

Partial nominal reduplication is attested, but only in frozen reduplications, where there is no unreduplicated counterpart. This form of reduplication is very common among flora and fauna terms, as in:

(60)	a.	artityerre-ityerre	'willy wagtail (bird)'	
	b.	kwepale-pale	'bellbird'	[DW 1984]

The focus of discussion in this section is on verbal reduplication. Reduplication in verbs is productive and indicates aspectual information, in which all or part of the event referred to in the verb stem is repeated in some way (Wilkins 1989:242). There are some examples of full reduplication, but the most frequent is partial reduplication. In both cases, 'linking' morphemes occur between the base and its copy. These linking morphemes occur in a number of Australian languages (eg Yir Yoront, Nunggubuyu) and have been variously referred to as a ligature, connective, augment or linking morpheme. In Arrernte, the form of the linking morpheme differs, depending on whether the reduplication indicates iterative, continuous or habitual aspects[18]. This is illustrated with the verb **/atak-/** 'to smash' in (61):

(61) a. *iterative* atake-p-<u>ake</u>-me /atak-p-ak-m/ 'smash in'
smash-IT-RED-PRES
b. *attenuative* <u>ate</u>-lp-atake-me /at-lp-atak-m/ 'continuously smashing'
RED-ATTEN-smash-PRES
c. *habitual* atake-nh-<u>ake</u>-nhe /atak-nh-ak-nh/ 'smasher'
smash-HAB-RED-habitual

There are two patterns of reduplication, prefixing and suffixing. Prefixing reduplication applies in the continuous aspect, while suffixing reduplication applies in the iterative and habitual aspects. Unless otherwise indicated, examples are from Wilkins (1989). The prefixing pattern of reduplication is discussed first.

6.3.1 Prefixing Reduplication

In consonant-initial roots, the initial syllable of the root is reduplicated. If the root is vowel-initial, the initial vowel along with the following syllable are copied. Both patterns are illustrated in (62). The linking morpheme **-lp-** occurs between the reduplicated copy and the root. The orthographic representations are given, where **e** is indicated morpheme-finally, but which underlyingly is not present. Vowels are neutralised morpheme-finally to **e**.

(62) Consonant initial roots
a. tnye-me 'falling'
<u>tnye</u>-lpe-tnye-me 'staggering' [GB:ms]
b. mpware-me 'making'
<u>mpwe</u>-lpe-mpware-me 'making' [GB:ms]
c. therre- 'to laugh'
<u>the</u>-lpe-therre[19] 'smiling'
Vowel initial roots
d. itirre-me ‘thinking'
<u>ite</u>-lp-itirre-me
e. atwe-me 'hitting'
<u>atwe</u>-lp-atwe-me

As morpheme-final vowels are always realised as **e**, there is no concrete evidence that CV syllables are copied. This could lead to an analysis that reduplication was consonantal or of (V)C sequences. However, I argue that the general prefixing pattern of reduplication is that exhibited by consonant-initial roots where a single syllable is copied, ie a prominent syllable. This assumption draws on evidence from the stress patterns, where in the general pattern,

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[18] Wilkins (1989), Breen (1990), Breen and Henderson (1992) analyse the linking morphemes as consisting of an initial vowel, ie **-elp**. I differ from these analyses in analysing the morphemes without underlying initial or final **e**, as discussed in section 6.2.

[19] John Henderson (pc) points out that this word has a different representation in the dictionary (H&D 1994) which is, **atherreme** whose reduplicated form is **athelpe-atherreme**.

feet align to prominent syllables. Evidence is also based on the process of allomorphy, which I argue is conditioned by word size defined in terms of prominence.

The more unusual reduplication pattern is exhibited by vowel-initial roots, where two syllables are reduplicated, ie VCV, but note that only one of these is a prominent syllable. If the reduplicated element consists of a vowel, the requirement that a prominent syllable be copied is not satisfied. I argue that this is because prominent syllables are targeted in prosodic processes.

The prefixing reduplication pattern in Arrernte is consistent; a single syllable is copied in consonant-initial words, and two syllables are copied in vowel-initial words. Like the stress patterns a prominent syllable is targetted. However, rather than specifying that a prominent syllable must be copied, we can specify that a minimal prosodic word is copied. Based on the pattern of allomorphy in Kaytetye (Koch 1990;1995), where VCV and CV words pattern the same, the evidence is that the minimal word is (V)CV (see section 6.4 on allomorphy). The single characteristic of VCV and CV forms is that they each contain a prominent syllable. This contrasts with disyllabic words of the form CVCV which contains two prominent syllables and patterns with VCVCV and longer words. The statement on the minimal word for Arrernte is:

(63) **Minimal Word**: The minimal word includes a single prominent syllable: (V)CV.

The minimal word requirement allows for the minimum word size, ie CV and for the maximum size, ie VCV. The reduplicative template can then be expressed as follows:

(64) **RED=MinPW:** The reduplicant is a minimal prosodic word.

While onsetless syllables on their own do not satisfy the reduplicative template, they cannot be skipped. The templatic constraint (RED=MinPW) allows for them, and, in addition, reduplicating CV syllables from VCV inputs would violate the reduplicative constraints ANCH and CONT. In fact, the template could specify that a prominent syllable be copied, given these latter constraints, except that the minimal prosodic word template can also account for allomorphy and for this reason is preferrable. While VCV does not constitute a prosodic constituent, I show that it satisfies the requirement for a single prominent syllable which is a valid prosodic constituent in the language. The generalisation is that a prominent syllable is copied and this is sufficient, and it is also a simpler description of the process.

