SWITCH LANGUAGES:

THEORETICAL CONSEQUENCE AND EMPIRICAL REALITY

By

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ABSTRACT OF THE DISSERTATION

Switch Languages: Theoretical Consequence and Empirical Reality

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The term *switch language* refers to a language which uses both iambs and trochees productively. Switch languages are often assumed not to exist, since the surface stress pattern is not distinct from a non-switch language. This dissertation argues that switch languages are both an empirical reality and an entailed theoretical consequence of Optimality Theory.

Empirical reality:

Yidiny and Wargamay are two switch languages with independent evidence for their switch footing; crucially, each has a regular process of lengthening stressed vowels when the feet are iambic but not when they are trochaic. In support of this claim, the dissertation also argues that this kind of vowel lengthening *never* occurs in trochaic languages. Trochaic languages which have been previously claimed to have regular lengthening of stressed vowels, such as Mohawk and Chimalapa Zoque, are shown to actually lengthen vowels for word or foot minimality.

Theoretical consequence:

> The presence of alignment, rhythm, and parsing constraints in Con entails the existence of switch languages. As long as there is some constraint that cares whether there is a foot at the beginning of the word or not, this constraint -- along with a rhythm constraint and a parsing constraint -- is sufficient for the typology to include switch languages. Various alternate definitions of alignment constraints are explored in the dissertation, but the conclusion is that any true alignment constraint predicts the existence of a switch language.

This dissertation illustrates the connection between a theoretical consequence of OT and an attested phenomenon in Yidiny and Wargamay. Switch languages are an entailed consequence of Optimality Theory whenever the constraint set includes alignment, rhythm, and parsing constraints; Yidiny and Wargamay are just such languages, as confirmed by independent evidence including vowel lengthening. Because parallel OT optimizes over complete forms instead of making extremely local decisions, global patterns like lapselessness are rewarded, leading to word-level footing decisions. Many theories of prosody include these essential components; OT compels them to interact in the right way.

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Contents

Chapter 1

Introduction

The term *switch language* refers to a language which uses both iambs and trochees productively. Switch languages are often assumed not to exist, since the surface stress pattern is not distinct from a non-switch language. This dissertation argues that switch languages are both an empirical reality and an entailed theoretical consequence of Optimality Theory (Prince and Smolensky 1993), given certain basic constraints -- each of which are needed for other aspects of metrical phonology.

Alber (2005) observed that switch languages are predicted within OT when the alignment constraint ALLFEETLEFT interacts with rhythm constraints *LAPSE and *CLASH[1], noting that Yidiny (Dixon 1977) is an example of this language type. Alber's finding is extended here in Chapters 2 and 3; Chapter 2 shows that *any* definition of alignment constraints will produce this same effect, while Chapter 3 provides a proof of the theoretical guarantee of switch languages.

OT is not unique in predicting the existence of switch languages. OT is a theory with clearly calculable typological predictions, so it is easy to show that switch languages are an entailed prediction of the theory; however, the actual prediction is broader. Any theory which allows foot type to be determined on a smaller scale, rather than setting foot type for the entire language at once, would predict the existence of switch languages. A

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[1] Alber's analysis includes IAMB and TROCHEE as the third relevant constraint type, but Chapter 3 will show that parsing constraints like PARSESYLL and FTBIN can establish the existence of switch languages before reaching the foot form constraints in the hierarchy.

parametric theory which sets a hard constraint on foot type for the entire language does not allow for the existence of switch languages; a theory like OT, which permits constraints to be violated or does not explicitly set a foot type parameter for the entire language, will include switch languages as a possibility. The feature of OT that produces switch languages as a theoretical consequence is the lack of ability to force uniformity of foot type across a language.

Dresher and Kaye (1990) an exemplar of the whole-language parametric approach; one of their eleven parameters (Dresher and Kaye 1990: 142) explicitly sets foot headedness for the entire language. Although they describe a mechanism for dealing with exceptions (like lexical stress, Dresher and Kaye 1990: 183-187), the parameter still must be set for left-headed or right-headed feet for the entire language. These exceptions are handled on a case-by-case basis, and there would be no way for the grammar to designate all words of a single length as one foot type and all words of another length as another foot type; novel words would default to whichever headedness is designated by the parameter setting. In a Dresher and Kaye style parameter system, it would be impossible to have a switch language like Yidiny or Wargamay.

Parameters are not inherently incompatible with switch languages. Hayes (1982, 1995) and Halle and Vergnaud (1987) utilize parametric theories which do allow for the switching of foot type; in fact, both analyses explicitly address the problem of switching foot type in Yidiny. Halle and Vergnaud's (1987: 24-25, 221-224) approach allows the foot type parameter to be set on a smaller scale. Rather than applying once for the entire language, the foot type parameter is sensitive to constituent boundaries and vowel length, allowing the foot type to change accordingly; in this analysis, the foot type parameter is left unset until evidence from a later rule can determine whether feet in the word are left-headed or right-headed. Hayes (1995: 54-55, 315) explicitly argues for a parametric view of assigning foot type; in Yidiny, the foot type parameter is set to iambic, but rules are allowed to override the foot type parameter and rewrite the feet as trochaic (Hayes 1995: 260; a more detailed analysis of the foot rewriting rule is found in Hayes 1982). Whether the parameter can be left unset or overwritten later, both of these approaches are parametric and allow for a single language to use both iambs and trochees. Although both cases utilize additional machinery to allow for switching of foot type, parameters governing rhythm and alignment of feet could force switching in these theories just as the related constraints do in OT; rather than forcing violation of foot type constraints through ranking, the switching is forced by setting or overwriting the foot type parameter.

McCarthy and Prince (1996) propose a uniformity parameter, which requires that all feet have the same foot type; however, unlike the Dresher and Kaye parameter for foot type, this parameter can either be set to the whole language *or* within words (or turned off completely, as in Cairene Arabic). McCarthy and Prince cite Yidiny (Dixon 1977) in support of this claim, illustrating that the scope of uniformity can be limited to within words rather than across the entire language. This differs from a situation like the one described in Prince and Smolensky (1993) where the foot type switches from iambic to trochaic in bisyllables to avoid a nonfinality violation; while each individual Yidiny word consists of only iambs or trochees, the entire language uses both productively. While McCarthy and Prince's approach still utilizes a parameter for foot type, the fact that the parameter can be set at the word level rather than the language level allows for the existence of switch languages. The crucial theoretical structure that predicts switch languages is the ability to *not* set the foot type a single time for the entire language, but to allow for both types to occur as circumstances demand.

The surface stress patterns described by a switch language match observed surface stress patterns that are routinely described with a single foot type. The interest of switch languages is in the footing, *not* in the stress patterns. In the example below, the stress pattern has perfect alternation between stressed and unstressed syllables. In (a), the stress pattern is provided without footing; in words with an even number of syllables, stress is initial and on every following odd syllable, while in words with an odd number of syllables, stress is peninitial and on every following even syllable. This is consistent both with the all-trochee footing in (c) and the footing in (b) where feet are trochaic in even-length words and iambic in odd-length words.

(1) Two parsings for a single stress pattern

a.	*stress pattern:*	X-o-X-o
		o-X-o-X-o
b.	*switch foot type:*	[Xu]-[Xu]
		[uX]-[uX]-o
c.	*all trochees:*	[Xu]-[Xu]
		o-[Xu]-[Xu]

An important terminological note illustrated by the above examples: descriptions of stress patterns in terms of feet refer to *binary* feet. A switch language uses both binary iambic feet and binary trochaic feet; an all-trochaic language has no binary iambic feet; an all-iambic has no binary trochaic feet. The presence of unary feet in a language has no bearing on its status in terms of being switch, all-trochaic, or all-iambic.

There are several possible definitions for foot type constraints IAMB and TROCHEE: both could penalize unary feet, neither could penalize unary feet, or only one of the pair could penalize unary feet. The constraint definitions used throughout this dissertation will be of the third variety: IAMB penalizes binary trochees, while TROCHEE penalizes both binary iambs and unary feet. The definition used is not crucial to the findings of the dissertation (the proof in chapter 3 makes no use of these constraints at all), but this definition will be used throughout for consistency. When this particular definition affects the outcome, the specific effects are noted in the text; these definitions are discussed both in chapter 2 and chapter 5. The terms *iamb* and *trochee*, when not the names of constraints, refer only to the binary versions of the feet.

(2) Terminological definitions

a. Trochee

a binary foot with stress on the initial syllable [Xu]

b. Iamb

a binary foot with stress on the final syllable [uX]

c. Trochaic language

a language where every binary foot is trochaic; may have unary feet

d. Iambic language

a language where every binary foot is iambic; may have unary feet

e. Switch language

a language where binary feet can either be iambic or trochaic, but rhythm is always perfectly alternating between stressed and unstressed syllables

Because switch languages have ‘normal’ looking stress patterns, documented switch languages are likely to have been previously described with an alternate analysis -- one with a single foot type throughout all of its words. In order to be certain that a language is switching foot type, there needs to be independent evidence for the foot type or foot boundaries. Chapter 4 explores two languages, Yidiny and Wargamay, where there is good evidence that the foot type switches between iambs and trochees depending on word length. The analysis of Yidiny and Wargamay provided in chapter 4 differs from most previous approaches (e.g. Hyde 2002; but see Alber 2005: 518-521 for a similar treatment of Yidiny) because the switching of foot type is an expected side effect of alignment and rhythm constraints instead of requiring overlapping feet or other complications. One of the best pieces of evidence for foot type is that iambic feet frequently have a regular process of vowel lengthening in stressed syllables; trochaic feet never do this. A full exploration of vowel lengthening in trochaic languages to support this claim can be found in Chapter 5.

This dissertation presents the finding that the presence of both alignment and rhythm constraints in CON entails the existence of switch languages. Chapter 3 shows that as long as there is some constraint that cares whether or not there is a foot at the beginning of the word (such as ALIGN-L), this constraint -- along with a rhythm constraint and a parsing constraint -- is sufficient for the typology to include switch languages. The constraints that will be used in this proof are ALIGN-L, *LAPSE or *CLASH, and FTBIN or PARSESYLL. *LAPSE and *CLASH are the rhythm constraints; FTBIN and PARSESYLL are the parsing constraints. ALIGN-L generalizes across any implementation of left-aligning constraints, simply assessing a violation for a word that lacks an initial foot. Chapter 2 explores various alternate definitions of alignment constraints, but the conclusion from this exploration is that any true alignment constraint predicts the existence of a switch language. These constraints, as well as some version of a left alignment constraint, are all independently motivated, and all are important components of analyses of metrical phenomena apart from foot-switching patterns.

Two- and three-syllable words are sufficient to exhibit the switch pattern; every possible parse of two- and three-syllable words that satisfies both *LAPSE and FT-BIN is provided in the tableau below, along with the violations of all three constraints. Notice that for two-syllable words there are two possible optima, while for three-syllable words there is only one possible optimum remaining which satisfies all three constraints.

(3)

			*LAPSE	FT-BIN	ALIGN-L
2s	(a)	{[uX]}	0	0	0
	(b)	{[Xu]}	0	0	0
3s	(c)	{[uX]-o}	0	0	0
	(d)	{o-[Xu]}	0	0	1

Some constraint further down the hierarchy can make the decision between which two-syllable candidate wins (such as IAMB or TROCHEE, though these are not the only constraints that can distinguish between the two candidates); however, when these three constraints are undominated, the decision for the three-syllable candidate has already been made. This means that there are two possible types of languages when these three constraints are undominated: an all iambic language (the first 2-syllable candidate (a) and the only 3-syllable candidate) and a switch language (the second 2-syllable candidate (b) and the only 3-syllable candidate).

Chapter 2 explores two possible alignment constraint schemas, focusing on three factors: 1) what categories can be aligned, 2) what can count as an 'intervener' between the category and the relevant edge, and 3) what the constraint can evaluate. Chapter 2 focuses on three possible categories to serve as both aligners and interveners, for a total of eighteen alignment constraints across the two schemas. Systematically exploring these variations leads to a number of findings, such as the fact that unparsed syllables made the best interveners in terms of typological predictions. Some of the constraints produced by the alignment schema do not actually show alignment effects; these are referred to as pseudoalignment constraints, as opposed to the true alignment constraints which group feet at either the left or right edge of a word. It is the true alignment constraints which predict the existence of switch languages.

This typological prediction is borne out in Yidiny (and Wargamay, though only Yidiny will be discussed here; see Chapter 4 for full analyses of Yidiny and Wargamay). As argued in Hayes (1982), evidence for foot type in Yidiny points to a trochaic analysis in even-length words and an iambic analysis in odd-length words. There are several kinds of evidence for foot boundaries and foot type: vowel lengthening in odd-length words only, reduplication of a single foot, entire feet being left out when taking a breath in recordings of singing, and deletion of unparsed syllables under certain phonological conditions. The generalization that even-length words are trochaic and odd-length words are iambic in Yidiny is exemplified by 0 and (5), which illustrate vowel lengthening in odd-length words only.

(4) **Even-length words:**

No long vowels, perfect rhythmic alternation. Initial stress indicates trochaic feet.

[ŋú.naŋ].[gá.ra] 'whale' *4 syllables*

(5) **Odd-length words:**

Main stress vowel is long, perfect rhythmic alternation. Vowel lengthening indicates iambic feet.

[ma.dín].[da.ŋá:].diŋ 'walk up-TRANS-ANTIPASSIVE-PRES' *5 syllables*

Vowel lengthening is one type of evidence for feet being iambs instead of trochees (Hayes 1995, Gonzalez 2003). The vowel length difference is not underlying, as the Yidiny examples in (6) illustrate. There are an odd number of syllables in the underlying form of 'dog' /gudaga/ and an even number of syllables in the underlying form of 'mother' /mudam/. The purposive affix [gu] changes the number of syllables for each, but it is always only the odd-length words that have long vowels.

(6) **ODD:**	/gudaga/ → [gu.dá:].ga	/mudam+gu/ → [mu.dá:m].gu
	'dog'	'mother-**PURPOSIVE**'
EVEN:	/gudaga+gu/ → [gú.da].[gá.gu]	/mudam/ → [mú.dam]
	'dog-**PURPOSIVE**'	'mother'

This dissertation illustrates the connection between a theoretical consequence of OT and an attested phenomenon in Yidiny and Wargamay. Chapters 2 and 3 deal with the fact that switch languages are a theoretical consequence of OT. Chapter 2 explores definitions of alignment constraints, yielding the finding that every true alignment constraint predicts the existence of switch languages; Chapter 3 provides a proof in support of this finding. Chapters 4 and 5 focus on the empirical reality of switch languages. Chapter 4 provides an analysis of two switch languages, Yidiny and Wargamay, along with evidence for the foot structure; Chapter 5 supports the claimed foot structure of Chapter 4 by showing that trochees never lengthen vowels purely because they are stressed.

Switch languages are entailed by Optimality Theory whenever the constraint set includes alignment, rhythm, and parsing constraints; Yidiny and Wargamay are just such languages. Because parallel OT optimizes over complete forms instead of making extremely local decisions, global patterns like lapselessness are rewarded, leading to word-level footing decisions. Many theories of prosody include these essential components; OT compels them to interact in the right way.

Chapter 2

Alignment Constraints

Alignment constraints are used in metrical stress theory to position feet (and unparsed syllables). This chapter examines the effects of two different proposed schemas for constructing alignment constraints for use in stress systems. The proposed schemas, referred to as between alignment and adjacent alignment, are defined below. Certain effects – both good and bad – emerge from various properties of these constraints, which will be shown throughout the chapter.

Specifically with regard to stress systems (though relevant in other applications of alignment as well), there is a certain standard set of alignment constraints that has been used. These constraints, first proposed by McCarthy and Prince (1993), all emerge from a particular constraint schema. A problem with this set of alignment constraints is that it predicts a number of *unattested* languages. Several proposals (e.g. Alber 2005, Hyde 2008/2012, McCarthy 2003) have been made for amending the alignment constraint set; the goal of these proposals is to find a constraint set which predicts all attested languages while *not* vastly overpredicting. This chapter systematically examines two possible constraint schemas and their typological results, and evaluates their merit in terms of how well they predict attested languages without overpredicting.

Abstracting away from differences in placement of main stress and considering only quantity insensitive systems, there are 32 attested language types (from Gordon 2002, Hayes 1995, StressTyp). The results found in this chapter are not unique to quantity insensitive languages; every quantity sensitive language contains a quantity insensitive sublanguage which emerges in words with all light syllables. Vowel lengthening is restrained by foot structure (see chapter 5), so quantity sensitive languages are restrained in terms of creating heavy syllables. The findings of this chapter are not a typological quirk of quantity insensitive stress, but persist with the addition of quantity sensitivity.

Of the 32 attested language types, six are dual fixed languages (Gordon 2002); these are languages where the main stress foot is fixed at one edge, while a secondary stress foot is fixed at the opposite edge. The analysis of these languages requires constraints which refer to main stress, and are not included in this typology. Six more of the 32 languages deal with ternary stress, where stress falls on every third syllable. Some additional constraint type is needed to account for ternary stress (Kager 1994, Elenbaas and Kager 1999, Kager 2001, Houghton 2006, Rice 2007, Rice 2011), and so they are also excluded from consideration here. This leaves 20 remaining binary language types. Half of the language types are characterized by a foot at one edge, any additional feet iterating from that same edge, the unparsed syllables or unary foot at the opposite edge, and all feet being either iambic *or* trochaic. These are all straightforward examples of sparse, weakly dense, or strongly dense parsing (Alber and Prince). The remaining ten languages have some additional complications, such as non-finality or switching of the foot type; in the tables below, these languages are shaded for contrast. At least the ten straightforward languages should all be captured by the alignment constraints. This chapter shows that switch languages are also a result of all alignment constraints. The remaining languages may require additional constraints (such as Nonfinality) to fully account for the stress pattern, but are included here for comparison.

The 20 attested language types are grouped below according to their foot density (Alber and Prince) for ease of comprehension. A note on notation: *X* represents a stressed syllable, *u* is an unstressed syllable within a foot, and *-o-* is an unstressed unparsed syllable; foot boundaries are marked with square brackets. The Gen used throughout will disallow unparsed forms and feet larger than two syllables.

(1) Sparse Languages

Languages with only a single foot, regardless of the word length (and many unparsed syllables) have **sparse parsing**. (Alber and Prince)

	Language[1]	**2 σ**	**3 σ**	**4 σ**	**5 σ**	**Foot Type**	**Aligned**
1	Lakota	[uX]	[uX]-o	[uX]-o-o	[uX]-o-o-o	Iamb	Left
2	Chitimacha	[Xu]	[Xu]-o	[Xu]-o-o	[Xu]-o-o-o	Trochee	Left
3	Atayal	[uX]	o-[uX]	o-o-[uX]	o-o-o-[uX]	Iamb	Right
4	Nahuatl	[Xu]	o-[Xu]	o-o-[Xu]	o-o-o-[Xu]	Trochee	Right
5	Macedonian	[Xu]	[Xu]-o	o-[Xu]-o	o-o-[Xu]-o	Trochee	Right + NF[2]
6	Oñati Basque	[Xu]	[uX]-o	[uX]-o-o	[uX]-o-o-o	Trochee/Switch	Left

[1] Lakota (Boas and Deloria 1933), Chitimacha (Swadesh 1946), Atayal (Egerod 1966), Nahuatl (Pittman 1954), Macedonian (Lunt 1952, Lockwood 1972), Oñati Basque (Hualde 1999, Hayes 1980, 1993), Hopi (Jeanne 1978). Evidence for foot type in Oñati Basque and Hopi is limited, but the stress pattern for each is as shown above.

[2] NF stands for nonfinality, meaning that feet or stress are avoided in word-final position. This is purely a descriptive term, making no claims about the analysis of these languages.

(2) Weakly Dense Languages

Languages which fill a word with binary feet have **dense parsing**; if leftover syllables are allowed to be unparsed, the language is **weakly dense**. (Alber and Prince)

	Language[3]	2 σ	3 σ	4 σ	7 σ	Foot Type	Aligned
7	Seminole/Creek	[uX]	[uX]-o	[uX]-[uX]	[uX]-[uX]-[uX]-o	Iamb	Left
8	Pintupi	[Xu]	[Xu]-o	[Xu]-[Xu]	[Xu]-[Xu]-[Xu]-o	Trochee	Left
9	Warao	[Xu]	o-[Xu]	[Xu]-[Xu]	o-[Xu]-[Xu]-[Xu]	Trochee	Right
10	Yidiny/Wargamay	[Xu]	[uX]-o	[Xu]-[Xu]	[uX]-[uX]-[uX]-o	Switch	Left
11	Southern Paiute	[Xu]	[uX]-o	[uX]-[Xu]	[uX]-[uX]-[uX]-o	Iamb/Switch	Left + NF
12	Cayuga	[uX]	[uX]-o	[uX]-o-o	[uX]-[uX]-[uX]-o	Iamb	Left + NF
13	Piro	[Xu]	o-[Xu]	[Xu]-[Xu]	[Xu]-[Xu]-o-[Xu]	Trochee	Left/Right
14	Indonesian	[Xu]	o-[Xu]	[Xu]-[Xu]	[Xu]-o-[Xu]-[Xu]	Trochee	Left/Right
15	Garawa	[Xu]	[Xu]-o	[Xu]-[Xu]	[Xu]-o-[Xu]-[Xu]	Trochee	Left/Right

(3) Strongly Dense Languages

Languages which fill a word with binary feet have **dense parsing**; if leftover syllables are parsed into unary feet rather than leaving any syllable unparsed, the language is **strongly dense**. (Alber and Prince)

	Language[4]	2 σ	3 σ	4 σ	5 σ	Foot Type	Aligned
16	Weri	[uX]	[X]-[uX]	[uX]-[uX]	[X]-[uX]-[uX]	Iamb	Left (AFL)
17	Passamaquoddy	[Xu]	[X]-[Xu]	[Xu]-[Xu]	[X]-[Xu]-[Xu]	Trochee	Left (AFL)
18	Maranungku	[Xu]	[Xu]-[X]	[Xu]-[Xu]	[Xu]-[Xu]-[X]	Trochee	Right (AFR)
19	Tauya	[X]-[X]	[X]-[uX]	[X]-[X]-[uX]	[X]-[uX]-[uX]	Iamb	Left (AFL)
20	Gosiute Shoshone	[X]-[X]	[Xu]-[X]	[Xu]-[X]-[X]	[Xu]-[Xu]-[X]	Trochee	Right (AFR)

[3] Seminole/Creek (Greenberg and Kashube 1976, Hayes 1995), Pintupi (Hansen and Hansen 1969), Warao (Osborn 1966), Yidiny (Dixon 1977), Wargamay (Dixon 1981), Southern Paiute (Sapir 1930, Harms 1966), Cayuga (Chafe 1977), Piro (Matteson 1965), Indonesian (Halim 1974), Garawa (Furby 1974)

[4] Weri (Boxwell and Boxwell 1969), Passamaquoddy (LeSourd 1993), Maranungku (Tryon 1970), Tauya (MacDonald 1990), Gosiute Shoshone (Miller 1996)

There are many possible combinations that are unattested, but there are two notable gaps. Specifically, no rightward dense iambic languages are attested. (Alber 2005, Hyde 2007, Kager 2001) This is disputed, as Ojibwa (Piggott 1983) and utterance-medial Central Alaskan Yupik (Gordon 2002, citing Menovshchikov 1962, 1975) may be examples of the strongly dense rightward iambic language. Both of these languages are quantity sensitive, however, so it is possible that there are additional complications resulting in this pattern. (See Alber 2005: 496 for additional references on right-aligning iambs.)

(4) Unattested: Rightward Dense Iambic Languages

	2 σ	**3 σ**	**4 σ**	**5 σ**	**Foot Type**	**Aligned**
Unattested Weakly Dense	[uX]	o-[uX]	[uX]-[uX]	o-[uX]-[uX]	Iamb	Right
Unattested Strongly Dense	[uX]	[uX]-[X]	[uX]-[uX]	[uX]-[uX]-[X]	Iamb	Right (AFR)

A successful constraint set will capture all of the languages in (1) - (3), with as few as possible additional languages -- such as those in (4).

The standard alignment constraints are defined in (5). The Generalized Alignment schema of McCarthy and Prince (1993: 2) is defined in (5a); the definition in (5b) describes how violations are assessed.

(5) Alignment Constraint Definitions

a. Generalized Alignment Schema

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}

b. All-Feet-Left (AFL) and All-Feet-Right (AFR)

for each foot, assign one violation for every syllable that intervenes between that foot and the left/right edge of the word

Another rewording of the definition for AFL and AFR which also gives the same violations as the definition in (5b) can be found in Hyde (2008: 11-12, 2012: 791). Hyde's aim is to give a categorical version of the alignment constraints, where each locus of violation can only assess one or zero violations -- unlike the definitions in (5a) and (5c), where a single locus of violation can assess more than one violation.

This chapter examines two distinct constraint schemas for alignment, and thoroughly examines what the typological predictions of those constraints are. In doing so, the goal is to more fully understand which aspects of constraints are responsible for favorable and unfavorable results in terms of the typology. The two constraint schemas are alike in that they are defined in terms of *interveners* which prevent an *aligning category* from being properly aligned. Reference to interveners as a method of formulating alignment constraints has also been proposed by Ellison (1995) and Zoll (1996). The same set of constituents is used both as possible interveners (I) and possible aligning categories (K); specifically, these constituents are *syllables*, *unparsed syllables*, and *feet*.

The first constraint schema is referred to as **between alignment**; these constraints assign violations for *every* intervener between the aligning category and the edge being aligned to. The second constraint schema is referred to as **adjacent alignment**; these constraints are more local, and only assign a violation for an intervener *directly* next to the aligning category in the direction of the edge being aligned to. The definition for between alignment is provided in (6), and the definition for adjacent alignment is provided in (7); both definitions provided are only for the left-aligning versions of the constraint family.

(6) Between alignment definition

I, K ∈ {syllable, unparsed syllable, foot}

∀x of category I, if ∃y of category K **following** x,

x, y in the same word,

assess one violation.

(7) Adjacent alignment definition

I, K ∈ {syllable, unparsed syllable, foot}

∀x of category I, if ∃y of category K **immediately to the right of** x,

x, y in the same word,

assess one violation.

Each of the constraints predicted by these constraint schemas is considered separately, along with a constant set of standard constraints which provide a foundation for the typologies. The set of six constraints used throughout is given and defined in section 1; the typology predicted by these constraints alone is referred to as System Zero. Each typology considered in sections 2 and 3 contains a total of seven constraints: the six constraints of System Zero (FTBIN, PARSESYLL, *LAPSE, *CLASH, IAMB, TROCHEE), plus one alignment constraint predicted by the constraint schemas in (6) and (7).

Not all of the constraints produced by these schemas are what are generally thought of as being alignment constraints. When the same category is selected as both the intervener (I) and the aligning category (K), the resulting constraints lack the property of moving feet to word edges. Only when I and K are *different* do **true alignment (TA)** constraints emerge. When I and K are the same, the resulting constraints are always **pseudo alignment (PA)**. I and K being different is necessary but not sufficient for TA; it is possible for a constraint to be PA while I≠K. A true alignment constraint will exhibit **clumping**, meaning that feet are grouped at a word edge. The definition and examples of clumping can be found in (13). The between alignment constraints and adjacent alignment constraints are sorted into TA and PA below. Detailed information and discussion for each constraint system is provided in sections 2 and 3 under the corresponding heading.

(8) True Alignment (TA) and Pseudo Alignment (PA) Systems

<table>
<tr><th rowspan="9">Between Alignment</th><th colspan="2">Pseudo Alignment</th><th colspan="2">True Alignment</th></tr>
<tr><td>System Name</td><td>Constraint</td><td>System Name</td><td>Constraint</td></tr>
<tr><td>BPA1</td><td>*σ/…σ</td><td>BTA1</td><td>*-o-/…σ</td></tr>
<tr><td>BPA2</td><td>*-o-/…-o-</td><td>BTA2</td><td>*F/…σ</td></tr>
<tr><td>BPA3</td><td>*F/…F</td><td rowspan="2">BTA3</td><td rowspan="2">*σ/…-o-
*F/…-o-</td></tr>
<tr><td colspan="2" rowspan="3"></td></tr>
<tr><td>BTA4</td><td>*σ/…F</td></tr>
<tr><td>BTA5</td><td>*-o-/…F</td></tr>
<tr></tr>
<tr><th rowspan="7">Adjacent Alignment</th><th colspan="2">Pseudo Alignment</th><th colspan="2">True Alignment</th></tr>
<tr><td>System Name</td><td>Constraint</td><td>System Name</td><td>Constraint</td></tr>
<tr><td>APA1</td><td>*σ/σ</td><td rowspan="2">ATA1</td><td rowspan="2">*σ/F
*F/σ</td></tr>
<tr><td>APA2</td><td>*-o-/-o-</td></tr>
<tr><td>APA3</td><td>*F/F</td><td rowspan="2">ATA2</td><td rowspan="2">*-o-/F
*F/-o-</td></tr>
<tr><td rowspan="2">APA4</td><td rowspan="2">*σ/-o-
*-o-/σ</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Following Alber (2005), only left-aligning versions of the constraints were used; everything said about left-aligning constraints can be projected by symmetry into statements about their right-aligned counterparts.

AFL and AFR, combined with the six constraints of System Zero, produce a total of 22 languages; 12 of those languages are unattested, including both from (4). AFL alone, combined with the same basic set of constraints, produces a total of 14 languages; 6 of these languages are unattested.

The measure of success for these constraints is how well they match attested languages. The constraints that do the best, in terms of their typologies adding attested languages missing from the System Zero typology and not adding unattested languages, are listed below.

(9) Properties of successful constraints

Between alignment: unparsed syllables as intervener[5]

*-o-/…σ : no unparsed syllable before a syllable (BTA1)

*-o-/…F : no unparsed syllable before a foot (BTA5)

Adjacent alignment: feet as intervener *or* aligner

*σ/F : no syllable to the immediate left of a foot (ATA1)

*-o-/F : no unparsed syllable to the immediate left of a foot (ATA2)

(plus the mirror images of the above two constraints)

All four of these constraints avoid adding unattested languages, while adding attested languages missing from System Zero. Specifically, the added languages are given below.

[5] Although those that use unparsed syllables as the intervener (*-o-/…σ and *-o-/…F) introduce one unattested language, the three-syllable iambic switch language is caused by these constraints interacting with the asymmetrical IAMB and TROCHEE constraints. With symmetrical versions of the foot form constraints, this problem does not occur.

(10) Attested languages not in System Zero, added by constraints

Density	*Foot Type*	*Aligned*	*Language Name*	*Constraint Name*			
				BTA1: *-o-/…σ	BTA5: *-o-/…F	ATA1: *σ/F	ATA2: *-o-/F
Sparse	Iamb	Left	Lakota	≈	★	★	★
Sparse	Trochee	Left	Chitimacha		★	★	★
Sparse	Trochee	Right	Nahuatl			≈	≈
Sparse	Trochee	Right + NF	Macedonian	≈			
Sparse	Trochee/Switch	Left	Oñati Basque			★	
Weakly Dense	Trochee	Left	Pintupi	★	★	★	★
Weakly Dense	Switch	Left	Yidiny/ Wargamay	★	★	★	★

★ indicates a fully decisive language matching the attested language
≈ indicates an indecisive language consistent with the attested language

Given that three out of the four constraints shown below refer explicitly to the location of unparsed syllables, it is unsurprising that none of the added languages are strongly dense, which have no unparsed syllables to refer to. In fact, the only constraint which adds an attested strongly dense language (Passamaquoddy) not found in System Zero is BTA4 (*σ/…F), which also adds a number of undesirable unattested languages.

Certain unusual properties not found in System Zero appear during these typological examinations, which are mostly undesirable. These properties include an additional parsing type (*scattered parsing*), as well as terms relating to foot size (*stretching* and *shrinking*) and alignment behavior (*hyperalignment*). Definitions for these properties are provided in the following section. A property that every single 'true' alignment constraint shares is *switching*. In a switch language, rather than having consistent iambs or consistent trochees, the foot type will alternate in order to improve on alignment and rhythm. These terms are defined further in section 1, and the constraint features which elicit these properties are examined in sections 2 and 3.

The effects of each alignment constraint in conjunction with System Zero are described in the following sections; section 2 deals with the between family of constraints, while section 3 looks at the adjacent family of constraints. A comparison of the two constraint schemas, as well as discussion of the properties of the constraints which contribute to positive and negative results, can be found in section 4.

1 System Zero

Each alignment constraint was considered one at a time, with a constant set of constraints to provide the foundation for each typology. The alignment constraints will interact with each other when more than one is present, but assessing one at a time enables us to establish a baseline for a single constraint. While it is true that the addition of constraints can alter the predicted typology, all of the languages predicted by System Zero will exist in all of the other typologies -- although, in some cases, with more decisiveness than is found in System Zero due to ties being broken by the added constraint. In order to understand which effects are being produced by the alignment constraints themselves, we must first consider what the system looks like *before* adding any alignment constraints into the mix. System Zero represents the baseline typology; each constraint will be added one at a time in order to interpret its effects. There are six constraints in System Zero: two foot type constraints (IAMB and TROCHEE), two foot parsing constraints (PARSESYLL and FTBIN), and two rhythm constraints (*LAPSE and *CLASH). These constraints are defined in (11).

(11) Constraint definitions

(a) IAMB (P&S 1993)

For each foot that is not right-headed, assess one violation.

*[Xu]

(b) TROCHEE (FOOT-NONFINAL) (P&S 1993, Tesar 2000)

For each foot that is right-headed, assess one violation.

*[uX], [X]

(c) PARSESYLL (P&S 1993)

For each syllable that is not parsed into a foot, assess one violation.

*-o-

(d) FTBIN (P&S 1993)

For each unary foot, assess one violation.

*[X]

(e) *LAPSE (Selkirk 1984, Kager 2001, Alber 2005[6])

For each sequence of two unstressed syllables, assess one violation.

*-o-o-, -o-[u, u]-o-, u]-[u

(f) *CLASH (Liberman & Prince 1977, Alber 2005[6])

For each sequence of two stressed syllables, assess one violation.

*X]-[X

It should be noted that there is an asymmetry in the foot type constraints; TROCHEE penalizes unary feet, while IAMB does not. This asymmetry prevents the

[6] Additional references on *LAPSE and *CLASH can be found in Alber (2005: 500, 504).

promotion of unary feet due to the satisfaction of both foot type constraints by the unary foot. Instead, IAMB penalizes only bisyllabic trochees, allowing bisyllabic iambs and unary feet, while TROCHEE allows only bisyllabic trochees, penalizing bisyllabic iambs and unary feet.

The combination of these six constraints produces six languages, which can be seen in the table below. There are three language types in terms of parsing, and each language type has both an iambic and a trochaic version -- for a total of six languages altogether.

(12) Language Types Predicted by System Zero

	2 σ	**3 σ**	**4 σ**	**Parsing Type**	**Foot Type**	**Attested Language**
(a)	[uX]	[uX]-o	o-[uX]-o [uX]-o-o	Sparse	Iambic	contains Lakota
(b)	[Xu]	o-[Xu]	o-o-[Xu] o-[Xu]-o	Sparse	Trochaic	contains Nahuatl
(c)	[uX]	[uX]-o	[uX]-[uX]	Weakly Dense	Iambic	Creek
(d)	[Xu]	o-[Xu]	[Xu]-[Xu]	Weakly Dense	Trochaic	Warao
(e)	[uX]	[X]-[uX]	[uX]-[uX]	Strongly Dense	Iambic	Weri
(f)	[Xu]	[Xu]-[X]	[Xu]-[Xu]	Strongly Dense	Trochaic	Maranungku

The first two languages in System Zero, (a) and (b), have only a single foot per prosodic word. The single foot is placed to minimize violations of *LAPSE; in the iambic version, the foot avoids the final position, while in the trochaic version, the foot avoids the initial position. In both cases, there is a lack of decisiveness in terms of where the foot will be placed once the words reach four syllables in length. With a two-syllable word, there is only one spot where the foot can go; with a three-syllable word, *LAPSE can decisively select one position over the other. However, in a four-syllable or longer word, *LAPSE only rules out one position for the foot -- any other location is equally possible for the position of single foot. Because this type of language has only a single foot, regardless of how long the word gets, and many unparsed syllables, we will refer to this language type as having **sparse parsing**.

While the first two languages in the System Zero typology have only a single foot, the other four languages contain more feet. Because parsing of feet is more compact in these languages, they will be referred to as having **dense parsing**. While a sparse language features only one foot per word, dense languages prefer to fill the word with binary feet. However, as can be observed from looking at the above chart, there are two kinds of dense languages. One variety, found in languages (c) and (d), allows for a single unparsed syllable to be left over in words with an odd number of syllables; the other variety, exemplified by languages (e) and (f), requires completely dense parsing no matter what -- and unary feet are used in place of leaving a syllable unparsed.

Languages (c) and (d) fill the word with binary feet as much as possible; when there is no more room for binary feet, the leftover syllable is left unparsed. This system type will be called **weakly dense**. The location of the unparsed syllable is determined, in System Zero, by *LAPSE. In the iambic system, the unparsed syllable is word-final to avoid a lapse; in the trochaic system, the unparsed syllable is word-initial to avoid a lapse.

Languages (e) and (f) fill the word with binary feet as much as possible; when there is no more room for binary feet, the leftover syllable creates a unary foot by itself. This system type will be called **strongly dense**. The location of the unary foot is determined here by *CLASH. To avoid a clash, the unary foot is word-initial in iambic languages and word-final in trochaic languages.

1.1 Special Effects Emerging from the Typologies

There are a few other terms that we will need to understand the results of our typological examinations, although the behaviors they describe are not present in System Zero. These terms include an additional parsing type (*scattered parsing*), as well as terms relating to foot type (*switch*), foot size (*stretching* and *shrinking*), and alignment behavior (*hyperalignment*). There is also a descriptive term for discussing foot placement that is not the direct result of alignment (*clumping*).

In the typologies resulting from the two alignment constraint schemas, it is sometimes the case that a left-alignment constraint will have the effect of grouping feet at the right edge of the word. Although these constraints are technically left-aligning, it is useful to refer to these as right-clumping constraints.

(13) Overview of Clumping

(a) Typological Occurrence of Clumping

Most alignment constraints either clump left or right. Left clumping refers to feet bunching up at the left edge. In sparse or weakly dense languages, this means unparsed syllables gather at the right edge while feet gather at the left edge. In strongly dense languages, this means unary feet at the left edge.

*(b) Left-aligned language with right-clumping predicted by *F/…σ (BTA2)*

	2 σ	**3 σ**	**4 σ**	**5 σ**
R-clumping sparse	[Xu]	o-[Xu]	o-o-[Xu]	o-o-o-[Xu]
R-clumping weakly dense	[Xu]	o-[Xu]	[Xu]-[Xu]	o-[Xu]-[Xu]
R-clumping strongly dense	[Xu]	[Xu]-[X]	[Xu]-[Xu]	[Xu]-[Xu]-[X]

(c) Typological Occurrence of No Clumping

There is no clumping of feet at a word edge with any of the pseudo alignment constraints. For two APA constraints (APA2: *-o-/-o-, APA3: *F/F), feet will clump together due to rhythm constraints, but show no preference for either edge; these are the same typologies that produce scattered parsing. For APA4 (*σ/-o-), feet will clump *near* an edge but with an effect of noninitiality or nonfinality. APA1 and all of the BPA constraints have no effect at all beyond the constraints of System Zero.

*(d) Example of no clumping predicted by *-o-/-o- (APA2)*

	2 σ	**3 σ**	**4 σ**	**5 σ**
No clumping	[Xu]	o-[Xu]	o-[Xu]-o	o-o-[Xu]-o o-[Xu]-o-o

Once alignment constraints are added to the mix with System Zero, we will discover that some languages *switch* foot type in order to better satisfy rhythm and alignment constraints. In fact, every true alignment constraint causes the existence of at least one switch language. While we will continue to refer to strictly iambic languages as iambic and strictly trochaic languages as trochaic, languages where the foot type can vary between word lengths -- or even within a single form -- are called **switch** languages. These languages are not strictly iambic or trochaic; both iambs and trochees appear productively, as in Yidiny and Wargamay. Even when a language is classified as being switch, there is still a ranking between IAMB and TROCHEE; as a result, even switch languages are inherently iambic or trochaic, and the difference will show up (at least) in two-syllable words when no other constraint can interfere. Specifically, there are two ways that a language can exhibit switching; either the language will have *mixed forms* or *solid forms*.

