

ON THE SPECIAL ROLE OF FAITHFULNESS CONSTRAINTS IN MORPHOLOGY-SENSITIVE  
PHONOLOGY: THE M-FAITHFULNESS MODEL

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## ABSTRACT

MATT FULLER: On The Special Role of Faithfulness Constraints in Morphology-Sensitive Phonology: The M-Faithfulness Model

(Under the direction of Jennifer L. Smith)

A number of accounts of morpheme boundary-sensitive phonology have been proposed - Stratal OT (Bermúdez-Otero 2013), Coloured Containment (van Oostendorp 2007), Local Constraint Conjunction (Lubowicz 2002). This thesis considers a number of case studies and demonstrates that none among these existing models can account for the range of boundary-sensitive phonological processes which exist. A new model, M-Faithfulness, is presented which can successfully analyze all of these case studies, including those which other models cannot. The M-Faithfulness model includes two crucial points - one, faithfulness constraints may refer to morphological information in the input only, and two, these faithfulness constraints may target non-morpheme-peripheral material. Along these lines, a new constraint family, M-IDENT, is proposed which extends the idea of IDENT constraints to specifically target morpheme-internal information.

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# CHAPTER 1

## INTRODUCTION

The interaction between phonology and morphology is a complex one which has been the subject of a great deal of research and a wide variety of theoretical approaches have been developed to account for it. The complex nature of this interaction is evident from the types of linguistic patterns which arise from it. Phonology may condition morphology in various ways, notably through allomorph selection and suppletive allomorphy, infixation (Yu 2007), and conditioning of morphological gaps, among others (Inkelas 2011). Conversely, morphological information also factors into phonological generalizations, particularly through the importance of morphosyntactic category (Smith 2010, 2012), morphological paradigmatic considerations like paradigm contrast or paradigm uniformity (Inkelas 2011), and conditioning of phonological processes or distributions (Inkelas 2011; Anttila 2002). The focus of this thesis will be on this last category, morphological conditioning of phonological processes and distributions - specifically boundary-sensitive phonological phenomena.

Another way to envision the influence of morphology on phonological generalizations is specifically from the perspective of phonology. Some phonological processes are conditioned by strictly phonological information and others are conditioned by a collection of phonological, morphological, and lexical information. This second class of pattern is one which poses interesting questions regarding the nature of theoretical models of grammar. Grammatical theories must be able to account for this interaction between phonology and morphology.

Historically, this interaction has been approached using models which characterize the relationship between different grammatical modules in very different ways. The late structuralists posited a highly modular grammar with sharp divisions between different grammatical domains that allowed little interaction between

them (Anttila 2002; Harris 1951). On the other hand, the influential rule-based approach of SPE (Chomsky and Halle 1968) laid out a framework in which phonological rules were free to refer to any grammatical or lexical information as conditioning factors. More recent models generally fall between these two extremes by more specifically characterizing how morphology may exert influence over phonology. Some such models include Stratal OT (Bermúdez-Otero 2011, 2012, 2013; Bermúdez-Otero and McMahon 2006; Kiparsky 2000), which may be seen as a specific type of cophonology approach (Inkelas and Zoll 2007; Anttila 2002), Coloured Containment (van Oostendorp 2006, 2007), Local Constraint Conjunction (Lubowicz 2002, 2003), constraint indexation (McCarthy and Prince 1995; Smith 1997; Pater 2000), and even some approaches within stochastic OT (Evanini 2007).

These models seek to capture different aspects of phonology-morphology interaction. Evanini's Stochastic OT approach and the constraint indexation approaches can be used to capture patterns sensitive to morphosyntactic category, but offer little unique insight into boundary-sensitive phonology. For this reason, this thesis will primarily address three of the above-mentioned theoretical frameworks which are designed to handle boundary-sensitive cases. These three are Stratal OT, Coloured Containment, and Local Constraint Conjunction.

None of these three models, however, can account for all attested types of boundary-sensitive processes. So, a new model or extension is needed to capture the variety of phonological processes at hand. This thesis presents such a new model, called M-Faithfulness, which can explain cases other models cannot. The central tenet of M-Faithfulness is that faithfulness constraints may refer to morphological structure in the input only. This arises out of the necessity to address *non-morpheme-peripheral* content to protect it using faithfulness constraints. These two points are the crucial aspects of M-Faithfulness theory which allow it to account for boundary-sensitive phonology. M-Faithfulness strikes a balance between limiting the ability of OT constraints to refer to non-phonological information in the interest of preserving modularity, and allowing the necessary interaction between morphology and phonology.