It is worth noting that there are very few examples of consonantal reduplication. Languages reported with this pattern typically allow consonants, including obstruents, in nucleus, or complex consonant clusters. Some, like Bella Coola (a Salish language), have been referred to as lacking syllables altogether (Newman 1947) based on words such as **tfktstt** ‘you sprained it (fem) and then you gave it (fem)’ and sentences such as **scqctx** ‘thats my fat over there’ (cited in Bagemihl 1989). However, Bagemihl argues convincing against this and against obstruent syllabicity with reference to Bella Coola. Obstruent-only words show reduplication, but with the addition of a sonorous segment, n or i, and in words with consonant clusters, the sonorous segment serves as the nucleus.

(65) Bella Coola reduplication (nasals are syllabic)
a. obstruent only words

🕐❑✍- 'slap' 🕐■⌶🕐■⌶❑✍ 'slap continuously'
⬧✠ 'peel' ⬧♓✠⬧✠ 'peel continuously'
b. clusters
❑✍🕐♋- 'wink, bat the eyes' ❑✍🕐♋🕐♋ 'wink,bat the eyes contin.'
tqn⌶k- 'be under' tqn⌶qn⌶k- 'underwear'

Consonantal reduplication has been reported in some Mon-Khmeric languages, although this is contested by Sloan (1988), who claims that reduplication is syllabic and involves two kinds of obstruent-only syllables, one with a single obstruent, the other with two.

(66) a. Semai (Diffloth 1976a) – a copy of the initial and final consonant are prefixed to the base.

d.noh dh.d.noh 'appearance of nodding'
sibi:t st.sibi:t 'squinting eyes'

b. Temiar (Benjamin 1976) – similar to Semai

kow kw.kow 'calling (CONT)'
lug lg.lug 'laughing (CONT)'

c. Kammu (Svantesson 1983) - a copy of the final consonant is infixed

sté:n☽ ⬧■☽⧫é:n☽ 'small steady still light'
lma:c lcma:c 'be stuck'

Another example of apparent consonant reduplication is Spokane, an Interior Salish language (Bates 1990, Bates & Carlson 1990-91). As mentioned for Bella Coola, Salish languages are known for their large consonant inventories and long strings of consonants. Spokane has an internal reduplication pattern known as Out-of-Control:

(67) hek^{w} 'opened a crack' (strong root)
$hék^{w}\underline{k}^{w}$ 'it came open a crack without my knowing it'
qic' 'braided; woven' (weak root)
qc'í<u>c'</u> 'it got tangled up [as a thread might during sewing]'

The reduplication patterns are conditioned by stress and vowel deletion, which are dependent on whether roots are strong or weak. Strong roots must be stressed, while, in weak roots, stress is placed on suffixes. Unstressed vowels delete, giving a different pattern of reduplication for strong and weak roots, and the impression of consonantal reduplication.

Given the pervasive nature of syllables as opposed to consonants in reduplication, together with evidence of syllable structure in Arrernte, and the fact that the same template can account for allomorphy, I adopt the template analysis.

Reduplication is an example of a prosodic process that dominates morphology, that is, the size of the reduplicated morpheme is determined prosodically (M&P 1986 et seq). Reduplication involves copying the prosodic constituents, syllable, foot and prosodic word. The underlying form of a reduplicative morpheme is unspecified for phonetic content, and in OT, is indicated by 'RED'. The reduplicative element is derived by stating that it is equivalent to a foot or syllable. The output of RED will have phonetic content, which is governed by constraints that require certain correspondence between the root and the copy. These constraints are discussed below.

There are general constraints which require a particular relationship between the root or base and the reduplicant, as well as between the input and the output. From M&P (1995):

(68) MAX-BR: Every segment of the base has a correspondent in the reduplicant. (Reduplication is total)
DEP-BR: Every segment of the reduplicant has a correspondent in the base. (Prohibits fixed default segmentism in the reduplicant)
IDENT-BR(F): Reduplicant correspondents of a base [γF] segment are also [γF].

More specific correspondence input and output constraints ensure that there is no skipping of segments, and that the left or right edges of the reduplication correspond with those in the base. Following M&P (1993a, 1995), the constraints are CONT and ANCH.

(69) **I-Contiguity (CONT):** The Reduplicant corresponds to a contiguous substring of the Base.

Under this constraint, segments cannot be skipped. The elements in the copy must be phonologically identical to the elements in the base. For example, in a reduplication **paka-palka** of a hypothetical string **plaka**, the /l/ is skipped which violates CONT. In prefixing reduplication, Anchor is specified for the left edge.

(70) **Anchor,Left (ANCH):** Any element at the left edge of the base has a correspondent at the left edge of the reduplicant.

ANCH requires that, in prefixing reduplication, the elements in the reduplicant are the same as those in the initial portion of the base. If there are three segments in the reduplicant, then these three segments must be identical to the first three segments in the base. CONT ensures that segments in the copy are in the same sequence as the base. The same requirement applies to the elements in suffixing reduplication. If a reduplicant is specified as a suffix but is prefixed, this will also incur a violation of ANCH.

