O'ODHAM RHYTHMS

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As members of the Final Examination Committee, we certify that we have read the dissertation prepared by Colleen Miriam Fitzgerald entitled O'ODHAM RHYTHMS

and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of Doctor of Philosophy

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I hereby certify that I have read the dissertation as prepared under my direction and recommend that it be accepted as fulfilling the dissertation requirement.

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ABSTRACT

Morphology and syllable weight have both been shown to affect stress patterns, but these effects are analyzed in different ways. The theoretical goal of this dissertation is to propose a Optimality Theoretic model to account for how morphology influences stress, and to do this in a way that parallels the influence of weight upon stress. Prince (1990) lays out the WEIGHT-TO-STRESS PRINCIPLE, formalizing the principle by which heavy syllables attract stress in quantity-sensitive systems. I argue for the MORPHEME-TO-STRESS PRINCIPLE, a constraint that forces morphemes to attract stress in morphological stress systems. The WEIGHT-TO-STRESS PRINCIPLE has a counterpart, the STRESS-TO-WEIGHT PRINCIPLE, which forces stressed syllables to be heavy. The counterpart of the MORPHEME-TO-STRESS PRINCIPLE is the STRESS-TO-MORPHEME PRINCIPLE, which forces stressed syllables to belong to morphemes. This accounts for systems where epenthetic vowels resist stress assignment.

The model proposed here has the following consequences. First, the MORPHEME-TO-STRESS PRINCIPLE can be invoked to account for the prosodic rooting constraint (as in Hammond 1984; or as in the LXWDÅPRWD constraint of McCarthy and Prince 1993). This one constraint handles word minimality as a morphological effect, just as it accounts for the assignment of stress on morphological grounds in nonminimal contexts. Second, the formalization of the MORPHEME-TO-STRESS and the STRESS-TO-MORPHEME PRINCIPLES treats MORPHEME and STRESS as variables. I claim that all logical possible relationships are attested for these three variables: MORPHEME, WEIGHT, and STRESS. Preliminary results (in Chapter Five) suggest that each possible ordering appears to be attested.

The foundation of the theoretical work is a description of the secondary stress patterns in Tohono O'odham, a Uto-Aztecan language formerly known as Papago. This description reveals that the primary way to predict the stress pattern of a word is the morphology. Words may surface with

varying stress patterns depending on the number of morphemes, the presence of epenthetic vowels, or whether a word has been morphologically truncated. The descriptive work is the result of my fieldwork on Tohono O'odham.

1. INTRODUCTION

The empirical goal of this dissertation is to describe the secondary stress patterns in Tohono O'odham. This description reveals that the primary way to predict the stress pattern of a word is the morphology. Words may surface with varying stress patterns depending on the number of morphemes, the presence of epenthetic vowels, or whether a word has been morphologically truncated.

The theoretical goal of this dissertation is to explain and unify these factors to make the correct predictions of surface stress. Specifically, I propose two constraints, none referring directly to morpheme count, epenthesis or truncation. I argue that the surface pattern of Tohono O'odham results as the interaction of two competing forces: Stress every morpheme and only morphemes are stressed. I further argue that the influence that morphology exerts on stress parallels the influence exerted by weight upon stress. First, I argue for a formalism that connects the interactions between morphology and stress with those interactions between weight and stress (Prince 1990).

Prince (1990) argues for the WEIGHT-TO-STRESS PRINCIPLE, giving evidence from various languages where if a syllable is heavy, it is stressed. The MORPHEME- and WEIGHT-TO-STRESS PRINCIPLES each offer an account for why and how strictly alternating stress systems are interrupted by either morphology or weight. Furthermore, I argue for the STRESS-TO-MORPHEME PRINCIPLE, where epenthetic segments are restricted from headship due to the fact that they do not belong to a morphemes. I formalize these two morpheme-based principles in a way that connects these principles with the weight-based principles. The theoretical goal of this dissertation then is to present evidence for the MORPHEME-TO-STRESS and STRESS-TO-MORPHEME PRINCIPLES from the complex, previously undescribed stress system of Tohono O'odham.

While I adopt an Optimality Theoretic approach, I show that an analysis of Tohono O'odham stress requires a different approach than those previously proposed in Optimality Theory to capture the morphology-stress connection. In particular, I argue against accounts rooted in Generalized Alignment (McCarthy and Prince 1993b) and accounts of transderivational identity (McCarthy 1995, Kenstowicz 1995). Instead, I propose the MORPHEME-TO-STRESS AND STRESS TO MORPHEME PRINCIPLES as the morphological constraints, which are ranked with rhythmic constraints to predict the patterns of Tohono O'odham stress.. The morphological constraints dictate two different mappings between morphemes and stress that hold without regard to edges or the stress pattern of the base. The relationships are simple. First, each morpheme must get a stress. Second, each stress must be associated with a mo rpheme. The notion of ranked, violable constraints is critical for an account of Tohono O'odham stress; only Optimality Theory allows violations of constraints. Under a rule based account, the stress system would appear rife with exceptionality. Thus, only Optimality Theory provides machinery necessary for a unified account of these facts, with the introduction of the MORPHEME-TO-STRESS and STRESS-TO-MORPHEME PRINCIPLES.

In this chapter, I lay out the organization of this dissertation, and familiarize the reader with theoretical background and the structure of Tohono O'odham. The first two sections outline the empirical and theoretical points of the dissertation. Section three gives background on metrical theory and Optimality Theory. Section four discusses the phonology and morphology of Tohono O'odham, including segmental inventory and syllable structure. Finally, in the last section, I preview the overall structure of the dissertation.

1.1 Empirical Goal of the Dissertation

The empirical contribution of this dissertation is to describe the complete stress system of Tohono O'odham words in isolation. This dissertation represents an empirical advance, as surface secondary stress in Tohono O'odham has not been previously described. The distributional pattern of primary stress is well-established; Hale (1959) and Saxton (1963) both observe that the initial syllable of the word receives primary stress.

The distribution of secondary stress in Tohono O'odham reveals a number of intricacies, always tied into the morphology of the language. The basic pattern of stress is as in (1), where monomorphemic forms disallow final stress (1a) and polymorphemic forms allow final stress (1b). The fact that both prefixed and suffixed forms allow final stress informs us that the morphological bracketing of these forms is irrelevant, and only morphological complexity matters: Finally, two sets of facts suggest that the system is trochaic: initial stress, and odd syllable stress.

Monomorphemic native words of Tohono O'odham do not appear to surface with more than two syllables, so we must look to borrowings for trisyllabic or longer monomorphemic words. The presentation of polymorphemic borrowings, all of which pattern with native vocabulary, shows that the "exceptional" behavior of these words is not due to the fact that they are borrowed words. The data in (1) show a number of monomorphemic trisyllables, with varying syllable structure, all with only initial stress. In contrast to (1), the trisyllables in (2) all surface with final secondary stress. These words are polymorphemic. To illustrate that it is not the case that suffixes attract stress, prefixed words without suffixes also appear in (2). The crucial asymmetry in Tohono O'odham stress is between words that do not allow final secondary stresses (which are always monomorphemic) and words that do allow final secondary stresses (which are polymorphemic).

(1) Monomorphemic trisyllables in Tohono O'odham[1]

	Form	**Gloss**
a.	mu@sigo	'musician (Sp)'[2]
b.	wi@silo	'calf (Sp)'

[1]Hyphens (and square brackets in tableaux) indicate the word-internal morphology, while a space separates a word from clitics and other words.

[2]The abbreviation (Sp) indicates a borrowing from Spanish.

c. 'a@sugal 'sugar (Sp)'

d. ma@ùgina 'car (Sp)'

(2) Monomorphemic trisyllables in Tohono O'odham[3]

	Form	**Gloss**
a.	mu@-msigo$	'musicians (Sp)'
	plural-musician	
b.	pa@-pado$	'ducks (Sp)'
	plural-duck	
c.	pa@ùdo-ga$	'having a duck (Sp)'
	duck-possession	
d.	hi@-him-a$d	'will be walking, plural'
	plural-walking-future imperfective	
e.	'a@suga$l-t	'making sugar (Sp)'
	sugar-to make	

The contrast between monomorphemic trisyllables (1) and polymorphemic trisyllables (2) shows that final stress is disallowed in monomorphemic forms, but allowed in polymorphemic forms. Further, this contrast occurs regardless of the partic ulars of the morphology, as (2) shows.

In this basic pattern, morphology is a crucial factor in determining stress. The contrast between various derived forms of three successive bases, *c&i@c&wi* 'playing', *c&i@kpan* 'working' and *mu@sigo* 'musician' demonstrates some of this interplay between the morphology and the metrical structure. In (3), various unaffixed and affixed forms appear with the root *c&i@c&wi* 'playing'. These forms exhibit stress on all odd syllables:

(3) Stress paradigms for *c&i@c&wi* 'playing'

[3]Morpheme glosses are given for the first appearance of each word. The plural morpheme is a prefixal reduplicant.

	Form	**Gloss**
a.	c&i@c&wi	'playing'
b.	c&i@c&wi	'playing, plural'
c.	s« c&i@c&wi-da$g	'to be good at playing'
	stative play-ability to	
d.	c&i@c&wi-c&u$d	'to make someone play'
	play-cause to do	
e.	c&i@c&wi-c&	'to make someone play, perfective'[4]
	play-cause to do; perfective	

However, this is not the pattern we find in the forms in (4), with the base *c&i@kpan* 'working'. A number of the forms in this paradigm surface with first and fourth stress, as shown below in 4c,e) (underlining indicates epenthetic vowels).

[4]Perfective verbs are formed by truncating the final one or two segments of the imperfective verb.

(4) Paradigms of stress for *c&i@kpan* 'working'

	Form	**Gloss**
a.	c&i@kpan	'working'
b.	c&i@-c&kpan	'working, plural'
	plural-working	
c.	s« c&i@kpan-a-da$g	'to be good at working'[5]
	stative working-epenthesis-ability to	
d.	c&i@kpan-a-c&u$d	'working for someone'
	working-epenthesis-cause to do	
e.	c&i@kpan-a$-c&	'work for someone, perfective'
	working-epenthesis-cause to do; perfective	

The forms in (3) and (4) share certain similarities in surface stress patterns. Both disyllabic bases surface with only one stress; compare (3a) with (4a). A uniform pattern also surfaces in all truncated words, as seen in the comparison with (3e) and (4e). All odd syllables are stressed for the base in (3), even with the truncated form. This is not true for (4), as the words in (4c) and (4d) surface with a pattern of first and fourth syllable stresses. To summarize, there are two basic stress patterns emerging in Tohono O'odham words: either odd-numbered syllables are stressed, or else stress falls on the first and fourth syllables from the left.

These facts are rather condensed here, but serve to illuminate some of the complexities that are described in this dissertation.

[5] Any consonant final base that is suffixed with certain consonant-initial suffixes has an *a* epenthesized between the two morphemes. Some of the suffixes that are involved in this pattern are *-c&ud*, *-dag*, *-kud`*, *-möd`*, and *-hun*. Saxton (1982) has examples of other suffixes that behave similarly. This epenthesis is indicated by underlining.

1.2 Theoretical Point of the Dissertation

In this section, I outline the theoretical point of this dissertation. The theoretical contribution of this dissertation is to model one system in which morphological composition of the word predicts the stress pattern, in spite of the fact that there is no one-to-one mapping between morphemes and stresses on the surface. In the process, I offer a model that also accounts for the stress pattern of languages that have been analyzed as 'cyclic' or with bracketing, such as English (Chomsky and Halle 1968), Chamorro (Chung 1983), and Diyari (Poser 1989).

The morphological model of stress argued for in this dissertation requires Optimality Theory (McCarthy and Prince 1993a, Prince and Smolensky 1993). One crucial tenet of Optimality Theory is that there is no derivation. A crucial assumption of pre-Optimality Theory work (for example, McCarthy and Prince 1990 or Hayes 1995) is that there is an ordered, serial derivation. What argues against a derivational account of O'odham stress?

Let us look at some Tohono O'odham data that are paradoxical under a derivational account. The treatment of epenthesis under derivational models orders it either before or after stress assignment. In Tohono O'odham, epenthetic vowels are never stressed. The data in (5) contrasts epenthetic vowels in even position (5a,b) with epenthetic vowels in odd position (5c,d). Although in both positions, epenthetic vowels are unstressed, this does not result in identical surface stress patterns for the two types of words. (Epenthetic vowels are underlined and foot structure is indicated by parentheses.)

(5) Epenthetic vowels in Tohono O'odham

	Form	**Gloss**
a.	(bi@d-s`p-a)-(ku$d`)	'instrument used for plastering'
	plaster-transitive-epenthesis-instrument	
b.	(c&ö@po)(s-i$d-a)-(c&u$d)	'to make someone brand animal'
	brand-beneficiary-epenthesis-cause to	
c.	(wa@kon)-a-(mö$d`)	'to go and wash'
	washing-epenthesis-go to	
d.	(c&i@kpan)-a-(mö$d`)	'to go and work'
	working-epenthesis-go to	

The failure of both even and odd epenthetic vowels to be stressed presents a paradox. Words with even epenthetic vowels have the same stress patterns as words without any epenthetic vowels, which suggests that they are incorporated into the foot structure, as indicated by the words in (5a,b). If odd epenthetic vowels were incorporated into the foot, we would expect them to be stressed, which they obviously are not. This suggests that odd epenthetic vowels cannot be footed, as in (5c,d). This data presents a paradox for a theory that relies on ordering stress assignment and epenthesis, as even epenthetic vowels argue for stress assignment after epenthesis and odd epenthetic vowels argue for stress assignment before epenthesis. The epenthetic data presents a paradox for a theory that relies on ordering epenthesis and stress assignment.

Furthermore, as we saw above in (4e), odd epenthetic vowels do get stressed in certain circumstances. A derivational theory would have trouble in accounting for both patterns, potentially resolving the problem with an additional stressing rule. In Optimality Theory, the stressing of epenthetic vowels in odd position is reduced to the violation of the constraint that prohibits this – in favor of satisfying a higher ranked constraint. The conflicting descriptive patterns seen in Tohono O'odham, then, result from the conflicting constraints that generate the patterns.

1.3 Theoretical Background

In this section, I present the necessary theoretical background. Three areas are of particular relevance, and each is discussed in the following order. First, some background on metrical theory is critical. For example, the characterization of stress in Tohono O'odham requires reference to feet (for further evidence for some constituency in O'odham, see Fitzgerald 1994a, 1994b, 1997). Metrical Theory informs us about such entities. Second, the analysis of Tohono O'odham stress relies on Optimality Theory. As discussed in the previous section, the Tohono O'odham stress data would not be accounted for in an approach that relies on rule-ordering. Optimality Theory makes use of violable, ranked constraints to characterize the fact that not all generalizations are surface-true. In cases such as the "ordering" paradox posed by epenthetic vowels, we will see that a constraint-based approach is superior to a derivational one.

1.3.1 Theoretical Background on Metrical Theory

Stress is not easily defined, but, by comparing two words in English, we can identify an example of what stress is. The difference in pronunciation between the following words of English results from a difference in the placement of stress in each word: *pŽrmit* versus *perm’t.* A stressed syllable is typically signaled by contrasting one or more of three main characteristics: loudness, pitch, and duration.[6] These phonetic correlates of stress are quite interesting, and have received quite a bit of attention (for example, Lehiste 1970, Hyman 1977, and Beckman 1986); here we focus on the phonological properties of stress.

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[6]Vowel quality may also play a role.

Syllables can be grouped together in a unit known as the FOOT. Feet are argued to consist, canonically at least, of a stressed syllable and an unstressed syllable. Much work in Metrical Theory (for example, Hayes 1987, 1995) argues that all groupings must consist of two syllables.[7] This disyllabic grouping is known as a binary foot. The principles of metrical grouping look in particular at two characteristics: binarity and headedness. A foot is binary if it consists of two elements.[8] All forms consisting of an odd number of total syllables contain a single syllable that must be on its own. Languages vary as to whether this syllable may be stressed or unstressed. If it is stressed, it is a foot, and a foot which consists of one element is a DEGENERATE foot. If unstressed, the syllable is unfooted. Finally, the head of a foot is the stressed syllable; a foot with a head on the right is IAMBIC, and a foot with a head on the left is TROCHAIC.

Languages vary in how they determine which syllables are stressed, and metrical theory accounts for the possible (and impossible) ways in which stress alternates. Hayes (1987)[9] argues that such alternations are accounted for a foot typology that is asymmetric, consisting of three feet: the iamb, the syllabic trochee , and the moraic trochee. The typology, together with schematized instantiations for each foot, appears below.

(6) Asymmetric Foot Typology (Hayes 1987: 279)[10]

(x .) (.)

a. Syllabic Trochee: Form σσ if possible; otherwise form σ.

(x .) (x .) (x .) (x)

b. Moraic Trochee: Form μμ if possible, where μμ is either ((or # ;

---

[7]Or two moras, but we turn to that topic later in the discussion of quantity sensitive systems.

[8]These elements may be either syllables or moras, which is discussed a bit more below.

[9]Similar arguments are made in McCarthy and Prince (1986) from prosodic morphology.

[10]An "x" indicates a stressed syllable and a "." indicates a stressless one. A σ indicates a syllable and a μ indicates a mora. Light syllable are indicated by " (" and heavy syllables by " # ".

(.)

otherwise form (.

(. x) (x) (.)

c. Iamb: Form (σ if possible, otherwise form # or (.

The foot typology varies headedness (left or right) with quantity-sensitive or -insensitive feet. The typology is asymmetric because it lacks a quantity-insensitive right-headed foot. With these three feet applied from either the right or left direction, we predict a limited number of attested stress patterns. Now let us briefly examine a stress system for each foot. The stress pattern of Munsee, an Algonquian language, is iambic. Syllabic trochees characterize Maranungku, an Australian language, while the moraic trochee accounts for Cairene Arabic.

The first set of data comes from Munsee. Munsee stresses all heavy syllables, as seen below. A heavy syllable in Munsee is one with either a long vowel or a coda consonant. A sequence of all light syllables, as in (7a), stresses even syllables. The second two forms show us that heavy syllables cannot be the unstressed member of a foot; instead, they are footed alone as in both (7b) and (7c).

(7) Munsee stress (Goddard 1982)

a. (n«ka$)(k«ta@)(k«ka$) 'I do a fast dance'

((σ)((σ)((σ)

b. (s«ka$h)(tak«$)(ni@i)(kana$l) 'reins'

((σ) ((σ)(#)((σ)

c. (n«s«$)(ka$h)(tak«$)(ni$i)(kan«@)(ma$l 'my reins'

)

((σ)(#)((σ)(#)((σ)(#)

The form in (7a) is made up of all light syllables, which are easily parsed into three iambic feet. In (7b), the parsing begins at the left edge. The first four syllables are grouped into iambs; the second syllable is heavy, but falls in the stressed portion of the iamb, so the footing is not disrupted. The fifth syllable is heavy and therefore cannot be footed with the subsequent syllable, as **(niik‡)* is an impossible iamb. The fifth syllable instead is footed by itself, and the subsequent two syllables form an iamb. The form in (7c) groups the first two leftmost syllables into an iamb, the next heavy syllable into its own iambic foot, and repeats the pattern twice. The word is made up of the following sequences: light-light-heavy-light-light-heavy-light-light-heavy, which gets footed as above, into 6 iambic feet.

The second foot in the Hayes (1987) typology is the syllabic trochee. This system is attested in Maranungku (Tryon 1970). Unlike the iamb, the syllabic trochee is quantity insensitive. This will permit unstressed heavy syllables in the language. Maranungku stresses all odd numbered syllables, showing that syllabic trochees are parsed starting from the left edge. Open and closed syllables are treated the same, there is no interruption in the stress pattern below when closed syllables are in an even syllable, as in (8c).

(8) Maranungku stress (Tryon 1970)

a. (ti@ralk) 'saliva'

(σσ)

b. (me@re)(pe$t) 'beard'

(σσ)(σ)

c. (ya@ngar)(ma$ta) 'the Pleiades'

(σσ) (σσ)

d. (la@ngka)(ra$te)(ti$) 'prawn'

(σσ) (σσ) (σ)

The assignment of stress in a language like Maranungku, which stresses all odd syllables, follows easily if we use the syllabic trochee. The location of the unary foot on the right edge, rather than the left edge, tells us that the footing must begin on the left edge of the word.

The third foot in this typology is a quantity sensitive, left headed foot, the moraic trochee. We have seen evidence for the first two, now let me briefly review evidence for the moraic trochee. This foot is argued to provide the proper characterization of Cairene Arabic in Hayes (1987), which has both heavy and light syllables. First, weight is determined as follows. Syllables are light (CV), heavy (CVC, CV:), and superheavy (CVCC, CV:C). The extrametricality of final consonants means that closed syllables count as light word-finally. Second, moraic trochees foot syllables starting from the left edge, with either two lights or one heavy making a foot. Third, only the final foot gets stressed. Finally, there are no degenerate feet. Cairene stress is illustrated by the data in (9):

(9) Cairene Arabic Stress (Mitchell 1960)

a.	ka(ta@bt)	'I wrote'
	((#)	
b.	ga(to@ù)	'cake'
	((#)	
c.	be@ùtak	'your (m.sg.) house'
	(#) (	
d.	muda@rris	'teacher'
	((#) (	
e.	mudarri@sit	'teacher (f. construct)'
	((#)((( )	
f.	fi@him	'he understood'
	((( )	
g.	katabi@tu	'she wrote it (m.)'
	((( )((( )	
h.	/inka@sara	'it got broken'
	(#)((() (	
i.	ka@taba	'he wrote'
	((() (	
j.	s&aj&ara@tuhu	'his tree (nom.)'
	((()((() (	

The words in (9a) and (9b) stress the final syllable, only because it is superheavy. The words start from the left edge and foot syllables iteratively. Like iambic feet, moraic trochees do not allow a foot to contain an unstressed heavy syllable. However, unlike iambs, moraic trochees cannot include a heavy and a light syllable. Any foot that would consist of two such syllables instead foots the heavy syllable into its own foot, as in (9e). The exception is a closed syllable word-finally (9c-f), which is treated as a light syllable only in this position. The moraic trochee and left-to-right footing predicts the intricate patterns manifested by Cairene Arabic.

To summarize this section, I have reviewed the asymmetrical foot typology. This typology, depending on whether it is applied from the right or left edge, provides the foundation for characterizing stress patterns. One property which I have not discussed in this section is the influence of morphology on stress patterns. This discussion occurs in the next section.

1.3.2 Theoretical Background on the Cycle

In this section, I briefly review the literature on the cycle with regard to metrical theory. Cyclic analyses are generally invoked for languages where the morphology influences the stress pattern. One kind of cyclic evidence in stress comes from systems which retain some element of metrical structure as words undergo successive derivations (Halle and Vergnaud 1987). This background is important because it constitutes a possible alternative to the ultimate analysis. In Chapter Two, I show that Tohono O'odham stress cannot be accounted for simply in terms of preserving metrical structure.

Morphology can influence stress through the cycle. One set of data used to motivate the cycle is given in (10). This argument comes from secondary stress in English (Chomsky and Halle 1968). In comparing the underlined syllables which receive secondary stress (10a) with the corresponding syllables (10b), we see that those in (10b) do not receive secondary stress.

(10) English Cyclic Secondary Stress

a. Underlined Syllable Stressed	b. Underlined Syllable Unstressed
condensa@tion	co$mpensa@tion
a@tte$sta@tion	de$monstra@tion
elasti@city	se$rendi@pity

The argument for cyclicity comes from the fact that words in (10a) are derived from words with a primary stress on the underlined syllable, while the words in (10b) are not. The stress pattern of the above words should not be different on the basis of their phonology, yet they are. This suggests that another factor, the word's derivational history, predicts the differing stress patterns. The associated bases for the forms in (10) are given in (11):

(11) English Cyclic Secondary Stress

a. Underlined Syllable Stressed		b. Underlined Syllable Unstressed	
condensa@tion	conde@nse	co$mpensa@tion	co@mpensa$te
a@tte$sta@tion	atte@st	de$monstra@tion	de@monstra$te
elasti@city	ela@stic	se$rendi@pity	not derived

This pattern is accounted for in Chomsky and Halle (1968) by considering the stress contours of embedded words (*conde@nse*) in computing the stress contours of their associated derived words (*condensa@tion*). Stresses are 'carried' over as words undergo derivation; this is cyclic stress assignment.

The differences between the words above is derived as in (12). The base form of the word receives stress, and then stress assignment begins again with the next layer of derivation, preserving the stresses from the earlier cycle.

(12) English Cyclic Secondary Stresses

a. condense →	conde@nse →	[conde@ns]ation→	condensa@tion
b. compensate →	co@mpensa$te →	[co@mpensa$t]ion →	co$mpensa@tion

The underlined syllables, while heavy in both words, do not surface as stressed in both words. This is because the underlined syllable in (12a) receives stress on the first cycle, and so preserves this stress on successive cycles. In contrast, (12b) does not stress its underlined syllable in the first stress cycle, and so this syllable remains unstressed in successive cycles. We must refer to the base stress pattern in order to predict the correct surface pattern of these complex words.

The data from English thus constitutes an argument in favor of preserving the stresses of the embedded words in derived forms. There are similar cases elsewhere in the literature in favor of cyclic stress assignment; see for example, Steriade (1988), Halle (1990) and Halle and Kenstowicz (1991). We see that the data here shows that word-building change words so that aspects of the earlier structures may be available to the rules of stress assignment.

1.3.3 Theoretical Background on Optimality Theory

In this section, Optimality Theory is explained. The strongest empirical support for this approach comes from prosodic morphological phenomena, such as infixation and reduplication. Some of these phenomena are discussed here, with Optimality analyses also reviewed. In addition, the more general principles that characterize this theory are outlined. Following this, I present an overview how the parametric metrical theory works in this framework.

1.3.3.1 Optimality Theory

McCarthy and Prince (1986) argue that the descriptive observations on reduplicative and root-and-pattern morphologies reveal that these operations only use authentic units of prosody. This makes certain predictions. For example, a language which reduplicates the first three elements of a word should be impossible under their theory. This rules out a pattern of reduplication such as (13).

(13) Impossible Reduplicative Pattern (McCarthy and Prince 1986: 3)

a. badupi → BAD badupi

b. bladupi → BLA bladupi

c. adupi → ADU adupi

The pattern in (13) is argued to be impossible because there is no authentic unit of prosody that characterizes the unit of reduplication. BAD, BLA and ADU differ in both weight and number of syllables. They can only be characterized in segmental terms, copying the first three segments. McCarthy and Prince (1986, 1990) argue that only the units in (14) may be used in reduplication and other templatic morphologies. This makes the prediction that all operations of prosodic morphology must use only authentic units of prosody.

(14) Prosodic Categories (McCarthy and Prince 1996: 7)

Prosodic word	PrWd
Foot	F
Syllable	σ
Mora	μ

This prediction should hold for infixation patterns. It predicts that the locus of infixation should be determined by one of these units of prosody. For example, the following pattern of infixation would be predicted to be impossible under this theory.

(15) Impossible Infixation Pattern

a. badupi baINdupi

b. baldupi baINdupi

c. adupi adINdupi

The only way to characterize the above pattern is by infixing after two segments. Again, two segments are not a unit, nor do the two segments used in this impossible infixation pattern resemble any one of the units of prosody above. The prediction for infixation patterns is challenged by some attested patterns of infixation. For example, Tagalog (French 1988) prefixes the affix *-um-* in vowel-initial words, or infixes it following the simple or complex onset in consonant-initial words.

(16) Tagalog Infixation (French 1988)

	Root	**um+Root**	**Gloss**
a.	aral	um-aral	'teach'
b.	sulat	s-um-ulat	'write'
c.	gradwet	gr-um-adwet	'graduate'

The generalization is that the infix always follows the onset, and appears word-initially if the word is onsetless. Furthermore, the shape of the infix (VC) seems to play a role – the infix only appears as a prefix when there is no onset in the base to syllabify with the infix. The descriptive generalization for the locus of infixation was problematic for the theory of Prosodic Morphology (McCarthy and Prince 1986, 1990) – infixation occurs before the vowel, or right after the entire onset. Neither of these loci can be characterized in terms of authentic units of prosody. Since the earlier versions of Prosodic Morphology argued that such operations must be characterizable in terms of authentic units of prosody, sets of data as in (16) were problematic. A solution to this problem comes from Optimality Theory (McCarthy and Prince 1993a,b, Prince and Smolensky 1993).

Under Optimality Theory (McCarthy and Prince 1993a, Prince and Smolensky 1993), the shape of the infix (VC) and its behavior as an infix in consonant-initial bases are connected facts. McCarthy and Prince (1993a) argue that the behavior of the *-um-* morpheme results from the tension of two competing demands, one in the morphology, the other in the phonology. The first demand is that *-um-* appear as far left as possible; the second demand is the avoidance of onsetless syllables. The tension between these two demands is formalized by invoking them as violable constraints. Thus the surface pattern emerges from the conflict between two constraints, one banning codas, the other constraint forcing *-um-* to be a prefix.

For evaluating the Tagalog infixation in (20), two constraints are relevant, NOCODA and EDGEMOST (McCarthy and Prince 1993a). These are given in (17) and (18) below:

(17) NOCODA

Syllables do not have codas.

(18) EDGEMOST (ψ ; E; D)

The item ψ is situated at the edge E of domain D.

The chart below exemplifies the Tagalog prefix /um/, which appears on verbs. The column beneath "Candidates" represents a sample of the set of outputs generated for evaluation; the other two columns represent the constraints relevant for *-um-* prefixation. The asterisk represents the violation of a constraint; while the exclamation point signals where in the evaluation the candidate is rejected. The 'p' indicates which output is chosen by the constraints as the optimal output. Under the "EDGEMOST" column, the distance from the left edge is indicated by the marking each segment that separates the prefix from that edge. The evaluation is as follows :

(19) Evaluations of /um + gradwet/ (Prince and Smolensky 1993, 36)

Candidates	NOCODA	EDGEMOST (um, L)

a. .UM.grad.wet.	***!	
b. .gUM.rad.wet	***!	g
p c. .grU.Mad.wet.	**	gr
d. .gra.UM.dwet.	**	gra !
e. .gra.dUM.wet.	**	gra ! d
f. .grad.w...UM...	**	gra ! dw...

When *-um-* is strictly prefixal (19a), three violations of coda are incurred, the same as when the prefix is immediately after the first consonant of the onset (19b). This makes both candidates worse than those in (19c-f), as they only incur two violations of the coda constraint. This immediately rules out the option of *-um-* surfacing as a prefix. If we reversed the ranking of the constraints, we would not correctly predict the optimal candidate for output. Constraint domination is indicated by a thick line separating the constraints.[11] Finally, note that under Optimality Theory, only one optimal candidate is allowed (although see Hammond 1994 for a constraint-based account of a language with multiple outputs). Ties are settled by descending down the constraint hierarchy to lower-ranked constraints to determine which output is the optimal one. The same hierarchy predicts that *-um-* surfaces as a prefix in vowel-initial words. Again, while constraints are violable, this violation is minimal, so that fewer violations is better. Form (16a) is evaluated here in (20):

(20) Evaluations of /um + aral/ (Prince and Smolensky 1993, 36)

Candidates	NOCODA	EDGEMOST (um, L)
pa. .U.Ma.ral.	*	#¯
b. .a.UM.ral.	**!	#a

[11]No ranking is indicated by a thin line separating constraints.

c. .a.rU.Mal.	*	#ar!

All of the candidates violate NOCODA, although violations are fatal only for candidate (20b). The competition passes to EDGEMOST, which prefers the prefixed output, candidate (20a). The asymmetrical distribution of *-um-* as a prefix in vowel-initial words and an infix in consonant-initial words follows from a preference for avoiding codas. Under a derivational approach, this could not be captured. The shape of the infix as VC, the locus of infixation – these facts are now connected under the auspices of prosodic well-formedness in Optimality Theory.

1.3.3.2 Optimality Theory and Metrical Theory

Metrical well-formedness is evaluated the same way in Optimality Theory. The simplest way to introduce a metrical version of Optimality Theory is to show how the asymmetric typology and directionality parameter from Hayes (1987) is translated into constraints, and how these constraints apply to produce the attested stress patterns. Three of the requisite constraints appear in (21-23). FOOTFORM evaluates the foot for headship, FOOTBINARITY assigns penalties for feet that are not binary, and PARSE-σ forces syllables into feet.

(21) FOOTFORM (abbreviated FTFM)

Heads are on the left/right.

(22) FOOTBINARITY (abbreviated FTBIN)

Feet are analyzable as binary on the syllabic/moraic level.

(23) PARSE-σ

Syllables must be parsed into feet.

The first constraint, FOOTFORM, evaluates whether the head of a foot is on the left or right edge of that foot. The constraint is specified for either left (trochaic systems) or right (iambic systems). In (22), FOOTBINARITY is a constraint that evaluates the binarity of feet, specifying whether that binarity is judged by syllables or moras. Finally, PARSE-σ in (23) judges every syllable on the basis of whether it is footed or not. Unfooted syllables incur violations. When PARSE-σ dominates FOOTBINARITY, all syllables are parsed, even when that forces degenerate feet. When the ranking is reversed between these two constraints, degenerate feet are disallowed.

The directionality of footing has been captured with various alignment constraints (McCarthy and Prince 1993b, 1994).[12] One way that this can be done is by a constraint that forces the alignment of a foot word-initially or word-finally. These constraints are formalized under the rubric of Generalized Alignment (McCarthy and Prince, 1993b). The schema for Generalized Alignment is given in (24).

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[12]See Crowhurst and Hewitt 1995 for extensive discussion of this issue, especially for the use of alignment constraints to predict the locus of degenerate feet.

(24) Generalized Alignment

Align (Cat1, Edge1, Cat2, Edge2)=def

$\forall$ Cat1 $\exists$ Cat2 such that Edge1 of Cat1 and Edge2 of Cat2 coincide

Where

Cat1, Cat2 $\in$ PCat $\cup$ GCat

Edge1, Edge2 $\in$ {Right, Left}

When the parse constraint, PARSE–σ is ranked highly enough, it will force iterative parsing. Align constraints can be formalized to force a foot at either the beginning or the end of the word to ensure that a word begins or ends with a foot.[13] A constraint forcing a word-initial foot is given in (25a), and its word-final counterpart is in (25b).

(25) Two Directionality constraints under Generalized Alignment

a. ALIGN PROSODICWORD-LEFT

Align (ProsodicWord, Left, Foot, Left)

b. ALIGN PROSODICWORD-RIGHT

Align (ProsodicWord, Right, Foot, Right)

The metrical version of Optimality Theory can be demonstrated with data from Pintupi (Hansen and Hansen 1969, 1978). Pintupi stress is identical with Maranungku stress, with one exception – it does not tolerate degenerate feet. Like Maranungku, it stresses odd syllables, and footing begins from the left edge. The patterns are shown below:

[13] Directionality in Optimality Theory is actually more complicated than this (see, for example, Crowhurst and Hewitt 1995, Zoll 1996).

(26) Pintupi stress (Hansen and Hansen 1969, 1978)

a. pa@÷a 'earth'

(σσ)

b. tJu@ÿaya 'many'

(σσ) σ

c. ma@ñawa$na 'through from behind'

(σσ) (σσ)

d. pu@ñiNka$latJu 'we sat on the hill'

(σσ)(σσ) σ

e. tJa@muli$mpatJu$Nku 'our relation'

(σσ)(σσ)(σσ)

f. ÿi@ñiri$Nula$mpatJu 'the fire for our benefit flared up'

(σσ)(σσ)(σσ)σ

From above, then, we know that Pintupi stresses odd syllables. There are no cases of final stress. Disyllables surface with stress on the initial syllable, suggesting that heads are on the left. Finally, the footing goes from left-to-right, as suggested by the two unstressed syllables on the right edge in forms like (26b).

The FOOTFORM constraint, with heads on the left, predicts that a disyllabic form will have initial stress. The evaluation of such a form appears in (27), where the two possible outputs vary in whether the first (27a) or second (27b) syllable is stressed.

(27) Evaluation of disyllabic *pa@÷a* 'earth'

	FTFM
pa. (pa@÷a)	
b. (pa÷a$)	*!

FOOTFORM prefers the output with a left-headed foot, (27a). A second aspect of Pintupi can also be evaluated by these constraints. The absence of final stress argues that degenerate feet are prohibited in this language, a fact analyzed by ranking FOOTBINARITY above PARSE–σ. The tableau in (28) evaluates a trisyllabic input in Pintupi, generating only an initial stress in the optimal output (28a).

(28) Evaluation of *tJu@ÿaya* 'many'

	FTBIN	PARSE–σ
pa.(tJu@ÿa)ya		*
b.(tJu@ÿa)(ya$)	*!	

The candidates in (28) differ in whether the final syllable is unparsed (28a) or parsed into a degenerate foot (28b). The primacy of FOOTBINARITY rules out the latter candidate, so that despite a violation of PARSE–σ, (28a) is the optimal candidate.

A third aspect of Pintupi also follows from these constraints. ALIGNPROSODICWORD-LEFT prefers candidates which begin with a foot. The ranking cannot be determined between this particular align constraint and the parse constraint (indicated with a light line separating the two). This motivates the ranking as in the tableau in (29).

(29) Evaluation of *tJu@ÿaya* 'many'

	FTBIN	PARSE–σ	PRWD-LEFT
pa.(tJu@ÿa)ya		*	
b.tJu(ÿa@ya)		*	*!
c. (tJu@ÿa)(ya$)	*!		

Candidate (29c) violates top-ranked FOOTBINARITY, a fatal mark. Both (29a) and (29b) satisfy binarity, and both incur a single violation on the parse constraint. The decision is made by ALIGNPROSODICWORD-LEFT, which is violated by the noninitial foot in (29b). In contrast, the one foot of (29a) is initial, thus satisfying ALIGNPROSODICWORD-LEFT and emerging as optimal. This ranking predicts the stress pattern of the longer words as well, although ALIGNPROSODICWORD-LEFT does not always actively participate in decisions on output. A quadrisyllabic word is evaluated in (30) to show this.