The second chapter of this thesis contains a description of these three theoretical models, and explains their handling of boundary-sensitive phonology. When possible, this description intends to highlight the specific restrictions unique to each model which limit or characterize its application to boundary-sensitive

phonology. The second chapter also presents the M-Contiguity model proposed by Landman (2003), which forms an important part of the proposed M-Faithfulness model. The third chapter introduces the M-Faithfulness model, as well as the M-IDENT constraint family. The fourth chapter presents a number of case studies from a variety of languages that demonstrate the failure of existing models and the success of the new M-Faithfulness model in the analysis of these cases. A brief summary of the languages and processes analyzed can be seen in the chart in (1)<sup>1</sup>.

(1) Summary of Languages

Language	Process	Source
Banoni (Austronesian)	Vowel Deletion	Lincoln 1976; Crowley et al. 2002
Macuxi (Cariban)	Vowel Reduction	Carson 1982
Anywa (Nilo-Saharan)	Stop Distribution	Reh 1996
Korowai (Trans-New Guinea)	/t/ → [l] and /p/ → [ɸ]	van Enk and de Vries 1997
Kashmiri (Indo-Aryan)	Deaspiration	Wale and Koul 1997
Sawai (Austronesian)	Stopping	Whisler 1992
Maale (Omotic)	Glottalization	Amha 2001

The fifth and final chapter discusses the M-Faithfulness model in the context of broader linguistic theory. Specifically, it first addresses M-Faithfulness in relation to the other theoretical frameworks at hand. Second, it presents a case study from Maale which initially appears problematic for M-Faithfulness and discusses the theoretical implications. And finally, it addresses the relationship between M-Faithfulness and other theories of positional faithfulness, and the typological predictions rendered.

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<sup>1</sup>In the interest of uniformity, language families are reported as listed in Ethnologue (Lewis et al. 2013)

## CHAPTER 2

### MODELS

This chapter will present three existing models which have been developed to account for some cases of boundary-sensitive phonology. Stratal OT is presented in section 2.1, Coloured Containment in section 2.2, and Local Constraint Conjunction in section 2.3. M-Contiguity, an existing model incorporated into the newly proposed M-Faithfulness approach, is presented in section 2.4. Finally, section 2.5 discusses these models, highlighting the essential aspects of each model which allow for them to account for specific types of boundary-sensitive phonological processes.

#### **2.1 Stratal OT**

One theory which attempts to account for certain types of phonology-morphology interaction is Stratal OT (Kiparsky 2000; Bermúdez-Otero and McMahon 2006; Bermúdez-Otero 2011, 2013). This theory attempts to preserve a certain degree of modularity in grammar by specifically constraining the way in which morphology can influence phonology. This conditioning arises through the triggering of phonological cycles by morphosyntactic constructions - increasingly large morphosyntactic domains trigger different phonological cycles. Precise conceptions of what exactly the relevant domains are differ, but the predominant model includes a stem-level, word-level, and phrase-level cycle (Bermúdez-Otero 2013). These cycles apply iteratively to an input, with some morphosyntactic operations occurring in between phonological cycles, and the output of one cycle serving as input to the next. This could be understood as a sequential process which alternates between morphological and phonological computation. At each level, morphology precedes phonology (i.e.

stem-level morphology precedes stem-level phonology), and cycles occur in order of increasing size (stem-level precedes word-level, which precedes phrase-level).

Take as an illustrative example Northern Irish English (NIE) dentalization discussed in (Harris 1989; Bermúdez-Otero and McMahon 2006). In NIE, coronal non-continuants /t d n l/ are dental before /ɪ ə/ and alveolar otherwise. So, for instance, the phonetic realization of ‘train’, ‘drain’, ‘minor’, and ‘pillar’ include dental consonants ([t̪]rain, [d̪]rain mi[n̪]or, pi[l̪]ar). This dentalization, however, takes place only when the coronal non-continuant and the conditioning liquid are a tautomorphemic sequence or the conditioning liquid is part of a class I affix (e.g. sani[t̪]ary). When the conditioning environment is met only through class II affixation, compounding, or syntactic concatenation, then no dentalization occurs. So, in ‘miner’, ‘footrest’, and ‘good riddance’, there is no dentalization (mi[n]er, foo[t]rest, goo[d] riddance).