M&P (1993a) point out that these constraints have evolved from the association constraints in autosegmental theory. CONT is like one-to-one association, and ANCH resembles directionality of association. M&P propose that ANCH and CONT are universals of reduplication and that these constraints are generally located at the top of constraint hierarchies. M&P find that for Axininca Campa, ANCH and CONT are unviolated, and that this is typically the case for many other languages.

The reduplication patterns show no evidence that segments are skipped, or that the reduplicated element attaches to the right edge rather than the left. This means that CONT and ANCH are dominant constraints. The operation of these two constraints is illustrated in the following tableau. The reduplicant is underlined.

(71) /RED-lp-iterr-m/	CONT	ANCH
a. te-lp-iterre-me	*	*

b. eti-lp-iterre-me		*
c. itrre-lp-iterre-me	*	

When the initial syllable of the root is not copied, as in (71a), both CONT and ANCH are violated. CONT is violated because an initial segment has been skipped over, and ANCH is violated because the initial element in the copy does not correspond to the initial element in the root. The initial two syllables have been copied in (50b), which does not violate CONT, since they have not been skipped over, but does violate ANCH. There is no correspondence between the root and copy in the order of segments. (50c) violates CONT, as the second syllable has been skipped.

In many languages with reduplication, it is only the root that is copied, other morphemes or segments from other morphemes are ignored. M&P (1993a) capture this behaviour in the following constraint.

(72) **R=root:** The reduplicant contains only the root.

The benefit of this constraint for our purposes is that it rules out the copying of onsets that are not part of the root. In reduplicated words, the root and copy are separated by the linking/aspect morpheme, for example, **atwe-lp-atwe-me**. This means that any root-initial onsetless syllable will be syllabified with a preceding consonant, as in:

(73) σ σ σ σ σ

a tw e-l p-a tw e - m e

The initial vowel in the root **atw** is syllabified with a consonant from the linking morpheme. If this syllable was copied, it would satisfy the requirement to reduplicate a syllable. However, since the copied syllable consists of material that does not belong to the underlying form of the root, it would be ruled out by R=root.

Evidence from suffixing reduplication suggests that R=root is a dominant constraint. The suffixing pattern involves copying a VCV sequence, but if the root is monosyllabic only the root copies. For example, **tn-m** 'is standing' is reduplicated to **tne-pe-tne-me** 'keeps standing'. Non-root material is not copied in order to satisfy the template.

Of the three patterns of verbal reduplication, the continuous aspect is the only one which is prefixing. This requires a specific constraint on the location of the continuous reduplicative prefix and is stated as:

(74) **Align Red: T**he continuous reduplicant R is a prefix.

The constraints ANCH, CONT and R=root are dominant constraints in Arrernte and are ranked above RED=MinPW. Other highly ranked constraints which are relevant are LE-Place, RE-Place and *COMPLEX (P&S 1993). Non-violable constraints will be confined to one column in the tableaux below. RED=MinPW is ranked above MAX-BR and DEP-BR.

(75) ANCH, CONT, R=root, LE-Place, RE-Place, *COMPLEX, Align R Left >> RED=MinPW >> MAX-BR, DEP-BR

(76) /RED-lp-kuty-m/		RED=MinPW	DEP-BR	MAX-BR
%a. ke-lpE-kutyE-mE				**
b. kutye-lpE-kutyE-mE		*!		
c. kE-lpE-kutyE-mE			*!	**
d. ku-lpE-kutyE-mE	*!RE-PLACE			
e.kutyeme-lpE-kutyE-mE	*!R=root			
f.kuty-lEpE-kutyE-mE	*!O-CONTIG			
g. kuty-lpE-kutyE-mE	*!COMPLEX			

(76a) violates the constraint on the correspondence of feature identity between base and reduplicant (IDENT(F)-BR), but this constraint is ranked below MAX-BR and does not have a say. In contrast, IDENT(F)-IO is highly ranked, guaranteeing exact feature correspondence between input and output. (b) contains two prominent syllables, violating RED=MinPW. (c) contains a consonant reduplicant followed by an epenthetic segment which violates DEP-BR.

(77) /RED-lp-itirr-m/		RED=MinPW	DEP-BR	MAX-BR
%a. ite-lp-itirrE-mE				**
b. te-lp-itirrE-mE	*!ANCH			***
c. i-lp-itirrE-mE	*!RE-Place	*		***
d. itirre-lp-iterrE-mE		*!		

ANCH ensures that a syllable is not skipped to get a LESP syllable, which explains why an onsetless syllable is copied as well. R=root ensures that non-root material cannot be included in the reduplicant. Thus, while the reduplicated syllable in **pi-lp-iterre-me** satisfies LESP, it includes the consonant from the linking morpheme violating R=root.

6.3.2 Comparison with Suffixing Reduplication

There are two kinds of suffixing reduplication in Arrernte, iterative and habitative, where a VCV sequence is copied. In the iterative pattern, the aspect morpheme **-p-** occurs between the base and the copy.