(30) Evaluation of *ma@ñawa$na* 'through from behind'

	FTBIN	PARSE–σ	PRWD-LEFT
pa.(ma@ña)(wa$na)			
b.(ma@ña)wana		*!*	
c. ma(ña@wa)na		*!*	*
d. ma(ña@wa)(na$)	*!	*	*

All candidates except (30d) contain binary feet, so only (30d) violates the highly ranked FOOTBINARITY. The three remaining candidates differ in whether they parse all syllables (30a) or leave any syllables unparsed (30b,c). The latter set of candidates fail on the PARSE-σ constraint due to unfooted syllables, which means that satisfaction of this constraint makes (30a) the optimal output.

As seen by these tableaux, metrical constraints act the same as other constraints in Optimality Theory. The parametric aspect of the derivational theory comes via constraint permutation in Optimality Theory. For example, Maranungku allows degenerate feet in trisyllabic forms, but in other regards is identical to Pintupi. This follows by reversing the ranking between FOOTBINARITY and PARSE-σ, as shown in the tableau below.

(31) Evaluation of a Maranungku trisyllable

/merepet/	PARSE−σ	FTBIN
a.(me@re)pet	*!	
pb.(me@re)(pe$t)		*

With PARSE−σ a higher ranked constraint than FOOTBINARITY, the violation incurred on the higher ranked constraint proves fatal to (31a), and (31b), even with a degenerate foot in the output, is optimal.

The combination of these various constraints predicts a number of possible patterns for stress systems. This results in constraining these systems along the parameters motivated in metrical theory before Optimality Theory. Optimality Theory in this respects is comparable to derivational theories. Optimality Theory has accounted for phenomena in quantitative systems with lengthening or shortening (for example, the analysis of Brevis Brevians in Latin, found in Prince 1990, Prince and Smolensky 1993).

1.3.4 Summary

In this section, I gave the relevant theoretical background. Metrical Theory is required background because the central empirical issues of this dissertation are stress, and a discussion of cyclicity is relevant since the focus here is on morphology interacting with stress. I argue below that the descriptive generalizations of Tohono O'odham stress, especially with regard to the facts in Chapter Three (the interaction of epenthesis and stress), lend themselves better to an approach within Optimality Theory.

1.4 Background on Tohono O'odham

Tohono O'odham is a Uto-Aztecan language spoken primarily in southern Arizona and Sonora, Mexico. In 1988, there were approximately 25,000 speakers combined for the Tohono O'odham and 'Akimel O'odham, an extremely closely related language. The Tohono O'odham were formerly known as the Papago[14].

There is a rich descriptive and analytical history of work on the grammar of the O'odham language, as evidenced in work such as Hale (1959,1965, 1973), Saxton (1963, 1982), Mathiot (1973), Zepeda (1984, 1987, 1988), Hale and Selkirk (1987), Saxton et. al (1989), Hill and Zepeda (1992).[15] These works have described and analyzed a number of linguistically interesting phenomena in Tohono O'odham. These phenomena are varied; they include syllabification, intonation and prosody, derivational morphology, and morphological truncation. The surface pattern of secondary stress in Tohono O'odham has never been described or analyzed completely using the

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[14]The 'Akimel O'odham were previously known as the Pima.

[15]Some of these descriptive issues, as well as a few new ones, are analyzed in Fitzgerald (1993, 1994a,1994b, 1995) and Fitzgerald and Fountain (1995,1996).

intuitions of native speakers.[16] In this dissertation, secondary stress in Tohono O'odham is completely described and analyzed.

In this section, I present background on the prosody of Tohono O'odham. The areas examined in the prosody section are segmental inventory, syllable structure, and minimal word size.

1.4.1 Tohono O'odham Prosody

In this section, I lay out details of three areas of Tohono O'odham phonology. The segmental inventory is the first to be discussed. Second, I describe and analyze syllable structure. The third topic discussed is minimal word size; I show that monosyllabic content words always surface with a coda, a long vowel, or both.

1.4.1.1 Segmental Inventory

In this section, I give the segmental inventory of Tohono O'odham. The stops[17] are generally placed into two series, although the associated features of these series vary from analysis to analysis. For example, Alvarez and Hale (1970) classify them as 'mellow' and 'sharp', while Saxton et al. (1989) describe them as varying between tense and lax distinction. Hill and Zepeda (1992) distinguish the two series as constricted glottis versus spread glottis stops, and a classification of voiced and voiceless is used in Hale (1959). In this analysis, the distinction invoked is one of voicing. While voiced phonemes do devoice in certain environments, only true voiceless stop

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[16] Secondary stress is invoked in several analyses as a means of getting surface syllable structure and other distributional facts, particularly vowel devoicing (see, for example, Hale 1965, Saxton 1963, 1982 and Hill and Zepeda 1992). These analyses focus primarily on short words, such as disyllables and trisyllables, and generally do not mark secondary stress. In the data I have collected, there is rich variation in longer words. For example, there are the variations in stress on trisyllabic forms that are attributed to the morphology, as seen in Chapter Two. Chapter Five discusses some of the shortcomings of the vowel deletion analyses, while acknowledging that they focus on a different problem (vowel syncope, rather than surface stress).

[17] This includes the palatal affricates, represented as **c&** and **j&**.

phonemes cooccur with preaspiration. This study adopts the voicing approach of Hale (1959) and assumes the consonant system in (36) for Tohono O'odham[18]:

(32) Consonant Inventory in Tohono O'odham

	Bilabial	Dental	Retroflex	Palatal	Velar	Glottal
Stop	p	t		c&	k	'
	b	d	d`	j&	g	
Fricative			s`	s		h
Nasal	m	n		n)	N	
Lateral				l		
Glide	w			y		

The /l/ is a palatal flap, and the symbol used reflects the orthography of Tohono O'odham. This study also assumes the vowel system in (33) for Tohono O'odham, following Hill et al. (1994) in their classification.

(33) Tohono O'odham vowel system:

	Front	**Central**	**Back**
High	i	ö	u
Mid			o
Low		a	

[18]I follow Americanist notation for phonetic symbols This notation differs from the official orthography in the following way: **[c&]** is represented by **c** and **[ö]** is represented by **e**, and the orthography represents the palatal lateral flap with an **l**, as done here.

Vowels may be long, short or what is termed extra-short (a voiceless vowel with a whispery quality).[19] Long vowels only appear in the first syllable[20] of the stem, which is also where primary stress occurs. Extra-short vowels primarily appear word-finally. Short vowels may appear in any position in a word. Vowels also may devoice, especially at the ends of words.

1.4.1.2 Syllable Structure

In this section, I discuss syllable structure in Tohono O'odham.

First, all syllables in Tohono O'odham surface with onsets. The set of possible onsets, both simple and complex, is /p,b,t,d,c&, j&, k, g, ',h, m, n, n), l, w, y, tl/. In (34), the possib le simple onsets are given in monosyllables, except for disyllabic (34q). Two consonants do not appear as onsets, /d`, N/. Hill et. al (1994) note that /d`/ can be treated as an allophonic variant of /l/, and /N/ is found only in borrowed words, such as *c&aùNgo* 'monkey (Sp)'. The restricted distribution of these two segments is unsurprising. Of the five vowels, none appear word-initial in content words.[21] Rather, as seen in (35), the vowels appear with initial glottal stop onsets.

(34) Simple Onsets in Tohono O'odham

	Transcription	Gloss
a.	daùk	'nose, nostril'
b.	taùn)	'to ask someone for object'
c.	baùb	'mother's father, mother's father's elder brother'
d.	mad`	'offspring, child'

[19] Some voiceless vowels are represented in the official orthography with a breve, (, as in *a(*.

[20] Except in borrowings from Spanish, where the words originally have a noninitial stress, such as Spanish *Mar'a* borrowed into Tohono O'odham as *Mali:ya*. These are discussed briefly in Chapter Two.

[21] There are a few function words that begin with a vowel, such as the future marker *o((*Zepeda 1988).

e.	naùk	'ear'
f.	siùs	'older sibling or cousin'
g.	paùn	'bread'
h.	n)öm	'liver'
i.	goùk	'two'
j.	kui	'mesquite tree'
k.	woùg	'road'
l.	j&ög	'hole'
m.	c&öùg	'mesquite bean flour'
n.	s`aùd	'to chase object to where one wants to go'
o.	hök	'armpit'
p.	lai	'king (Sp)'
q.	yaùwi	'a key, a lock (Sp.)

(35) Glottal-vowel onset sequences

r.	'at	'beginning of a basket or jar'
s.	'iù	'to greet object by the kinship term'
t.	'öùb	'to stop crying'
u.	'od`	'to harvest object'
v.	'uag	'marrow, brain'

Complex onsets within words only appear in certain borrowings, especially from English. These loanwords preserve complex onsets. Interestingly, the reduplicated correspondents of these words include only one complex onset. These words appear in (36).

(36) Complex Onsets in Tohono O'odham

	Transcription	**Gloss**
a.	tlaùmba	'tramp (Eng)'
b.	tlalamba	'tramps (Eng)'
	plural-tramp	
c.	tloùgi	'truck (Eng)'
d.	tlologi	'trucks (Eng)'
	plural-truck	

Rhyme structures in Tohono O'odham are considerably more varied. Open and closed syllables are attested, with both simple and complex codas are permitted. First, all segments, both vocalic and consonantal, can appear word-finally except the two laryngeals, /',h/.[22] The distribution of simple codas is given in (37), with all monosyllables, except (37a).[23]

(37) Simple Codas in Tohono O'odham

	Transcription	**Gloss**
a.	c&aùNgo	'monkey (Sp)'
b.	haùg	'to melt'
c.	haùk	'to parch object in a special basket
d.	haùl	'squash'
e.	höùn)	'to have a fit of whooping cough'
f.	wiùs	'fine (stative)'
g.	wiùp	'to suck object'

[22]Syllables with diphthongs, transcribed as a vowel+i, show that /y/ may occur as a coda.

[23]The absence of a monosyllabic coda for /N/ is suspicious, but this segment is limited to only a few borrowings. This, combined with its absence as an onset, highlights its marked status as a phoneme.

h.	wiùb	'milk'
i.	wöùm	'with object'
j.	wiù	'to stay, remain'
k.	wiw	'calf'
l.	wöùc&	'heavy (stative)'
m.	j&öùj&	'smoke, perfective'
n.	mö@d`	'running'
o.	miùs1	'Protestant'
p.	ban	'coyote'
q.	biùt	'excrement'
r.	bid	'clay, mud plaster'
s.	kaù	'hearing'
t.	kiù	'house'
u.	kuù	'to close object, perfective'
v.	köù	'to get to be daybreak'
w.	koù	'to put one's arms around object, perfective'
x.	muù	'to shoot and hit object with bullet or arrow'

Simple codas are also possible medially. The absence of complex onsets in native words means that medial sequences of consonants will force codas word-medially, as demonstrated in the words below.

(38) Word-medial Codas in Tohono O'odham[24]

a.	s« hiopc&-ig	'to be full of body lice in one location'
	stative lice-full of	
b.	dak-po-kam	'one with hair in his nose; one with a mustache'
	nose-hair of-one characterized by	
c.	'at-c&ud	'to start a basket'
	start of a basket-cause to	
d.	s« kuùb-s-ig	'to be full of dust in one location'
	stative dust-state of-full of	
e.	s« möhi-d-kam	'to be something that is inflammable'
	fire-transitive-one characterized by	
f.	magkan)	'to be perforated'
g.	kai-c&k-a-c&ud`	'to put aside for planting one variety of seeds for someone'
	seed-to separate by-epenthesis-cause to	
h.	ma-mad`-hog	'to give birth to a child'
	plural-offspring-to be expected to	
i.	mac&pud`	'toe'
j.	kuswo	'neck'
k.	miùs`mad	'to preach (Sp)'
	mass-to apply	

[24]In this set of data, the morpheme composition of certain words could not be determined.

l. monj&ul 'bandana (Sp)'

m. mö-mhö-id 'to light up object repeatedly in a single fire'

repeatedly-fire-beneficiary

n. hön)hup-dam 'one having the hiccoughs'

hiccoughs-one who does

o. möltod` 'to calm down repeatedly'

Closed syllables may also surface with complex codas. As noted in Hill and Zepeda (1992), the complex codas always respect downward cline in sonority within the coda. For example, there are no words in Tohono O'odham of the shape **mismtol* or **c&ic&mp*. Second, also as observed by Hill and Zepeda (1992), these prevalence of these codas is also a factor of how complex the word is morphologically. For example, *mimstol* 'cats' is a reduplicated word and *sitolt* is suffixed with the causative suffix *-t*..

The sonority relations in a coda do respect the Sonority Sequencing Principle, (Clements 1987), where the most sonorous elements in the coda are closest to the vowel, and sonority declines from the vowel outward. There are a few wrinkles to this, however. Two stops or two fricatives are acceptable codas, but two nasals or a nasal plus /l/ are not. Furthermore, codas are restricted in that only one of the sonorous consonants is permitted in the codas. For example, codas with both a nasal and an oral obstruent would permit a coda of /mk/ but not /*km/. Stops and fricatives are treated as having equal sonority, and are not restricted in their ordering. For example, a stop and fricative combined in a complex coda could be either /ps`/ or /s`p/. The codas are grouped to show whether or not a complex coda attests to the logically possible combinations of manner types. For example, (39a) gives words with final complex codas consisting of oral obstruents, showing that sequences of the same sonority are permitted for both stops and fricatives.

(39) Complex Codas in Tohono O'odham

	Transcription	**Gloss**
a.	Stop+Stop	
	hikck	'chopping'
	c&öpk	'working, perfective'
	c&öc&pk	'working, plural, perfective'
b.	Stop + Fricative	
	gogs	'dog'
	gogogs	'dogs'
	koùks`	'sleeping, plural'
	wapks	'bedrolls'
c.	Stop + Liquid	Unattested
d.	Stop + Nasal	Unattested
e.	Fricative + Stop	
	s`is`p	'pin'
	wopsk	'fathers'
	bisck	'sneezing'

f. Fricative + Fricative

dags`sp	'pressing down with a finger'

g. Fricative + Liquid Unattested

h. Fricative + Nasal Unattested

b. Liquid + Stop

s`a'alk	'mountain passes'
sitolt	'to make syrup'
'a@suga$lt	'to make sugar'
Liquid + Fricative	Unattested
Liquid + Liquid	Unattested
Liquid + Nasal	Unattested

c. Nasal + Stop

koùmc&	to have one's arms around object'
toùnk	'hills
hiùnk	'barking'
Nasal + Fricative	Unattested
Nasal + Liquid	Unattested
Nasal + Nasal	Unattested

A dictionary search shows that the following manner combinations are attested as codas in Tohono O'odham: stop+stop, stop+fricative, fricative+stop, fricative+fricative, liquid+stop,nasal+stop. Where examples could not be found, the type is listed as unattested. The distribution of consonant sequences word-finally can be accounted for under principles of sonority, provided they occur in the same syllable margin. The distributional argument that these segments constitute codas is supported by the patterning of native speaker intuitions. If some of these segments constituted their own syllable, we might expect such segments to receive stress. Certainly any disyllabic form with a final consonant cluster, such as *si@tol-t* 'making sugar' or *go@-gogs* 'dogs' would be treated as a polymorphemic trisyllable if the final consonant was also a syllable. While speakers may be unsure if such consonants are syllables, they do not ever stress these consonants. This supports treating these consonant clusters as complex codas (rather than syllabic obstruents) in Tohono O'odham.

In summary, I have described syllable structure in Tohono O'odham. The language almost uniformly prohibits complex onsets, while tolerating complex codas. Clearly syllabification in O'odham is highly complex, with both sonority and morphology playing major roles. This section has established the empirical background concerning licit syllable structures in Tohono O'odham.

1.4.1.3 Constraints on Minimal Word Size

In this section, I give data showing that monosyllabic content words in Tohono O'odham occur with either a long vowel or a coda consonant (or consonants) or both. However, monomoraic content words (the shape CV) are unattested in this language. The absence of such forms suggests that word minimality is determined separately from the syllable-based stress system in Tohono O'odham, as the data argues that the bimoraic minimum is determined on the basis of weight, while stress never is.

First let us examine the types of monosyllabic words permitted in the language. The chart in (40) gives monosyllabic content words. Forms of the type CVV, CVC, CVCC and CVVC all appear, while forms of the type CV are absent.

(40) Monosyllabic c ontent words

	Form	Gloss
a.	ki@ù	'house'
b.	hi@ù	'walking, perfective'
c.	ka@ù	'hearing'
d.	j&u@k	'to behave in a certain way'
e.	no@d`	'a plant of the yucca family'
f.	ke@ùs`	'to put object in a standing positions'
g.	ma@ùc&	'knowing'
h.	da@-dp-k	'smooth, plural'
	plural-smooth-be	
i.	go@gs	'dog'
j.	ku@ùbsc&	'made smoky, dusty perfective'
	smoke-state of-cause to	
k.	da@ù-dk	'noses'
	plural-nose	

The forms in (40a-c) are open syllables with long vowels. In (40d-e), forms with a short vowel and a single coda appear. (40f) and (40g) give examples of words with both a long vowel and a single coda. Both of the forms in (40h-i) give examples of words with short vowels and consonant cluster in the coda. Finally, in (40j-k), the words contain a long vowel and a coda cluster.

If we break down the combinatorial possibilities in terms of the length of the vowel and coda complexity, we see that there are no monosyllabic CV attested forms. This is illustrated in (41). The leftmost column of the chart characterizes coda complexity, from no coda ('¯'), to a single consonant ('C'), to multiple consonants ('C+'). The next two columns are both grouped under the heading of vowel length; the middle column applies to short vowels and the third column to long vowels. Each cell of the block is filled with an attested word to indicate that such a type appears, or 'unattested' to indicate that such a form is absent.

(41) Patterns of codas and vowel length in monosyllabic content words

	VOWEL LENGTH	
CODA COMPLEXITY	**Short**	**Long**
–	unattested	ki@ù
C	no@d`	ke@ùs`
C+	go@gs	da@ùdk

The form which is unattested is a monosyllabic form with only a short vowel. I take this as evidence that words must meet a minimal size of two moras. The binarity requirement for minimal word is determined by moras, while binarity in the stress system is evaluated by syllables, and independent of moras. This suggests a typological difference from other stress systems that invoke the syllabic trochee, as well as suggesting that the minimal word effects are not accounted for under the rubric of stress assignment. The minimality of words is determined on a moraic analysis, rather than on a syllabic one.

1.4.1.4 Summary

In this section, I have presented the empirical background required for this dissertation. First, I presented the segmental inventory of Tohono O'odham. Second, I characterized syllable structure in this language. Third, I showed the facts for minimal word size.

1.5 Outline of the Dissertation

The subsequent chapters offer evidence that Tohono O'odham stress is critically dependent on the morphology and that this system is best characterized by two components:

(42) a. MORPHEME-TO-STRESS PRINCIPLE

Every morpheme gets a stress.

b. STRESS-TO-MORPHEME PRINCIPLE

Every stress belongs to a morpheme.

These principles supplant constraints that align edges of morphological categories with the edges of prosodic categories – in no domain do we find evidence that it is the edges of morphemes which play a relevant role. Rather, we see that the relevant asymmetry is between monomorphemic and polymorphemic forms, where bracketing plays no role.

Chapter Two presents the data and arguments for (42a) by showing that the generalizations of Tohono O'odham stress depend on the number of morphemes in a given word. In Chapter Three, the behavior of epenthetic vowels argues for (42b), by showing that epenthetic vowels in all positions are best left unstressed. Chapter Four shows that truncation leads to the stressing of epenthetic vowels in odd position. This follows if the MORPHEME-TO-STRESS and the STRESS-TO-MORPHEME PRINCIPLES are interpreted as satisfied by stressing some element in the rhyme (formally, dominated by a mora), even if that element itself cannot bear stress (cf. the Percolation Convention of Archangeli 1984). If the presence of morphemes within the rhyme determines satisfaction (and the absence violation) of the STRESS-TO-MORPHEME PRINCIPLE, these facts follow. Finally, in Chapter Five, I summarize the empirical and theoretical claims made in this dissertation.

2. THE GENERAL PATTERN OF STRESS

In this chapter, I describe the patterns of stress for monomorphemic and polymorphemic forms, analyze the patterns, and argue against possible alternative analyses.

The empirical point of this chapter is the asymmetry between morphologically simple and complex forms. Monomorphemic words stress every nonfinal odd syllable, and never stress the ultima. Polymorphemic words also stress every nonfinal odd syllable. However, unlike monomorphemic words, polymorphemic forms allow secondary stress to fall on a final odd syllable. Accounting for this asymmetry leads to the theoretical point of this chapter. I argue that this data is best accounted for by a constraint requiring every morpheme to be stressed, the MORPHEME-TO-STRESS PRINCIPLE. Words with two morphemes and three syllables best satisfy this constraint by stressing the first and third syllables of the word, regardless of whether the word is prefixed or suffixed. This constraint crucially dominates FOOTBINARITY, to force final stress in words with an odd number of syllables.

The empirical and theoretical points of this chapter relate to the overall themes of the dissertation. The empirical goal of this chapter is to describe the asymmetrical distribution of secondary stress in final syllables, thus demonstrating that morphology is critical to defining the stress pattern in Tohono O'odham. This comes specifically from the asymmetrical distribution of stress in trisyllables. There is no way to characterize the descriptive generalization without reference to morphology. The theoretical goal is to argue for a model of how morphology influences stress assignment, and in doing so, to account for this generalization. This pattern is true regardless of the morphological bracketing. That is, morphological edges do not dictate the particular pattern, such that words of the same size but different morphology have different stress patterns. Rather, the distinct stress patterns emerge based on whether a word has one morpheme or many. A word with a prefix plus root behaves the same as its suffixed counterpart. The particular aim here is to develop a model that accounts for this type of morphological influence. There are a variety of accounts for other languages, such as Diyari (Poser 1989) and Indonesian (Cohn and McCarthy 1994), where the morphological bracketing predicts the metrical structure. Finally, there are languages where paradigmatic similarity is exhibited throughout the stress patterns of morphologically related words, such as Polish (Kraska 1994) or Shanghai Chinese (Kenstowicz 1995). Neither of these theoretical approaches are sufficient here. I propose that the MORPHEME-TO-STRESS PRINCIPLE accounts for the descriptive generalizations of Tohono O'odham, as neither morphological bracketing nor the cyclic preservation of stress plays a role. Here I present language-specific arguments for the MORPHEME-TO-STRESS PRINCIPLE based on the stress pattern of Tohono O'odham. Following this analysis, I demonstrate why alternate analyses do not work.

2.0 Introduction

Primary stress in Tohono O'odham regularly falls on the initial syllable of the word[1], while secondary stress is determined by the morphological complexity of the form. Describing and analyzing the morphological principles which determine secondary stress in Tohono O'odham is the focus of this chapter. Nonfinal, odd-numbered syllables are assigned secondary stress. However, odd-numbered final syllables only receive stress in morphologically complex forms; monomorphemic forms do not receive stress on final odd-numbered syllables. The relevant generalization is that a final secondary stress is only permitted in words which are morphologically complex. This generalization is independent of morphological bracketing; the polymorphemic data shows that final stress occurs regardless of the form's morphological complexity.

Below I argue that Tohono O'odham is a language with binary syllabic trochees aligned from the left edge. I propose that the stress pattern of polymorphemic forms is generated by a constraint that

[1] Spanish borrowings with noninitial stress act slightly differently. Here the only Spanish borrowings treated are those that surface with initial stress in Tohono O'odham.

requires all morphemes to be associated with at least one stressed syllable. This constraint, the MORPHEME-TO-STRESS PRINCIPLE, is satisfied when a morpheme is stressed at least once. As a result, degenerate feet are permitted only in those words with complex morphology. I show that this proposed constraint accounts for the patterning of stress in Tohono O'odham.

After arguing for the correct characterization of the metrical pattern, I then demonstrate that alternatives are inadequate. There are four alternate analyses that I argue against. The first analysis invokes alignment constraints, while the second requires morphemes to be at least partially footed. I also reject a third analysis which suggests that Spanish borrowings disallow final stress. Finally, I demonstrate that an account invoking identity constraints, as in Kenstowicz (1995), cannot completely account for the data presented here. All of these analyses are shown to be inferior to the analysis based on the MORPHEME-TO-STRESS PRINCIPLE.

The organization of this chapter is as follows. The first section presents the data. This consists of a discussion of the phonetic correlates of stress and examples of simple and complex forms to illustrate the general patterns of stress in Tohono O'odham. The second section proposes an analysis of the data presented in the first section. The combination of morphological and prosodic constraints accounts for all of the generalizations. In the third section, I argue against three possible alternative analyses. The final section summarizes the descriptive and theoretical points made in this chapter.

2.1 Evidence for Stress in Tohono O'odham

In this section, I discuss some of the phonetic and phonological evidence for stress. Where relevant, I give instances where primary and secondary stresses can be distinguished. The first subsection discusses the presence of phonetic correlates of stress. This is followed by a discussion of native speaker intuitions, with an explanation of the method used in collecting data. Finally, I outline a phonological argument for the distinction between primary and secondary stress. This argument originates in an analysis of reduplication in Tohono O'odham song meter (Fitzgerald 1994a). The phonetic and phonological domains both provide evidence for the existence of stress in Tohono O'odham.

2.1.1 Native Speaker Intuitions and Methodology

Three methods are discussed in the literature for gaining access to native speaker intuitions about stress: tapping, "reiterant" speech, and repetition. I employed all three in eliciting data, although tapping was the primary method used. The description of Tohono O'odham stress in this dissertation thus reflects the judgments of Tohono O'odham speakers.[2]

The first method used in this study involved tapping. Speakers simultaneously said a word while hitting on a table or other surface, to "tap out" a word's stress pattern. Speakers learned how to use tapping and reiterant speech first on English words, then transferred the skills to Tohono O'odham words.[3] The tapping method worked as follows. First, speakers were trained on the task using English words, and tapping on syllable where they perceived stress.[4] Speakers began by tapping on all syllables in the word. They were then asked if they could only tap once during the word, where would they tap. They repeated the word with a single tap. Then speakers were asked if they felt any other syllables should be tapped. The word was repeated with additional taps where the speakers had deemed them necessary. After this, speakers were asked to compare the same word with different tapping patterns. They would be asked whether, for example, a quadrisyllabic word sounded better with taps on first and third syllables, the first and fourth syllables, or second and fourth syllables. The

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[2]I take another opportunity to thank Felicia Alvarez and George JosŽ for their judgments in these matters.

[3]By no means did this appear to affect the judgments. First, the O'odham speakers did not give canonical stress judgments for the English words. As these speakers did not learn English as a native language, this is unsurprising. They did stress the same syllables as in standard English, but often differed in judgments of primary versus secondary stress. Second, speakers do not use English patterns to stress O'odham words. Therefore, the training procedure was most effective in producing stress judgments.

[4]Both speakers are fluent in Tohono O'odham and English.

speakers' judgments were confirmed by comparing the pattern they had given with another pattern, where they were asked which sounded best. This was done when speakers gave forms that were inconsistent with previous elicitations, as well as when speakers gave forms that cohered with other similar forms. For example, most quadrisyllabic forms surface with first and third stress. A small set of words, however, take first and fourth stress. When these words were first elicited, I asked speakers which sounded better, first and third syllables stressed, or first and fourth syllables. For this particular set of words (to be discussed in Chapter Three), first and fourth was preferred. This method is illustrated by the table in (1), with a Tohono O'odham word, *pa@pado$gaka$m* 'ones owning ducks'.

(1) Tapping (*pa@-pado$-ga-ka$m*, 'ones owning ducks (Sp)' from root *pa@ùdo* 'duck (Sp)')

a.	Tap first on all syllables please.	pa TAP	pa TAP	do TAP	ga TAP	kam TAP
b.	If you could only tap once, which syllable would you tap on?	pa TAP	pa	do	ga	kam
c.	If you tapped twice, where would you tap?[5]	pa TAP	pa	do	ga	kam TAP
d.	Should any other syllables be tapped?	pa TAP	pa	do TAP	ga	kam TAP
e.	Which sounds better	pa TAP	pa TAP	do	ga TAP	kam

[5]The second tap varied in these quinquesyllabic words, sometimes falling on the third syllable, other times on the fifth. There may be a secondary/tertiary distinction in the stress system. However, the judgments here are not consistent, and the possible phonological relevance of such a distinction is unclear. These matters are left for future research.

	or	pa TAP	pa do TAP	ga	kam TAP

In English, if one taps on unstressed syllables rather than stressed ones, the pronunciation of the word generally changes. This is because cues such as reduced vowels, pitch and intensity generally change. The same is true for Tohono O'odham; mistapping a word changed its pronunciation.[6]

This method has been found to be particularly useful in both field research and experimental phonology. For example, Everett, Ladefoged and Everett (1996) report that tapping was used successfully by speakers of Banaw‡ in assessing stressed syllables. Different speakers tapped in the same places in words, suggesting that the taps reflected a particular rhythmic organization for Banaw‡ speakers. They also note that this method was less successful with speakers of Pirah‹. They conclude that this is likely due to the absence of an explicit phonetic correlate of stress in the language.

For Tohono O'odham speakers, successful tapping was judged in several ways. First, different speakers tapped in the same places. Second, tapped syllables carried acoustic features that are commonly associated with stress. Third, certain patterns were so salient to the speakers that before even tapping them, they describe the word as being stressed in the "one, three, five" pattern or the "usual" (meaning first, third and fifth syllables were stressed).

A second method used in this study is reiterant speech. This has been particularly useful in the phonetic and acoustic analysis of prosodic features. This technique involves the use of a nonsense syllable, such as *ma*, in place of the actual segmental content of the syllable (Liberman and Streeter 1976, Liberman 1978, as well as the references in Lindblom and Rapp, 1973. Essentially the same

[6]The consequences of ungrammatical stress patterns were noted by G. JosŽ, who commented that he had noticed second language learners of Tohono O'odham frequently mispronounced the vowels. After learning this method, he corrected this observation to say that they stressed the wrong vowels. This reinforces the fact that stress is relevant in Tohono O'odham.

steps are used – speakers are asked to first say the word, and then to say it in reiterant speech. Judgments are also elicited on variable pronunciations. The chart in (2) illustrates how this procedure worked.

(2) Reiterant Speech (*mu@sigo* 'musician (Sp)' and *pa@ùdo-ga$* 'owning ducks (Sp)')

a.	Say the word please.		mu si	go
b.	Now, please say the word with ma's.[7]		MA ma	ma
c.	Which sounds better		MA ma	ma
	or		MA ma	MA
d.	Say the next word please.		pa: do	ga
e.	Now, please say the word with ma's.		MA ma	MA
f.	Does this word sound the same or different from *musigo*?		different.	

Successful reiterant speech occurred when speakers were able to mimic the number of syllables in the word, as well as approximate the acoustic correlates. Reiterant speech proved to be extremely useful in highlighting the contrast between trisyllables that allow final stress and those that do not. Speakers contrasted these forms without problem. For example, the contrast between forms like *mu@sigo* 'musician' and *pa@do-ga$* 'possessing a duck' was especially salient. Speakers even compared and contrasted words. For example, they categorized subsequent words as the same or different than *mu@sigo* 'musician'. However, this method was less effective on words longer than

[7]Capital letters are used informally to indicate a higher degree of pitch or amplitude than an adjacent syllable.

three syllables. Speakers had difficulty producing the correct number of *ma* syllables. This may be due to the length of the words, given that in this task, speakers had trouble remembering how many syllables were in the words, as well as where stress falls.

One potential asset to this method is that the nonsense syllable is strung together in such a way that the speaker mimics the prosodic effects of the actual word. If duration plays a role in stress, this is especially important. By using reiterant speech, phoneticians are able measure such things as the duration, while reducing the interference of other factors known to affect duration, such as the segmental point of articulation, syllabification, or environment (Liberman 1978).[8] Reiterant speech has been especially helpful in experimental phonetics (for example, Larkey, 1983), as well as in the field research carried out here.

The final method used involves repeating the word back to the speaker. Repetition has been used widely in eliciting all types of data. The technique is especially valuable for eliciting judgments of prosody. An example of this comes from Pirah‹, where high tone and stress are both present, but high tone does not mark stress (Everett and Everett 1984a). Everett (1988: 213) reports that speakers corrected him when he stressed syllables with high tones (stressed syllables underlined):

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[8]Liberman (1978) notes that Liberman and Streeter (1976) borrowed and "redeveloped" this idea from Lindblom and Rapp (1973).

(3) Pirah‹ stress judgments

a. pao@.hoa.hai (Everett's self-reported incorrect speech)

'anaconda'

b. pao@.hoa.hai, hiaba! (native speaker correction)

'anaconda, no!'

c. pao@.hoa.hai (correction)

'anaconda'

The relevance of stress in Pirah‹ (or any language) is emphasized by the corrected form in (3c). As Everett notes, if stress were irrelevant, this correction would not take place. Repetition serves as an extremely useful method for accessing native speaker intuitions about stress.

For Tohono O'odham, elicitations and corrections occurred much as they did in Pirah‹. A word was pronounced with an ungrammatical stress pattern, and speakers corrected the form. One ungrammatical pattern that occurred was changing acoustic correlates so that primary and secondary stresses were switched. An illustration of this appears in (4), where the "Elicitor" column produces forms where the final syllable (rather than the initial one) is wrongly produced as the loudest stress. Speakers corrected such forms so that the first syllable had the highest degree of stress.

(4) Repetition

Elicitor					**Native Speaker**				
PA	pa	DO	ga	**KAM**	**PA**	pa	DO	ga	KAM
mu	si	**GO**			**MU**	si	go		

All three of these methods were employed in the elicitation of Tohono O'odham words.[9] Tapping and repetition were most useful, although reiterant speech was also used, especially during the initial stages of data collection. All methods involve accessing native speaker intuitions about stress.

There are three issues that should be mentioned at this point. First, as noted in the previous section, there was one type of words where judgments became less clear. When asked to tap for words with complex codas, speakers were often unsure what to do with the released coda consonants. For example, a word like *hi@kc&k* 'chopping', speakers might ask if they should tap on the /c&/ or the final /k/, or perhaps both. This occurred only when speakers were asked to tap on all syllables. The difficulty here was in whether these coda consonants should be treated as syllables or not. Speakers never tapped on these segments when asked to tap on stressed syllables. There was a consistent judgment that these were not stress-bearing elements.[10]

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[9]In addition, speakers were often randomly asked about different patterns, just as a test of their judgments. This results in a "double-check" of the work for a large set of the data collected.

[10]One observation that is perhaps of note –when asked for syllable judgments of English words, the same confusion arose when words were said with released stops (i.e., *cat*). The final burst of the consonant, in both English and Tohono O'odham, appears to cause this problem.

The second issue has to do with the treatment of a vowel-laryngeal-vowel sequence. For some words with a sequence of this sort, the sequence surfaces as one syllable (5).

(5) Examples of V'V words treated as one syllable

a.	'a@-'a.d`o.-ka$m	'people with parrots'
	plural-parrot-one with	
b.	mo@ù.-to'o.-ku$d`	'instrument for carrying on head (?)'
	head-carry on-instrument	
c.	c&u@'i.-mad	'adding flour'
	flour-adding	
d.	'i@'-is.pul	'spurs (Sp, from espuŽla)'
	plural-spur	

As the examples above show, a vowel-glottal stop-vowel sequence may be judged as monosyllabic in both initial and medial positions in the word. Other examples, however, show that the same type of sequence may be judged to be disyllabic. Examples of such words appear in (6).

(6) Examples of V'V words treated as two syllables

a. da@'a-.ku$d1 'instrument for flying'

flying-instrument

b. ba@.'iwc&.-k-i$m 'to wish, try to get ahead of object'

to get ahead of object-repeated-desiderative

c. pa@.ko.'o$.la 'Pascola dancer (Sp, from Pascu‡l)'

d. s« o.@'o.ho$.na-.da$g 'to be good at writing'

stative handwriting-ability to

e. du@-.du.'a$g 'mountains'

plural-mountain

Predicting the syllabification of a sequence of vowel-glottal stop-vowel appears quite difficult. Initial syllables can be parsed both ways, as seen above. Both types are attested for both stressed and unstressed vowels. The data does not appear to have a ready solution here. One possible explanation may be that there is a glottalized vowel sequence, one syllable, and a vowel-consonant-sequence, where the glottal stop divides vowels into separate syllables. To my knowledge, this issue has not been raised in the literature, although other problematic issues regarding laryngeals have been discussed (see, for example, Hale 1971, Hill and Zepeda 1992). It deserves more attention, but the problem is not solved here.

The third set of forms which deserve note are those with surface vowels that were never tapped in the syllable count. These vowels, almost always schwas, appear between two consonants. The vowels seem to be playing a purely phonetic role, acting as a transition between consonants[11]. This

[11]These vowels are generally left out of the orthography as well.

effect is not indicated in the transcription, since the vowels have no phonological effect, and are not noted by speakers. Some examples of the transitional vowels are given below, indicated by double-underlining. Beneath each form, the number of syllables tapped out is given.

(7) "Transitional" vowels never tapped

a. 'ö@ùk-«-d-aj& 'shade, shadow of a specified entity'

σ@σ

get in the shade-make-nominal-possessive

b. 'o@n-«-mad 'adding salt'

σ@σ

salt-adding

c. pi@-p«los 'pear trees'

σ@σ

plural-pear tree

d. s« c&u@c&ul-l-ga 'to own a chicken'

σ@σσ$

stative chicken-possession

e. ta@ùtam-«-c&u$d 'to make teeth for object'

σ@σσ$

tooth/teeth-cause to

f. s« c&u@c&ul-«-da$g 'to go to bed as early as a chicken'

σ@σσ$

stative chicken-abilty to

g. s« ha@iwan)-I-ga$ 'to own cattle'

σ@σσ$

stative cow-possession

h. ba@n)-I-möd`-da$m 'crawler'

σ@σσ

?-walk-one who[12]

i. ta@ùtal-«ba$d` 'mother's deceased younger brother

σ@σσ$

plural maternal younger brother-defunct

j. wa@-paino$mI-ga 'to own knives'

σ@σσ$σ

plural-metal-possession

k. tu@-tun«go$-kam 'people with dresses'

σ@σσ$σ

plural-dress-one with

l. ha@iwan)-i-ga$-kad-«-ma$ 'will seem to be owning a cow'

σ@σσ$σσ$

cow-possession-future imperfect-seem

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[12] I am unable to determine the exact gloss for *ban)* – its use in conjunction with *möd`*, which is clearly a separate morpheme, suggests that there are indeed three morphemes total in this form.