When a switch language permits more than one foot type within a single word, this is referred to as a **mixed form** (for example, [Xu]-[uX]). A switch language with mixed forms might have forms with both foot types occurring only in a certain word length, or it might occur more productively in the language. On the other hand, in some switch languages, every word contains *only* iambs or *only* trochees; in these languages, the switching happens across forms rather than within a single form. Because every word of these languages contains only one kind of foot, these are referred to as **solid form** (for example, [Xu]-[Xu] and [uX]-[uX]-o in a single language). Again, a language might switch to the opposite foot type only in one word length or the change might be governed by another rule. Every alignment constraint produces at least one solid form switch language, though only certain types of alignment constraints result in mixed form switching.

One common type of solid form switch language appears in several of the typologies, due to the specific definition of TROCHEE being used. In mostly trochaic, strongly dense languages, there will be a switch in three-syllable words to iambic and weakly dense. The reason for the three-syllable switch is that [Xu]-[X] and [uX]-o both violate TROCHEE a single time. This makes it possible for a constraint which favors the second parsing to force the switch, as shown below.

(14) Three-syllable iambic switch

Winner	**Loser**	**TROCHEE**	**FTBIN**	**IAMB**	**PARSESYLL**
[uX]-o	[Xu]-[X]	e	W	W	L
[Xu]-[Xu]-[X]	[uX]-[uX]-o	W	L	L	W

This three-syllable iambic switch is explained in more detail when it first occurs in the between alignment section.

(15) Overview of Switch Footing

(a) Typological Occurrence of Mixed Form Switch

Mixed form switch occurs with two between alignment constraints (BTA4: *σ/…F and BTA2: *F/…σ) and one adjacent alignment constraint (APA3: *F/F).

*(b) Mixed form switch language predicted by *σ/…F (BTA4)*

	2 σ	**4 σ**	**5 σ**
Mixed form switch language	[Xu]	[uX]-[uX]	[Xu]-[X]-[uX]

(c) Typological Occurrence of Solid Form Switch

Solid form switch occurs with all true alignment constraints. Specifically, all adjacent constraints where I≠K, all between constraints where I≠K, and with AFL.

*(d) Solid form switch language predicted by *σ/…F (BTA4)*

	2 σ	**3 σ**	**4 σ**	**5 σ**
Solid form switch language	[Xu]	[uX]-o	[Xu]-[Xu]	[uX]-[uX]-o

(e) Typological Occurrence of Three-Syllable Iambic Switch

Three-syllable iambic switch occurs with between alignment constraints that have unparsed syllables as interveners (BTA1: *-o-/…σ and BTA5: *-o-/…F) and adjacent alignment constraints that have unparsed syllables as intervener or aligner (ATA2: *-o-/F and its mirror image).

*(f) Three-syllable iambic switch with *-o-/…F (BTA5)*

	2 σ	**3 σ**	**4 σ**	**5 σ**
Three-syllable iambic switch	[Xu]	[uX]-o	[Xu]-[Xu]	[Xu]-[Xu]-[X]

(g) Typological Occurrence of Both Mixed and Solid Switch

Only one constraint produces **both mixed and solid switch forms** in a single language, the between constraint *σ/…F. (BTA4) *(h) Mixed and solid form switch language predicted by *σ/…F (BTA4)*

	2 σ	**5 σ**	**6 σ**
Mixed and solid form switch language	[Xu]	[uX]-[uX]-o	[Xu]-[X]-[uX]-o

Stretching and shrinking are opposites of each other, both pertaining to adjusting foot size on behalf of alignment constraints. **Stretching** (Alber and Prince) refers to the use of a binary foot in lieu of a unary foot in order to do better on alignment; for instance, the final foot in the word will be binary (instead of unary) in order to make that foot be slightly closer to the beginning of the word. Stretching occurs primarily in strongly dense languages; for example, stretching might produce the parsing [Xu]-[X]-[Xu] rather than the more expected (and better rhythmically) [Xu]-[Xu]-[X]. On the other hand, **shrinking** refers to the use of a unary foot where a binary foot might otherwise be found. An example of shrinking might prefer the parsing [X]-o-[Xu] rather than [Xu]-[Xu] in order to improve on some alignment constraint; in this example, the unary foot appears where a binary foot might usually be used.

(16) Overview of Shrinking and Stretching

(a) Typological Occurrence of Stretching

Stretching occurs with AFL and one between alignment constraint (BTA4: *σ/…F).

*(b) Two stretching languages predicted by *σ/…F (BTA4)*

	2 σ	**3 σ**	**4 σ**	**5 σ**
Stretching language	[Xu]	[X]-[Xu]	[Xu]-[Xu]	[Xu]-[X]-[Xu] [X]-[Xu]-[Xu]
Stretching switch language	[Xu]	[X]-[uX]	[Xu]-[Xu]	[Xu]-[X]-[uX]

(c) Typological Occurrence of Shrinking

Shrinking occurs *only* in scattered parsing languages, which occur with the adjacent constraints *-o-/-o- (APA2) and *F/F (APA3). Never occurs with true alignment constraints.

*(d) Two shrinking (and scattered) languages predicted by *F/F (APA3)*

	2 σ	**3 σ**	**4 σ**	**5 σ**	**6 σ**
Language 1	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[uX]	[uX]-o-[X]-o-[X]
Language 2	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[X]-o	[uX]-o-[X]-o-[X]

Hyperalignment (Alber and Prince) refers to the phenomenon where unary feet and unparsed syllables are introduced in order to bring feet slightly closer to the aligning edge. For example, in a hyperaligning language, the parsing [X]-[uX]-o might win over the parsing [uX]-[uX]; in this case, the unparsed syllable at the end and the unary foot at the beginning have the effect of moving every foot slightly closer to the beginning of the word. This effect will be explained in more detail when examples emerge in the between alignment section.

(17) Overview of Hyperalignment

(a) Typological Occurrence

Hyperalignment occurs with AFL and one between alignment constraint (BTA4: *σ/…F).

*(b) Hyperaligned language predicted by *σ/…F (BTA4)*

	2 σ	**3 σ**	**4 σ**	**5 σ**
Hyperaligned language	[uX]	[uX]-o	[X]-[uX]-o	[uX]-[uX]-o

Scattered parsing falls in between sparse parsing and dense parsing in terms of the number of binary feet per word. While sparse parsing prefers a single binary foot and dense parsing prefers the maximum number of binary feet, scattered parsing prefers something in between; a scattered parsing language will exhibit more than a single foot, but less than the maximum total of binary feet that could fit given the number of syllables. Ternary stress languages, such as Chugach Yupik (Leer 1985a, 1985b, 1985c), Cayuvava (Key 1967) or Tripura Bangla (Das 2001), are real life examples of scattered parsing. Scattered parsing does not come from true alignment constraints, and so will only be observed when I=K.

(18) Overview of Scattered Parsing

(a) Typological Occurrence

Scattered parsing languages occur *only* with the adjacent constraint schema when I=K; specifically, the constraints *-o-/-o- (APA2) and *F/F (APA2). Never occurs with true alignment constraints.

*(b) Chugach Yupik pattern and a language predicted by *F/F (APA3)*

	2 σ	**3 σ**	**4 σ**	**5 σ**	**6 σ**
Chugach Yupik	o-X	o-X-o	o-X-o-X	o-X-o-o-X	o-X-o-o-X-o
Scattered language	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[uX]	[uX]-o-[uX]-o

These properties will be shown in more detail in sections 2 and 3, as constraints which exhibit these behaviors are examined.

1.2 Methodology

To ensure that every candidate and ranking were considered in each case, all aspects of the typologies were calculated automatically instead of by hand. The bulk of the work was done by OT Workplace (OTWPL; Prince and Tesar 2007-2013).

1.2.1 Gen

The candidates were generated with OTWPL's GenStress, with quantity insensitive candidates up to seven syllables, no main stress, and no completely unstressed forms. Chapter 5 reveals that vowel lengthening is tightly controlled; to avoid additional complications, this chapter focuses only on quantity insensitive forms but the results will still be valid with the addition of quantity sensitivity.

Slight modifications were made to the default encoding of candidates, and the complete schematization is provided in (19). In total, 1404 candidates were generated for each typology.

(19) *OTWPL Candidate Schematization*

a. Iambic foot [uX]

b. Trochaic foot [Xu]

c. Unary foot [X]

d. Unparsed syllable o

e. Word boundary { }

f. Any constituent between (a) and (e) is separated with hyphen (-)

No spacer between a constituent and a word boundary

For example, a word consisting of two iambic feet and a unary foot would be schematized as {[uX]-[uX]-[X]}. Note that there are spacers between each foot, but none between the foot and the word boundary markers.

1.2.2 Eval

When possible to reduce the definition of an alignment constraint to a banned string, OTWPL's built-in DefineConstraints was used. All of the constraints from System Zero (PARSESYLL, FTBIN, *CLASH, *LAPSE, IAMB, TROCHEE) and all of the adjacent alignment constraint definitions were assessed with a banned string search. Two of the between alignment constraint definitions could be assessed with a string search, and the remaining six between alignment constraints were assessed via Visual Basic for Applications (VBA) macros. The VBA code for these constraint definitions, as well as the strings used for all other constraints, can be found in Appendix 1.

1.2.3 Factorial Typology

Once all candidates were generated and all of their violations were assigned, OTWPL was used to compute the factorial typologies. OTWPL has two features that were used to reduce the size of the candidate set before calculating the factorial typologies: DeDupe, which consolidates candidates with identical violation profiles, and HBFinder, which eliminates all harmonically bounded candidates from consideration. After applying DeDupe and HBFinder, the reduced candidate sets were then run through OTWPL's FacTyp program, which yielded the typologies for consideration. When further information about the rankings for a particular language was needed, RUBOT (a Ruby program included in OTWPL) performed those calculations.

2 Between Alignment

The 'between' family of alignment constraints is defined in terms of interveners that are anywhere between the category being aligned and the edge being aligned to. These constraints assign one violation for *each intervener*, giving them the ability to encode distance from the edge. For now, the only kind of edge that can be aligned to is a *word edge*. However, the constraint only cares about an intervener existing between *some* member of the aligning category and the edge of the word; this means that these constraints have the property of looking for the last (or first, in a right-aligned version) member of the category being aligned. While the definition does not explicitly refer to last or first, this is a property that emerges from the particular definition of alignment. The constraint looks for all I such that there is *any* K to the right of it; since the constraint doesn't care how many K's are to the right of each I, any I to the left of *some* K is also to the left of the last K. Additionally, any I's to the right of the final K will not count as a violation of the constraint; therefore, the final K also marks the end of the zone of violation. These two facts together explain why the constraint can be thought of in terms of the *last* (or first) K, even though the definition itself does not refer explicitly to the last (or first) K. The version of the alignment constraint being used here is defined in (20).

(20) Between alignment definition

I, K $\in$ {syllable, unparsed syllable, foot}

$\forall$x of category I, if $\exists$y of category K following x,

x, y in the same word,

assess one violation.

This expression will be written as *I/…K; the symbol 'I' is mnemonic for 'intervener' and the symbol 'K' for 'category being aligned.' The above definition describes only left-aligning versions of the constraints; the right-aligned version would penalize K…/I rather than I/…K. Everything said about left-aligned constraints can be projected by symmetry into statements about their right-aligned counterparts. For now, we will only be considering left-aligned versions of the constraints.

This definition of alignment differs from Hyde (2008/2012) because each I can contribute at most one violation -- no matter how many K's it serves as an intervener for. In Hyde's approach, triplets of I, K, and the domain are formed; each triplet is a single locus of violation, but a given I can participate in more than one triplet. The difference between this constraint schema and the Generalized Alignment schema of McCarthy and Prince (1993) or Hyde (2008/2012) can be illustrated by comparing the violations of the constraint *σ/…F with AFL and Hyde's ALIGN(F, L).

(21) Comparison of violation profiles for three left-aligning foot constraints

5-syllable input	*σ/…F	AFL	ALIGN(F, L)	Parsing
[uX]-o-o-o	0	0	0	Sparse
o-[uX]-o-o	1	1	1	
o-o-[uX]-o	2	2	2	
[uX]-[uX]-o	2	2	2	Weakly Dense
[uX]-o-[uX]	3	3	3	
o-[uX]-[uX]	**3**	**4**	**4**	
[uX]-[uX]-[X]	**4**	**6**	**6**	Strongly Dense
[uX]-[X]-[uX]	**3**	**5**	**5**	
[X]-[uX]-[uX]	**3**	**4**	**4**	

Because both interveners and aligned categories can be any member of the same set (syllables, unparsed syllables, feet) and we are holding the edge being aligned to constant for now (word edge), there are nine possible combinations predicted. The full set is shown in the following table. In this table, the following symbols are used:

σ any syllable

-o- unparsed syllable

F foot

(22) Table of between constraints

	Intervener			
Aligning Category		*Syllable*	*Unparsed Syllable*	*Foot*
	Syllable	(a) *σ/…σ	(b) *-o-/…σ	(c) *F/…σ
	Unparsed Syllable	(d) *σ/…-o-	(e) *-o-/…-o-	(f) *F/…-o-
	Foot	(g) *σ/…F	(h) *-o-/…F	(i) *F/…F

Full descriptions for each of these constraints are provided in the next table. ‘Description’ gives the definition for each constraint in plain language, while ‘effective description’ explains how that definition manifests itself. The final header, ‘favors,’ describes what the constraint prefers in a candidate. Within the ‘favors’ category, there are four types of descriptions: *fewer X*, *places X*, *pushes X*, and *pulls X*. The simplest description is *fewer X* -- in these cases, the constraint favors *fewer* of the category in question. *Places X* means that the constraint prefers having a single X at the edge of the word, but has no preference about the placement of other X’s. *Pushes X* and *pulls X* are counterparts of each other. If a constraint directly refers to the alignment of a category (K), then the category can be *pulled* in a direction (towards the beginning of the word, since we are only considering left-alignment constraints). Because K is being pulled in one direction, I’s must be *pushed* off in the other direction to get out of the way of the aligning K’s. Whenever K is being pulled to the beginning, I is being pushed to the end. In the table below, the position of feet is referred to whenever possible – the term *pull* is used when the constraint prefers feet at the beginning and the term *push* is used when the constraint prefers some other category at the beginning, but feet are preferred at the end of the word as a side effect.

(23) Table of between constraints with explanations of their definitions

		Intervener		
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/…σ	(b) *-o-/…σ	(c) *F/…σ
	description	no syll before a syll	no usyll before a syll	no foot before a syll
	effective description	no syll before the final syll	no usyll before the final syll	no feet before the final syll
	favors	fewer sylls	places usyll at end	places foot at end
	Unparsed Syllable	(d) *σ/…-o-	(e) *-o-/…-o-	(f) *F/…-o-
	description	no syll before a usyll	no usyll before a usyll	no foot before a usyll
	effective description	no syll before the final usyll	no usyll before the final usyll	no foot before the final usyll
	favors	pushes feet to the end	fewer usylls	pushes feet to the end
	Foot	(g) *σ/…F	(h) *-o-/…F	(i) *F/…F
	description	no syll before a foot	no usyll before a foot	no foot before a foot
	effective description	no syll before the final foot	no usyll before the final foot	no foot before the final foot
	favors	pulls feet to the left	pulls feet to the left	fewer feet

Each of these constraints was considered one at a time, along with the consistent set of constraints from System Zero: FTBIN, IAMB, TROCHEE[7], PARSESYLL, *LAPSE, and *CLASH. Deletion and insertion of syllables was not considered, meaning that every candidate set contained candidates of the same length but with different footing. As with System Zero, words were also assumed to have at least one syllable, and to have at least one foot. The effects from each of the constraints defined in (20) will be explained in the following sections. Every language from System Zero was represented in each of the typologies predicted by the addition of an alignment constraint; languages were *added*, but none were lost. The sparse parsings in System Zero were indecisive, unable to

7 The version of TROCHEE used here which penalizes [uX] as well as [X]; see section 1 for details.

choose between candidates which tied on all constraints available. However, in some of the systems with an alignment constraint, a further decision was able to be made elsewhere. The narrowing down of possibilities present within the indecisive System Zero languages was indicated with the symbol Z+ in the typology charts.

The behavior of these systems fall into two major types, depending on whether I=K or not. When I=K, the constraint has the effect of minimizing whatever category is being picked out by K and I. When I≠K, we can again divide the constraints into two groups – one group where K is the syllable, and the other group where K is either the unparsed syllable or the foot. When the syllable is the category being aligned, the constraints have the effect of placing a single intervener at the end of the word. These constraints favor having an intervener at the end of the word in order to avoid a violation; however, an intervener will only escape violating the constraint in *final* position. Since there can only be one intervener in the final position, any additional interveners will violate these constraints regardless of how close to an edge they fall. As a result, this constraint has the effect of *placing* a single intervener at the end of the word (…I#).

On the other hand, when unparsed syllables or feet are K, *all* interveners are pushed to the end of the word. Unlike when the syllable is K, now the constraint can position more than one intervener. Rather than *placing* an intervener at the edge, these constraints actively pull each K to the beginning, with the result that every I is pushed off to the end (#KKK…III#). When K is the unparsed syllable, feet are pushed off to the end while unparsed syllables are pulled to the beginning; when K is the foot, feet are pulled to the beginning while unparsed syllables are pushed off to the end. However, in languages with strongly dense parsing – where there are no unparsed syllables – the constraints in this category which refer directly to unparsed syllables have nothing to say about the parsing. If there is a unary foot to be placed somewhere in the word, the constraints in this grouping which refer to unparsed syllables have no preference about the location of the unary foot, and so the decision can be made by rhythm constraints instead.

The table below shows each constraint and the name of the system it produces, which also contains whether a constraint is true alignment (BTA) or pseudo alignment (BPA). As the table reveals, the nine BA constraints yield eight unique systems: three pseudo alignment (all where I=K) and five true alignment (all where I≠K). None of the BPA systems are distinct from System Zero.

(24) Table of BA Systems

		Intervener		
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/…σ	(b) *-o-/…σ	(c) *F/…σ
	System Name	BPA1 (= System Zero)	BTA1	BTA2
	Unparsed Syllable	(d) *σ/…-o-	(e) *-o-/…-o-	(f) *F/…-o-
	System Name	BTA3	BPA2 (= System Zero)	BTA3
	Foot	(g) *σ/…F	(h) *-o-/…F	(i) *F/…F
	System Name	BTA4	BTA5	BPA3 (= System Zero)

Certain properties emerge with the addition of the alignment constraint, which will be detailed in each of the following sections. These include *stretching* of the final foot, where the final foot of the word is binary (where it would otherwise be unary) in order to do slightly better on alignment, and *hyperalignment*, where unary feet and unparsed syllables are introduced in order to bring feet slightly closer to the aligning edge. These properties are discussed in more detail in the systems that exhibit the behavior.

2.1 Intervener and Category Match (I=K)

		Intervener		
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/…σ	(b) *-o-/…σ	(c) *F/…σ
	Unparsed Syllable	(d) *σ/…-o-	(e) *-o-/…-o-	(f) *F/…-o-
	Foot	(g) *σ/…F	(h) *-o-/…F	(i) *F/…F

The cases where the intervener and the category are the same (the diagonal from the upper left to the lower right) share the property of minimization. They are not true alignment constraints; while they are able to prefer the minimization of a particular category, they do not push or pull feet to the edges of words. Each of these constraints has a minimizing effect, preferring the fewest number of the category in question. Syllable-syllable minimizes syllables, down to one in the word; unparsed syllable-unparsed syllable minimized unparsed syllables, down to one in the word; and foot-foot minimizes feet, down to one in the word. Each of these constraints is equally happy with *one* of the category in question or *none* of the category in question. This minimizing effect could be used for the generation of templates; Alber and Lappe (2012: 303-304) use AFL to create a bisyllabic template, while a constraint ALL-SYLLABLES-LEFT (which is the same as the syllable-syllable constraint used here) would be capable of producing a monosyllabic template (Alber and Lappe 2012: 305, and references therein: McCarthy and Prince 1993, Mester and Padgett 1994, Spaelti 1997).

However, the set of assumptions being used here restricts the ability of these constraints to have an effect on the typology. For instance, the fact that we are not considering insertion or deletion means that syllable-syllable cannot actively encourage the deletion of syllables. In fact, given the set of assumptions being used here, none of these constraints contribute any interesting effects; interesting effects, in this case, means the addition of languages to the typology, beyond those found in System Zero. Because none of these constraints adds languages to this typology, they are considered to be uninteresting here.

The definition of all three of these constraints can be schematized as *X/…X; this represents the preference for words to have, at most, one X. The constraints penalize having more than one of the category in question; syllable-syllable is perfectly satisfied by a word with one (or no) syllables, unparsed syllable-unparsed syllable is perfectly satisfied by a word with one (or no) unparsed syllables, and foot-foot is perfectly satisfied by a word with one (or no) feet.

2.1.1 System BPA1: *σ/…σ

		Intervener		
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/…σ	(b) *-o-/…σ	(c) *F/…σ
	Unparsed Syllable	(d) *σ/…-o-	(e) *-o-/…-o-	(f) *F/…-o-
	Foot	(g) *σ/…F	(h) *-o-/…F	(i) *F/…F

Unparsed syllables and feet both make direct reference to prosodic structure; feet are the syllables which have been grouped into bigger prosodic units, while unparsed syllables are those which haven't. On the other hand, the category 'syllable' makes no reference at all to metrical structure. Most of the constraints in the above table have at least one unit (either I or K) which refers to prosodic structure; however, the **syllable-syllable** constraint has no connection with higher prosodic structure.

The syllable-syllable constraint penalizes every syllable between the last syllable and the left edge of the word. In effect, this constraint returns a value equal to the number of syllables in the word minus one. Given that the set of assumptions being used here does not allow for deletion or insertion of syllables, every candidate in a given candidate set has the same number of syllables -- and, therefore, the same number of violations on this constraint. Because this constraint can never distinguish between candidates in a candidate set, it contributes nothing to this typology. However, if deletion or insertion of syllables were to be considered, this constraint would favor minimizing the number of syllables in a word; a word with just one syllable would perfectly satisfy this constraint. Some examples of five-syllable candidates are shown below, with their violations on the syllable-syllable constraint.

(25) 5-syllable input with SYLLABLE-SYLLABLE

5-syllable input	SYLLABLE-SYLLABLE (*σ/…σ)	Parsing
[uX]-o-o-o	**4**	Sparse
o-[uX]-o-o	**4**	
o-o-[uX]-o	**4**	
[uX]-[uX]-o	**4**	Weakly Dense
[uX]-o-[uX]	**4**	
o-[uX]-[uX]	**4**	
[X]-[uX]-[uX]	**4**	Strongly Dense
[uX]-[X]-[uX]	**4**	
[uX]-[uX]-[X]	**4**	

As this table shows, every candidate with five syllables will have the exact same number of violations; this means that it doesn't matter where this constraint is ranked -- it will never have an impact on which candidate is selected.

The unparsed syllable-unparsed syllable and foot-foot constraints, on the other hand, *do* distinguish between candidates in the candidate set. However, they still contribute nothing to the typology, because they simply double the effects of constraints already being used.

2.1.2 System BPA2: *-o-/…-o-

The **unparsed syllable-unparsed syllable** constraint defined in (e) is a special case of PARSESYLL, since it penalizes every unparsed syllable except the final one. The violations for this constraint are always the violations for PARSESYLL, minus one (a single unparsed syllable in the word is no violations). For this constraint, dense parsings are favored -- though it has no preference between a strongly dense parsing and a weakly dense parsing -- and sparse parsings are rejected. On the other hand, PARSESYLL prefers strongly dense parsing over weakly dense parsing, with sparse parsing the worst of all.

(26) 5-syllable input with USYLL-USYLL

5-syllable input	USYLL-USYLL (*-o-/…-o-)	PARSESYLL	Parsing
[uX]-o-o-o	**2**	**3**	Sparse
o-[uX]-o-o	**2**	**3**	
o-o-[uX]-o	**2**	**3**	
[uX]-[uX]-o	**0**	**1**	Weakly Dense
[uX]-o-[uX]	**0**	**1**	
o-[uX]-[uX]	**0**	**1**	
[uX]-[uX]-[X]	**0**	**0**	Strongly Dense
[uX]-[X]-[uX]	**0**	**0**	
[X]-[uX]-[uX]	**0**	**0**	

This constraint has no effect on the typology, predicting the same six languages[8] that are predicted with no alignment constraint being considered -- feet are placed solely by rhythm. The effect that this constraint has is identical to the effect of PARSESYLL, and so it adds nothing. There is a potential, however, for this constraint to disagree with PARSESYLL with respect to the candidates with just one unparsed syllable. USYLL-USYLL treats one unparsed syllable the same as no unparsed syllables, while PARSESYLL treats one unparsed syllable as worse.

However, USYLL-USYLL does not actually make a decision between the two groups; all this constraint can do is pass the decision further down the hierarchy, where a constraint favoring the weakly dense parsing (such as FTBIN and TROCHEE, which are opposed to the strongly dense parsing's unary foot) can make a decision. This would be useful if there was a situation where something like PARSESYLL needed to dominate the constraints in favor of weakly dense over strongly dense, yet the output still was weak density. With only PARSESYLL in the arsenal, this would result in a contradiction; USYLL-USYLL would provide a way around this issue, taking the place of PARSESYLL

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[8] Three parsing types (sparse, weakly dense, strongly dense) times two foot types (iambic, trochaic).

higher in the hierarchy. However, with the set of constraints being considered, the unparsed syllable-unparsed syllable constraint adds no new languages to the typology.

2.1.3 System BPA3: *F/…F

Similarly, the **foot-foot** constraint in (i) simply doubles the effects of already existing foot antagonist constraints. This constraint penalizes any foot between the left edge of the word and the final foot; essentially, this constraint only cares about having more than one foot per word. There are already foot antagonists in the constraint set being considered, in the form of IAMB and TROCHEE. Because these constraints already have foot-minimizing effects in the typology with no alignment constraints, the addition of this foot-foot constraint cannot change anything here. As with the unparsed syllable-unparsed syllable constraint, the foot-foot constraint predicts only the six languages predicted with no alignment constraint in the constraint set. Violations of the foot-foot constraint are shown below, in comparison with IAMB, one of the other foot antagonists.

(27) 5-syllable input with FOOT-FOOT

5-syllable input	FOOT-FOOT (*F/…F)	IAMB	Parsing
[Xu]-o-o-o	**0**	**1**	Sparse
o-[Xu]-o-o	**0**	**1**	
o-o-[Xu]-o	**0**	**1**	
[Xu]-[Xu]-o	**1**	**2**	Weakly Dense
[Xu]-o-[Xu]	**1**	**2**	
o-[Xu]-[Xu]	**1**	**2**	
[Xu]-[Xu]-[X]	**2**	**3**	Strongly Dense
[Xu]-[X]-[Xu]	**2**	**3**	
[X]-[Xu]-[Xu]	**2**	**3**	

Although the total numbers of violations differ from FOOT-FOOT to IAMB, the effect of these two constraints is the same. They both separate the candidate set into the same sets of candidates; the absolute number of violations doesn't matter, but rather the relative number of violations. The table above only shows parsings where all of the feet are of the same type -- either all iambs or all trochees. However, this set of constraints does not permit any parsings of the "switch" type. Because the alignment constraint being used gives no benefit to changing foot type, no switch languages will be found here.

Any heterogeneous foot parsings will be harmonically bounded under this set of constraints, given that no constraint favors it. Parsings such as [Xu]-[uX]-o or [uX]-[Xu]-o fail on rhythmic grounds, violating LAPSE, CLASH, or both. Both of these parsings are harmonically bounded by another harmonically bounded candidate, [uX]-o-[Xu].

(28) Candidates with imperfect rhythm and heterogeneous foot parsing

5-syllable input	**FT-FT**	***LAPSE**	***CLASH**	**PARSESYLL**	**FTBIN**	**TROCHEE**	**IAMB**
[uX]-[Xu]-o	*1*	**1**	**1**	*1*	*0*	*1*	*1*
[Xu]-[uX]-o	*1*	**1**	*0*	*1*	*0*	*1*	*1*
[uX]-o-[Xu]	*1*	**0**	**0**	*1*	*0*	*1*	*1*

On the other hand, mixed form switch candidates with perfect rhythm like [uX]-o-[Xu] and [Xu]-[X]-[uX] are harmonically bounded by candidates with a single foot type. The sparsely dense [uX]-o-[Xu] is collectively harmonically bounded by [uX]-[uX]-o and o-[Xu]-[Xu], while the strongly dense [Xu]-[X]-[uX] is collectively harmonically bounded by [X]-[uX]-[uX] and [Xu]-[Xu]-[X].

(29) Candidates with perfect rhythm and heterogeneous foot parsing

5-syllable input	FT-FT	*LAPSE	*CLASH	PARSESYLL	FTBIN	TROCHEE	IAMB
[uX]-o-[Xu]	*1*	*0*	*0*	*1*	*0*	**1**	**1**
[uX]-[uX]-o	*1*	*0*	*0*	*1*	*0*	*2*	**0**
o-[Xu]-[Xu]	*1*	*0*	*0*	*1*	*0*	**0**	*2*
[Xu]-[X]-[uX]	*2*	*0*	*0*	*0*	*1*	**2**	**1**
[X]-[uX]-[uX]	*2*	*0*	*0*	*0*	*1*	*3*	**0**
[Xu]-[Xu]-[X]	*2*	*0*	*0*	*0*	*1*	**1**	*2*

In both cases, IAMB prefers one of the bounders and TROCHEE prefers the other. While the mixed, switch candidates may do slightly better on both constraints than one candidate, they are not *best* on either. As a result, switch foot parsings are not possible with this constraint set.

As has been shown here, none of these constraints have any impact on the typology. We will now move to constraints where I and K are *not* the same category, to see what effects emerge under these conditions.

2.2 Intervener and Category Differ (I≠K)

		Intervener		
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/…σ	(b) *-o-/…σ	(c) *F/…σ
	Unparsed Syllable	(d) *σ/…-o-	(e) *-o-/…-o-	(f) *F/…-o-
	Foot	(g) *σ/…F	(h) *-o-/…F	(i) *F/…F

When the intervener and the aligning category are *different*, there are effects on positioning that emerge; these are true alignment constraints. These constraints can be grouped in terms of what K is; there are properties in common for both of the remaining constraints which align syllables, both which align unparsed syllables, and both which align feet.

When the aligning category is the syllable, an intervener can be placed at the end of the word by the alignment constraint (*I/…σ favors …I#). On the other hand, when K is unparsed syllables or feet, feet are bunched together at one end of the word. With unparsed syllables as K, feet are pushed off to the end of the word as unparsed syllables are pulled to the left (*I/…-o- favors …(FF)F#); with feet as K, feet are pulled to the left of the word (*I/…F favors #F(FF)…).

2.2.1 Aligning Category is Syllable

		Intervener		
Aligning Category		*Syllable*	*Unparsed Syllable*	*Foot*
	Syllable	(a) *σ/…σ	(b) *-o-/…σ	(c) *F/…σ
	Unparsed Syllable	(d) *σ/…-o-	(e) *-o-/…-o-	(f) *F/…-o-
	Foot	(g) *σ/…F	(h) *-o-/…F	(i) *F/…F

The first group to consider is the set where the category of alignment is syllables. For both of these constraints (unparsed syllable-syllable and foot-syllable), the constraint has the effect of placing an intervener at the *right* edge. The class of syllables as K has an interesting property, because a syllable can overlap with either of the interveners -- an unparsed syllable is a syllable, and a foot is made up of syllables. Because the number of syllables is consistent across a candidate set, the only way to minimize violations is by placing whatever *would* be an intervener at the edge opposite the aligning edge. By doing this, that potential intervener becomes the syllable being aligned, thus escaping a violation. Essentially, these constraints only penalize *non-final* interveners. For an example of how this would work with a five-syllable input, see (30) below. This example uses the unparsed syllable-syllable constraint to illustrate the point explained here.

2.2.1.1 System BTA1: *-o-/…σ

Stretching?	No	*Shrinking?*	No
Hyperalignment?	No	*Clumping direction?*	left
Number of switch languages?	2	*Switch types?*	
		T → I / solid forms: 3-sylls only	
Number of scattered languages?	0	*Number of additional languages?*	4

For the **unparsed syllable-syllable** constraint, this means that if there is at least one unparsed syllable, one will be placed at the *right* edge of the word. Consider the violations assigned by this constraint to a five-syllable word, below.

(30) 5-syllable input with USYLL-SYLL

5-syllable input	USYLL-SYLL (*-o-/…σ)	Parsing
[Xu]-o-o-o	**2**	Sparse
[o-[Xu]-o-o	**2**	
o-o-[Xu]-o	**2**	
o-o-o-[Xu]	**3**	
o-[Xu]-[Xu]	**1**	Weakly Dense
[Xu]-o-[Xu]	**1**	
[Xu]-[Xu]-o	**0**	
[Xu]-[Xu]-[X]	**0**	Strongly Dense
[Xu]-[X]-[Xu]	**0**	
[X]-[Xu]-[Xu]	**0**	

As this table shows, a candidate with an unparsed syllable at the right edge has one less violation than a candidate with the same number of unparsed syllables which *lacks* an unparsed syllable at the right edge. That is, …o# is better than …F# where both candidates have the same number of unparsed syllables.

For this reason, the constraint has a sort of non-finality effect in terms of possible languages. Rather than forcing feet away from the end of the word to achieve non-finality, this constraint places an unparsed syllable at the end of the word. While both reach the same result of an unparsed syllable rather than a foot in the final position of the word (for example, #FFo# rather than #oFF# or #FoF#), there are key differences in the constraint formulation. For instance, if there are no unparsed syllables in the word (either because it is a strongly dense language or simply a word with an even number of syllables in either type of dense language), this constraint does not contribute any non-finality effect; for example, the word might be parsed #FFF#. On the other hand, the view of non-finality where a foot is being moved away from the word edge might still force an unparsed syllable at the end of the word; for instance, #FFoo# with two unparsed syllables or #FFFo# with a degenerate foot.

Note also that this constraint cannot distinguish between candidates which fully parse the word; if there are no unparsed syllables, then there are no potential interveners. As a result, this constraint can also have a parsing effect in some system, since fully parsed forms perform better on this alignment constraint than those with unparsed syllables. The decision in strongly dense languages will be made by the remainder of the constraint hierarchy, without any influence from this constraint; only in sparse or weakly dense languages, where there are unparsed syllables, can this constraint have any effect.

The possible languages generated by the unparsed syllable-syllable constraint in conjunction with the System Zero constraints are shown in (32). The columns on the right edge of the table indicate parsing, foot type, and whether alignment or rhythm is positioning the feet. The final column indicates the relationship to the languages produced by System Zero. The sparse languages of System Zero are not decisive, with many co-optima tying to create the languages found in System Zero. Once alignment constraints are added, some of the resulting sparse languages are compatible with the System Zero counterparts -- but with fewer co-optima. This is marked with the code Z+, while a perfect match of any kind is marked with Z. There are also many languages produced with the addition of alignment constraints not found in System Zero; new languages, whether attested or unattested, are marked with ★. The complete key for these abbreviations is in (31).

A brief reminder of the definitions from section 1.1: Sparse parsing has a single foot per word, while dense parsing fills a word fully with binary feet (the leftover syllable in odd-length words is unparsed in weakly dense and a unary foot in strongly dense). Scattered parsing has more feet than a sparse language but fewer than a dense language. Switching refers to the use of both iambs and trochees within a single language; mixed form means that both foot types occur within a single word, while solid form means that each individual word contains only one type of feet. All true alignment constraints predict some kind of solid form switching. For more on these terms, and examples of languages which exemplify them, see section 1.1.

(31) Key for typology tables

Parsing (P)	**Foot Type (F)**	**Foot Positioning (A)**	**System Zero (Z)**
Sparse (SP)	Iambic (I)	Alignment (A)	Matches System Zero (Z)
Scattered (SC)	Trochaic (T)	Rhythm (R)	More decisive than System Zero counterpart (Z+)
Weakly Dense (WD)	Switching, Mixed Forms (SM)	Both (B)	Not in System Zero (★)
Strongly Dense (SD)	Switching, Solid Forms (SF)		

(32) Unparsed Syllable-Syllable

	2 σ	**3 σ**	**4 σ**	**5 σ**	**P**	**F**	**A**	**Z**	**Attested Language**
(a)	[uX]	[uX]-o	o-[uX]-o [uX]-o-o	o-o-[uX]-o o-[uX]-o-o [uX]-o-o-o	SP	I	B	Z	contains Lakota
(b)	[Xu]	o-[Xu]	o-[Xu]-o	o-o-[Xu]-o o-[Xu]-o-o	SP	T	R	Z+	consistent with Hopi stress
(c)	[Xu]	[Xu]-o	o-[Xu]-o	o-o-[Xu]-o o-[Xu]-o-o	SP	T	A	★	contains Macedonian
(d)	[uX]	[uX]-o	[uX]-[uX]	[uX]-[uX]-o	WD	I	B	Z	Creek
(e)	[Xu]	o-[Xu]	[Xu]-[Xu]	o-[Xu]-[Xu]	WD	T	R	Z	Warao
(f)	[Xu]	[Xu]-o	[Xu]-[Xu]	[Xu]-[Xu]-o	WD	T	A	★	Pintupi
(g)	[Xu]	[uX]-o	[Xu]-[Xu]	[uX]-[uX]-o	WD	T/SF	B	★	Yidiny/Wargamay
(h)	[uX]	[X]-[uX]	[uX]-[uX]	[X]-[uX]-[uX]	SD	I	B	Z	Weri
(i)	[Xu]	[Xu]-[X]	[Xu]-[Xu]	[Xu]-[Xu]-[X]	SD	T	B	Z	Maranungku
(j)	[Xu]	[uX]-o	[Xu]-[Xu]	[Xu]-[Xu]-[X]	SD	T/SF	B	★	

From the set of possible languages, we see that the alignment constraint has the power to place an unparsed syllable (in sparse languages and odd-length words in weakly dense languages) at the non-aligned edge, pushing the intervener off to the non-aligned edge so that it is no longer an intervener. This produces a non-finality effect since it means that languages will prefer to have an unparsed syllable at the right edge rather than a foot (if they must have an unparsed syllable at all). When there is more than one unparsed syllable (sparse languages), the constraint can only place one unparsed syllable word-finally; it says nothing about the placement of the single foot.

The languages above where the alignment constraint does not place an unparsed syllable at the right edge (in at least one length of words) are those which are obeying rhythm instead, as in (b) the sparse, rhythmic trochaic language and (e) the weakly dense, rhythmic trochaic language.

Similarly, there are certain languages where the foot type switches between iambic and trochaic depending on the length of the word; these are always languages which ranking both alignment and rhythm highly at the expense of the foot type constraints. With this constraint, all of the switch languages are inherently trochaic, with TROCHEE ranked above IAMB. This can be observed by inspecting the two-syllable words in the switch languages; because the factors which prompt switching to occur are not relevant in a two-syllable word, there is the possibility for the preferred foot type to emerge. In all of the cases predicted by USYLL-SYLL, the language is inherently trochaic.

One of the switch languages, (j) is a mostly trochaic, strongly dense language -- but switches to iambic and weakly dense in the three-syllable word. This is a type of switch language that appears in several of the typologies, due to the specific definition of TROCHEE being used; specifically, this language type was defined in section 1 as the **three-syllable iambic switch**. The reason for the three-syllable switch is that [Xu]-[X], the parsing with a trochee and a degenerate foot, and [uX]-o, the parsing with a single iamb and no degenerate feet, both violate TROCHEE a single time. The three-syllable iambic switch only occurs when an unparsed syllable is the intervener. These constraints penalize unparsed syllables except when they come *after* the aligning category, resulting in their violations being a subset of PARSESYLL's violations; this means that the effects of PARSESYLL are duplicated in terms of density *except* in this one instance. If the intervener 'unparsed syllable' was replaced by an intervener that contained unparsed syllables and unary feet (for instance, a category 'unary constituent' which targeted single unparsed syllables or unary feet), this type of switch would also disappear.

(33) Violation tableau for three-syllable candidates

	TROCHEE	**FTBIN**	**IAMB**	**PARSESYLL**	**USYLL-SYLL**	***LAPSE**	***CLASH**
{[uX]-o}	**1**			1			
{[Xu]-[X]}	**1**	1	1				

[X] and [uX] are both bad trochees by the definition of the constraint being used, so TROCHEE cannot distinguish between the two candidates. As a result, it is possible for a constraint which favors the second parsing -- IAMB or FTBIN -- to be ranked high enough to force the switch in the three-syllable word. However, PARSESYLL prefers the parsing with the trochaic foot and the degenerate foot; when PARSESYLL dominates both IAMB and FTBIN, the switch does not happen.