(78) Iterative reduplication

a. unte-me 'running'
   unte-p-unte-me

b. atwerre-me 'fighting'
   atwerre-p-erre-me 'keeps fighting'

c. mpware-me 'making'
   mpware-p-are-me 'keeps making'

d. kemirre-me 'getting up'
   kemirre-p-irre-me 'keeps getting up'

e. tne-me 'standing'

tne-pe-<u>tne</u>-me 'keeps standing'

In suffixing reduplication, a single syllable or two syllables are reduplicated, depending on the size of the root. In polysyllabic roots, two syllables are reduplicated, as, for example in **atwerre-p-erre-me**. If the root is monosyllabic, only CV is copied, as in **tne-pE-<u>tne</u>-me**.

The aspectual maker **-nh-** occurs in the habitual reduplication patterns. I assume that the final morpheme **nhe** is not reduplicated, but that behaves like the tense markers.

(79) Habitual reduplication

a. arlkwe	‘eat’	arlkwe-nh-<u>arlkwe</u>-nhe	‘food’
b. atwere	‘talk’	atwere-nh-<u>ere</u>-nhe	‘talker’
c. rake	‘to snatch’	rake-nh-<u>ake</u>-nhe	‘snatcher’

In contrast to prefixing reduplication, the patterns for suffixing reduplication are consistent, ie VCV, whether the root is consonant-initial or vowel-initial, except for monosyllabic roots. Recall that the number of syllables in prefixing reduplication varies, depending on whether the root is vowel-initial or not. While it is possible to invoke the prefixing reduplicative constraint to account for the suffixing ones, I claim that, in keeping with the partial reduplication forms (albeit frozen) which clearly involve a foot and in keeping with the claim that prominence is relevant word-initially, a foot template is required for the suffixing patterns. The reason that the initial consonant in the reduplicated foot is absent is that it is overridden by the aspectual marker, which is a fixed morphological segment (see Alderete, Beckman, Benua, Gnanadesikan, McCarthy & Urbanczyk 1997 for a convincing distinction between phonological and morphological fixed segments). Fixed morphological segments align simultaneously with the copy and contrast with phonological fixed segments whose features are often context dependent, as determined by phonological markedness constraints. Phonological fixed segments are typically unmarked. The fixed segment is treated like any affix and is thus subject to assessment by the faithfulness and alignment constraints.

The reduplicative constraint is expressed in (80). An additional constraint on the location of the reduplicant is required, stated in (81).

(80) **REDsfx=Foot**

(81) **Align R right**: The Iterative and Habitual reduplicant is a suffix.

Since overlapping of the aspect morpheme is required in the reduplicant, it is necessary to specify that it aligns to the left of the prosodic word. Aligning to the left edge of the entire word would violate AlignL, but aligning to the left edge of the reduplicant which is a prosodic word will not. The alignment will allow overlapping as stated in (82) which is specified for the iterative, but is also applicable for the habitual marker.

(82) **Align -p-**: Align -p- at the left edge of the prosodic word.

This constraint, together with MAX-IO, which requires exact identity between inputs and outputs will ensure VCV sequences are copied. Both constraints must be ranked above O-CONTIG.

To allow for clear representations the aspect morpheme is kept separate using '-' and it will be placed before RED in the underlying form, though normally it should be after RED. Only outputs with reduplicants consisting of a foot are considered in the tableau below.

(83) mpwar-p-RED-m	Align/-p-/	MAX-IO	O-CONTIG	MAX-BR
a. [mpware]-[p-are]-me]		**	*	*
b.[mpware-pe-[mpware]-me]	*!	***		
c. [mpware]-[mpware]-me]		****!		

Where larger words undergo reduplication and three syllables are reduplicated, then REDsfx=FOOT will determine the optimal output.

Suffixing reduplication shows a fairly straightforward pattern of foot reduplication where fixed segments override the initial onset in the reduplicant. Thus the only place where prominence is an issue is word-initially.

6.3.3 Reduplicating onsetless syllables in other languages

As previously noted, syllabic constraints frequently determine the form of the reduplicative element. Cross-linguistically, word-initial onsetless syllables often behave differently in prosodic processes, compared to syllables with consonants. In Arrernte, reduplication patterns involving onsetless syllables contrast with those of other languages where satisfying ONSET is crucial. Whether a single V or VCV sequence is copied in Arrernte, there will only be a single ONSET violation and thus something more than ONSET is required to ensure well-formedness.

Onsetless syllables in Timugon Murut are ignored in reduplication, as shown in the following examples.

(84) Timugon Murut reduplication

a. bulud	bu-bulud	'hill/ridge'
b. limo	li-limo	'five/about five'
c. ompodon	om-po-podon	'flatter/always flatter'
d. abalan	a-ba-balan	'bathes/often bathes'
e. ulampoy	u-la-lampoy	no gloss

In Timugon Murut, ANCH and CONT are dominated by ONSET, which means that a syllable can be skipped in order to copy a syllable with an onset. This contrasts with Arrernte, where ONSET is dominated by the two reduplicative constraints.

Another strategy is to copy an onset from another syllable, as in Mokilese (Harrison and Albert 1976; M&P 1986). In Mokilese the reduplicant is a heavy syllable. The following are reduplications of words with word-initial consonants.