During the process of elicitation, speakers never tapped on underlined vowels.[13] These forms are typical of forms with such vowels; size varies, with forms above ranging from two to five syllables. The form in (7) has two transitional vowels. These vowels must differ from the epenthetic vowels discussed in the following chapter, as those vowels are tapped on speakers. The vowels above, however, are never acknowledged in the syllable count by speakers. They play a transitional role between two adjacent consonants, and from this point, are not indicated in the data.

Together, the use of tapping, repetition and reiterant speech has proven to be extremely valuable in obtaining the stress intuitions of Tohono O'odham speakers.

2.1.2 Phonetic Correlates of Stress

Stress is commonly associated with one or more of three phonetic features (Lehiste 1970, among others): amplitude (or loudness), pitch, and duration (length). All three play a role in Tohono O'odham. These factors are used in various ways to mark the difference between stressed and unstressed syllables, as well as between primary and secondary stress.

First, let us consider the role of pitch. The pitch contour of Tohono O'odham words has been described and analyzed in various works, notably Hale (1959), Saxton (1982) and Hale and Selkirk (1987). The initial syllable of the word begins with a high pitch, and subsequent syllables are lower in pitch. There is a marked difference in pitch between primary stresses and all other syllables, as noted above. The highest pitch in the word is always associated with the syllable that bears primary stress. A difference in pitch also exists between secondary and unstressed syllables. This contrast must be salient to speakers as it is invoked in reiterant speech production and in repetitions and corrections. These manipulations of the frequency of stressed syllables show the importance played by pitch in the phonetics of the stress system.

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[13]This provides a further argument against discussions of secondary stress as in Hill and Zepeda (1992). According to their analysis, these vowels are present underlyingly, but must be counted for stress assignment. These vowels clearly play no role in stress assignment.

The second and third correlates of stress, loudness and duration, also play a role in Tohono O'odham. Loudness is more prominent in the primary stressed syllable than in syllables that receive secondary or no stress. Duration plays a role in Tohono O'odham stress. The contrast is most salient in comparing the length of syllables (and more specifically, vowels) between primary and secondary stresses. Vowels characterized as "extra-short" due to their devoicing never bear stress.[14]

While all three of these phonetic effects correlate with stress in Tohono O'odham, these characterizations require further study under acoustic analysis to determine the precise role they play. Impressionistically, the correlates not only mark the difference between stressed and unstressed syllables, but they are also invoked to differentiate primary and secondary stress. An acoustic analysis may well determine that pitch, amplitude, and duration play an important role in marking primary stress, but that only a smaller subset of these features is used to mark secondary stress. I leave further development and study of these issues to future research.

2.1.3 Phonological Evidence for Stress from Meter

A fourth set of evidence bearing on the relevance of stress in Tohono O'odham is found in the treatment of stress in traditional songs. The analysis of meter has long been invoked by researchers because meter utilizes stress patterns in various linguistic ways (for some examples of this point, see Kiparsky 1975, 1977, Hayes 1989b, Hammond 1991a and others). Fitzgerald (1994a, 1995) shows that Tohono O'odham song meter uses semantically empty reduplication to satisfy constraints on the meter. This provides an argument that stress is phonologically relevant in Tohono O'odham. There is a further asymmetry between primary and secondary stresses, as there is no evidence that the restrictions on the distribution of primary stress in meter also holds for secondary stress.[15]

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[14]Without quantitative acoustic data, it is not clear whether this distinction is phonological and phonetic, or just phonological.

[15]The discussion here is a much abbreviated version of Fitzgerald (1994a, 1995), to which I refer the reader.

First let me introduce background for this issue. The song corpus analyzed for these purposes consists of 11 songs totaling 78 lines found in Wallace (1981). The songs used are traditional[16], and are used for social or ceremonial purposes, such as traditional round dance songs or healing songs. Musical content is generally associated with a specific purpose; for instance, a certain type of dance requires a certain rhythm (much like a polka or waltz requires certain rhythms). Also, traditional songs are those which are either passed down from one generation of a singer to another or come to the singer via the inspiration of a dream.

The example below shows a song line. Each song line is noted by SONG. Underneath the example is given in CITATION form. CITATION lines gloss the O'odham song forms into the official orthography.[17] I then provide an English gloss of the O'odham forms in GLOSS.[18] The final line, TRANSLATION, represents the song line in an approximate English translation. The format is given in (8):

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[16]My understanding of 'traditional' comes primarily from Haefer (1977) and Ofelia Zepeda (p.c.).

[17]Citation forms were confirmed in Mathiot (1973) and Saxton, et al. (1989) wherever possible. As both dictionaries use orthographies other than Alvarez and Hale, I also changed the forms to represent the Alvarez and Hale orthography, where *e*=/ö/, *j*=/j&/ and *c*=/c&/.

[18]Ofelia Zepeda, a native speaker of O'odham and a linguist, was an invaluable source of help in both the Tohono O'odham and English glossing of the songs.

(8) Tohono O'odham Song Line

SONG	W'-pis -mel –Ž—ei wa— b'-je-mi-da.
CITATION	w'pismel –Ž–e'i a ––b'jemid
GLOSS	hummingbird pl-song AUX 1SG-to surround
TRANSLATION	'Hummingbird songs surround me.'

In example (8), reduplication is used to indicate the plurality of the noun for song. The semantic change from singular to plural is indicated by the reduplication. Of the 48 instances of reduplication found in the song corpus, only 20 are plural reduplications. This means that there are 28 reduplicated forms which do not have an associated change in meaning. These latter cases are examples of nonmorphological (or Vacuous) reduplication, as words reduplicate without an associated change in meaning. As we examine the data, the generalizations show that Vacuous Reduplication is motivated by stress considerations.

Contrasting examples of morphological and nonmorphological reduplication leads to the conclusion that Vacuous Reduplication ensures that each primary stress is followed by an unstressed syllable. As mentioned above, the songs do contain examples of morphological reduplication marking plural. An example of this appears in (7) above, as well as (9) below, with the reduplicated word underlined in song and citation lines. The singular form, *g'dwul* 'swallow' reduplicates as *g'gidwul* 'swallows' (the reduplicant is underlined).

(9) Morphological Reduplication in Tohono O'odham Songs

E-d1a gg'gi-dwul-e –Ži-o-pa-ha

ed1a gg'gidwul –Ž'iopa

while DET PL-swallow PL-to fly

'While the swallows flying...'

However, there are also song lines which contain reduplication without a corresponding semantic change. That is, singular nouns and verbs reduplicate in song lines, where they would not reduplicate in citation lines. This can be seen in the examples below, with prefixal reduplicants underlined.[19]

(10) Vacuous Reduplication in Tohono O'odham Songs

a. Vacuous Reduplication line-initially:

W‡-wai g'-wa-lige we-co n‡-ha-gio kc in mŽm-e(-li-hi-me.

W‡w g'wulk weco n‡hagio kc in mŽmelihim.

rock Cinched below mouse CONJ LOC to run to repeatedly

'The mouse runs around there below Cinched Rock.'

b. Vacuous Reduplication line-finally:

Ji—s` oi k‡-wu-li-ki yam-e kŽ-he-ka

Ji—s` 'o i-g‡wulk 'am kŽ:k

God AUX INIT-to differ LOC to stand

'God starts to differ standing there.'

c. Multiple instances of Vacuous Reduplication within a line:

oi na s`—-s`o kœ:-ku:-Ne.

oi na s`—n kœ:g

soon perhaps the beginning the end

'soon perhaps the beginning, the end,'

[19]There are a variety of phonological processes at work here, including lenition and nasalization. These are not discussed here.

The first example in (10a) shows that Vacuous Reduplication may occur line-medially (seen also in (10c).. These forms also show that Vacuous Reduplication may occur line-finally (10b,c). Finally, the two reduplicated forms in (9c) also show that a given line may have more than one occurrence of this type of reduplication.

In order to demonstrate the metrical nature of Vacuous Reduplication, I give the song lines from (10) again below in (11), with both citation and song lines in the grid-based theory of meter used by Hayes (1983, 1989). Under this approach, primary stressed syllables are represented with 'X' and all other syllables are represented with '.'. This allows us to indicate prominent syllables in a given line.[20] An examination of these forms shows that Vacuous Reduplication only occurs wherever either two primary stresses are adjacent (*X̲X*) or wherever a primary stress would fall at the rightmost edge of a line (*X̲*).

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[20]In certain analyses, more detail is required for degree of stress. In such cases (for example, Hayes 1989), the level of stress correlates with the height of the 'X' column, such that the higher the column, the greater the relative prominence.

(11) Grid-aligned Song Lines

a. X . X . . . . . X . . . . X . . . .

W‡-wai g’-wa-lige we-co n‡-ha-gio kc in mŽm-e(-li-hi-me.

X X . . . X . . . . X . . .

W‡w g’wulk weco n‡hagio kc in mŽmelihim.

rock Cinched below mouse CONJ LOC to run to repeatedly

'The mouse runs around there below Cinched Rock.'

b. X . X . . . . . X . .

Ji—s` oi k‡-wu-li-ki yam-e kŽ-he-ka

X . . X . . X

Ji—s` 'o i-g‡wulk 'am kŽ:k

God AUX INIT-to differ LOC to stand

'God starts to differ standing there.'

c. . . X . X . .

Oi na s`—s`o kœ:-ku:-Ne.

. . X X

oi na s`—n kœ:g

soon perhaps the beginning the end

'soon perhaps the beginning, the end,'

By aligning the song and citation lines to the metrical grid, the generalization is validated: Wherever citation lines appear with adjacent stresses or a line-final stress, the song line appears with the leftmost word of two stressed words or the final word in a line vacuously reduplicated. In fact, these are the only positions where Vacuous Reduplication occurs. These observations suggest two conclusions: 1) Stress clash and line-final stresses are impermissible in the song meter and 2) Vacuous Reduplication resolves these stress violations where they would otherwise occur, given the corresponding citation line.[21]

Interestingly, these claims accurately describe only the behavior of primary stress. Syllables with secondary stresses are invisible to the meter in this regard; for instance, the example in (8) shows that the final syllables of polymorphemic trisyllabic words, which are stressed in speech, do not reduplicate. In the citation line, there are both a line-final and an adjacent stress, shown below with secondary stress indicated.

(12) Secondary stress in the meter (double-underlined)

W'-pis-me$l –Ž—ei wa— b'-je-mi$-da.

w'pisme$l –Ž–e'i a –-b'jemi$d

hummingbird pl-song AUX 1SG-to surround

'Hummingbird songs surround me.'

The difference between the stressed syllables that undergo Vacuous Reduplication and those stressed syllables that do not undergo Vacuous Reduplication results from the asymmetrical treatment of primary and secondary stresses in the meter. Citation-line primary stresses always reduplicate when either adjacent to another stressed syllable or when line-final. Citation-line secondary stresses never reduplicate.[22] This division gives phonological support for the relevance of primary stress in Tohono O'odham.

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[21]These two findings can be grouped together if FOOTBINARITY is top-ranked in the meter.
[22]Other metrical systems also distinguish primary from secondary, so this is not unusual.

2.1.4 Summary

In this section, I have presented arguments for the presence of stress in Tohono O'odham. These arguments come fromnative speaker intuitions about stress, from native speaker corrections of misplaced stress, and from the phonological evidence of how stressed syllables are treated in meter.

2.2 Description of the General Stress Pattern

In this section, the general stress pattern of Tohono O'odham is described. The general pattern covers both monomorphemic words and polymorphemic words. In subsequent chapters, words with epenthetic vowels (Chapter Three) and truncated words (Chapter Four) are covered, but the description of these words does not appear in this chapter. This section describes the stress pattern of monomorphemic forms first, followed by a description of polymorphemic stress patterns.

2.2.1 Monomorphemic Words

The first set of data (13) shows the distribution of stress in monomorphemic forms. Monosyllabic forms (13a) receive one stress[23], as do disyllables (13b) and trisyllables (13c). Although two stressed syllables are possible in trisyllables, this pattern does not appear in monomorphemic words . Finally, the quadrisyllabic forms in (13d) show that monomorphemic forms do have secondary stress, and that secondary stress falls on the third syllable of the word.

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[23]As discussed in Chapter One, there are no content words of the shape CV, suggesting a bimoraic word minimum.

(13) Stress in monomorphemic words[24]:

a.	σ@	ki@ù	'house'
		'o@ùt	'dripping, leaking'
		to@ùn	'knee'
		to@n	'ant'
		go@gs	'dog'
		mö@d`	'running'
b.	σ@σ	wi@ùkol	'great-grandparent'
		pi@ùba	'pipe (Sp, from p'pa)'
		ta@dai	'roadrunner'
		wa@ika	'ditch'
		ha@iwan)	'cow'
		pa@ùdo	'duck (Sp, from p‡to)'
c.	σ@σσ	mu@sigo	'musician (Sp, from mœsico)'
		ma@ùgina	'car (Sp, from mach'na)'
		si@minj&ul	'cemetery (Sp, from cementŽrio)'
		'a@sugal[25]	'sugar (Sp, from azœcar)'
d.	σ@σσ@σ	pa@ko'o$la	'Pascola dancer (Sp, from P‡scual)'
		pi@mia$ndo	'pepper (Sp, from pimiŽnta)'

[24]Spanish loanwords and sourcewords are given on the first citation of each form in this chapter.

[25]According to J. Hill (p.c.), some speakers do say *'asu@ùgal* 'sugar'; these speakers are primarily from the northern area of the Tohono O'odham reservation. The speakers consulted for this study reported the form with initial stress, *'a@sugal* 'sugar'.

Again, we see above that the forms in (13), the initial syllable consistently receives the main stress of the word. The preference for the leftmost syllable is demonstrated by the data in (13b-c), with the longer words. Neither the disyllables in (13b) nor the trisyllables in (13c) have more than one stress. Secondary stress does surface on the third syllable of the quadrisyllabic forms in (13d). From the monomorphemic words, then, we see in (13) that primary stress falls on the initial syllable of the stem, and that secondary stress is permitted, on subsequent odd-numbered syllables, but only where it appears nonfinally (13d).

The data in (13) leads to another point regarding the use of native versus nonnative words. Monomorphemic native words are never larger than two syllables. The words in (13c,d) are three and four syllables are borrowings. Monomorphemic words larger than four syllables do not appear, not even as borrowings. Furthermore, the four syllable pattern is itself underrepresented, with the two forms in (13) reflecting the only forms of such size found in either in a dictionary search or by speakers' conscious recollection of such words.

The use of borrowed words to demonstrate the pattern of stress in monomorphemic words is not at all unusual. Metrical theory has often looked to borrowings to determine the stress pattern in longer words. A prime example of this is English; monomorphemic native words of English are all extremely short. To determine how English assigns stress in long, monomorphemic words, borrowed words are analyzed, such as *Mississippi, Monongahela, Apalachicola,* and *Ticonderoga*. Analyses of English stress crucially invoke the stress patterns of such words, as seen in Chomsky and Halle (1968), and others. The same is true in other languages, such as Indonesian (Cohn 1989, Cohn and McCarthy 1994).

There are languages where borrowed words have a markedly different stress pattern than native words; this is the case with Turkish (Inkelas 1994) and Yawelmani (Archangeli 1988). The argument here is that the set of borrowings analyzed in this dissertation acts like the set of native words, in the same manner as in English or Indonesian. Consequently, there is no reason to treat these borrowed words as a different set of Tohono O'odham stress patterns, as the stress patterns of monomorphemic and polymorphemic forms resemble those of native words.

This argument is supported by a different set of borrowings that do act differently. Native words never have noninitial long vowels. There are a number of nonnative words, however, that occur with noninitial long vowels. There are approximately 150 of these words in the Mathiot (1973) dictionary, so they are a very small portion of the vocabulary. In Mathiot (1973), these words are represented with the long vowel stressed, as in *palo@ùma* 'dove' or *Mali@ùya* 'Maria'. The stressed long vowel in the Tohono O'odham corresponds to a stressed vowel in the Spanish version. However, speakers vary in how they stress these words (J. Hill, p.c.). For some speakers, the words are stressed in much the same way that the words in (13) are stressed. Other speakers stress the words according to the Spanish pronunciation. The fact that these words are treated inconsistently by speakers suggests that the systematic exclusion of these words is unproblematic for the description and analyses presented in this dissertation. The phonology of such words(especially with regard to vowel length) is different enough from native words to suggest that this set of borrowings act like the borrowings in Turkish.

To summarize this section, the data in this section is limited to monomorphemic words. The forms showed that initial syllables receive primary stress. Secondary stress only appeared in the quadrisyllabic words; in these forms, the penultimate syllable received stress. Finally, I also discussed the use of borrowed words, showing that the set of borrowed words used here behave like native words, and thus present no problem for the subsequent analysis.

2.2.2 Polymorphemic Words

The second set of data to be examined are morphologically complex words. The pattern found in (13) is mimicked in polymorphemic forms, with one crucial difference: odd-numbered syllables are stressed even when they are word-final. This is true regardless of morphological bracketing; to reinforce this point, the polymorphemic forms are broken down into three groupings: one suffix only, one prefix only and multiple affixes.

In (14), suffixed words are given. Tohono O'odham allows monosyllabic suffixes to consist of either a consonant (as in the causative *-t*), a vowel (as in the nominalizing *-a*), or an open or closed syllable (as in the future imperfective, *-ad*, or the agentive *-kam*. The previous section demonstrated that monomorphemic forms vary in size from one to four syllables. When these monomorphemic forms constitute the bases, each size of the base can be assessed as to what types of suffixes appear on it, and what the stress pattern of the word is. Generally, the consonantal suffix does not add a syllable, while the other (vowel or syllabic) suffixes all add a syllable. In (14), the data is categorized in precisely this way for bases plus suffixes. For example, (14a) displays monosyllabic bases plus each of the three type of suffixes. In all of the words, every odd syllable is stressed, even if this means that a final syllable would be stressed. (Morpheme glosses are directly under each word that has not previously been glossed.)

(14) Stress in suffixed words[26]:

a. Monosyllabic Bases

σ+c	pa@ùn-t	'making bread (Sp, p‡n)'
	bread-to make	
σ+v	hi@m-a	'the walking'
	walking-nominal	
σ+σ	hi@m-ad	'will be walking'

[26] Suffixes are glossed where possible following Saxton et al. 1989 and Zepeda 1984. Note the following: for glosses, a=epenthetic vowel; *s* (transcribed as s« above) in TO form indicates stativity.. Some arguments for treating the *s* stative marker as a clitic rather than a prefix are given in the previous chapter.

	walking-future imperfective	
	'o@n-mad	'adding salt'

b. Disyllabic Bases

σσ+c	c&ö@mai-t	'making tortillas'
	tortilla-to make	
σσ+v	n)u@ùkud-a$	'the care-taking'
	take care of-one who	
σσ+σ	ci@kpan-da$m	'worker'
	work-one who	
	s« pa@ùdo-ga$	'having a duck (Sp)'
	s« pi@ùlos-ga$	'having a pear tree (Sp)'
	stative pear tree-possession	

c. Trisyllabic Bases

σσσ+c	'a@suga$l-t sugar-to make	'making sugar (Sp)'
σσσ+v	—	
σσσ+σ	ma@ùgina$-kaj& car-in a similar manner	'by means of a car (Sp)'
	'a@suga$l-mad sugar-adding	'adding sugar (Sp)'
	s« mu@sigo$-dag stative musician-ability to	'to be good at being a musician (Sp)'
	ma@ùgina$-kam car-one with	'one with a car (Sp)'

d. Quadrisyllabic Bases

σσσσ+c	—	
σσσσ+v	—	
σσσσ+σ	pi@mia$ndo-ma$d pepper-adding	'adding pepper (Sp)'
	s« pa@ko'o$la-da$g stative Pascola dance-ability to	'to be good at Pascola dancing (Sp)'

From (14), we see that like monomorphemic forms, primary stress falls on the stem-initial syllable. Also like monomorphemic forms, words of two syllables only receive a single, primary stress. Suffixed words that result in trisyllables, such as those latter cases in (14b), all exhibit final stress in addition to the initial primary. This is a pattern at odds with that evidence by monomorphemic forms from above, where final stress was never exhibited in trisyllables. Forms of five syllables that result from suffixation onto a quadrisyllabic base (14d) show that final stress is allowed in these cases also. The data in (14) shows a basic pattern where suffixed words stress all odd syllables, permitting final stress. The suffixed forms above show strict iterative stress with all odd-numbered syllables receiving stress, even when word-final.[27]

Next we shall examine the stress pattern of prefixed words.[28] Here this consists of the set of reduplicated words, as the reduplicant is prefixal in nature, as discussed in Chapter One. The stress patterns of these words are identical to those of their suffixed counterparts. For example, a trisyllable that includes prefix surfaces with stresses on the first and third syllables. Trisyllables with suffixes also surface with stresses on these syllables. This means that final syllables do get stressed in reduplicated forms. These patterns are shown in (15):

(15) Patterns of stress in prefixed words:[29]

a.	σ@	c&u@-c&s`	'extinguishing a fire, plural'
		ko@-ks`	'sleeping, plural'
		ga@ù-gt	'guns'
b.	σ@σ	to@-ton)	'ants'

[27]One analysis of these forms might be to treat them as the product of final lengthening, as Hayes (1995) suggests for certain languages. If we treated the final stresses in polymorphemic words as final lengthening instead, this would in no way change the basic asymmetry found in this data. An approach invoking final lengthening would still require a distinction between morphologically simple and complex forms, so there would be no advantage, empirical or theoretical, in such an analysis. Additionally, speakers do not treat these stresses as different from nonfinal stresses in their judgments. This might be expected if the final stress were not stress at all, but rather lengthening.

[28]Person markers precede nouns to indicate possession and verbs to mark objects. A stative marker precedes certain words to indicate their function as stative verbs. I follow Saxton (1982) and Hill and Zepeda (1992) in treating these markers as clitics. One reason for doing this is that person markers are never stressed. Another reason is that there is generally a pause between these markers and the content word.

[29]These words contain two morphemes, the first is a plural reduplicant, the second is the base. Segmentation only is given, as the glosses follow given this information.

		hi@-him	'walking, plural'
		c&i@-c&pkan	'working, plural'
		wa@-pkon	'washing, plural'
		wo@-pson	'sweeping, plural'
c.	σ@σσ$	pi@@-piba$	'pipes (Sp)'
		la@@-labi$s	'pencils (Sp, from l‡piz)'
		ta@-tada$i	'roadrunners'
		wa@-paika$	'ditches'
		ta@@-tablo$	'shawls (Sp, from ch‡l)'
		ha@-hawu$l	'lima beans'
		mu@-msigo$	'musicians (Sp)'
		wi@-psilo$	'calves (Sp becŽrro)'
		si@-sminj&u$l	'cemeteries (Sp)'
d.	σ@σσ@σ	pa@-pko'o$la	'Pascola dancers (Sp)'
e.	σ@σσ@σσ$	?	

Reduplicated words that result in trisyllables exhibit final stress. This contrasts with monomorphemic data in (13), but replicates the pattern of the suffixed forms in (14). Thus suffixed and prefixed forms group together in allowing a final odd-numbered syllable to be stressed. Words of one and two syllables only surface with initial stress (15a,b), while the larger words surface with first and third syllable stress (15c,d). Final stress is permitted in these trisyllables (15c), even if the word is the reduplicated version of a Spanish borrowing that surfaces without final stress as monomorphemic (cf. *mu@-msigo$* 'musicians'). This suggests that it cannot be the case that borrowings reject final stress, but rather that it is the monomorphemic status of these words that disallows final stressed syllables. Only one quadrisyllabic form is attested (15d). The effects of syncope (plus the extremely small number of four syllable bases) result in there being no quinquesyllabic forms in (15e), because the one quadrisyllabic base that does reduplicate, also deletes a base vowel (15d).

One additional comment on this set of data is necessary. Nonreduplicated words with long vowels never surface with long vowels in reduplicated words. Base long vowels, as in *pi@ùba* 'pipe', alternate with short vowels in reduplicated forms, *pi@-piba$* 'pipes' (the alternation is indicated by underlining).

The next set of data consists of forms with more than one affix. These more complex polymorphemic forms, with multiple affixes, pattern the same way as the polymorphemic forms in (14) and (15). Trisyllables (16a) and quadrisyllables (16b) receive stress on the first and third syllables of the word. Longer words are also given, showing that for polymorphemic words, all odd-numbered syllables are stressed.

(16) Words with multiple affixes

a. σ@σσ$	hi@-him-a$d	'will be walking, plural'
	plural-walk-future imperfective	
	mö@-möd`-a$	'the running, plural'
	plural-run-nominal	
	pi@ùgo-ka$m	'one with a pick (Sp)'
	pick-one with	
	wa@–pkon-da$m	'ones who wash'
	plural-wash-one who	
	j&ö@@-j&ön-a$	'the smoking, plural'
	plural-smoke-nominal	
	j&ö@n)-kud`-da$m	'one with a smoking instrument'
	smoke-instrument-one with	
b. σ@σσ$σ	s« pa@-pado$-ga	'owning ducks (Sp)'
	stative plural-duck-possession	
	hi@-hido$d`-a	'the cooking, plural'
	plural-cooking-nominal	
	wa@-paila$-kud`	'instruments for dancing (Sp, bail‡r)'
	plural-dancing-instrument	
	c&ö@pos-i$d-ad	'will be branding'
	brand-beneficiary-future imperfective	
	wa@-pc&uwi$-kud`	'instruments for bathing'
	plural-bathe-instrument	

b. σ@σσ$σ	pi@-piba$-kam	'ones with pipes (Sp)'
	plural-pibe-one who	
	la@-lamba$-dam	'ones with lamps (Sp, from l‡mpara)'
	plural-lamp -one with	
	wi@-psilo$-kam	'ones with calves'
	plural-calf-one with	
	ba@-bayo$k-a	'necklaces'
	plural-neck-nominal	
c. σ@σσ$σσ$	ha@-haiwa$n)-ga-ka$m	'ones having cattle'
	plural-cow-possession-one who	
	c&uc&ul-ga-ka$d-ma	'will seem to be owning chickens, plural'
	chicken-possession-future imperfective-seem	
	s« ha@iwan)-ga$-kad-ma$	'will seem to be owning cattle'
	cow-possession-future imperfective-seem	
	ö pa@-pko'o$la-c&u$d	'to act like a Pascola dancer'
	reflexive plural-Pascola dance-make to	
d. σ@σσ$σσ$σ	ha@-haiwa$n)-ga-ka$d-ma	'will seem to be owning cattle, plural'
	plural-cow-possession-future imperfective-seem	

The full range of polymorphemic forms shown in (16) exhibit stress in all odd numbered syllables. The leftmost stress is always the primary stress, and stresses may fall on both final and nonfinal syllables in a given word. There are no differences between words with native or borrowed bases, as all complex forms exhibit stress on every odd numbered syllable, as in (14-16). This pattern holds regardless of the morphological bracketing of the individual forms.

2.2.3 Generalizations

In comparing the monomorphemic forms with their polymorphemic counterparts, one important distinction emerges: complex words allow a final odd syllable to be stressed. It does not appear to be particular morphemes that get stressed word-finally, but rather that any word with more than one morpheme must stress the final syllable. The relevance of position over particular morphemes is reinforced by the following pairs, where suffixal stress is predicted by whether they syllable is in an odd or even position (note this holds regardless of syllable quantity):

(17) ODD POSITION EVEN POSITION

a.	ha@iwan)-ga$-kam	ha@-haiwa$n)-ga-ka$m
	'one owning a cow'	'one owning cows'
b.	pi@ùba-ka$m	ma@ùgina$-kam
	'one with a pipe (Sp)'	'one with a car (Sp)'
c.	s« ha@-ha'a$-t-a-da$g	s« mu@sigo$-dag
	'to be a good potter'	'to be a good musician (Sp)'
d.	mö@-möd`-a$	hi@-hido$d`-a
	'the runnings'	'the cookings'

From these contrasts in (17), we see that it is the presence of multiple morphemes that forces final stress in odd position. For example, the comparison between the *mö@-möd-a$* and *hi@-hido$d`-a* shows that the nominalizing suffix, *-a*, is stressed in odd position in the first word, but unstressed in even position in the second word. If it were the case that this suffix always surfaced as stressed word-finally, we might expect a surface form like \**hi@-hidod`-a$*. Instead, the suffix is unstressed in word-final even position. A pattern emerges where final odd syllables always gets stressed in polymorphemic forms.

Now let us characterize the descriptive points made by the data. The sets above lead us to the following generalizations, stated in (18):

(18) **Generalizations:**

a. Primary stress is always on the first syllable of the word.

b. Secondary stress falls on subsequent odd-numbered nonfinal syllables.

c. Final odd-numbered syllables are assigned secondary stress if the word is polymorphemic; such syllables are unstressed in monomorphemic words.

From these generalizations, together with the sets of data given above, the following patterns are attested, giving the chart in (19). Note that extremely long words, of five or six syllables, only occur with multiple affixes. This is a result of the apparently small size of monomorphemic stems, with only a few forms attested with more than three syllables, and no monomorphemic forms found with more than five syllables. The chart is organized in the following way. The leftmost column, headed by 'Number of Syllables' organizes the rows of the chart from one to six syllables. For each size, the columns across denote the possible morphological structure of the word, from root only ('Simple') to one affix ('Prefixed' and 'Suffixed') and 'Multiple Affixes'. The stress pattern of each attested word type is given, and if no form has been found, a question mark ('?') appears in the block. A double line separates the simple forms from all the complex patterns, as this is the major divide in how these words pattern with regard to stress.

(19) Chart of stress patterns for Tohono O'odham words[30]:

	MORPHOLOGICAL COMPOSITION			
Number of Syllables	Simple	Prefixed	Suffixed	Multiple Affixes
One	σ@	σ@	σ@	?
Two	σ@σ	σ@σ	σ@σ	σ@σ
Three	σ@σσ	σ@σσ$	σ@σσ$	σ@σσ$
Four	σ@σσ$σ	σ@σσ$σ	σ@σσ$σ	σ@σσ$σ
Five	?	?	σ@σσ$σσ$	σ@σσ$σσ$
Six	?	?	?	σ@σσ$σσ$σ

The chart characterizes the surface effects of morphological form upon the stress pattern of a given word. The gaps are where forms do not appear, generally due to what appear to be limitations on the size of monomorphemic bases in Tohono O'odham. It is also a function of the limits to affixation, as bases do not surface with large numbers of affixes.

30The chart is limited to forms with initial stress, and such forms do not appear to include any monomorphemes longer than four syllables. It is possible that if the chart included borrowings with noninitial long stressed vowels, there might be monomorphemes of a longer size.

2.2.4 Summary

To summarize this section, I have described the pattern of stress in Tohono O'odham. The language assigns stress to odd-numbered syllables. Final stress is disallowed in monomorphemic forms and allowed in polymorphemic forms. This generalization holds regardless of the morphological bracketing of a given form.

2.3 Introduction to the Analysis

In this section, we turn to an account of the Tohono O'odham stress facts presented above. The basic problem is this: Derived forms allow final stress in odd-numbered syllables regardless of the morphological bracketing (e.g., *pa@-pado$*, 'pl-duck' versus *pa@ùdo-ga$*, 'duck-poss' versus *hi@-him-a$d* 'pl-walking-fut.imp.'). I argue that each morpheme must be stressed. This constraint, formalized as the MORPHEME-TO-STRESS PRINCIPLE, is surface violated, as it is not the case that all morphemes are stressed. Surface violation is captured in a straightforward manner under constraint ranking in Optimality Theory. With the MORPHEME-TO-STRESS PRINCIPLE dominated by two rhythmic constraints, *CLASH and *LAPSE, this surface violation can be characterized. We begin with monomorphemic forms, and then turn to a proposal to account for polymorphemic forms.

2.3.1.1 The Analysis of Monomorphemic Forms

In this section, monomorphemic forms are analyzed. The pattern of these forms is stress on odd syllables, and final stressed syllables are disallowed. These forms are all accounted for without any new theoretical proposals.

The first fact to account for is initial stress. The initial stress on a disyllabic form follows if the form is analyzed as a disyllabic foot with a head on the left. This analysis parses an input like *tadai* 'roadrunner' as the output *(ta@dai)*.[31] Under Optimality Theory, the foot type is assigned by a

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[31]Parentheses indicate feet; square brackets indicate morphemes.

constraint, FOOTFORM. Here this constraint evaluates a foot to ensure that the head appears on the left side of the foot; the constraint appears in (20).

(20) FOOTFORM (abbreviated FTFM)

Heads are on the left edge of the foot.

This constraint will reject a candidate where the head is on the right edge of the foot. A disyllabic input could surface with either the first or second syllable stressed. The FOOT FORM constraint in (20) will evaluate this input to choose an output with initial stress, such as the candidate below (21a):

(21) Evaluation of /tadai/ 'roadrunner'

/tadai/ 'roadrunner'	FTFM
pa.([ta@dai])	
b.([tadai@])	*!

The difference between the two candidates is whether the first syllable (21a) or the second syllable (21b) is stressed. FOOTFORM is satisfied by (21a), and this is the optimal output. Another candidate exists, one without any stresses. However, there must be a constraint that forces syllables into the feet, so that an unfooted *tadai* 'roadrunner' does not emerge as optimal. The PARSE-σ constraint forces syllables into feet; it is given in (22):

(22) PARSE-σ (abbreviated PARSE)

Syllables must be parsed into feet.

PARSE-σ prefers a candidate with all syllables parsed to one with no or some syllables unparsed. This preference is demonstrated by the tableau in (23); PARSE-σ is below FOOTFORM because it can be surface violated (seen below), while FOOTFORM cannot be surface violated.

(23) Evaluation of /tadai/ 'roadrunner'

/tadai/ 'roadrunner'	FTFM	PARSE
pa. ([ta@dai])		
b. [tadai]		*!*

The two candidates both satisfy FOOTFORM, even if (23b) does this vacuously with the absence of any prosodic heads. On PARSE–σ however, (23b) fails. (23a) better satisfies the hierarchy, emerging as the optimal output.

With disyllabic input, there are only two possible locations for stress to fall.[32] A trisyllabic form offers more logical possibilities for stressed syllables, so le t us turn to the consideration of such a form. The description of monomorphemic words showed that these trisyllabic forms surface with only initial stress. We therefore need to be able to exclude candidates with a single stress on either the second or third syllables or with stress on both the first and third syllables. FOOTFORM and PARSE–σ do not do this. The tableau in (24) demonstrates the inadequacy of these two constraints for predicting the stress pattern of trisyllables; the attested output (24a) is not predicted. Instead, the unattested form in (24) is incorrectly selected as optimal because it satisfies these two constraints (the selection of nonoptimal output is indicated with the k symbol).

[32]This does not consider a form which stresses both syllables; below we see that such a form is excluded by a highly ranked constraint banning stress clash, *CLASH.

(24) Evaluation of /'asugal/ 'sugar'

/'asugal/	FT FM	PARSE
a.(['a@su)gal]		*!
kb. (['a@su)(ga$l])		
c. ['a(su@gal])		*!
d. ['asu(ga$l])		**!
e. [('asu$)gal]	*!	

Two constraints are needed, one to force an initial foot, another to force feet to be binary. I motivate each in turn. The first output to be excluded is (24b), with a degenerate foot. Degenerate feet are excluded by a constraint requiring that feet be binary. In Tohono O'odham, binarity is judged on the syllabic level, as heavy syllables do not attract stress. The constraint is formalized in (24):

(25) FOOTBINARITY (abbreviated FTBIN)

Feet are analyzable as binary on the syllabic level.

FOOTBINARITY excludes degenerate feet. As binarity is evaluated purely on the syllabic level, all monosyllabic feet will violate (25), even if those syllables are bimoraic. Syllable count, not mora count, drives this system. Any system that utilizes strictly binary syllabic trochees predicts that final stress is absent. In Tohono O'odham, final stress only appears in morphologically complex forms. This suggests that FOOTBINARITY is surface violated. In contrast, FOOTFORM is never surface violated, arguing for a ranking in which FOOTFORM appears in the top block of constraints (those constraints that are unviolated), with FOOTBINARITY ranked below this block of constraints. Furthermore, the absence of final stress in trisyllables means that FOOTBINARITY must dominate PARSE-σ. With FOOTBINARITY dominating PARSE-σ, (24b) is excluded as the optimal output. (26) shows the success of this ranking in predicting (26b) as nonoptimal.

(26) Evaluation of /'asugal/ 'sugar'

/'asugal/	FT FM	FT BIN	PARSE
pa.(['a@su)gal]			*
b.(['a@su) (ga$l])		*!	

Both candidates satisfy FOOT FORM. However, (26b) fails on FOOT BINARITY, since the output surfaces with a degenerate foot. The optimal candidate is (26a), which is stressed only on the first syllable and surfaces with a single binary foot. If the rankings between FOOT BINARITY AND PARSE−σ were reversed, (26a) would not be the optimal output,. Instead, (26b) would be selected as optimal by the hierarchy. PARSE-σ must be sufficiently low enough on the hierarchy to prevent the final degenerate foot in trisyllabic monomorphemic words.

What of the outputs from (24) which did not have initial feet? Forms such as (24c) are excluded by an alignment constraint that requires prosodic words to begin with a foot. Like FOOT BINARITY, this constraint is motivated in a number of places in the literature (for example, McCarthy and Prince 1993b). The specific alignment constraint required for Tohono O'odham forces the alignment of a foot for every prosodic word. In Optimality Theory, the constraint that forces initial feet is formalized under the rubric of Generalized Alignment (McCarthy and Prince, 1993b). (The schema for Generalized Alignment appeared in Chapter One.) ALIGN PROSODIC WORD appears in (27).

(27) ALIGN (PROSODIC WORD, LEFT, FOOT, LEFT) (abbreviated ALIGN PW)

The left edge of every Prosodic Word is aligned with the left edge of a foot.