(34) Three-syllable iambic switch in language (j)

Winner	**Loser**	**TROCHEE**	**FTBIN**	**IAMB**	**PARSESYLL**
[uX]-o	[Xu]-[X]	e	W	W	L
[Xu]-[Xu]-[X]	[uX]-[uX]-o	W	L	L	W

The ranking for language (j) is provided above; only one of FTBIN and IAMB must dominate PARSESYLL, but it is not fully determined by the evidence. In the case of language (i), both FTBIN and IAMB are dominated by PARSESYLL to avoid the three-syllable iambic switch.

This set of languages is very similar to the one predicted by the other constraint with unparsed syllable as the intervener, *-o-/…F or USYLL-FT (BTA5). The only difference between the two is that language (c), the sparse, aligning trochaic language, is more decisive with feet as the aligning category. Otherwise, the languages predicted are identical. The features observed here can all also be observed in System BTA5.

2.2.1.2 System BTA2: *F/…σ

Stretching?	No	*Shrinking?*	No
Hyperalignment?	No	*Clumping direction?*	right
Number of switch languages?	2	*Switch types?*	
		I → T /	1 solid forms: 3+ sylls
			1 mixed forms: odd lengths
Number of scattered languages?	0	*Number of additional languages?*	4

Similar to the effects of the unparsed syllable-syllable constraint, the **foot-syllable** constraint can only place a foot at the right edge of the word. A word-final foot escapes a violation by virtue of the fact that it contains the last syllable, and therefore is not an intervener. For the same reason that the unparsed syllable-syllable constraint places an unparsed syllable at the right edge, the foot-syllable constraint places a foot at the right edge. The only exceptions to this generalization are the two rhythmic iambic languages -- the sparse language (b) and the weakly dense language (g). In these two languages, the foot-syllable alignment constraint is dominated by rhythm constraints which prefer not to have a foot at the end of the word.

(35) Foot-Syllable

	2 σ	**3 σ**	**4 σ**	**5 σ**	**P**	**F**	**A**	**Z**	**Attested Language**
(a)	[uX]	o-[uX]	o-o-[uX]	o-o-o-[uX]	SP	I	A	★	Atayal
(b)	[uX]	[uX]-o	o-[uX]-o [uX]-o-o	o-o-[uX]-o o-[uX]-o-o [uX]-o-o-o	SP	I	R	Z	contains Lakota
(c)	[Xu]	o-[Xu]	o-o-[Xu]	o-o-o-[Xu]	SP	T	B	★	Nahuatl
(d)	[uX]	o-[Xu]	o-o-[Xu]	o-o-o-[Xu]	SP	I/SF	B	★	
(e)	[uX]	o-[uX]	[uX]-[uX]	o-[uX]-[uX]	WD	I	A	★	*unattested*[9]
(f)	[uX]	[uX]-o	[uX]-[uX]	[uX]-[uX]-o	WD	I	R	Z	Creek
(g)	[Xu]	o-[Xu]	[Xu]-[Xu]	o-[Xu]-[Xu]	WD	T	B	Z	Warao
(h)	[uX]	o-[Xu]	[uX]-[uX]	[uX]-o-[Xu]	WD	I/SM	B	★	
(i)	[uX]	[X]-[uX]	[uX]-[uX]	[X]-[uX]-[uX]	SD	I	B	Z	Weri
(j)	[Xu]	[Xu]-[X]	[Xu]-[Xu]	[Xu]-[Xu]-[X]	SD	T	B	Z	Maranungku

The foot-syllable constraint penalizes any non-final foot, desiring that a foot coincides with the right edge of the word. Although this is a left-alignment constraint, it has the appearance of a right-alignment constraint on feet -- because the thing being aligned is *not* the foot; rather, the foot is an intervener being pushed away from the alignment edge.

With the exception of the two rhythmic iambic languages mentioned above ((b) and (g)), every possible language will have a foot in the final position. These languages cannot satisfy both rhythm and alignment at the same time (in words of three or more syllables for the sparse parsing, and in words with an odd number of syllables for the weakly dense parsing), and so there are possible languages where alignment -- and, consequently, a word-final foot -- are sacrificed at the expense of improved rhythm.

In the typology predicted by this constraint set, all of the switching languages are inherently *iambic*, as opposed to what was seen in the previous constraint set. Again, this can be observed by inspecting the two-syllable words in the switch languages. All of

[9] Right-aligned, dense, iambic languages are listed as *unattested* rather than leaving the cell blank, to indicate that these are the languages specifically avoided by Alber (2005) and Kager (2001).

them select iambs when the choice is not being determined by other factors, meaning that IAMB dominates TROCHEE. The sparse switch language (d) uses a single trochee in words three syllables or longer, with an iamb only showing up in two-syllable words. On the other hand, the weakly dense switch language (h) contains mixed forms. In odd-length words, the final foot is always a trochee -- even though the rest of the feet are iambic. Odd-length words of language (h) are always of the form [uX]*-o-[Xu].

Of the four languages added beyond System Zero with the addition of the alignment constraint FT-SYLL, all but one of them are also found in the languages predicted by SYLL-USYLL and FT-SYLL (which are discussed in the next section). The language found only in this typology is (d) the sparse switch language. Otherwise, the predictions of the two constraints are identical.

2.2.2 Other Aligning Categories

		Intervener		
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/…σ	(b) *-o-/…σ	(c) *F/…σ
	Unparsed Syllable	(d) *σ/…-o-	(e) *-o-/…-o-	(f) *F/…-o-
	Foot	(g) *σ/…F	(h) *-o-/…F	(i) *F/…F

The group of constraints that have unparsed syllables or feet as an aligning category share some properties. For these constraints, the general property is that K appears as far to the left as possible. Because the violations are calculated from the *last* member of the category being aligned, violations can be minimized by selecting a candidate where the last member of the aligning category as close to the edge as possible.

Consequently, all members of the aligning category all clump to the left, with all interveners clumping off to the right.

	Intervener			
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/…σ	(b) *-o-/…σ	(c) *F/…σ
	Unparsed Syllable	(d) *σ/…-o-	(e) *-o-/…-o-	(f) *F/…-o-
	Foot	(g) *σ/…F	(h) *-o-/…F	(i) *F/…F

2.2.2.1 System BTA3: *σ/…-o- *and* *F/…-o-

Stretching? No

Shrinking? No

Hyperalignment? No

Clumping direction? right

Number of switch languages? 1

Switch types?

I → T /solid forms: odd lengths

Number of scattered languages? 0

Number of additional languages? 3

For **unparsed syllables** as the aligning category, the two constraints actually give the exact same typological results -- both foot-unparsed syllable and syllable-unparsed syllable predict the same nine languages. In both cases, the constraint simply brings unparsed syllables as close to the left edge as possible. It doesn't matter *what* I is -- just that there *is* an intervener. The violations assessed by the two candidates are not the same; however, they divide the candidate set up in the same way.

(36) 5-syllable input with FOOT-USYLL and SYLL-USYLL

5-syllable input	FOOT-USYLL (*σ/…-o-)	SYLL-USYLL (*F/…-o-)	Parsing
[Xu]-o-o-o	**1**	**4**	Sparse
o-[Xu]-o-o	**1**	**4**	
o-o-[Xu]-o	**1**	**4**	
o-o-o-[Xu]	**0**	**2**	
[Xu]-[Xu]-o	**2**	**4**	Weakly Dense
[Xu]-o-[Xu]	**1**	**2**	
o-[Xu]-[Xu]	**0**	**0**	
[Xu]-[Xu]-[X]	**0**	**0**	Strongly Dense
[Xu]-[X]-[Xu]	**0**	**0**	
[X]-[Xu]-[Xu]	**0**	**0**	

As the table above shows, both FOOT-USYLL and SYLL-USYLL pick o-o-o-[Xu] as the best sparse language; there is the same three-way distinction for both constraints in the weakly dense languages; and both constraints are perfectly satisfied when the language is strongly dense. Although the violations are not identical, their behavior with respect to the candidate sets is the same, thus predicting the same typology with both constraints. The languages predicted by these constraints are shown below.

(37) Foot-Unparsed Syllable and *Syllable-Unparsed Syllable (BTA3)*

	2 σ	**3 σ**	**4 σ**	**P**	**F**	**A**	**Z**	**Attested Language**
(a)	[uX]	o-[uX]	o-o-[uX]	SP	I	A	★	Atayal
(b)	[uX]	[uX]-o	o-[uX]-o [uX]-o-o	SP	I	R	Z	contains Lakota
(c)	[Xu]	o-[Xu]	o-o-[Xu]	SP	T	B	Z+	Nahuatl
(d)	[uX]	o-[uX]	[uX]-[uX]	WD	I	A	★	*unattested*
(e)	[uX]	[uX]-o	[uX]-[uX]	WD	I	R	Z	Creek
(f)	[Xu]	o-[Xu]	[Xu]-[Xu]	WD	T	B	Z	Warao
(g)	[uX]	o-[Xu]	[uX]-[uX]	WD	I/SF	B	★	
(h)	[uX]	[X]-[uX]	[uX]-[uX]	SD	I	B	Z	Weri
(i)	[Xu]	[Xu]-[X]	[Xu]-[Xu]	SD	T	B	Z	Maranungku

The languages which have an unparsed syllable *not* being dragged to the left (as in (b) the sparse rhythmic language and (e) the weakly dense rhythmic language) are languages where rhythm takes precedence over alignment; having a word-final unparsed syllable is better in terms of lapses for the sparse and weakly dense iambic languages. Otherwise, the imperative to bring unparsed syllables leftward is seen in the predicted languages.

There is only one switch language predicted by these constraint sets, the weakly dense switch language in (g). This language is inherently iambic, as can be observed from the fact that the two-syllable word contains a single iamb. This set of languages is a proper subset of the ones predicted by the constraint *F/…σ, discussed in the previous section (BTA2; Section 2.2.1.2). One of the switch languages found in that set is missing here; otherwise, the two typologies are identical.

2.2.2.2 Feet as Aligning Category

		Intervener		
Aligning Category		*Syllable*	*Unparsed Syllable*	*Foot*
	Syllable	(a) *σ/…σ	(b) *-o-/…σ	(c) *F/…σ
	Unparsed Syllable	(d) *σ/…-o-	(e) *-o-/…-o-	(f) *F/…-o-
	Foot	(g) *σ/…F	(h) *-o-/…F	(i) *F/…F

For **feet** as the aligning category, there are two possibilities: unparsed syllables as interveners and any syllable as an intervener. Both possibilities have the same effect of pulling feet to the left.

2.2.2.2.1 System BTA4: *σ/…F

Stretching?	Yes	*Shrinking?*	No	
Hyperalignment?	Yes	*Clumping direction?*	left	
Number of switch languages?	5	*Switch types?*		
		T → I /	solid forms:	1 3+ sylls
				1 odd lengths
			mixed forms:	1 odd lengths
			both:	2 solid odd,
				mixed even
Number of scattered languages?	0	*Number of additional languages?*	9	

When any **syllable** acts as I, this has the effect of pulling feet leftward as expected in sparse and weakly dense systems; unparsed syllables, though not explicitly identified in the constraint definition, end up off to the right edge to avoid additional violations. Candidates accrue violations of this constraint for each syllable that intervenes between *any* foot and the left edge of the word; although the definition does not reference the final foot, in practice the final foot is the constituent that is being left-aligned. Although this constraint has similarities to AFL (McCarthy and Prince 1993, Hyde 2008/2012), they assess violations differently and predict different typologies; see (21) for an explication of the distinction between the two constraints.

In strongly dense systems, this constraint has the property of *stretching* the final foot; rather than having a unary foot word finally, the final foot will always be binary. By being a binary foot, this means the final foot is one syllable closer to the left edge of the word, and therefore avoids one violation of the alignment constraint. This observation only holds when the alignment constraint is not dominated by rhythm or foot form constraints; the strongly dense language (m) has a binary foot word-finally because alignment is violated at the expense of rhythm and uniformity of foot type.

For example, in the strongly dense trochaic language (n), the final foot is always binary. In a five-syllable word, the possible parsings are [Xu]-[X]-[Xu] and [X]-[Xu]-[Xu]; the perfectly rhythmic candidate [Xu]-[Xu]-[X] is excluded because the final foot is one syllable further away from the left edge of the word. However, the unary foot cannot be placed otherwise.

Another characteristic seen in this language set is the switch language; that is, a language where both trochees and iambs can be observed. These languages emerge from this constraint set due to a desire to satisfy *both* rhythm and alignment at the expense of a consistent foot type.

There are two examples of stretching, (n) the strongly dense aligning trochaic language and (o) the strongly dense switch language; additionally, there are three hyperalignment languages, (f) a weakly dense iambic language, plus the weakly dense switch languages (j) and (k). These specific languages are looked at in more detail below the following chart, which shows all languages predicted by this alignment constraint.

(38) Syllable-Foot

	2 σ	3 σ	6 σ	7 σ	P	F	A	Z	Attested Language
a)	[uX]	[uX]-o	[uX]-o-o-o-o	[uX]-o-o-o-o-o	SP	I	B	Z+	Lakota
b)	[Xu]	o-[Xu]	o-[Xu]-o-o-o	o-[Xu]-o-o-o-o	SP	T	R	Z+	
c)	[Xu]	[Xu]-o	[Xu]-o-o-o-o	[Xu]-o-o-o-o-o	SP	T	A	★	Macedonian
d)	[Xu]	[uX]-o	[uX]-o-o-o-o	[uX]-o-o-o-o-o	SP	T/SF	B	★	Basque
e)	[uX]	[uX]-o	[uX]-[uX]-[uX]	[uX]-[uX]-[uX]-o	WD	I	B	Z	Creek
f)	[uX]	[uX]-o	[X]-[uX]-[uX]-o	[uX]-[uX]-[uX]-o	WD	I	B	★	Cayuga
g)	[Xu]	o-[Xu]	[Xu]-[Xu]-[Xu]	o-[Xu]-[Xu]-[Xu]	WD	T	R	Z	Warao
h)	[Xu]	[Xu]-o	[Xu]-[Xu]-[Xu]	[Xu]-[Xu]-[Xu]-o	WD	T	A	★	Pintupi
i)	[Xu]	[uX]-o	[Xu]-[Xu]-[Xu]	[uX]-[uX]-[uX]-o	WD	T/SF	B	★	Yidiny/ Wargamay
j)	[Xu]	[uX]-o	[Xu]-[X]-[uX]-o	[uX]-[uX]-[uX]-o	WD	T/SM	B	★	
k)	[Xu]	[uX]-o	[Xu]-[X]-[uX]-o	o-[Xu]-[X]-[uX]-o	WD	T/SM	B	★	
l)	[uX]	[X]-[uX]	[uX]-[uX]-[uX]	[X]-[uX]-[uX]-[uX]	SD	I	B	Z	Weri
m)	[Xu]	[Xu]-[X]	[Xu]-[Xu]-[Xu]	[Xu]-[Xu]-[Xu]-[X]	SD	T	R	Z	Maranungku
n)	[Xu]	[X]-[Xu]	[Xu]-[Xu]-[Xu]	[Xu]-[Xu]-[X]-[Xu] [Xu]-[X]-[Xu]-[Xu] [X]-[Xu]-[Xu]-[Xu]	SD	T	A	★	Passamaquoddy
o)	[Xu]	[X]-[uX]	[Xu]-[Xu]-[Xu]	[Xu]-[Xu]-[X]-[uX]	SD	T/SM	B	★	

The languages which exhibit clear stretching of the final foot are the strongly dense languages in (n) and (o). In these languages, the stretching effects can be seen in words with an odd number of syllables. For example, in language (n), there are three possibilities for a seven-syllable word: [Xu]-[Xu]-[X]-[Xu], [Xu]-[X]-[Xu]-[Xu], and [X]-[Xu]-[Xu]-[Xu]. There is no possibility where the unary foot is word-final, because of the stretching of the final foot. Note that this pattern of stretching comes at the expense of perfect rhythm; language (o), on the other hand, exhibits both the stretching of the alignment constraint and perfect rhythm. What language (o) has sacrificed is a consistent foot type, as the final stretched foot is iambic instead of trochaic.

The languages in (l) and (m) are also strongly dense, but have perfect rhythm; the language in (m) does this at the expense of alignment, while the language in (l) satisfies both alignment *and* rhythm.

The switch languages can be seen again in (39), separated from the homogenous foot type languages for clarity. In looking at the two-syllable words, where alignment and rhythm are both perfectly content with either type of binary foot, it can be observed that all five of the switch languages have TROCHEE outranking IAMB; if the ranking were reversed, we would see iambs in some of these two-syllable words. Therefore, the switch phenomenon only occurs in languages which are basically trochaic -- and sometimes switch to iambs due to rhythm or alignment.

All of the switch languages are marked with B in the alignment column, since switching is caused by satisfying both alignment and rhythm at the expense of foot form constraints.

(39) Switch languages

	2 σ	**3 σ**	**4 σ**	**5 σ**	**6 σ**	**7 σ**	**P**	**F**	**A**	**Z**
d)	[Xu]	[uX]-o	[uX]-o-o	[uX]-o-o-o	[uX]-o-o-o-o	[uX]-o-o-o-o-o	SP	T/SF	B	★
i)	[Xu]	[uX]-o	[Xu]-[Xu]	[uX]-[uX]-o	[Xu]-[Xu]-[Xu]	[uX]-[uX]-[uX]-o	WD	T/SF	B	★
j)	[Xu]	[uX]-o	[X]-[uX]-o	[uX]-[uX]-o	[Xu]-[X]-[uX]-o	[uX]-[uX]-[uX]-o	WD	T/SM	B	★
k)	[Xu]	[uX]-o	[X]-[uX]-o	[uX]-[uX]-o	[Xu]-[X]-[uX]-o	o-[Xu]-[X]-[uX]-o	WD	T/SM	B	★
o)	[Xu]	[X]-[uX]	[Xu]-[Xu]	[Xu]-[X]-[uX]	[Xu]-[Xu]-[Xu]	[Xu]-[Xu]-[X]-[uX]	SD	T/SM	B	★

The first two switch languages are solid form. The sparse language (d) only has trochees in two-syllable words; in words which are longer in length, the foot type switches to iambs. Because alignment is perfectly satisfied with the single foot at the left edge, and is violated worse when the foot moves further to the right, the foot is firmly affixed at the beginning of the word. However, keeping that foot in place, it is still possible to improve on rhythm; namely, by switching to iambs, a lapse violation can be avoided. Since [uX]-o-o features one less lapse than [Xu]-o-o, the iamb is preferred in longer words. The first weakly dense language, (i), is doing the exact same thing as the sparse language. Where a purely trochaic parse would create a lapse in odd-length words, keeping all the feet as close to the left as possible, the iambic parse avoids any lapses. The trochaic [Xu]-[Xu]-o is perfectly aligned, but with a lapse at the end of the word; on the other hand, the iambic [uX]-[uX]-o is both perfectly aligned and perfect on lapses. Because this circumstance only arises in odd-length words, the even-length words remain trochaic -- only in odd-length words does the switch to iambs occur.

The remaining three switch languages are all mixed form, with both iambs and trochees found in a single prosodic word. The strongly dense language (o) was discussed above, with regard to stretching. In this language, the final foot has been stretched to avoid an extra alignment violation; however, in avoiding a clash (as would be created by sticking to trochees, with [Xu]-[X]-[Xu]), the final foot switches to an iamb for rhythmic purposes. The mixed parse [Xu]-[X]-[uX] has the improved alignment, without sacrificing rhythm.

The weakly dense languages (j) and (k) are identical until the seven-syllable word. In both of these languages, the last syllable is left unparsed in order to have a slight improvement on the alignment constraint, providing an example of hyperalignment. The dense parsing in these languages is motivated by LAPSE rather than PARSESYLL, so the unparsed syllable is not ruled out. However, an unparsed final syllable would create a lapse with a final trochee (…[Xu]-o), and so an iamb is used for the final foot of words three syllables or longer. The avoidance of parsing the last syllable means that even-length words (longer than two) will contain a unary foot; for instance, the four-syllable [X]-[uX]-o. Because the language is still basically trochaic, with TROCHEE ranked above IAMB, the language will switch back to trochees wherever possible; the zone where this possibility arises is to the *left* of the unary foot. Both languages (j) and (k) return to a trochee when they can, resulting in the six-syllable [Xu]-[X]-[uX]-o, with the initial trochee -- rather than sticking with iambs and parsing the word as [X]-[uX]-[uX]-o (as in the iambic language (f)).

The weakly dense iambic language (f) is also an example of hyperalignment, following the same logic described here. However, since the language is already iambic, the final foot is already perfectly configured for avoiding lapses and no switching is necessary.

The difference between the two languages (j) and (k) has to do with the ranking of TROCHEE relative to PARSESYLL and FTBIN. The two languages agree up until the seven-syllable word, where language (j) uses the parsing [uX]-[uX]-[uX]-o and language (k) uses the parsing o-[Xu]-[X]-[uX]-o. Language (j)'s parsing does better on both PARSESYLL and FTBIN, while language (k) is superior on TROCHEE. TROCHEE is ranked over both of the other constraints in (k), while at least one of them dominates TROCHEE in language (j).

(40) Ranking for language (j)

Winner	Loser	PARSESYLL	FTBIN	TROCHEE	IAMB
[uX]-[uX]-[uX]-o	o-[Xu]-[X]-[uX]-o	W	W	L	W

The ranking in (40) is the one used by language (j), though only one of PARSESYLL and FTBIN must dominate TROCHEE; for language (k), TROCHEE dominates all three of the other constraints.

The languages predicted by this constraint set are almost a superset of those predicted by the next and final constraint set, with *-o-/…F as the alignment constraint (BTA5). The languages found here but missing in the next constraint set are the stretching and hyperaligned languages, as well as an additional switching language. However, there is one additional language found in the next constraint set not found with *σ/…F. These differences are explicated further in the next section.

2.2.2.2.2 System BTA5: *-o-/…F

Stretching?	No	*Shrinking?*	No
Hyperalignment?	No	*Clumping direction?*	left
Number of switch languages?	2	*Switch types?*	
		T → I /	solid forms: 1 3-sylls only
			1 odd lengths
Number of scattered languages?	0	*Number of additional languages?*	4

When the intervener is **unparsed syllables**, the number of predicted languages is reduced. Specifically, languages that are eliminated are languages which switch foot type ((d), (j), (k), (o)), the languages where the final foot is stretched ((n), (o)), and the languages with hyperalignment ((f), (j), (k)). None of the eliminated languages are attested; the switch language which is not eliminated matches the pattern of Yidiny and Wargamay. The languages predicted by this alignment constraint are shown below.

(41) Unparsed Syllable-Foot

	2 σ	3 σ	4 σ	5 σ	P	F	A	Z	Attested Language
(a)	[uX]	[uX]-o	[uX]-o-o	[uX]-o-o-o	SP	I	B	Z+	Lakota
(b)	[Xu]	o-[Xu]	o-[Xu]-o	o-[Xu]-o-o	SP	T	R	Z+	
(c)	[Xu]	[Xu]-o	[Xu]-o-o	[Xu]-o-o-o	SP	T	A	★	Nahuatl
(d)	[uX]	[uX]-o	[uX]-[uX]	[uX]-[uX]-o	WD	I	B	Z	Creek
(e)	[Xu]	o-[Xu]	[Xu]-[Xu]	o-[Xu]-[Xu]	WD	T	R	Z	Warao
(f)	[Xu]	[Xu]-o	[Xu]-[Xu]	[Xu]-[Xu]-o	WD	T	A	★	Pintupi
(g)	[Xu]	[uX]-o	[Xu]-[Xu]	[uX]-[uX]-o	WD	T/SF	B	★	Yidiny/Wargamay
(h)	[uX]	[X]-[uX]	[uX]-[uX]	[X]-[uX]-[uX]	SD	I	B	Z	Weri
(i)	[Xu]	[Xu]-[X]	[Xu]-[Xu]	[Xu]-[Xu]-[X]	SD	T	B	Z	Maranungku
(j)	[Xu]	[uX]-o	[Xu]-[Xu]	[Xu]-[Xu]-[X]	SD	T/SF	B	★	

The only language predicted by this constraint but not by the general syllable constraint, on the other hand, is the language in (j). Language (j) represents a phenomenon that occurs in several of these predicted typologies; in this language, a generally trochaic and strongly dense language will switch in three-syllable words to an iambic weakly dense parse. This is the same phenomenon observed earlier, where the reason for this switch is due to the specific definition of TROCHEE being used and the use of unparsed syllables as a category in the alignment constraint. The general syllable constraint does not have the three-syllable switch because the constraint does not refer specifically to unparsed syllables at any point. The unparsed syllable version of the constraint does not care about a single unparsed syllable at the end of the word, unlike the general syllable version. The violation tableau from (33) is repeated here.

(42) Violation tableau for three-syllable candidates

	TROCHEE	FTBIN	IAMB	PARSESYLL	USYLL-SYLL	*LAPSE	*CLASH
{[uX]-o}	**1**			1			
{[Xu]-[X]}	**1**	1	1				

With this definition of TROCHEE, a trochaic foot and a unary foot as in [Xu]-[X] violates TROCHEE once for the unary foot; additionally, the iambic parse [uX]-o also violates TROCHEE once for the single iambic foot. Both [X] and [uX] incur a single violation of TROCHEE, which renders the two candidates equivalent in the eyes of this constraint. Since there is no cost to switching foot types as far as TROCHEE is concerned, the decision is instead made by IAMB, which prefers the single iambic foot. An overview of the three-syllable iambic switch is provided in section 1; further explication of the issue can be found in section 2.2.1.1. The phenomenon is described again here only as a brief reminder.

This is also the same predicted typology as the one found with *-o-/…σ (BTA1), except that (c) the sparse aligning trochaic language is more decisive here than with USYLL-SYLL.

3 Adjacent Alignment

The 'adjacent' family of constraints is defined in terms of interveners (I) that are *directly* next to the category that is being aligned (K). Each K can potentially be a locus of violation, if there is an intervener directly to the left (or right, in a right-aligning version) of it. This means that the maximum number of violations possible in a word cannot exceed the total number of K's in the word. These constraints are not able to count the total number of interveners between a category and the edge of the word; in fact, the entire power of this constraint set lies in looking for illicit sequences. For now we will only be considering left-aligning versions of the constraints; the definition of the alignment constraint schema being used here is provided in (43).

(43) Adjacent alignment definition

I, K $\in$ {syllable, unparsed syllable, foot}

$\forall$x of category I, if $\exists$y of category K immediately to the right of x,

x, y in the same word,

assess one violation.

While the 'between' alignment constraints were written *I/…K, this expression will be written as *I/K. The above definition describes only left-aligning versions of the constraints; the right-aligned version would penalize K/I rather than I/K. Because every constraint is really just picking out an illicit string XY, it does not matter which part of the string is the target and which part is the intervener; whenever the string appears, it incurs a violation mark. *X/Y could be a left-aligning constraint where I=X and K=Y *or* a right aligning constraint where I=Y and K=X. Although we are only considering left-aligning constraints here, there is still a 'right-align' version of every constraint present. *X/Y and *Y/X will both be present in the set of constraints, which can simply be written as *XY and *YX; for this reason, we can think of these opposite constraints as right-aligning versions of their symmetrical counterparts. Most things said about left-aligned constraints can be projected by symmetry into statements about their right-aligned counterparts, with one exception.

The difference that can emerge between right-aligned and left-aligned versions of the constraints has nothing to do with the alignment constraints themselves; instead, this slight asymmetry is caused by the asymmetry in the definitions of IAMB and TROCHEE. While IAMB allows unary feet, they are penalized by TROCHEE. The difference between the right- and left-aligning versions emerges only in constraints where either I or K is an unparsed syllable: syll-usyll and usyll-foot. The language which occurs only in one direction of alignment is the three-syllable iambic switch language observed in the previous section. When the direction of alignment forces a foot at the beginning of the word, an extra trochaic language emerges; this language is strongly dense and trochaic, except in the three-syllable word which is parsed with a single iamb, [uX]-o instead of [Xu]-[X]. Other than this difference on the two constraints which include an unparsed syllable in the definition, everything said about the left-aligned constraint is perfectly symmetrical with the right-aligned version.

Because both interveners and aligned categories can be any member of the same set (syllables, unparsed syllables, feet), there are nine possible combinations predicted. The full set is shown in the following table. As in earlier sections, the following symbols are used:

σ	any syllable
-o-	unparsed syllable
F	foot

(44) Table of adjacent constraints

			Intervener	
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/σ	(b) *-o-/σ	(c) *F/σ
	Unparsed Syllable	(d) *σ/-o-	(e) *-o-/-o-	(f) *F/-o-
	Foot	(g) *σ/F	(h) *-o-/F	(i) *F/F

Full descriptions of these constraints are given in the table in (45). 'Description' gives the definition for the constraint in plain language, while 'effective description' explains how that definition manifests itself. 'Favors' indicates what the constraint prefers in a candidate. The terms *place*, *push*, and *pull* are used here as in the 'between' constraints section; a brief reminder is provided here, but see the previous section for a more thorough explanation. The phrase *place X* is used when a constraint prefers a single X at a word edge, but has no opinion about the placement of the rest of the X's. The terms *push* and *pull* are opposites; *pull* is used when a constraint refers directly to the alignment of that constituent, while *push* is used when the constituent is moved to one word edge as a side effect -- getting out of the way of the category actually being aligned. Because only left-alignment is being considered here, *pulling* is always to the beginning and *pushing* is always to the end of the word.

(45) Table of adjacent constraints with explanations of their definitions

		Intervener		
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/σ	(b) *-o-/σ	(c) *F/σ
	description	no syll next to syll	no usyll before a syll	no foot before a syll
	effective description	no adjacent sylls	no usyll before the final syll	no feet before the final syll
	favors	fewer sylls	places usyll at end	places foot at end
	Unparsed Syllable	(d) *σ/-o-	(e) *-o-/-o-	(f) *F/-o-
	description	no syll before a usyll	no usyll next to usyll	no foot before a usyll
	effective description	no usyll after the first syll	no adjacent usylls	no feet before the final usyll
	favors	places usyll at beginning	separates usylls	pushes feet to end
	Foot	(g) *σ/F	(h) *-o-/F	(i) *F/F
	description	no syll before a foot	no usyll before a foot	no foot next to foot
	effective description	no feet after the first syll	no usyll before the final foot	no adjacent feet
	favors	places foot at beginning	pulls feet to beginning	separates feet

Each of these constraints was considered one at a time, along with the consistent set of constraints from System Zero: FTBIN, IAMB, TROCHEE[10], PARSESYLL, *LAPSE, and *CLASH. Deletion and insertion of syllables was not considered, meaning that every candidate set contained candidates of the same length but with different footing. As in the previous sections, words were also assumed to have at least one syllable, and to have at least one foot. The effects from each of the constraints defined in (43) will be explained in the following sections. Every language from System Zero was represented in each of the typologies predicted by the addition of an alignment constraint; languages were *added*, but none were lost.[11]

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[10] The version of TROCHEE used here which penalizes [uX] as well as [X]; see section 1 for details.

[11] The sparse parsings in System Zero were indecisive, unable to choose between candidates which tied on all constraints available. However, in some of the systems with an alignment constraint, a further decision was able to be made elsewhere. The narrowing down of possibilities present within the indecisive System Zero languages was indicated with the symbol Z+ in the typology charts.

Again, we will separate the constraints into two groups depending on whether I and K are the same category. When I=K, the constraint has the property of being perfectly symmetrical; a left-aligning version and a right-aligning version would be completely identical in their effects. When I≠K, there is a different kind of symmetry in the constraints. Unlike when I=K, the constraint itself is not symmetrical; however, every one of these asymmetrical constraints has a perfectly symmetrical counterpart. The results of the two constraints are perfect mirror images of each other; while *XY might, for example, cause feet to clump at the left edge, *YX will cause feet to clump at the right edge in the exact same manner. Because the results are perfectly symmetrical in this way, we will only consider one constraint from each pair -- the predictions of the reversed constraint can be projected by symmetry. This leaves only three constraints to consider in the I≠K category, which will be fully described in a later section.

The following table names the resulting systems for each constraint. The nine AA constraints yield six systems: four pseudo alignment and two true alignment. All of the constraints where I=K result in pseudo alignment, as well as one constraint (and its mirror image) where I≠K. One of the pseudo alignment systems is indistinct from System Zero (APA1), two show a lack of clumping (APA2 and APA3), and the final system (APA4) results in noninitiality/nonfinality rather than alignment.

(46) Table of AA Systems

		Intervener		
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/σ	(b) *-o-/σ	(c) *F/σ
	System Name	APA1 (= System Zero)	APA4	ATA1
	Unparsed Syllable	(d) *σ/-o-	(e) *-o-/-o-	(f) *F/-o-
	System Name	APA4	APA2	ATA2
	Foot	(g) *σ/F	(h) *-o-/F	(i) *F/F
	System Name	ATA1	ATA2	APA3

3.1 Intervener and Category Match (I=K)

		Intervener		
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/σ	(b) *-o-/σ	(c) *F/σ
	Unparsed Syllable	(d) *σ/-o-	(e) *-o-/-o-	(f) *F/-o-
	Foot	(g) *σ/F	(h) *-o-/F	(i) *F/F

The constraints where the intervener and the category are the same (the diagonal from the upper left to the lower right) all penalize adjacent pairs of the category in question; none of these are true alignment constraints. These constraints are perfectly symmetrical. For instance, a foot directly to the left of a foot is the same as a foot directly to the right of a foot; both penalize the adjacent sequence *FF. Although the definitions of these constraints are aimed at the intervener in a particular context, they in fact only pick out strings of a banned configuration; there is no difference in banning, for example, two feet next to each other or banning a foot directly preceding a foot. There is also no difference between the leftward and rightward versions of these symmetrical types, since a pair of adjacent feet will always be a pair of adjacent feet -- regardless of whether you are checking the first foot for a following foot or the second foot for a preceding foot.

Although all three of these constraints have this perfect symmetry in common, there is a distinction between the syllable-syllable constraint and the other two constraints. While the usyll-usyll constraint and the foot-foot constraint are satisfied by separating the constituents, it is impossible to put any barriers between syllables. There is no way to satisfy the syll-syll constraint by separating syllables; the only solution is to minimize the word so that there is only a single syllable. On the other hand, it is possible to separate unparsed syllables from other unparsed syllables, or feet from other feet. The syll-syll constraint prefers constituent reduction, while the usyll-usyll and the foot-foot constraints prefer constituent repulsion. The specifics of these constraints and their properties are further explicated in the following sections.

3.1.1 System APA1: *σ/σ

		Intervener		
Aligning Category		*Syllable*	*Unparsed Syllable*	*Foot*
	Syllable	(a) *σ/σ	(b) *-o-/σ	(c) *F/σ
	Unparsed Syllable	(d) *σ/-o-	(e) *-o-/-o-	(f) *F/-o-
	Foot	(g) *σ/F	(h) *-o-/F	(i) *F/F

This constraint penalizes pairs of syllables; that is, each sequence of syllables incurs a violation. With this definition, the only way to perfectly satisfy the constraint would be having just a single syllable in the word. When considering candidate sets where a candidate is competing only with other candidates of the same length, there can be no distinguishing amongst candidates in the set; all words of a given length will have the same number of violations -- equal to the total number of syllables, minus one.

The set of assumptions being used here does not allow for deletion or insertion of syllables; therefore, every candidate in a candidate set has the same number of syllables --

and thus the same number of violations on this constraint. Because this constraint cannot distinguish between members of a candidate set, it has nothing to contribute to the typology here. However, if deletion or insertion of syllables was allowed, this constraint would favor minimizing the number of syllables in a word. Some examples of a five-syllable candidate are shown below, with their violations on the syllable-syllable constraint.

(47) *5-syllable input with SYLLABLE-SYLLABLE*

5-syllable input	SYLLABLE-SYLLABLE (*σ/σ)	Parsing
[uX]-o-o-o	**4**	Sparse
o-[uX]-o-o	**4**	
o-o-[uX]-o	**4**	
[uX]-[uX]-o	**4**	Weakly Dense
[uX]-o-[uX]	**4**	
o-[uX]-[uX]	**4**	
[X]-[uX]-[uX]	**4**	Strongly Dense
[uX]-[X]-[uX]	**4**	
[uX]-[uX]-[X]	**4**	

As can be observed in this table, every candidate with five syllables has the exact same number of violations. Because this constraint cannot make any determinations, it doesn't matter where the constraint is ranked -- it will never have an impact on which constraint is selected. As a result, no new languages or refinements are added by this constraint to the typology of System Zero.

The other symmetrical (I=K) constraints do make distinctions between candidates in the candidate set, and make additions to the typology. In fact, both of these constraints have been independently proposed in the literature -- though *not* as alignment constraints.

3.1.2 System APA2: *-o-/-o-

Stretching?	No	*Shrinking?*	No
Hyperalignment?	No	*Clumping direction?*	only rhythmic
Number of switch languages?	0	*Switch types?*	n/a
Number of scattered languages?	2	*Number of additional languages?*	2

The unparsed syllable-unparsed syllable constraint was proposed by Kager (1994) using the name PARSE-2[12]. This constraint penalizes sequences of unparsed syllables, which means that the constraint favors separating unparsed syllables from each other. Unparsed syllables can be separated by placing feet between them; additionally, having only one (or no) unparsed syllables in the word -- as in the dense systems -- means that there will not be any violations of the usyll-usyll constraint. However, in the other systems, the only option is to separate the unparsed syllables from each other.

For the first time, we observe a type of parsing between sparse (with just a single foot) and dense (with as many binary feet as can fit in the word); this intermediate type of parsing will be referred to as *scattered*. Scattered parsing contains more binary feet than a sparse parsing, but less than a dense parsing. The label for this style of parsing is added to the key below.

[12] Kager's PARSE-2 penalizes any sequence of two unparsed *moras*; a single unparsed heavy syllable is a violation of his constraint. PARSE-2 and *LAPSE overlap in terms of violations, but neither is a subset of the other. However, since only quantity insensitive systems are considered here, this distinction does not make a difference.

(48) Updated key for typology tables

Parsing (P)	**Foot Type (F)**	**Foot Positioning (A)**	**System Zero (Z)**
Sparse (SP)	Iambic (I)	Alignment (A)	Matches System Zero (Z)
Scattered (SC)	Trochaic (T)	Rhythm (R)	More decisive than System Zero counterpart (Z+)
Weakly Dense (WD)	Switching, Mixed Forms (SM)	Both (B)	Not in System Zero (★)
Strongly Dense (SD)	Switching, Solid Forms (SF)		

The typology predicted by the usyll-usyll constraint is provided below, in (49). The first examples of the scattered parsing type can be observed in languages (c) and (d).

(49) Unparsed Syllable-Unparsed Syllable

	2 σ	**3 σ**	**4 σ**	**5 σ**	**6 σ**	**P**	**F**	**A**	**Z**	**Attested Language**
a)	[uX]	[uX]-o	o-[uX]-o	o-o-[uX]-o o-[uX]-o-o	o-o-o-[uX]-o o-o-[uX]-o-o o-[uX]-o-o-o	SP	I	B	Z+	
b)	[Xu]	o-[Xu]	o-[Xu]-o	o-o-[Xu]-o o-[Xu]-o-o	o-o-o-[Xu]-o o-o-[Xu]-o-o o-[Xu]-o-o-o	SP	T	B	Z+	
c)	[uX]	[uX]-o	o-[uX]-o	[uX]-[uX]-o	o-[uX]-[uX]-o [uX]-o-[uX]-o	SC	I	A	★	
d)	[Xu]	o-[Xu]	o-[Xu]-o	o-[Xu]-[Xu]	o-[Xu]-o-[Xu] o-[Xu]-[Xu]-o	SC	T	A	★	
e)	[uX]	[uX]-o	[uX]-[uX]	[uX]-[uX]-o	[uX]-[uX]-[uX]	WD	I	B	Z	Creek
f)	[Xu]	o-[Xu]	[Xu]-[Xu]	o-[Xu]-[Xu]	[Xu]-[Xu]-[Xu]	WD	T	B	Z	Warao
g)	[uX]	[X]-[uX]	[uX]-[uX]	[X]-[uX]-[uX]	[uX]-[uX]-[uX]	SD	I	B	Z	Weri
h)	[Xu]	[Xu]-[X]	[Xu]-[Xu]	[Xu]-[Xu]-[X]	[Xu]-[Xu]-[Xu]	SD	T	B	Z	Maranungku

The effects of the usyll-usyll constraint can be observed in the non-dense systems; both the weakly and strongly dense systems are perfect matches with their System Zero counterparts. The sparse systems in languages (a) and (b) are close to the sparse languages from System Zero, but are slightly more decisive, eliminating one possibility from words with a length of four syllables or longer. The usyll-usyll constraint is interested in keeping unparsed syllables separate from each other, using feet as a barrier; since these sparse systems have only a single foot, the way to accomplish this separation with more than one unparsed syllable is by placing at least one unparsed syllable on either side of the foot. Having all of the unparsed syllables on one side of the foot incurs an extra violation of the usyll-usyll constraint, and is thus dispreferred. As a result, the iambic option of an initial foot and the trochaic option of a final foot are eliminated. Other than this exclusion, these sparse systems are identical to the ones found in System Zero.