(85)

a. podok	pod-podok	'plant'
b. kaso	kas-kaso	'eat'
c. pa	paa-pa	'weave'

d. caak caa-caak 'bend'

Consonants in coda position contribute to the weight of a syllable. The examples in (85a,b) have a coda consonant in the reduplicant, making the reduplicant heavy. If there is no consonant available for copying into coda, the vowel lengthens, as in (85c). If the stem is vowel-initial, lengthening of the copied consonant occurs, as opposed to vowel lengthening, shown in (86).

(86) a. ir irr-ir 'string'
b. onop onn-op 'prepare'
c. alu all-alu 'walk'
d. uruur urr-uruur 'laugh'

M&P argue that the consonant lengthens to fulfil the requirements of the reduplicative template, as well as to provide an onset. Lengthening of the consonant ensures that there is an onset for the word-internal root.

```
(83)  σ    σ          *σ   σ
     /\   /|\          /\  /\
     μ μ/ μ μ         μ  μ μ μ
     i r   i r           i   i r
```

The difference in the reduplication patterns between consonant-initial and vowel-initial roots is due to the need to resolve the word-internal vowel hiatus. Reduplication of vowel-initial roots differs from that of consonant-initial roots because of the requirement on onsets.

In Arrernte, it is possible to copy an onsetless syllable without violating the requirement for an onset for the following syllable. This is due to the morphological organisation of words in reduplication, where an aspect morpheme intervenes between the reduplicant and the root. These aspect morphemes are consonantal and provide an onset for any vowel initial root.

Constraints on syllable structure account for the variation in the reduplication patterns in Mokilese. However, this analysis cannot extend to Arrernte. Compare the following two reduplications, where in (88a) the reduplicant consists of one syllable, a marked syllable, and in (88b) where the reduplicant consists of two syllables, the first one marked.

```
(88) a.  σ  σ  σ σ   σ          b.  σ  σ   σ  σ σ   σ
         /\  /\  /\  /\   /\             |  /|\   /\  /\ /\   /\
        i -l p-i t i rr e-m e            i  t i-l p-i t i rr e- m e
```

In both (88a,b) there is one syllable that lacks an onset. /l/ from the linking morpheme **-lp-** syllabifies into coda position of the reduplicated syllable in both cases. /p/ of the linking morpheme provides on onset for the vowel in initial position in the root. Each output has one violation of ONSET, and ONSET is not able to enforce well-formedness of the reduplicant.

Constraints on syllable structure do not affect the form of the reduplicant in Arrernte. This contrasts with the other languages discussed here, where the syllabic constraints are responsible for the form of the reduplicant. For this reason the notion of prominence must be explicit in the reduplicative constraint, which accounts for the behaviour of onsetless syllables in reduplication in Arrernte.

6.3.4 Reduplication in Nunggubuyu

According to Heath (1984), the pattern of reduplication in Nunggubuyu is sensitive to the quality of the initial onset in the root. Roots commencing with stops undergo syllable reduplication, while roots commencing with all other consonants undergo foot reduplication.

(89) a. Nunggubuyu monosyllabic reduplication

dhudabada	‘white (person) non-Aboriginal'	dhu-dhudabada
galga	'warrior'	ga-galga
jawulba	'old (man or woman)'	ja-jawulba
junggayi	'ritual manager'	ju-junggayi

b. Disyllabic reduplication

mardbal	'expert, master'	mardba-mardbal
numa:du	'wounded, injured'	numa-numa:du
rnamir	'expert,very good'	rnama-rnamir
rlandhurg	'dog'	rlandha-rlandhurg
adharwara	'late afternoon, dusk'	adha-adhawara

The size difference in the reduplication pattern is due to a sonority distinction made of segments in root-initial position. Stops are the least sonorous segments and their presence root-initially affects the size of the reduplicated element. Disyllabic reduplication is the general pattern, while monosyllabic reduplication is more specific, as it requires that roots with initial stops undergo monosyllabic reduplication.

Given the pattern of reduplication, a hierarchy of syllable prominence can be proposed as follows:

(90) LESP: CV > CV
stops

The constraints are:

(91) RED=σ: RED is a prominent syllable
RED=Foot: RED is a foot

Ranking the more specific constraint over the more general will generate the reduplicative patterns. I assume that syllabic and correspondence constraints determine the syllable structure of the final syllable of the reduplicant. Since the constraint RED=σ specifies that the reduplicant is a prominent syllable as defined by the LESP, there is no need for LESP to occur in tableaux.

(92) galga	RED=σ	RED=Foot
%a. ga-galga		*
b. galga-galga	*!	

(93)

%a. mardba-mardbal	*	
b. ma-mardbal	*	*!

Nunggubuyu shows that the sonority of an onset is a contributing factor to differences in prosodic processing. The sonority scale is based on universal patternings and whether languages make reference to it or not for prosodic processes is language specific. In the next section, I propose that the syllable prominence affects the definition of minimal word and thus the process of allomorphy.

6.3.5 Alternatives

The reduplication patterns indicate that onsetless syllables are not extrametrical. In prefixing reduplication onsetless syllables are copied and depending on the size of the word may also be copied in suffixing reduplication. If onsetless syllables were extrametrical, invisible to reduplication, then only CV syllables would reduplicate. An extrametrical analysis would therefore be unsuitable to account for reduplication patterns.