The constraint in (27) evaluates words to determine whether they begin with a foot. This will rule out an output like **'a(su@gal)* 'sugar', because it violates the alignment constraint. The constraint is surface unviolated, placing it with FOOT FORM in the top block of constraints. The tableau in (28) shows how this ranking rejects the output *[a(su@gal)] , 'sugar' because it fails to satisfy ALIGNPROSODICWORD.

(28) Evaluation of /'asugal/ 'sugar'

/'asugal/	FT FM	ALIGNPW	FTBIN	PARSE
pa.(['a@su)gal]				*
b. ['a(su@gal])		*!		*
c. ['asu(ga$l])		*!	*	**

All three candidates satisfy FOOTFORM, since the feet are trochaic. Only (28a) satisfies ALIGNPROSODICWORD. The high ranking of this constraint means that (28a) is optimal. The lower ranked FOOTBINARITY is irrelevant, so the success of (28a,b) and failure of (28c) at this point is moot. Finally, PARSE–σ is even lower on the hierarchy, and so also plays no role in selecting the optimal output.

At this point, it is prudent to consider monosyllables. The ranking of FOOTBINARITY dominating PARSE argues against degenerate feet. However, monosyllabic content words do appear in Tohono O'odham. These forms do emerge as stressed output, with the incorporation of the alignment constraint, ALIGNPROSODICWORD. In the tableau in (29), a monosyllabic input is considered. The optimal output is stressed, in (29a):

(29) Evaluation of /ton)/ 'ant'

/ton)/ 'ant'	FT FM	ALIGNPW	FT BIN	PARSE
pa.([to@n)])			*	
b. [ton)]		*!		*

The competition is between stressing a monosyllabic input or not stressing such an input. The stressed form best satisfies the highly ranked ALIGNPROSODICWORD constraint, so monosyllabic forms do surface with stresses, despite the fact that they constitute degenerate feet.[33]

The final monomorphemic candidate to be considered is a quadrisyllabic form, which is stressed on the first and third syllables. This optimal output is predicted by the hierarchy and constraint rankings above. In (30), the input *pako'ola* 'Pascola dancer', is evaluated; the correct output surfaces as (30a).

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[33]This constraint hierarchy predicts that monosyllabic content words of the shape CV should exist; they do not. This can be treated in several ways. For example, CV inputs could be analyzed for words that surface as CV:. This augmentation might be expected to disappear under affixation. Or it might be that augmentation is kept under affixation to preserve phonological identity with the unaffixed form. There is no evidence for either approach. Here I assume that there are simply no content words with inputs in the shape CV.

(30) Evaluation of /pako'ola/ 'Pascola dancer'

/pako'ola/ 'Pascola dancer'	FT FM	ALIGNPW	FT BIN	PARSE
pa.([pa@ko)('o$la])				
b. ([pa@ko)'ola]				**!
c. ([pa@ko)('o$)la]			*!	*
d.([pa@ko)('ola$])	*!			
e. [pa(ko@'o)(la$])		*!	*	*
f. [pa(ko@'o)la]		*!		**

To demonstrate the rankings a bit more fully, a number of ungrammatical outputs are considered. Three candidates are excluded because they violate one of the top block of constraints. (30d) violates FOOTFORM, as the second foot is iambic. Both (30e) and (30f) violate ALIGNPROSODICWORD, as they do not begin with feet. FOOTBINARITY rules out (30c), leaving only two candidates that satisfy the constraint rankings to that point. Of these two candidates, only (30a) satisfies the entire hierarchy. (30b) incurs two violations of PARSE-σ, and so is a worse candidate than (30a). With the hierarchy currently in place, all of the monomorphemic forms surface with correct outputs.

2.3.1.2 Summary of the Analysis

In this section, monomorphemic stress patterns were analyzed for the attested shapes of such forms. Four constraints were motivated on the basis of the monomorphemic data. Left-headed feet are ensured by FOOTFORM. This constraint is surface-true, and falls in the top block. A second constraint falls in this block, ALIGNPROSODICWORD. This constraint ensures that all prosodic words begin with a foot, and must dominate PARSE-σ.

Two additional constraints were needed: FOOTBINARITY and PARSE-σ. FOOTBINARITY is surface-violated, and appears in a block below the top set of constraints; it also dominates PARSE-σ, thus preventing final degenerate feet in trisyllables. PARSE-σ is at the bottom of the constraint hierarchy argued for in this section. The following constraint ranking has been motivated thus far: FOOTFORM, ALIGNPROSODICWORD È FOOTBINARITY È PARSE−σ. With these constraints, the stress patterns for monomorphemic forms are correctly predicted.

2.3.2 The Analysis of Polymorphemic Forms

In this section, the polymorphemic stress patterns are analyzed. Polymorphemic forms allow final stressed syllables. The current hierarchy fails to account for the presence of final stress in polymorphemic forms. First, the inadequacy of the current constraint ranking is established. Following this, a constraint is proposed to generate final odd syllables in polymorphemic forms. This constraint, the MORPHEME-TO-STRESS PRINCIPLE forces every morpheme to surface with at least one stress. I show how this constraint applies to the various morphophonological shapes. The first set of words that are accounted for are prefixed words. Seven prefixed forms are accounted for, so that forms of each possible size, both with and without syncope, are analyzed. Following this, I demonstrate that forms with one suffix are also accounted for by the MORPHEME-TO-STRESS PRINCIPLE. Finally, I show that the stress pattern of words with multiple affixes and reduplication also follows under this analysis.

The MORPHEME-TO-STRESS PRINCIPLE dominates the prosodic constraints, FOOTFORM and PARSE-σ. In turn, it is dominated by two constraints. The first of these, *CLASH, excludes two adjacent stressed syllables. This constraint is unviolated in the language. The second constraint, *LAPSE, bans lapses of two unstressed syllables before a stressed syllable. The MORPHEME-TO-STRESS PRINCIPLE, plus these two constraints, accounts for all of the polymorphemic data described in this chapter.

2.3.2.1 The Failure of the Current Hierarchy

The first step in the analysis is to establish the failure of the current hierarchy. This is done rather simply, in the tableau below. Two outputs are evaluated for a polymorphemic trisyllable. The competing candidates are the attested output, (31a) and the ungrammatical (31b). Under the constraints in (31), the ungrammatical output is incorrectly predicted to surface as optimal, while the actual output (31a) is considered nonoptimal.

(31) Evaluation of /RED-paùdo/ 'pl-duck'

/RED-paùdo/ 'pl-duck'	FT FM	ALIGN PW	FT BIN	PARSE
a.([pa@][pa)(do$])			*!	
kb. ([pa@][pa)do]				*

Candidate (31b) is incorrectly selected as optimal because it only violates the lowest-ranked constraint, PARSE-σ. (31b) has only an initial stress, which is the pattern found in monomorphemic trisyllables. However, a form consisting of a prefix plus a base surfaces with final stress if the form is trisyllabic. In fact, all polymorphemic trisyllables surface with final stress. The output with this pattern, (31a), is discarded because of a violation of the higher-ranked FOOT BINARITY. A constraint must outrank FOOT BINARITY to force a foot on the suffix.

Observe that the two morphemes in (31) each receive a stress. Furthermore, the constraint that applies to prefixed words like (31) must also apply to all other polymorphemic words; final stresses are also allowed in a word such as *pa@ùdo-ga$* 'owning a duck', where the base and suffix each receive a stress. The patterns of stress in these words argues in favor of a constraint that requires all morphemes to be stressed. However, it cannot be that all prefixes and suffixes get stressed; witness the stress patterns of words like or *hi@-him-a$d* 'will be walking' or *'a@suga$l-mad* 'adding sugar'. Rather, the generalization is that all morphemes must get stressed, but that the satisfaction of this constraint cannot override the basic rhythmic constraints, thus producing alternating stress.

2.3.2.2 The Analysis of Prefixed Forms

In this section, I outline the specific proposed constraint, the MORPHEME-TO-STRESS PRINCIPLE. Here I show how this constraint operates with regard to prefixed words. While accounting for all prefixed words, I also motivate a constraint against stress clash, *CLASH. *CLASH dominates the MORPHEME-TO-STRESS PRINCIPLE, thus preventing words where all morphemes are stressed in way that produces adjacent stresses.

First let us turn to the formulation of the MORPHEME-TO-STRESS PRINCIPLE. The proposal is that each morpheme must be stressed. Needless to say, as all morphemes do not actually surface as stressed, this constraint may be (and in fact, is) surface violated. The MORPHEME-TO-STRESS PRINCIPLE must dominate FOOTBINARITY, so that morphemes will be stressed even if that results in degenerate feet. A higher ranking of FOOTBINARITY would negate the effect of the MORPHEME-TO-STRESS PRINCIPLE. The proposed constraint is formalized in (32).[34]

(32) The MORPHEME-TO-STRESS PRINCIPLE (abbreviated: MSP)

For every morpheme, there exists some stressed syllable that falls in the

domain of that morpheme.

(∀ MORPHEMES ∃ STRESSED SYLLABLE such that the STRESSED SYLLABLE falls within the domain of that MORPHEME).

The MORPHEME-TO-STRESS PRINCIPLE is a domain bounded constraint, where something holds within a given domain, as opposed to the edges of this domain. Parallel cases of domain-bounded phonological processes are noted in the literature on the Prosodic Hierarchy (see especially Hayes

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[34]This constraint is also argued for in Fitzgerald (To appear a).

1989b). For example, Hayes (1989b) notes that there are cases of prosodic phenomena that are bounded by a particular domain, such as Chi:mwini phrasal lengthening.

Returning to the subject of constraint ranking, if we rank the MORPHEME-TO-STRESS PRINCIPLE above FOOTBINARITY in the hierarchy, the nonoptimal pattern of (33b) is ruled out. Instead, the optimal output, with final stress, is correctly chosen. A third candidate, (33c) is also represented below. This form has the correct stress contour, but is footed in such a way that the first foot is degenerate, and the second foot is iambic. Such a candidate is shown to be excluded by its failure on FOOTFORM. This reevaluation is given in (33).

(33) Evaluation of /RED-paùdo/ 'pl-duck'

/RED-paùdo/ 'pl-duck'	FTFM	ALIGNPW	MSP	FTBIN	PARSE
pa.([pa@][pa)(do$])				*	
b. ([pa@][pa)do]			*!		*
c. ([pa@])([pado$])	*!			*	

The output in (33a) violates FOOTBINARITY, while the output in (33b) violates the MORPHEME-TO-STRESS PRINCIPLE. Because FOOTBINARITY is the lower-ranked constraint, satisfaction of the MORPHEME-TO-STRESS PRINCIPLE means that (33a) is the optimal candidate. The ranking of the MORPHEME-TO-STRESS PRINCIPLE falls below the other constraints, but above FOOTBINARITY, showing that FOOTBINARITY must be dominated by the MORPHEME-TO-STRESS PRINCIPLE. If the rankings were reversed between the two, we would expect (33b) to be the optimal output. Tableau (33) serves to establish the ranking between the two constraints. There are two other candidates that do not appear in (33). One of these is a form like **pa@pa$do*, 'ducks', with two adjacent stresses. This form does not appear; stress clash is not permitted in Tohono O'odham words.[35]

In (34), this candidate appears in the tableau. Given the rankings argued for thus far, candidate (34b) ties with the attested output (34a). Both candidates incur one violation on the same constraint, FOOTBINARITY.

[35]More evidence for this appears in Fitzgerald (1996c, 1997).

(34) Evaluation of /RED-paùdo/ 'ducks

/RED-paùdo/ 'ducks	FTFM	ALIGNPW	MSP	FTBIN	PARSE
pa.([pa@][pa)(do$])				*	
kb. ([pa@])([pa$do])				*	

There is nothing ruling out the candidate with the unattested surface contour in (32b), **(pa@)-(pa$do)*. However, candidates with two adjacent stresses violate a constraint that prohibits such stress clash. Constraints against stress clash have been argued for especially in the context of rhythm rules and destressing (see especially Hayes 1984, Hammond 1988, and Kager 1989). A constraint banning stress clash, *CLASH, has also been invoked in more recent work, for example, Kager (1994), Green and Kenstowicz (1995) and Kenstowicz (1995). The constraint invoked here appears in (35):

(35) *CLASH

Adjacent stresses are not permitted.

The constraint appears in the unranked top block of constraints, as it is surface unviolated.[36] In the tableau below, the tied candidates are reevalauted, with *CLASH incorporated into the top block of constraints in (36).

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[36]*CLASH is also necessary elsewhere in the system to prevent stress clash in words in context (Fitzgerald 1996c, 1997).

(36) Evaluation of /RED-paùdo/ 'pl-duck'

//RED-paùdo/ 'pl-duck'	FTFM	*CLASH	ALIGNPW	MSP	FTBIN	PARSE
pa.([pa@][pa)(do$])					*	
b. ([pa@])([pa$do])		*!			*	

Both candidates possess degenerate feet, and so each output violates FOOTBINARITY. They are distinguished by the higher-ranked *CLASH constraint, which rules out (36b). The rejection of this output in no way changes the predictions made by the hierarchy above, as none of the monomorphemic outputs surface with adjacent stresses. We shall also see below that this constraint prevents a number of unattested patterns from surfacing.

With the MORPHEME-TO-STRESS PRINCIPLE and *CLASH in the hierarchy, we should consider the range of morphological possibilities for inputs to be assured that these constraints predicts the full range of patterns for polymorphemic words. In this section, prefixed inputs are evaluated. These inputs include only the reduplicant and the base; the outputs include both forms with and without syncope in the base. Six forms in total are evaluated.

(37) Reduplicated forms evaluated in this section

a. pa@-pado$ 'ducks (Sp'

b. hi@-him 'walking, plural'

c ko@ù-ks` 'sleeping, plural'

d. c&i@-c&pkan 'working, plural'

e. mu@-msigo$ 'musicians (Sp)'

f. pa@-pko'o$la 'Pascola dancers (Sp)'

The first input to be considered is monosyllabic. Two possible outputs may appear, depending on whether the environment for syncope is met. First we evaluate a monosyllabic form without syncope, the output *hi@-him* 'walking, plural'. While this disyllabic form has exactly two morphemes, it does not receive exactly two stresses. Rather, *CLASH prevents each morpheme from surfacing with a stress and the word surfaces as a canonical syllabic trochee, in (38a).

(38) Evaluation of /RED-him/ 'pl-walking'

/RED-him/ 'pl-walking'	FTFM	*CLASH	ALIGNPW	MSP	FTBIN	PARSE
pa.([hi@][him])				*		
b. ([hi@])([hi$m])		*!			*	

Candidate (38a) violates only the MORPHEME-TO-STRESS PRINCIPLE by failing to stress the base morpheme. This violation is sufficiently low enough that it does not prevent (38a) from emerging as the optimal candidate, as (38b) violates the higher-ranked *CLASH. The violation incurred on FOOTBINARITY by (38b) is irrelevant, again since it falls below the fatal violation.

For the second monosyllabic input, syncope applies to the base vowel so that the output is also monosyllabic. This pattern is exemplified by *ko@ù-ks1* 'sleeping, plural'. Because there is only one vowel in this form, there is only one possible stress-bearing element. However, the form does allow us to compare an output with stress (39a) with one without stress (39b). A third candidate appears, one that is footed but not stressed, (39c).[37]

(39) Evaluation of /RED-koùs`/ 'pl-sleeping'

/RED-koùs`/ 'pl-sleeping'	FTFM	*CLASH	ALIGNPW	MSP	FTBIN	PARSE
pa.([ko@ù][ks`])				*	*	
b. [koù][ks`]			*!	**		*

[37]Base vowel syncope often occurs under reduplication (see Hill and Zepeda 1992 for more on this phenomenon).

c.([koù][ks`])	*!			**	*	

(39a) satisfies the alignment constraint, while the top block of constraints eliminates (39b), which fails on ALIGNPROSODICWORD by virtue of an absent initial foot. (39c) is excluded by FOOTFORM, as the foot has no head. The reduplicant is overtly stressed in (39a), while the base morpheme is not directly stressed and in fact, has no stress-bearing elements within its domain. The resulting violation of the MORPHEME-TO-STRESS PRINCIPLE is sufficiently low for (39a) to still be the optimal candidate.

The next set of forms to be evaluated are disyllabic inputs. A form with syncope still needs to be analyzed. Such a form is *c&i@-c&pkan* 'working, plural', appearing below in (40).

(40) Evaluation of /RED-c&ipkan/ 'pl-working'

/RED-c&ipkan/ 'pl-working'	FTFM	*CLASH	ALIGNPW	MSP	FTBIN	PARSE
pa.([c&i@][c&pkan])				*		
b. ([c&i@][c&p)(ka$n])		*!			*	

In the above tableau, the candidates differ as to whether the word is parsed as one foot (40a) or two (40b). Parsing into two feet produces a word with stress clash (40b), which means that (40a) is optimal by better satisfying the top constraints. Two morphemes, but only one stressed syllable in the output, means that (40a) violates the MORPHEME-TO-STRESS PRINCIPLE, although the violation does not threaten the optimality of this candidate. Likewise, (40b) violates FOOTBINARITY, but the violation is too low to be relevant in the constraint evaluation.

Now let us move to trisyllabic inputs. All trisyllabic outputs show syncope[38], so only one possible output (with syncope) results from a trisyllabic input. This form is exemplified by *mu@-msigo$* 'musicians (Sp)', evaluated in the tableau below.

[38]However, note that there are not many trisyllabic monomorphemic words, and only a subset reduplicate.

(41) Evaluation of /RED-musigo/ 'musicians (Sp)'

/RED-musigo/ 'musicians (Sp)'	FtFm	*Clash	AlignPW	MSP	FtBin	Parse
pa.([mu@][msi)(go$])					*	
b.([mu@][msi)go]				*!		*
c. ([mu@][m)(si$go])		*!			*	
d. ([mu@][m)(sigo$])	*!				*	

Four possible outputs appear in (41). The first output, (41a), stresses the first and third syllables at the expense of one violation on FOOT BINARITY. The MORPHEME-TO-STRESS PRINCIPLE excludes (41b), which does not stress either vowel of the base morpheme. *CLASH rules out (41c), which stresses the first and second syllables. Finally, the stress contour of (41d) is identical to (41a), with the first and third syllables stressed; however, this form is footed differently, and the second foot incurs a fatal violation of FOOT FORM. The violation of FOOT BINARITY is low enough on the constraint hierarchy that it does not prevent (41a) from being the optimal output.

The final reduplicated form to be evaluated is the quadrisyllable. This form, *pa@-pko'o$la* 'Pascola dancers (Sp)', allows syncope in the base morpheme under reduplication. The form surfaces with the first and third syllables stressed, a pattern that is identical to monomorphemic quadrisyllables. The evaluation of such a form shows that this hierarchy does produce the normal alternating stress pattern even with the incorporation of the MORPHEME-TO-STRESS PRINCIPLE.

(42) Evaluation of /RED-pako'ola/ 'Pascola dancers (Sp)'

/RED-pako'ola/ 'Pascola dancers (Sp)'	FtFm	*Clash	AlignPW	MSP	FtBin	Parse

pa.([pa@][pko)('o$la])						
b. ([pa@][pko)'ola]				*!		**
c.([pa@][p)(ko$'o)(la$])		*!			**	

The set of possible candidate analyses in (42) makes (42a) a more plausible form than the others, and this is borne out by the absence of any violations for this candidate. In contrast, (42b) violates both the MORPHEME-TO-STRESS PRINCIPLE and PARSE–σ by failing to exhaustively foot syllables. The violation on the former constraint proves fatal for (42b). Finally, (42c) stresses the first, second and fourth syllables; the violation of *CLASH by this output excludes it from the competition. The optimal candidate, (42a), thus replicates the stress pattern of polymorphemic forms, rather than producing a different stress pattern under the influence of the MORPHEME-TO-STRESS PRINCIPLE.

To summarize, the set of prefixed forms evaluated in this section give strong motivation for the MORPHEME-TO-STRESS PRINCIPLE. The most convincing argument for this constraint comes from the first form, *pa@-pado$* 'ducks (Sp)', where the morphological bracketing does not predict the phonological footing. The constraint, *CLASH, has also been motivated in this section. In the sections to follow, both constraints play a critical role in predicting the surface pattern of Tohono O'odham complex words.

2.3.2.3 The Analysis of Words with One Suffix

In this section, the simplest set of suffixed words are evaluated, those words composed only of a base and a single suffix. These words provide further evidence for the constraint hierarchy motivated above, as well as for an additional constraint banning lapses (two unstressed syllables). Five forms are evaluated in this section, with the base size covering the range from one to four syllables. Two trisyllabic bases are evaluated. These forms are all listed in (43).

(43) Words evaluated in this section

a. hi@m-ad 'will be walking

b. pa@ùdo-ga 'owning a duck (Sp)'

c. 'a@suga$l-mad 'adding sugar (Sp)'

d. 'a@suga$l-t 'to make sugar (Sp)'

e. pi@mia$ndo-ma$d 'adding pepper (Sp)'

First on the list of output types to consider is a suffixed monosyllabic base, resulting in a disyllabic output. A form like *hi@m-ad* 'will be walking' exemplifies this type. In (44), the constraint ranking generates this output. The hierarchy motivated by the prefixed words is used here.

(44) Evaluation of /him-ad/ 'will be walking'

/him-ad/ 'will be walking'	FTFM	*CLASH	ALIGNPW	MSP	FTBIN	PARSE
pa.([hi@m][ad])				*		
b. ([hi@m])([a$d])		*!			**	
c. ([him][a$d])	*!					

Three forms are evaluated, one with stress on the first syllable (44a), one with stress on both syllables (44b), and one with stress on the second syllable (44c). Candidates (44b) and (44c) both violate constraints in the top block. A *CLASH violation suffices to rule out (44b), while the iambic footing in (44c) disqualifies it with respect to FOOTFORM. (44a) is optimal, despite its violation of the MORPHEME-TO-STRESS PRINCIPLE, because of its satisfaction of the higher ranked constraints that the other candidates fail.

A disyllabic base plus a suffix is evaluated in the same way as the suffixed monosyllabic base. Tableau (45) demonstrates this, comparing the trisyllabic output with final stress (45a) with the candidate without final stress (45b). The addition of the MORPHEME-TO-STRESS PRINCIPLE correctly predicts (45a) as optimal.

(45) Evaluation of /paùdo-ga/ 'owning a duck'

/paùdo-ga/ 'owning a duck'	FTFM	*CLASH	ALIGNPW	MSP	FTBIN	PARSE
pa.([pa@ùdo])([ga$])					*	
b. ([pa@ùdo])[ga]				*!		*

Both candidates satisfy the top block of constraints, so the decision is made by the lower ranked MORPHEME-TO-STRESS PRINCIPLE, which (45b) violates. Since (45a) satisfies this constraint, it is the optimal output under the hierarchy. The FOOT BINARITY violation is too low to be counted against (45a).

The third form to be evaluated consists of a trisyllabic base plus a suffix. Such a case generates a form like *'a@suga$l-mad* 'adding sugar'. The suffix gets footed, but is not stressed. Unlike the previous case, *pa@ùdo-ga$* 'owning a duck', the two morphemes do each get a single stress. Instead, here the suffix shares a foot with the final syllable of the base, seen in the attested output (46a). Unfortunately, the hierarchy incorrectly selects a nonoptimal candidate, (46d), as optimal.

(46) Evaluation of /'asugal-mad/ 'adding sugar'

/'asugal-mad/ 'adding sugar'	FT FM	*CLASH	ALIGN PW	MSP	FT BIN	PARSE
a.(['a@su)(g a$l][mad])				*!		
b.(['a@su)(ga$l])([ma$d])		*!			**	
c.(['a@su)(gal][ma$d])	*!					
kd.(['a@su)gal]([ma$d])					*	*

Two candidates, (46b) and (46c) fail on constraints from the top block. This winnows the competition down to (46a) and (46d). Since both candidates succeed in the top block, the next highest ranked constraint passes judgment on the candidates. The MORPHEME-TO-STRESS PRINCIPLE throws out the attested form, (46a) with one violation. In contrast, (46d) satisfies this constraint and is incorrectly predicted as the optimal output. The additional violations on FOOTBINARITY and PARSE−σ are sufficiently low on the hierarchy to be of no consequence. The problem then is that the hierarchy cannot predict the correct output for a trisyllabic base with a monosyllabic suffix.

How do we eliminate (46d) and correctly predict (46a) as the optimal candidate? From the tableau above, we see that some constraint must dominate the MORPHEME-TO-STRESS PRINCIPLE in such a way as to exclude (46d). The crucial problem with (46d) stems from a 'lapse' of two unstressed syllables before a stressed syllable. The key to this problem is the second of these two weak syllables, which is unfooted. Recent work in Optimality Theory has argued for constraints against lapses, for example, Kager (1994) and Green and Kenstowicz (1995). *LAPSE has been invoked for a variety of languages.[39]

The constraint in (47) is adopted:

(47) *LAPSE *W(

Avoid an unfooted syllable (WEAK) followed by a footed syllable.[40]

*LAPSE must dominate the MORPHEME-TO-STRESS PRINCIPLE to prevent first and fourth syllable stress as in (46). As *LAPSE is not surface true (evidence comes from the stress pattern of words with odd epenthesis, presented in the next chapter), it is not in the top ranked block of constraints, but rather below them. The ranking is argued for by the reevaluation in (48) below.[41]

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[39] A second possibility is to reconsider the ranking between the MSP and FOOTBINARITY, so that the two tie and violations are considered in sum. This does not eliminate the (a) candidate. The disadvantage of this approach (argued for in Fitzgerald To appear a) is in its introduction of rather powerful machinery to the theory. In contrast, the *LAPSE approach is simpler, as lapses have been argued against elsewhere in the literature. *LAPSE is thus preferable to introducing tied constraints.

[40] Green and Kenstowicz (1995) adopt a slightly different version, where two unstressed syllables violate the constraint, unless there is a foot separating the two. This will not work for Tohono O'odham. Furthermore, a constraint that simply bans two unstressed syllables fails, as it would predict final stress in monomorphemic trisyllables.

[41] The top block of constraints all appear in a single column to conserve space.

(48) Evaluation of /'asugal-mad/ 'adding sugar'

/'asugal-mad/ 'adding sugar'	FT FM *CLASH ALIGN PW	*LAPSE	MSP	FTBIN	PARSE
pa.(['a@su)(ga$l][mad])			*		
b.(['a@su)gal]([ma$d])		*!		*	*

The tableau shows the two main competitors for such an input, with first and third stress (48a) and first and fourth stress (48b). *LAPSE excludes (48d), so that the satisfaction of this constraint by (48a) means that the correct optimal candidate is now selected. The violation on the MORPHEME-TO-STRESS PRINCIPLE is irrelevant in (48), as the higher ranked *LAPSE prevents lower ranked constraints from playing an active role.

One potential problem might occur if *LAPSE were to force final stress in monomorphemic words. To demonstrate that this does not occur, a monomorphemic trisyllable is evaluated below:

(49) Evaluation of /musigo/ 'musician (Sp)'

/musigo/ 'musician (Sp)'	FT FM *CLASH ALIGN PW	*LAPSE	MSP	FTBIN	PARSE
pa.([mu@si)go]					*
b.([mu@si)(go$])				*!	

Neither *LAPSE nor the MORPHEME-TO-STRESS PRINCIPLE change the evaluation for such cases. Since *LAPSE ignores all unfooted syllables, unless followed by subsequent footed syllables, it is unviolated by (49a). Also, the input is monomorphemic; the presence of a single stress in the word is enough to satisfy the MORPHEME-TO-STRESS PRINCIPLE, so nothing forces the degenerate foot in the nonoptimal (49b). *LAPSE only applies when the two unstressed syllables come before a stress, not when the order is reversed and the two unstressed syllables follow a stress. Therefore, the evaluation of monomorphemic trisyllables is unchanged, and (49a) continues to be the optimal candidate.

An additional ramification of this formulation of *LAPSE is that it also does the work of ALIGNPROSODICWORD. This can be seen in the following tableau, where the *pa@-pko'o$la* 'Pascola dancers (Sp)'. With * LAPSE banning unfooted syllables that are followed by footing, the same candidates are discarded, even without ALIGNPROSODICWORD in the hierarchy.

(50) Evaluation of /RED-pako'ola/ 'Pascola dancers (Sp)'

/RED-pako'ola/ 'Pascola dancers (Sp)'	FTFM *CLASH	*LAPSE	MSP	FTBIN	PARSE
pa.([pa@][pko)('o$la])					
b. ([pa@][pko)'ola]			*!		**
c. ([pa@][pko)('o$)la]				*!	*
d.([pa@][pko)('ola$])	*!				
e. [pa][p(ko@'o)(la$])		*!	*	*	*
f. [pa][p(ko@'o)la]		*!	*		**

The alignment constraint is completely unnecessary with *LAPSE. FOOTFORM eliminates (50d) from competition. The remaining candidates are weeded out by *LAPSE (50e,f), the MORPHEME-TO-STRESS PRINCIPLE (50b), and FOOTBINARITY (50c). Only (50a) satisfies all constraints in the hierarchy. This eliminates one task performed by ALIGNPROSODICWORD. The other task performed by the alignment constraint was to stress the word under prosodic rooting (Hammond 1984). This task is accomplished by the MORPHEME-TO-STRESS PRINCIPLE, which stresses every morpheme in a word. The duplication of effort, and efficiency of the *LAPSE constraint and the MORPHEME-TO-STRESS PRINCIPLE, argues for the elimination of ALIGNPROSODICWORD.

Before turning to a suffixed quadrisyllabic base, let us consider one more trisyllabic base. We have not yet considered a form with the consonantal suffix, *-t* 'causative'. This form produces a final stress when it is suffixed to a monomorphemic trisyllable. However, under the formalization of the MORPHEME-TO-STRESS PRINCIPLE, the stressed final syllable does not fall within the domain of the consonantal morpheme. This makes the incorrect predictions below.

(51) Evaluation of /'asugal-t/ 'sugar-causative (Sp)'

/'asugal-t/ 'sugar-causative (Sp)'	FTFM *CLASH	*LAPSE	MSP	FTBIN	PARSE
a.(['a@su)(ga$l][t])			*	*!	
kb.(['a@su)gal][t]			*		*

Under the MORPHEME-TO-STRESS PRINCIPLE, a stressed syllable must fall in the domain of that morpheme. As *-t* is not stressed, nor is there a stressed syllable within its domain, the form in (51a) must violate this constraint. This predicts, wrongly, that the optimal candidate would be the form without final stress. However, the *-t* could not bear stress – consonants are not stress-bearing elements in Tohono O'odham. Furthermore, *-t* does appear in a stressed syllable – indeed, in the rhyme of a stressed syllable. How can we formally associate the final stress in *'a@suga$l*-t 'adding sugar' with the *-t*?

The answer to this lies in the Percolation Convention, which Archangeli (1988) proposes for extrametricality of a terminal rhyme element. She argues that extrametricality is assigned to an element of the rhyme, the extrametricality percolates so that the entire rhyme (but not syllable) dominating the terminal element becomes extrametrical. The Percolation Convention can be used to apply to Tohono O'odham as well, although with some revision. Rather than formally refer to the rhyme, we can refer to the mora. If a mora dominates a stressed element, the stress percolates up to the syllable. Onsets are assumed to not be dominated by moras, so that we get an effect for the rhyme. We can revise the MORPHEME-TO-STRESS PRINCIPLE to refer to moraic material; thus while -*t* is not stressed on the surface, it does represent a stressed mora. By the Percolation Convention, this stressed consonant appears on the surface as a stressed syllable with the vowel manifesting the stress. The MORPHEME-TO-STRESS PRINCIPLE appears revised as:

(52) The MORPHEME-TO-STRESS PRINCIPLE (revised)

For every morpheme, there exists some stressed mora that falls in the domain of that morpheme.

With these revisions, let us revisit and reevaluate *'a@suga$l-t* 'to make sugar (Sp)' in (53).

(53) Evaluation of /'asugal-t/ 'sugar-causative (Sp)'

/'asugal-t/ 'sugar-causative (Sp)'	FtFm *Clash	*Lapse	MSP	FtBin	Parse
pa.(['a@su)(ga$l][t])				*	
b.(['a@su)gal][t]			*!		*

The decisive role in (53) is played by the MORPHEME-TO-STRESS PRINCIPLE, which selects (53a) over (53b). The consonantal suffix is included in a stressed syllable; since the suffix has no stress-bearing element, it must be grouped in a stressed syllable to count as stressed. This is the case in (53a), where the suffix groups with the final syllable, which is stressed. In (53b), the grouping is identical, but the syllable is unstressed, triggering a fatal violation of the MORPHEME-TO-STRESS PRINCIPLE. The stress percolates from the suffix to the entire syllable; this pattern is not expected for a consonantal prefix, which is not a terminal moraic element.

The final form to be considered in this section is a suffixed quadrisyllable. Such a form stresses the first, third and fifth syllables, as in *pi@mia$ndo-ma$d* 'adding pepper (Sp)'. The final stress on this form is easily predicted by the constraint hierarchy, as demonstrated in (54):

(54) Evaluation of /pimiando-mad/ 'pepper-adding (Sp)'

/pimiando-mad/ 'pepper-adding (Sp)'	FTFM *CLASH	*LAPSE	MSP	FTBIN	PARSE
pa.([pi@mi)(a$ndo])([ma$d])				*	
b.([p@imi)(a$ndo])[mad]			*!		*
c. ([pi@mi)an(do$][mad])			*!		*

Three candidates appear above, the first with the attested surface pattern, stressing all odd syllables. The other two forms avoid the degenerate foot by stressing only the first and third syllables (54b) or only the first and fourth syllables (54c). The MORPHEME-TO-STRESS PRINCIPLE rules out both these forms, as neither (54b) nor (54c) stresses the suffix. Only (54a) passes this constraint, and so it is the optimal candidate.

A quick summary of this section will be helpful before we turn to the final set of complex forms, those with multiple affixes. Here singly-suffixed bases, ranging from one to four syllables, demonstrated the efficacy of the constraint hierarchy. One modification was needed. A constraint, *LAPSE, was introduced to prevent an unfooted, weak syllable from preceding a foot. The introduction of this constraint was shown to have no effect on other forms previously accounted for, mainly monomorphemic trisyllables.

2.3.2.4 The Analysis of Words with Multiple Affixes

In this section, words with more than one affix are considered. First, two bases, each with two suffixes, are evaluated. The bases are monosyllabic and disyllabic, as larger bases do not appear with more than a single suffix. The disyllabic form is also analyzed in its reduplicated form. Four additional bases are evaluated, each with a reduplicant and a single suffix. The final set of forms are a reduplicated and nonreduplicated disyllabic base with three suffixes. In all, nine forms are considered in this evaluation, leading to the conclusion that the constraint hierarchy predicts the surface stress pattern for all morphological shapes.

The first set of words to be considered are those with two suffixes. For these words, only a monosyllabic and disyllabic base are attested, with only the disyllabic form attested with reduplication. A monosyllabic base with two suffixes stresses the first and third syllables, just like other complex trisyllables.

(55) Evaluation of /paùn-c&ud-dam/ 'bread-causative-agent (Sp)'

/paùn-c&ud-d`am/ 'bread-causative-agent (Sp)'	FTFM *CLASH	*LAPSE	MSP	FTBIN	PARSE
pa. ([pa@ùn][c&ud])([da$m])			*	*	
b.([pa@ùn][c&ud])[dam]			**!		*
c. ([pa@ùn])([c&u$d])([da$m])	*!			***	

The candidates surface with one (55b), two (55a) and three stresses (55c). The optimal candidate, (55a) incurs one violation each on the MORPHEME-TO-STRESS PRINCIPLE and FOOTBINARITY. The other candidates fare worse; (55b) is excluded because it has two violations on the MORPHEME-TO-STRESS PRINCIPLE. The two suffixes are both unstressed, causing two violations on this constraint. (55c) violates *CLASH in the top block by surfacing with adjacent stresses.

A disyllabic base with two suffixes produces similar results, with the first and third syllables stressed. In (56), the tableau shows that such an output is preferred over the other candidates, especially an output where all morphemes are stressed (56c). The constraint hierarchy continues to predict precisely those outputs that are attested.

(56) Evaluation of /haiwan)-ga-kam/ 'cow-owning-agent'

/haiwan)-ga-kam/ 'cow-owning-agent'	FtFm *Clash	*Lapse	MSP	FtBin	Parse
☞a.([ha@iwan)])([ga$][kam])			*		
b.([ha@iwan)])[ga][kam])			**!		**
c.([ha@iwan)])([ga$])([ka$m])	*!				
d. ([ha@iwan)])[ga]([ka$m])		*!	*	*	*

The optimal candidate, (56a), satisfies the two top blocks of constraints. Two nonoptimal candidates do not. (56c), with its adjacent stresses, violates *Clash. The candidate in (56d) has an unfooted syllable preceding the final foot, and so violates *Lapse. The competition between (56a) and (56b) is settled by the Morpheme-to-Stress Principle, which renders fatal the second violation incurred by (56b). For the two suffixes, at least one must be stressed to best-satisfy the Morpheme-to-Stress Principle, and the penultimate syllable must be stressed to prevent a violation of *Lapse.

When this form is reduplicated, evaluation proceeds much as it did above. The optimal output again stresses all syllables; satisfaction of the rhythm constraints outweighs satisfaction of the Morpheme-to-Stress Principle. The candidate analyses appear below:

(57) Evaluation of /RED-haiwan)-ga-kam/ 'pl-cow-owning-agent'

/RED-haiwan)-ga-kam/ 'pl-cow-owning-agent'	FtFm *Clash	*Lapse	MSP	FtBin	Parse
pa.([ha@][hai)(wa$n)][ga][)(ka$m])			*	*	
b.([ha$][hai)(wa$n)][ga])[kam]			**!		*
c.([ha$])([ha$iwan)])([ga$][kam])	*!		*	*	
d. ([ha$])([ha$iwan)])([ga$])([ka$m])	*!			***	
e. ([ha$])([haiwa$n)])([ga][ka$m])	**!		*	*	

Constraints in the top block rule out several outputs. *Clash excludes (57c) and (57d), as both contain adjacent stresses. Stressing every morpheme thus proves to be fatal for (57d). FootForm violations are fatal for (57e), which surfaces with two iambic feet. The Morpheme-to-Stress Principle determines that (57a) is optimal, with one violation, compared with the two violations of nonoptimal (57b).