The two completely new languages produced by the addition of the usyll-usyll constraint are the scattered parsing languages, (c) and (d). The scattered languages introduce a unique parsing in words that are six syllables or longer. In shorter words, the forms match those of sparse parsing (up to four syllables) or weakly dense parsing (five syllables). Comparing the scattered languages first with their sparse counterparts, they look identical through four-syllable words. Both the sparse and the scattered languages have only a single foot in these lengths, while the dense languages introduce a second binary foot in the four-syllable words. However, scattered languages break apart from the sparse languages in the five-syllable and longer words. In fact, the scattered languages pattern with the weakly dense languages in five-syllable words -- with just a single unparsed syllable at a word edge (depending on whether the language is trochaic or iambic). It is not until six-syllable and longer words that the scattered forms truly distinguish themselves as a unique parsing type, instead of a combination of other types.

In this length of word, it can be observed that the scattered forms contain less binary feet than the dense forms, but more than the single foot of the unary forms. This pattern continues in longer words, setting apart this parsing style as distinct -- rather than just a combination of sparseness and denseness across lengths.

(50) Scattered languages

	2 σ	**3 σ**	**4 σ**	**5 σ**	**6 σ**	**P**	**F**	**A**	**Z**
(c)	[uX]	[uX]-o	o-[uX]-o	[uX]-[uX]-o	o-[uX]-[uX]-o [uX]-o-[uX]-o	SC	I	A	★
(d)	[Xu]	o-[Xu]	o-[Xu]-o	o-[Xu]-[Xu]	o-[Xu]-o-[Xu] o-[Xu]-[Xu]-o	SC	T	A	★

The iambic and trochaic versions of this language type use the minimum number of feet possible without creating any sequences of unparsed syllables. Because the spacing out of unparsed syllables creates a kind of ternary stress pattern, the lengths of languages can be thought of as 3n, 3n+1, and 3n+2 (as opposed to the two-way distinction of odd/even that can be used in binary stress patterns). A new binary foot needs to be introduced at each sequential 3n+2, in order to prevent any unparsed syllables from touching each other; a length of 3n+1 is completely decisive, as there is only one way to parse the form so that no unparsed syllables are sequential. With a length of 3n+1, the parsing is always $[\sigma(\sigma\sigma)]^{+}\sigma$.

Scattered parsing creates a more ternary rhythm, and can also be found in the next constraint. For this reason, it is not surprising that these two constraints have been previously proposed in the ternary stress literature.

None of the languages produced with the addition of this constraint alone produce a known ternary stress language; however, the addition of an additional (true) alignment constraint can produce a system consistent with an existing ternary stress language. Adding a constraint which cares only about having an initial foot, like ALIGN-L(WD, FT), produces systems which look like Estonian (Hint 1973).

(51) Estonian pattern and two predicted languages

	2 σ	**3 σ**	**4 σ**	**5 σ**	**6 σ**
Estonian	X-o	X-o-o	X-o-X-o	X-o-o-X-o X-o-X-o-o	X-o-o-X-o-o X-o-X-o-X-o
Language 1	[Xu]	[Xu]-o	[Xu]-[Xu]	[Xu]-o-[Xu] [Xu]-[Xu]-o	[Xu]-o-[Xu]-o
Language 2	[Xu]	[Xu]-o	[Xu]-[Xu]	[Xu]-o-[Xu] [Xu]-[Xu]-o	[Xu]-[Xu]-[Xu]

Both Language 1 and Language 2 perfectly match the Estonian rhythm through five-syllable words; in six-syllable words, Estonian allows the possibility of either the parsing in Language 1 or Language 2.

3.1.3 System APA3: *F/F

Stretching? No — *Shrinking?* Yes

Hyperalignment? No — *Clumping direction?* only rhythmic

Number of switch languages? 8 — *Switch types?*

4 I → T, 4 T → I / mixed forms

Number of scattered languages? 12 — *Number of additional languages?* 16

Like the usyll-usyll constraint above, the foot-foot constraint was previously proposed for dealing with ternary stress systems. Called *FTFT (Kager 1994), this constraint penalizes two adjacent feet. *FTFT was proposed as a way of translating weak local parsing (Hayes 1995) into a constraint. The constraint was used previously to create ternary rhythm, by repelling feet from each other. Having a single foot, as in a sparse system, incurs no violations of this constraint -- since there are not two feet to be next to each other. In languages with more than one foot, the constraint separates the feet from each other using unparsed syllables to space out the feet. The languages predicted by this constraint are shown below, in (52).

(52) *Foot-Foot*

	2s	3s	4s	5s	6s	P	F	A	Z	Attested Language
(a)	[uX]	[uX]-o	o-[uX]-o [uX]-o-o	o-o-[uX]-o o-[uX]-o-o [uX]-o-o-o	o-o-o-[uX]-o o-o-[uX]-o-o o-[uX]-o-o-o [uX]-o-o-o-o	SP	I	B	Z	contains Lakota
(b)	[Xu]	o-[Xu]	o-o-[Xu] o-[Xu]-o	o-o-o-[Xu] o-o-[Xu]-o o-[Xu]-o-o	o-o-o-o-[Xu] o-o-o-[Xu]-o o-o-[Xu]-o-o o-[Xu]-o-o-o	SP	T	B	Z	contains Nahuatl
(c)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[uX]	[uX]-o-[X]-o-[X]	SC	I	B	★	
(d)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[X]-o	[uX]-o-[X]-o-[X]	SC	I	B	★	
(e)	[uX]	[uX]-o	o-[uX]-o [uX]-o-o	[uX]-o-[uX]	[uX]-o-[uX]-o	SC	I	A	★	
(f)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[uX]	[uX]-o-[uX]-o	SC	I	A	★	
(g)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[Xu]	[uX]-o-[X]-o-[X]	SC	I/SM	B	★	
(h)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[Xu]	[uX]-o-[uX]-o	SC	I/SM	B	★	
(i)	[uX]	[uX]-o	o-[uX]-o [uX]-o-o	[uX]-o-[Xu]	[uX]-o-[uX]-o	SC	I/SM	B	★	
(j)	[Xu]	o-[Xu]	o-o-[Xu] o-[Xu]-o	[Xu]-o-[Xu]	o-[Xu]-o-[Xu]	SC	T	A	★	
(k)	[Xu]	o-[Xu]	[X]-o-[Xu]	[Xu]-o-[Xu]	o-[Xu]-o-[Xu]	SC	T	A	★	
(l)	[Xu]	o-[Xu]	[X]-o-[Xu]	[uX]-o-[Xu]	[X]-o-[X]-o-[Xu]	SC	T/SM	B	★	
(m)	[Xu]	o-[Xu]	[X]-o-[Xu]	[uX]-o-[Xu]	o-[Xu]-o-[Xu]	SC	T/SM	B	★	
(n)	[Xu]	o-[Xu]	o-o-[Xu] o-[Xu]-o	[uX]-o-[Xu]	o-[Xu]-o-[Xu]	SC	T/SM	B	★	
(o)	[uX]	[uX]-o	[uX]-[uX]	[uX]-o-[uX]	[uX]-[uX]-[uX]	WD	I	A	★	
(p)	[uX]	[uX]-o	[uX]-[uX]	[uX]-[uX]-o	[uX]-[uX]-[uX]	WD	I	R	Z	Creek
(q)	[uX]	[uX]-o	[uX]-[uX]	[uX]-o-[Xu]	[uX]-[uX]-[uX]	WD	I/SM	B	★	
(r)	[Xu]	o-[Xu]	[Xu]-[Xu]	[Xu]-o-[Xu]	[Xu]-[Xu]-[Xu]	WD	T	A	★	contains Indonesian
(s)	[Xu]	o-[Xu]	[Xu]-[Xu]	o-[Xu]-[Xu]	[Xu]-[Xu]-[Xu]	WD	T	R	Z	Warao
(t)	[Xu]	o-[Xu]	[Xu]-[Xu]	[uX]-o-[Xu]	[Xu]-[Xu]-[Xu]	WD	T/SM	B	★	
(u)	[uX]	[X]-[uX]	[uX]-[uX]	[X]-[uX]-[uX]	[uX]-[uX]-[uX]	SD	I	R	Z	Weri
(v)	[Xu]	[Xu]-[X]	[Xu]-[Xu]	[Xu]-[Xu]-[X]	[Xu]-[Xu]-[Xu]	SD	T	R	Z	Maranungku

As in the usyll-usyll constraint, the foot-foot constraint produces a number of scattered parsing systems. There are a total of twelve scattered parsing languages predicted by this constraint; seven iambic and five trochaic. Two of the iambic languages do not have a trochaic counterpart due to the asymmetry in the definitions of IAMB and TROCHEE; however, the remaining five iambic languages are the mirror images of their trochaic counterparts. For this reason, we will look just at the iambic languages in more detail. Just the scattered languages predicted by the foot-foot constraint are provided in the table in (53).

(53) Scattered languages

	2s	**3s**	**4s**	**5s**	**6s**	**P**	**F**	**A**	**Z**
(c)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[uX]	[uX]-o-[X]-o-[X]	SC	I	B	★
(d)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[X]-o	[uX]-o-[X]-o-[X]	SC	I	B	★
(e)	[uX]	[uX]-o	o-[uX]-o [uX]-o-o	[uX]-o-[uX]	[uX]-o-[uX]-o	SC	I	A	★
(f)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[uX]	[uX]-o-[uX]-o	SC	I	A	★
(g)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[Xu]	[uX]-o-[X]-o-[X]	SC	I/SM	B	★
(h)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[Xu]	[uX]-o-[uX]-o	SC	I/SM	B	★
(i)	[uX]	[uX]-o	o-[uX]-o [uX]-o-o	[uX]-o-[Xu]	[uX]-o-[uX]-o	SC	I/SM	B	★
(j)	[Xu]	o-[Xu]	o-o-[Xu] o-[Xu]-o	[Xu]-o-[Xu]	o-[Xu]-o-[Xu]	SC	T	A	★
(k)	[Xu]	o-[Xu]	[X]-o-[Xu]	[Xu]-o-[Xu]	o-[Xu]-o-[Xu]	SC	T	A	★
(l)	[Xu]	o-[Xu]	[X]-o-[Xu]	[uX]-o-[Xu]	[X]-o-[X]-o-[Xu]	SC	T/SM	B	★
(m)	[Xu]	o-[Xu]	[X]-o-[Xu]	[uX]-o-[Xu]	o-[Xu]-o-[Xu]	SC	T/SM	B	★
(n)	[Xu]	o-[Xu]	o-o-[Xu] o-[Xu]-o	[uX]-o-[Xu]	o-[Xu]-o-[Xu]	SC	T/SM	B	★

Languages (c) and (d) are the two scattered iambic languages without trochaic counterparts. These languages are characterized by the proliferation of unary feet; there is a *shrinking* effect on feet in order to keep the feet from touching without sacrificing rhythm. Unary feet can be spaced out, with a single unparsed syllable in between, in order to avoid having feet touch while maintaining perfect rhythm. This only emerges with iambic systems, since a unary foot is accepted as a perfectly good iamb; because both [uX] and [X] are legitimate iambs, the iambic foot can shrink to being a unary foot without any penalty of the foot type constraint.

There are five remaining types of scattered language, showing up both with an iambic and trochaic version. The first two are aligning iambic languages (e) and (f) (corresponding to the aligning trochaic languages (j) and (k)), while the remaining three are switch languages. The non-switching languages differ in their treatment of words with 3n+1 syllables, observable here in the four-syllable word. Language (e) contains a single binary foot, while language (f) adds a degenerate foot; language (e) also contains a lapse that is not present in language (f). These languages closely resemble the patterns found in actual ternary stress languages.

An example of a real ternary stress language is provided in (54). The stress pattern found in Chugach Yupik matches the output of stress predicted in language (f).

(54) Chugach Yupik data and a predicted language

	2 σ	**3 σ**	**4 σ**	**5 σ**	**6 σ**
Chugach Yupik	o-X	o-X-o	o-X-o-X	o-X-o-o-X	o-X-o-o-X-o
Language (f)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[uX]	[uX]-o-[uX]-o

On the other hand, the final three iambic languages -- (g), (h), and (i) -- are switch languages. The fact that these languages are inherently iambic can be observed in words up to four syllables in length, as well as in even-length longer words. However, languages (g) and (h) introduce mixed forms in odd-length words five syllables or longer; language (i) only uses the mixed form in the five-syllable word. The same generalization is true of the trochaic counterparts of these languages; languages (l) and (m) have the mixed forms in odd-length words five syllables and longer, while language (n) uses the mixed form only for the five-syllable word. The form used in five-syllable words for both the inherently iambic and trochaic languages is [uX]-o-[Xu]; using this mixed foot type form enables the language to maintain perfect rhythm and avoid degenerate feet while still keeping the feet separated from each other.

Language (i) avoids unary feet in all word lengths, while languages (g) and (h) both allow degenerate feet. The difference between the last two switch languages is that language (g) achieves perfect rhythm through the use of unary feet and mixed foot type forms, while language (h) still contains lapses.

In total, six of the eight switch languages produced by this alignment constraint are scattered parsing, while the remaining two are weakly dense. There are a total of four switch types (three scattered, one weakly dense), with an iambic and trochaic version of each.

(55) Switch languages

	2s	3s	4s	5s	6s	P	F	A	Z
(g)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[Xu]	[uX]-o-[X]-o-[X]	SC	I/SM	B	★
(h)	[uX]	[uX]-o	[uX]-o-[X]	[uX]-o-[Xu]	[uX]-o-[uX]-o	SC	I/SM	B	★
(i)	[uX]	[uX]-o	o-[uX]-o [uX]-o-o	[uX]-o-[Xu]	[uX]-o-[uX]-o	SC	I/SM	B	★
(l)	[Xu]	o-[Xu]	[X]-o-[Xu]	[uX]-o-[Xu]	[X]-o-[X]-o-[Xu]	SC	T/SM	B	★
(m)	[Xu]	o-[Xu]	[X]-o-[Xu]	[uX]-o-[Xu]	o-[Xu]-o-[Xu]	SC	T/SM	B	★
(n)	[Xu]	o-[Xu]	o-o-[Xu] o-[Xu]-o	[uX]-o-[Xu]	o-[Xu]-o-[Xu]	SC	T/SM	B	★
(q)	[uX]	[uX]-o	[uX]-[uX]	[uX]-o-[Xu]	[uX]-[uX]-[uX]	WD	I/SM	B	★
(t)	[Xu]	o-[Xu]	[Xu]-[Xu]	[uX]-o-[Xu]	[Xu]-[Xu]-[Xu]	WD	T/SM	B	★

The final switch language is a weakly dense language -- in both an iambic and trochaic form. The iambic weakly dense switch language (q) and its trochaic counterpart (t) utilize the same strategy as was seen in the scattered parsing languages. Specifically, the mixed form [uX]-o-[Xu] is once again found in the five-syllable words for these weakly dense languages; longer words with an odd number of syllables feature just one binary foot of the opposite foot type. In the iambic language, there is a trochaic foot word-finally -- $[uX]^{+}$-o-[Xu]; in the trochaic language, there is an iambic foot word-initially -- [uX]-o-$[Xu]^{+}$.

The constraints where I=K share in common a property of driving the targeted constituents away from each other; because syllables cannot be separated from each other by anything else, the syll-syll constraint has no effect under the assumptions set out in System Zero. However, the usyll-usyll and the foot-foot constraint are both able to successful drive apart members of the same category; for this reason, they produce the only examples of scattered systems. The scattered systems contain more feet than a sparse system, yet less than a dense system; the real world instantiation of scattered parsing is reflected by ternary stress languages. For this reason, it is unsurprising that the usyll-usyll and foot-foot constraints have been previously proposed in the literature for dealing with ternary stress systems.

3.2 Intervener and Category Differ (I≠K)

		Intervener		
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/σ	(b) *-o-/σ	(c) *F/σ
	Unparsed Syllable	(d) *σ/-o-	(e) *-o-/-o-	(f) *F/-o-
	Foot	(g) *σ/F	(h) *-o-/F	(i) *F/F

When the intervener and the category are different, there are no longer any scattered parsing languages. Because of the symmetrical properties of the adjacent alignment constraints, each constraint has a perfectly symmetrical counterpart; *X/Y and *Y/X will have the exact same results, though the effects are relative to opposite ends of the word. For this reason, *X/Y and *Y/X could be considered left- and right-aligning versions of a single constraint. Because the effects are identical (only mirrored) for the symmetrical counterpart of a constraint, we will only consider one of each pair -- for a total of three constraints to examine. The three below the I=K diagonal will be considered here, matching their mirror images on the opposite side of the diagonal. These constraints are (d) APA4: *σ/-o-, (g) ATA1: *σ/F, and (h) ATA2: *-o-/F.

3.2.1 System APA4: *σ/-o-

Stretching? No *Shrinking?* No

Hyperalignment? No *Clumping direction?* Noninitiality

Number of switch languages? 1 *Switch types?*

I → T / solid forms: odd lengths

Number of scattered languages? 0 *Number of additional languages?* 3

		Intervener		
Aligning Category		*Syllable*	*Unparsed Syllable*	*Foot*
	Syllable	(a) *σ/σ	(b) *-o-/σ	(c) *F/σ
	Unparsed Syllable	(d) *σ/-o-	(e) *-o-/-o-	(f) *F/-o-
	Foot	(g) *σ/F	(h) *-o-/F	(i) *F/F

For the syllable-unparsed syllable constraint, no syllable should come before an unparsed syllable. The way to avoid a violation of this constraint is by placing an unparsed syllable at the beginning of the word, if there are any; a word with no unparsed syllables vacuously satisfies the syll-usyll constraint. A single unparsed syllable at the left edge of the word satisfies this constraint because there are no syllables *before* the aligning category. Although this constraint does not produce foot clumping at either edge, the initial unparsed syllable creates a noninitiality effect (and the reverse constraint *-o-/σ would create a nonfinality effect). The predicted typology from adding the syll-usyll constraint to the constraint set of System Zero can be seen in (56).

(56) Syllable-Unparsed Syllable

	2s	3s	4s	P	F	A	Z	Attested Language
(a)	[uX]	o-[uX]	o-[uX]-o	SP	I	A	★	
(b)	[uX]	[uX]-o	o-[uX]-o	SP	I	R	Z+	
(c)	[Xu]	o-[Xu]	o-o-[Xu] o-[Xu]-o	SP	T	B	Z	contains Nahuatl
(d)	[uX]	o-[uX]	[uX]-[uX]	WD	I	A	★	*unattested*
(e)	[uX]	[uX]-o	[uX]-[uX]	WD	I	R	Z	Creek
(f)	[uX]	o-[Xu]	[uX]-[uX]	WD	I/SF	B	★	
(g)	[Xu]	o-[Xu]	[Xu]-[Xu]	WD	T	B	Z	Warao
(h)	[uX]	[X]-[uX]	[uX]-[uX]	SD	I	B	Z	Weri
(i)	[Xu]	[Xu]-[X]	[Xu]-[Xu]	SD	T	B	Z	Maranungku

Because there must be at least one unparsed syllable for this constraint to have any effect on the positioning of feet, strongly dense languages are unaffected by the presence of the syll-usyll constraint. On the other hand, there are two new *weakly* dense languages, as well as a new sparse language and a refinement to the iambic sparse language from System Zero.

The sparse languages in System Zero are indecisive, with several possibilities for the position of the single foot; because this constraint favors an unparsed syllable at the beginning of a word, a candidate *without* an unparsed syllable at the beginning of the word can suddenly be distinguished from the rest of the sparse candidates. Because the candidate without a word-initial unparsed syllable -- that is, a candidate with an initial foot in a word with four or more syllables -- incurs an extra violation on the alignment constraint, it is eliminated as one of the possibilities.

The new sparse iambic language (a) is very similar to the other sparse iambic language (b); in fact, the sole difference between the two languages can be found in the three-syllable word. Because alignment and rhythm have different -- but fully decisive --

opinions on where the single foot should be placed in a three-syllable word, there are two possible languages: one where alignment outranks rhythm, and one where rhythm outranks alignment. Language (a) ranks alignment above rhythm, thus placing the foot at the end of the three-syllable word: o-[uX]. While this parsing incurs a *LAPSE violation, it perfectly satisfies the syll-usyll constraint. On the other hand, the parsing [uX]-o is preferred by language (b), incurring a violation of the syll-usyll constraint while possessing perfect rhythm.

Similarly, the new weakly dense iambic language (d) is closely related to the weakly dense iambic language (e) from System Zero. The difference between these two languages, as with the above comparison, is in whether alignment or rhythm is ranked more highly. The comparison here emerges in all odd-length words. Having the unparsed syllable at the beginning of the word, as in o-$[uX]^{+}$, perfectly satisfies the alignment constraint while creating a lapse; having the unparsed syllable at the end of the word, as in $[uX]^{+}$-o, has perfect rhythm while incurring a violation of the alignment constraint. The aligning language (d) always places the unparsed syllable at the beginning (giving the appearance of right-to-left assignment of iambic feet -- one of the unattested languages from (4)), while the rhythmic language (e) always places the unparsed syllable at the end (giving the appearance of left-to-right assignment of iambic feet).

The final new language tries to appease both alignment and rhythm at the expense of foot type; the weakly dense switch language is inherently iambic, but switches to trochees in words with an odd number of syllables. The switching is across lengths; a single form will only contain one foot type. Because an iambic parse in odd-length words must choose between alignment and rhythm, the only way to satisfy both of these constraints is by switching to trochees for odd-length words.

3.2.2 System ATA1: *σ/F

Stretching?	No	*Shrinking?*	No
Hyperalignment?	No	*Clumping direction?*	Left
Number of switch languages?	2	*Switch types?*	
		T → I / solid forms:	1 odd lengths,
			1 3+ syllables
Number of scattered languages?	0	*Number of additional languages?*	4

		Intervener		
		Syllable	*Unparsed Syllable*	*Foot*
Aligning Category	*Syllable*	(a) *σ/σ	(b) *-o-/σ	(c) *F/σ
	Unparsed Syllable	(d) *σ/-o-	(e) *-o-/-o-	(f) *F/-o-
	Foot	(g) *σ/F	(h) *-o-/F	(i) *F/F

The syllable-foot constraint penalizes any syllable which precedes a foot; the effect of this constraint is to place a foot at the beginning of the word. A foot in the initial position incurs no violation, though feet anywhere else in the word *do* incur violations of the alignment constraint. This constraint is distinct from one like Kager's (1994) ALIGN-L, which also places a foot at the left edge. While Kager's ALIGN-L either assigns zero violations (if there is a foot at the left edge) or one violation (if there is not), the syllable-foot constraint assigns a violation for *each* foot not at the left edge -- meaning the number of violations is only limited by word-length. With more than one foot in a word, there is no way to avoid violations of alignment; however, placing a foot in initial position will incur one less violation than *not* having a foot in initial position. Because of the extremely local nature of this constraint schema, it makes no difference whether the initial foot is binary or unary; all that matters is the total number of non-initial feet in a word. The typology produced by the addition of this constraint can be found in (57).

(57) Syllable-Foot

	2s	**3s**	**4s**	**P**	**F**	**A**	**Z**	**Attested Language**
(a)	[uX]	[uX]-o	[uX]-o-o	SP	I	B	Z+	Lakota
(b)	[Xu]	o-[Xu]	o-o-[Xu] o-[Xu]-o	SP	T	R	Z	contains Nahuatl
(c)	[Xu]	[Xu]-o	[Xu]-o-o	SP	T	A	★	Chitimacha
(d)	[Xu]	[uX]-o	[uX]-o-o	SP	T/SF	B	★	Basque
(e)	[uX]	[uX]-o	[uX]-[uX]	WD	I	B	Z	Creek
(f)	[Xu]	o-[Xu]	[Xu]-[Xu]	WD	T	R	Z	Warao
(g)	[Xu]	[Xu]-o	[Xu]-[Xu]	WD	T	A	★	Pintupi
(h)	[Xu]	[uX]-o	[Xu]-[Xu]	WD	T/SF	B	★	Yidiny/Wargamay
(i)	[uX]	[X]-[uX]	[uX]-[uX]	SD	I	B	Z	Weri
(j)	[Xu]	[Xu]-[X]	[Xu]-[Xu]	SD	T	B	Z	Maranungku

As can be seen above, there are four new languages predicted, as well as a refinement on the iambic sparse language (a) from System Zero. Because the iambic sparse language in System Zero is indecisive, it is possible for a new constraint to refine the language and be more fully decisive. In this case, since an initial foot was a possibility for all lengths of the iambic sparse language -- and an initial foot is preferred by the new alignment constraint -- the language becomes fully decisive in favor of always placing a single foot at the beginning of the word.

On the other hand, the trochaic sparse language in System Zero does not have an initial foot as a possibility, due to rhythm concerns. Because rhythm and alignment disagree on placement of the trochaic foot -- alignment prefers initial, rhythm prefers anywhere *but* initial -- there are two possible languages that emerge. The rhythmic sparse trochaic language (b) is identical to the sparse trochaic language of System Zero; the aligning sparse trochaic language (c) ranks the syll-foot constraint above *LAPSE to produce a language which always contains an initial trochee. The compromise to produce *both* perfect alignment and rhythm is to violate the foot form constraint. The final sparse language (d) is inherently trochaic, but switches to an iambic foot in words three syllables or longer. A single foot at the left edge perfectly satisfies alignment, no matter what the foot type; however, an initial trochee produces an extra lapse that can be avoided by switching initial iamb.

A similar effect takes place with the weakly dense languages. The rhythmic weakly dense trochaic language (f) is straight from System Zero; the aligning weakly dense trochaic language (g) incurs an extra *LAPSE violation by placing a foot at the beginning of the word. While the rhythmic language (f) has the unparsed syllable in odd-length words at the beginning of the word, the aligning language (g) has a foot at the beginning of the word and the unparsed syllable later on in the word. Again, as with the sparse systems, there is a possibility to satisfy both the alignment and the rhythm constraints at the expense of foot form.

Language (h), the switch weakly dense language, is essentially trochaic. However, in odd-length words -- where an unparsed syllable appears and therefore provides some flexibility about the placement of feet -- all of the feet in the word switch to iambs. The reason for this is the same as with the sparse systems: to avoid alignment violations by having an initial foot, yet also avoiding an extra *LAPSE violation by switching to iambs.

3.2.3 System ATA2: *-o-/F

Stretching?	No	*Shrinking?*	No
Hyperalignment?	No	*Clumping direction?*	Left
Number of switch languages?	2	*Switch types?*	
		T → I / solid forms:	1 odd lengths,
			1 3-sylls only
Number of scattered languages?	0	*Number of additional languages?*	4

		Intervener		
Aligning Category		*Syllable*	*Unparsed Syllable*	*Foot*
	Syllable	(a) *σ/σ	(b) *-o-/σ	(c) *F/σ
	Unparsed Syllable	(d) *σ/-o-	(e) *-o-/-o-	(f) *F/-o-
	Foot	(g) *σ/F	(h) *-o-/F	(i) *F/F

The final constraint to be considered is the unparsed syllable-foot constraint. This constraint penalizes an unparsed syllable immediately to the left of a foot boundary. Since any unparsed syllable before the final foot of the word will incur a violation, the constraint prefers unparsed syllables at the end of the word; this has the effect of pulling feet to the beginning of the word. The languages predicted by this constraint are shown in (58).

(58) Unparsed Syllable-Foot

	2s	3s	4s	5s	P	F	A	Z	Attested Language
(a)	[uX]	[uX]-o	[uX]-o-o	[uX]-o-o-o	SP	I	B	Z+	Lakota
(b)	[Xu]	o-[Xu]	o-o-[Xu] o-[Xu]-o	o-o-o-[Xu] o-o-[Xu]-o o-[Xu]-o-o	SP	T	R	Z	contains Nahuatl
(c)	[Xu]	[Xu]-o	[Xu]-o-o	[Xu]-o-o-o	SP	T	A	★	Chitimacha
(d)	[uX]	[uX]-o	[uX]-[uX]	[uX]-[uX]-o	WD	I	B	Z	Creek
(e)	[Xu]	o-[Xu]	[Xu]-[Xu]	o-[Xu]-[Xu]	WD	T	R	Z	Warao
(f)	[Xu]	[Xu]-o	[Xu]-[Xu]	[Xu]-[Xu]-o	WD	T	A	★	Pintupi
(g)	[Xu]	[uX]-o	[Xu]-[Xu]	[uX]-[uX]-o	WD	T/SF	B	★	Yidiny/Wargamay
(h)	[uX]	[X]-[uX]	[uX]-[uX]	[X]-[uX]-[uX]	SD	I	B	Z	Weri
(i)	[Xu]	[Xu]-[X]	[Xu]-[Xu]	[Xu]-[Xu]-[X]	SD	T	B	Z	Maranungku
(j)	[Xu]	[uX]-o	[Xu]-[Xu]	[Xu]-[Xu]-[X]	SD	T/SF	B	★	

Like the effect observed in the previous two sections, there is conflict between rhythm and alignment. Whenever there are any unparsed syllables (sparse or weakly dense languages) trochaic feet are preferred non-initially in terms of lapses; however, just as was seen in the last section, this alignment constraint prefers feet initially. Because these constraints have opposite preferences for trochaic feet, there are two ways to resolve the conflict.

The rhythmic trochaic languages -- the sparse language (b) and the weakly dense language (e) -- are identical to the languages found in System Zero. On the other hand, the aligning languages where the usyll-foot alignment constraint dominates *LAPSE are new additions -- the sparse language (c) and the weakly dense language (f). The difference between the rhythmic languages and their aligning counterparts is about where the feet are positioned; in the rhythmic languages, there is an unparsed syllable in the first position, while in the aligning languages, there is a foot in the initial position. The aligning sparse language (c) has a single trochaic foot at the left edge, while the aligning weakly dense language (f) has trochaic feet iterating from the left edge and, in odd-length words, the unparsed syllable at the end of the word.

The other two new languages created by adding the usyll-foot constraint to the constraint set are both switch languages. Language (g), the weakly dense switch language, and language (j), the strongly dense switch language, are both inherently trochaic. Language (g), much like the switch languages of the previous sections, switches to iambic feet in odd-length words in order to satisfy both alignment and rhythm constraints. The only way to satisfy both the usyll-foot constraint and *LAPSE at the same time is by switching to iambic feet, as language (g) does in odd-length words. Each form is either all iambic or all trochaic, without any mixing of feet within a word; specifically, all odd-length words are iambic, while the even-length words remain trochaic.

The switch language found in (j), the strongly dense version, is unlike anything seen in the adjacent alignment section -- but appears twice in the between alignment section (BTA1 and BTA5). Specifically, this is a case of the three-syllable iambic switch. Because an iambic foot and a unary foot both violate TROCHEE, this constraint cannot choose between the trochaic parsing [Xu]-[X], which incurs one violation, and the iambic parsing [uX]-o, which also incurs one violation. This decision can then be made by other constraints; when the trochaic parsing wins, we get the strongly dense language (i) from System Zero, but when the iambic parsing wins, the switch language (j) emerges. For more details on this kind of three-syllable iambic switch, see the explanation in the between alignment section.

The final difference between this typology and the typology of System Zero is the refinement of the sparse iambic language (a). Since the sparse iambic language of System Zero allows a word-initial foot as one of the many parsing options, and the word-initial foot is preferred by alignment, there is no conflict; instead, the indecision can be resolved decisively, producing the language where there is always a single initial foot.

Where I≠K, the constraints have the property of moving categories to word edges; unlike the constraints where I=K, this is more like alignment constraints are expected to behave. When I≠K, the result is a true alignment constraint, while the results when I=K are not true alignment constraints. When either I or K is a foot, we see even more normal-looking alignment behavior, since feet are typically the relevant category for alignment. Specifically, either a foot is placed at word edge (foot-syll or syll-foot) or feet are pushed/pulled to a word edge (foot-usyll or usyll-foot). The remaining constraint usyll-syll/syll-usyll exhibits behavior similar to the foot-syll/syll-foot constraint; the same effect of *placing* a category at a word edge emerges from having either I or K as a syllable. When either I or K is a syllable, the other category is what is being placed at a word edge; for the foot-syll constraint, a foot is placed at the edge, while in the usyll-syll constraint, it is an unparsed syllable being placed at the edge.

4 Discussion

Both the between and adjacent constraint schemas predict languages beyond those of System Zero, including some languages that we might not expect to see in the languages of the world.

An interesting property of all the true alignment constraints is the emergence of switch languages in the typology. Every true alignment constraint produces at least one solid form switch language in its typology, a fact which will be demonstrated in the next chapter.

In left-clumping languages, trochees switch to iambs, while in right-clumping languages, iambs switch to trochees. For instance, in a left-clumping weakly dense trochaic language, [Xu] and [Xu]-[Xu] have perfect rhythm -- but the iambic parse [uX]-[uX]-o improves on rhythm over [Xu]-[Xu]-o; the reverse is true in a weakly dense right-clumping iambic language, where [uX] and [uX]-[uX] are perfectly rhythmic but trochaic o-[Xu]-[Xu] is better rhythmically than o-[uX]-[uX]. The same is true in strongly dense languages, where left-clumping trochaic languages will switch to iambic for rhythm (even-length is [Xu]-[Xu], odd-length is [X]-[uX]-[uX]) and right-clumping iambic languages switch to trochees in odd-length words to improve on rhythm (even-length is [uX]-[uX], odd-length is [Xu]-[Xu]-[X]).

When I=K, none of the resulting constraints are true alignment constraints. For both constraint schemas, the syllable-syllable constraint has no effect beyond System Zero (BPA1 and APA1); however, for the between constraint schema, *no* constraint where I=K makes any effect on the typology. For the adjacent constraint schema, it is possible for I=K constraints to effect the typology (though they are still not true alignment constraints); specifically, these constraints are responsibility for effects of ternarity. Scattered parsing languages occur *only* in the adjacent I=K constraints APA2 and APA3. Additionally, these scattered languages exhibit the only examples of foot shrinking in any of the predicted typologies.

Both constraint schemas introduce some unattested languages when I≠K. One such language type is a feature of using unparsed syllables as a potential category; specifically, the language in question is the three-syllable iambic switch. This language is inherently trochaic and strongly dense, but uses the parse [uX]-o rather than [Xu]-[X] in three-syllable words. For all other lengths of words, the three-syllable iambic switch language looks just like the standard trochaic strongly dense language. For between constraints, this language only emerges when I is the unparsed syllable (BTA1 and BTA5); for adjacent constraints, it doesn't matter whether I or K is the unparsed syllable due to the symmetric nature of the constraints -- in either case, the three-syllable iambic switch language is present (ATA2). There is no right-aligned trochaic switch counterpart because the constraint IAMB does not penalize unary feet; the primary reason for the three-syllable iambic switch is the asymmetrical definitions of the foot-type constraints.

Another prediction of both the between and adjacent constraints relates to the solid form switching languages. These languages must have a foot at a word edge due to the alignment constraint, but switch foot types in order to improve on lapses. In sparse languages, the switch occurs in all words of three or more syllables, while in weakly dense languages the switch occurs in all words of odd-lengths. This seems like a strange prediction, but there is actually an attested language which appears to follow this pattern, shown in (59).

(59) Oñati Basque pattern[13]

2 σ	**3 σ**	**4 σ**	**5 σ**	**6 σ**	**7 σ**
[Xu]	[uX]-o	[uX]-o-o	[uX]-o-o-o	[uX]-o-o-o-o	[uX]-o-o-o-o-o

This language is inherently trochaic, as can be observed in the two-syllable word. However, in longer words the single foot switches to an iamb in order to lessen the *LAPSE violations by one.

When I≠K, there are special phenomena predicted only by the between constraints and one type predicted only by the adjacent constraints.

Only the between alignment constraints have switch languages with mixed foot forms when I≠K (BTA2 and BTA4). In these languages, one word edge has the opposite foot type in odd-length words. The dominant foot type is separated from this switched foot by either a unary foot (in strongly dense languages) or an unparsed syllable (in weakly dense languages). In the strongly dense languages, this is a possible side effect of stretching; this kind of switching occurs with stretching, in order to maintain perfect rhythm. There are no actually attested languages which exhibit either the weakly or strongly dense versions of the mixed foot forms.

Relatedly, only the between alignment constraints produce languages with stretching of the final foot (BTA4). Since the between alignment constraints, but not the adjacent alignment constraints, can care about the distance between any foot and the edge

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[13] Data comes from Hualde 1999, Hayes 1980, 1993. Evidence for foot type in Oñati Basque is limited, but the stress pattern is as shown above.

of the word, a final foot can become binary rather than unary in order to improve on the alignment constraint. However, adjacent alignment constraints cannot evaluate such a non-local choice, and so cannot produce stretching. Again, no known languages exhibit stretching.

The final language type predicted only by the between alignment constraints is hyperalignment (BTA4). In these languages, the final syllable is left unparsed in words of three or more syllables. Additionally, a unary foot emerges in (at least) even-syllable words. No attested languages exhibit this pattern of hyperalignment; however, like switch languages, their stress pattern is indistinguishable from a more expected pattern. The hyperalignment pattern {[X]-[uX]-o} yields the same stresses as a right-aligned trochaic pattern {[Xu]-[Xu]}. If a right-aligned trochaic language appeared to have iambic lengthening, this could be an example of a hyperaligning language.

The only effect predicted by the adjacent alignment constraints but not the between alignment constraints is non-initiality (APA4). In these languages, the word *must* start with an unparsed syllable. Although there are no attested languages which look exactly like the predicted non-initiality language, non-initiality has been previously proposed to account for stress patterns of attested languages (Kennedy 1994, Kenstowicz 1994, Hayes 1995, Alderete 1995). It is possible that the non-initiality of the adjacent alignment constraints could be used in an account of one of these languages, combined with other constraints.

There is one additional distinction between the between alignment constraint predictions and the adjacent alignment constraint predictions; specifically, the between alignment constraints overall are more decisive in the predicted languages. Only a small number of the languages predicted by the between constraints are not completely decided by the constraint set, while many more of the languages predicted by the adjacent constraints are not fully decisive. The reason for this difference has to do with the local character of the adjacent alignment constraints; since these constraints can only see what is directly adjacent to the category of alignment, it is impossible to make more global decisions over the entire word.

Overall, the constraints which predict typologies that are the *best* fits with reality are ones which do not produce any strange unattested languages, but capture some attested languages missing from System Zero. From the between alignment schema, the successful constraints in this sense are the ones which utilize unparsed syllables either as the intervener or the category of alignment: foot-usyll/syll-usyll (BTA3), usyll-syll (BTA1), and usyll-foot (BTA5). For the adjacent alignment schema, the successful constraints refer to feet either as the intervener or the aligning category: syll-foot (ATA1) and usyll-foot (ATA2), as well as their mirror images.[14]

When attempting to map the predictions of these constraints onto actually attested languages, all of the constraints mentioned above (except adjacent syll-usyll, APA4) predict additional attested languages not captured by System Zero. However, the between alignment constraints which use unparsed syllables as the category of alignment -- foot-usyll/syll-usyll (BTA3) -- do predict a language which is unattested, according to Alber (2005), Hyde (2007), and Kager (2001). Specifically, the predicted language is an

[14] The only remaining constraint where I≠K is the syll-usyll constraint; this is the constraint which predicts non-initiality (APA4). If languages with non-initiality in the manner imposed by this constraint are attested, the syll-usyll constraint becomes a viable possibility again. However, this constraint does not add any attested languages, and does predict a language which is unattested according to Alber (2005), Hyde (2007), and Kager (2001). This is the same unattested language predicted by the between constraints foot-usyll/syll-usyll (BTA3).

iambic weakly dense language with an initial unparsed syllable, resulting in an initial lapse. Because this constraint produces a language which is not attested, it is eliminated from the final consideration.

After taking into account attested and unattested languages, the constraints which best map onto observed attested and unattested languages are the between constraints which use unparsed syllables as interveners (BTA1: usyll-syll and BTA5: usyll-foot) and the adjacent constraints which refer to feet (ATA1: syll-foot and ATA2: usyll-foot).