Previous models of reduplication have problems in accounting for the variable reduplicative template in Arrernte reduplication. In a segmental templatic analysis, such as Marantz (1984), the root reduplicates and the melody of the copy associates to a pre-determined segmental template. To ensure the right outputs two templates would be required, one for the onsetless roots, eg VCV, and one for those with onsets, eg CV. A single template would be unable to derive both VCV and CV patterns. The segmental template analysis will derive the attested forms but lacks any explanation for the different reduplicative patterns, and thus gives the impression that the patterns are arbitrary.

A full-copy analysis (Steriade 1988) avoids the problems of association to segmental templates, but also lacks an explanatory account of the reduplication patterns. In a full-copy analysis, the full root is copied and then reduced, by rule, to meet template requirements. Two rules would be required to derive the prefixing pattern, given as:

(i) delete the final syllable in copies that are trisyllabic or longer when the root has an initial onsetless syllable.
(ii) delete the final syllable in copies that are disyllabic or longer.

(94)	a.	/itirre-me/	b.	/therre-/
		itirre-lp-itirre-me		therre-lpe-therre-me
Rule (i):		ite-lp-itirre-me		n/a
Rule (ii):		n/a		the-lpe-therre-me

In the suffixing reduplication patterns, different rules would be required and would need to make reference to onsets. Recall that VCV copies in suffixing reduplication whether the initial syllable in the root is onsetless or not. The rules would state:

(iii) in disyllables delete the first onset.
(iv) in trisyllables delete the first syllable and following onset.

In standard prosodic morphology, templates are prosodic constituents. OT combines this notion of templates with reduplicative constraints, which together assess prosodic structure in outputs. It is this combination and simultaneous assessment that ensures the generation of the different reduplicative patterns in Arrernte. This contrasts with derivational models where rules or templates are required for constructing such structures and where little or no explanation is given for the patterns of onsetless syllables in reduplication.

Breen & Pensalfini's (1999) more recent analysis of reduplication under a rule-based approach argues that a VC syllable analysis better accounts for suffixing reduplication because a CV syllable account requires complicated templates. The templates for the reduplication patterns are straightforwardly expressed in my analysis. While the minimal word template is unusual, it is not complicated; its shape is able to be characterised without resorting to an exotic template. The foot template for suffixing reduplication is a standard one.

6.4 Allomorphy

Onsetless syllables behave similarly in the other Arandic languages. This is strikingly illustrated in ergative allomorphy in Kaytetye (Koch 1980;1995). The ergative allomorphs are **-ng** and **-l**. **-l** is suffixed to stems of the form CVCV or longer, while **-ng** is suffixed to stems of the form V(C)CV. The exception is the demonstratives, which take **-l** regardless of the stem shape and length. The allomorphy is interesting, since both allomorphs attach to stems consisting minimally of two syllables.

(95a) *disyllabic consonant-initial words*

werke-le	'scrub-ERG'
ngketye-le	'foot-ERG'
kayle-le	‘boomerang-ERG'

(95b) *disyllabic vowel-initial words*

ake-nge	'head-ERG'
atnme-nge	'red orche-ERG'
aynpe-nge	'pouch-ERG'
erlkwe-nge	'old man-ERG'

(95c) *words longer than two syllables*

rlwetnpere-le	'forehead-ERG'
artweye-le	'man-ERG'
amarle-le	'female-ERG'

The stress patterns in Kaytetye are similar to those in Arrernte, except that onsetless syllables are not stressed in disyllabic words.

(96)

Onset	No Onset
ngkétye 'foot'	aléke-le 'dog-ERG'
	(cf máliki 'dog' Warlpiri)

káyte 'grub' aké-nge 'head-ERG'

I propose that allomorphy in Kaytetye is conditioned by prominence. There are two ways prominence may be relevant. Firstly, it may be relevant through word minimality, which can be defined on the basis of syllable prominence. A minimal word *includes* a single prominent syllable, (V).CV, and **-ng** can then be specified to suffix to a minimal word.

The second way that prominence can be relevant is through stress. Note that -**ng** follows the syllable that carries the main stress. **-l** may follow an unstressed syllable (in vowel-initial trisyllabic words, quadrisyllabic words), or a syllable carrying secondary stress (trisyllabic words). For example:

(97)	V(Cv✍-nge)	V(Cv✍CV)-le	(Cv✍CV)(Cv✍CV)-le
	(Cv✍-nge)	(Cv✍CV)-le	V(Cv✍CV)(Cv✍-le)
		(CVCV)(Cv✍-le)	

Allomorphy conditioned by word size occurs in a number of languages, particularly Australian languages. In Warlpiri (Hale 1977; Nash 1986) the ergative allomorphs **-ngku** and -**rlu** and the locative allomorphs -**ngka**, -**rla** are selected on the basis of word size. The nasal allomorph is suffixed to bimoraic words and those commencing with the lateral **rl** are suffixed to words containing more than two moras[20].

(98) a. ngurrpa-ngku 'throat-ERG'
b. palya-ngku 'adze-ERG'
c. *maliki-rli* 'dog-ERG'
d. yama-ngka 'shade-LOC'
e. *watiya-rla* 'tree-LOC'

Given that word size determines allomorphy in other languages, it might be preferable to analyse allomorphy in Kaytetye along similar lines. A foot template is the typical requirement for allomorphy, but in Kaytetye, this template has been eroded through sound change and the template can now only be characterised as a minimal word. The following constraint expresses this.