With the set of words with two suffixes covered, let us turn to words with a prefix and a single suffix. Each base size is attested for these type of words. The first form of this type is a reduplicated, suffixed monosyllable, as in *hi@-him-a$d* 'will be walking, plural'. Again, this form surfaces with the first and third syllable stress typical of the complex trisyllabic pattern. As seen in the previous examples, *Clash restricts the application of the Morpheme-to-Stress Principle, shown in (58).

(58) Evaluation of /hi-him-ad/ 'they will be walking'

/hi-him-ad/ 'they will be walking'	FT FM *CLASH	*LAPSE	MSP	FTBIN	PARSE
pa.([hi@][hi)(m][a$d])			*	*	
b.([hi@][hi)m][ad]			**!		*
c. ([hi@])([him][a$d])	*!		*	*	
d. ([hi@])([hi$m][ad])	*!		*	*	
e. ([hi@])([hi$)(m][a$d])	*!			***	

Top-ranked constraints discard (58c-e). (58c) violates FOOT FORM with an iambic foot, and adjacent stresses in (58d-e) provoke fatal violations of *CLASH. The remaining two candidates are distinguished by the MORPHEME-TO-STRESS PRINCIPLE, (58a) with one violation and (58b) with two violations. The candidate with the fewest violations, (58a) is the optimal output. Of particular interest is the candidate in (58e), where each morpheme gets stressed. While this output satisfies the MORPHEME-TO-STRESS PRINCIPLE completely (it incurs no violations), it unfortunately is rejected by a constraint higher on the hierarchy, *CLASH. The MORPHEME-TO-STRESS PRINCIPLE is prevented from overapplying to O'odham morphemes by other constraints above it in the hierarchy.

Disyllabic bases undergo a similar evaluation, with the interaction between *CLASH and the MORPHEME-TO-STRESS PRINCIPLE producing odd syllable stress. A form of this type appears in (59):

(59) Evaluation of /RED-paùdo-ga/ 'pl-duck-owning (Sp)'

/RED-paùdo-ga/ 'pl-duck-owning (Sp)'	FtFm *Clash	*Lapse	MSP	FtBin	Parse
☞a. ([pa@][pa)(do$][ga])			*		
b.([pa@])([pado$])([ga$])	*!			**	
c. ([pa@])([pa$do])([ga$])	*!			**	

The various outputs show that there is no way to satisfy the MORPHEME-TO-STRESS PRINCIPLE completely, without incurring violations on *CLASH. (59b) produces two adjacent stresses between the base and the suffix, while (59c) produces two word-initial adjacent stresses. The locus of the clashing stresses varies according to which syllable of the base is stressed. The optimal candidate, (59a), does violate the MORPHEME-TO-STRESS PRINCIPLE once, but satisfies all the higher ranked constraints.

The third input to consider in this set is a trisyllabic base. The role of the rhythmic constraints, *CLASH and *LAPSE, is critical in the determination of the optimal output, as in (60).

(60) Evaluation of /RED-maùgina-kaj&/ 'pl-car-instrumental (Sp)'

/RED-maùgina-kaj&/ 'pl-car-instrumental (Sp)'	FtFm *Clash	*Lapse	MSP	FtBin	Parse
pa. ([ma@][mgi)(na$][kaj&])			*		
b.([ma@][mgi)na]([ka$j&])		*!	*	*	*
c.([ma@][mgi)(na$])([ka$j&])	*!			**	
d. ([ma@][m)(gi$na])([ka$j&])	*!			**	

The optimal candidate satisfies all constraints down to the MORPHEME-TO-STRESS PRINCIPLE, on which (60a) incurs a single violation. This makes it a better output than (60b), which violates *LAPSE, or both (60c) and (60d), which violate *CLASH.

The final form to consider in this set is the reduplicated, suffixed quadrisyllabic base, evaluated in (61). The form surfaces with five syllables, stressing each odd numbered one, as in the optimal (61a):

(61) Evaluation of /RED-pako'ola-kaj&/ 'like Pascola dancers (Sp)'

/RED-pako'ola-kaj&/ 'like Pascola dancers (Sp)'	FtFm *Clash	*Lapse	MSP	FtBin	Parse
pa. ([pa@][pko)('o$la])([ka$j&])				*	
b.([pa@])([pko$'o)(la$][kaj&])	*!		*	*	
c. ([pa@][pko)('o$la])[kaj&]			*!		*
d. ([pa@][pko)'o(la$][kaj&])		*!	*		*

A *CLASH violation for (61b) is fatal for the output. The two unstressed syllables before the stressed penult in (61d) exclude that candidate from consideration. The competition between (61a) and (61c) is settled by the MORPHEME-TO-STRESS PRINCIPLE, which only the optimal (61a) satisfies. The reduplicated, suffixed bases, including the form in (61), are all accounted for under this hierarchy.

Now let us turn to disyllabic bases with three suffixes. The first of these candidates is the output *ha@iwan)-ga$-kad-ma* 'will seem to be owning a cow' (the second form is its reduplicated counterpart). The form has five syllables and four morphemes. Despite the size and shape of the form, it surfaces with stress on all odd syllables, the pattern which recurs throughout the polymorphemic data in this chapter.

(62) Evaluation of /haiwan)-ga-kad-ma/ 'will seem to be owning a cow'

/haiwan)-ga-kad-ma/ 'will seem to be owning a cow'	FTFM *CLASH	*LAPSE	MSP	FTBIN	PARSE
pa.([ha@iwan)])([ga$][kad])([ma$])			*	*	
b.([ha@iwan)])([ga$])([ka$d])([ma$])	*!			***	
c.([ha@i)(wa$n)][ga])([ka$d][ma])	*!		**	*	
d.([ha@iwan)])[ga]([ka$d][ma])		*!	**		*

If we consider the evaluation of the candidates starting with those that satisfy the top block of constraints, (62b) and (62c) are excluded from consideration. A *LAPSE violation rules out (62d). Output (62a) remains as it satisfies *LAPSE, and its violations occur on lower ranked constraints, allowing the form to surface as the optimal output.

The final candidate set to be considered is the reduplicated version of the form evaluated in (63).

(63) Evaluation of /ha-haiwan)-ga-kad-ma/ 'will seem to be owning cows'

/ha-haiwan)-ga-kad-ma/ 'will seem to be owning cows'	FTFM *CLASH	*LAPSE	MSP	FTBIN	PARSE
pa.([ha@][hai)(wa$n)][ga])([ka$d][ma])			**		
b.([ha@])([ha$iwan)])([ga$][kad])([ma$])	*!		*	**	
c.([ha@])([ha$iwan)])([ga$][kad])[ma]	*!		**	*	*
d.([ha@])([ha$iwan)])([ga$])([ka$d])([ma$])	*!			***	
e. ([ha@][hai)(wa$n)][ga])[kad][ma]			***!		**
f.([ha@][hai)(wa$n)][ga])([ka$d])[ma]			**		*!

Violations on *CLASH exclude (63b-d). This allows lower ranked constraints to play a role. Three violations on the MORPHEME-TO-STRESS PRINCIPLE rules out (56e) from consideration. (63a) incurs two violations on the MORPHEME-TO-STRESS PRINCIPLE, as does (63f). This tie means that the next constraint decides, but both candidates satisfy FOOT BINARITY. The decision is made by the single violation on PARSE by (63f). The optimal candidate is (63a), with no violations on the parse constraint.

The wide variety of candidates considered in this section provided additional support for the three constraints argued for here: the MORPHEME-TO-STRESS PRINCIPLE, *CLASH, and *LAPSE.

2.3.3 Summary of the Analysis of Polymorphemic Words

In this section, I argued that the pattern of stress in polymorphemic odd-numbered words is accounted for by the MORPHEME-TO-STRESS PRINCIPLE. This constraint requires all morphemes to be stressed, although it is surface violated. This surface violation occurs in order to satisfy two rhythmic constraints. The first of these, *CLASH, holds that adjacent stresses are not permitted. It is a constraint that is surface true. The second constraint, *LAPSE, prohibits two weak syllables from preceding a strong one. This constraint may be surface violated, and so is below *CLASH, but it does rank above the MORPHEME-TO-STRESS PRINCIPLE..

2.3.4 Summary of the Analysis

A recapitulation of the main points here will be helpful. First, binary syllabic trochees are left-edge aligned. The constraint *LAPSE accounted for this fact. Second, each morpheme must have a stress by the MORPHEME-TO-STRESS PRINCIPLE. This constraint is surface-violated, as demonstrated above. Optimality Theory nicely captures this violability. Third, the prosodic constraints (*CLASH, *LAPSE, FOOTFORM, FOOT BINARITY, and PARSE-σ) interact with the MORPHEME-TO-STRESS PRINCIPLE to generate stress on odd syllables. *CLASH dominates the MORPHEME-TO-STRESS PRINCIPLE to prevent stress clash that would result if all morphemes were to be stressed. The MORPHEME-TO-STRESS PRINCIPLE is crucially dominated by *LAPSE to prevent first and fourth syllable stress when trisyllabic bases are suffixed with monosyllables.. I argued for the following constraint hierarchy: FOOT FORM, *CLASH È *LAPSE È MORPHEME-TO-STRESS PRINCIPLE È FOOTBINARITY È PARSE-σ.

2.4 Alternative Proposals

In this section, I briefly present four alternative proposals. First I show why a proposal relying on alignment constraints is inadequate. Then I show the shortcomings of a replacing the MORPHEME-TO-STRESS PRINCIPLE with a constraint that requires morphemes to be at least partially footed, rather than stressed. The third alternative is one that suggests that Spanish borrowings reject final stress; I reject this notion on empirical grounds. Finally, I also demonstrate that an analysis that invokes the BASEIDENTITY constraint of Kenstowicz (1995) only incompletely accounts for the facts.

2.4.1 Against the Alignment Alternative

An alternative account of Tohono O'odham stress might well invoke alignment constraints, as in the treatment of Indonesian stress by Cohn and McCarthy (1994). One consequence of this proposal is that it would allow two different types of feet in the metrical system. In Indonesian, the stress foot is trochaic, except in certain words, which surface with trochaic and iambic feet. This "head reversal" solution would also surface if alignment constraints were adopted to analyze Tohono O'odham stress. In this section, I show such an account should be rejected, and why the proposal presented in the previous section is preferred.

Their analysis is quite complex, but a brief review of some of the central facts is helpful. First, monomorphemic words exhibit main stress on the penultimate syllable, an initial secondary stress, and secondary stress on alternating syllables between these two stresses (Cohn 1989, Cohn and McCarthy 1994):

(64) Indonesian Stress, Monomorphemic Words

a.	c‡t	'print'
b.	c‡ri	'search for'
c.	bic‡ra	'speak'
d.	b“jaks‡na	'wise'
e.	k—ntinu‡si	'continuation'
f.	• rod“nam’ka	'aerodynamics'
g.	ˆmerikˆnis‡si	'Americanization'

Morphologically complex words, however, act differently. Prefixed and compound words act similarly, with essentially the same pattern of the word in isolation. These patterns are illustrated in (65-6), with the column labeled 'Unattested' showing how the word would be stressed if it followed the pattern for monomorphemic words.

(65) Indonesian Stress, Prefixed Words

	Attested	**Gloss**	**Unattested**
a.	di-c‡t	'printed'	*d’-cat
b.	di-korŽksi	'corrected'	*d“-korŽksi

(66) Indonesian Stress, Compound Words

	Attested	**Gloss**	**Unattested**
a.	hˆk-h‡k	'rights'	*h‡k-hak
b.	cˆp-p—s	'postmark'	*c‡p-pos
c.	wan’ta-wan’ta	'women'	*wˆnitˆ-wan’ta
d.	b˜m-‡tom	'atom bomb'	*bom-‡tom

Under suffixation, a third pattern emerges. In the words in (67), the primary stress is assigned to the penult, suggesting that all stresses are assigned according to the monomorphemic stress pattern. Secondary stress, however, is identical to the pattern of the word as it appeared as a monomorpheme (these forms appear above). Examples in (67) show suffixed Indonesian words.

(67) Indonesian Stress, Suffixed Words

	Attested	**Gloss**	**Unattested**
a.	m¶m-bicar‡-kan	'speak about something'	*m¶m-b“car‡-kan
b.	k˜ntinuas’—a	'the continuation'	*k˜ntin• as’—a
c.	m¶m-bicˆra-k‡n—a	'speak about it'	*m¶m-b“cara-k‡n—a

To recapitulate, the relevant three generalizations are these. Monomorphemic words stress the penult and the initial syllable, and on alternating syllables in between. Prefixed words and compound words surface so that the roots of these words are stressed as if they were monomorphemic. Suffixed words surface with essentially the same pattern as monomorphemic words . Cohn and McCarthy (1994) use these facts to argue that this system is best accounted for by alignment constraints. First, they argue that the behavior of prefixed and compound words follows by forcing a foot to begin each root as a prosodic word. Prefixes will not be incorporated into this because they fall outside of the root. Second, they argue that suffixes are incorporated into footing with the root because these forms always have penultimate stress, just like their monomorphemic counterparts. Finally, they argue that the stressing of all other syllables follows if intermediate syllables allow iambic, rather than trochaic feet. Under Cohn and McCarthy (1994), Indonesian stress requires both alignment constraints and the "head reversal" of allowing iambic feet in a trochaic system.

These constraints do account for the data, but they are forced to argue that the disruption of medial stresses in suffixed words is attributed to iambic parsing in these words, even as they acknowledge the lack of empirical evidence for the iamb in this otherwise trochaic language. The attested stress pattern in suffixed words, then, is iambic when there is a single suffix (68a,b) and trochaic when the word is doubly-suffixed (68c). The figure below shows the proposed footing.

(68) Footing in Indonesian Suffixed Words

	Attested	**Gloss**
a.	m¶m-bi(car‡)-kan	'speak about something'
b.	(k˜nti)nu(as’)—a	'the continuation'
c.	m¶m-bi(cˆra)-(k‡n—a)	'speak about it'

The first two examples above violate the trochaic foot form constraint with this iambic parsing. This violation is forced by a higher ranked constraint, ALIGN-ROOT-FOOT, which forces every root to end with a foot:

(69) ALIGN-ROOT-FOOT (Cohn and McCarthy (1994)

Align (Root, Right; Foot, Right)

The right edge of every root coincides with the right edge of some foot.

With the alignment constraint dominating the constraint on foot form, iambic feet surface in precisely those cases where words end in one suffix. Cohn and McCarthy (1994, fn 11) further observe that "there is no independent evidence for the iamb in these words". Their account thus relies on align constraints coupled with the head reversal. This allows an iambic foot in the optimal output, as the FOOTFORM violation is too low to play a role.

One alternative account for the Tohono O'odham data presented here would be to use alignment constraints so that foot and edges correspond. This might invoke a constraint that aligns the left edge of every morpheme with the left edge of a foot, as in the constraint below.

(70) ALIGN-MORPH-FOOT

Align (Morpheme, Left; Foot, Left)

The optimal satisfaction of this constraint occurs when the left edge of every morpheme coincides with the left edge of a foot. If FOOT BINARITY dominates PARSE-σ as above, all syllables are parsed, as long as degenerate feet do not result. Finally, if ALIGN-MORPH-FOOT dominates FOOTBINARITY, then the footing forced by this constraint appears as shown in (71).

(71) a. Monomorphemic words

(σ@σ)	ta@dai	'roadrunner'
(σ@σ)σ	'a@sugal	'sugar (Sp)'
(σ@σ)(σ@σ)	pi@mia$ndo	'pepper (Sp'

b. Suffixed words

(σ@σ)-(σ$)	pa@ùdo-ga$	'owning a duck'
*(σ@σ)σ-(σ$)	'a@suga$l-mad	'adding sugar

c. Prefixed words

*(σ@)-(σ$σ)	pa@-pado$	'ducks (Sp)'
*(σ@)-(σ$)	hi@-mad	'will be walking'

d. Trimorphemic words

*(σ@)-(σ$σ)-(σ$)	ha@-haiwa$n)-ga	'owning cows'
*(σ@)-(σ$)-(σ$)	hi@-him-a$d	'will be walking, plural'

The unattested forms above can be ruled out by incorporating *CLASH and *LAPSE, as was also needed for the analysis relying on the MORPHEME-TO-STRESS PRINCIPLE. To exclude the unattested forms, then, *CLASH and *LAPSE must outrank the alignment constraint. Considering these constraints leads us to the following hierarchy: FOOTFORM È *CLASH, *LAPSE È ALIGN-MORPH-FOOT È FOOTBINARITY È PARSE-σ. As most of these constraints are identical in content and ranking to those mo tivated for the MSP account, I do not reintroduce them here. The prefixed trisyllable proves damning to this approach; the incorrect output is predicted in the tableau below.

(72) Evaluation under an Alignment approach

/RED-paùdo/ 'RED-duck (Sp)'	FOOT FORM	*LAPSE *CLASH	ALIGN MORPH-FT	FT BIN	PARSE
a. (σ@-σ)(σ$)			*	*!	
b.(σ@)-(σ$σ)		*!		*	
kc. (σ@-σ)σ			*		*
d. (σ@)-(σσ$)	*!			*	

Neither output with the correct stress pattern (72a,d) surfaces above. (72a) is excluded by the violation on FOOT BINARITY, while (72d) violates FOOT FORM. The optimal output surfaces with the same pattern as a monomorphemic word, initial stress only. To predict final stress on this form, we either need a lower ranking of FOOT FORM or we must add another constrain t to force final stress. The former solution is inadvisable as it would make incorrect predictions elsewhere in the metrical system; for example, earlier in this chapter the trochaic patterns of the meter were demonstrated. The latter solution suggests a constraint equivalent to the MORPHEME-TO-STRESS PRINCIPLE.

Utilizing an alignment constraint cannot account for the stress patterns of Tohono O'odham without further modifications. Even if we were able to allow head reversal to predict the form in (72d), this would run counter to the evidence for trochaic feet in this system. In addition to the evidence from song meter, the distributional patterns of stress support a trochaic analysis. Primary stress falls on the initial syllable, a pattern characterized by left-headed trochaic feet. Stress alternates on odd syllables, counting from the left edge. Again, odd syllable stress is associated with trochaic, not iambic feet. The system is quantity-insensitive. To use iambic feet, we would have to use the quantity-insensitive iamb. Hayes (1987) argues from a typological perspective that there is an overwhelming lack of evidence in favor of a quantity-insensitive right headed foot.

There is an additional consideration. An alignment analysis would invoke bracketing constraints to capture a generalization that occurs independent of morphological bracketing. Trisyllabic polymorphemic words all have first and third syllable stress, regardless of the morphological composition of the word. The result of this approach would necessitate extremely different metrical analyses for two forms with the identical surface pattems. Under this analysis, the surface similarities between prefixed and suffixed forms become accidental.

The analysis of the previous section is preferred for the following reasons. First, the distinction between morphologically simple and morphologically complex forms is easily captured by the MORPHEME-TO-STRESS PRINCIPLE. Bracketing plays no role in the analysis. Second, the proposed analysis utilizes one foot. It is to be preferred over an analysis that uses two feet to account for the same data. Third, the MORPHEME-TO-STRESS PRINCIPLE directly connects the link between degenerate feet and morphemes. Under Generalized Alignment, this connection is opaque. On the basis of these reasons, the MORPHEME-TO-STRESS PRINCIPLE provides the best analysis of Tohono O'odham stress.

2.4.2 Against an Approach Requiring Partial Footing

In this section, I analyze the stress pattern with a constraint forcing partial footing of morphemes. I show that this approach cannot account for the presence of stress in trisyllabic prefixed forms, and therefore should be rejected.

The contrast between the various morphologically complex examples given above suggests that morphemes must either be stressed, or surface as part of some foot. The absence of stress on the final syllable of a monomorphemic trisyllable declares that morphemes cannot be exhaustively footed. Recall this data, given again for convenience in (73).

(73) Monomorphemic words without exhaustive footing

a.	mu@sigo	'musician (Sp)'
b.	ma@ùgina	'car (Sp)'
c.	si@minj&ul	'cemetery (Sp)'
d.	'a@sugal	'sugar (Sp)'

The proposal is that each morpheme must be at least partially footed. Thus a constraint forces each morpheme to posses some degree of metrical structure. This constraint dominates FOOTBINARITY, so that morphemes will be footed even if that results in degenerate feet. The proposed constraint is given in (74).

(74) The MORPHEME FOOTING CONSTRAINT (MFC)

Every morpheme must possess some metrical structure.

If we introduce this constraint into the hierarchy so that it dominates FOOTBINARITY, the optimal (75a) is correctly chosen. This evaluation is given in (68).

(75) Evaluation of /paùdo-ga/ 'owning a duck'

/paùdo-ga/ 'owning a duck'	FT FM	ALIGN PW	MFC	FT BIN	PARSE-σ
pa.([pa@ùdo])([ga$])				*!	
b. ([pa@ùdo])[ga]			*!		*

The ranking of the MFC is below the other constraints, but above FOOT BINARITY. The ranking will be further motivated in Chapter Four. For now, we know that FOOT BINARITY must be dominated by the MFC. If the rankings were reversed, we would expect (75b) to be the optimal output. This establishes the ranking between the two constraints.

While the MFC accounts nicely for the suffixed trisyllable above, it has more difficulty with a prefixed trisyllable. A form like *pa@-pado$* 'ducks' is predicted incorrectly to surface without final stress. The MFC does not force the final stress in prefixed cases. The preference for the form with nonfinal stress is demonstrated in the following tableau.

(76) Evaluation of /pa-paùdo/ 'ducks

/pa-paùdo/ 'ducks	FT FM	*CLASH	ALIGN PW	MFC	FT BIN	PARSE-σ
a.([pa@][pa)(do$])					*!	
kb.([pa@][pa)do]						*

With an identical set of constraints, save for the replacement of the MORPHEME-TO-STRESS PRINCIPLE with a constraint like the MFC, nonoptimal output is predicted, as above. Something additional is still required for final degenerate footing to surface in these forms. In an analysis relying on the partial footing of morphemes, an additional mechanism is necessary to somehow predict final stress in a word like *pa@-pado$* 'ducks'. It is not clear what this mechanism should be; therefore, the analysis invoking the MORPHEME-TO-STRESS PRINCIPLE is preferred.

2.4.3 Against Nonfinality in Spanish Borrowings

One possible account would be to argue that the absence of final stress in monomorphemic words is the wrong generalization. Rather, as the evidence for this pattern comes from borrowed words, it could be argued that the 'tru e' generalization is that borrowed words reject final stress generally. Two sets of borrowed words disprove this, both by showing that final stress is permitted in certain borrowings. First, the data below shows that words which preserve the stress of the Spanish word may result in surface monomorphemic words with final stress.

(77) Borrowings

a.	milga@ùn	'white man, American (Sp, from americ‡no)'
b.	pana@ùl	'honey bee (Sp, from pan‡l)'
c.	saldi@ùn	'frying pan (Sp, from sartŽn)'
d.	'an)i@ùl	'blueing (Sp, from azœl)'
e.	hamo@ùn	'ham (Sp, from ham—n)'
f.	kanti@ùn	'bar (Sp, from cant’na)'
g.	kawhi@ù	'coffee (Sp, from cafŽ)'

Second, reduplicated words show final stress when the resulting word is a trisyllable. The data in (78) shows this point:

(78) Patterns of stress in prefixed words:

a. pi@@-piba$ 'pipes (Sp)'

b. la@@-labi$s 'pencils (Sp)'

c. ta@@-tablo$ 'shawls (Sp)'

d. c&a@-c&aNgo$ 'monkeys (Sp, from ch‡ngo?)'

e. c&i@-c&ino$ 'Chinese man (Sp, from ch’no)'

f. mu@-msigo$ 'musicians (Sp)'

g. wi@-psilo$ 'calves (Sp)'

h. si@-sminj&u$l 'cemeteries (Sp)'

An account that relied on the assumption that borrowings must reject final stress would have great difficulty reconciling these two sets of data with the rest of the patterns presented in this chapter. Forms like *wi@psilo$* 'calves (Sp)' and *mu@msigo$* 'musicians (Sp)' surface with the final stress only because they are reduplicated. The same is true of the following alternation for suffixed forms: *'a@sugal* 'sugar (Sp)' ~ *'a@suga$l-t* 'to make sugar (Sp)'. Such forms also surface with final stress on the root. To propose that the singular versions of such forms reject final stress solely because of their linguistic origins forces us to propose a highly idiosyncratic constraint. In contrast, the MORPHEME-TO-STRESS PRINCIPLE recognizes that it is the morphology that forces final stress. The formalism of this constraint explicitly incorporates this assumption. A constraint that forces Spanish words to reject final stress would necessarily be outranked by a constraint forcing final stress in polymorphemic words. Again, this would incorporate the MORPHEME-TO-STRESS PRINCIPLE. By Occam's Razor, the account that only needs the MORPHEME-TO-STRESS PRINCIPLE is preferable to an account that includes both a ban on final stress in Spanish words and the MORPHEME-TO-STRESS

PRINCIPLE to stress these roots in polymorphemic words. We are led directly back to the original proposal, which suggests the inadequacy of this alternative.

Additionally, there is a long tradition of treating borrowings under the phonology used for native words, wherever the phonological evidence supports this. In Tohono O'odham, there do appear to be two distinct patterns of phonology in loanwords, those which preserve an original, noninitial stress pattern (and hence surface with a noninitial long vowel) and those which surface with an initial stressed syllable like native words. The first class of words, which are exceptional in their stress pattern, might be treated in a manner similar to Turkish loanwords, as in Inkelas (1994). The second class of words clearly act like native words, and should be treated in such a way. A parallel example is seen especially in work on English stress (for example, Chomsky and Halle 1968, Hammond 1988). For these reasons, this alternative proposal is highly unsatisfactory in accounting for the stress pattern of Tohono O'odham.

2.4.4 Against an Identity-Based Analysis

A final possible analysis might invoke the BASE IDENTITY constraint, following Kenstowicz (1995). Kenstowicz (1995) argues for an Optimality Theoretic model to capture cases of cyclicity, such as the English stress pattern discussed in Chapter 1. Kenstowicz offers two constraints within Optimality Theory to capture cyclic data; of interest here is BASE-IDENTITY (79):

(79) BASE-IDENTITY Given an input structure [X Y] output candidates are evaluated for how well they match [X] and [Y] if the latter occur as independent words.

BASE-IDENTITY allows outputs to be evaluated against the surface form of all embedded constituents. This constraint is ranked within the hierarchy, and like all constraints, its ranking determines what effect the constraint has. An example of how this constraint works is in (80), where compound stress is evaluated for Shanghai Chinese.

(80) Shanghai Chinese Compound Stress

/ya#thi#Nu/ output: (ya@),(thi@Nu)	Clash	Base-Ident	Faithfulness
(σ@)(σ@σ)	*!		*
p(σ@σ)σ		*	**
(σ@σ)(σ@)		**!	*

The first candidate violates * CLASH and FAITHFULNESS; the second candidate satisfies the higher ranked *CLASH, and violates BASE-IDENTITY only once. The first syllable of the compound is stressed, as it ought to be in isolation, but the second syllable, which would head a disyllabic foot when compounded with the final syllable, is unstressed, and so forces a violation of BASE-IDENTITY. The third candidate violates BASE-IDENTITY twice, once for failing to stress the second syllable, once for stressing the third syllable, which is unstressed in isolation. Without BASE-IDENTITY forcing the structure to parallel the output of embedded constituents, the third candidate would be incorrectly selected as optimal, as it has one fewer violation of FAITHFULNESS. This constraint would preserve the stress of words as they are successively affixed with additional morphemes. Kenstowicz (1995) cites a number of examples to motivate this constraint, such as Chinese compound stress, Polish stress, as well as featural processes.

How would BASE IDENTITY work in Tohono O'odham? This constraint might work well for suffixed forms , as *(pa@ùdo)* 'duck' is stressed the same way in its various suffixed counterparts: *(pa@ùdo)-(ga$)*, *(pa@ùdo)-(ga$-kam)*. Some additional constraint would still be required to allow the final degenerate foot – since the suffix does not occur as an independent word, BASEIDENTITY cannot do this. If we examine schematized forms, we see that complex words do not consistently preserve the foot structure or stress pattern of the root.

(81) Roots in Monomorphemic and Polymorphemic Words (roots underlined)

	Complex Form	**Root**	**Complex vs. Root**
a.	(σ@-σ)	(σ@)	different
	hi@-him	hi@m	
b.	(σ@-σ)	(σ@)	same
	hi@m-ad	hi@m	
c.	(σ@-σ)-(σ$)	(σ@)	different
	hi@-him-a$d	hi@m	
d.	(σ@σ)-(σ$)	(σ@σ)	same
	pa@ùdo-ga$	pa@ùdo	
e.	(σ@-σ)(σ$)	(σ@σ)	different
	pa@-pado$	pa@ùdo	
f.	(σ@-σ)(σ$-σ)	(σ@σ)	different
	pa@-pado$-ga	pa@ùdo	
g.	(σ@σ)-(σ$-σ)	(σ@σ)	same
	pa@ùdo-ga$-kam	pa@ùdo	
h.	(σ@σ)(σ$-σ)	(σ@σ)σ	different
	'a@suga$l-mad	'a@sugal	
i.	(σ@σ)(σ@σ)-(σ$)	(σ@σ)(σ@σ)	same
	pi@mia$ndo-ma$d	pi@mia$ndo	

Root size is not a predictor of whether the complex word mimics the stress pattern of the root. For example, both monosyllabic and disyllabic roots may surface either way. Different patterns do result when words are prefixed, but there are also cases of words that only have suffixes (81h) and still surface with different stress patterns. There is no single generalization for those cases where roots have different stress patterns in complex words. A constraint like BASE-IDENTITY does not provide a neat characterization of the facts, suggesting that the correct generalization ignores the role played by the root. Rather, the generalization is that the stress pattern is predicted by morphological complexity, such that final stress is only allowed in complex words. Such a characterization leads us to the conclusion that the MORPHEME-TO-STRESS PRINCIPLE provides a better account of the data.

2.4.5 Summary

In this section, I demonstrated that none of a number of possible alternatives adequately account for the data. The approaches vary in how they characterize the data, but ultimately the MORPHEME-TO-STRESS PRINCIPLE and the notion of tied constraints provides the best account for the data.

2.5 Conclusion

In this chapter, I did the following. First, I showed that there is an asymmetry in final stress between monomorphemic words and polymorphemic words. Second, I attributed this to fact that only morphologically complex words allow degenerate feet. Third, I accounted for this by proposing a constraint that stresses every morpheme, the MORPHEME-TO-STRESS PRINCIPLE. This constraint is dominated by*CLASH and FOOTFORM, which in turn dominate *LAPSE. *LAPSE dominates the MORPHEME-TO-STRESS PRINCIPLE to predict the full range of data presented in this chapter. Finally, I showed that there are a number of alternative analyses, all of which are inadequate in one way or another.

3. THE INTERACTION OF STRESS AND EPENTHESIS

In Chapter Two, I argued for the MORPHEME-TO-STRESS PRINCIPLE, whereby every morpheme must be stressed. Here, I argue that every stressed item must be a morpheme, the STRESS-TO-MORPHEME PRINCIPLE. This argument derives from the notion that epenthetic elements never belong to morphemes, and thus reinvents this idea as presented in McCarthy and Prince (1993a). The STRESS-TO-MORPHEME PRINCIPLE further crystallizes the model of how stress and morphology interact.

The empirical point of this chapter is to describe the asymmetry between the stress patterns of words with epenthesis in even and odd syllables. Words with even epenthesis stress every odd syllable, while words with odd epenthesis stress the first and fourth syllables of the word. Accounting for this asymmetry leads to the theoretical point of this chapter. I argue that this behavior is best accounted for by exploiting the fact that epenthetic vowels do not belong to morphemes and that stressed syllables should belong to morphemes. To this end, I propose a constraint that militates against stressed syllables that do not belong to morphemes, the STRESS-TO-MORPHEME PRINCIPLE. I demonstrate that this constraint, incorporated into the constraint hierarchy argued for in Chapter Two, accounts for the epenthetic data. The STRESS-TO-MORPHEME PRINCIPLE provides us with the logical counterpart of the MORPHEME-TO-STRESS PRINCIPLE, in the same way that the STRESS-TO-WEIGHT PRINCIPLE forms the logical counterpart to the WEIGHT-TO-STRESS PRINCIPLE.

These points tie in to the empirical and theoretical points of the dissertation. First, the empirical goal of this dissertation is to describe the system of secondary stress that operates in Tohono O'odham. This chapter does this in describing yet another set of data in pursuit of this objective. Second, the theoretical goal of the entire dissertation is to present a model of the interaction of stress and morphology within Optimality Theory. In this chapter, I propose that the behavior of epenthetic vowels with regard to stress assignment must be attributed to their absent morphological structure. In this way, I integrate epenthesis into the morphological model of stress, thus increasing the empirical power of my proposal.

This chapter is organized as follows. First I briefly introduce the set of facts dealt with in this chapter. Then I present arguments for epenthesis in Tohono O'odham. Following this is the description of the epenthetic data in Tohono O'odham. I then propose that the analysis of these facts is best served by introducing the STRESS-TO-MORPHEME PRINCIPLE. This constraint dominates *LAPSE, with this ranking predicts that we will find unstressed epenthetic vowels in odd positions. Finally, I present a derivational alternative proposal, and show why it fails to adequately address the descriptive patterns of the data.

3.0 Introduction

From the data in Chapter Two, we know that complex words in Tohono O'odham stress every odd syllable. This pattern is only partially true of words with epenthesis. For such words, the regular pattern is one with unstressed epenthetic vowels, in both even and odd epenthetic positions. Words with even epenthesis surface with the same stress contour as a polymorphemic word without epenthesis. However, words with odd epenthesis surface with a different stress pattern. (1) shows this contrast, with epenthetic vowels in even (1a) and odd (1b) positions (epenthetic vowels are underlined).

(1) Epenthetic vowel, -a, in even and odd position :

a. Even position, unstressed		b. Odd position, unstressed	
(bi@d-s`p-a)-(ku$d`)	'instrument for plastering'	(wa@kon)-a-(mö$d`)	'going and washing'
(c&ö@po)(s-i$d-a)-(c&u$d)	'cause someone to brand an animal'	(ci@kpan)-a-(mö$d`)	'going and working'

The forms in (1a) demonstrate that epenthetic vowels in even syllables produce surface patterns identical to polymorphemic forms where all odd syllables are stressed. This occurs regardless of whether the epenthetic vowel is in the second or fourth syllable. In contrast, (1b) shows that epenthetic vowels in odd syllables produce a stress pattern markedly different from the one found in (1a). Epenthetic vowels in odd position do not get stressed, and the syllable that follows is stressed instead. The resulting stress pattern is one where the first and fourth syllables get stressed. For the forms in (1a), the general pattern is stressed syllables in the first and third positions. In (1b) above, this difference is characterized by footing epenthetic vowels only when they appear in even syllables.

This pattern is captured by appealing to the fact that the epenthetic element does not belong to a morpheme. I argue for the STRESS-TO-MORPHEME PRINCIPLE, which forces stressed elements to belong to morphemes. Any word that stresses an epenthetic element, then, violates this constraint. This constraint outranks *LAPSE, which disallows particular sequences of stressless vowels, so that the first and fourth pattern of stress in (1b) emerges in surface forms.

3.1.1 Arguments for Epenthesis in Tohono O'odham

The purpose of this section is to demonstrate that there are two elements of the shape *-a*; one is a nominalizing suffix and the other is appears between verb bases and certain suffixes (Zepeda 1984).[1] I expand upon the arguments given in Zepeda (1984) in favor of an epenthetic analysis of this element. In this section, I first describe the behavior of the nominalizing suffix, both in terms of phonology and morphology. Then I outline the distributional facts regarding the epenthetic element. I follow this with a section on the representation of this element. This section includes a discussion of previous analyses of this vowel, which used both diachronic and synchronic motivation to argue that this vowel is underlyingly part of the verb. I argue against such an approach. These sets of data, and the contrast between them, leads to the conclusion that the two elements are different. The evidence shows that there is a nominalizing suffix, *-a*, which acts like other morphemes, and that there is another element that epenthesizes between verb stems and subsequent suffixes.

3.1.2 The behavior of the nominalizing suffix *-a*

The first *-a* element to be examined is the nominalizing suffix. This suffix is easily characterized in terms of its morphological and phonological distribution. There are four main characteristics associated with this suffix. First, the suffix is stressed in odd syllables, like other morphemes. Second, the addition of this suffix causes a category change, as a verb becomes a noun. Third, the suffix possesses semantic content. Fourth, the suffix can be word final. This section illustrates each of these characteristics.

The forms in (2) compare verbs and nouns. The nouns are derived by adding an *-a* to the verbs in the first column. Thus the suffixation of *-a* causes a category change. The forms also show that when the suffix is in an even syllable, as in (2c-d), it is unstressed, and when it appears in an odd syllable, as in (2a-b), it is stressed.

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[1] This vowel appears between consonant-final verb stems and certain consonant-initial suffixes.

(2) Distribution of the suffix *-a*:

	Verb	Noun (Verb+a)	Gloss of Noun
a.	n)u@ùkud	n)u@ùkud-a$	'the care-taking'
	taking care of	taking care of-nominal	
b.	wa@kon	wa@kon-a$	'the washing'
	washing	washing-nominal	
c.	j&ö@n	j&ö@n-a	'the smoking'
	smoking	smoking-nominal	
d.	hi@-hido$d`	hi@-hido$d`-a	'the cookings'
	plural-cooking	plural-cooking-nominal	

The semantic content added when the suffix is added changes a verb that means 'x-ing' to a noun that means 'the x-ing'. There is an identifiable change in meaning that occurs when this suffix appears. Finally, the data in (2) shows the suffix as word-final.

Based on the distributional facts presented in this section, this *-a* is a suffix with identifiable phonological and morphological characteristics.