(60) Promising constraints

Between alignment: unparsed syllables as intervener[15]

*-o-/…σ : no unparsed syllable before a syllable (BTA1)

*-o-/…F : no unparsed syllable before a foot (BTA5)

Adjacent alignment: feet as intervener *or* aligner

*σ/F : no syllable to the immediate left of a foot (ATA1)

*-o-/F : no unparsed syllable to the immediate left of a foot (ATA2)

(plus the mirror images of the above two constraints)

[15] Although those that use unparsed syllables as the intervener (BTA1: *-o-/…σ and BTA5: *-o-/…F) introduce one unattested language, the three-syllable iambic switch language is caused by these constraints interacting with the asymmetrical IAMB and TROCHEE constraints. With symmetrical versions of the foot form constraints, this problem does not occur.

(61) Attested languages not in System Zero, added by constraints

Density	*Foot Type*	*Aligned*	*Language Name*	*Constraint Name*			
				BTA1: *-o-/…σ	BTA5: *-o-/…F	ATA1: *σ/F	ATA2: *-o-/F
Sparse	Iamb	Left	Lakota	≈	★	★	★
Sparse	Trochee	Left	Chitimacha		★	★	★
Sparse	Trochee	Right	Nahuatl			≈	≈
Sparse	Trochee	Right + NF	Macedonian	≈			
Sparse	Trochee/ Switch	Left	Oñati Basque			★	
Weakly Dense	Trochee	Left	Pintupi	★	★	★	★
Weakly Dense	Switch	Left	Yidiny/ Wargamay	★	★	★	★

★ indicates a fully decisive language matching the attested language
≈ indicates an indecisive language consistent with the attested language

The typological examinations in this paper have provided insight into sources for various unusual alignment properties, as well as desirable effects. The interesting result is the discovery of which properties produce desirable effects, given above in (60). Also notable is the fact that switch languages appear in the typology of every true alignment constraint. A proof that switch languages will occur with any definition of true alignment can be found in the following chapter.

Chapter 3

Proof of Switch Languages

Switch languages are an entailed typological result when the constraint set includes three common constraint types. The basic constraint types which produce switch languages are rhythm, alignment, and parsing. This chapter systematically explores the inevitability of switch languages, given these three constraint types.

The class of rhythm constraints contains *LAPSE and *CLASH, which respectively penalize consecutive unstressed syllables and consecutive stressed syllables. Parsing constraint refers to a constraint such as FTBIN or PARSESYLL, which influence the density of foot parsing. The exact definition of alignment constraints is described further in the following sections, as it varies slightly between the two parsing densities (due to the absence of unparsed syllables in a strongly dense language, a more stringent version of alignment is needed).

Any constraint that puts a binary foot at the beginning of a three-syllable word (including constraints that are not typically thought of as alignment constraints, such as NONFINALITY) will have this effect in the grammar. This minimum requirement is the same for any parsing density, but the implementation of the alignment constraint for a strongly dense language is slightly different because all words are fully parsed. The generalization about the entailment of switch languages is based on these universals, not on the subtleties of definitions of alignment constraints. Any of the true alignment constraints from Chapter 2 will have this effect, as well as other foot alignment constraints, main stress alignment constraints, and constraints like NONFINALITY. All stress typologies include at least something with this property, including a system like Kager's (2001) which primarily relies on rhythm constraints instead of alignment constraints. In Kager's system, constraints which place main stress at the left edge are still required -- and therefore, switch languages are still a result of his typology. This is discussed further in section 1.4.

The switch languages which result from *LAPSE and *CLASH are separable by foot density; *LAPSE creates switch languages with sparse or weakly dense parsing, while *CLASH creates switch languages with strongly dense parsing. Section 1 deals with the languages resulting from *LAPSE, while section 2 focuses on the languages resulting from *CLASH. In both cases, I will use a simple model with only three constraints to show that a switch language is an entailed typological prediction.

1 Sparse and Weakly Dense Languages

Switch languages with sparse or weakly dense parsing are produced by the rhythm constraint *LAPSE, a constraint penalizing unary feet, and an alignment constraint. In any system that contains these three constraints, a switch language is inevitable. Even with other constraints added to CON, it will always be possible for these three constraints to be the top ranked and thus yield a switch language.

1.1 The Constraints

There is more than one option for the anti-unary foot constraint; for example, definitions of IAMB and TROCHEE where one or both penalize unary feet (e.g. TROCHEE = *[uX], *[X]), or FTBIN (*[X]). I will use FTBIN here, though any anti-unary foot constraint will work.

Rather than committing to particular alignment constraint, INITIALFOOT stands in for a class of alignment constraints, all of which look for feet to be aligned to the left edge of a word. Violations for this constraint will either be zero or one; if there is no foot aligned with the left edge of the word, there is a violation.

(1) Definition of INITIALFOOT

assign one violation for each word that lacks a foot at the left edge

This is different from any of the individual alignment constraints discussed in Chapter 2, but is a distillation of a fundamental property that all the alignment constraints share. INITIALFOOT is not grounded in alignment theory, but is based on a shared crucial property of all alignment constraints. For more discussion of possible alignment constraints, see the previous chapter.

The crucial property (that all of the constraints in this class have in common) **is just whether there is a foot at the beginning of the word or not.**

While the number of violations for INITIALFOOT does not necessarily match the number of violations assigned by the individual constraints in the class it represents, the constraints will agree on which candidate is optimal. For every candidate that doesn't have a foot at the left edge, there is some relevant candidate that does; this does not mean that *every* candidate with a foot at the left edge is better than every candidate without a foot at the left edge for every version of a left alignment constraint. For instance, consider the comparison in (2); three candidates and their violations on ALL-FEET-LEFT are provided.

(2) Violations on AFL for three candidates

		AFL
a)	[Xu]-o-o-o-o-[Xu]	6
b)	o-[Xu]-[Xu]-o-o-o	4
c)	[Xu]-o-[Xu]-o-o-o	3

While the candidate in (a) has a foot at the left edge and the one in (b) does not, (b) is still doing a better job at aligning *all* of its feet to the left edge than (a) is; however, this is not the relevant comparison. The candidate in (b) could be improved by having the initial foot to the left edge, as in (c); this *is* the relevant comparison. The comparison between (b) and (c) shows that a candidate without a foot at the left edge can be improved upon by having a foot to the left edge.

The table in (3) displays every two- and three-syllable candidate, along with their violations for six different left-clumping constraints from the previous chapter. The seventh constraint, INITIALFOOT is the constraint used in this model. INITIALFOOT's violations are a subset of the violations produced by the other left-clumping constraints; every candidate which is considered to be an optimum by at least one constraint is also considered to be an optimum by INITIALFOOT.

The first group without shading indicates candidates which are considered optimal by every constraint; a dashed line separates these from candidates which are considered optimal by *some* constraint; shading indicates candidates which are considered optimal by *no* constraint.

(3) Left-clumping constraint violations

		BUSYLLSYLL	BSYLLFT	BUSYLLFT	ADJSYLLFT	ADJUSYLLFT	AFL	INITIALFT
2s	{[uX]}	0	0	0	0	0	0	0
	{[Xu]}	0	0	0	0	0	0	0
	{[X]-o}	0	0	0	0	0	0	0
	{[X]-[X]}	0	1	0	1	0	1	0
	{o-[X]}	1	1	1	1	1	1	1
3s	{[Xu]-o}	0	0	0	0	0	0	0
	{[X]-[uX]}	0	1	0	1	0	1	0
	{[uX]-o}	0	0	0	0	0	0	0
	{[X]-[Xu]}	0	1	0	1	0	1	0
	{[X]-[X]-o}	0	1	0	1	0	1	0
	{[uX]-[X]}	0	2	0	1	0	2	0
	{[Xu]-[X]}	0	2	0	1	0	2	0
	{[X]-[X]-[X]}	0	2	0	2	0	3	0
	{[X]-o-o}	1	0	0	0	0	0	0
	{[X]-o-[X]}	1	2	1	1	1	2	0
	{o-[uX]}	1	1	1	1	1	1	1
	{o-[Xu]}	1	1	1	1	1	1	1
	{o-[X]-o}	1	1	1	1	1	1	1
	{o-[X]-[X]}	1	2	1	2	1	3	1
	{o-o-[X]}	2	2	2	1	1	2	1

As the above table shows, INITIALFOOT's violations are a subset of the violations produced by other left-clumping constraints. There is no candidate considered to be a possible optimum by some other left-clumping constraint that INITIALFOOT does not also consider to be a possible optimum.

In fact, INITIALFOOT is even more permissive than the other alignment constraints, as can be seen in the final three-syllable candidate with zero INITIALFOOT violations -- {[X]-o-[X]}. All of the other left-clumping constraints assign at least one violation to this constraint, yet INITIALFOOT is satisfied by this candidate since it has an initial foot. All of these constraints penalize an unparsed syllable at the left edge.

1.2 Laying Out the Model

The assumptions about GEN, as well as the specific definitions for the constraints described above are given in (4).

(4) Assumptions of the model

GEN

Each foot is only 1 or 2 syllables

CON

INITIALFOOT:

one violation for each word that lacks an initial foot

*LAPSE:

one violation for each sequence of two consecutive unstressed syllables

FTBIN:

one violation for each unary foot

The table in (5) shows all possible candidates for two- and three-syllable words, and the violations assigned to them by two of the constraints in our model. For simplicity, only two- and three-syllable words are used here, but they are sufficient to show switching. There are three kinds of predicted switch languages in Chapter 2: (1) only the two-syllable form is different from the others in foot type, (2) only the three-syllable form is different from the others in foot type, and (3) odd-lengths are one foot type and even-lengths are the other foot type. With only two- and three-syllable words, we will capture all three of these kinds of switching. Additionally, two- and three-syllable words do not distinguish between a sparse and a weakly dense parsing, so these results can be applied to both of those realms.

(5) Violations for two- and three-syllable words

		*LAPSE	FTBIN
2s	{[uX]}	0	0
	{[Xu]}	0	0
	{o-[X]}	0	1
	{[X]-o}	0	1
	{[X]-[X]}	0	2
	{o-o}	1	0
3s	{[uX]-o}	0	0
	{o-[Xu]}	0	0
	{o-[uX]}	1	0
	{o-o-[X]}	1	1
	{[uX]-[X]}	0	1
	{o-[X]-o}	0	1
	{o-[X]-[X]}	0	2
	{[Xu]-o}	1	0
	{[Xu]-[X]}	0	1
	{[X]-o-o}	1	1
	{[X]-[uX]}	0	1
	{[X]-o-[X]}	0	2
	{[X]-[Xu]}	0	1
	{[X]-[X]-o}	0	2
	{[X]-[X]-[X]}	0	3
	{o-o-o}	2	0

No shading indicates that a candidate is a possible optimum; shading indicates that a candidate cannot win if these two constraints are top ranked. This is not harmonic bounding, because this candidate can win under other rankings when additional constraints are added -- but never while these two constraints are top ranked. While it is possible for the shaded candidate to win with the addition of another constraint, it is always possible for these two constraints to be ranked higher than the new constraint. Therefore, the only decision that can be made by lower-ranked constraints will be selecting between the set of optima determined by these constraints if there is a tie; if these candidates select a single optimum, lower-ranked constraints will be unable to do anything.

With *LAPSE and FTBIN top-ranked, the candidate sets for both two- and three-syllable words are winnowed down to a choice between two candidates. In each case, there is an iambic option and a trochaic option, both with a single binary foot.

1.3 Limited Possible Optima

Given that every permutation of the constraints is possible, I will now consider what happens when *LAPSE and FTBIN are top-ranked. These constraints narrow the candidate set down to a pair of candidates each for two-syllable and three-syllable words, as shown above. The below table includes only those candidates selected by top-ranked *LAPSE and FTBIN. Any set of constraints which winnows the candidate set down to this comparison could be used in place of *LAPSE and FTBIN.

(6) Violations for two- and three-syllable words with INITIALFOOT

		*LAPSE	FTBIN	INITIALFOOT
2s	{[uX]}	0	0	0
	{[Xu]}	0	0	0
3s	{[uX]-o}	0	0	0
	{o-[Xu]}	0	0	1

This table shows that there are two possible optima for two-syllable words, and only a single possible optimum for three-syllable words when INITIALFOOT is added to the top-ranked constraints. This means that, regardless of which two-syllable form is selected, the three-syllable form will always be the same. Some other constraint further down the hierarchy will make the choice between [uX] and [Xu], such as IAMB or TROCHEE. Specifically, there are two possible languages, provided in (7).

(7) Possible languages

a) *All Iambic Language*

[uX]

[uX]-o

b) *Switch Language*

[Xu]

[uX]-o

Even when additional constraints are added, every permutation of constraints is possible; there will always be some ranking where these three constraints outrank everything else. This means that there will always be some permutation of constraints that produces a switch language, although it is not the case that *every* predicted language will be a switch language.

1.4 Discussion

Making a Choice at the Left Edge

In order to avoid switch languages, there cannot be *any* constraint which makes a decision in the three-syllable candidate set without also deciding in favor of the two-syllable candidate which has the same foot type. That is, if *any* constraint selects {[uX]-o} without also selecting {[uX]}, or {o-[Xu]} without also selecting {[Xu]}, then a switch language will always be predicted.

Even if the only alignment constraint simply aligns a single *main* stress to the left edge, this same property will emerge; this is true regardless of whether the constraint wants the main stress-containing foot at the edge or the actual main-stressed syllable at the left edge.

In the following table, MFL represents a constraint that penalizes not having the main stress *foot* at the left edge, while MSL represents a constraint that penalizes not having the main stress *syllable* at the left edge. The ERCs here are perfectly symmetrical, although the total numbers of violations are not. In two-syllable words MFL has no preference while MSL decides in favor of a trochaic parse; in three-syllable words MSL has no preference while MFL decides in favor of an iambic parse.

(8) Violation tableau: Main stress aligning constraints

		MFL	MSL
2s	{[uX]}	0	1
	{[Xu]}	0	0
3s	{[uX]-o}	0	1
	{o-[Xu]}	1	1

As the table in (8) in shows, each of these constraints can decide in *one* of the word lengths but not both; this means that, either way, you will be left with a single option for one word length but two options for the other word length -- meaning switch languages will be possible. The tableau from (8) is repeated as a comparative tableau in (9), first with both iambic parses as winners (a) and second with both trochaic parses as winners (b).

(9) Comparative tableau: Main stress aligning constraints

a) All iambic

		MFL	MSL
2s	{[uX]} ~ {[Xu]}	e	L
3s	{[uX]-o} ~ {o-[Xu]}	W	e

b) All trochaic

		MFL	MSL
2s	{[Xu]} ~ {[uX]}	e	W
3s	{o-[Xu]} ~ {[uX]-o}	L	e

Switch languages are certain, so long as there is *some* constraint which makes a distinction between {[uX]-o} and {o-[Xu]}, without distinguishing between {[uX]} and

{[Xu]} -- or vice versa. Any constraint which can make a choice for only one of those pairs will ensure that the predicted typology contains a switch language.

The Need for Making a Choice at the Left Edge

We cannot do away with all constraints that make a choice at the left edge, as there are languages which crucially rely on such constraints. For example, consider the language in (10), which is a left-aligned sparse trochaic language. Languages of this type, such as Tunica (Haas 1953), need some constraint to require a foot at the left edge; otherwise, rhythm constraints will force a single trochee to be anywhere *but* in initial position. Since Tunica has initial stress, there must be a foot in initial position and some constraint which favors an initial foot. Any left-alignment constraint will suffice, including a constraint that aligns only one foot per word like ALIGN-L(WD, FT) or aligns only the main stress like HEADLEFT. INITIALFOOT stands in for the entire class of constraints that minimally requires a foot at the left edge.

(10) Left-aligned sparse trochaic language

Language	2 σ	3 σ	4 σ	5 σ
Tunica	[Xu]	[Xu]-o	[Xu]-o-o	[Xu]-o-o-o

(11) Left-aligning constraint necessary

	*LAPSE	INITIALFOOT	FTBIN
[Xu]-o ~ o-[Xu]	L	W	e
[Xu]-o-o ~ o-[Xu]-o	L	W	e

Because languages like Tunica require some kind of constraint that prefers leftward alignment, it is impossible to do away with all constraints of this type. Alternately, there is no constraint that can care about having a foot at the left edge in (11) but not in (8) or (9); in order to have a constraint which differs on violations, it would have to be something that is violated by not having a trochee at the left edge of a word, without any reference to iambs. We would then need to have ALIGN-TROCHEE-LEFT, ALIGN-IAMB-LEFT, ALIGN-TROCHEE-RIGHT, and ALIGN-IAMB-RIGHT in order to account for the full range of stress patterns.

Avoiding Alignment Constraints

Kager's (2001) proposal does away with constraints like ALL-FT-L and ALL-FT-R which align multiple feet to word edges, in favor of only using rhythm constraints. A system which avoids the use of alignment constraints still cannot avoid predicting switch languages because a constraint like HEADLEFT is still required to explain the Tunica-type languages.

Kager does assume the use of a constraint like HEADLEFT which can align main stress to an edge. This constraint still has the relevant property for switch languages: deciding between candidates based on the presence or absence of a foot at the beginning of a word. As shown with the Tunica case above, a constraint which places main stress at the left edge of a word is necessary. Therefore, Kager's system still predicts switch languages due to the presence of HEADLEFT in the constraint set.

Aligning to the Right Edge

By symmetry, the same that is true for INITIALFOOT is also true for FINALFOOT; instead of an all-iambic language and a switch language, FINALFOOT will produce an all-trochaic language and a switch language. A table showing the violations with FINALFOOT is given in (12).

(12) Violations with FINALFOOT

		FINALFOOT	*LAPSE	FTBIN
2s	{[uX]}	0	0	0
	{[Xu]}	0	0	0
	{o-[X]}	0	0	1
	{[X]-o}	1	0	1
	{[X]-[X]}	0	0	2
	{o-o}	1	1	0
3s	{o-[Xu]}	0	0	0
	{o-[uX]}	0	1	0
	{o-o-[X]}	0	1	1
	{[uX]-o}	1	0	0
	{[uX]-[X]}	0	0	1
	{o-[X]-o}	1	0	1
	{o-[X]-[X]}	0	0	2
	{[Xu]-o}	1	1	0
	{[Xu]-[X]}	0	0	1
	{[X]-o-o}	1	1	1
	{[X]-[uX]}	0	0	1
	{[X]-o-[X]}	0	0	2
	{[X]-[Xu]}	0	0	1
	{[X]-[X]-o}	1	0	2
	{[X]-[X]-[X]}	0	0	3
	{o-o-o}	1	2	0

As with INITIALFOOT, there are two possible optima for two-syllable words and only one possible optimum for three-syllable words, resulting in the two possible languages listed in (13).

(13) Possible languages with FINALFOOT

a) *All Trochaic Language*

[Xu]

o-[Xu]

b) *Switch Language*

[uX]

o-[Xu]

With either alignment constraint -- in addition to the other two necessary constraints -- a switch language is a predicted to be a part of the typology.

2 Strongly Dense Languages

The rhythm constraint that was used for sparse and weakly dense languages was *LAPSE; the same switching effects will emerge with the use of *CLASH instead, if we look at the strongly dense realm. However, since the conditions are different for *CLASH, the constraints will need to be different as well.

To achieve strongly dense parsing will require the use of PARSESYLL instead of FTBIN, and *CLASH will replace *LAPSE. The alignment constraint will also need to be modified somewhat.

2.1 More Restrictive Alignment Constraint

The alignment constraint used in the previous section only assigned a violation when there was no foot at the beginning of the word; this constraint penalized only those candidates with an unparsed syllable at the left edge of the word. However, in the strongly dense realm there are no unparsed syllables. All words are exhaustively parsed, and so all words will have a foot at the edge. The version of alignment used here in strongly dense systems must be slightly stronger than the one used for the sparse and weakly dense systems. While the previous version of alignment simply assessed one violation when there was not a foot at the edge and no violations when a foot was present at the edge, the constraint needed for strongly dense systems must be able to in some way count how far away the feet are from the word edge.

A smaller set of candidates and constraints than the one used in the previous section is provided here; only exhaustively parsed candidates are shown, and constraints which cannot sufficiently distinguish between these candidates (e.g. those which look for unparsed syllables) have been eliminated from consideration. Using terminology from Chapter 2, left-clumping refers to a configuration where feet are as close to the left edge as possible. For a strongly dense language, this means a unary foot at the left edge and binary feet filling the remainder of the word.

(14) Left-clumping constraint violations

		BSYLLFT	AFL	LEFTCLUMP
2s	{[uX]}	0	0	0
	{[Xu]}	0	0	0
	{[X]-[X]}	1	1	1
3s	{[X]-[uX]}	1	1	1
	{[X]-[Xu]}	1	1	1
	{[uX]-[X]}	2	2	2
	{[Xu]-[X]}	2	2	2
	{[X]-[X]-[X]}	2	3	2

The general alignment constraint LEFTCLUMP has a subset of the violations of the other left-clumping constraints which have a difference with respect to the strongly dense candidates. Specifically, this constraint must favor every candidate which is considered to be a possible optimum by any of the other left-clumping constraints, and disfavor the candidates which are dispreferred by all of the other constraints.

(15) Left-clumping constraint definition

LEFTCLUMP: *{…σ…[

for each syllable, assign one violation if it is between the left edge of the word and a foot

This constraint assesses one violation for every syllable that intervenes between *some* foot and the left edge of the word; this definition is the same as the between alignment constraint *σ/…F (referred to as BSYLLFT in (3)). Although the last foot is not explicitly mentioned in this definition, this constraint effectively counts the number of syllables between the beginning of the word and the last foot. This is the version of general left alignment that will be used for this section.

2.2 Laying Out the Model

The assumptions about GEN are the same here as they were for the sparse and weakly dense cases; the only difference in the model is that the constraints in CON have changed.

(16) *Assumptions of the model*

GEN

Each foot is only 1 or 2 syllables

CON

LEFTCLUMP:

one violation for each syllable between left edge and final foot

*CLASH:

one violation for each sequence of two consecutive stressed syllables

PARSESYLL:

one violation for each unparsed syllable

The table below shows all possible candidates for two- and three-syllable words, along with the violations assigned to them by two of the constraints in our model. No shading indicates that a candidate is a possible optimum; shading indicates that a candidate is not a possible optimum with respect to these candidates.

(17) *Violations for two- and three-syllable words*

		*CLASH	PARSESYLL
2s	{[uX]}	0	0
	{[Xu]}	0	0
	{o-[X]}	0	1
	{[X]-o}	0	1
	{o-o}	0	2
	{[X]-[X]}	1	0
3s	{[X]-[uX]}	0	0
	{[Xu]-[X]}	0	0
	{[uX]-o}	0	1
	{o-[Xu]}	0	1
	{o-[uX]}	0	1
	{[Xu]-o}	0	1
	{[X]-o-[X]}	0	1
	{o-o-[X]}	0	2
	{o-[X]-o}	0	2
	{[X]-o-o}	0	2
	{o-o-o}	0	3
	{[X]-[Xu]}	1	0
	{[uX]-[X]}	1	0
	{[X]-[X]-[X]}	2	0
	{o-[X]-[X]}	1	1
	{[X]-[X]-o}	1	1

Although it is possible to for an eliminated candidate to be optimal with the addition of new constraints, when these two constraints are highest ranked, they will make these distinctions; only candidates which are possible optima here will be possible optima when *CLASH and PARSESYLL are top-ranked.

These constraints narrow the candidate set down to a two-way choice for both the two-syllable and three-syllable words; the possible optima from (17) are the only possibilities shown below in (18).

(18) Violations for two- and three-syllable words

		*CLASH	PARSESYLL	LEFTCLUMP
2s	{[uX]}	0	0	0
	{[Xu]}	0	0	0
3s	{[X]-[uX]}	0	0	1
	{[Xu]-[X]}	0	0	2

As the above table shows, the addition of the alignment constraint described in this section makes a choice in the three-syllable case but not in the two-syllable case. This means that, regardless of which two-syllable form is selected, the three-syllable form will always be the same. Specifically, this means that there are two possible languages, provided in (19).

(19) Possible languages

a. *All Iambic Language*

[uX]

[X]-[uX]

b. *Switch Language*

[Xu]

[X]-[uX]

Even when additional constraints are added, every permutation of constraints is possible;

there will always be some ranking where these three constraints outrank everything else. This means that there will always be *some* permutation of constraints that produces a switch language.

2.3 More Restrictive Alignment with Sparse and Weakly Dense

While a more restrictive version of alignment was needed for *CLASH and the strongly dense system, this version of the alignment constraint will still produce switch languages in sparse and weakly dense cases.

As in the previous section, *LAPSE and FTBIN narrow down the candidate set to the candidates shown in (20). When the more restrictive LEFTCLUMP used in this section is added, the same decision is made as before.

(20) Violations for two- and three-syllable words

		*LAPSE	FTBIN	LEFTCLUMP
2s	{[uX]}	0	0	0
	{[Xu]}	0	0	0
3s	{[uX]-o}	0	0	0
	{o-[Xu]}	0	0	1

Even with this more restrictive alignment constraint, there is no change with regards to the sparse and weakly dense languages; there are still the two possible languages provided in (21).

(21) *Possible languages*

a. *All Iambic Language*

[uX]

[uX]-o

b. *Switch Language*

[Xu]

[uX]-o

3 Discussion

This chapter details the claim that switch languages are a consequence of three basic types of constraints -- alignment, rhythm, and parsing. Switch languages come into existence due to the conflict between the placement of stress and the placement of feet. Because switch languages are an effect of satisfying rhythm constraints above other considerations, switch languages always have perfectly alternating stress. *LAPSE produces sparse and weakly dense switch languages, since there is at least one leftover unparsed syllable in the word to interact with *LAPSE. Strongly dense switch languages are produced by *CLASH, since the addition of a unary foot can create a stress clash. Since the constraints which produce switching are necessary constraints elsewhere in phonology, switch languages are an entailed consequence of the theory.

Chapter 4

Case Studies

Two Australian languages from Queensland, both in the Pama-Nyungan family, are examples of switch languages. Yidiny and Wargamay have a solid form switch stress pattern; for both languages, even-length words are trochaic while odd-length words are iambic. In Yidiny and Wargamay, primary evidence for the foot type in each word-length is regular vowel lengthening in iambic feet but not in trochaic feet. Further support for this claim can be found in Chapter 5.

1 Yidiny

Yidiny is an Australian language extensively studied by Dixon (1977). Dixon's comprehensive grammar and vocabulary list are the source of all data found in this section.

1.1 Yidiny is trochaic and iambic

Hayes (1982) argues that Yidiny must be a switch language, citing evidence from Dixon (1977); this pattern is also discussed as a consequence of certain Optimality Theoretic metrical constraints in Alber (2005: 518). McCarthy and Prince (1996) also note that Yidiny has uniformity of foot type within individual words but not across the entire language, supporting their principle that requires uniformity of foot type within certain domains. In Yidiny, even-length words are productively trochaic, while odd-length words are productively iambic. An illustration of the Yidiny stress pattern is provided in (1).

(1) [Xu]-[Xu] even number of syllables: trochee, trochee

[uX]-[uX]-o odd number of syllables: iamb, iamb, unparsed syllable

Since the locations of stress predicted by switch languages are indistinct from those predicted by uniform foot type -- both yield the same oXoXo pattern -- additional evidence for foot boundaries or foot type is needed in order to establish that Yidiny is a switch language.

1.2 Stress pattern of Yidiny

Every Yidiny word has perfectly alternating stress (Dixon 1977: 40). Long vowels are always only in stressed syllables, but it is not the case that every stressed vowel is long (Dixon 1977: 40). The only Yidiny words that consist solely of short vowels also have an even number of syllables; every odd-length word has at least one long vowel in it (Dixon 1977: 41, 43).

1.2.1 Even-length words

Words with all short vowels have stress on the initial syllable, with perfectly alternating stress falling on every odd-numbered syllable afterwards. In this quantity insensitive sublanguage of Yidiny, initial stress indicates that these words are trochaic — though this only applies to even-length words, since there are no odd-length words with all short vowels. (Dixon 1977: 40-41, 43)

(2) six (light) syllables, three trochees [Xu][Xu][Xu]

[ḍám.bu].[lá.ŋal].[ɲún.da] [LL][LL][LL]

'two-TR VBLSR-DAT SUBORD'

There are also even-length words with underlying long vowels, but there is no lengthening process applied to them. Minimal pairs illustrate that there is a length contrast in even-length words.

(3) LL:	málan	'flat rock'	wúɽu	'spear handle (generic)'
LH:	malá:n	'right hand'	wuɽú:	'river, snake species'

Although stress is generally initial in even-length words, an underlying long vowel on an even-numbered syllable can force an iambic rather than trochaic foot. In the examples in (3), the words with only short vowels have initial stress, while the words with a final long vowel have final stress. More discussion of these words can be found in section 3.1.1.

1.2.2 Odd-length words

Unlike even-length words, which either contain all short vowels or have faithfully realized underlyingly long vowels, every odd-length word has at least one long vowel in it. (Dixon 1977: 41, 43) Specifically, all long vowels must be in one of the even-numbered syllables. If there is not an underlying long vowel in the penultimate syllable, vowel lengthening will apply.

(4) five syllables, two iambs [uX][uX]o

[bur.wá:].[li.ŋá:l].na [LH][LH]L

'jump-GOING-COMIT-PURP'

The stress pattern of the odd-length words is compatible with a trochaic analysis as in (5), but evidence for foot boundaries supports the hypothesis that odd-length words are iambic. More details on the various forms of evidence for foot boundaries, including vowel lengthening, can be found in the following section.

(5) *alternate analysis:*

five syllables, two trochees	o[Xu][Xu]
*bur.[wá:.li].[ŋá:l.na]	L[HL][HL]
'jump-GOING-COMIT-PURP'	

1.3 Evidence for foot type

There are four forms of evidence for foot type and foot boundaries in Yidiny that will be brought forth and assessed; the evidence reveals a trochaic analysis in even-length words and an iambic analysis in odd-length words. The primary piece of evidence, briefly mentioned in the previous section, is the fact that there is a regular process of lengthening stressed vowels *only* in odd-length words; this means that the odd-length words are iambic but not the even-length words. Chapter 5 deals extensively with vowel lengthening in trochaic languages, and argues that the kind of vowel lengthening in Yidiny is only found in iambs, not trochees. Another form of evidence comes from reduplication, where an entire foot is the target of reduplication; the foot is an iamb in odd-length words but a trochee in even-length words. Dixon (1977: 41-42) also has recordings of singing in Yidiny, where Dixon argues that the singer leaves out an entire foot ('disyllabic stress unit') while taking a breath; there too, the missing foot is a trochee in even-length words but an iamb in odd-length words. Finally, there is evidence that unparsed syllables can be deleted under certain phonological conditions; since Yidiny is a weakly dense language, the only unparsed syllables occur in odd-length words. If the unparsed syllable were deleted from the left edge of the word, it would mean a trochaic parse; however, since the unparsed syllable is deleted from the right edge, this also indicates an iambic parse for the odd-length words.

1.3.1 Vowel lengthening

Lengthening a stressed vowel means that feet are iambic (Gonzalez 2003, Hayes 1995; also see next chapter). Vowel lengthening occurs in every odd-length word that does not already contain a long vowel, assuring an uneven iamb for the main stress of the word. However, there is no such lengthening process in even-length words. Since even-length words are trochaic instead of iambic, they do not also undergo this lengthening process.

1.3.1.1 Length contrast and predictability

As described in the previous section, there is a length contrast in Yidiny. Certain morphemes do have underlying long vowels, which is the primary way to have a long vowel in an even-length word since there is no regular process of lengthening[1]. There are a number of affixes with underlying long vowels, which can appear in words with an even number of syllables. When underlying long vowels occur in even-length words, it is possible to have an iambic parse. The data from (3) above is repeated here to illustrate the length contrast in even-length words. Note that the words with underlying long vowels have an iambic parse rather than a trochaic one.

[1] Dixon (1977: 77-83) also describes a process of Pre-Yotic Lengthening, where a word final /y/ is deleted after [i], and the [i] is lengthened to compensate. This can also produce long vowels in even-length words, but it is not the same process as the regular penultimate lengthening in odd-length words.

(6) [LH]: [málan] 'flat rock' [wúɽu] 'spear handle (generic)'

[LH]: [malá:n] 'right hand' [wuɽú:] 'river, snake species'

According to Dixon (1977), there is an audible phonetic difference between underlying long vowels and those that have been lengthened. Underlying long vowels are noticeably longer than those that have been lengthened. This difference means that there is no doubt in terms of whether a vowel is underlyingly long or has been phonologically lengthened. While the only long vowels in even-length words are underlying, there are *predictable* long vowels in odd-length words. Specifically, every odd-length word has a long vowel in the penultimate syllable. However, it is still possible to have underlying long vowels in odd-length words. Consider the examples in (7), which show odd-length words with underlying long vowels as well as the predictable vowel lengthening in penultimate position.

(7) **underlying long vowel:** /burw**a:**liŋ**a**lna/ → [bur.w**á:**].[li.ŋ**á:**l].na

'jump-ASPECT-COMIT-PURP'

no underlying long vowel: /maḍindaŋ**a**lna/ → [ma.ḍín].[da.ŋ**á:**l].na

'walk up-COMIT-PURP'

1.3.1.2 Vowel lengthening and shortening

If there is no underlying long vowel in an odd-length word, then vowel lengthening applies to the penultimate vowel. It is clear that the vowel is not underlyingly long through examination of alternations as in (8). There are an odd number of syllables in the underlying form of 'dog' /gudaga/ and an even number of syllables in the underlying form of 'mother' /mudam/. The purposive affix [gu] changes the number of syllables for each, but it is always only the odd-length words that have long vowels. This illustrates that the length of the vowel is not coming from the affix nor the root.

(8) **ODD:**	/gudaga/ → [gu.dá:].ga	/mudam+gu/ → [mu.dá:m].gu
	'dog'	'mother-**PURPOSIVE**'
EVEN:	/gudaga+gu/ → [gú.da].[gá.gu]	/mudam/ → [mú.dam]
	'dog-**PURPOSIVE**'	'mother'

In fact, in every word with an odd number of syllables, the penultimate vowel is lengthened. (Dixon 1977: 41, 43) If there is an even-numbered syllable in the word which is already long, it is allowed to surface faithfully; however, there is no requirement that any vowel other than the main stressed penultimate vowel lengthens. As the data in (9) -- repeated from above -- shows, an underlying long vowel surfaces faithfully, but only the penultimate vowel is lengthened.

(9) **underlying long vowel:**	/burw**a:**liŋ**a**lna/ → [bur.w**a:**.li.ŋ**a:**l.na]
	'jump-ASPECT-COMIT-PURP'
no underlying long vowel:	/maḍindaŋ**a**lna/ → [ma.ḍin.da.ŋ**a:**l.na]
	'walk up-COMIT-PURP'

Because there are affixes with underlying length, it is possible to have an underlying long vowel in a spot that should be the weak position of a foot. When this happens, the vowel is shortened. (Dixon 1977: 74-76) For example, consider the antipassive suffix [:d̪in], which lengthens the preceding vowel. In an odd-length word like /barganda:d̪iŋa/ 'pass by-ANTIPASS-PURP', we expect penultimate lengthening to create a long vowel -- resulting in both the third and fourth vowel having long vowels. The result is that the underlying long vowel from the suffix is shortened, leaving the penultimate vowel as the sole long vowel in the word.

(10)	**underlying form**	**illicit long vowel**	**vowel shortening**
	/bargand**a:**ḍ**i**ŋa/	*[bar.gan].[d**a:**.ḍ**i:**].ŋa	[bar.gan].[d**a**.ḍ**i:**].ŋa
	'pass by-ANTIPASS-PURP'		

1.3.2 Singing

In a recording of a native Yidiny speaker singing, Dixon (1977: 41-42) observed that the singer always missed an entire foot ('disyllabic stress unit') when taking a breath. In an even-length word, a trochee was missing -- as in <búŋ.gu>; in an odd-length word, an iamb was missing -- as in <bu.gú:>. Since an entire foot is missing in each case, this supports this claim that even-length words are trochaic while odd-length words are iambic.

1.3.3 Reduplication

The domain of reduplication in Yidiny is a disyllabic foot (Dixon 1977: 86, 156-157, Hayes 1982, McCarthy and Prince 1996: 233). If, instead of targeting the entire foot, the template was a CVCV sequence, there would be no explanation for why the coda is included in the reduplicant in words like [ŋá.lal] → [ŋá.lal].[ŋá.lal] 'lots of big (ones)'; if the template was a CVCVC sequence, there would be similarly no explanation for why the coda is *not* included in words like [mu.lá].ri → [mu.lá].[mu.lá].ri 'initiated men.'

(11)

	root		reduplicated form		copied
even-length	[bú.ɲa]	‘woman’	[bú.ɲa].[bú.ɲa]	‘women’	CVCV
	[ŋá.lal]	‘big’	[ŋá.lal].[ŋá.lal]	‘lots of big (ones)’	CVCVC
odd-length	[mu.lá].ri	‘initiated man’	[mu.lá].[mu.lá].ri	‘initiated men’	CVCV
	[gin.dál].ba	‘lizard’	[gin.dál].[gin.dál].ba	‘lizards’	CVCVC

Since the reduplicated material consists of a complete foot, it is easy to examine the disyllabic unit and note the headedness. In even-length words, the foot being targeted as the domain of reduplication has initial stress, revealing the feet in even-length words to be trochees. On the other hand, the foot being targeted in the odd-length words has stress on the final syllable, revealing these feet to be iambs.

If the odd-length words were right-aligned trochees instead of left-aligned iambs, the footing would be as shown in the table below. As a result of this footing, the reduplication would then be something like the forms shown in the rightmost column below.

(12)

	root with trochees only		incorrect reduplicated form	
odd-length	*mu.[lá.ri]	‘initiated man’	*mu.[lá.ri].[lá.ri]	‘initiated men’
	*gin.[dál.ba]	‘lizard’	*gin.[dál.ba].[dál.ba]	‘lizards’

1.3.4 Vowel deletion

About 85% of Yidiny words can be evenly parsed into feet, without extra unparsed syllables. (Dixon 1977: 40) One reason for this fact is that most affixes have two instantiations, adding an odd number of syllables to odd-length stems and an even number of syllables (including zero, such as adding a coda to a vowel-final stem) to even-length stems -- yielding an even number of syllables in either case. (Dixon 1977: 40-41, 44-68) Yidiny consists of about 1300 nominals; about 91 of these are trisyllables that meet the phonological conditions to delete the final vowel, improving their performance on PARSESYLL. (Dixon 1977: 56)

1.3.4.1 Generalization from Hayes

Hayes (1997) observes a pattern missed in the original Dixon (1977) analysis of the vowel deletion. Following Dixon, Hayes notes that this deletion only applies to vowel-final trisyllables where the final consonant of the word is a possible coda in Yidiny. Hayes's contribution is the observation that there is a strong tendency to delete the final vowel only when it is recoverable from the truncated stem. Specifically, the generalization is provided in (13).

(13) Deletion of the final vowel occurs if:

a. final vowel is identical to penultimate vowel

b. final consonant is nasal and final vowel is [u]

Predictability of the final vowel comes from the two sources listed above. In Dixon's complete list of trisyllables that delete the final vowel, 24 of the 25 which end in a nasal have [u] as the final vowel. Of the 66 deleting trisyllables that do not end in a nasal, 50 have the same vowel for both the second and third vowels. An additional 6 trisyllables alternate between a vowel that matches the penultimate vowel and one that doesn't; 3 have an unspecified final vowel that changes to match whatever vowel follows in a suffix. Only 7 of the 66 deleting trisyllables that end in a non-nasal have a mismatch between the deleted vowel and the penultimate vowel.

According to Dixon, there are an additional 35 trisyllables that end in a CV sequence where the C is a possible coda, but deletion does not occur. Only 20 of these trisyllables are listed in Dixon's glossary, but a much smaller percentage of these trisyllables fit the pattern described above; that is, in *most* of the trisyllables that do not delete the final vowel, that vowel is not predictable from (13). Only 7 of the non-deleters are predictable, while 13 would not be predictable.

1.3.4.2 Deletion not insertion

The motivation for this truncation, when the phonological restrictions on codas and predictability of the deleted vowel allow it, is to produce a disyllabic word without a stray unparsed syllable. Because only odd-length words have an unparsed syllable, this process only occurs in trisyllables (and pentasyllables, which Dixon mentions although no examples are provided). Yidiny's preference for words with an even-number of syllables makes sense in terms of PARSESYLL, since it yields words that can be exhaustively parsed into feet. Since it is the final syllable that deletes in odd-length words, this indicates that it is the final vowel that is unparsed. If the final vowel is unparsed, then this means that the word must be parsed into iambic feet. As (14) shows, a trochaic parse would mean that the unparsed syllable is initial rather than final, and there is no explanation for why deleting the final syllable would improve on PARSESYLL.