The stratal OT account of this pattern argues that in NIE, dentalization is a stem-level process, and that class II affixes are word-level affixes (and compounding and syntactic concatenation are not stem-level processes). So, the constraint ranking for stem-level evaluation enforces dentalization (and the ranking at word-level evaluation doesn’t). In cases like ‘miner’, the conditioning environment for dentalization has not been met at the stem-level, and so the /n/ is not dentalized. Once the agentive -er affix is added, the conditioning environment for dentalization is met, but the constraint ranking no longer enforces the dentalization, so the /n/ remains alveolar. (2) provides an illustration of dentalization in tautomorphemic and class I affixation (minor, elementary) and lack of dentalization in an example with class II affixation (miner).

		‘miner’	‘minor’	‘elementary’
	<b>Stem Level</b>	/main/	/mainə/	/ɛləmənt+ɹi/
(2)	Dentalization	–	[main̪ə]	[ɛləmənt̪.ɹi]
	<b>Word Level</b>	/main+ə/	–	–
	Result:	[main̪ə]	[main̪ə]	[ɛləmənt̪.ɹi]

Stratal OT successfully handles some boundary-sensitive phonological processes, such as NIE dentalization, but other boundary-sensitive processes require locality (for instance, processes which occur only at morpheme boundaries). One such example is Korean palatalization. In Korean, /t, t<sup>h</sup>/ palatalize to [tʃ, tʃ<sup>h</sup>]<sup>1</sup> before

<sup>1</sup>As Korean has an unrelated process wherein unaspirated stops are voiced, palatalized /t/ often surfaces as [dʒ]

the high front vowel [i], but only when the /t, t<sup>h</sup>/ and the /i/ are part of a heteromorphemic sequence (van Oostendorp 2006; Lubowicz 2002). Consider the two examples in (3).

- (3)     a) /mati/ → [madi] ‘knot’  
           b) /hɛ+tot+i/ → [hɛdodʒi] ‘sunrise-NOM’

In (3a), the /ti/ form a tautomorphemic sequence, and so no palatalization occurs, while in (3b) the /ti/ sequence is heteromorphemic and so the /t/ is palatalized. Consider a hypothetical form /tit+i/. The predicted phonetic form based on the phonological generalizations would be [tidʒi] - the first /t/ remains unpalatalized and the second palatalizes. Attempting to account for these facts in Stratal OT reveals the locality problem. The forms in (3) can be generated correctly, but the hypothetical form /tit+i/ demonstrates that stratal OT does not correctly predict [tidʒi] as the output form. Palatalization is assigned to the word level in (4) in order to generate the correct output forms for the examples in (3).

	‘knot’	‘sunrise-NOM’	hypothetical form
<b>Stem Level</b>	/mati/	/hɛ/, /tot/	/tit/
(4) <b>Word Level</b>	–	/hɛ+tot+i/	/tit+i/
Palatalization	–	[hɛdodʒi]	[tʃidʒi]
Result:	[madi]	[hɛdodʒi]	*[tʃidʒi]

The model of Stratal OT which correctly predicts the output forms for examples in (2) incorrectly predicts [tʃidʒi] as the output form for hypothetical /tit+i/ because the palatalization process takes place in the tautomorphemic /ti/ sequence, as well as the heteromorphemic one. The palatalization cannot be restricted to the /t/ occurring at the morpheme boundary. Several theories aiming to explain such boundary-sensitive processes as Derived Environment Effects (DEE) have been developed which are able to constrain processes so that they only occur at morpheme boundaries. Two such theories are Coloured Containment (van Oostendorp 2006) and Local Constraint Conjunction (Lubowicz 2002) which can both handle an example like Korean palatalization, though in very different ways.

## 2.2 Coloured Containment

Coloured Containment is a theory which is an alternative to the popular correspondence theory (McCarthy and Prince 1995) and can explain certain types of boundary-sensitive phonological processes. In particular, Coloured Containment excels at explaining processes which involve spreading across morpheme boundaries. Under containment theory, morphemes, features, and association lines between morphemes and features are all colored according to morpheme. So, for instance, in /hɛ+tot+i/, the morpheme /tot/ and its accompanying segmental feature values and association lines are of one color while those of the suffix /i/ are another. Additionally, newly formed association lines (e.g. due to spreading) are colorless. According to coloured containment, colorless association lines may not link elements of the same color, only elements of two different colors. This restriction, called ALTERNATION by Oostendorp, is the crucial aspect of coloured containment which allows it to account for cases such as Korean.