3.1.3 Behavior of the epenthetic -*a*

The second element to be examined appears with a different constellation of features. There are five characteristics of the morphological and phonological behavior of this -*a*. First, this element is unstressed in both even and odd positions. Second, it only surfaces between consonant-final verb bases and consonant-initial suffixes. Third, it has no semantic content. Fourth, it appears with verbs that cannot take the nominalizing suffix -*a*. Fifth, it never appears word-finally. As we examine the data further, each of these points will become apparent.

Suffixes can be added to verbs for a variety of reasons. For example, -*kud*` signifies the instrumental, and -*dag* indicates being good at the action indicated by the verb. The data in (3) illustrate how suffixation operates in Tohono O'odham. The verbs in (3) are vowel-final verbs; they are followed by the suffix. These verbs do not appear with the -*a*.

(3) Absence of -a in vowel-final verbs:

	Verb	Verb+suffix	Gloss of Suffixed Form
a.	c&i@c&wi	c&i@c&wi-ku$d`	'instrument for playing'
	playing	playing-instrument	
b.	c&i@c&wi	c&i@c&wi-da$g	'to be good at playing'
	playing	playing-ability	
c.	wa@ila	wa@ila-ku$d`	'instrument for dancing (Sp)'
	dancing	dancing-instrument	

d.	wa@-paila$	wa@paila$-kud`	'instruments for dancing (Sp)'
	plural-dancing	plural-dancing-instrument	
e.	wa@c&uwi	wa@c&uwi$-kud`	'instrument for bathing'
	bathing	combing-instrument	
f.	ga@swua	ga@swua-ku$d`	'comb'
	combing	combing-instrument	
g.	ga@swua	ga@swua-da$g	'to be good at combing'
	combing	combing-ability	
h.	na@ggia	na@ggia$-kud`	'instrument for hanging'
	hanging	hanging-instrument	

The suffixed words partition into verb and suffix easily. The verbs are all vowel-final, while the suffixes are consonant-initial. In this context, an -*a* never surfaces between the verb and the following suffix.

The data in (4) shows the distribution of -*a*. It appears between two consonants, the final consonant of a verb base and the initial consonant of the following suffix. The suffix also appears in both odd and even syllables, surfacing without stress in both of these positions. Finally, the forms in (4) show that the -*a* element appears word-medially, and that there are no words where this element appears word-finally. These phonological characteristics are apparent from the forms in (4).

(4) Distribution of epenthetic -a

	Verb	Verb+a+suffix	Gloss of Suffixed Form
a.	mö@d`	mö@d`-a-ku$d`	'track, trail'
	running	running-epenthesis-instrument	
b.	pa@ùn-t	pa@ùn-t-a-da$g	'good at making bread (Sp)'
	bread-to make	bread-to make-epenthesis-ability	
c.	pa@ùn-t	pa@ùn-t-a-ku$d`	'instrument for making bread (Sp)'
	bread-to make	bread-to make-epenthesis-instrument	
d.	c&i@pkan	c&i@pkan-a-ku$d`	'instrument for working'
	working	working-epenthesis-instrument	
e.	c&i@pkan	c&i@pkan-a-da$g	'good at working'
	working	working-epenthesis-ability	
f.	wa@kon	wa@kon-a-ku$d`	'instrument for washing'
	washing	washing-epenthesis-instrument	
g.	wa@kon	wa@kon-a-mö$d`	'go and wash'
	washing	washing-epenthesis-to go	
h.	c&ö@pos-i$d	c&ö@pos-i$d-a-ku$d`	'instrument for branding'
	brand-beneficiary	brand-beneficiary-epenthesis-instrument	
i.	c&ö@pos-i$d	c&ö@pos-i$d-a-c&u$d	'cause someone to brand'

brand-beneficiary brand-beneficiary-<u>epenthesis</u>-causative

Consonant-final verbs surface with an intervening *-a* when followed by the consonant-initial suffixes. This contrasts with the vowel-final verbs in (3), which did not surface with such an element. If the *-a* were a morpheme, we would expect that it would appear on both vowel-final and consonant-final verbs, where phonologically possible. This fact again suggests that the *-a* is epenthetic, a conclusion bolstered by the absence of the *-a* in the forms in (4). Another possibility is that the suffixes are vowel-initial, so for example, *-adag* is the morpheme. This presents two problems. First, why doesn't the first syllable of the suffix get stressed in odd syllables? We already know that suffixes that consist of a single vowel (for example, *-a* the nominalizer) can get stressed in odd position. It can't be a matter of the second syllable of *-adag* attracting stress because it doesn't get stressed in even position when suffixed to the vowel-final verbs above. Second, we would have to formulate a rule that deletes the *a* in *-adag* following vowel-final bases, even though the identical vowel sequences are possible elsewhere in the language. If we treat the element as not belonging to either the suffix or the base, these facts (especially the stress facts) follow. A final argument comes from the fact that there is no meaning difference based between forms with a final consonant versus with a final vowel.

There are several additional features (or absence of features) in (4) that argue that the *-<u>a</u>* is epenthetic, and not a morpheme. First, an examination of the glosses suggests that there is no semantic content, as there appears to be no meaning associated with the presence of this element. This point receives additional emphasis from the comparison between vowel- and consonant-final verbs. Second, the *-<u>a</u>* makes no category change. No definitive morphological characteristics are associated with this element. Third, if the *-<u>a</u>* were a morpheme, it would create phonologically possible words if suffixed onto vowel-final verbs, as in the ungrammatical counterpart to (3a), **c&i@c&wi-<u>a</u>-ku$d`*. Such a word would be phonologically well-formed, as demonstrated by the well-formedness of (3h), *na@ggia$-kud`* 'instrument for hanging'. This word shows that vowel hiatus is not prohibited, and that the specific sequence of vowels is licit. Thus the ungrammaticality of * *c&i@c&wi-a-ku$d`* thus lends support to the analysis of -*a* as epenthetic.

Finally, there is a set of verbs that appear with the epenthetic -*a*, but which cannot appear with the nominalizing suffix -*a*. The data appears in (5), showing consonant-final verbs with an -*a* intervening before the instrumental suffix *-kud`*. These forms are shown with the corresponding disallowed forms with the nominalizing -*a* suffix. These are taken from Zepeda (1984: 62)

(5) Verbs which disallow the -*a* suffix, but allow the -*a* epenthetic element:

	Verb	Instrument	Nominalized Verb	Verb Gloss
a.	toùb	toùb-a-kud`	*toùb-a	'to pour'
	pour	pour-epenthesis -instrument		
b.	hads-id	hads-id-a-kud`	*hads-id-a	'to sprinkle object'
	sprinkle-object	sprinkle-object-epenthesis -instrument		
c.	ton-lid	ton-lid-a-kud`	*ton-lid-a	'to light object'
	light-object	light-object-epenthesis -instrument		
d.	wepog-id	wepog-id-a-kud`	*wepog-id-a	'to level object'
	level-object	level-object-epenthesis -instrument		
e.	widut	widut-a-kud1`	*widut-a	'to swing'
	swing	swing-epenthesis -instrument		
f.	wu-psot	wu-psot-a-kud`	*wupsot-a	'to blow'
	plural-blow	plural-blow-epenthesis -instrument		
g.	sölin	sölin-a-kud`	*sölin-a	'to straighten'

	straighten	straighten-<u>epenthesis</u>-instrument		
h.	maniad	maniad-<u>a</u>-kud	*maniad-a	'to hobble'
	hobble	hobble-<u>epenthesis</u>-instrument		
i.	ki'ick	ki'ick-<u>a</u>-kud`	*ki'ick-a	to tweeze'
	tweeze	tweeze-<u>epenthesis</u>-instrument		

The data in (5) shows that certain consonant-final verbs never get suffixed with the nominalizing suffix *-a*, although they do surface with the epenthetic element -<u>*a*</u> intervening between the consonant-final verb and the consonant-initial suffix. Again, this restricted distribution pattern argues that the -<u>*a*</u> element is epenthetic, appearing as a phonologically-motivated element, rather than as a suffix or other morpheme. The generalization of these sets of data is that the -<u>*a*</u> only appears between two consonants of different morphemes, as in (4) and (5) above.

3.1.4 Analysis of the Epenthesis Data

In this section, I review the possible representations of -<u>a</u>. First, the element could be part of the verb base or the suffix, which is deleted on the surface in certain contexts. Second, the element could be epenthetic, not present at the input stage, but present on the surface in certain contexts. Third, the element could be present in both the input and output in certain contexts, but semantically empty in both contexts (and hence, not a morpheme). A fourth possibility, that this element is a suffix, has been argued against in the previous section and is not considered here. I argue that the restricted distribution of the element results in a very idiosyncratic formalization of the epenthetic process. Consequently, the best representation of the epenthesis is where it appears in the output, predicted by a lexically specified constraint.

An account of precisely where this vowel appears meets with some difficulty. First, we must restrict it so that the vowel appears only between base-final consonants and suffix-initial consonants. The base requirement does appear to require that the base be an independent word; this excludes forms like *tatab*-, presumably a bound morpheme. It also includes forms like *c&ö@pos-i$d* 'to brand object', which do not have intransitive imperfective counterparts, as bases. The process appears to be highly morphologically restricted, which makes it extremely difficult to formalize.[2]

Second, the vowel also appears associated with certain suffixes, rather than with the base. In fact, it also appears that there is no way to predict which suffixes will trigger the epenthesis, as a comparison of both triggering and nontriggering suffixes below demonstrates:

(6) a. Consonant-initial suffixes which follow the epenthetic -a[3]

Suffix	Gloss
-dag	ability
-c&ud	causative
-hun	transitive
-kud`	instrument
-möd`	to go

b. Consonant-initial suffixes which do not appear with the epenthetic -a

Suffix	Gloss
-kaj&	by means of
-dam	one who
-kam	one with
-t	to make

[2]On a related note, O. Zepeda (p.c.) notes that second language learners have a difficult time with the epenthetic process as well.

[3]Saxton (1982) lists some additional suffixes which appear with this element, such as -him 'to walk and x'. These elements can be treated formally the same as those listed above.

-id/lid/julid object

This raises problems for analyses in which the vowel is not the product of epenthesis, but rather undergoes deletion from the verb stem. This is similar to the approach in earlier works, such as Hale (1965), Saxton (1982) and Hill and Zepeda (1992). In these accounts, however, the final vowel does not surface because unstressed vowels are deleted, and the final vowel is argued to be unstressed. For instance, we might assume that the input was *c&i@kpana* 'working', rather than the consonant-final *c&i@kpan*. The surface form emerges due to a some constraint deletes that final vowel. Such a constraint would need to be formalized in such a way as to exclude words that do allow a final vowel, such as *mu@sigo* 'musician'. It cannot be a simple matter of deleting unstressed vowels, as the final odd-numbered vowel always surfaces when unstressed in monomorphemic words. An additional problem with such an approach is a pair like *c&i@kpan-da$m* 'worker' and *c&i@kpana-da$g* 'to be good at working.' An account which preserves the base final vowel with the suffix *-dag* would surely be expected to preserve it with the suffix *-dam.* Segmentally, the two are minimal pairs, they have no prosodic differences, and both surface with stress. Furthermore, under the surface-based account of stress that I have argued for here there is no reason why a base vowel in such a position would not be stressed; my analysis predicts *c&i@kpana$-kud`* for a word of such phonological and morphological composition. If the vowel is treated as base-final, its asymmetrical behavior with regard to stress is highly irregular and not easily explained. If the vowel is epenthesized, its behavior is consistent with other accounts of stress and epenthesis, such as in Mohawk (Michelson 1989) or Negev Bedouin Arabic (Hayes 1995).

Formalizing the epenthetic element leads to a number of difficulties. First, the element appears in an environment which is characterized partly by phonological and mostly by morphological considerations. This limited distribution is reminiscent of both the stem-joiner vowel in Mohawk verbs (Michelson 1988, 1989) and the theme vowels of Spanish verbs (Harris 1969). Second, the process is just as difficult to characterize as deletion, in large part because of the idiosyncratic behavior. Third, if the vowel is not epenthetic, but part of the base, there is a great asymmetry between words with such surface-absent vowels and words which do end with vowels on the surface. This asymmetry cannot be explained by stress, and so we are left with yet another paradox. Fourth, if the vowels are part of the suffix, and delete when such suffixes are affixed to vowel-final verbs, we have difficulty formalizing a constraint that forces such deletion without affecting similar vowel-vowel sequences in different morphological environments.

One proposal for dealing with such idiosyncratic distribution can be found in Pater (1995). To account for stress preservation effects in English stress, he proposes a constraint, STRESSIDENT. However, certain words do not exhibit these preservation effects. He argues that there are two versions of STRESSIDENT, one a general version, the other referred to as STRESSIDENT-γ, which applies only to lexically specified items.

This proposal can be extended to account for the epenthesis data in Tohono O'odham. We can propose that certain suffixes are specified lexically to avoid codas, NOCODA-γ. Words which contain these suffixes, then, allow epenthesis. CONTIGUITY forces the same order of elements in both input and output, so that epenthesis (or deletion) cannot disrupt the internal ordering. To prevent epenthesis within the morpheme, CONTIGUITY must be highly ranked. Specifically, NOCODA–γ must be dominated by CONTIGUITY. Finally, DEP_{IO}, which bans epenthesis, must be ranked below NOCODA-γ so that we can see the effects of the lexically specified coda constraint. The constraints appear in (7)-(9).

(7) NOCODA-γ

Avoid codas in γ-marked words.

(8) CONTIGUITY_{IO}

Each element in the input must correspond to an element in the output, such that there is no skipping or intrusion in the output.

(9) DEP IO

Each element in the output must have a correspondent in the input.

All suffixes which trigger the epenthesis will be γ-marked. The following tableau shows how the correct output will be generated. (Stress is treated in another section of this chapter.)

(10) Evaluation of /c&ikpan-dag, γ / 'good at working'

/c&ikpan-dag, γ / 'good at working'	CONTIGUITY$_{IO}$	NOCODA-γ	DEP$_{IO}$
a. c&ikpan-dag		***!	
pb. c&ikpan-a-dag		**	*
c. c&ikapan-a-dag	*!	*	***

A form that is γ-marked will always violate the lexically specified coda constraint. Candidate (10a) shows this, as it has three syllables with codas, and three violations of NOCODA–γ. Candidate (10b) epenthesizes between the two morphemes, thus satisfying CONTIGUITY and incurring one fewer violation on the coda constraint than the (10a) candidate.[4]

In contrast, a form that is not γ-marked will not be subject to NOCODA-γ. Without violations on the coda constraint, the decision on optimal candidates is passed to DEP$_{IO}$, which prefers candidates with no epenthesis. The evaluation appears in (11).

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[4]Presumably a candidate that epenthesizes word-finally is ruled out by an ANCHOR constraint (McCarthy and Prince, 1995) that forces the final segment of input and output to be identical.

(11) Evaluation of /c&ikpan-dam/ 'worker'

/c&ikpan-dam/ 'worker'	CONTIGUITY$_{IO}$	NOCODA-γ	DEP$_{IO}$
pa. c&ikpan-dam			
b.c&ikpan-a-dam			*!
c. c&ikapan-a-dam	*!		***

A candidate which epenthesizes within a morpheme, like (11c), violates the higher-ranked CONTIGUITY. The coda violations in the output candidates are not evaluated by NOCODA-γ, because the form is not γ–marked. This leaves two candidates, (11a) and (11b), with the decision being made by DEP$_{IO}$. This constraint favors candidates without epenthesis, choosing (11a) as optimal and (11b) as nonoptimal.

The lexically specified constraint, NOCODA–γ, provides us with a mechanism to predict the idiosyncratic behavior of epenthesis. We mark suffixes that trigger this epenthesis with an index that corresponds to a constraint banning codas. All other unmarked forms are evaluated satisfactorily by this constraint, so that we can predict the appearance of the epenthetic -a.

3.1.5 Summary

The previous section has demonstrated that the contrast between the nominalizing suffix and the epenthetic element is rather sharp. Only the nominalizing suffix gets stressed in odd position, and only the nominalizing suffix has semantic content. The suffix also causes a category change, while the epenthetic element is inert in this regard. The epenthetic element is restricted in appearing only word-medially, and only between two consonants in different morphemes. Additionally, verbs which appear with the epenthetic vowel may be restricted from appearing with the nominalizing suffix.

Based on the multitude of asymmetries between these two elements, we conclude that the -*a* is an epenthetic element, rather than a morpheme. The analysis of this epenthesis relies on a lexically specified constraint, NOCODA–γ, to restrict epenthesis to a limited set of suffixes.

3.3 Description of the Epenthetic Stress Data

In this section, the interaction of epenthesis and stress is described. This section shows that epenthetic vowels are unstressed in both even and odd position. This means that the surface patterns of forms with even epenthetic vowels patterns with the polymorphemic data, with every odd syllable stressed. In contrast, odd epenthetic vowels produce a surface pattern with stress on e first and fourth syllables, which creates a pattern different from both the monomorphemic and the polymorphemic patterns.

3.3.1 Epenthesis and Stress Data

A brief recap of the data without epenthetic vowels may be helpful at this point. First, recall that in monomorphemic forms, all nonfinal odd syllables get stressed. This is illustrated by the data in (12):

(12) Monomorphemic Forms

a.	σ@	ki@ù	'house'
b.	σ@ σ	ta@dai	'roadrunner'
c.	σ@ σ σ	si@minjul	'cemetery'
d.	σ@ σ σ$ σ	pa@ko'o$la	'Pascola dancer'

Polymorphemic forms pattern similarly, stressing all nonfinal syllables. They also stress final odd syllables. This is shown in (13):

(13) Polymorphemic Forms

a.	σ@ σ σ$	hi@-him-a$d	'pl-walking-fut imp'
		c&i@cwi-ku$d`	'playing-instrument'
b.	σ@ σ σ$ σ	pa@-pado$-ga	'pl-duck-poss'
		c&i@cwi-ku$d`-dam	'playing-instrument-AGENT'
c.	σ@ σ σ$ σ σ$	ha@-haiwa$n)-ga-ka$m	'pl-cow-poss-one with'
		pi@mia$ndo-ma$d	'pepper-adding'
d.	σ@ σ σ$ σ σ$σ	ha@-haiwa$n)-ga-ka$d-ma	'pl-cow-poss-fut imp-seem to be'

The difference between monomorphemic and polymorphemic forms is that only morphologically complex forms allow final stress. This difference is highlighted by the boxed forms above, (12c) disallowing final stress and (13a) allowing final stress.

Now we consider how these patterns interact with the epenthetic element. Epenthetic vowels produce two patterns, although the epenthetic vowels themselves are never stressed. These two patterns surface based on whether the epenthetic vowel falls in an even or odd syllable. For forms with even epenthesis, the word patterns with the polymorphemic forms in (13), stressing all odd syllables. Such forms suggest that there are no differences between forms with and without epenthesis. This is not true, however, when we examine forms with odd epenthesis. An epenthetic vowel in odd position is never stressed in such forms,[5] and the form surfaces with the first and fourth syllables stressed. We examine each pattern in turn.

The first pattern to be described is that of epenthetic vowels in even position. The pattern produced by even epenthesis appears in (14). The epenthetic vowel (underlined) appears in the second syllable (14a-b) and the fourth syllable (14c-d). In both cases, it is unstressed. All the odd syllables are stressed, even odd ultimas. This pattern duplicates the one seen in the polymorphemic forms in (13).

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[5]Under two conditions, truncation and stress clash, unstressed epenthetic odd syllables become stressed. Discussion of these truncation appears in Chapter Four, while Fitzgerald (1997) analyzes the clash data.

(14) Epenthetic vowels in even position

a. σ@σσ$ bi@d-s`p-a-ku$d` 'instrument for plastering'

mud-put-epenthesis -instrument

wu@d`-a-da$g 'to be good at roping'

rope-epenthesis -ability

pa@ùn-t-a-ku$d` 'bread pan'

bread-to make -epenthesis -instrument

b. σ@σσ$σ pa@ùn-t-a-ku$d`-dam 'one with a bread pan'

bread-to make -epenthesis -instrument-one with

mö@d`-a-ku$d`-dam 'one with a track, trail'

run-epenthesis -instrument-one with

c. σ@σσ$σσ$ c&ö@pos -i$d-a-ku$d` 'instrument for branding'

brand-benefactive-epenthesis -instrument

ho@'ig-i$d-a-hu$n 'to pray'

to be kind-benefactive-epenthesis -transitive

hi@-hido$d`-a-mö$d` 'to go and cook, plural'

plural-cook--epenthesis -to go

ta@wog-i$d-a-ku$d` 'shade'

shade-benefactive-epenthesis-instrument

d. σ@σσ$σσ $σ ho@'ig-i$d-a-hu$n-a 'prayer'

to be kind-benefactive-epenthesis-transitive-nominal

pi@-pisa$l-t-a-ku$d`-kaj& 'by scales'

plural-weigh-to make-epenthesis-instrument-in a similar manner

hu@ùka-j&i$d-a-ku$d`-dam 'one with a heater'

to be warm-benefactive-epenthesis-instrument-one with

The data above consist of words that vary in their morphological composition and in where the epenthetic vowel appears. For example, in (14a), the epenthetic vowel falls in the second syllable and the words have one suffix each. These words stress the first and third syllables, and the epenthetic vowel is unstressed. In (14c), the epenthetic vowel falls in the fourth syllable; the words have one suffix. Still, the pattern is the same as those words in (14a) and elsewhere in this set of data. The generalization is that epenthetic vowels in even position never get stressed, and that all odd syllables are stressed.

This generalization is not true of all words with epenthetic vowels. Epenthetic vowels in odd position behave markedly different. The next set of data demonstrates this difference by showing words with epenthetic vowels in odd position. Like their even-positioned counterparts, odd epenthetic vowels never get stressed. However, this does not produce the same surface stress pattern as seen in polymorphemic forms in either (13) or (14), where odd syllables get stressed. For words with epenthetic vowels in odd position, stress appears displaced, and surfaces on the syllable following the epenthetic odd vowel. Thus the actual pattern surfaces with stress on the first and fourth syllables of the word. This is demonstrated by the data in (15), where all epenthetic vowels are in the third syllable of the word:

(15) Epenthetic vowels in odd position

a. σ@σσσ$	hi@dod`-a-ku$d`	'cooking pot'
	cook-epenthesis-instrument	
	c&i@kpan-a-mö$d`	'to go and work'
	work-epenthesis-to go	
	c&i@kpan-a-ku$d`	'tool'
	work-epenthesis-instrument	
	c&ö@mai-t-a-ku$d`	'instrument for making tortillas'
	tortilla-to make-epenthesis-instrument	
	wo@son-a-ku$d`	'broom'
	sweep-epenthesis-instrument	
b. σ@σσσ$ σ	hi@dod`-a-ku$d`-dam	'one with a cooking pot'
	cook-epenthesis-instrument-one with	
	c&i@kpan-a-ku$d``-dam	'one with a tool'

work-epenthesis-instrument one with

wa@kon-a-ku$d``-dam 'one with a basin'

wash-epenthesis-instrument-one with

b. σ@σσσ$ si@kon-a-ku$d`-dam 'one with a hoe'

σ

hoe-epenthesis-instrument-one with

c&ö@mai-t-a-ku$d`-dam 'one with an instrument for making tortillas'

tortilla-to make-epenthesis-instrument-one with

The forms of four syllables in (15a), with an epenthetic vowel in the third syllable, surface with stress on the first and fourth syllables. This is markedly different than the patterns for quadrisyllables in (13b) and (13b), where the first and third syllables are stressed. The first and fourth syllables are also stressed for the form of five syllables in (15b). In both (15a) and (15b), the odd epenthetic vowel is unstressed and the following vowel is stressed.

In considering these two sets of data, we find the following descriptive generalizations. First, epenthetic vowels in both even and odd position are never stressed. Second, nonepenthetic vowels are almost always stressed in odd position. The only case where nonepenthetic vowels are unstressed in odd position is when an epenthetic vowel is in odd position (15b). This is also the only case where a nonepenthetic vowel is stressed in even position, when it follows an odd epenthetic vowel.

The distributional patterns for epenthetic vowels are summarized by the chart in (16).[6] The chart is divided into two major subgroupings, one for even epenthesis, and the other for odd epenthesis. As

[6]There is a set of words that I do not consider here, words of the shape *ga@tw-id-a-d-ka$m* 'one who is good at shooting'. There are three reasons as to why the forms are absent. First, while the primary stress is unambiguously word-initial, my field notes contain only a few of these forms, and

above, epenthetic vowels are underlined. One addition is the inclusion of foot structure, indicated by parentheses. The locus of epenthesis is indicated, as is the size of the word in syllables.

(16) Distributional Patterns For Epenthetic Vowels:

	Epenthesis in even position			Epenthesis in odd position	
s count	Syllable with Epenthesis	Normal		Syllable with Epenthesis	Normal
3	2	(σ@<u>σ</u>)(σ$)$			–
4	2	(σ@<u>σ</u>)(σ$σ)		3	(σ@σ)<u>σ</u>(σ$)
5	4	(σ@σ)(σ$<u>σ</u>)(σ$)		3	(σ@σ)<u>σ</u>(σ$σ)
6	4	(σ@σ)(σ$<u>σ</u>)(σ$ σ)			—

The chart above gives forms with even epenthesis for words of three to six syllables. In all of these forms, each odd syllable is stressed. Additionally, the epenthetic vowel falls in the weak position of the foot. In contrast, words with an epenthetic vowel in odd position are limited to words of four and five syllables. The absence of words of three syllables is because an epenthetic vowel

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speaker judgments prefer a fourth syllable, although there are a few cases where pronunciations sound as if the third, and not the fourth, syllable of the word is stressed. More forms of this type need to be collected to determine precisely what the facts are. Second, these forms reflect truncation of the suffix, so that surface *ga@tw-id-<u>a</u>-d-kam* 'one who is good at shooting' reflects the shorting of the -*dag* suffix when it is followed by -*kam*. We expect **ga@tw-id-<u>a</u>-dag-kam*, but this longer form is unattested. The following chapter presents words that are morphologically truncated, but these words are nouns, and hence not morphologically truncated, as noted in Zepeda (1984). Therefore, the status of these forms as potential counterexamples to the analysis depends on how this different, uninvestigated truncation works. The issue is put aside for future research.

would have to fall in either the first or third syllable. This is not possible with the environment for epenthesis falling between a base and a suffix. Words of six syllables are also absent because of the upper limit of three syllables on the size of verb bases and the distribution and selectional restrictions for suffixes. An epenthetic vowel in odd position can fall only in third position, thus limiting the number of possible word sizes.

3.3.2 Summary

The following points have been shown in this section. First, epenthetic vowels are unstressed, regardless of position. Second, nonepenthetic vowels are stressed in odd position. The only case where nonepenthetic vowels are stressed is when they follow an epenthetic vowel in odd position. And finally, we continue to see evidence that a final secondary stress surfaces in morphologically complex forms.

3.4 The STRESS-TO-MORPHEME PRINCIPLE

In this section, the analysis of epenthetic vowels is presented. The account of even epenthetic vowels follows from the analysis of polymorphemic forms argued for in Chapter Two. However, accounting for the odd epenthetic vowels requires some modification. The proposal made in this section is the STRESS-TO-MORPHEME PRINCIPLE (SMP), which requires all stressed elments to belong to a morpheme. This principle is the logical counterpart of the MORPHEME-TO-STRESS PRINCIPLE proposed in the previous chapter, and enabling the relationship between morphemes and stress to be evaluated in two possible ways. The first condition requires morphemes to include a stressed syllable, while the second condition requires a stressed syllable to be included in a morpheme.

3.4.1 The Analysis of Even Epenthetic Vowels

The first set of data to be accounted for is the pattern of odd syllable stress in forms with even epenthesis. The hierarchy argued for in the previous chapter is given in (12):

(17) *CLASH, FOOTFORM È *LAPSE È MORPHEME-TO-STRESS PRINCIPLE È FOOTBINARITY È PARSE-σ

In addition to accounting for the monomorphemic and polymorphemic forms in Chapter Two, this hierarchy will also account for polymorphemic forms with an epenthetic vowel in an even syllable. This section argues that the same result obtains regardless of which even-numbered syllable is epenthesized and regardless of the size of the word. We examine each of the types of data (second or fourth syllable epenthesized and word varying from three to six syllables).[7]

The first set of forms to be examined are those such as *wu@d`-a-da$g*, 'good at roping', which surface with epenthetic vowels in the second syllable. Because our interest lies in the prosodic consequences of this epenthetic element, all previously argued for prosodic constraints are present in the tableau below. The optimal output, (18a), parses all syllables into feet and stresses the first and third syllables in the word.

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[7] I assume that the constraints motivated in the previous section are incorporated into this hierarchy, although I will not address how those epenthetic constraints will be ranked with the prosodic constraints.

(18) Evaluation of /wud`-dag/ 'good at roping'

/wud`-dag/ 'good at roping'	FT FM *CLASH	*LAPSE	MSP	FTBIN	PARSE
pa. ([wu@d`]a)([da$g])				*	
b. ([wu@d`]a)[dag]			*!-dag		*
c. ([wu@d`])(a[da$g])	*!			*	
d. ([wu@d`])a([da$g])		*!		**	*

Candidate (18a) violates only FOOT BINARITY – with both of its two morphemes stressed, no other constraint incurs a violation. The contrasts directly with (18b), which violates both the MORPHEME-TO-STRESS PRINCIPLE and the PARSE-σ constraint by failing to parse the suffix into the head position of a foot. It is the violation of the MORPHEME-TO-STRESS PRINCIPLE that is fatal for (18b). Candidate (18c) is excluded by its violation of a constraint in the top block, FOOT FORM, and (18d) has two degenerate feet. However, (18d) is ruled out by the fatal violation of *LAPSE.

A similar process of evaluation occurs for a quadrisyllabic form with an epenthetic vowel in the second syllable, such as *mö@d`-a-ku$d`-dam* 'one with an instrument for running'. The optimal candidate, (19a) below, incurs only one violation on all six constraints. It violates the MORPHEME-TO-STRESS PRINCIPLE, as it has one suffix that surfaces without stress:

(19) Evaluation of /möd`-kud`-dam/ 'one with an instrument for running'

/möd`-kud`-dam/ 'one with an instrument for running'	FT FM *CLASH	*LAPSE	MSP	FT BIN	PARSE
pa. ([mö@d]a)([ku$d`][dam])			*-dam		
b. ([mö@d]a)([ku$d`])([da$m])	*!			**	
c. ([mö@d])a([ku$d`][dam])		*!	*-dam	*	*
d. ([mö@d])(a[ku$d`])([da$m])	**!			**	

By failing to stress the suffix *-dam*, (19a) violates the MORPHEME-TO-STRESS PRINCIPLE once; the same is true of (19c), which is excluded by the *LAPSE constraint. Both (19b) and (19d) violate higher ranked constraints. Candidate (19b) is discarded when it violates the constraint banning stress clash, and candidate (19d) earns one violation each for FOOT FORM and *CLASH by surfacing with an iambic foot.

The second set of outputs to consider are those appearing with epenthetic vowels in the fourth syllable of the word. The outcomes are consistent with those for outputs with epenthetic even vowels. Here we evaluate forms of five and six syllable, such as *c&ö@pos-i$d-a-ku$d1* 'instrument for branding', and *pi@-pisa$l-t-a-ku$d`-kaj&* 'one with a scale'. The first of the two is evaluated in (20) below; again we see that the optimal candidate incurs only one violation, here on FOOT BINARITY:

(20) Evaluation of / c&öpos-id-kud/1 'instrument for branding'

/c&öpos -id-kud/1 'instrument for branding'	FTFM *CLASH	*LAPSE	MSP	FTBIN	PARSE
pa.([c&&ö@po)(s][i$d] a)([c&u$d])				*	
b.([c&ö@po)(s][i$d] a) [c&ud]			*!-c&ud		*
c.([c&&ö@po)(s][i$)d] a ([c&u$d])		*!		**	*
d. ([c&ö@po)(s][i$d])(a [c&u$d])	*!			*	

Of the candidates above, the top-ranked block of constraints is violated only by (20d), which is excluded from consideration as optimal. All of the above candidates satisfy *LAPSE, save for (20c), which has a medial unfooted syllable. One of the remaining candidates, (20b) violates the MORPHEME-TO-STRESS PRINCIPLE by surfacing without stress on its final suffix. The optimal candidate has only one violation on FOOTBINARITY, and so better satisfies the constraint hierarchy to emerge as the output.

The second output to be considered is *pi@-pisa$l-t-a-ku$d`-kaj&* 'one with a scale'. Again, the form with an epenthetic vowel in even position surfaces with stress in all odd syllables. This output (21a) emerges with two violations on the MORPHEME-TO-STRESS PRINCIPLE, but crucially satisfying FOOTBINARITY.

(21) Evaluation of /pi-pisal-t-kud`-kaj&/ 'one with an instrument for weighing'

/pi-pisal-t-kud`-kaj&/ 'one with an instrument for weighing'	FtFm *Clash	*Lapse	MSP	FtBin	Parse
pa.([pi@][pi)(sa$l][t]a)([ku$d`][kaj&])			*-t *-kaj&		
b.([pi@])([pi$sal])([t]a$[kud`])([ka$j&])	*!		*-t *-kud1	**	
c.([pi@])([pisa$l])([t]a[ku$d`])([ka$j&])	***!		*-t	**	
d.([pi@])([pisa$l])([t]a[ku$d`])[kaj&]	**!		*-t *-kaj&	*	*
e.([pi@][pi)(sa$l])[t]a([ku$d`][kaj&])		*!	*-t *-kaj&	*!	*

The nonoptimal candidates a re ruled out for a variety of violations; the outputs in (21b-d) all incur at least one violation on the top-ranked block of constraints. (21b) violates *CLASH. (21c) violates FOOTFORM twice and *CLASH once. (21d) violates FOOTFORM twice. All three are nonoptimal. (21e) violates *LAPSE, so the hierachy chooses (21a).

The tableaux in this section demonstrate that the hierarchy of Chapter Two accounts for words with epenthetic vowels in even position. This is unsurprising, given that these words pattern with polymorphemic words without epenthesis.

In summary, all of the possible forms with epenthesis in even positions satisfy the previously motivated constraint hierarchy. Nothing additional is required. The rankings of argued for in

Chapter Two suffice in accounting for the stress patterns of words with epenthetic vowels in even position.

3.4.2 The Analysis of Odd Epenthetic Vowels

We can similarly examine the patterns of words with odd epenthetic vowels. However, the stress pattern of these words is not correctly predicted by the current constraint ranking. Rather, the hierarchy predicts that forms with odd epenthetic vowels surface with all odd syllables stressed. As a result, an input like *hidod`-a-kud`* 'cooking pot' is predicted to incorrectly surface as **hi@dod`-a$-kud`* rather than the actual surface form, *hi@dod`-a-ku$d`*. This is demonstrated in the tableau in (22), where (22a) is the actual surface form, but (22b) is incorrectly predicted as optimal.:

(22) Nonoptimal evaluation of /hidod`-kud`/ 'instrument for cooking'

/hidod`-kud`/ 'instrument for cooking'	FTFM *CLASH	*LAPSE	MSP	FTBIN	PARSE
a.([hi@dod`])a([ku$d`])		*!		*	*
kb.([hi@dod`])(a$[kud`])			*-kud`		
c.([hi@dod`])(a[ku$d`])	*!				
d.([hi@)(do$d`]a)([ku$d`])	*!			**	
e. [hi(do$d`]a)([ku$d`])		*!		*	*

Candidates (22c-d) are excluded by constraints from the top-ranked block. (22c) violates FOOTFORM, (22d) violates *CLASH. (22e) violates *LAPSE. Both (22a) and (22b) satisfy this block of constraints, allowing lower-ranked constraints to play a role. The attested output, (22a) violates *LAPSE with a sequence of two unstressed syllables followed by a stressed syllable. Satisfaction of

*LAPSE predicts, incorrectly, that (22b) is the optimal output, despite its violation of the still lower MORPHEME-TO-STRESS PRINCIPLE. The hierarchy does not make the correct predictions for epenthetic vowels in odd position; it wrongly predicts that they should be stressed in such words. The problem is that nothing prefers a foot headed by a nonepenthetic vowel, so *LAPSE rules against the candidate with the unparsed syllable (22a), meaning that the optimal candidate parses all syllables into syllabic trochees (22b).

One solution would be to rank *LAPSE below the MORPHEME-TO-STRESS PRINCIPLE, so that (22a) is predicted as optimal. Such a solution cannot be used because we saw evidence for the opposite ranking in the previous chapter. *LAPSE must outrank the MORPHEME-TO-STRESS PRINCIPLE to predict *'a@suga$l-mad* 'adding sugar'. When *LAPSE ranks below the MORPHEME-TO-STRESS PRINCIPLE, **'a@sugal-ma$d* 'adding sugar' is incorrectly predicted as the optimal output. We cannot reverse the ranking of *LAPSE and the MORPHEME-TO-STRESS PRINCIPLE for the analysis of epenthetic vowels in odd position.

A second solution could invoke a constraint that penalizes forms with stressed epenthetic vowels. This can be done directly or indirectly. The proposal I argue for here, the STRESS-TO-MORPHEME PRINCIPLE, indirectly prohibits stressed epenthetic vowels. By appealing to the fact that epenthetic vowels do not belong to morphemes, this constraint bans stressed vowels because these vowels do not belong to morphemes. The proposed constraint appears in (23):

(23) STRESS-TO-MORPHEME PRINCIPLE (abbreviated: SMP)

For every stressed mora, there exists a morpheme such that the mora is within the boundaries of the morpheme.

(∀ STRESSED MORA ∃ MORPHEME such that the STRESSED MORA falls within the domain of that MORPHEME).[8]

This constraint is the logical counterpart of the MORPHEME-TO-STRESS PRINCIPLE motivated in the previous chapter. The two constraints switch the variables quantified by the universal quantifier and the existential quantifier, so that both quantification possibilities are formalized as constraints. The advantages to this are threefold. First, both possibilities are constraints, and both are motivated by the data. Second, by defining both constraints in terms of the relationship between morphemehood and stressed syllables, the data is accounted for in a symmetrical fashion. The behavior of the epenthetic vowel in Tohono O'odham is derived as a consequence of the morphology. This unifies the stress pattern of polymorphemic forms with and without epenthesis. Third, by linking the relationship between stress and morphemes in these two ways, we formally connect these two properties just as stress and weight are formally connected under the WEIGHT-TO-STRESS and STRESS-TO-WEIGHT PRINCIPLES. For all these reasons, the proposed constraint in (23) is adopted.