In fact, given the resulting stress pattern, a trochaic parse would mean that the truncated form has both an unparsed syllable *and* a unary foot, while the iambic parse yields two perfect feet.

(14) *Iambic feet:* *Trochaic feet:*

[uX]-[uX]-o → [uX]-[uX] <o> o-[Xu]-[Xu] → o-[Xu]-[X] <o>

Counting the deleting trisyllables that alternate between predictability and mismatch and those where the final vowel is unspecified as *not* obeying the pattern, 87 of the 111 listed trisyllables *do* obey the pattern laid out in (13) -- 78% compliance with the phonological generalization.

Hayes (1997) actually argues that this process is insertion of a predictable vowel rather than deletion; however, if this were the case, the deleting trisyllables (which would actually be inserting disyllables) would need to be compared with other *disyllables* -- not the trisyllables. There are 215 disyllabic nominals of the appropriate form in Dixon's glossary; if it were not a recoverable vowel being deleted, but rather a predictable pattern of insertion, there is no reason why the insertion could not apply to any of these non-inserting disyllables. If we consider this to be an insertion process rather than a deletion one, then there is only 24% compliance with the pattern. While Dixon provides every example of a deleting trisyllables, there are far more disyllables that are not listed; with a more complete list of two-syllable nominals, the percentage would drop still lower without any chance of increasing.

1.4 OT analysis

No special mechanism is required to account for Yidiny. Using basic constraints that are necessary elsewhere for prosodic theory, the footing and subsequent stress pattern of

Yidiny are contained within the basic typology. The analysis provided here is an abstraction of the system, ignoring segmental processes like deletion. The stress pattern of Yidiny, including the switching of foot type, is captured by this analysis. Additional constraints would be required to analyze vowel deletion, such as MAX, DEP, and constraints which refer to vowel features.

Using only the six constraints from System Zero plus an alignment constraint, the basic stress pattern of Yidiny can be accounted for. There are six constraints in System Zero: two foot type constraints (IAMB and TROCHEE), two foot parsing constraints (PARSESYLL and FTBIN), and two rhythm constraints (*LAPSE and *CLASH). These constraints are defined in (15).

(15) *Constraint definitions*

(a) IAMB (P&S 1993)

For each foot that is not right-headed, assess one violation.

*[Xu]

(b) TROCHEE (FOOT-NONFINAL) (P&S 1993, Tesar 2000)

For each foot that is right-headed, assess one violation.

*[uX], [X]

(c) PARSESYLL (P&S 1993)

For each syllable that is not parsed into a foot, assess one violation.

*-o-

(d) FTBIN (P&S 1993)

For each unary foot, assess one violation.

*[X]

(e) *LAPSE (Selkirk 1984, Kager 2001, Alber 2005)

For each sequence of two unstressed syllables, assess one violation.

*-o-o-, -o-[u, u]-o-, u]-[u

(f) *CLASH (Liberman & Prince 1977, Alber 2005)

For each sequence of two stressed syllables, assess one violation.

*X]-[X

It should be noted that there is an asymmetry in the foot type constraints; TROCHEE penalizes unary feet, while IAMB does not. This asymmetry prevents the promotion of unary feet due to the satisfaction of both foot type constraints by the unary foot. Instead, IAMB penalizes only bisyllabic trochees, allowing bisyllabic iambs and unary feet, while TROCHEE allows only bisyllabic trochees, penalizing bisyllabic iambs and unary feet.

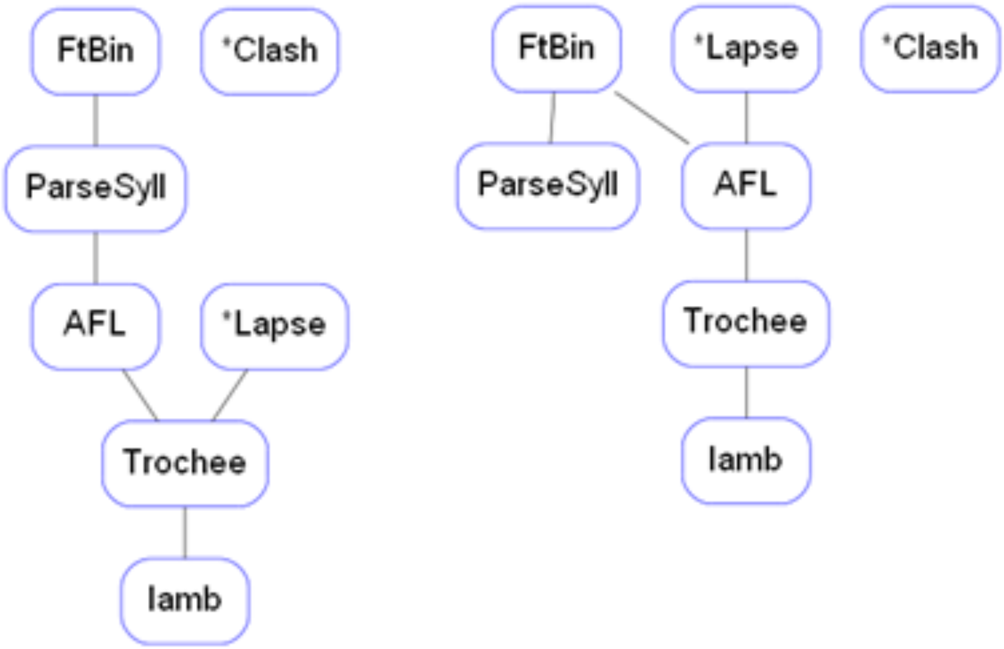
In addition to the six constraints described above, it is also necessary to have a left-aligning constraint. The details of the rankings depend on which alignment constraint is being used, so it is necessary to commit to a particular alignment constraint. For the purposes of providing a ranking, the constraint that will be used is ALL-FEET-LEFT (AFL), defined below.

(16) *All-Feet-Left (AFL)*

for each foot, assign one violation for every syllable that intervenes between that foot and the left edge of the word

The total rankings that are necessary for Yidiny stress are provided in (17). Note that there are two possible rankings, since either *LAPSE or PARSESYLL can be responsible for dominating AFL. Additionally, *Clash is not doing any work in terms of getting the foot structure and stress pattern of Yidiny.

(17) *Yidiny rankings*



The only difference between the diagram in (a) and the diagram in (b) is which constraint from the set of *Lapse and ParseSyll is dominating AFL. This is an irreducible disjunction, as shown in the skeletal basis (Brasoveanu and Prince 2005) below. Both the skeletal basis and its support (as schematized data) are provided here to illustrate the disjunction (calculated by the RUBOT component of OTWorkplace, Prince and Tesar 2007-2013), but all rankings are shown and discussed separately in the following pages.

(18) Grammar of Yidiny

a. Skeletal Basis

	*Clash	FtBin	*lapse	ParseSyll	AFL	Trochee	Iamb
ERC1∘ERC2		**W**		**L**	**L**		
ERC3			**W**	**W**	**L**		
ERC4			**W**			**L**	
ERC5					**W**	**L**	
ERC6						**W**	**L**

b. Support

	Input	Winner	Loser	*Clash	FtBin	*Lapse	ParseSyll	AFL	Trochee	Iamb
ERC1	/ooo/	{[uX]-o}	{[Xu]-[X]}		**W**		**L**	**W**		*W*
ERC2	/oooo/	{[Xu]-[Xu]}	{[X]-[uX]-o}		**W**		**W**	**L**	*W*	*L*
ERC1∘ERC2					**W**		**L**	**L**	*W*	*L*
ERC3	/oooo/	{[Xu]-[Xu]}	{o-o-o-o}			**W**	**W**	**L**		*L*
ERC4	/ooo/	{[uX]-o}	{[Xu]-o}			**W**			**L**	*W*
ERC5	/ooo/	{[uX]-o}	{o-[Xu]}					**W**	**L**	*W*
ERC6	/oo/	{[Xu]}	{[uX]}						**W**	**L**

ERC3 in the skeletal basis has two W's (ParseSyll and *Lapse), as the shaded cells in (a) point out. This is the source of the disjunction in Yidiny, since these two constraints cannot be ranked with respect to each other and either could be responsible for dominating AFL.

The generalization about switch languages, explained in more detail in Chapter 3, is that a switch language emerges when an alignment constraint, a rhythm constraint, and an anti-unary-foot constraint outrank the foot type constraints. As the above lattices show, these conditions are met in the Yidiny rankings. The alignment constraint is AFL, the rhythm constraint is *LAPSE, and the anti-unary-foot constraint is FTBIN. All three of these constraints dominate the highest ranked foot type constraint, which is TROCHEE for Yidiny.

Although TROCHEE is dominated by these three constraint types in order to produce switching, when none of the higher ranked constraints forces a particular foot type, Yidiny generally prefers to have trochees instead of iambs. In the two-syllable word, either parse would do equally well in terms of rhythm or alignment; the only difference between the winner and loser is that the winner has a single trochee while the loser has a single iamb. This comparison shows that the highest ranked foot type constraint is TROCHEE.

(19) TROCHEE >> IAMB

Input	Winner	Loser	FtBin	*Lapse	*Clash	ParseSyll	AFL	**Trochee**	**Iamb**
/waɽil/	{(wá.ɽil)}	{(wa.ɽíl)}	e	e	e	e	e	**W**	**L**

In order to force switching foot type in order to improve on alignment, AFL must dominate TROCHEE. (20) shows that AFL must dominate the foot form constraint TROCHEE. The winner has an iamb instead of a trochee, but the foot is aligned perfectly at the left edge; the loser satisfies trochee, but at the expense of left alignment.

(20) AFL >> TROCHEE

Input	Winner	Loser	FtBin	*Lapse	*Clash	ParseSyll	**AFL**	**Trochee**	*Iamb*
/gudaga/	{(gu.dá:).ga}	{gu.(dá.ga)}	e	e	e	e	**W**	**L**	*W*

IAMB also contributes a W to the ERC above; however, fusing the comparisons (Brasoveanu and Prince 2005, 2011) from (19) and (20) shows that AFL must be responsible for dominating TROCHEE.

(21) Fusion of (19) and (20)

Input	FtBin	*Lapse	*Clash	ParseSyll	**AFL**	**Trochee**	**Iamb**
(20)	e	e	e	e	**W**	**L**	**W**
(19)	e	e	e	e	e	**W**	**L**
(19)◦(20)	e	e	e	e	**W**	**L**	**L**

*LAPSE must also dominate TROCHEE in order to get switching of foot form. If, instead of switching foot type, there was simply a trochee at the left edge of the word, there would be an additional violation of *LAPSE. (22) illustrates this point; the winner has no lapse but violates TROCHEE, while the loser has only a trochee but produces a lapse.

(22) *LAPSE >> TROCHEE

Input	Winner	Loser	FtBin	***Lapse**	*Clash	ParseSyll	AFL	**Trochee**	*Iamb*
/gudaga/	{(gu.dá:).ga}	{(gú.<u>da).ga</u>}	e	**W**	e	e	e	**L**	*W*

Again, IAMB also contributes a W to the ERC, but fusion will again reveal that this W is superfluous since TROCHEE must dominate IAMB.

As described above, the third constraint that must dominate the top-ranked foot type constraint is FTBIN. As the Hasse diagrams in (17) show, FtBin dominates TROCHEE through transitivity; FTBIN dominates AFL, which dominates TROCHEE. In (23)a, the winner lacks a unary foot while the loser improves on left alignment (through hyperalignment). (23)b shows that Yidiny is weakly dense rather than strongly dense. Note that the difference between the winner and the loser is that the winner has an unparsed syllable while the loser has a unary foot.

(23) FtBin >> AFL, ParseSyll

Input	Winner	Loser	**FtBin**	*Lapse	*Clash	**ParseSyll**	**AFL**	*Trochee*	*Iamb*
(a) /gudagani/	{(gú.da).(gá.ni)}	{(gú).(da.gá).ni}	**W**	e	e	**W**	**L**	*W*	*L*
(b) /gudaga/	{(gu.dá:).ga}	{(gú).(da.gá)}	**W**	e	e	**L**	**W**	e	*W*
(a)◦(b)			**W**	e	e	**L**	**L**	*W*	*L*

In both of these ERCs, FtBin does not contribute the only W; however, fusing these two comparisons shows that FtBin is the only possible dominator for both ParseSyll and AFL. The lingering additional W from Trochee can be shown to be superfluous by additional fusion with (20), which shows that AFL must dominate Trochee and is therefore unavailable to dominate AFL and ParseSyll.

Accounting for the difference between the two versions of the Hasse diagram, the tableau in (24) indicates that *either* *Lapse or ParseSyll must dominate AFL; this is the one true disjunction in the grammar. There are two W's in the comparative tableau, showing that either constraint could be responsible for dominating the L contributed by AFL. The winner has neither a lapse nor any unparsed syllables, with all syllables evenly parsed into feet; the loser features a sequence of two unparsed syllables, producing two violations of ParseSyll, and a sequence of three unstressed syllables, producing two violations of *Lapse.

(24) *Lapse *or* ParseSyll >> AFL

Input	Winner	Loser	FtBin	***Lapse**	*Clash	**ParseSyll**	**AFL**	Trochee	*Iamb*
/gudagani/	{(gú.da).(gá.ni)}	{(gú.da).ga.ni}	e	**W**	e	**W**	**L**	e	*L*

2 Wargamay

Wargamay is an Australian language from Queensland, in the same language family as Yidiny. All data and generalizations on Wargamay phonology in this section come from Dixon (1981).

2.1 Stress pattern of Wargamay

Wargamay is a quantity sensitive language, preserving the length of underlying long vowels in initial position. In the quantity insensitive sublanguage of Wargamay, the observed stress pattern is the same as the stress pattern of Yidiny. In words with an even number of syllables, stress falls on the initial syllable and every odd-numbered syllable afterwards; in words with an odd number of syllables, stress falls on the peninitial syllable (which undergoes vowel lengthening, Dixon 1981: 20-21) and every even-numbered syllable afterwards.

(25) Even-length words, stress on odd-numbered syllables (Dixon 1981: 20)

a. **bá**.da ‘dog’

b. **gí**.d̪a.**wù**.lu ‘freshwater jewfish’

c. **mú**.ŋan ‘mountain-ABS’

(26) Odd-length words, stress on even-numbered syllables, peninitial vowel lengthened (Dixon 1981: 20-21)

a. ga.**gá·**.ra 'dilly bag'

b. d̪u.**ɽá·**.gay.**mì**.ri 'Niagara Vale-FROM'

c. mu.**ŋá·n**.da 'mountain-LOC'

The exception to this pattern is when there is an underlying long vowel in initial position, in which case the first syllable is always stressed.

(27) Long vowel on first syllable

a. **mú:**.ba 'stone fish'

b. **gí:**.ba.ɽa 'fig tree'

Like Yidiny, Wargamay (Dixon 1981) is both iambic and trochaic. In even-length words, feet are trochaic, while feet are iambic in odd-length words. Even-length words are filled completely with trochees, resulting in initial primary stress; odd-length words leave the final syllable unparsed, resulting in primary stress on the second syllable. In both lengths of words, secondary stresses are on every other syllable following the primary stress.

(28) Even-length words, trochaic feet

a. (bá.da) 'dog'

b. (gí.d̪a).(wù.lu) 'freshwater jewfish'

c. (mú.ŋan) 'mountain-ABS'

(29) Odd-length words, iambic feet

a. (ga.gá·).ra 'dilly bag'

b. (d̪u.ɽá·).(gay.mì).ri 'Niagara Vale-FROM'

c. (mu.ŋá·n).da 'mountain-LOC'

The above pattern holds for the quantity insensitive sublanguage of Wargamay, in all words with no underlying long vowels.

Vowel length is contrastive in Wargamay, but underlying long vowels are only preserved in initial position.

(30) Contrastive vowel length

a.	ŋana	'1pl pronoun, SA form'	ŋa:na	'interrogative pronoun, 0 form'
b.	badi-	'to hook a fish'	ba:di-	'to cry, weep'
c.	giba	'liver'	gi:ba-	'to scratch'
d.	d̪ura	'cloud, sky'	d̪u:ra-	'to rub'
e.	d̪ulu	'buttocks'	d̪u:lu	'black'
f.	nuba	'bark bag'	nu:ba-	'to sharpen'
g.	ganda-	'to burn, cook'	ga:nda-	'to crawl'

If the first syllable of a word has an underlying long vowel, primary stress is on the first syllable regardless of word length.

(31) Long vowel on first syllable

a. mú:.ba ‘stone fish’

b. gí:.ba.ɽa ‘fig tree’

Separately from the underlying long vowels, Wargamay also lengthens the primary stressed vowel in certain circumstances. All monosyllabic words in Wargamay contain a long vowel; although Dixon does not give any examples of alternations, the implication is that an underlyingly short vowel would be lengthened in a monosyllabic word. Underlyingly short vowels which are lengthened on the surface are distinguishable from underlyingly long vowels which preserve their length. Underlying length ‘has stronger and more consistent quantitative realisation.’ (Dixon 1981)

The primary stress vowel is also lengthened whenever the word is parsed with iambic feet. This means that the second vowel is lengthened in every word with an odd number of syllables and no underlying long vowels. These lengthened vowels are not as long as the underlyingly long vowels, and are marked as V· instead of V:. In the example below, both words share the root for ‘mountain’ /muŋan/. The second word has an affix which yields an odd-length word instead of an even-length word. Since the odd-length word is iambic rather than trochaic, the stressed vowel is lengthened.

(32) Vowel lengthening in iambic words

a. (mú.ŋan) ‘mountain-ABS’

b. (mu.ŋá·n).da ‘mountain-LOC’

2.2 OT analysis

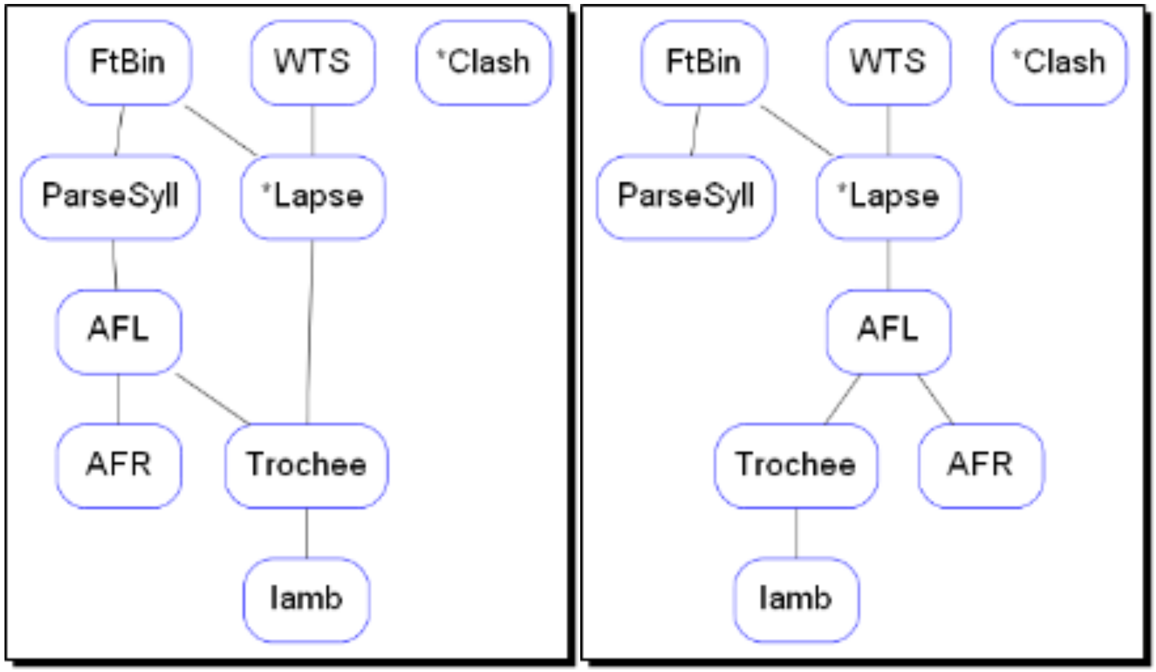
No new or special constraints are needed for an OT analysis of Wargamay. As in Yidiny, this pattern of switching foot type between iambs and trochees based on word length is an expected result from the interaction basic prosodic constraints. This analysis uses the six constraints from System Zero (IAMB, TROCHEE, PARSESYLL, FTBIN, *LAPSE, *CLASH) plus two alignment constraints (AFL and AFR). Since Wargamay is quantity sensitive, the Weight-to-Stress Principle (WSP; Prince 1990) is also needed to yield the observed results. To distinguish between the principle and the constraint based on it, the concept is referred to throughout as WSP (Weight-to-Stress Principle) and the constraint as WTS (Weight-to-Stress). More on the WSP can be found in the following chapter.

(33) WTS

assign one violation for every unstressed heavy syllable

The total ranking for Wargamay is provided in (34). There are two possibilities, since either *LAPSE or PARSESYLL can be responsible for dominating AFL.

(34) Rankings for Wargamay



Because there is no way to determine whether *LAPSE or PARSESYLL dominates AFL, there is an irreducible disjunction in the ranking for Wargamay. The entire skeletal basis for Wargamay and its support (with schematized data) is provided in (35). (Calculated by the RUBOT component of OTWorkplace.)

(35) Grammar of Wargamay

a. Skeletal Basis

	FtBin	*Clash	WTS	ParseSyll	*Lapse	AFL	Trochee	AFR	Iamb
ERC1	**W**			**L**	**L**				
ERC2			**W**		**L**				
ERC3				**W**	**W**	**L**			
ERC4					**W**		**L**		
ERC5						**W**	**L**	**L**	
ERC6							**W**		**L**

b. Support

	Input	Winner	Loser	FtBin	*Clash	WTS	ParseSyll	*Lapse	AFL	Trochee	AFR	Iamb
ERC1	/o:oo/	{[Xu]-o}	{[Xu]-[X]}	**W**			**L**	**L**	*W*	*W*		
ERC2	/o:oo/	{[Xu]-o}	{[uX]-o}			**W**		**L**		*W*		*L*
ERC3	/oooo/	{[Xu]-[Xu]}	{o-o-o-o}				**W**	**W**	**L**		*L*	*L*
ERC4	/ooo/	{[uX]-o}	{[Xu]-o}					**W**		**L**		*W*
ERC5	/ooo/	{[uX]-o}	{o-[Xu]}						**W**	**L**	**L**	*W*
ERC6	/oo/	{[Xu]}	{[uX]}							**W**		**L**

The shaded cells in (a) from ERC3 show the source of the disjunction; in the skeletal basis, there are two W's (from PARSESYLL and *LAPSE) that could each be responsible for dominating the L. The support from (b) is separated out and shown in detail below.

To induce a switch language, an anti-unary foot constraint, a rhythm constraint, and an alignment constraint must outrank the foot form constraints. In Wargamay, these constraints are FTBIN, *LAPSE, and AFL. As shown in (36), TROCHEE outranks IAMB in Wargamay, so FTBIN, *LAPSE, and AFL all must dominate TROCHEE.

(36) TROCHEE >> IAMB

Input	Winner	Loser	FtBin	WTS	ParseSyll	Lapse	AFL	**Trochee**	AFR	**Iamb**
/bada/	{(bá.da)}	{(ba.dá)}	e	e	e	e	e	**W**	e	**L**

Feet are left-aligned in Wargamay, so AFL outranks AFR as well as TROCHEE.

(37) AFL >> TROCHEE, AFR

Input	Winner	Loser	FtBin	WTS	ParseSyll	*Lapse	**AFL**	**Trochee**	**AFR**	Iamb
/gagara/	{(ga.gá).ra}	{ga.(gá.ra)}	e	e	e	e	**W**	**L**	**L**	*W*

In the comparative tableau above, Iamb also contributes a W to the ERC. In a vacuum, IAMB could also be responsible for dominating TROCHEE and AFR; however, the comparison in (36) shows that TROCHEE must dominate IAMB. Fusing the comparisons in (36) and (37) eliminates the disjunction, proving that AFL must dominate TROCHEE and AFR.

(38) Fusion of (36) and (37)

	FtBin	WTS	ParseSyll	*Lapse	**AFL**	**Trochee**	**AFR**	**Iamb**
(37)	e	e	e	e	**W**	**L**	**L**	**W**
(36)	e	e	e	e	e	**W**	e	**L**
(36)◦(37)	e	e	e	e	**W**	**L**	**L**	**L**

Because AFL dominates TROCHEE, Wargamay switches to iambs rather than being imperfectly aligned at the left edge of the word. A parse where the foot is left-aligned but remains trochaic is ruled out because *LAPSE also dominates TROCHEE, as shown below.

(39) *LAPSE >> TROCHEE

Input	Winner	Loser	FtBin	WTS	ParseSyll	***Lapse**	AFL	**Trochee**	AFR	Iamb
/gagara/	{(ga.gá).ra}	{(gá.ga).ra}	e	e	e	**W**	e	**L**	e	*W*

The final element for a switch language is for the anti-unary foot constraint FTBIN to outrank TROCHEE. There is no direct ranking between FTBIN and TROCHEE, as shown in (40), since AFL could also be responsible for ruling out the strongly dense parse.

(40) FTBIN *or* AFL >> TROCHEE

Input	Winner	Loser	**FtBin**	WTS	ParseSyll	*Lapse	**AFL**	**Trochee**	AFR	Iamb
/d̥uɽagaymiri/	{(d̥u.ɽá).(gay.mì).ri}	{(d̥ú ɽa).(gày.mi).(rì)}	**W**	e	e	e	**W**	**L**	e	*W*

The comparison in (40) adds nothing to the rankings already established; however, the necessary relationship between FTBIN and TROCHEE for a switch language can be reached through transitivity. (41) shows that FTBIN outranks *LAPSE, which -- as shown in (39) -- outranks TROCHEE. In addition to dominating *LAPSE, FTBIN also dominates PARSESYLL, preventing a winner where the final syllable is unparsed without being adjacent to a stressed syllable.

In the comparison below, the input contains a long vowel that is faithfully realized in the output. It is only in initial position that an underlying long vowel emerges faithfully, so positional faithfulness must be at play here. For more on this, see section 3; the immediate relevance of this fact is the effect this input has on rankings. When the initial vowel is long underlyingly, the first syllable is stressed regardless of word length. For the input in (11) and (12), the winner has initial stress rather than the peninitial stress usually observed in words of three syllables.

(41) FTBIN >> *LAPSE, PARSESYLL

Input	Winner	Loser	**FtBin**	WTS	**ParseSyll**	***Lapse**	AFL	Trochee	AFR	Iamb
/gi:baɽa/	{(gí:.ba).ɽa}	{(gí:.ba).(ɽà)}	**W**	e	**L**	**L**	*W*	*W*	e	e

To eliminate the lapse from the winner above without violating FTBIN would require stressing the peninitial vowel instead of the initial vowel; this is what happens generally in Wargamay, but in this case stressing the peninitial syllable would result in an unstressed long vowel, violating WTS as shown in (42). While TROCHEE also favors the winner in this comparison, *LAPSE crucially dominates TROCHEE in Wargamay, as shown in (39). Because WTS rules out the possibility of stressing the peninitial vowel, the rankings in (41) and (42) result in an optimal form with initial stress and a final lapse.

(42) WTS >> *LAPSE

Input	Winner	Loser	FtBin	**WTS**	ParseSyll	***Lapse**	AFL	Trochee	AFR	Iamb
/gi:baɽa/	{(gí:.ba).ɽa}	{(gi:.bá).ɽa}	e	**W**	e	**L**	e	*W*	e	L

Either PARSESYLL or *LAPSE must also dominate AFL in order to force additional feet to be formed. While AFL is content with a single foot at the left edge of the word, PARSESYLL and *LAPSE require additional feet in order to minimize the number of unparsed syllables and lapses.

(43) *LAPSE *or* PARSESYLL >> AFL

Input	Winner	Loser	FtBin	WTS	**ParseSyll**	***Lapse**	**AFL**	Trochee	AFR	Iamb
/gid̪awulu/	{(gí.da).(wù.lu)}	{(gí.da).wu.lu}	e	e	**W**	**W**	**L**	e	e	L

While iambic feet would reduce the number of *Lapse violations, (44) shows that the iambic parse will not win. In a word with an even number of syllables, there is no benefit to switching to an iambic parse.

(44) Iambic parses in even-length words

Input	Winner	Loser	FtBin	WTS	**ParseSyll**	***Lapse**	**AFL**	**Trochee**	AFR	**Iamb**
/gid̪awulu/	{(gí.d̪a).(wù.lu)}	{(gi.d̪á).wu.lu}	e	e	**W**	**W**	**L**	e	e	**L**
/gid̪awulu/	{(gí.d̪a).(wù.lu)}	{(gi.d̪á).(wu.lú)}	e	e	e	e	e	**W**	e	**L**

*Clash is unranked in Wargamay, because there are no comparisons that can be made on the basis of a stress clash. A clash can either arise from having a unary foot before a trochee [**X**]-[**X**u], a unary foot after an iamb [u**X**]-[**X**], or an iamb followed by a trochee [u**X**]-[**X**u]. The two cases which involve a unary foot are uninformative about *Clash since FtBin is undominated in Wargamay. It is never possible to make a comparison where *Clash crucially outranks some other constraint, because FtBin must already dominate that constraint.

(45) FtBin covers all cases that could be decided by *Clash

Input	Winner	Loser	***Clash**	**FtBin**	WTS	ParseSyll	*Lapse	AFL	Trochee	AFR	Iamb
/gagara/	{(ga.gá).ra}	{(ga.gá).(rà)}	**W**	**W**	e	L	e	W	W	e	e
/gagara/	{(ga.gá).ra}	{(gá).(gà.ra)}	**W**	**W**	e	L	e	W	e	W	W
/gi:baɽa/	{(gí:.ba).ɽa}	{(gi:.bá).(ɽà)}	**W**	**W**	W	L	L	W	W	e	L
/gi:baɽa/	{(gí:.ba).ɽa}	{(gí:).(bà.ɽa)}	**W**	**W**	e	L	L	W	W	W	e

Candidates with an iamb followed by a trochee to create a clash are harmonically bounded, so they are also not informative in terms of ranking *Clash. The only motivation for combining iambs and trochees in a single language is to improve upon rhythm constraints -- so mixed foot type candidates that violate a rhythm constraint are not possible without adding additional constraints.

2.3 Positional faithfulness

In Wargamay, underlying long vowels emerge faithfully only in initial position. Selected data from section 1 on contrastive vowel length is repeated here.

(46) Contrastive vowel length

a.	ŋana	'1pl pronoun, SA form'	ŋa:na	'interrogative pronoun, 0 form'
b.	badi-	'to hook a fish'	ba:di-	'to cry, weep'

When the first syllable has an underlying long vowel, that syllable always receives primary stress. It does not matter if the word has an odd or even number of syllables in this case, because the faithfulness to vowel length in initial position prevails over other pressures.

(47) Long vowel on first syllable

a.	mú:.ba	'stone fish'
b.	gí:.ba.ɽa	'fig tree'

If there are long underlying vowels elsewhere, they do not emerge faithfully. In order to account for long underlying vowels in initial position only, a positional faithfulness constraint (Beckman 1998) will be added to the constraints from section 2.

(48) Positional faithfulness constraint

a. IDENT-INITIAL-LENGTH[2]

assign one violation if the length of the initial vowel in the input does not match its length in the output

This constraint protects an underlying long vowel in initial position, as in /gi:baɽa/, but not a hypothetical long vowel in another position, such as /gibaɽa:/. IDENT-INITIAL-LENGTH does not distinguish any of the competing pairs used to establish the ranking in section 2.2.

As (48) shows, IDENT-INITIAL-LENGTH must outrank *LAPSE in order to prevent shortening the initial vowel and producing the usual form of the three-syllable word in Wargamay. This is different from the comparison in (42), which shows that WTS must dominate *LAPSE, because in the following comparison the initial long vowel is shortened rather than being an unstressed heavy syllable (like the loser in (42)).

(49) IDENT-INITIAL-LENGTH >> *LAPSE

Input	Winner	Loser	**Ident-IL**	FtBin	WTS	ParseSyll	***Lapse**	AFL	Trochee	AFR	Iamb
/gi:baɽa/	{(gí:.<u>ba).ɽa</u>}	{(gi.bá:).ɽa}	**W**	e	e	e	**L**	e	*W*	e	L

[2] Morén (1999) argues that faithfulness to length is more accurately described with a set of MAX and DEP constraints which prevent the deletion or insertion of moras, rather than an IDENT constraint. I do not commit to one interpretation over the other; this constraint can equally be considered to be standing in for the set of MAX and DEP constraints that would collectively penalize changing the vowel length from the input to the output.

However, IDENT-INITIAL-LENGTH does not protect long vowels in other positions. If an input had an underlying long vowel in another position, IDENT-INITIAL-LENGTH does not prevent it from shortening and resulting in the typical three-syllable word for Wargamay.

(50) Non-initial underlying long vowels not maintained

Input	Winner	Loser	Ident-IL	FtBin	**WTS**	ParseSyll	***Lapse**	**AFL**	Trochee	AFR	Iamb
/gibaɽa:/	{(gi.bá:).ɽa}	{gi.(ba.ɽá:)}	e	e	e	e	**W**	**W**	e	L	e
/gibaɽa:/	{(gi.bá:).ɽa}	{(gi.bá).ɽa:}	e	e	**W**	e	e	e	e	e	e

3 Previous analyses

A theme that has been repeated throughout this dissertation is the difficulty of distinguishing between a switch language and a uniform foot type language, due to the stress pattern being compatible with either analysis. Hayes's (1995: 140-142) analysis of Wargamay is an example of this, as he analyzes Wargamay as a right-aligned trochaic language.

Hayes's analysis of Wargamay does not deal with the vowel lengthening found only in odd-length words. On the other hand, Hyde's (2002) analysis of Yidiny and Wargamay explains why vowel lengthening only happens in odd-length words. In order to accomplish this, an additional theoretical apparatus is required; no such extra mechanism is needed if the stress pattern is a side effect of alignment constraints and rhythm constraints interacting, as in sections 1 and 2, as well as Alber (2005).

Hyde's (2002: 345-349) analysis of Yidiny and Wargamay relies on overlapping feet. All words are fully parsed into binary feet, but a single syllable may belong to more than one foot. Under his account, it is only odd-length words in Yidiny and Wargamay which require overlapping feet. The syllable which belongs to two feet undergoes vowel lengthening as a result of its ambipodal status.

The benefit of the analyses provided here, as opposed to an analysis of Yidiny and Wargamay where the foot type is not switching, is that no extra mechanism is required. The fact the feet switch between iambs and trochees based on word length is not a problem, but rather an expected effect with a straightforward explanation.

Chapter 5

Trochaic Vowel Lengthening

1 Trochaic Vowel Lengthening and the Iambic/Trochaic Law

The Iambic/Trochaic Law (ITL) is an observation on the differences between rhythmic groupings for right-headed and left-headed feet; specifically, that sequences with contrasting durations naturally group into right-headed feet and sequences with contrasting intensities (and without contrasting durations) naturally group into left-headed feet. The basis for the ITL is grounded in perceptual experiments (Bolton 1884, Woodrow 1909, Cooper and Meyer 1960; Vos 1977, Rice 1992, Hay and Diehl 2007), but the theoretical impact of this perceptual bias is open to more than one interpretation. Hyde (2011: 1054-1055) carefully separates two possible definitions of the ITL into a strong interpretation and a weak interpretation, clarifying the distinction between the two possibilities.

(1) Strong interpretation of ITL (Prince 1990)

a. If a foot contains a durational contrast, it is iambic

b. If a foot lacks a durational contrast, it is trochaic

The problem with the strong interpretation is that iambic languages with even feet do exist. Araucanian (Echevarria and Contreras 1965) is an example of an iambic language which allows (L'L), iambic feet with no durational contrast. Prince (1990), however, only uses the strong interpretation for quantity sensitive languages, and the ITL is treated as a preference rather than an inviolable condition.

(2) Weak interpretation of the ITL (Hayes 1985)

a. If parsing is sensitive to the position of heavy syllables, it is iambic

b. If parsing is insensitive to the position of heavy syllables, it is trochaic

The problem with the weak interpretation is languages like Osage (Altshuler 2009), which contain quantity-insensitive iambs, and Palestinian Arabic (Brame 1973, 1974; Kenstowicz and Abdul-Karim 1980, Kenstowicz 1983), which contain quantity-sensitive trochees.

(3) Mixed interpretation of the ITL (Hayes 1987, 1995; McCarthy and Prince 1996)

a. If a foot contains a durational contrast, it is iambic

b. If parsing is insensitive to the position of heavy syllables, it is trochaic

The mixed interpretation takes the first half of the strong interpretation and the second half of the weak interpretation, allowing even iambs like in Araucanian and quantity-sensitive trochees like in Palestinian Arabic to be accounted for. Quantity-insensitive iambic languages like Osage are still unaccounted for if the ITL is inviolable.

Hayes (1995: 81-85) expounds on the ITL to note that trochaic feet are expected to consist of units with equal duration, while iambic feet are expected to consist of a light syllable followed by a heavy one. Because of this difference, iambic languages have vowel lengthening in stressed syllables in order to create a durational contrast, while trochaic languages do not (Hayes 1995: 82-85). This distinction matches the prediction of the ITL: final prominence (as in iambs) correlates with a difference in length, while initial prominence (as in trochees) does not. Iambs tend to be uneven, with greater weight on the stressed member of the foot, while trochees tend to have even weight on both syllables. However, as mentioned above, the ITL is not absolute, and is better considered as a violable constraint rather than an inviolable restriction on Gen.

The important fact is that the ITL provides no motivation for trochaic languages to create uneven feet. Iambic languages do better in terms of the ITL if they undergo vowel lengthening on the stressed syllable, but not every iambic language (e.g. Araucanian) obeys this; however, there is no anti-Strong version of ITL that prefers trochaic feet with a durational contrast. While it is possible for an iambic language to lack lengthening or a trochaic language to lack shortening, there is no reason for iambic vowel shortening to eliminate a durational contrast or trochaic vowel lengthening to create one. Hayes's (1987, 1995) account means that lengthening should only happen to create durational contrast in iambs, shortening should only happen to eliminate durational contrast in trochees.

Iambic languages frequently have a regular process of lengthening stressed vowels, in order to produce uneven feet with greater prominence on the strong member of the foot (Hayes 1995: 82-83). Trochaic languages, on the other hand, do not have the same regular process of lengthening stressed vowels. (Hayes 1995: 84, 145-149) In fact, some trochaic languages exhibit vowel *shortening* under stress in order to produce even feet. Hayes (1995: 84) provides a list of many such languages; Hixkaryana, Potawatomi, Cayuga, and Pacific Yupik are examples of iambic languages with vowel lengthening, while Fijian, Hawaiian, and Latin are examples of trochaic languages with vowel shortening.

(4) Iambic lengthening in Hixkaryana (Derbyshire 1985)

a.	/tor**o**no/	[(to.r**ó:**).no]	'small bird'
b.	/nem**o**kot**o**no/	[(ne.m**ó:**).(ko.t**ó:**).no]	'it fell'
c.	/akmat**a**rɨ/	[(ák).(ma.t**á:**).rɨ]	'branch'

(5) Trochaic shortening in Fijian (Schütz 1978: 528)

a.	/mb**u:**+ ŋgu/	[(mb**ú**.ŋgu)]	'my grandmother'
b.	/t**a:**+y+a/	[(t**á**.ya)]	'chop-TRANS-3 SG OBJ'

(6) Trochaic shortening in Tongan (Churchward 1953: 10-11)

a.	/h**u:**+fi/	[hu.(**ú**.fi)]	'to open officially'
b.	/fakah**a:+**i/	[fa.ka.ha.(**á**.i)]	'to show'
c.	/p**o:**+ni/	[po.(**ó**.ni)]	'night'

Every stressed syllable is heavy in iambic Hixkaryana; if the stressed syllable is light and open, it undergoes vowel lengthening to create an uneven foot. Fijian and Tongan show two approaches to vowel shortening in a trochaic language. In Fijian, a long vowel is shortened by deleting a mora, while Tongan preserves both moras by dividing the vowel into two syllables. In both cases, the stressed vowel is shortened to avoid an uneven trochee.

This is not to say that it is impossible to have a process of vowel lengthening in a trochaic language; however, I will show that vowel lengthening in a trochaic language is never to increase contrast on the stressed syllable, and only occurs for one of the following two reasons[1]:

[1] This does not include cases where vowels are lengthened in a trochaic language for some morphological reason, such as Tongan (Churchward 1953, Feldman 1978) which uses lengthening to indicate a number of meanings, including the superlative.