- (5) ALTERNATION - If an association line links two elements of color  $\alpha$ , the line should also have color  $\alpha$ .

(van Oostendorp 2006:95)

Under Oostendorp's (2006; 2007) analysis, Korean palatalization involves spreading of the [+high] feature from /i/ to the preceding /t/ or /t<sup>h</sup>/. In cases like /mati/ - 'knot' this spreading cannot happen, as the /t/ and the [+high] feature associated with /i/ are both part of the same morpheme, and thus similarly colored and the newly formed (colorless) association line linking [+high] to /t/ would be linking two elements of the same color (violating ALTERNATION). In /hɛ+tot+i/ - 'sunrise-NOM' palatalization is allowed, because the [+high] feature is not the same color as /t/, as they belong to different morphemes. In this case, the newly formed colorless association line links elements of different colors, and ALTERNATION is not violated. (5) demonstrates the allowed palatalization in [tod<sub>3</sub>+i] and why palatalization is banned in [madi] (i.e. why \*[mad<sub>3</sub>i] is not allowed).

In this example, subscripts represent colors.



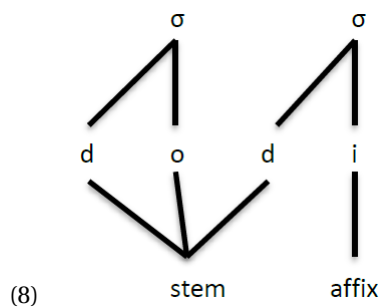
In (6a), [dʒ] and [+high] are different colors (colors  $\alpha$  and  $\beta$ , respectively) because they belong to different morphemes, and so the colorless (black) association line may link the two, resulting in spreading of [+high] from [i] to the preceding consonant. In (6b), [dʒ] and [+high] are the same color (color  $\gamma$ ), and so the colorless association line linking them violates ALTERNATION.

## 2.3 Local Constraint Conjunction

Local Constraint Conjunction is another theory which can account for certain types of boundary sensitive phonological effects through the use of conjoined constraints. In particular, it accounts for boundary-sensitive processes which involve a prosody-morphology misalignment (i.e. when syllable and stem boundaries do not coincide). A conjoined constraint is a combination of a markedness constraint and a faithfulness constraint that is violated whenever both of the component constraints are violated within the same domain specified by the constraint. Conjoined constraints are denoted and defined as in (7).

- (7) The Local Conjunction of  $C_1$  and  $C_2$  in domain  $D$ ,  $[C_1 \ \& \ C_2]_D$  is violated whenever there is some domain of type  $D$  in which both  $C_1$  and  $C_2$  are violated. (Smolensky 1993 via Lubowicz 2002:5)

This mechanism can be used to explain cases of phonological and morphological derived environment effects (which include some types of boundary sensitive phonological processes like Korean palatalization). The key to explaining Korean palatalization with local constraint conjunction is the fact that in cases with palatalization, there is a misalignment of syllable and stem edges - shown in (8). The [dʒ] is at the right edge of the stem, but the left edge of a syllable.




The right edge of the stem does not coincide with the right edge of a syllable in each case in which there is palatalization. This is crucial in explaining the boundary-sensitive nature of the palatalization in Korean, and


indeed a general property of boundary-sensitive phonological processes which can be explained by local constraint conjunction. The reason this mismatch is necessary, is that the faithfulness constraint involved must be an ANCHOR family constraint. That is to say, the ANCHOR constraint is the single element which provides the link between phonology and morphology under the Local Conjunction approach. Only through the use of an ANCHOR constraint is the process in question localized to a morpheme boundary. The constraints given in (9) and the tableaux in (10) illustrate how palatalization occurs only across morpheme boundaries, and not in tautomorphemic sequences of /ti/ (the voicing alternation is not analyzed here, so stops are transcribed as having the same voicing as their surface correspondents).

- (9) a) PAL - Assign one \* for each [+ant, -cont] ([t, t<sup>h</sup>, d]) segment before a [+high] segment in the output
- b) IDENT[PLACE] - Assign one \* for each segment in the output whose place node does not match that of its input correspondent
- c) IDENT[strident] - Assign one \* for each segment in the output whose [+/-strident] value does not match that of its input correspondent
- d) R-ANCHOR(stem;  $\sigma$ ) - Assign one \* for each segment which is the rightmost segment of a stem in the input that does not have a correspondent at the rightmost edge of a syllable in the output
- e) [PAL & R-ANCHOR]<sub>AdjSeg</sub> - Assign one \* for each sequence of adjacent segments which includes a violation of PAL and R-ANCHOR. This constraint is abbreviated [PAL & ANCHOR] in tableaux.