How does this constraint operate? Recall from the tableau in (22) that the incorrect selection is made by *LAPSE. The STRESS-TO-MORPHEME PRINCIPLE must dominate *LAPSE in order to correctly discard the nonoptimal candidate. This ranks the STRESS-TO-MORPHEME PRINCIPLE directly below the top-ranked block of constraints, and directly above *LAPSE in the constraint hierarchy. This ranking is given in the tableau in (24), where reevaluation selects the correct optimal candidate, (24a).

(24) Evaluation of /hidod`-kud`/ 'cooking pot'

/hidod`-kud`/ 'cooking pot'	FTFM *CLASH	S M	*LAPSE	MSP	FTBIN	PARSE

8I continue to assume the Percolation Convention for stressed moras (Archangeli 1984).

		P			
pa.([hi@dod`])a([ku$d`])			*	*	*
b.([hi@dod`])(a$[kud`])		*!		*-kud`	
c.([hi@dod`])(a[ku$d`])	*!				
d.([hi@)(do$d`]a)([ku$d`])	*!			**	
e. [hi(do$d`]a)([ku$d`])	*!		*	*	*

The only violation of the STRESS-TO-MORPHEME PRINCIPLE in the above tableau is incurred by (24b). Because the STRESS-TO-MORPHEME PRINCIPLE now outranks *LAPSE, this candidate is no longer incorrectly selected as the optimal output. In fact, the introduction of the STRESS-TO-MORPHEME PRINCIPLE results in the correct surface output above. All of the other candidates satisfy this constraint by stressing only nonepenthetic vowels. (24c-e) continue to violate higher-ranking constraints, (24b) falls by the wayside with a violation on the STRESS-TO-MORPHEME PRINCIPLE. The optimal candidate, (24a), still violates *LAPSE, but the lower-ranking of this constraint means it does not play a role in determining the correct output, as it is too low-ranked for its violations to be significant in (24). Thus by incorporating the STRESS-TO-MORPHEME PRINCIPLE into the hierarchy above *LAPSE, the STRESS-TO-MORPHEME PRINCIPLE decides in favor of (24a), which leaves the epenthetic vowel unstressed and unfooted in the output. (The violation of PARSE–σ is too low to play a role in affecting the outcome of the candidate evaluation above.)

The revised constraint hierarchy also makes correct predictions for a more complex form, a quinquesyllabic word with an epenthetic vowel in the third syllable. The input for such a form surfaces with stress on only the first and fourth syllables, as in *c&ö@mai-t-a-ku$d`-dam*.

(25) Evaluation of /c&ömai-t-kud`-dam/ 'one with an instrument for making tortillas'

/c&ömai-t-kud`-dam/ 'one with an instrument for making tortillas'	FTFM *CLASH	SMP	*LAPSE	MSP	FTBIN	PARSE
pa. ([c&ö@mai])[t]a([ku$d`][dam])			*	*-t *-dam		*
b.([c&ö@mai])([t]a$)([ku$d`][dam])	*!	*		*-t *-dam	*	
c.([c&ö@mai])([t]a$[kud`])([da$m])		*!		*-t *-kud`	*	
d.([c&ö@mai])([t]a[ku$d`])([da$m])	**!		*	*-t	*	
e. ([c&ö@mai])([t]a$[kud`])[dam]		*!		*-t *-kud` *-dam		*

Candidate (25b) is excluded by a violation on *CLASH, respectively, while candidate (25d) is excluded by violations on both *CLASH and FOOTFORM. (25c) and (25e) each fatally violate the STRESS-TO-MORPHEME PRINCIPLE. (25a) is selected as the optimal output despite a violation on *LAPSE, as it best satisfies the highly ranked constraints in the hierarchy. For this tableau evaluation, constraints below the STRESS-TO-MORPHEME PRINCIPLE do not play a role in excluding or including the candidates, as the higher ranked constraints do all the work in candidate selection.

The input for (25) is rather complex. The selection of (25a) as optimal demonstrates the empirical adequacy of the current constraint hierarchy in a convincing manner. One additional evaluation bolsters this point further – the reevaluation of a form with epenthesis in an even syllable.

The tableau in (26) does precisely this. There is no change in the predictions made for the optimal output of forms with epenthetic vowels in even position. The predictions remain the same because the STRESS-TO-MORPHEME PRINCIPLE only rules out stressed epenthetic vowels, and output with stressed epenthetic vowels will be ruled out by other conditions for forms with even epenthesis.

(26) Evaluation of /pi-pisal-t-kud`-kaj&/ 'one with an instrument for weighing'

/pi-pisal-t-kud`-kaj&/ 'one with an instrument for weighing'	FTFM *CLASH	SMP	*LAPSE	MSP	FTBIN	PARSE
pa.([pi@][pi)(sa$l][t]a)([ku$d`][kaj&])				*-t *-kaj&		
b.([pi@])([pi$sal])([t]a$[kud`])([ka$j&])	*!	*		*-t *-kud1	**	
c.([pi@])([pisa$l])([t]a[ku$d`])([ka$j&])	***!			*-t	**	
d.([pi@])([pisa$l])([t]a[ku$d`])[kaj&]	**!			*-t *-kaj&	*	*
e.([pi@][pi)(sa$l])[t]a([ku$d`][kaj&])			*!	*-t *-kaj&	*	

The correct optimal candidate continues to be selected by the revised constraint hierarchy. In fact, only candidate (26b) violates the STRESS-TO-MORPHEME PRINCIPLE; however, this candidate is rejected from consideration at a much higher place in the hierarchy, as it violates *CLASH in the top block. As the top constraints are violated by (26b-d), only (26a) and (26e) are truly competing to surface as optimal. Both satisfy the STRESS-TO-MORPHEME PRINCIPLE. It is on *LAPSE that differing results emerge; (26a), the optimal candidate, satisfies it, while (26e) incurs a violation on this constraint.

The competition between outputs with even epenthesis is unaffected by the addition of the Stress-to-Morpheme Principle; the Stress-to-Morpheme Principle only plays a role in forms with odd epenthesis, where it correctly selects the optimal surface forms.

3.4.3 Summary

In this section, forms with even and odd epenthesis were accounted for. The analysis from Chapter Two consistently and correctly predicted the optimal output for forms with even epenthesis. These forms stress all odd syllables, just like polymorphemic forms without epenthetic vowels, so the two sets of data receive a uniform accounting. Forms with odd epenthetic vowels surface with a different stress pattern; they stress the first and fourth syllables in the word. The constraint hierarchy incorrectly predicted nonoccurring surface forms as optimal output. Specifically, the hierarchy produces output with first and third syllable stress, which results in a stressed epenthetic vowel. To rectify this problem, I proposed the Stress-to-Morpheme Principle. The Stress-to-Morpheme Principle is violated whenever an output has a stressed epenthetic vowel. This constraint dominates *Lapse. The introduction of the Stress-to-Morpheme Principle into a high position in the hierarchy changed the predictions for the optimal surface forms. The Stress-to-Morpheme Principle favored outputs where epenthetic vowels were unstressed. Words with epenthetic vowels in odd position surface with first and fourth syllables stressed as a consequence of the Stress-to-Morpheme Principle. Introducing this constraint to the hierarchy results in the correct optimal output surfacing for forms with odd epenthetic vowels. Furthermore, the Stress-to-Morpheme Principle has no affect on words with epenthetic vowels in even position. The hierarchy argued for so far accounts for all the data described in Chapters Two and Three. The current hierarchy is:

(27) *Clash, FootForm È Stress-to-Morpheme Principle È *Lapse È Morpheme-to-Stress Principle È FootBinarity È Parse-σ

3.5 An Alternative Analysis

In this section, I consider a possible alternative. This alternative is derivational, and demonstrates conclusively that such an approach creates an ordering paradox, similar to others discussed in the literature.[9]

3.5.1 A Derivational Alternative

A derivational account cannot work, regardless of whether the epenthetic vowel's behavior is characterized via epenthesis or deletion. The crucial asymmetry to account for is the fact that this vowel does not get stressed in odd position. This requires the vowel to be unfooted – which argues it appears after stress assignment. However, if the vowel is inserted following stress assignment, why are vowels in even position footed?

First let us examine a derivational account whereby epenthesis precedes stress assignment. Such an account correctly predicts the surface pattern of unstressed even epenthetic vowels, but fails in its account of odd epenthetic vowels.

(28) Derivational Account 1: Epenthesis before Stress

a.	Underlying	/hidod`-kud`/	/wud`-dag/
b.	Epenthesis	hidod`-a-kud`	wud`-a-dag

[9]An Optimality-based alternative might rely on a constraint forcing the heads of feet to obey faithfulness constraints, as in Alderete (1995). The proposal might be a notational variant of the STRESS-TO-MORPHEME PRINCIPLE, and so is not discussed here. If the proposal is ultimately not a notational variant, at least two objections to this approach can be raised. First, if the relevant category is the head of the foot, Alderete's proposal does not capture the asymmetrical behavior of onset versus rhyme material. Related to this, the Percolation Convention may not be useful under a head-based approach. Second, an alternative way to analyze the epenthesis might be for it to be present in the input, but as a semantically empty element. A semantically empty element is not a morpheme; under the STRESS-TO-MORPHEME PRINCIPLE, any element that is not a morpheme (regardless of whether it appears in the input) should not be stressed. However, under Alderete's proposal, the asymmetrical behavior of epenthetic type elements is due to their absence from the input, rather than the fact that they are not morphemes. Under this different approach to epenthesis, then, Alderete's proposal fails.

c.	Stress Assignment	(hi@do)(d`-a$-kud`)	(wu@d`-a)-(da$g)
d.	Surface	*(hi@do)(d`-a$-kud`)	(wu@d`-a)-(da$g)

If epenthesis precedes stress, there is no way to prevent the stressing of epenthetic vowels. The account cannot predict the correct surface forms. The same problem is true if we reverse the order so that epenthesis follows stress. This is shown below:

(29) Derivational Account 2: Stress before Epenthesis

a.	Underlying	/hidod`-kud`/	/wud`-dag/
b.	Stress Assignment	(hi@dod`)-(ku$d`)	(wu@d`-dag)
c.	Epenthesis	(hi@dod`)-a-(ku$d`)	(wu@d`-a-dag)
d.	Surface	(hi@dod`)-a-(ku$d`)	*(wu@d`-a-dag)

Under this version, we predict the incorrect stress pattern for those vowels in even position, as in the unattested **wu@d`1adag*.[10]

The next account assumes that the vowel is not epenthetic, but rather gets deleted in surface constructions. This account is the most problematic, as it makes two incorrect predictions rather than just one.

(30) Derivational Account 3: Deletion instead of Epenthesis

[10]One possible adjustment might be the Domino Condition (Halle and Vergnaud, 1987), which was proposed for the interaction of stress and epenthesis in Winnebago. However, metrical theory has not widely accepted this innovation; it is attested for Winnebago only in Halle and Vergnaud (1987) and there are various different formal alternatives in the literature (Hammond 1995c, Hayes 1995, Idsardi 1992, as well as other derivational accounts). It is clear that this approach is not without serious problems.

a.	Underlying	/hidod`a/	/musigo/	/hidod`a-kud`/	/musigo-dag/
b.	Stress Assignment	(hi@do)d `a	(mu@si)g o	(hi@do)(d`a$- kud`)	(mu@si)(go$- dag)
c.	Deletion	(hi@do)d `	(mu@si)g	(hi@do)(d`a$- kud`)	(mu@si)(go$- dag)
d.	Surface	(hi@do)d `	*(mu@si) g	*(hi@do)(d`a$- kud`)	(mu@si)(go$- dag)

If we propose a deletion rule to delete the vowel in *hidod`a* 'cooking', it will incorrectly predict deletion in *musigo* 'musician'. This prediction means that we would need to refine the deletion rule somehow to avoid the unattested **mu@sig* 'musician'. However, even if we were able to make correct predictions for surface *hi@dod`* 'cooking and *mu@sigo* 'musician', we would still fail to predict the correct output under affixation. If the vowel is part of the underlying representation rather than epenthetic, we expect the unattested **hi@dod`a$kud`*. This argues that any account (for example, Hale 1965, Saxton 1982, and Hill and Zepeda, 1992) that treats these vowels as present in the stem is an account that makes the incorrect prediction above.[11]

Whatever the treatment of the vowels, a derivational account is untenable. It makes the wrong predictions, and cannot adequately characterize the asymmetrical surface distribution. For this reason, such an account should be rejected.

3.5.2 Summary

In this section, I have argued against a possible alternative analysis. The alternative consisted of three possible derivational analyses. An approach which relies on rule-ordering cannot order

[11]The same criticisms also hold if the vowel appears underlyingly in the suffix, so this possibility is not explicitly analyzed above.

epenthesis before stress assignment without predicting the wrong surface forms for epenthetic vowels in odd position. The reversed ordering, where epenthesis follows stress assignment, predicts the wrong stress pattern for words with epenthetic vowels in even position. To get the correct surface forms, some type of adjustment to foot structure would be required. In contrast, the STRESS-TO-MORPHEME PRINCIPLE needs no adjustments to footing. A third derivational alternative is one in which the vowel is present in the input. If the vowel is part of the input, we predict wrongly that epenthetic vowels in odd position should be stressed. An additional prediction, also incorrect, is made; we predict that whatever deletion rule applies to such words also applies to words that do surface with final vowels. In fact, we do not get the surface form **mu@sig* 'musician'. The deletion rule would need to avoid applying to such forms. There is no derivational alternative which offers as neat an account as the STRESS-TO-MORPHEME PRINCIPLE. Based on the problematic predictions made by the alternatives, I conclude that the STRESS-TO-MORPHEME PRINCIPLE represents the best possible analysis of the data.

3.6 Conclusion

In this section, I did the following. First, I motivated the epenthetic vowel. Second, I described the pattern of words with epenthetic vowels in both even and odd position. Words with even epenthesis stress all odd syllables while words with odd epenthesis stress the first and fourth syllables. Third, I accounted for the data by incorporating a new constraint into the hierarchy, the STRESS-TO-MORPHEME PRINCIPLE. I demonstrated that this allows an account of all the epenthetic data.

In this section, the empirical point consisted of the description of the stress pattern of words with epenthetic vowels. The theoretical point made in this chapter is that the behavior of these vowels is rooted in the fact that they do not belong to morphemes.

4. MORPHOLOGICAL TRUNCATION AND STRESS

In this chapter, I describe the stress patterns of truncated words, analyze the patterns, and argue against a possible alternative analysis.

The empirical point of this chapter is to motivate the descriptive generalizations of truncated words. In general, truncated words are stressed like their nontruncated counterparts, with the exception that when a syllable is truncated, epenthetic vowels in odd position do get stressed. The theoretical point of this chapter lies in accounting for the fact that epenthetic vowels in odd position do get stressed under truncation. I show that these facts follow from the current hierarchy, mainly due to the fact that epenthetic vowels appear in closed syllables, where the coda consonant is part of a truncated morpheme. Therefore words with a subtractive morpheme (or a zero morpheme) thus surface with an extra stress in order to overtly mark those morphemes without featural or segmental content.

These points continue the empirical and theoretical themes of this dissertation. The empirical goal of this dissertation is the description of the secondary stress system in Tohono O'odham; here in this chapter, the stress patterns of truncated words are described. This set of data expands the empirical contribution of the previous chapter on epenthetic vowels by showing that these vowels do get stressed in one inflectional paradigm. The theoretical goal of the dissertation is to construct a model of the interaction of the morphology and the stress system. The model thus consists of two constraints: the MORPHEME-TO-STRESS PRINCIPLE (morphemes must be stressed), and the STRESS-TO-MORPHEME PRINCIPLE (stresses only appear on morphemes).

4.1 Introduction

The focus of this chapter lies with truncated words in Tohono O'odham. Words with even epenthetic vowels still surface with these vowels unstressed under truncation, but truncated words with odd epenthetic vowels stress such vowels. The basic pattern to be described and analyzed in this chapter is as in (1).

(1) Stress in nontruncated and truncated words with odd epenthesis

a. Nontruncated (imperfective aspect)		b. Truncated (perfective aspect)	
wa@kon-a-mö$d`	'to go and wash'	wa@kon-a$-m	'went and washed'
wash-epenthesis-to go		wash-epenthesis-to go; perfective	
ci@kpan-a-c&u$d	'to make someone work'	c&i@kpan-a$-c&	'made someone work'
work-epenthesis-causative		work-epenthesis-causative; perfective	

The nontruncated imperfective forms in (1a) surface with first and fourth stress, and epenthetic vowels are unstressed. In contrast, the truncated perfective words in (1b) surface with first and third stress, and epenthetic vowels are stressed. The task of this chapter is accounting for the pattern of stress that emerges under truncation, particularly as relates to the stressing of epenthetic vowels. In fact, the crucial observation is that *wa@kon-a$-m* 'went and washed' is metrically and morphologically identical to *'a@suga$l-t* 'to make sugar'. The word-final consonant is the sole realization of a morpheme, which in this metrical system must get stressed.

If we view the emergent stressability of epenthetic vowels as a consequence of the addition of an abstract morpheme, a relatively simple account of this pattern follows. The behavior of odd epenthetic vowels in truncated words is due to the same constraints that force final stress in other polymorphemic words. For a morpheme without segmental or featural content, like a truncated word, the extra morpheme must be signaled overtly by means of the stress system. Thus the epenthetic vowel gets stressed only in service of the morphology. This analysis accounts for all truncated words, including those which do not surface with epenthetic vowels.

This chapter is organized in the following manner. First, I present the general facts of truncation in Tohono O'odham. Second, I describe the stress facts of truncated words. This is followed by an analysis of these facts; specifically I argue that a constraint forces morphemes to be present in the output. Finally, I present an alternative and demonstrate its inadequacy. The alternative applies the output-based correspondence constraints of Benua (1995) and McCarthy and Prince (1995), militating against truncated words that do not match the phonology of their bases. This approach simply does not capture the descriptive generalizations, and cannot predict the correct output for words with epenthetic vowels in odd position.

4.2 Background on Tohono O'odham Truncation

In this section, I describe the morphological truncation that occurs in Tohono O'odham.[1].

Tohono O'odham perfectives are formed by truncation. This process has been couched in derivational terms in the literature (see Hill and Zepeda 1992, Lombardi and McCarthy 1991, Weeda 1992, and others). Fitzgerald and Fountain (1995a, 1995b) characterize the data in terms of surface generalizations. The facts of Tohono O'odham perfective formation are as follows: One segment is truncated from the right edge in the word, unless the antepenultimate segment is a [coronal] followed by a [high] vowel. When this configuration is present, two segments are truncated from the right edge of the imperfective.

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[1]This discussion is taken mainly from Fitzgerald and Fountain (1995, 1996).

The analysis of these facts is achieved by invoking the notion "minimal violation", whereby constraints may be violated, but only minimally. The general pattern thus consists of truncating one segment to effect the aspectual change. Two segment truncation arises when a higher-ranked constraint militates against coronal consonants followed by high vowels, *COR-HI.

4.2.1 A General Description

The data in (2) present the two basic patterns of truncation. These patterns are given below. The cases of one segment truncation appear in (2a), and the cases of two segment truncation appear in (2b)

(2) Morphological Truncation in Tohono O'odham

	Imperfective	Perfective	Gloss
a.	hi@wa	hi@w	'rubbing against object'
	ma@ùk	ma@ù	'giving'
	hi@kck	hi@kc	'cutting'
	hi@him	hi@hi	'walking (pl)'
	n)ö@n)ok	n)ö@n)o	'speaking (pl)'
	na@kog	na@ko	'enduring'
	c&ö@’öwid	c&ö@’öwi	'covering (sg and pl)'

b.	mö@liw	mö@l	'arriving by running or driving'
	s7ö@lin	s7ö@l	'straightening'
	c&ö@ùc&ög	c&ö@ùc&	'calling out name of obj'
	bi@ac&ug	bi@ac&	'carrying obj on serving plate'
	bö@ic&ug	bö@ic&	'carrying obj'
	c&ö@posid	c&ö@pos	'branding'

The perfective forms in (2a) truncate one segment. These forms do not have a sequence of [coronal] [high] before the final consonant. The majority of truncated forms in Tohono O'odham follow the pattern in (2a). The forms above show that either final vowels or consonants may truncate. A further observation is that forms with complex codas, such as *hi@kc&k* 'cutting' and its perfective, *hi@kc&* 'cut,' truncate only the final segment. In the perfective forms in (2b), two segments truncate. The imperfective forms have a [coronal] [high] before the final consonant of the form, and the perfective forms truncate the [high] vowel and the final consonant.

4.2.2 Analysis

The analysis of this data relies on a constraint that forces a subtractive relationship between imperfective and perfective forms. To capture the relationship between the truncated form and the base, the perfective morpheme is formulated as a constraint. This constraint is presumably in a family with constraints on reduplication, such as RED≤BASE (McCarthy and Prince 1994a).

(3) TRUNC

Perfective output contains fewer segments than Imperfective output.

Second, to force truncation on the right edge only, two constraints suggested by McCarthy and Prince (1994a, 1995) are invoked, ANCHORING and CONTIGUITY. These two constraints conspire to guarantee the faithfulness of the output string when compared to the input string. ANCHORING ensures that the two either begin or end with the same segment, while CONTIGUITY ensures that they each consist of an identical, contiguous string. The specific formulation of these constraints for Tohono O'odham truncation is given below.

(4) LEFT-ANCHOR (INPUT, OUTPUT)

Correspondence preserves alignment in the following sense: the left peripheral element of Input corresponds to the left peripheral element of Output.

(5) CONTIGUITY

a. I-CONTIG ("No skipping.")

The portion of Input standing in correspondence forms a contiguous string.

b. O-CONTIG ("No intrusion.")

The portion of Output standing in correspondence forms a contiguous string.

The tableau below demonstrates how the two constraints coordinate to govern the locus of truncation. CONTIGUITY is treated as a block containing both of its subparts; this in no way impacts the analysis, it only simplifies the tableau.

(6) Evaluation of trisyllabic form /RED-hidod`-TRUNC/:

/RED-hidod`-TRUNC/ 'to cook, plural, perfective'	L-ANCHOR	TRUNC	CONTIG	MAX_{IO}
a. hi@hido$d`		*!		
pb. hi@hido$				*
c. hi@hid				**!
d. hi@hi				**!*
e. i@hido$d`	*!			*

Truncation never occurs word-initially, and candidates which would surface with such a pattern (6e) are ruled out by L-ANCHOR. Candidates that are identical to the imperfective output, as in (6a), violate TRUNC. This leaves MAX_{IO} to sort out the remaining candidates, with (6b) selected optimal. One segment is truncated, and one violation only incurred on that faithfulness constraint.[2]

In turning to cases of two segment truncation, the hierarchy incorrectly predicts that such forms should surface as cases of one segment deletion. This incorrect prediction (indicated by k) chooses (7b) over the attested form, (7c).

[2]This ignores a number of variations in one segment truncation, but is certainly sufficient for the reader here. Fitzgerald and Fountain (1995,1996) accounts for all of the data, and I suggest these sources to the interested reader.

(7) Evaluation of trisyllabic form /c&ö@pos-id-TRUNC/

/c&ö@pos-id-TRUNC/ 'to brand, perfective'	L-ANCHOR	TRUNC	CONTIG	MAX_{IO}
a. c&ö@posid		*!		
kb. c&ö@posi				*
c. c&ö@pos				**!
d. c&ö@po				**!*
e. c&ö@p	*!			**!**

The selection of (7b) occurs because it incurs fewer violations of MAX_{IO} than the attested output in (7c). To rule out (7b), a higher constraint must dominate the faithfulness constraint to rule out words with final coronal consonant-high vowel sequences. This constraint, *COR-HI is in (8):

(8) *CORONAL-HIGH

The feature sequence of [coronal][high] is a banned configuration.

This constraint dominates the constraint banning deletion, to give us the constraint ranking in (9). Here the optimal candidate is correctly selected as (9c).

(9) Reevaluation of trisyllabic form /c&ö@pos-id-TRUNC/

/c&ö@pos-id-TRUNC/	L-ANCHOR	TRUNC	CONTIG	*COR-HI	MAX_{IO}
a. c&ö@posid		*!		**	
b. c&ö@posi				**!	*
pc. c&ö@pos				*	**
d. c&ö@po				*	**!*
e. c&ö@p	*!			*	**!**

Candidates begin with complete identity to the imperfective (9a) and successively truncate one more segment in each output down the tableau. Above (9b) is rejected by two violations on *COR-HI, while (9c-d) each incur only one violation. MAX_{IO} selects (9c) by virtue of the minimal violation it incurs compared with the other candidates.

This section has offered a description and analysis of Tohono O'odham truncation. The truncated form in (9c) results in the loss of a stressed syllable. For certain truncated words, the stress (rather than truncating) 'shifts' to another syllable. The understanding of truncation serves to illuminate the metrical facts of this language further.

4.2.3 Summary

Tohono O'odham verbs truncate either one or two segments from the imperfective aspect to form the perfective. Two-segment truncation occurs in those words where if only one segment were to be truncated, the word would end with a coronal consonant followed by a high vowel. The surface patterns are predicted by the interaction of constraints, TRUNC, which forces perfectives to differ subtractively from imperfective counterparts, and *COR-HI, which bans the configuration of a coronal consonant followed by a high vowel. The general pattern, one segment truncation, emerges because such forms best satisfy the lower-ranked MAX_{IO}. Additionally, *COR-HI does not obliterate all instances of this feature configuration; it is held in check by higher-ranking constraints, such as CONTIGUITY and LEFT-ANCHOR.

4.3 The Interaction of Stress and Truncation

In this section, the stress pattern of truncated words is described. I demonstrate that the stress contours of truncated words are identical to the stress contours of their nontruncated counterparts. Words that delete stressed syllables surface with different stress contours only if the word contains an unfooted epenthetic vowel.

4.3.1 Truncated Words Without Epenthetic Vowels

In this section, I describe the stress patterns of words that are morphologically truncated. The nontruncated words associated with these forms display the regular stress pattern, surfacing with stress on odd syllables. These forms also do not contain epenthetic vowels.

The first set of data is given in (10). The first column gives the nontruncated (imperfective) form, the second column gives the truncated (perfective) form, and the third column glosses the verb base. The words vary in size from two to five syllables in the nontruncated forms, and one to four syllables in the truncated words. In most of the examples in (10), two segments are lost, which means that the truncated form has one fewer syllable than its counterpart.

(10) Stress in Truncated Words without Epenthetic Vowels

	Nontruncated	Truncated	Gloss
a.	'ö pa@ùn-c&ud	'ö pa@ùn-c&	'to turn into bread'
	reflexive bread-causative	reflexive bread-causative; perfective	
b.	si@kon	si@ko	'to hoe object'
	hoe	hoe; perfective	
c.	hi@dod`	hi@do	'to cook'
	cook	cook; perfective	
d.	c&ö@pos-i$d	c&i@pos	'to brand object'
	brand-benefactive	brand-benefactive; perfective	
e.	ba@hi-j&i$d	ba@hi-j&	'to eat object'
	eat-benefactive	eat-benefactive; perfective	
f.	hi@-hido$d`	hi@-hido$	'to cook, plural'
	plural-cook	plural-cook; perfective	
g.	wa@-pc&uwi$-c&ud	wa@-pc&uwi$-c&	'to make someone swim, plural'
	plural-swim-causative	plural-swim-causative; perfective	

h. wa@cuwi$-c&ud wa@cuwi$-c& 'to make someone swim'

swim-causative swim-causative; perfective

i. pa@koí'ola$-c&ud[3] pa@koí'ola$-c& 'to make someone Pascola dance'

Pascola dance-causative Pascola dance-causative; perfective

Disyllables (10a,b) surface with one stress only in both nontruncated and truncated words. In such a word, if a syllable is lost, it is unstressed (10a). Trisyllables (10c-e) surface with two stresses in the nontruncated word (first and third) and one stress in the truncated form (first). This form involves the loss of segments that would otherwise be stressed in the surface form. Nontruncated words of four syllables, as in (10f-h), stress the first and third syllable, as do their trisyllabic truncated counterparts.

4.3.2 Truncated Words with Epenthetic Vowels

In this section, the truncation patterns for words with epenthetic vowels are described. In these types of forms, the truncation of stressed syllables result in stressed epenthetic vowels in odd position, where such vowels are unstressed in nontruncated forms. The truncation of stressed syllables in forms with even epenthetic vowels does not produce the same pattern.

The data in (11) is set up exactly like the previous set of data in (10), with the first column representing the nontruncated forms, the second column representing truncated forms, and the third column giving the glosses of imperfective forms. The data below divides into forms with odd epenthetic vowels (11a-e) and forms with even epenthetic vowels (11f-g). The truncated versions of both forms surface with first and third syllables stressed. With truncation, a word like (11a) has three morphemes, two of them with segmental content.

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[3]The vowel-glottal stop-vowel sequence was treated as a single vowel in this instance, and so the form constitutes a quadrisyllabic output.

(11) Stress in Truncated Words with Epenthetic Vowels

	Nontruncated	**Truncated**	**Gloss**
a.	wa@kon-a-mö$d`	wa@kon-a$-m	'to go and wash'
		wash-epenthesis -to go; perfective	
b.	c&i@kpan-a-c&u$d	c&i@kpan-a$-c&&	'to make someone work'
		work-epenthesis -causative; perfective	
c.	c&i@kpan-a-mö$d`	c&i@kpan-a$-m	'to go and work'
		work-epenthesis -to go; perfective	
d.	ga@tw-id-a-c&u$d	ga@tw-id-a$-c&	'to shoot at object for someone'
		shoot-benefactive-epenthesis -causative; perfective	
e.	ga@-gtw-id-a-c&u$d	ga@-gtw-id-a$-c&	'to shoot at object for someone, plural'
		plural-shoot-benefactive-epenthesis -causative; perfective	
f.	c&ö@pos-i$d-a-c&u$d	c&ö@pos-i$d-a-c&	'to make someone brand object'
		brand-benefactive-epenthesis -causative; perfective	
g.	ba@hij&-i$d-a-c&u$d	ba@hij& -i$d-a-c&	'to make someone eat object'
		eat-benefactive-epenthesis -causative; perfective	

The first set of forms in (11) are those quadrisyllabic nontruncated words with stress on the first and fourth syllables. In their truncated counterparts, the forms are trisyllabic with stress on the first and third syllable, as shown in (11a-e). The second group of forms are quinquesyllabic; they have even epenthetic vowels in the nontruncated forms, and surface with stress on the first, third, and fifth syllables of the word. Their truncated forms are quadrisyllabic, with stress on the first and third syllables.

4.3.3 The Descriptive Generalizations

In this section, the descriptive generalizations of the data in (10) and (11) are presented. First, in comparing nontruncated and truncated words, nonepenthetic vowels that are stressed in odd position in the nontruncated word are also stressed (if present) in the truncated form. Second, there are no stressed even vowels in truncated words. Third, epenthetic vowels are always unstressed in even position, whether the word is truncated or not. Finally, epenthetic vowels in odd position are stressed in truncated words.

The chart in (12) represents these patterns in an abstract schematization. The first column of the chart indicates the number of syllables in the nontruncated form. The second column gives an abstract example of the stress pattern of the nontruncated form. The next two columns do the identical things, except that the third column indicates the number of syllables in truncated words, and the fourth column indicates the stress contour of the truncated form. Where truncated outputs exhibit variability in possible output, this is indicated by multiple rows in the column for a particular size (for example, two syllables for nontruncated words corresponds with either one or two syllables in the truncated forms).

(12) Chart of Generalizations For Truncated Words (epenthetic vowels underlined)

# of Syllables	Nontruncated Form	# of Syllables	Truncated Form
2	(σ@σ)	2	(σ@σ)
2	(σ@σ)	1	(σ@)
3	(σ@σ)(σ$)	3	(σ@σ)(σ$)
3	(σ@σ)(σ$)	2	(σ@σ)
4	(σ@σ)(σ$σ)	3	(σ@σ)(σ$)
4	(σ@σ)σ(σ$)	3	(σ@σ)(σ$)
5	(σ@σ)(σ$σ)(σ$)	4	(σ@σ)(σ$σ)

The comparison between nontruncated and truncated yields certain observations. First, in several cases, forms which end with degenerate feet in nontruncated words correspond with truncated words without degenerate feet. In one case, however, this is not true. Nontruncated quadrisyllables with epenthesis in the third syllable end with degenerate feet in both outputs. Interestingly, these forms are also the only forms with unfooted syllables. Second, the stress contours for all truncated forms are the same – first and third syllables are stressed. The same observation cannot be made for the stress contours of nontruncated words, as forms with odd epenthesis surface with first and fourth stress.

4.3.4 Summary

In this section, I described the stress patterns of truncated words. While nontruncated words display two distinct patterns of stress, truncated words surface with one pattern. Nontruncated forms surface with all odd syllables surfaced, if the form has no epenthetic vowels or has epenthetic vowels in even position. If the form has odd epenthesis, the nontruncated pattern stresses the first and fourth syllables of the word. Truncated words surface with all odd syllables stressed, regardless of the locus of epenthesis.

4.4 Analysis of the Interaction of Truncation and Stress

The leveling of the stress pattern in truncated words, such that every truncated word stresses all odd numbered syllables. This follows from the currently argued for constraint hierarchy, which predicts odd syllable stress in nontruncated words. The problem is to predict epenthetic heads in truncated forms.

4.4.1 Truncated Words without Epenthetic Vowels

Truncated words without epenthetic vowels surface with all odd vowels stressed, in concordance with the pattern that emerges in nontruncated words without epenthetic vowels. We expect, then, that such stress patterns follow easily from the constraint hierarchy motivated in Chapter Two. This expectation is borne out by the following tableau. Truncated words of two, three and four syllables without epenthesis are analyzed under the current constraint ranking. As these words do contain an additional morpheme, the subtractive perfective morpheme TRUNC, they incur an additional violation on the MORPHEME-TO-STRESS PRINCIPLE, should there not be an extra stress associated with this morpheme. The attested patterns for truncated words without epenthetic vowels is given in (13), where words with both one segment and one syllable truncation appear. The unattested forms all have as many stresses as morphemes in the word, but must be ruled out as possible output. The constraint ranking argued for thus far does precisely this.

(13) Comparison of attested and unattested stress patterns

	Truncated	Nontruncated	Unattested
a.	(si@ko)	(si@kon)	*(si@)(ko$)
b.	(pa@ùnc&)	(pa@ùnc&ud)	–
c.	(hi@hi)(do$)	(hi@hi)(do$d`)	*(hi@)(hi$)(do$)
d.	(c&i@c&wic&)	(c&i@c&wi)(c&u$d)	*(c&i@c&)(wi$c&)
e.	(wa@c&u)(wi$c&)	(wa@c&u)(wi$c&ud)	*(wa@)(c&u$)(wi$c&)

The attested forms all follow the general pattern of odd syllable stress seen in Tohono O'odham, with final stress permitted as words are polymorphemic. Given that we have seen in a number of places that stress clash is banned in Tohono O'odham, we anticipate that the unattested forms are easily excluded by the hierarchy. To prove that this is so, a series of tableaux evaluate the forms from (13).

The tableau in (14) demonstrates how this evaluation proceeds. The output is a disyllable that has truncated a single segment, meaning that the imperfective and perfective forms both have two syllables. The stress pattern of the truncated word is identical to the nontruncated form; only the initial syllable is stressed (14e). Any other stress pattern for this word would violate higher-ranked constraints.

(14) Evaluation of /sikon-TRUNC/

/sikon-TRUNC/ 'to sweep, perfective'	FTFM *CLASH	SMP	*LAPSE	MSP	FTBIN	PARSE
pa. (si@ko)				*-TRUNC		
b.(siko@)	*!			*-TRUNC		
c. (si@)(ko$)	*!				**	

(14a) mimics the stress pattern of the nontruncated counterpart by stressing only the initial syllable. A violation of the MORPHEME-TO-STRESS PRINCIPLE is incurred because there is no stress that can be assigned to this morpheme. However, this violation is irrelevant, as competing candidates violate constraints higher on the hierarchy. *FOOTFORM is violated by (14b), as the form surfaces with an iambic foot. The adjacent stresses in (14c) mean that that output violates *CLASH. This produces output (14a).

The evaluation goes similarly for a disyllabic imperfective that truncates an entire syllable in the perfective form. With a monosyllabic output, only two real possible outputs are possible: one stressed, the other unstressed. Both are given in (15).

(15) Evaluation of /paùn-c&ud-TRUNC/

/paùn-c&ud-TRUNC/ 'to turn into bread, perfective'	FT FM *CLASH	SMP	*LAPSE	MSP	FT BIN	PARSE
pa. (pa@ùnc&)				*-c&ud *TRUNC	*	
b. paùnc&	*!			*-paùn *-c&ud *TRUNC		*

The output in (15a) emerges as optimal because it satisfies the higher-ranked constraints, while its competitor, (15b), violates ALIGNPROSODICWORD. The evaluation stops there, although if it were to proceed lower, the same result would obtain. (15b) is nonoptimal and thus represents an unattested surface form.

Slightly more complex in evaluation are trisyllabic imperfectives. Some of these imperfectives truncate a segment, while others truncate an entire syllable. In (16), an example of the former appears. The optimal output is a form where the first and third syllables are stressed, shown in (16a).

(16) Evaluation of /RED-hidod`-TRUNC/

/RED-hidod`-TRUNC/ 'to cook, plural, perfective'	FTFM *CLASH	SMP	*LAPSE	MSP	FTBIN	PARSE
pa. (hi@hi)(do$)				*TRUNC	*	
b.(hi@hi)do				*hidod` *!TRUNC		*
c. (hi@)(hi$)(do$)	*!				***	

Three outputs are evaluated in (16). The first stresses the first and third syllables (16a). The second stresses only the first syllables (16b), while the third output stresses all three syllables. The top block of constraints rules out (16c), with a *CLASH violation. Even though each morpheme is considered to be stressed, the resulting clash excludes this candidate from consideration. The competition between (16a) and (16b) is settled by their respective behaviors on the MORPHEME-TO-STRESS PRINCIPLE, where (16b) has one more violation than (16a). (16a) surfaces as the optimal output in this case.