(7) Reasons for Phonological Trochaic Lengthening

a. Lengthening to meet a minimal word or minimal foot requirement

b. General word or phrase final lengthening

There are a number of trochaic languages which exhibit phonological vowel lengthening. However, this lengthening can be described with one of the explanations in (7). Since these cases of vowel lengthening are not motivated by the creation a duration contrast within the foot, this conclusion is in line with the claims of the Iambic/Trochaic Law. It is argued here that examples of trochaic lengthening are not counterexamples to the generalizations of the ITL, but rather are motivated by independent principles.

The asymmetrical foot inventory used here is the same as Hayes (1995: 71). The iamb and moraic trochee are quantity sensitive, while the syllabic trochee is quantity insensitive.

(8) Foot inventory

a. Iamb

(L'X) *or* ('H)

light syllable followed by any stressed syllable *or* single stressed heavy syllable

→ feet are at least two moras, stress is final

b. Syllabic Trochee

('Xu)

any stressed syllable followed by any unstressed syllable

→ feet are two syllables, stress is initial

c. Moraic Trochee

('LL) *or* ('H)

stressed light syllable followed by unstressed light syllable *or* single stressed heavy syllable

→ feet are two moras, stress is initial

These foot definitions are the minimum required for a foot to be iambic or trochaic; there is nothing in these definitions that forces stressed vowels to be lengthened, although the moraic trochee definition does force vowel shortening. Iambic lengthening does not fall out of this definition, because it demands 'at least' two moras, meaning it will be satisfied by an (L'L) foot, and the final syllable in a bisyllabic iamb is not required to be heavy. On the other hand, moraic trochees prohibit vowel lengthening in a bisyllable, since the foot can maximally be bimoraic; if either of the syllables contains a long vowel, vowel shortening must occur. The syllabic trochee definition does not require vowel lengthening *or* vowel shortening. Because neither the iamb definition nor the syllabic trochee definition contain any reason for vowels to lengthen or shorten, there must be a separate principle that would require these changes; these definitions allow for iambic languages like Araucanian to lack vowel lengthening and trochaic languages like Anguthimri (Crowley 1981; section 3.2.2) to lack vowel shortening. Anguthimri is a trochaic language with phonemic vowel length, which is ignored by the foot parsing and is not subject to vowel shortening.

(9) Vowel contrast in Anguthimri

a. (pá:.na) 'level'

b. (pá.na) 'friend'

The foot inventory described in (8) aims to capture not just observed stress patterns, but also other converging pieces of evidence, like minimal word sizes and prosodic morphology templates. This inventory is in opposition to a symmetrical inventory that includes the uneven trochee ('HL), which would provide motivation for trochaic vowel lengthening (Jacobs 1990, 2000; Rice 1992; van der Hulst and Klamer 1996; Mellander 2001, 2002, 2003). Vowel lengthening to create ('HL) trochaic feet is motivated by the constraint HEADPROMINENCE in Mellander (2003: 248). This constraint assesses a violation whenever the head syllable of a foot is not more prominent than the weak member of the foot. In support of this claim, Mellander provides analyses of Mohawk, Selayarese, Icelandic, Chimalapa Zoque, and Chamorro; each of these languages are analyzed in sections 2 and 3 of this chapter, in a manner consistent with the claims in (7). The key contrast between the Mellander's approach and the analysis advocated here are elucidated in the discussion of Mohawk in section 3.1.

Prince (1990) proposes a harmonic scale which informs how feet are parsed. In parsing, the best foot is created from what is available according to a harmonic scale. This harmonic hierarchy divides feet according to their quantity (iambs preferring unevenness, trochees preferring evenness) and binarity.

(10) Harmonic Hierarchy of Feet

a. Iambs

LH > {LL, H} > L

b. Trochees

{LL, H} > HL > L

Under both foot types, a single light syllable is the least harmonic. I will be separating trochees into two types, following McCarthy and Prince (1996) and Hayes (1995): moraic trochees and syllabic trochees. Moraic trochee languages are perfectly satisfied by either an LL foot or an H foot, while syllabic trochees are only perfectly satisfied by a bisyllabic (LL) foot. These hierarchies make a three-way harmonic distinction which has been flattened to a binary distinction in the constraints found in (12).

(11) Harmonic Hierarchy of All Foot Types

a. Iambs

LH > {LL, H} > {L}

b. Syllabic Trochees

LL > HL > {H, L}

c. Moraic Trochees

{LL, H} > HL > {L}

Bisyllabic feet where the unstressed element is heavier than the stressed element are not included in either hierarchy; these are ruled out by Prince's (1990) Weight-to-Stress Principle (WSP). Hayes's (1987, 1995) claim that vowel lengthening only occurs to create a durational contrast in iambs is supported by the WSP. The WSP states that all heavy syllable are stressed, as well as the contraposition that all unstressed syllables are light. The WSP therefore rules out a (H'L) iamb or a ('LH) trochee. As in Prince (1990), there is a Weight-to-Stress Principle, but there is no corresponding Stress-to-Weight

Principle (SWP). Stressed syllables are not motivated to increase their heaviness; trochaic systems never lengthen stressed syllables to give increased weight, while iambic systems lengthen stressed syllables purely to improve on the harmonic hierarchy of feet and create unevenness.

These harmonic hierarchies partially inform the following Optimality Theoretic foot type constraints, which penalize any non-optimal foot.

(12) Foot Type Constraints

a. IAMB

F=μ'X *mora followed by stressed mora/syllable*

assign one violation for each foot that does not match the above template

(at least two moras, stress is final)

b. SYLLABICTROCHEE

F='σσ *stressed syllable followed by unstressed syllable*

assign one violation for each foot that does not match the above template

(two syllables, stress is initial)

c. MORAICTROCHEE

F='μμ *stressed mora followed by unstressed mora*

assign one violation for each foot that does not match the above template

(two moras, stress is initial)

Since the harmonic hierarchies in (11) are three-way distinctions and the foot type constraints above are binary, there is a layer of detail that is missing from the foot type constraints. Each of the constraints penalizes subminimal feet, as well as feet stressed on the wrong element. In order fully capture the above hierarchies, additional constraints would need to be added which are more stringent than these general ones. Specifically, these constraints would need to distinguish between even and uneven feet.

Alber (1997) and Kager (1993) each have a proposal that would allow for a more detailed distinction between the relative harmony of feet which meet the minimum requirements above. Alber (1997: 6-7) includes a constraint ITL, which is violated if elements of a trochaic foot are unequal or elements of an iambic foot do not contrast in quantity. ('LH), ('HL), (H'H), and (L'L) would all receive a violation from this constraint; Alber leaves open the question of whether or not this should all be a single constraint. Kager (1993) achieves a similar result through a foot-internal *LAPSE constraint.[2] The uneven trochees ('LH) and ('HL) each have a lapse at the moraic level: ('LH) → ('L[μμ]) and ('HL) → (['μμ]L). On the other hand, an uneven iamb has no lapse when stress is on the heavy syllable (L'H) →(L['μμ]) but not when the unstressed element is the heavy syllable (H'L) → ([μμ]'L). An even iamb as in Araucanian is also not ruled out, since there are no foot-internal lapses in (L'L). The best combination of constraints to accomplish this hierarchy remains an unanswered question; the typological predictions of these three systems would need to be examined and compared in order to begin to answer this question.

The argument is broken into two parts: trochaic languages which lengthen generally in a final position and trochaic languages which lengthen to satisfy minimality

[2] Kager's (1993) foot-internal *LAPSE constraint is not an Optimality Theoretic constraint, but is easily converted into a constraint that is violated once for each foot-internal sequence of two unstressed moras.

restrictions. Hungarian is an example of a trochaic language with a general process of phrase-final lengthening. Minimality restrictions from the foot type constraints can enforce binarity at the foot level or at the word level; Mohawk is an example of a moraic trochee language where foot binarity compels lengthening.

2 Final Lengthening

Hockey and Fagyal's (1999) investigation of Hungarian, a trochaic language with a long/short vowel distinction, shows that there is consistent pre-boundary lengthening. Hungarian has initial primary stress, with secondary stress on every odd syllable.

(13) Hungarian Stress (Kerek 1971, Hayes 1995)

a. (ká.to).(lì.tsiz).(mùʃ) 'Catholicism'

b. (kɛ́.reʃ).(kɛ̀.de).(lɛ̀m) 'commerce'

Hockey and Fagyal's experiment (based on restricted spontaneous speech by native Hungarian speakers) showed that Hungarian had consistent preboundary lengthening, yielding significantly longer vowels in word-final position than in word-medial position. The difference in length between these phonetically lengthened and unlengthened vowels was even greater than the difference in length between the lexical long and short vowels.

Hungarian is not the only trochaic language with final vowel lengthening. In the Icelandic data below, it can be observed from the initial primary stress and secondary stresses on odd syllables that Icelandic is a trochaic language. In each word, the final vowel of the word is lengthened, regardless of whether or not it is stressed. In the odd-length words in (b) and (d), the final vowel is the stressed head of a degenerate foot; however, the lengthening also occurs in the even-length words in (a) and (c), where the final syllable is the weak member of a foot.

(14) Icelandic stress and vowel lengthening (Árnason 1985, Hayes 1995)

a.	/('σσ:)/	'taska:	‘briefcase’
b.	/('σσ)(ˌσ:)/	'höfðingˌja:	‘chieftain (gen. pl.)’
c.	/('σσ)(ˌσσ:)/	'akvaˌrella:	‘aquarelle’
d.	/('σσ)(ˌσσ)(ˌσ:)/	'bíóˌgrafíˌa:	‘biography’

These final long vowels only occur at the end of a phrase or in a word in isolation; when the word is phrase-medial, there is no long vowel.

3 Foot Minimality

Some trochaic languages exhibit a systematic phonological lengthening of stressed vowels, but I argue that this lengthening is not due to the vowel being stressed. Instead, these vowels are lengthening due to foot minimality requirements. Other factors, such as nonfinality, work together with foot minimality to require certain stressed vowels to lengthen. It is not the case that the vowels are lengthened *because* they are stressed. Mohawk (Michelson 1988) is an example of a trochaic language with vowel lengthening that may appear at first glance to simply apply to every stressed vowel. In the following section, a detailed look at Mohawk stress will reveal that *not* every stressed vowel is lengthened -- only those which must be lengthened in order to satisfy foot minimality requirements. A brief look at the patterns of stress and vowel lengthening in Badimaya, Anguthimri, Chamorro, Selayarese, and Chimalapa Zoque, will show that this analysis can be extended to other languages which similarly may appear to be trochaic languages where vowels are lengthened because they are stressed.

3.1 Mohawk

Mohawk (Michelson 1988) is a moraic trochee language (following Rawlins 2006) with vowel lengthening to ensure a minimal foot; it is not the case that every stressed syllable is lengthened. They are lengthened in a wide variety of cases, but crucially not *every* stressed syllable is lengthened; (15)a and (15)c show the type of feet where the stressed vowel is not lengthened. On this basis, I will argue that Mohawk is a moraic trochee language which does not require every stressed syllable to be heavy. Vowel lengthening occurs only when the foot would otherwise be a single light syllable. Closed syllables and open syllables with long vowels both count as heavy in Mohawk. On this view, there are three acceptable foot types in Mohawk:

(15) Feet in Mohawk

a. (C)V́C — *monosyllabic: heavy syllable with coda*

b. (C)V́: — *monosyllabic: heavy syllable with long vowel*

c. (C)V́.(C)V — *bisyllabic: two light syllables*

Generally, the penultimate syllable is stressed in Mohawk -- though epenthesis can shift the stress to the antepenult or the pre-antepenult. Mohawk has strong nonfinality, such that the final syllable of a word cannot be in the head foot, but main stress is aligned to the right edge of the word and gets as close as possible to the end. When the penultimate syllable is closed, the main stress can fall on that syllable by creating a (C)VC foot as in (15)a; when the penultimate syllable is open, the vowel lengthens to create a (C)V: foot for the main stress, as in (15)b.

The foot type in (15)c is only possible when the second syllable of the foot is light *and* headed by an epenthetic vowel. Since Mohawk avoids stressing an entirely epenthetic rime, stress appears on the previous syllable. If that previous syllable is also open, vowel lengthening is not needed -- the epenthetic syllable is perfectly acceptable as the weak member of the foot. Vowel lengthening does not simply apply to every stressed syllable; it only applies when there is no other way to make a minimal trochee without violating higher ranked constraints.

3.1.1 The problem

Mohawk is a trochaic language with vowel lengthening, but the analysis provided here will show that the cause for this lengthening is foot minimality rather than a regular process of vowel lengthening for stressed syllables. The analysis given here will be stratal, with slightly different phonotactic requirements at each of the two levels.

Most words in Mohawk have stress on the penultimate syllable, as shown below. When the penultimate syllable is closed, there is no vowel lengthening; however, open syllables lengthen the stressed vowel to create a bimoraic foot.

(16) Penultimate syllable is stressed

a. Penultimate syllable is closed **…CV'C.σ#**

i. /k-ohar-haʔ/ [ko.(hár).haʔ] 'I attach it'

ii. /wak-nyak-s/ [wa.(k**ʌ́**n).yaks] 'I get married'

iii. /s-k-ahkt-s/ [(skáh).k**e**ts] 'I got back'

b. Penultimate syllable is open **…CV:'.σ#**

i. /k-hyatu-s/ [(khyá:).tus] 'I write'

ii. /k-haratat-s/ [kha.(rá:).tats] 'I am lifting it up a little (with a lever)'

iii. /w-e-ʔs/ [(**í**:).weʔs] 'she, it is walking around'

Notice that the penultimate vowel is epenthetic in the second example under (16)a. However, since the resulting syllable is closed, it is able to bear the main stress. The final example under (16)b shows another stressed epenthetic vowel; in this case, the vowel has been epenthesized in order to make a minimal word. It is more important to keep stress off the final syllable than to avoid stressing an epenthetic vowel. However, since the resulting syllable is open, it is necessary for the epenthetic vowel to be long.

In (17) are Mohawk words where the main stress is on the antepenultimate syllable rather than the penultimate. Each of the foot types from (15) are represented in the data below.

(17) Antepenultimate syllable is stressed

a. /wak-itskw-ot-ʔ/ [wa.(kít).sko.t**e**ʔ] 'I was seated'
(CVC)

b. /waʔ-k-yerit-ʔ/ [waʔ.(kyé:).ri.t**e**ʔ] 'I accomplished it'
(CV:)

c. /te-k-rik-s/ [(té.k**e**).riks] 'I put them next to each other'
(CV.CV)

In (17)a and (17)b, the epenthesis which breaks up a final Cʔ cluster applies postlexically, when stress has already been assigned; stress is assigned in the first stratum, but the epenthesis does not take place until the second stratum. At the point when stress is assigned, the words in (17)a and (17)b are only three syllables long instead of four -- the final syllable of each word has not yet been created through the addition of a vowel. When ignoring the final syllable, these examples become exactly like the forms found in (16). In (17)c, the epenthesis occurs in the first stratum, at the same time as the epenthesis found in the words in (16). The penultimate syllable of (17)c is open and headed by an epenthetic vowel; since Mohawk avoids epenthetic vowels as the head of the word, the stress shifts to the antepenultimate syllable, with the penult as the weak member of the foot.

This epenthesis to break up a word-final Cʔ cluster is general, as can be seen in the following examples which involve several different morphemes.

(18) Other words with word-final Cʔ

a.	/k-nuhweʔ-s-hkwʔ/	[ke.(nú:).weʔ.skw**e**ʔ]	'I used to like it'
b.	/ʌ-k-nuhweʔ-nʔ/	[ʌ.ke.(nú:).weʔ.n**e**ʔ]	'I will like it'
c.	/te-k-hsaʔkt-a-nyu-hʔ/	[tek.saʔk.(tán).yu.h**e**ʔ]	'I folded them'
d.	/ʌ-t-k-wʌn-inkʌʔ-nʔ/	[ʌt.ke.wʌ.(ní.n**e**).kʌʔ.n**e**ʔ]	'I speak up, out'

In the examples above, all have a word-final Cʔ cluster where the glottal stop is not the entire morpheme. Stress is antepenultimate in the first three cases and pre-antepenultimate in the fourth, with each of the three foot types represented. In (a) and (b), there is vowel lengthening to make a single heavy syllable; in (c) the syllable is already heavy due to a coda. In (d), the antepenultimate vowel was stressed before the post-lexical epenthesis to break up the Cʔ cluster, since the penultimate vowel is epenthetic. When the final epenthesis occurs in the second stratum, this leaves the stress on the pre-antepenultimate syllable.

3.1.2 The premises

A key premise of the Mohawk analysis is that the grammar is stratified. Phonology applies at two levels in this analysis, once when the morphemes combine and once post-lexically; to capture this stratification, the analysis will be represented with a separate tier for each phonological level.[3] There is a difference in the allowed syllable structure between the two strata. The first stratum ignores consonant+glottal stop clusters, so no epenthesis will occur to break up the word-final Cʔ cluster -- or Cʔ clusters

[3] This separation is similar to the analysis of Axininca Campa in McCarthy and Prince (1993/2001), where there are distinct phonological tiers for suffix-, prefix-, and word-level phonology.

anywhere else in the word. In the second, post-lexical stratum, the Cʔ cluster is now targeted for epenthesis, but faithfulness to the outputs of the first stratum prevents the stress from shifting as an extra syllable is added due to epenthesis.

There are seven faithfulness constraints that will be relevant to this analysis of Mohawk, listed below. The first two constraints are Ident constraints, penalizing outputs that differ from their inputs in terms of some feature; specifically, the first penalizes changing stress from input to output and the second penalizes changing length from input to output.

(19) Faithfulness constraints: Ident

(McCarthy and Prince 1995, Kenstowicz 1996, Benua 1997, Kager 1999, 2000)

a. IDENTSTRESS

assign one violation for each stressed syllable in the input that is not stressed in the output

(stresses assigned in the first stratum will be preserved in subsequent strata)

b. IDENTLENGTH

assign one violation for each vowel in the input that has a different length in the output

(do not change underlying length)

The next four faithfulness constraints penalize output segments that lack an input correspondent; one penalizes consonants, one penalizes vowels, one penalizes long vowels, and one penalizes heads.

(20) Faithfulness constraints: Dep

a. DEPC (Prince and Smolensky 1993)

assign one violation for each consonant in the output that lacks an input correspondent

(do not insert a consonant)

b. DEPV (Prince and Smolensky 1993)

assign one violation for each vowel in the output that lacks an input correspondent

(do not insert a vowel)

c. *LONGEPV (DEPV:)

assign one violation for each long vowel in the output that lacks an input correspondent

(do not insert a long vowel)

d. HEAD-DEP (Alderete 1995)

assign one violation for each prosodic head that lacks an input correspondent

(do not stress an epenthesized vowel)

The final two faithfulness constraints focus on the location of elements in the input compared with their location in the output. Specifically, the first penalizes changing the final segment of the word, and the second penalizes anything that prevents adjacent input segments from being adjacent in the output.

(21) Faithfulness constraint: Various

a. ANCHORR-IO (McCarthy and Prince 1995)

assign one violation if the final element in the input does not match the final element of the output

(do not change the last segment of the word)

b. CONTIGUITY-IO (Lamontagne 1996)

assign one violation for each sequence of segments that is adjacent in the input but not in the output

(do not change adjacency relations present in the input)

There are also eleven markedness constraints that will be used in this analysis, provided below. The first three are foot form constraints, as described above -- IAMB, SYLLABICTROCHEE, and MORAICTROCHEE.

(22) Markedness constraints: Foot form (Prince and Smolensky 1993)

a. IAMB (Alber and Prince)

assign one violation for each [Xu], [L]

b. SYLLABICTROCHEE (Tesar 1995: FTNONFINAL)

assign one violation for each [uX], [X]

c. MORAICTROCHEE

assign one violation for each [uX], [L]

([CVV] or [CVC] is okay as a single syllable foot, but [CV] is not)

The next two are alignment constraints; these alignment constraints position the head foot of the word, in both a leftward and a rightward version.

(23) Markedness constraints: Alignment

(Prince and Smolensky 1993, McCarthy and Prince 1995)

a. MAINR

assign one violation for each syllable between the main stress and the right edge of the word

b. MAINL

assign one violation for each syllable between the main stress and the left edge of the word

The next two constraints penalize consonant clusters. The first of the pair is *Cʔ, which specifically targets consonant+glottal stop sequences; the second constraint is *CLUSTER, which is standing in as a single constraint to represent all other illicit consonant clusters in Mohawk according to the restrictions described in Michelson (1988) and Rawlins (2006).[4]

[4] Specifically, any cluster that is a consonant followed by a resonant consonant ([Cn], [Cr], [Cw]), or any cluster that begins with an oral consonant and is not followed by [h] or [s]. (Michelson 1988: 133)

(24) Markedness constraints: Clusters (Prince and Smolensky 1993)

a. *Cʔ

assign one violation for each consonant+glottal stop sequence

b. *CLUSTER

assign one violation for each banned sequence of consonants

The final three constraints necessary for the Mohawk analysis penalize an assortment of marked structures.

(25) Markedness constraints: Various

a. *V: (Rosenthall 1994)

assign one violation for each long vowel

b. NONFINALITY (Prince and Smolensky 1993)

assign one violation if the head foot contains the final syllable of the word

c. WTS (Prince and Smolensky 1993)

assign one violation for each unstressed heavy syllable

The first is *V:, which penalizes any long vowel in the output, regardless of its input status. NONFINALITY penalizes including the final syllable of the word in the head foot. This constraint is violated not only by putting main stress on the final syllable; if the final syllable is the weak member of the head foot, this constraint is violated. WEIGHT-TO-STRESS (WTS) is the constraint version of the Weight-to-Stress Principle (WSP), and is the primary motivation for quantity sensitive systems, penalizing unstressed heavy syllables.

3.1.3 The argument

First stratum

The first stratum is where individual morphemes combine to form a single word. Mohawk is a moraic trochee language with nonfinality, and epenthesis occurs at this stage to break up different types of clusters. Only one kind of cluster is not resolved at this stratum -- Cʔ clusters. The different environments for epenthesis are not the focus of this analysis (for more on the choice of vowel and the environments for epenthesis, see Michelson 1988, Rawlins 2006), so although it is represented as a single constraint *CLUSTER is actually the bundle of constraints that would penalize all banned consonant sequences *except* Cʔ clusters.

Clusters

The general constraint *CLUSTER must outrank DEPV and CONTIGUITY. Since the illicit clusters are resolved through epenthesis of a vowel, DEPV must be dominated by *CLUSTER in order to force the insertion. The addition of a vowel in the middle of the word also violates CONTIGUITY, since it interrupts the order of segments that is found in the input. This is illustrated below in (26).

(26) *CLUSTER >> DEPV, CONTIGUITY

Input	Winner	Loser	*Cluster	DepV	Contiguity	*Cʔ
waknyaks	{wa.(k**é**n).yaks}	{(wák).**ny**aks}	**W**	**L**	**L**	**e**

The winner has an epenthetic vowel -- violating DEPV; the epenthetic vowel also disrupts contiguity -- the /kn/ sequence which is adjacent in the input has been separated by the inserted vowel in the output. On the other hand, the loser violates neither faithfulness constraint, but fatally fails to break up the illicit consonant cluster.

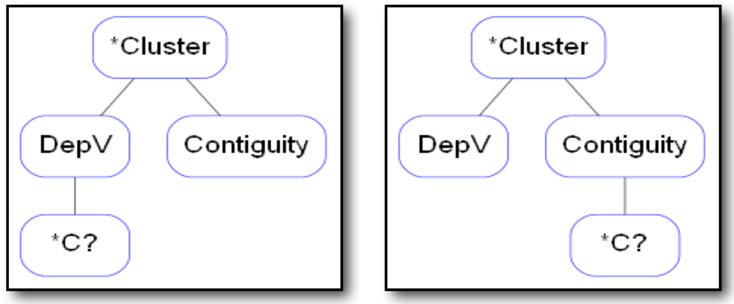
Word-final glottal stop clusters are not resolved in this stratum, so one of the two faithfulness constraints that are violated in the previous tableau must dominate the more specific anti-cluster constraint, *Cʔ. The general *CLUSTER dominates both of the faithfulness constraints in order to break up the illicit clusters other than Cʔ; in order to *not* break up Cʔ clusters, one of those two same constraints must dominate *Cʔ.

(27) CONTIGUITY *or* DEPV >> *Cʔ

Input	Winner	Loser	*Cluster	DepV	Contiguity	*Cʔ
wakitskwotʔ	{wa.(kít).skwotʔ}	{wa.(kít.skwo).t**e**ʔ}	**e**	**W**	**W**	**L**

The loser avoids the Cʔ cluster, satisfying the markedness constraint *Cʔ; however, the loser violates both DEPV and CONTIGUITY. The addition of a vowel violates DEPV, and the placement of that inserted vowel violates CONTIGUITY by interrupting the underlying /tʔ/ sequence. The winner violates neither of these faithfulness constraints, though it still contains the Cʔ cluster; either of these faithfulness constraints could be responsible for ensuring the winner's victory here.

(28) Sub-Ranking from clusters in first stratum



Nonfinality

Mohawk has strong nonfinality. The final syllable of a word is never included in the main stress foot; since there is only one foot per word in Mohawk, this means that the final syllable is never in *any* foot. A word that is only a single syllable in the input will clearly illustrate Mohawk's avoidance of a word-final main foot; rather than allow the word-final syllable to be included in the main foot, an additional syllable is epenthesized. Not only does an extra syllable need to be added to bear the stress, that extra syllable needs to be big enough to be a monosyllabic foot.

(29) Nonfinality >> DepV, *LongEpV

Input	Winner	Loser	Nonfinality	DepV	*LongEpV	*MainR*	**V:*	*IdentLength*	*HeadDep*	*WTS*
weʔs	{(í:).weʔs}	{(wéʔs)}	**W**	**L**	**L**	**L**	**L**	**e**	**L**	**L**

The winner violates a wide variety of constraints; not only is DepV violated by inserting a vowel, that vowel then becomes the head of a foot -- violating HeadDep. The winner violates *V: by creating a long vowel; creating a long vowel that is entirely epenthetic also violates *LongEpV. The addition of a non-final syllable to stress means that the main stress is one syllable further away from the right edge, worsening performance on MAINR. WTS also disprefers the winner, since it leaves a heavy syllable unstressed.

However, despite the winner's myriad problems on this wide range of constraints, it has one crucial benefit: the final syllable is not in the main foot. For all of the loser's comparative merit on every other constraint, the loser crucially *does* have the final syllable in the main foot of the word. NONFINALITY is never violated on the surface in Mohawk, which is reflected in NONFINALITY's dominance over DEPV and *LONGEPV (as well as the other five constraints shown in (29)).

Alignment

Main stress in Mohawk is right-aligned. Although, as shown above, stress cannot be on the rightmost syllable due to nonfinality, Mohawk still produces stress on the rightmost syllable that will not cause a violation of nonfinality.

(30) MAINR >> *V:, IDENTLENGTH, WTS, MAINL, SYLLABICTROCHEE

Input	Winner	Loser	MainR	*Head Dep*	*V:	IdentLength	WTS	MainL	Syll Troch
tekhsakts	{tek.(hsá:).kets}	{(ték.hsa).kets}	**W**	***e***	**L**	**L**	**L**	**L**	**L**

In (30), the winner has stress one syllable closer to the right edge of the word than the loser does; the winner does better on MAINR while the loser does better on MAINL. The winner also has a long vowel while the loser has none, and the winner has more unstressed heavy syllables than the loser does. The foot in the winner is a perfectly acceptable moraic trochee, but it is not a good syllabic trochee; the loser, on the other hand, features a perfect syllabic trochee. Because the one syllable difference from the right edge of the word is more important than these other factors, MAINR must dominate *V:, IDENTLENGTH, WTS, MAINL, and SYLLABICTROCHEE.

MAINR also must dominate HEADDEP, since an epenthetic vowel will be stressed if it improves on right-alignment.

(31) MAINR >> HEADDEP

Input	Winner	Loser	MainR	Head Dep	*V:	IdentLength	WTS	MainL	SyllTroch
waknyaks	{wa.(k**é**n).yaks}	{(wá:).ken.yaks}	**W**	**L**	***W***	***W***	***W***	***L***	***e***

Both candidates have an epenthetic vowel in the same location; the loser satisfies HEADDEP by stressing an underlying vowel instead. The winner stresses an epenthetic vowel, but in doing so improves right-alignment by one syllable. Since having the stress as close to the right as possible is more important than avoiding stressed epenthetic vowels, MAINR dominates HEADDEP.

There is a limit to right alignment's authority, however. While Mohawk allows the lengthening of vowels and the stressing of epenthetic vowels in order to improve on right alignment, the two cannot happen in conjunction; long, wholly epenthetic vowels are not permitted in order to improve on right alignment. As shown in (30) and (31), MAINR dominates IDENTLENGTH, *V: and HEADDEP -- but *LONGEPV must dominate MAINR.

(32) *LONGEPV >> MAINR

Input	Winner	Loser	*LongEpV	MainR
tekriks	{(té.k**e**).riks}	{te.(k**é:**).riks}	**W**	**L**

The winner in (32) has stress one syllable further to the left than the loser; however, the winner also avoids having a long, purely epenthetic vowel -- while the better-aligned loser has inserted a long vowel where there was nothing in the input.

Long epenthetic vowels

While long epenthetic vowels cannot be created for better right-alignment, there *are* some long epenthetic vowels in Mohawk. Constraints other than right alignment are sufficient to create a long epenthetic vowel when necessary, as shown in the section on nonfinality. When an input consists of a single syllable, nonfinality outranks the constraint against long epenthetic vowels; this was shown in (29), repeated below without the other constraints that must also be dominated by NONFINALITY.

(33) NONFINALITY >> *LONGEPV

Input	Winner	Loser	Nonfinality	*LongEpV
weʔs	{(**í:**).weʔs}	{(wéʔs)}	**W**	**L**

Other constraints also outrank *LONGEPV in order to produce the output with long epenthetic vowels. Specifically, ANCHORR and CONTIGUITY combine to prefer insertion of a long vowel at the left edge of the word; if these constraints were ranked below *LONGEPV, it would be possible to epenthesize a short vowel. First, we'll consider a candidate where the epenthetic vowel is inserted at the end instead of the beginning -- violating ANCHORR, but not CONTIGUITY.

(34) ANCHORR >> *LONGEPV

Input	Winner	Loser	AnchorR	*LongEpV
weʔs	{(**í:**).weʔs}	{(wéʔ).s**e**}	**W**	**L**

In (34), the winner has epenthesized at the left edge while the loser epenthesizes at the right edge. Epenthesizing at the end of the word means that it is not necessary to insert a long vowel; however, this candidate loses because the right edge of the input does not match the right edge of the output.

In order to preserve the input-output correspondence at the right edge of the word and satisfy ANCHORR, the loser below epenthesizes between the final two consonants; in order for this candidate to have a minimally bimoraic foot and still observe nonfinality, the underlying vowel must be lengthened.

(35) CONTIGUITY >> *LONGEPV

Input	Winner	Loser	Contiguity	*LongEpV	*HeadDep*
weʔs	{(**í:**).weʔs}	{(wé:).ʔ**e**s}	**W**	**L**	**L**

The loser in (35) does not contain a long epenthetic vowel, but it does disrupt the order of segments from the input. The epenthetic vowel now interrupts an underlying /ʔs/ sequence, violating CONTIGUITY; the winner, on the other hand, does not violate CONTIGUITY -- but does so at the expense of inserting a long epenthetic vowel.

Foot type

As previously stated, Mohawk is a moraic trochee language. This means that the only acceptable feet are those listed in (15), repeated here.

(36) Feet in Mohawk

a. [σ] = (C)V́C

b. [σ] = (C)V́:

c. [σσ] = (C)V́.(C)V

Crucially, monosyllabic feet are allowed -- as long as they are bimoraic -- and any bisyllabic foot must be stressed on the initial syllable. The tableau below shows that it is more important for feet to be trochees, even though the iambic foot from the loser would also improve right alignment; [σσ] feet are always trochaic.

(37) MORAICTROCHEE >> IAMB, MAINR

Input	Winner	Loser	MoraicTrochee	Iamb	MainR
tekriks	{(té.k**e**).riks}	{(te.k**é**).riks}	**W**	**L**	**L**

Having moraic trochee feet is also more important in Mohawk than the avoidance of long epenthetic vowels. In the tableau below, the loser does not have a minimal moraic trochee -- but it also does not have a long epenthetic vowel. The winner, on the other hand, violates *LONGEPV in order to have a minimal foot.

(38) MORAICTROCHEE >> *LONGEPV

Input	Winner	Loser	MoraicTrochee	*LongEpV
weʔs	{(**í:**).weʔs}	{(**í**).weʔs}	**W**	**L**

There is not necessarily a ranking between SYLLABICTROCHEE and IAMB in Mohawk; since Mohawk is a moraic trochee language, there does not have to be a ranking between SYLLABICTROCHEE and IAMB -- as long as MORAICTROCHEE is over IAMB, as shown in

(37). However, SYLLABICTROCHEE *could* dominate IAMB; as shown below, either SYLLABICTROCHEE, *V:, or IDENTLENGTH must dominate IAMB.

(39) SYLLABICTROCHEE *or* *V: *or* IDENTLENGTH >> IAMB

Input	Winner	Loser	SyllTroch	*V:	IdentLength	Iamb
tekriks	{(té.k**e**).riks}	{(té:).k**e**.riks}	**W**	**W**	**W**	**L**

In (39), the winner has fewer long/lengthened vowels than the loser; the winner also contains a syllabic trochee instead of an iamb. Either SYLLABICTROCHEE, *V:, or IDENTLENGTH could be responsible for crucially dominating Iamb in this comparison, but one of the three must outrank IAMB.

It is also necessary to determine how minimal moraic trochees will be created in Mohawk. As shown in the tableaux above, when the stressed syllable would not be able to make a bimoraic foot, an extra mora is added through the lengthening of a vowel. It would also be possible for the extra mora to be added through the insertion of a coda consonant. In order to ensure that Mohawk lengthens vowels instead of inserting consonants, DEPC must outrank *V: and IDENTLENGTH.

(40) DEPC >> *V:, IDENTLENGTH

Input	Winner	Loser	DepC	*V:	IdentLength
khyatus	{(khyá**:**).tus}	{(khyá**ʔ**).tus}	**W**	**L**	**L**

In both candidates, the first vowel is stressed, forming a bimoraic, monosyllabic moraic trochee. The difference between the candidates is that the winner creates the bimoraic foot by lengthening the vowel while the loser creates the bimoraic foot by inserting a consonant. Since Mohawk enforces foot minimality through vowel lengthening, DEPC must outrank *V: and IDENTLENGTH.

Ranking summary

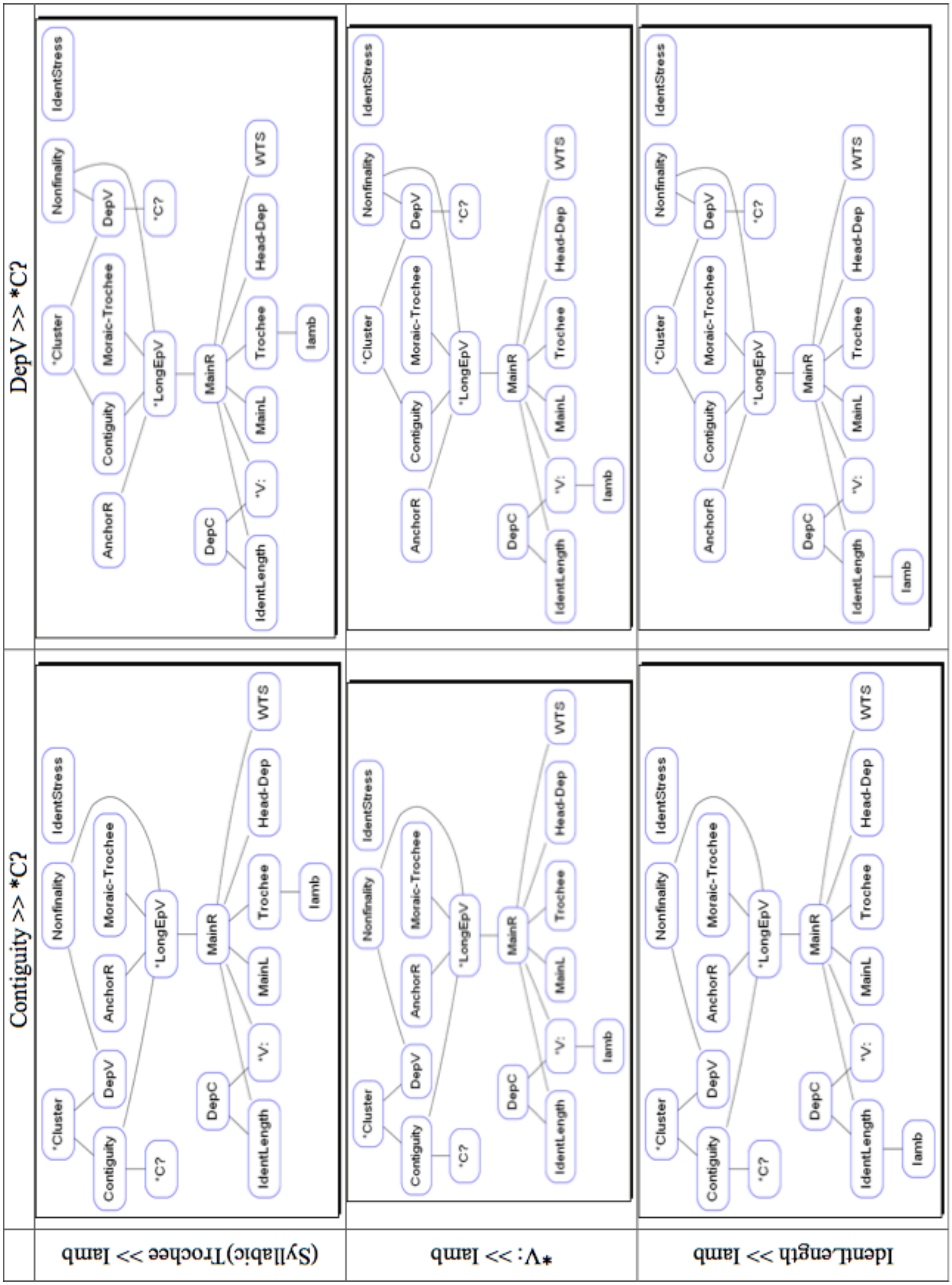
The total ranking at the end of the first stratum is shown below. Because there were two disjunctions in the rankings, there are multiple possibilities for the total ordering of the constraints. The first disjunct is that either CONTIGUITY or DEPV must outrank *Cʔ; the second disjunct is that one of SYLLABICTROCHEE, *V:, or IDENTLENGTH outranks IAMB. Since there are two possibilities in the first disjunct and three independent possibilities in the second disjunct, there are a total of six possible orderings.

(42) shows all six possible linear orders, but the skeletal basis (Brasoveanu and Prince 2005) is provided first to aid in comprehension (calculated by the RUBOT component of OTWorkplace, Prince and Tesar 2007-2013). The disjunctions stem from the shaded cells in ERC (27) and ERC (39).

(41) Skeletal Basis for First Stratum Rankings

	AnchorR	*Cluster	Nonfinality	DepC	IdentStress	MoraicTrochee	Contiguity	DepV	*Cʔ	*LongEpV	MainR	IdentLength	*V:	Head-Dep	WTS	MainL	(Syllabic)Trochee	Iamb
ERC (34)	**W**									**L**								
ERC (26)		**W**					**L**	**L**										
ERC (29)			**W**					**L**		**L**								
ERC (40)				**W**								**L**	**L**					
ERC (38)						**W**				**L**								
ERC (35)							**W**			**L**								
ERC (27)							**W**	**W**	**L**									
ERC (32)										**W**	**L**							
ERC (30)◦(31)											**W**	**L**	**L**	**L**	**L**	**L**	**L**	
ERC (39)												**W**	**W**				**W**	**L**

(42) First stratum rankings for Mohawk



Second stratum

In the second stratum, the Cʔ clusters that escaped notice in the first stratum are eliminated. As the following tables from Michelson (1988: 12-13) show, there are no surface clusters in Mohawk that have a glottal stop following another consonant.