(99) **ERG:** the ergative -**ng** suffixes to a minimal word.

ERG is a dominant constraint and rules out the allomorph -**l** attaching to VCV roots. If **-ng** was attached to words of the form CVCV, ERG would be violated since it is not a minimal word. If the constraint specified that -**nge** suffix to a main stressed syllable, the optimal output would still be generated. Further work in allomorphy in general is required before its clear what kind of prominence constraint is needed. This is not to say, however, that a minimal word or foot is not a prosodic constituent of some prominence. It may be that a single grouping, ie a foot, reflects a particular kind of prominence not present or different from instances where there is more than one grouping.

[20] There are some exceptions. The determiners which are bimoraic take the lateral allomorph.

Arrernte has the same pattern for allomorphy in the plural and reciprocal forms as those evidenced in the Kaytetye ergative forms, shown in the examples from Henderson (1998; cited in Breen & Pensalfini 1999).

(100) *disyllabic consonant initial words*

tangke-war	'be pleased (PL1)'	tangk-ir	PL2
mpware-war	'make (PL1)	mpwar-ir	REC/PL2
disyllabic vowel initial words			
are-rir	'watch (PL1)'	are-r	REC/PL2
angke-rir	'talk (PL1)	angke-r	REC/PL2
trisyllabic vowel initial			
inngelhe-war	'be like (PL1)	inngelh-ir	PL2

The process of allomorphy in Kaytetye and Arrernte lends further support to the claim that a distinction in prominence of word-initial syllables plays a role in prosodic processes. It is also clear that a prosodic constituent has to be specified and that it is possible to generalise as to what this constituent is.

An alternative would be to specify that the ergative attaches to VCV or CV sequences. Referring to the number of syllables would not work since, while VCV and CVCV have the same number of syllables, they have different ergative markers. I have shown that VCV and CV sequences have one feature in common: they consist of a well-formed or prominent syllable. By using this feature, it is possible to account for the allomorphy patterns.

Allomorphy is an intriguing process across languages and I hypothesize that prominence, whether of syllables or of edges, plays a role in the process. In a number of Australian languages, a foot may be marked out in some way, for instance Hale (cited in Dixon 1980) reports that in some dialects of Anmatjera, a velar nasal is added only to disyllabic words. In Dyirbal (Dixon 1972), stress influences nasal insertion and allomorphy: /n/ is inserted at morphological boundaries usually after a stressed syllable, and the dative suffix varies -**gu** or -**ngu** where -**ngu** occurs after a stressed syllables. Nasal allomorphs are frequently attested on disyllabic words in other languages, including Warlpiri and Kaytetye, discussed above. It is worthwhile considering that in many languages the right edge is the least prominent edge and that it is at this edge that allomorphy occurs, that it is frequently noted with suffixes. Formalising the role of prominence requires substantial discussion and analysis which is not possible here. I leave it for further research.

6.4.1 Alternatives

An alternative analysis of the allomorphy processes in Arrernte has been proposed in Breen & Pensalfini (1999). They claim that all morphemes are vowel-initial and that word-initial **e** does not surface unless preceded by a word; in other words, **e**'s appearance is phrasally determined. This means that a CVC word is underlyingly /eCVC/. Based on this they claim that disyllables and longer words take the glide allomorph analysed as -**ewar**, while monosyllables /VC/ take the rhotic allomorph -**erir**. No derivations are given, but under their rule-based analysis for other processes, I assume that the allomorph would have to be attached after syllabification and before **e** deletes. This order is necessary so that **e** can be counted as a syllable before it deletes. Presumably stress is assigned after **e** deletion.

They claim that if analyses do not recognise that **e** is underlyingly initial, they would be forced to say that onsets had weight to account for the patterns. While the full implication of this is not made explicit, I have shown that recourse to an onset weight analysis is not needed to account for the patterns.

As has been shown in this thesis, simultaneous operations provide better and more explanatory accounts of processes and are not plagued by paradoxical rule applications. Therefore, I reject Breen & Pensalfini's analysis.

Templates are used to account for reduplication, minimal word size and allomorphy and I believe that, despite the move away from a dependency on templates (Alderete et al 1997), some languages are more reliant on templates or grouping phenomena than others. With regards to allomorphy, Kager (1995) points out that there are three common conditioning factors: (1) syllable structure - C or V final; (2) syllable count; (3) stress on final syllable or not. This fact suggests that reliance on only a template or only a non-templatic analysis would be unsuccessful to account for the range of patterns.

Providing an explanation for all the prosodic processes in Arrernte is possible if it is acknowledged that prominence plays a role in determining optimal outputs. Such an analysis is more successful since it also accounts for a range of phenomena. While alternative analyses, such as extrametricality or onset alignment, may account for stress, they are unable to extend the analysis to account for allomorphy and reduplication in the same language, nor onset sensitivity in other languages. I have argued that these syllables must be visible in order to explain all the prosodic processes in the language.

As a result of historical changes, the phonology of Arrernte contrasts with the phonology of many other languages. For instance, the alignment of feet with the edge of the prosodic word must always occur in neighbouring languages, like Warlpiri, but in Arrernte, this is dependent on the presence of onsetless syllables. As I have shown, the analysis of the behaviour of onsetless syllables is captured straightforwardly in OT, which allows for constraint ranking and violation.