The evaluation of the output which has truncated an entire syllable appears in (17). With a disyllabic output, stress can fall on the first, second, or both syllables, as shown below.

(17) Evaluation of /c&ic&wi-c&ud-TRUNC/

/c&ic&wi-c&ud-TRUNC/ 'to make someone play, perfective'	FT FM *CLASH	SMP	*LAPSE	MSP	FT BIN	PARSE
pa. (c&i@c&wic&)				*-c&ud *TRUNC		
b.(c&i@c&)(wi$c&)	*!			*TRUNC	**	
c. (c&ic&wi$c&)	*!			*c&ic&wi *TRUNC		

The form with one stress on the first syllable (17a) only violates the MORPHEME-TO-STRESS PRINCIPLE, as two morphemes are unstressed in a word of three morphemes and one stressed syllable. However, the competing candidates violate higher ranked constraints, which means that (17a) is the optimal candidate. The output in (17b) is excluded by the *CLASH violation incurred by its adjacent stresses, while (17c) fails on FOOT FORM with second syllable stress.

Quadrisyllabic forms are only attested with perfectives that truncated an entire syllable, as in the pair *wa@c&uwi$c&ud* and *wa@c&uwi$c&* 'to make someone bathe'. These forms surface with the same general stress pattern for polymorphemic words, stressing all odd syllables. In (18), the tableau shows precisely this effect.

(18) Evaluation of /wac&uwi-c&ud-TRUNC/

/wac&uwi-c&ud-TRUNC/ 'to make someone bathe, perfective'	FT FM *CLASH	SMP	*LAPSE	MSP	FT BIN	PARSE
pa. (wa@c&u)(wi$c&)				*TRUNC	*	
b.(wa@c&u)wic&				*!-c&ud *-TRUNC		*
c. (wa@)(c&u$)(wi$c&)	*!				***	

The word has three morphemes: a base, a suffix and a subtractive morpheme. Any form with fewer than three stresses violates the MORPHEME-TO-STRESS PRINCIPLE. This is true of both (18a) and (18b). However, the candidate that does have three stresses, (18c), fails in this competition because of a violation on *CLASH. The decision of which is optimal, (18a) or (18b), falls to the MORPHEME-TO-STRESS PRINCIPLE. (18a) wins as it has only one violation, and (18b) has two.

The hierarchy argued for in Chapters Two and Three does account for these truncated words, showing that no further modification is needed. The constraint rankings can account for the stress patterns of those words with both segmental and syllable truncation.

4.4.2 Truncated Words with Even Epenthetic Vowels

In this section, I demonstrate that the constraint hierarchy also accounts for truncated words with even epenthetic vowels. This is the case even though the preferred surface pattern for such words has fewer stresses than morphemes. The attested stress contours follow from the presence of highly ranked rhythmic constraints, particularly *CLASH.

For words with even epenthetic vowels and truncation, there is only one set of forms. These consist of trisyllabic bases with an epenthetic vowel in the fourth syllable, followed by a suffix.[4] The trisyllabic bases consist of two morphemes. The causative suffix, *-c&ud*, truncates two segments, resulting in the loss of an entire syllable for the word. The evaluation of such a form appears in (19), where the first and third syllables surface as stressed in the optimal form (19a).

(19) Evaluation of /c&öpos-id-c&ud-TRUNC/

/c&öpos-id-c&ud-TRUNC/ 'to make someone brand object'	FTFM *CLASH	SMP	*LAPSE	MSP	FTBIN	PARSE
pa. ([c&ö@po)(s][i$d]a[c&)				*-c&ud *TRUNC		
b. ([c&ö@po)(s][i$)(d]a$[c&)	*!	*		*-c&ud	**	
c. ([c&ö@po)(s][id]a$[c&)	*!	*	*	*-id *-c&ud		

[4]There is a gap in the data, as truncated words with epenthetic vowels in the second syllable were not collected.

The nonoptimal candidates, (19b,c) fail because they incur violations on the top block of constraints. *CLASH rules out (19b), as the output has adjacent stresses, and FOOTFORM violations work to the detriment of (19c). As (19a) satisfies this block of constraints, it constitutes the optimal output, even with its two violations on the MORPHEME-TO-STRESS PRINCIPLE. The tableau in (19) demonstrates that better satisfaction of the MORPHEME-TO-STRESS PRINCIPLE results in worse satisfaction of the higher ranked constraints, as in (19b).

The analysis presented in this section demonstrates that truncated words with even epenthetic vowels are accounted for by the hierarchy argued for previously.

4.4.3 Truncated Words with Odd Epenthetic Vowels

In this section, I account for the stress pattern of words with epenthetic vowels in odd position. These forms stress first and fourth syllables in the nontruncated form, and stress the first and third syllables in the truncated form. In particular, we are concerned with predicting that epenthetic vowels in odd syllable are stressed. The high ranking of the STRESS-TO-MORPHEME PRINCIPLE rules out any optimal output in which a stressed epenthetic vowel appears. We expect then that epenthetic vowels will not be stressed. However, the STRESS-TO-MORPHEME PRINCIPLE is satisfied when a stressed mora dominates a morphemic element. Under the Percolation Convention, this means that if some rhyme element is stressed, stress is passed to the entire syllable. This allows a stressed coda, even in a syllable with an epenthetic vowel, to satisfy the STRESS-TO-MORPHEME PRINCIPLE, if an element of the rhyme is morphemic. With the current rankings, the attested pattern of stress to surface in truncated forms with odd epenthetic vowels.

First we show that the hierarchy motivated so far predicts the attested pattern as the optimal output. The tableau in (20) demonstrates this.

(20) Evaluation of /c&ikpan-c&ud-TRUNC/

/c&ikpan-c&ud-TRUNC/ 'to make someone work'	FTFM *CLASH	SMP	*LAPSE	MSP	FTBIN	PARSE
pa. ([c&i@kpa)(n]a$[c&)				*-TRUNC	*	
b.([c&i@kpa)n]a[c&				*!-c&ud *TRUNC		*
c. ([c&i@k)(pan]a$[c&)	*!			*TRUNC	*	
d. ([c&i@k)(pa$n]a[c&)	*!			*-c&ud *TRUNC	*	

The attested output, (20a) with first and third syllables stressed, satisfies the STRESS-TO-MORPHEME PRINCIPLE because the coda is morphemic, even if the epenthetic vowel is not. The truncation forces a coda (a morphemic coda, in fact) into the syllable with the epenthetic vowel. The subtractive morpheme provides the catalyst that produces stressed epenthetic vowels. Candidate (a) thus incurs only one violation of the MORPHEME-TO-STRESS PRINCIPLE. (20b) fails on the MORPHEME-TO-STRESS PRINCIPLE with three morphemes and only one stress, resulting in two violations of this constraint. The remaining two forms, (20c,d), are both excluded by their failure on the top block of constraints. (20c) violates FOOTFORM, as its second foot is right-headed, and (20d) violates *CLASH.

A second trisyllabic truncated output is evaluated in (21) to reinforce the efficacy of the hierarchy. This form, *(ga@tw-i)(d-a$-c&)* 'to shoot at object for someone', has two morphemes in the base, plus a suffix, plus the subtractive morpheme. As a more complex form, it potentially creates a greater challenge to constraint evaluation. Despite this, the optimal form, (21a), is correctly chosen as optimal under the hierarchy.

(21) Evaluation of /gatw-id-c&ud-TRUNC/

/gatw-id-c&ud-TRUNC/ 'to shoot at object for someone'	FT FM *CLASH	SMP	*LAPSE	MSP	FT BIN	PARSE
pa. ([ga@tw][i)(d]a$[c&)				*-id *TRUNC	*	
b. ([ga@tw][i)d]a[c&				*-id *-c&ud *TRUNC		*
c. ([ga@t)(w][i$d]a[c&)	*!			*-c&ud *TRUNC	*	
d. ([ga@t)(w][id]a$[c&)	*!			*-id *-c&ud	*	

Candidate (21a) has four morphemes, with two of these stressed. The stressed epenthetic vowel signals the truncated suffix. Two morphemes do not get stressed in this output, but these violations on the MORPHEME-TO-STRESS PRINCIPLE are fewer than those incurred by the closest competitor, (21b). (21b) has only one stress, appearing on the base, which means that three morphemes are not stressed and three violations are incurred. This is fatal for (21b). The final two candidates, (231c) and (21d), fall out of favor due to violations on the top block of constraints, where *CLASH and FOOTFORM respectively rule out these candidates.

The hierarchy makes the correct predictions for the truncated words with epenthesis in odd position. Epenthetic vowels do get stressed, but only under truncation. The subtractive morphology forces a morphemic coda into the syllable with the epenthetic vowel. By the Percolation Convention, this means that such a form satisfies the STRESS-TO-MORPHEME PRINCIPLE.

4.4.4 Summary

In this section, I showed that the constraint hierarchy from Chapter Three does account for the stress patterns of all truncated words. In particular, the hierarchy makes the correct predictions for the truncated words with epenthetic vowels in odd position. I argued that following the Percolation Convention, epenthetic vowels in closed syllables will not violate the STRESS-TO-MORPHEME PRINCIPLE if the coda belongs to an otherwise unstressed morpheme.

4.5 Alternative Proposal

In this section, I explore an alternative proposal based on Correspondence Theory (McCarthy and Prince 1995, McCarthy 1995). The necessary background is given, and then I demonstrate the shortcomings of this approach.

4.5.1 Identity of the Base and Truncated Word

Correspondence Theory (McCarthy and Prince 1995, McCarthy 1995) has been proposed to account for identity between phonological strings in the following relations to each other: between the base and reduplicant (McCarthy and Prince 1995), between the input and output (McCarthy and Prince 1995), and between a base and a truncated word (Benua 1995) or two morphologically related words in different paradigms (McCarthy 1995). First, I outline how constraints apply between morphologically related outputs. Then I present a possible alternative analysis to the proposal made for truncated words here in this chapter.

Correspondence is defined in (22):

(22) Correspondence (McCarthy 1995: 4):

Given two strings S_1 and S_2, related to one another by some linguistic process, Correspondence is a relation *f* from any subset of elements of S_1 to S_2. Any element α of S_1 and any element β of S_2 are *correspondents* of one another if β is the image of α under Correspondence; that is, $\beta = f(\alpha)$.

Constraints in the Correspondence family include IDENT and MAX. These constraints require, for example, that features in the two strings are identical. Examples of these two constraints appear in (23):

(23)

a. MAX

Every element of S_1 has a correspondent in S_2.

Domain $(f) = S_1$

b. IDENT(ξF) Constraint Family

If α is [ξF] and $\alpha \in$ Domain (f), then $f(\alpha)$ is [ξF].

These constraints have been argued to hold over the various relations listed above. Of particular interest to us is the relationship between truncated words and their nontruncated counterparts. Benua (1995) argues that the relationship is the result of an identity effect from the correspondence relations diagrammed below:

(24) Base-Truncated Word Identity

B-T Identity

base -------------- truncated word

Input-Output |

Faithfulness |

input

The constraints in this family are generally invoked in the form of IDENT-BT [feature].[5] If such a constraint operated in Tohono O'odham, presumably it would require identity of stressed syllables. However, the critical problem raised by the Tohono O'odham data is not that base and truncated word need to share the same value of stress. Rather it is that in the truncated word, something must force the epenthetic vowel in odd position to surface with stress. If we propose an identity constraint to do this, as in (25), the evaluation of candidates in (26) shows that the predictions are incorrect.

(25) IDENT-BT [stress][6]

Base and truncated words share the same value for stress.

(26) Evaluation of /gatw-id-c&ud-TRUNC/ (base: ga@twidac&u$d)[7]

/gatw-id-c&ud-TRUNC/ 'to shoot at object for someone'	IDENT-BT [stress]	SMP	*LAPSE	MSP	FTBIN	PARSE
a. ([ga@tw][i)(d]a$[c&)	*!	*		*-id *-c&ud	*	
kb. ([ga@tw][i)d]a[c&				*-id *-c&ud *TRUNC		*

[5]Benua (1995) leaves the constraints schematized as above, and so never makes clear how the truncated word does not surface without truncation. Fitzgerald and Fountain (1995) are able to capture the truncation effect of subtractive morphology, as illustrated in the previous section. This presents an additional argument against Benua's approach.

[6]An objection may be raised to treating stress as a feature. There are numerous arguments against stress as a feature; Hayes (1995) is a detailed enumeration of such points.

[7]The top block of constraints are ignored in this evaluation – they do not effect the outcome here.

c. ([ga@t)(w][i$d]a[c&)	*!			*-c&ud *TRUNC	*	
d. ([ga@t)(w][id]a$[c&)	*!	*		*-id *-c&ud	*	

The tableau shows that the identity constraint rules out the actual optimal candidate, (26a), instead choosing the unattested (26b). This follow because the behavior of truncated words with regard to stress is not due to constraints on identity, but rather related to the addition of a morpheme without segmental content, as argued in the previous section. The Correspondence-based account fails, while under the analysis argued here, the STRESS-TO-MORPHEME PRINCIPLE not only accounts for the data, but explains why this pattern surfaces.

4.5.2 Summary

In this section, I showed that a Correspondence-based account cannot fully account for the distribution of stress in truncated words. This is because truncated words with epenthetic vowels in odd position do not maintain identity with their base forms; rather, these words have a completely different stress pattern. Under the STRESS-TO-MORPHEME PRINCIPLE, the surface stress pattern of these words is correctly predicted.

4.6 Conclusion

In this chapter, the stress pattern of truncated words was described. These words stress all odd syllables. The pattern follows from the Percolation Convention and the previously argued for constraint rankings. Furthermore, I argued against a correspondence treatment of these facts in an alternative proposal.

The empirical point of this chapter was the presentation of the stress pattern of truncated words, particularly the pattern of stressed epenthetic vowels in odd syllables. The theoretical point of this chapter was the introduction of a constraint forcing the overt presence of all morphemes.

5. CONCLUSION

This dissertation has described and analyzed the stress system of Tohono O'odham words. Furthermore, I have argued here for an analysis that accounts for the intricate interplay between the morphological and phonological components of this system. In this Chapter, I conclude this study. In doing so, I recapitulate the main points. First I review the empirical goal of the dissertation, and those points made in each Chapter to achieve this goal. Then I review the theoretical goal of this dissertation, showing how each Chapter worked to achieve the overall theoretical point. I then discuss the consequences and predictions made by this analysis. In particular, I give some evidence for a theory that allows for all possible variable orderings for morphemes, stress and weight, within the formalism proposed for the MORPHEME-TO-STRESS and STRESS-TO-MORPHEME PRINCIPLES here. Finally, I conclude the chapter, and the dissertation.

5.1 Synopsis of Main Points

In this paper, I have argued that there are direct links between morphemes and stressed syllables. This is formalized in two principles, the MORPHEME-TO-STRESS PRINCIPLE and the STRESS-TO-MORPHEME PRINCIPLE. Given these principles, plus additional prosodic constraints, we can account for the stress system of Tohono O'odham. Furthermore, the two principles easily extend to other languages to demonstrate their cross-linguistic validity. These proposals are restated again in (1-2):

(1) MORPHEME-TO-STRESS PRINCIPLE (abbreviated: MSP)

For every morpheme, there exists some stressed mora that falls in the domain of the morpheme.

(∀ MORPHEMES ∃ STRESSED MORA such that the STRESSED MORA falls within the domain of that MORPHEME).

(2) STRESS-TO-MORPHEME PRINCIPLE (abbreviated: SMP)

For every stressed mora, there exists a morpheme such that the stressed mora is within the boundaries of the morpheme.

(∀ STRESSED MORA ∃ MORPHEME such that the STRESSED MORA falls within the domain of that MORPHEME).

Both are constraints that operate under the basic principles of Optimality Theory (Prince and Smolensky 1993): minimal violation, parallel evaluation of outputs, violability and universality of constraints. With a constraint system of this sort, we expect systems that show the results of such constraints, due to the high ranking of the constraints, as well as systems that do not show surface effects, due to the low ranking of the constraints. The constraints in (1-2) connect the behavior of three types of entities: morphemes with segmental content, epenthetic vowels, and subtractive morphemes. These are all unified here under the auspices of the morphology-prosody interface. With such an approach, the surface stress patterns of Tohono O'odham exhibit a remarkable symmetry. Furthermore, the ranking of these constraints as motivated in the previous three chapters predicts precisely the attested output.

These constraints account for three basic empirical asymmetries in Tohono O'odham. In Chapter Two, I showed that trisyllabic words that are monomorphemic do not have final stress, while trisyllabic words that are polymorphemic do. This asymmetry, repeated again in (3), follows from the MORPHEME-TO-STRESS PRINCIPLE.

(3) Stress and Trisyllables in Tohono O'odham

a. Monomorphemic words

'a@sugal 'sugar'

mu@sigo 'musician'

b. Polymorphemic words

'a@sugal-ma$d 'adding sugar'

mu@-msigo$ 'musicians'

The second basic asymmetry holds of words with an epenthetic vowel. Words with such a vowel in an even position behave as if this vowel is in the weak position of a foot. In contrast, words with epenthetic vowels in odd syllables behave as if this vowel is completely unfooted. This pattern is accounted for by the STRESS-TO-MORPHEME PRINCIPLE above in (2). It derives the behavior of epenthetic vowels from the fact that they do not belong to morphemes, which provides a neat parallel to the account of the forms in (3). The asymmetry is shown again in (4):

(4) Epenthesis and Stress in Tohono O'odham

a. Even epenthesis

s« wu@d`-a-da$g 'to be good at roping'

c&ö@pos-i$d-a-ku$d` 'instrument for branding an object'

b. Odd epenthesis

c&i@kpan-a-ku$d` 'tool'

c&i@kpan-a-ku$d`-dam 'one with a tool'

The final asymmetry appears in words that have been morphologically truncated to indicate an aspectual change. In these words, epenthetic vowels in odd position get stressed, while epenthetic vowels in even position are not stressed. This pattern follows from the Percolation Convention and the STRESS-TO-MORPHEME PRINCIPLE, which results in stressed epenthetic vowels when they appear in syllables with morphemic codas. This pattern appears in (5):

(5) Truncation, Stress and Epenthesis in Tohono O'odham

a. Odd epenthesis

c&i@kpan-a$-c& (cf. c&i@kpan-a-c&u$d) 'make someone work, perfective'

wa@kon-a$-c& (cf. wa@kon-a-c&u$d) 'make someone wash, perfective'

b. Even epenthesis

c&ö@pos-i$d-a-c& (cf. c&ö@pos-i$d-a-c&u$d` 'make someone brand, perfective'

ba@hij&-i$d-a-c& (cf. ba@hij&-i$d-a-c&u$d) 'make someone eat object, perfective'

The empirical goal of this dissertation has been to describe the stress system of Tohono O'odham. This goal has certainly been achieved here, and is particularly important given that the I have presented a novel description of the stress patterns of Tohono O'odham. Of particular interest has been the interaction between the stress system and the morphology. The theoretical proposal made here argues for a direct link between the morphology and the prosody, via the constraints in (1-2). This proposal has motivated to an analysis of Tohono O'odham stress that unifies the behavior of segmental morphemes, epenthetic vowels and subtractive morphemes.

5.2 Predictions and Further Issues

In this section, I discuss some predictions made by this analysis. Following this, I discuss some of the ramifications of the MORPHEME-TO-STRESS PRINCIPLE and the formulation of *LAPSE. Finally, I conclude the section with a brief discussion on previous descriptions of stress in Tohono O'odham.

5.2.1 On the Interaction of Weight, Stress and Morphemes

In this section, I briefly discuss the formal predictions made by the proposal here. I offer preliminary empirical support for these predictions from a variety of languages. Given the formal parallels between the MORPHEME-TO-STRESS and STRESS-TO-MORPHEME PRINCIPLES, and given the parallels between this pair of constraints and the WEIGHT-TO-STRESS and STRESS-TO-WEIGHT PRINCIPLES, we might expect the following set of constraints:

(6) Predicted constraints

a. WEIGHT-TO-STRESS PRINCIPLE

b. STRESS-TO-WEIGHT PRINCIPLE

c. MORPHEME-TO-STRESS PRINCIPLE

d. STRESS-TO-MORPHEME PRINCIPLE

e. WEIGHT-TO-MORPHEME PRINCIPLE

f. MORPHEME-TO-WEIGHT PRINCIPLE

In this section, I show preliminary evidence for at least five of these systems. Evidence for (6a), the WEIGHT-TO-STRESS PRINCIPLE is widely found. There are a number of languages that force the heavy syllable to attract stress. One language in which this pattern appears is Pirah‹ (Everett and Everett 1984a, Everett 1988), where the following weight hierarchy determines stress assignment:

(7) Pirah‹ Weight Hierarchy

CVV > GVV > VV > CV > GV

(where C=voiceless consonant, G=voiced consonant, and >="is heavier than")

Thus in Pirah‹, the heaviest syllable from right to left is assigned stress. This pattern is illustrated in (8), where stressed syllables are underlined and tones (« for high and ` for low tones) are marked on vowels:

(8) Pirah‹ Stress (Everett and Everett 1984a)

a. <u>/a$</u>ba$gi 'toucan' (<u>CV</u> GV GV)

b. ti$<u>po$</u>gi$ 'species of bird' (CV <u>CV</u> GV)

c. gi@<u>/ai</u> '2sg' (GV <u>CVV</u>)

d. bi$i@si$ 'red' (GVV CV)

Stress in Pirah‹ is predictable if we accept that the heaviest, rightmost syllable attracts stress according to the hierarchy in (7). The metrical analysis requires the WEIGHT-TO-STRESS PRINCIPLE, as do a number of other languages (see Prince 1990 for more discussion).

The second principle, STRESS-TO-WEIGHT, predicts that stressed syllables are heavy. This pattern is found in Choctaw and Chickasaw (Munro and Ulrich 1984, Ulrich 1986, Hayes 1995), where iambic feet that consist of two light syllables surface as a foot composed of a light and heavy syllable. The alternation is particularly evident when one compares forms of varying morphological composition, as in (9):

(9) Choctaw Rhythmic Lengthening (Munro and Ulrich 1984)

a.	/litiha-tok/	(liti@ù)(hato$k)	'it was dirty'
b.	/sa-litiha-tok/	(sali@ù)(tiha@ù)(to @k)	'I was dirty'

The length alternation in the root /litihi/ shows up in the contrast between (9a), where only the root-medial syllable is long, and (9b), where the first and third syllables of the root are long. This alternation is the lengthening of a stressed syllable, arguing for the STRESS-TO-WEIGHT PRINCIPLE.

The third constraint, the MORPHEME-TO-STRESS PRINCIPLE, has already been argued for in Chapter Two for Tohono O'odham. Another language which argues for this principle is Diyari (Austin 1981, Poser 1989). In Diyari, degenerate feet are strictly prohibited. This results in trisyllabic monomorphemic words with only one stress (10a). When these same words are followed by a disyllabic suffix (10b), the suffix gets stressed.

(10) Diyari Stress (Austin 1981)

a. Monomorphemic words

ma@nkar`a 'girl'

ma@nkar`a 'girl'

pu@l¦uru 'mud'

b. Polymorphemic words

pi@nadu-wˆr`a 'old man-PL'

ya@kalka-yi$pa-ma$li-na 'ask-BEN-RECIP-PART'

Diyari shows another argument in favor of the MORPHEME-TO-STRESS PRINCIPLE, as one of the factors that predicts stress is the morphemic composition of a word. This language is also interesting because it has different conditions on FOOT BINARITY than Tohono O'odham.

The fourth predicted constraint, the STRESS-TO-MORPHEME PRINCIPLE, has been argued for on the basis of Tohono O'odham epenthetic vowels. An additional argument for the STRESS-TO-MORPHEME PRINCIPLE comes from Mohawk. The avoidance of epenthetic vowels during stress assignment receives a straightforward account under the STRESS-TO-MORPHEME PRINCIPLE. Michelson (1988,1989) notes that in Mohawk the penult receives stress, except in certain word with an epenthetic vowel. This pattern is shown in (11):

(11) Mohawk Stress (Michelson 1989)

a. Without epenthetic vowels in the penult

wakeruhya@ùkÃ 'I suffer'

keru@nyus 'I put it into something; I sketch'

ratatewÃniyo@stha/ 'he takes advantage of everything'

b. With epenthetic vowels in penult

te@keriks 'I put them together, next to each other'

teka/sha@ùrariks 'I put the knives side by side'

tÃ@kerike/	'I will put together side by side'
Ã@kerÃ/	'I will put it into a container'

Words without epenthetic vowels in penultimate position (11a) surface with penult stress. The pattern in (11b) shows that epenthetic vowels in the penult are skipped, and the word surfaces with antepenultimate stress. This "skipping" pattern mimics Tohono O'odham; if we avoid epenthetic heads under the STRESS-TO-MORPHEME PRINCIPLE, the pattern in Mohawk is predicted.

Finally, the MORPHEME-TO-WEIGHT PRINCIPLE finds evidence from minimal word lengthening. In a number of the world's languages, a monomorphemic, monosyllabic word lengthens.[1] McCarthy and Prince (1990) cite arguments for a bimoraic minimal word from Arabicized loanwords. These forms appear below.

(12) Lengthening of Monomoraic Loanwords in Arabic (McCarthy and Prince 1990: 256)

Source	Arabicized Form
bar	baar
jazz	jaaz
gas	gaaz
Shem	saam
Gaul	gaal
shawl	s&aal

Morphemes (which may be words in the case of monomorphemes) must be minimally bimoraic or heavy in Arabic, and thus provide a nice example of the MORPHEME-TO-WEIGHT PRINCIPLE.

The missing constraint is the WEIGHT-TO-MORPHEME PRINCIPLE, where if a syllable is heavy, then it is a morpheme. It is possible that evidence from this comes from Cantonese, where Yip

[1]This constraint may also find application in languages where morphological gemination exists, as in Choctaw (Ulrich 1986, Lombardi and McCarthy 1991).

(1994: 297) argues that "the bi-moraic syllable requirement can be viewed as...morphemes must be Minimal Words." If a syllable is heavy in this language, then it must be a morpheme. More research is needed to support this and the other patterns, but this does outline the thrust of the typological predictions claimed in this dissertation.

The variety of examples presented here are not meant to be neither exhaustive nor definitive. They lay out a set of predictions for what types of interactions we expect from morphemes, stress and weight. What they do attest to the patterns predicted by the formalism of the MORPHEME-TO-STRESS/STRESS-TO-MORPHEME PRINCIPLES. This sets a direction for future research in unifying the interactions between weight, morphemes and stress in prosodic systems. Furthermore, they are suggestive in that they instantiate some of the cross-linguistic predictions made in this dissertation. This allows us to see how the analysis of Tohono O'odham can be extended to other languages. In a theoretical framework such as Optimality Theory, these cross-linguistic consequences should be considered as we propose constraints, as all constraints are considered to be universal. By exploring some of the ramifications of this proposal, we provide additional support for the proposal made for Tohono O'odham.

5.2.2 The MORPHEME-TO-STRESS PRINCIPLE and Minimality

The MORPHEME-TO-STRESS PRINCIPLE, when ranked high enough, forces all morphemes to be stressed. This constraint does the same work as the prosodic rooting constraint (Hammond 1984) and the Optimality Theoretic-constraint, LEXICALWORDÅPROSODICWORD (McCarthy and Prince 1993). And like LEXICALWORDÅPROSODICWORD, the MORPHEME-TO-STRESS PRINCIPLE can be ranked in various permutations to predict lengthening to satisfy minimality, or that lengthening never occurs in satisfying the MORPHEME-TO-STRESS PRINCIPLE.

5.2.3 Ramifications of *LAPSE

The *LAPSE constraint formalized in this dissertation allows us to eliminate an additional alignment constraint. In fact, this elimination gives additional support for the formulation of *LAPSE as "avoid an unfooted syllable followed by a foot". The constraint works at a number of levels, in addition to banning dips of unstressed syllables in the surface stress pattern. This argument favors the version of *LAPSE articulated here over versions in Kager (1994) and Green and Kenstowicz (1995).

5.2.4 On Previous Descriptions of Tohono O'odham Stress

An evaluation of previous descriptions of stress in Tohono O'odham is somewhat complicated by the paucity of forms with secondary stress marked. Previous analyses (Hale 1959, Saxton 1963, Hill and Zepeda 1992, to cite the primary works) have made several claims about stress, which are evaluated in this section.

The first claim is that primary stress assigned to the initial syllable of the prosodic word; primary stresses are often marked in words, so this claim is easily investigated. There is robust evidence for the salience of these syllables; in addition to the nonnative impression that these syllables are stressed, we have seen that there is concurrence from native speakers on this issue. Furthermore, the target of reduplication is the primary stressed syllable, which provides additional phonological evidence. The claim that primary stress is word-initial finds a multitude of evidence in various domains.

The analyses vary in how they approach the issue of secondary stress. In the three main works considered here (Hale 1959, Saxton 1963, and Hill and Zepeda 1992), various secondary stresses are posited in order to maintain an abstract underlying representation and especially, to account for the size of consonant clusters. The surface complex codas are thus analyzed as the result of the distribution of secondary stress. In this dissertation, the focus has been on generalizations about stress that hold over output forms. The generalizations shown here have not required abstract representations. It may well be that previous analyses are correct about these more abstract representations. This does not change the analysis I have argued for here, although it might require additional constraints to map the stresses posited by Hill and Zepeda (1992) and others, onto those stresses described here. Saxton et al. (1989) and Hill and Zepeda (1992) both give forms with secondary stresses which conflict with the judgments described in this dissertation. These analyses argue that certain vowels are stressed in order to explain surface complex codas as the product of the deletion of unstressed vowels. As a consequence, most of the surface vowels are allowed to appear on the surface because they are stressed, and thus resist deletion (or demorafication, in the case of Hill and Zepeda 1992). One problematic aspect of these analyses comes as secondary stress assignment is argued to occur from the right edge.

We can examine this argument by looking at a sample derivation from Hill and Zepeda (1992). They claim that a trisyllabic reduplicated word stresses all surface syllables, leading to a form such as *ka@-ka$nj&u$l* 'candles.' (This differs from judgments on similar forms described here.) Hill and Zepeda (and the other analyses) assume underlying representations which are essentially strings of CVs. To predict the correct surface form, certain vowels are argued to be stressed. The vowel "deletion" process thus takes the underlying form, /ka-kanaj&uli/ and surfaces *ka@-ka$nj&u$l*. A sample derivation is given below:[2]

[2]This derivation is simplified somewhat. Hill and Zepeda actually argue not for vowel deletion, but for vowel "demorafication". The simplification here does not change the problematic aspects of secondary stress in their analysis.

(13) Sample Derivation

a. Underlying form	ka-kanaj&uli
b. Primary stress (initial syllable)	ka@-kanaj&uli
c. Secondary stress assignment (syllabic trochees from right edge)	ka@-(ka$na)(j&u$li)
d. Deletion of unstressed vowel	ka@-ka$nj&u$l

The underlying form is first subject to the primary stress assignment, which stresses the initial syllable. Secondary stresses are assigned from the right edge, with syllabic trochees parsed from right to left. Then a deletion rule applies to delete unstressed vowels (except in certain contexts). As a result, the surface form then stresses each syllable.

While these abstract stresses provide the basis of a plausible analysis of vowel syncope in Tohono O'odham, they are not distributed where we have found that overt stresses occur in Tohono O'odham. For example, the vowel syncope analysis makes the wrong prediction for the surface form in a word like *pa@pko'o$la* 'Pascola dancers'. The assignment of syllabic trochees from the left edge (and as seen above, the tolerance of stress clash) incorrectly predicts **pa@pa$k'o$l* 'Pascola dancers'. The crucial problem is that reduplication triggers syncope in the base, and that unstressed syllables are allowed in output forms in places where previous analyses argue they are not. A derivation showing this incorrect prediction is given in (14)

(14) Incorrect prediction made by right-to-left secondary stress assignment

a. Underlying form	pa-pako'ola
b. Primary stress (initial syllable)	pa@-pako'ola
c. Secondary stress assignment (syllabic trochees from right edge)	pa@-pa$ko'o$la
d. Deletion of unstressed vowel	pa@-pa$k'o$l

Their analysis also make the wrong predictions for forms like *mu@msigo$* 'musicians'. The derivation in (15) shows that the correct vowels do not surface with secondary stress, and that vowels delete where they actually should appear.

(15) Incorrect prediction made by right-to-left secondary stress assignment

a. Underlying form	mu-musigo
b. Primary stress (initial syllable)	mu@-musigo
c. Secondary stress assignment (syllabic trochees from right edge)	mu@-musi$go
d. Deletion of unstressed vowel	mu@-msi$g

The vowel syncope analyses offer a differing directional assignment of secondary stress. The right-to-left directionality does not account for surface stress patterns; under such an account, we incorrectly predict stress on the penultimate vowel whenever there are two final light syllables. Under the analysis presented in this dissertation, both primary and secondary stresses are assigned counting from the left edge.

The previous analyses focused on explaining surface consonant strings as the result of underlying vowels that delete. As a result, these analyses cannot explain the generalizations of surface stress. In particular, they make the wrong predictions, as secondary stresses are hypothesized in order to predict the retention of a vowel in a surface form. Therefore one problematic aspect of assuming underlying CV strings and a rule of vowel deletion is that surface secondary stress patterns are not correctly predicted.

Another problematic aspect of the syncope-based approach is that all surface vowels are not treated the same by native speakers. Under Hill and Zepeda (1992)[3] , where all surface vowels are underlyingly present, we predict that surface vowels should behave the same. As we have seen in the previous three chapters, this is not the case. Two sets of examples show this, epenthetic vowels and "transitional" vowels. Epenthetic vowels do not get stressed in either odd or even position, as shown in (16). This is not expected when these vowels are assumed to be present underlyingly. If the underlying vowels were present underlyingly, they should behave uniformly under stress assignment.

(16) Epenthetic vowel, -*a*, in even and odd position :

a. Even position, unstressed

(bi@d-s`p-a)-(ku$d`) 'instrument for plastering'

(wa@kon)-a-(mö$d`) 'going and washing'

---

[3]I believe that some of these 'transitional' vowels are treated as epenthetic under Saxton (1963) and Hale (1965).

b. Odd position, unstressed

(c&ö@po)(s-i$d-a)-(c&u$d) 'cause someone to brand an animal'

(ci@kpan)-a-(mö$d`) 'going and working'

The second problematic case comes from transitional vowels, discussed in Chapter Two above. Under the account offered by Hill and Zepeda (1992), these are argued to be present underlyingly. However, as we saw in Chapter Two, they are not only different than both epenthetic and morphemic vowels, but are also ignored by speakers in syllable count. Some of these examples are repeated in (17).

(17) "Transitional" vowels never indicated in syllable count

a. 'ö@ùk-«-d-aj& 'shade, shadow of a specified entity'

σ@σ

get in the shade-make-nominal-possessive

b. 'o@n-«-mad 'adding salt'

σ@σ

salt-adding

c. pi@-p«los 'pear trees'

σ@σ

plural-pear tree

d. s« c&u@c&ul-I-ga 'to own a chicken'

σ@σσ$

stative chicken-possession

e. ha@iwan)-i-ga$-kad-«-ma$ 'will seem to be owning a cow'

σ@σσ$σσ$

cow-possession-future imperfect-seem

Again, analyses that assume the underlying status of the double-underlined vowels predict that they should be tapped by speakers in the syllable count. This is an incorrect prediction of such an analysis, as the vowels are systematically ignored by speakers. The descriptive patterns of both epenthetic and transitional vowels are completely unexpected under the assumption that all vowels are underlyingly present.

In this section, I have demonstrated that the abstract stresses posited by the vowel syncope analyses are not where surface stress occurs. The simplest account would seem to be that Tohono O'odham exhibits two kinds of stress. Abstract stress is part of the analysis of vowel syncope; overt stress is based instead on native speaker intuitions. The two kinds of stress are therefore not in conflict. Rather, these two types of stress are simply different objects.

The differing analyses of which syllables are stressed can be viewed as the product of analyses with differing goals. Analyses like Hale (1965), Saxton (1963), and Hill and Zepeda (1992) focused their attention on the thorny problem of consonant clusters, and did so within a phonological model that favored abstract representations at an underlying level. The analysis here has focused on surface generalizations, finding an explanation for these generalizations that corresponds with their surface morphological structure, rather than appealing to abstract underlying representations. The previous analyses of Hale, Saxton, and Hill and Zepeda are not about surface stress, but rather about underlying vowels. The descriptive results of this study thus complicate the analyses of clusters, while also contributing to our knowledge of surface stress in Tohono O'odham.

5.3 Conclusion

This dissertation has provided a complete description of word-internal stress in Tohono O'odham. In accounting for these patterns, I have proposed that morphological constraints are interleaved with prosodic and rhythmic constraints. I have proposed the MORPHEME-TO-STRESS PRINCIPLE to account for a variety of metrical patterns in Tohono O'odham where morphemes attract stress. The STRESS-TO-MORPHEME was invoked to account for the "invisibility" of epenthetic vowels in odd positions with regard to stress assignment. Together these constraints offer a tightly constrained model of how morphology and stress interact.

While it is premature to argue against alignment constraints (as in McCarthy and Prince 1993b) entirely, this dissertation does suggest the direction for future research on the morphology-phonology interface. One area that may prove promising is the development of Grouping Harmony for the MORPHEME-TO-STRESS PRINCIPLE. Prince (1990) takes the WEIGHT-TO-STRESS PRINCIPLE and breaks it down into a particular ranking for each foot type. A similar proposal may well prove promising for the MORPHEME-TO-STRESS PRINCIPLE, with roots, for example, as the "canonical" stressed morpheme. These avenues of research may serve to illuminate the relationship between morphological and phonological constraints, particularly in the domain of metrical theory.

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