- (10) a) Palatalization in heteromorphemic sequences

/ {hɛ+dod} <sub>stem</sub> +i/	[PAL & ANCHOR]	IDENT[PLACE]	IDENT[strident]	PAL
a. [hɛ.do.di]	*!			*
b.  [hɛ.do.dʒi]		*	*	

- b) No palatalization in tautomorphemic sequences

/ {madi} <sub>stem</sub> /	[PAL & ANCHOR]	IDENT[PLACE]	IDENT[strident]	PAL
a.  [ma.di]				*
b. [ma.dʒi]		*!	*	

- c) Palatalization is localized to only cases at morpheme boundaries

/{tid} <sub>stem</sub> +i/		[PAL & ANCHOR]	IDENT[PLACE]	IDENT[strident]	PAL
a.	[ti.di]	*!			**
b.	 [ti.dʒi]		*	*	*
c.	[tʃi.dʒi]		**!	**	
d.	[tʃi.di]	*!	*	*	*

## 2.4 M-Contiguity

A fourth approach which can sometimes account for boundary-sensitive phonological phenomena is one known as Morphological Contiguity, or M-Contiguity (Landman 2003). This approach builds on earlier approaches to contiguity (Kenstowicz 1994; McCarthy and Prince 1995) and posits a family of four constraints defined as in (11) (definitions taken from (Landman 2003:7)).

- (11) a) M-I-CONTIG ("No M-internal deletion") - The portions of the input standing in correspondence and belonging to the same M form contiguous strings
- b) M-O-CONTIG ("No M-internal insertion") - The portions of the output standing in correspondence and belonging to the same M form contiguous strings

Where  $M \in \{\text{morpheme, stem}\}$

This family of constraints can handle certain cases of boundary-sensitive phonology, specifically those which involve insertion or deletion only at a morpheme (or stem) boundary. This could potentially remedy some of the limitations of the Coloured Containment approach, which can explain only cases of spreading at morpheme boundaries, not deletion or insertion.

For an example, take the case of Guhaŋ Ifugao ?-insertion described in (Landman 2003) (there is a very similar pattern in Standard German described in (Landman 2003; Alber 2001) as well). Stem-initial syllables require onsets, while morpheme-internal syllables and suffix-initial syllables do not - see (12).

- (12) a) **Forms with ?-insertion**

ʔiŋŋi - 'baby girl'

ʔume - 'go'

ʔalgo - 'sun, day'

b) **Monomorphemic forms containing onsetless syllables**

ʔi.a.lim - 'bring'

ha.i.tan - 'whet stone'

bu.ma.nu.at - 'smolder'

c) **Prefix-initial onsetless syllables**

/manigo+aʔ/ → [ma.ni.go.aʔ] - 'I am looking for'

/lele+on/ → [le.le.ɔn] - 'make wider'


/agge+aʔ/ → [ʔag.ge.aʔ] - 'I did not'

M-Contiguity models can explain this type of pattern through the use of the STEM-O-CONTIG constraint, as demonstrated in (15)-(16). The winning candidate has ʔ-insertion to repair the stem-initial onsetless syllable but not the stem-internal one, as the STEM-O-CONTIG constraint prevents stem-internal insertions while allowing stem-peripheral ones.

(13)

(14) ONSET - Assign one \* for each syllable without an onset (Adapted from (Prince and Smolensky 1993))

(15) DEP - Assign one \* for each segment in the output without an input correspondent (Adapted from (McCarthy and Prince 1995))

(16)	/ {stem agge+aʔ} /			
		STEM-O-CONTIG	ONSET	DEP
	a.  [ʔag.ge.aʔ]		*	*
	b. [ʔag.ge.ʔaʔ]	*!		**
c. [ag.ge.aʔ]			**!	