(43) Mohawk CC Clusters (Michelson 1988: 12)

Table I: ***Mohawk Surface Word-Medial CC Clusters***

C_1 \ C_2	y	w	n	r	s	t	k	h	ʔ
y									
w								wh	
n	ny							nh	
r	ry						rk	rh	
s	sy	sw	sn			st	sk	sh	
t	ty				ts	tt	tk	th	
k	ky	kw			ks	kt	kk	kh	
h	hy	hw	hn	hr	hs	ht	hk		
ʔ		ʔw	ʔn	ʔr	ʔs	ʔt	ʔk		

(44) Mohawk CCC Clusters (Michelson 1988: 13)

Table II: *Surface Word-medial CCC Clusters by Initial CC*

C_1 \ C_2	w	n	r	s	t	k	h
n							nhy nhr
r							rhy rhw
s		sny			sth sty	sky skt skw skk	shy shn shw shr
t				tsy tst tsn tsk tsh		tky tkw	thy thn thw thr ths
k				ksw ksk kst ksh	kts kth	kkw	khy khn khw khr khs kht
h		hny hnh	hry hrh	hsy hst hsw hsk hsh	hty htk hts hth	hkw hkh	
ʔ	ʔwh	ʔny ʔnh	 ʔrh	ʔsw ʔsk ʔst ʔsh	ʔty ʔtk ʔts ʔth	ʔky ʔkt ʔkw ʔkk ʔks ʔkh	

In order to eliminate all Cʔ clusters, *Cʔ must crucially dominate *at least* the two constraints that could have dominated it in the first stratum. In the first stratum, either DEPV *or* CONTIGUITY needed to dominate *Cʔ; in the second stratum, *Cʔ must dominate both of these constraints -- as well as MainR.

(45) *Cʔ >> DEPV, MAINR, CONTIGUITY

Input	Winner	Loser	*Cʔ	DepV	MainR	Contiguity
{wa.(kít).skwotʔ}	{wa.(kít).skwo.**te**ʔ}	{wa.(kít).skwotʔ}	**W**	**L**	**L**	**L**

In the tableau in (45), the winner epenthesizes a vowel to break up the Cʔ cluster. This disrupts the order of segments from the input, violating contiguity. The epenthesized vowel similarly creates a preference for the loser over the winner in terms of DEPV -- and, through adding an additional syllable, makes the stress be further away from the right edge in the winner than in the loser. However, the winner has no Cʔ cluster, while the loser does; this is the fatal difference, revealing that *Cʔ outranks DEPV, MAINR, and CONTIGUITY.

However, vowel epenthesis only happens to break up word-final Cʔ clusters; word-medially, the glottal stop is metathesized to a later position in the word.

(46) DEPV *or* MAINR >> CONTIGUITY

Input	Winner	Loser	DepV	MainR	Contiguity
{ka.(tít).**ʔa**s}	{ka.(tít).**aʔ**s}	{ka.(tí.te).**ʔa**s}	**W**	**W**	**L**

Both candidates in the above tableau eliminate the Cʔ cluster; the winner does so through metathesis, while the loser inserts a vowel. The addition of the vowel improves on CONTIGUITY -- there is only one pair of segments that are adjacent in the input but not in the output (tʔ), as opposed to the winner where there are two such sequences (tʔ, ʔa). However, the addition of a vowel makes the loser do worse on both DEPV and MAINR; in order for epenthesis to occur only word-finally (where metathesis is not an option), either DEPV or MAINR must outrank CONTIGUITY. CONTIGUITY outranks MAINR in the first stratum, but there is no existing ranking between DEPV and CONTIGUITY from the first stratum. Either could be responsible for dominating CONTIGUITY in the second stratum, but if DEPV outranks CONTIGUITY there is no need to reverse the earlier ranking.

Metathesis is not a possibility word-finally, due to the requirement carried over from the first stratum for the right edge of the input to correspond to the right edge of the output. When metathesis disrupts the right edge of the word, this violates ANCHORR.

Inserting a vowel is preferable here, because it avoids disrupting the alignment at the right edge of the word.

(47) ANCHORR >> DEPV

Input	Winner	Loser	AnchorR	DepV
{wa.(kít).skwotʔ}	{wa.(kít).skwo.t**e**ʔ}	{wa.(kít).skwo**ʔt**}	**W**	**L**

In the first stratum, there were no existing stresses in the inputs and so there was nothing for IDENTSTRESS to be faithful to. At the second stratum, the stresses assigned in the first stratum are now a part of the input, so IDENTSTRESS will assess violations. However, IDENTSTRESS is never crucially responsible for dominating another constraint; anytime IDENTSTRESS picks the winner, there is at least one other constraint that would make the same decision. For example, one of the set IAMB, WTS, or IDENTSTRESS must outrank MAINL; IDENTSTRESS is not the crucial dominator here -- any of the three constraints would suffice. The existence of IDENTSTRESS in CON is independently motivated by other languages, and its presence in Mohawk would allow for fewer rerankings between Stratum 1 and Stratum 2; however, since it is not a crucial part of the analysis, it is included here only for completeness.

(48) IAMB *OR* WTS *OR* IDENTSTRESS >> MAINL

Input	Winner	Loser	Iamb	WTS	IdentStress	MainL
{wa.(kén).yaks}	{wa.(kén).yaks}	{(wa.kén).yaks}	**W**	**W**	**W**	**L**

Similarly, in the next two tableaux, either IDENTLENGTH or IDENTSTRESS can be responsible for dominating WTS and MAINR. For instance, in (49) and (50), changing the stress also means changing the vowel length for foot minimality.

(49) IDENTLENGTH *or* IDENTSTRESS >> MAINR

Input	Winner	Loser	IdentLength	IdentStress	MainR
{wa.(kít).skwotʔ}	{wa.(kít).skwo.teʔ}	{wa.kit.(skwó:).teʔ}	**W**	**W**	**L**

(50) IDENTLENGTH *or* IDENTSTRESS >> WTS

Input	Winner	Loser	IdentLength	IdentStress	WTS
{tek.(hsá:).kets}	{tek.(hsá:).kets}	{(ték).hs**a**.kets}	**W**	**W**	**L**

Since there is always some other constraint that can preserve the position of the stress from the previous stratum, there is no need for IDENTSTRESS in the analysis of Mohawk. This is not a general statement on the status of IDENTSTRESS, but rather an effect of the same constraints that put the stress there in the first place continuing to exert their will.

The final updates to rankings in the second stratum disambiguate underspecified rankings from stratum one. In the first stratum, either IDENTLENGTH, *V:, or SYLLABICTROCHEE is responsible for dominating IAMB. In the second stratum, this disjunction is resolved: IDENTLENGTH must crucially dominate IAMB, and IAMB will dominate SYLLABICTROCHEE.

(51) IDENTLENGTH >> IAMB

Input	Winner	Loser	IdentLength	Iamb
{(té.ke).riks}	{(té.ke).riks}	{(té:).ke.riks}	**W**	**L**

(52) IAMB >> SYLLABICTROCHEE

Input	Winner	Loser	Iamb	SyllabicTrochee
{wa.(kít).skwotʔ}	{wa.(kít).skwo.teʔ}	{wa.(kít.skwo).teʔ}	**W**	**L**

Additionally, this is the first time when IDENTLENGTH and *V: directly conflict. Since, following Michelson (1988), all the inputs to the first stratum have short vowels only, there was no difference in terms of violations of IDENTLENGTH and *V:. However, in this stratum there are underlying long vowels (created in stratum one) to be faithful to -- so IDENTLENGTH and *V: can differ for the first time.

(53) IDENTLENGTH >> *V:

Input	Winner	Loser	IdentLength	*V:
{ke.(nú:).weʔskwʔ}	{ke.(nú:).weʔ.skweʔ}	{ke.(n**ú**.weʔ).skw**e**ʔ}	**W**	**L**

The summary of all the crucial rankings for the second stratum in Mohawk is provided on the following page. Just as in the first stratum, there are a number of disjuncts. Two of the disjuncts involve IDENTSTRESS, which is not crucial in this analysis: IDENTSTRESS or IDENTLENGTH over MAINR and WTS, and IDENTSTRESS, WTS, or IAMB over MAINL. The third disjunct is that either MAINR or DEPV must outrank CONTIGUITY. These disjuncts are not completely independent -- if IDENTSTRESS outranks MAINR, it also must outrank MAINL through transitivity -- so there are a total of eight possible rankings.

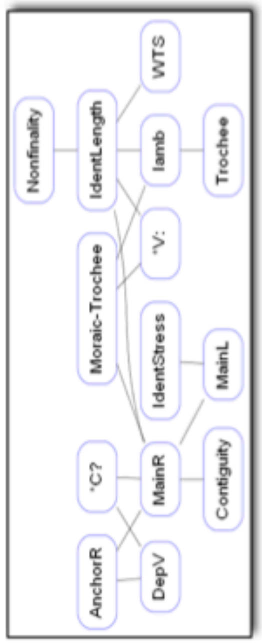
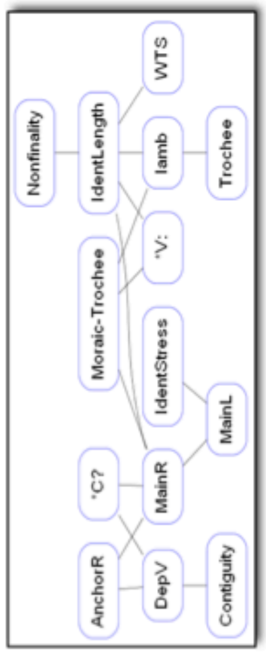
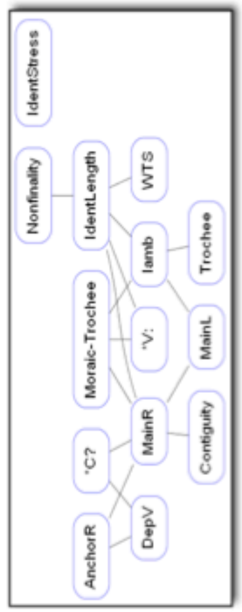
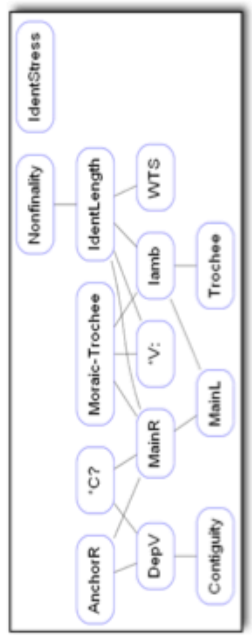
(55) shows all eight possible linear orders, but the skeletal basis is also provided to aid in comprehension (calculated by the RUBOT component of OTWorkplace). The

disjunctions stem from the shaded cells in ERC (49)◦(50), ERC (41) and ERC (39). The changes in ranking between Stratum 1 and Stratum 2 are shown in (56).

(54) Skeletal Basis for Second Stratum Rankings

	AnchorR	*Cʔ	Nonfinality	IdentStress	MoraicTrochee	IdentLength	DepV	WTS	MainR	Iamb	Contiguity	*V:	MainL	SyllabicTrochee
ERC (47)	**W**						**L**		**L**					
ERC (45)		**W**					**L**		**L**					
ERC (49)◦(50)				**W**		**W**		**L**	**L**					
ERC (48)				**W**				**W**		**W**			**L**	
ERC (46)							**W**		**W**		**L**			
ERC (51)◦(53)						**W**				**L**		**L**		
ERC (52)										**W**				**L**

(55) Second stratum rankings for Mohawk

		MainR >> Contiguity	DepV >> Contiguity
IdentStress >> MainR, WTS, MainL			
IdentLength >> MainR, WTS	IdentStress >> MainL		
	Iamb >> MainL		
	WTS >> MainL		

(56) Changes between Stratum 1 and Stratum 2

<table>
<tr><th colspan="2"></th><th>Stratum 1</th><th>Stratum 2</th></tr>
<tr><td colspan="2">Reranking between strata</td><td>DepV or Contiguity >> *Cʔ</td><td>*Cʔ >> DepV, Contiguity, MainR</td></tr>
<tr><td colspan="2" rowspan="2">No reranking if underlined constraint dominates</td><td>Contiguity >> MainR</td><td>DepV or MainR >> Contiguity</td></tr>
<tr><td>MainR >> IdentLength</td><td>IdentStress or IdentLength >> MainR</td></tr>
<tr><td rowspan="5">No evidence for ranking in first stratum</td><td>Disambiguation of disjunction</td><td>IdentLength or *V: or SyllTroch >> Iamb</td><td>IdentLength >> Iamb
Iamb >> SyllabicTrochee</td></tr>
<tr><td rowspan="4"></td><td>no ranking</td><td>AnchorR >> DepV</td></tr>
<tr><td>no ranking</td><td>Iamb or WTS or IdentStress >> MainL</td></tr>
<tr><td>no ranking</td><td>IdentLength or IdentStress >> WTS</td></tr>
<tr><td>no ranking</td><td>IdentLength >> *V:</td></tr>
</table>

The most important fact about Mohawk is that the data supports a trochaic analysis where vowel lengthening only occurs to satisfy foot minimality, while still observing Nonfinality and optimizing right-alignment. An analysis where a trochaic foot lengthens because of being stressed is not possible with this set of constraints. Mellander's (2001, 2002, 2003) analysis of Mohawk assumes the exact opposite, that the head syllable of a trochaic foot undergoes vowel lengthening in order to be more prominent than the weak member of the foot. While the analysis provided here assumes that Mohawk uses moraic trochees, Mellander's analysis features uneven syllabic trochees. For both approaches, the key data are forms like [(té.k**e**).riks]; I claim that this word shows that vowel lengthening only occurs when word minimality demands it, since the stressed vowel remains short. The crucial assumption for Mellander's analysis is that an epenthetic vowel is less prominent than a non-epenthetic vowel, meaning that (té.k**e**) *is* an uneven trochee. However, epenthetic vowels are shown to be sufficiently prominent elsewhere in Mohawk; epenthetic vowels can be stressed in closed syllables, as in [wa.(k**é**n).yaks], or in words like [(**í**:).weʔs], where the epenthetic vowel is also long.

Vowel lengthening is not a regular process that occurs in every stressed syllable, as it is in some iambic languages. Stressed closed syllables do not undergo lengthening, such as [ko.(hár).haʔ]; vowel lengthening also does not apply to open syllables when a minimal foot can be created in other ways, as in the case of [(té.k**e**).riks] with its epenthetic penultimate vowel. Vowel lengthening only occurs when necessary to create a binary foot, instead of regularly occurring on every stressed syllable.

3.2 Other Languages

In this section, the same basic analysis that was used for Mohawk will be extended to other examples trochaic languages with phonological vowel lengthening. In these languages, the vowel lengthening is due to foot minimality requirements. Badimaya and Anguthimri are examples of trochaic languages with vowel lengthening only in monosyllables.[5] Chamorro, Selayarese, Chimalapa Zoque, and Italian have vowel lengthening in words of any length. In Chamorro and Chimalapa Zoque, lengthening occurs only when a bisyllabic foot is not possible -- like in Mohawk; in Selayarese and Italian, a bisyllabic foot is never possible.

3.2.1 Badimaya

Badimaya (Dunn 1988) has trochaic feet, with stress is on every odd-numbered non-final syllable.

(57) Badimaya stress

a.	(wá.na).ra	'long, thin'
b.	(wín.d^{y}in).d^{y}i	'grasshopper'
c.	(ŋán.gaŋ).(gú.wa)	'to choke on something'
d.	(wá.nal).(d^{y}í.li).ŋa	'scorpion'

Long vowels occur only in monosyllables, and every monosyllabic word contains a long vowel. The vowel lengthening in monosyllables takes place to create a minimal word, which requires two moras. Codas do not count towards syllable weight, as seen in (58).

(58) Monosyllables in Badimaya

a.	ngud	(ŋú:d)	'horse'
b.	dha	(d̪á:)	'hole'
c.	warn	(wá:ɳ)	'creek'

---

[5] See Hayes (1995: 101-105) for discussion of monosyllables with long vowels in quantity insensitive languages.

In affixed versions of the monosyllables, there is no long vowel because the lengthening is unnecessary. For instance, the ergative form of 'horse' is *ŋú.du* rather than *ŋú:.du*. The vowels are lengthened in compounds, however, since each component forms its own phonological word. The Badimaya word for 'water hole' is a compound formed from *gabi* 'water' and *da* 'hole'; since the second phonological word is monosyllabic, vowel lengthening is still required to ensure a minimal word, yielding *ga.bi.da:*.

3.2.2 Anguthimri

Like Badimaya, Anguthimri (Crowley 1981) is a trochaic language with stress on every odd-numbered non-final syllable, except in the case of monosyllables where the final (and only) syllable is stressed.

(59) Anguthimri stress

a. ðú.ʔu 'yamstick'

b. bwá.ʔa 'meat'

c. ká.li.pwa 'gully'

d. á.ra.na 'toenail, fingernail'

e. ʔú.nu.wá.na 'blister'

Unlike Badimaya, Anguthimri has a contrast between long and short vowels, as seen in (60). Not all stressed vowels are lengthened, but some stressed vowels happen to be long.

(60) Vowel contrast in Anguthimri

c. pá:.na 'level'

d. pá.na 'friend'

In addition to the contrastive vowel length difference, Anguthimri has a process of vowel lengthening in monosyllabic words. All monosyllables have a long vowel, so words with underlying short vowels lengthen the vowel for word minimality.

(61) Monosyllables in Anguthimri

a.	/ra/	'stomach'	ra:
b.	/raŋa/	'stomach-LOC'	ra.ŋa

As in Badimaya, the vowel lengthening does not occur in every stressed syllable -- only when necessary for word minimality.

3.2.3 Chamorro

Much like Mohawk, Chamorro (Chung 1983) is a trochaic language with right-aligned stress and nonfinality, which results in lengthening the stressed vowel in certain circumstances. Stress in Chamorro most frequently falls on the penultimate syllable; if the penultimate syllable is open, the vowel lengthens. However, as in Mohawk, if the antepenultimate syllable is stressed, there is no need for the vowel to lengthen since the (light) penultimate syllable can be included as the weak member of the foot for no additional violations of ALIGNR. This interpretation of Chamorro footing and vowel lengthening is the same as Prince (1990).

(62) Chamorro Penultimate Stress

a.	/nana/	(ná:).na	'mother'
b.	/alitus/	a.(lí:).tus	'earrings'

(63) Chamorro Antepenultimate Stress

a.	/higadu/	(í.ga).du	'liver'
b.	/pikaru/	(pí.ka).ru	'sly'

This analysis of Chamorro is very similar to the analysis of Mohawk provided above. Vowel lengthening occurs because the best right-aligned foot (given nonfinality) is a monosyllabic foot on the penultimate syllable; in order for that foot to satisfy foot minimality, the syllable must be heavy. When other factors result in antepenultimate stress, there is no need for the syllable to be heavy, because there is no cost in terms of right alignment for the penultimate syllable to become the weak member of the foot. This is what happens in the Mohawk word [(té.ke).riks] -- no vowel lengthening is necessary because a bisyllabic trochee can be formed.

3.2.4 Selayarese

In Selayarese (Mithun and Basri 1986), stress is generally penultimate. When the penultimate syllable is open, the stressed vowel is long; when the penultimate syllable is closed, no lengthening is needed. Selayarese can be analyzed as a trochaic language with right-aligned stress and nonfinality, much like Mohawk. In order to get the stressed syllable as close to the right edge as possible, a monosyllabic moraic trochee is optimal.

(64) Penultimate stress in Selayarese

a. (sá:).sa 'cut (grass)'

b. (sás).sa 'wash'

c. (rá:).mãŋ personal name

d. (rám).mãŋ 'cloud'

e. (ká:).si 'white cloth'

f. (kás).si 'sour'

Selayarese prohibits ending a word in l, r, or s, and epenthesizes a vowel at the ends of words which have one these consonants in final position underlyingly. In these words, stress is antepenultimate. Unlike in Mohawk, this epenthesis happens at a later stratum than the vowel lengthening and stress assignment -- and IDENTLENGTH ensures that the lengthened vowels remain.

(65) Word-final epenthesis and antepenultimate stress in Selayarese

a. /katal/ (ká:).ta.l*a* 'itch'

b. /botol/ (bó:).to.l*o* 'bottle'

c. /mintar/ (mín).ta.r*a* 'tomorrow'

Only the word-final epenthesis shown above happens at a later stratum; other epentheses, such as the epenthesis in (66), occur in time for stress assignment to consider the epenthetic vowel as the head of a foot. In Mohawk, HEADDEP dominates ALIGNR to yield forms which contain bisyllabic trochees like [(té.ke).riks]; in Selayarese, ALIGNR dominates HEADDEP. Since epenthetic vowels are allowed to bear stress, there are no definitive cases to show that Selayarese is trochaic.

(66) Epenthetic penultimate vowel in Selayarese

[sa.ha.(lá̆ʔ).mu] 'your (familiar) profit'

It is possible that IAMB and MORAICTROCHEE are working together in Selayarese to ensure that all feet are monosyllabic, thus satisfying both foot type constraints. However, the crucial fact, as in Mohawk, is that there is a possible trochaic analysis of Selayarese where the vowel lengthening is due to foot minimality and not due to the vowel being stressed. A syllabic trochee analysis with stress-induced vowel lengthening is not possible in this system.

3.2.5 Chimalapa Zoque

In Chimalapa Zoque (Knudson 1975), secondary stress falls on the first syllable of the stem (prefixes contain no stress) and primary stress falls on either the penultimate or antepenultimate syllable. Chimalapa Zoque is a moraic trochee language, with a foot minimality requirement of two moras. As in Selayarese, it is possible that IAMB and MORAICTROCHEE conspire to make monosyllabic feet preferred; however, there are certain instances where monosyllabic feet are not allowed.

(67) Possible feet in CZ

a. CV.CV

b. CV:

c. CVC

The bisyllabic foot in (a) only occurs when the second C is a glottal stop, so it is possible to specify that foot as CV.ʔV.[6] The final syllable of a word cannot be included in the foot due to NONFINALITY. The primary stress is penultimate when the penultimate syllable is heavy, but antepenultimate when the penultimate syllable is light.

(68) Penultimate syllable is heavy

a. CVC (mìn).(*kéʔt*).pa

b. CV: (hù:).(*kú:*).ti

(69) Penultimate syllable is light

a. CV.CV (né.ʔa)

(sí.*ʔi*).ci

(wì:).(tú.*ʔu*).pa

(nìk).span.ki.(cé.*ʔe*).wi

While most of the stressed syllables in Chimalapa Zoque are lengthened, this lengthening only occurs when the foot is monosyllabic. In a case where the foot cannot be monosyllabic due to the glottal stop, there is no lengthening of the stressed syllable. If the vowel lengthening applied uniformly to every open stressed syllable, the forms in (69) would be expected to have long vowels, as shown below.

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[6] The unique status of this intervocalic [ʔ] presents a temptation to treat it as an epenthetic segment to prevent vowel hiatus. However, Knudson claims that VV sequences are broken up by epenthetic [j] and not by a glottal stop (p 285), as well as arguing that the glottal stop is present underlyingly (p 298).

(70) No vowel lengthening in bisyllabic feet

a. *(né:.ʔa) -- vowel lengthening, bisyllabic

b. *(né:).ʔa -- vowel lengthening, monosyllabic

c. (né.ʔa) -- no vowel lengthening, bisyllabic

Since vowel lengthening does not occur in every stressed syllable in Chimalapa Zoque, it is not the case that the vowels are lengthened due to being stressed.

3.2.6 Italian

Morén's (1999) analysis of Italian, citing data from Vogel (1982, and references therein), is similar to the analyses of Mohawk and Selayarese presented here. Italian is a moraic trochee language, with nonfinality and right-alignment. The optimal foot position, due to NONFINALITY and MAINR, is a monosyllable in the penultimate position. The only long vowels in Italian are open, stressed penultimate syllables, which undergo lengthening for foot minimality.

(71) Penultimate open syllables are lengthened (Morén 1999: 171)

a. [(ví:.le)] 'mean'

b. [(ká:.sa)] 'house'

c. [(nó:.no)] 'ninth'

These forms can be contrasted with closed penultimate syllables; the minimal pairs below have closed penultimate syllables, and the stressed vowel is not lengthened.

(72) Penultimate closed syllables contain short vowels (Morén 1999: 171)

a. [(víl.le)] ‘villas’

b. [(kás.sa)] ‘case’

c. [(nón.no)] ‘grandfather’

Morén’s (1999: 179-190) analysis of Italian vowel lengthening is similar to the analysis of Mohawk given in section 3.1. As in Mohawk, nonfinality and right-alignment conspire to create a monosyllabic foot in the penultimate position. In order to ensure that this penultimate syllable is a minimal foot, it must be heavy; when the penultimate syllable is open, the vowel must lengthen for foot minimality -- not simply because it is stressed.

Chapter 6

Conclusion

Switch languages are both an entailed theoretical consequence of OT (given key basic constraints) and an empirical reality. The essential constraints which yield the switch language pattern, forcing feet to switch between iambs and trochees based on word length, are basic constraints that are necessary for the analysis of a variety of metrical phonology phenomena. No matter what definition of alignment is used, the core feature of alignment necessary to account for observed stress patterns is the same feature that produces switch languages -- the ability to detect whether or not there is a foot at the word edge. Because switching occurs to satisfy rhythm and alignment constraints, switch languages always have a pattern of perfectly alternating stress; this makes it difficult to tell whether a language is switch, since the pattern of stress is compatible with a homogeneous foot analysis.

(1) Two parsings for a single stress pattern

a.	*stress pattern:*	X-o-X-o
		o-X-o-X-o
b.	*switch foot type:*	[Xu]-[Xu]
		[uX]-[uX]-o
c.	*all trochees:*	[Xu]-[Xu]
		o-[Xu]-[Xu]

In the above example, the pattern in (a) is compatible with a heterogeneous or homogeneous foot type analysis. The footing in (b) represents a left-aligned switch language, while the footing in (c) represents a right-aligned trochaic language.

Because it is impossible to tell whether a language is switch based on the stress pattern alone, it is necessary to have additional evidence for the foot boundaries or foot type. Yidiny and Wargamay are two languages with clear evidence in favor of a switch analysis. The primary piece of evidence is the regular process of vowel lengthening in words with iambic feet, but no vowel lengthening in words with trochaic feet. An all-trochaic analysis is not possible for Yidiny or Wargamay because, as Chapter 5 argues, the kind of regular vowel lengthening found in these languages never occurs with trochees.

Empirical Reality

Yidiny and Wargamay are clear illustrations that switch languages are an empirical reality. (Chapter 4) An OT analysis of their stress patterns requires no special mechanism, unlike earlier analyses (e.g. Hyde 2002), because the switching of foot type is an expected side effect of alignment and rhythm constraints instead of requiring overlapping feet or other complications. Indications of foot boundaries and foot type in Yidiny come from reduplication, vowel deletion, and singing patterns -- but the primary evidence of foot type in both Yidiny and Wargamay is regular lengthening of stressed vowels in words with iambs but not in words with trochees.

A typological survey of trochaic languages reveals two kind of vowel lengthening: a general process of word-final or phrase-final lengthening, and lengthening in order to meet minimal foot or word requirements. (Chapter 5) Mohawk is an example of a trochaic language which seems at first glance to require a regular process of lengthening stressed vowels (as found in iambic languages). Upon closer examination, it becomes clear that vowel lengthening only occurs in Mohawk to create a minimal foot, given the constraints imposed by nonfinality and right-alignment; it is not the case that every stressed vowel is long, as there are words like {(té.ke).riks} with a stressed light syllable.

Theoretical Consequence

The existence of switch languages is not obvious, since their stress patterns are compatible with an all-iambic or all-trochaic analysis. However, since switch languages are an empirical reality, the fact that they are an unavoidable consequence of OT is a benefit and not a detriment. Rather than requiring special mechanisms to account for the switching foot types in Yidiny and Wargamay, basic constraints are sufficient to produce switch languages. These basic constraints -- parsing constraints (PARSESYLL or FTBIN), rhythm constraints (*CLASH or *LAPSE), and alignment constraints -- are key components in the analysis of several aspects of metrical phonology.

Kager (2001) proposes doing away with foot alignment constraints in favor of an expanded set of rhythm constraints; however, the key feature of alignment constraints that produces switching is still required even in his system. In order to account for languages like Tunica, there must be some constraint that requires main stress at the left edge of the word.

(2) Left-aligned sparse trochaic language

Language	2 σ	3 σ	4 σ	5 σ
Tunica	[Xu]	[Xu]-o	[Xu]-o-o	[Xu]-o-o-o

Having a single trochee at the left edge of the word is disfavored by rhythm; with at least one unparsed syllable to the left of the trochee, a *LAPSE violation can be avoided.

(3) *LAPSE violations in five-syllable word

	*LAPSE
[Xu]-o-o-o	3
o-[Xu]-o-o	2
o-o-[Xu]-o	2
o-o-o-[Xu]	2

A purely rhythmic account could not account for Tunica's initial stress; there must be some constraint that can detect whether or not there is a foot at the left edge of the word.

Chapter 2 explores different definitions of alignment constraints, but any definition that yields a true alignment constraint -- one that meets the bare minimum requirements to produce a language like Tunica -- will also yield switch languages. Chapter 3 proves this point by stripping away everything but the three constraint types that combine to create switch languages and showing that it is impossible to avoid a language which alternates foot type.

Future Research

Chapter 5's investigations into trochaic lengthening raise the question of how foot form constraints should be defined. Prince and Smolensky (1993/2002) have a single foot type constraint, RHTYPE=I/T, which is set like a parameter to either RHTYPE=I or RHTYPE=T. With two distinct foot type constraints, it is possible to have symmetrical constraints that do not penalize unary feet, symmetrical constraints that penalize unary feet, or asymmetrical constraints where Trochee penalizes unary feet but Iamb does not (e.g. Tesar 1995, Kager 2001, Alber and Prince). It is further possible to encode information about the relative goodness of a foot type in the constraint definitions, for instance a constraint which penalizes LL iambs but not LH iambs. A systematic study of the typological results of different foot type constraints, similar to the undertaking with alignment constraints in Chapter 2, would be a valuable investigation and is likely to reveal some unexpected consequences.

Conclusion

This dissertation connects a theoretical consequence of OT and an attested phenomenon. Given the nature of alignment constraints, it is impossible to avoid switch languages by redefining those constraints while still retaining the essential properties of a true alignment constraint. No matter what definition of alignment constraint used, as long as it has the key property of an alignment constraint, a switch language will be predicted in the typology. Switch languages are an empirical reality, as illustrated by Yidiny and Wargamay. The fact that switch languages are a consequence of Optimality Theory is a benefit to the framework, since no special apparatus is needed to account for the stress pattern and footing of these languages. Instead, an empirical phenomenon and a theoretical consequence comport elegantly.

Appendix 1

Chapter 2 Constraint Definitions

The following are the constraint definitions used to automatically calculate violations for the typologies in Chapter 2. The built-in candidate generator in OTWorkplace was used to generate candidates of up to seven syllables. Binary feet were schematized as *[Xu]* or *[uX]*, unparsed syllables as *o*, and word boundaries as *{ }*. Feet and unparsed syllables were separated from each other by -, but there was no spacer next to a word edge. An example candidate with two trochaic feet and three unparsed syllables would look like this: {[Xu]-[Xu]-o-o-o}.

String Searches

For constraint definitions that searched for a string and counted the number of occurrences, the following VBA macro was used:

OccurStr

```
Function OccurStr(ByVal config As String, ByVal cand As String)
As Long

Dim P As Long, LastP As Long, n As Long

P = InStr(1, cand, config)
Do While P
    n = n + 1
```

```
        LastP = P
        P = InStr(LastP + 1, cand, config, 0)
    Loop

    OccurStr = n

End Function
```

System Zero Definitions

All of the System Zero constraints simply searched for a string and counted how many times it occurred. If more than one string incurs a violation, each string is separated by a comma.

*LAPSE:	*o-o, o-[u, u]-o, u]-[u
*CLASH:	*X]-[X
PARSESYLL:	*o
FTBIN:	*[X]
TROCHEE:	*[uX], [X]
IAMB:	*[Xu]

SyllSyll Alignment Constraints (Between and Adjacent)

For both the Between Alignment Constraints and the Adjacent Alignment Constraints, the SYLLSYLL constraint assigned the same number of violations for every candidate of the same length. Because insertion and deletion were not being considered, the SYLLSYLL constraints gave the same number of violations to every member of a candidate set. As a result, no typologies were calculated for these constraints -- and so no constraint definitions were needed for *σ/…σ (BSYLLSYLL) or *σ/σ (ASYLLSYLL).

Between Alignment Constraints: String Searches

Two of the nine Between Alignment Constraints were also calculated by searching for an illicit string and tallying the occurrences.

*-o-/…σ	(BUSYLLSYLL):	*o-
*F/…σ	(BFTSYLL):	*]-

Between Alignment Constraints: Macros

The remaining six Between Alignment Constraints used VBA macros to calculate their violations. The following macros were utilized in the constraint definition: FindLastUSyll, FindLastFt, and FindFirstFt.

FindLastUSyll

```
Function FindLastUSyll(ByVal cand As String) As Long


Dim pos As Long
Dim isUSyll As String


For pos = Len(cand) To 1 Step -1   ' start at the end of the word
    isUSyll = Mid(cand, pos, 1)     ' take off a chunk that is one
segment long
    FindLastUSyll = pos
        If isUSyll Like "o" Then    ' is it an unparsed syllable?
            FindLastUSyll = pos - 1 ' if so, set that as the
value
    If FindLastUSyll <> pos Then Exit Function
    End If
Next pos


FindLastUSyll = 0    ' if you never found an unparsed syllable,
return zero


End Function
```

FindLastFt

```
Function FindLastFt(ByVal cand As String) As Long


Dim pos As Long

Dim isFt As String


For pos = Len(cand) To 1 Step -1

    isFt = Mid(cand, pos, 2)

    FindLastFt = pos

        If isFt Like "[X-Y,x][X-Y,x]" Or isFt Like "?[X,Y]" Then

            FindLastFt = pos - 1

    If FindLastFt <> pos Then Exit Function

    End If

Next pos


FindLastFt = 0


End Function
```

FindFirstFt

```
Function FindFirstFt(ByVal cand As String) As Long

Dim pos As Long
Dim isFt As String

For pos = 1 To Len(cand) Step 1
    isFt = Mid(cand, pos, 2)
    FindFirstFt = pos
        If isFt Like "[X-Y,x][X-Y,x]" Then
            FindFirstFt = pos + 2
        ElseIf isFt Like "[X-Y]?" Then
            FindFirstFt = pos + 1
        End If
    If FindFirstFt <> pos Then Exit Function
Next pos

FindFirstFt = 0

End Function
```

The VBA macro definitions for the remaining six Between Alignment Constraints are listed below.

*-o-/…-o- (BUSYLLUSYLL):

```
Function USyllUSyll(ByVal cand As String) As Long

Dim short As String

USyllUSyll = OccurStr("o", cand) - 1

End Function
```

*σ/…-o- (BSYLLUSYLL):

```
Function SyllUSyll(ByVal cand As String) As Long

Dim short As String

short = Mid(cand, 1, FindLastUSyll(cand))
short = WorksheetFunction.Substitute(short, "-", "")
short = WorksheetFunction.Substitute(short, "{", "")
short = WorksheetFunction.Substitute(short, "}", "")
short = WorksheetFunction.Substitute(short, "[", "")
short = WorksheetFunction.Substitute(short, "]", "")
SyllUSyll = Len(short)

End Function
```

*F/…-o- (BFTUSYLL):

```
Function FtUSyll(ByVal cand As String) As Long

Dim short As String

short = Mid(cand, 1, FindLastUSyll(cand))
short = WorksheetFunction.Substitute(short, "-", "")
short = WorksheetFunction.Substitute(short, "{", "")
short = WorksheetFunction.Substitute(short, "}", "")
short = WorksheetFunction.Substitute(short, "[", "")
short = WorksheetFunction.Substitute(short, "X", "")
short = WorksheetFunction.Substitute(short, "o", "")
short = WorksheetFunction.Substitute(short, "u", "")
FtUSyll = Len(short)

End Function
```

*σ/…F (BSYLLFT):

```
Function FAL(ByVal cand As String) As Long


Dim short As String


short = Mid(cand, 1, FindLastFt(cand))
short = WorksheetFunction.Substitute(short, "-", "")
short = WorksheetFunction.Substitute(short, "{", "")
short = WorksheetFunction.Substitute(short, "}", "")
short = WorksheetFunction.Substitute(short, "[", "")
short = WorksheetFunction.Substitute(short, "]", "")

FAL = Len(short)

End Function
```

*-o-/…F (BUSyllFt):

```
Function USyllFt(ByVal cand As String) As Long

Dim short As String

short = Mid(cand, 1, FindLastFt(cand))
short = WorksheetFunction.Substitute(short, "-", "")
short = WorksheetFunction.Substitute(short, "{", "")
short = WorksheetFunction.Substitute(short, "}", "")
short = WorksheetFunction.Substitute(short, "[", "")
short = WorksheetFunction.Substitute(short, "]", "")
short = WorksheetFunction.Substitute(short, "X", "")
short = WorksheetFunction.Substitute(short, "u", "")
USyllFt = Len(short)

End Function
```

*F/…F (BFtFt):

```
Function CatAlignFt(ByVal cand As String) As Long

Dim short As String

CatAlignFt = OccurStr("[", cand) - 1

End Function
```

Adjacent Alignment Constraints: String Searches

All of the Adjacent Alignment Constraints (other than SYLLSYLL, described above) were calculated by searching for a banned sequence and counting occurrences using OccurStr. The strings used are listed below.

*-o-/-o-	(AUSYLLUSYLL):	*o-o
*F/F	(AFTFT):	*]-[
*σ/-o-	(ASYLLUSYLL):	*-o
*σ/F	(ASYLLFT):	*-[
*-o-/F	(AUSYLLFT):	*o-[

Appendix 2

Chapter 4 and 5 Constraint Definitions

The analyses of Yidiny and Wargamay from Chapter 4 utilize the System Zero constraint definitions defined in Appendix 1, along with OTWorkplace's built-in constraint definition for All-Feet-Left.

The Mohawk data in Chapter 5 was schematized differently from the candidates in Chapters 2 and 4. Underlying consonants in onset or coda position were schematized as *c*, except glottal stop which was *t*; epenthesized consonants were *z*. Unstressed underlying vowels were *v*, epenthetic unstressed vowels were *e*; stressed underlying vowels were *A* and epenthetic stressed vowels were *E*. Vowel lengthening was indicated with *M* (or *m* if unstressed), while shortening was indicated with a '-' after the shortened vowel; underlying long vowels were marked with ':'. A lengthened underlying vowel is therefore *AM* and an long epenthetic vowel is *EM*. Syllable boundaries were marked with '.' while foot and word boundaries were indicated with *[ ]* and *{ }*, respectively.

Utilizing the above schematization, the constraints for Mohawk searched for strings using OccurStr (defined in Appendix 1) and calculated violations accordingly. All input vowels were short in the first stratum, so shortening was only a possibility in the second stratum; the following definitions were used to calculate violations in the first stratum (when there were no '-' or ':' in the candidates) and adjusted to account for candidates with shortening in the second stratum.

ALIGNMORPHR	*e}
*V:	*M, :
IDENTLENGTH	*M, -
*Cʔ	*ct, zt, c.t, z.t, c).t, z).t, c.(t, z.(t
*CLUSTER	*cc
HEADDEP	*E
NONFINALITY	*]}
DEPC	*z
DEPV	*e, E
WTS	*cvc, cec, cvz, cez, vm, em
*LONGEP	*EM
IAMB	*(cA., (cAM., (cE., (cEM., (cAc., (cAMc., (cEc., (cEMc., (cAz., (cAMz., (cEz., (cEMz. (A., (AM., (E., (EM., (Ac., (AMc., (Ec., (EMc., (Az., (AMz., (Ez., (EMz.
SYLLABICTROCHEE	*A), AM), E), EM), Ac), AMc), Ec), EMc), Az), AMz), Ez), EMz), AMcc), Ecc), EMcc), Act), AMct), Ect), EMct)
MORAICTROCHEE	*.cA), .cAM), .cE), .cEM), .cAc), .cAMc), .cEc), .cEMc), .cAz), .cAMz), .cEz), .cEMz), .cAcc), .cAMcc), .cEcc), .cEMcc), .cAct), .cAMct), .cEct), .cEMct), (cA), (cE), (A), (E), .AM), .EM), .A), .E), .Ac), .AMc), .Ec), .EMc), .Az), .AMz), .Ez), .EMz), .Acc), .AMcc), .Ecc), .EMcc), .Act), .AMct), .Ect), .EMct)

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