Arrernte is unusual in comparison to other languages with initial onsetless syllables because the constraints on syllable structure cannot explain the behaviour of these syllables. This behaviour can only be explained by an analysis that distinguishes prominent and non-prominent syllables.

6.5 Concluding Remarks

This chapter provides an analysis of the behaviour of onsetless syllables in Arrernte and of onset sensitivity in other languages with regards to stress, among other prosodic processes. I introduced the notion of LESP, which is used to construct hierarchies of syllable prominence. It is claimed that syllable prominence exists at the left edge, which is supported by languages showing onset sensitivity, by saliency factors and by prominence dimension which combines position with sonority.

Some languages pay more attention to the left edge because of the kinds of things that happen at the left edge of the prosodic word. In Arrernte, the left edge of the prosodic word is prominent and prosodic processes are generally read on that edge. This is also the case for Nunggubuyu, and, for Spanish, can explain why **e** is not stressed word-initially. The prominence of the left edge of the word and the left edge of the syllable can sometimes be in conflict, which can explain variation in stress placement in Arrernte and in Ngalakan where the left edge can be less important when prominent syllables are nearby.

There are two kinds of prominence relevant to prosodic processes, Peak-Prominence and LESP, which may be in conflict with alignment constraints. For instance, in Arrernte, foot alignment is overridden by LESP. There are a number of instances when foot alignment to the left edge of the prosodic word is overridden as discussed in this thesis; these are when there is lexical stress, morphological boundaries, and in connected speech. In general, foot alignment is morphologically or lexically determined, even with alignment to the left edge of the prosodic word, as this edge is typically also the edge of the word/stem. However, morphological alignment is sometimes overridden by rhythmic considerations. Recall from Chapter 4, if foot alignment results in a sequence of unfooted syllables, Rhythmic Alternation (RA) takes over, ensuring such unfooted sequences are not generated. Thus RA, like LESP, overrides alignment. Given this fact, it could be assumed that LESP is like a rhythmic constraint, although of a markedness kind. While RA is concerned about where prominence is, LESP (and PK-PROM) is concerned about what is prominent. A sequence of CV syllables may be equally prominent as determined by LESP, while RA will determine which one will be more prominent, or which one will be stressed.

That LESP should be considered a markedness-rhythmic constraint is interesting if we consider the constraint that prohibits word-final stress, Non-Finality (NON-FIN), purported to be a rhythmic constraint (Hung 1993). Languages which do not allow word-final stress or where segments in word-final position do not contribute to weight in this position have NON-FIN as a highly ranked constraint. NON-FIN is required in languages with one stress and where PK-PROM is an active constraint.

NON-FIN operates at the right edge of the word, a position which is less prominent. In fact, it could be stated that NON-FIN is an anti-prominent constraint (ruling out prominence) required to account for the invisibility of syllables and segments at the right edge. It contrasts with LESP which accounts for invisibility of syllables at the left edge.

The fact that there is this relationship lends support to LESP – the prominence at the left edge of the word is expressed in LESP and the absence of prominence at the right edge is expressed in NON-FIN. Spanish is one example which requires both constraints: LESP to account for absence of stress on word-initial **e** and NON-FIN to account for absence of stress word-finally. There is also right edge prominence of syllables expressed in PK-PROM. Given that left edge prominence exists, we expect to find right edge prominence features, ie NON-FIN and PK-PROM. There is support for a typology where prominence dominates alignment:

Prominence >> Alignment

This ranking accounts for languages where prominence or non-prominence at the left or right edges of words influences foot alignment, if any, or placement of stress. Prominence, like alignment, can be tied to edges and in this sense they are similar. The difference is that prominence is based on markedness. This is evident in the fact that prominence may influence the shape of prosodic structure or prosodic templates, as in Nunggubuyu where LESP determines whether the reduplicant is a foot or a syllable; and as in Arrernte where minimal word is based on a LESP definition. To some extent this is also true of PK-PROM ,which influences the location of a foot, if any, and the shape of one (ie, heavy syllable, two light syllables).

In sum, prominence can account for the location of and the shape of a prosodic constituent. Prominence constraints may be thought of as markedness constraints and as a subset of rhythmic constraints.

In Chapter 4, a typology where prosodic considerations, such as rhythm, dominated interface constraints, that is, alignment between phonological and morphological constituents, is advocated and is similar to the typology that has emerged here. The conclusion from this is that when there is conflict between interface constraints and prosodic ones, it is the prosodic/rhythmic ones that win.

I have proposed a theory on left edge syllable prominence, LESP, which can be used to account for various prosodic processes. It is a formal way to express various kinds of behaviour which previously were thought to be unrelated. Prominence has typically been accounted for through syllable structure, that is, a heavy syllable has two moras and a light syllable one mora. I have identified another type of prominence which cannot be expressed in structural terms and it is only this prominence which can explain behaviour evidence in Arrernte, Spanish, Pirahã, Ngalakan, and Nunggubuyu.

In this thesis I have shown that alignment constraints combined with those on adjacency and prominence can account for vowel harmony, as well as a range of stress patterns: morphological, lexical, variable, those involving binary and ternary rhythm, and prominent syllables. The fact that all processes can be accounted for in OT lends support to this theory.

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