While this family of contiguity constraints can help to explain certain types of boundary sensitive deletion and epenthesis processes, it is not compatible with some other models (notably Stratal OT). Stratal OT places specific restrictions on the nature of phonological constraints, and the information available to them, and

stipulates that they may refer only to phonological information. Bermúdez-Otero makes this claim explicit: "In line with its modular approach to the morphosyntax-phonology interface, Stratal OT imposes strict limits on the ability of phonological constraints to refer to extraphonological information..." (2013). M-Contig constraints clearly do refer to extraphonological information, and to the extent a model forbids such constraints, this set of constraints is incompatible with that model.

The M-Contiguity constraint family is fully compatible with M-Faithfulness, in that it is a collection of faithfulness constraints which refer to morphological structure in the input. It is, in fact, an essential part of M-Faithfulness, and complements the newly proposed M-IDENT constraint family well. M-Contiguity provides an approach to making insertion and deletion sensitive to morpheme boundaries, and M-IDENT provides a way to make featural alternations similarly sensitive.

## 2.5 Comparison

One of the most glaring problems with a simple Stratal OT model is that there is no way to explain certain boundary-sensitive phonological processes like palatalization in Korean. Stratal OT is particularly effective at explaining certain sorts of boundary-sensitive processes. It is well suited to cases such as NIE dentalization when a morphological boundary *blocks* a process, rather than conditions it. It can also explain some cases which take place at a position which can be targeted as domain-initial or domain-final in one of its three cycles, as this allows it to target boundaries without explicitly referring to them. The cases like Korean palatalization are problematic because they exhibit a certain property - they are conditioned by a boundary, as well as some material on both sides of the boundary. In Korean, for instance, the palatalization happens only at morpheme boundaries (it is conditioned by the boundary), and requires a high vowel on one side of it and an anterior coronal stop on the other.

Coloured Containment and Local Constraint Conjunction are two theories which provide methods of handling certain types of boundary-sensitive processes, including some (like Korean) which are problematic for Stratal OT. In each of the two models, there are specific restrictions on the nature of the cases they can explain, because of the way in which they capture the boundary-sensitive aspect of cases like Korean.

Coloured Containment relies on the restriction ALTERNATION to ensure that processes like Korean palatal-

ization happen only at morpheme boundaries. The crucial aspect here is that the processes requiring locality can be explained if they involve featural spreading (i.e. they are cases of assimilation). Oostendorp specifically states this requirement: "I propose a different diagnostic here: [derived environment effects] will always involve spreading" (2006:94).

Local Constraint Conjunction incorporates boundary sensitivity by using a conjoined constraint composed of some markedness constraint conjoined with a syllable-stem anchor constraint. The syllable-stem misalignment exhibited by Korean is a crucial aspect of cases which can be explained by local constraint conjunction. Lubowicz also makes this restriction explicit: "...all legitimate cases of morphologically-derived environments always involve misalignment of stem and syllable edges" (2002:255).

While Coloured Containment and Local Constraint Conjunction can explain some of the same cases of boundary-sensitive phonology (e.g. Korean), they place very different restrictions on what cases are possible to explain. Coloured containment requires that the processes involved be describable as spreading, while local constraint conjunction requires that there be a syllable-stem boundary misalignment. To the extent that cases of boundary-sensitive phonological processes exist which are not spreading and do not involve syllable-stem misalignment, there is a gap in the explanatory power of modern theories. Interesting cases to consider would meet the specific criteria listed in (17).

(17) Interesting cases must:

- a) Be sensitive to morpheme boundaries and require locality
- b) Not be cases of spreading
- c) Not involve syllable-stem misalignment

## CHAPTER 3

### M-FAITHFULNESS

Existing accounts of morpheme boundary-sensitive phonological processes, including Coloured Containment (van Oostendorp 2006, 2007), Stratal Optimality Theory (Bermúdez-Otero and McMahon 2006; Bermúdez-Otero 2011, 2013), and Local Constraint Conjunction (Lubowicz 2002, 2003) do not successfully explain all boundary-sensitive phenomena. The M-Contiguity model of (Landman 2003) can explain some of these phenomena, such as Banoni, but offers no help when there is no disruption of contiguity, as in many cases. As the cases in chapter 4 will demonstrate, a model is needed which incorporates morphological information differently than the models above. In an optimality theoretic framework, boundary-sensitive phenomena may be handled by allowing constraints which refer to morphology in some principled way.

There are two potential ways to do this - one which places the burden on markedness constraints, and the other which places the burden on faithfulness constraints. Under the first approach, markedness constraints explicitly refer to morpheme boundaries as conditioning environments. Under the second approach, markedness constraints may not refer to morpheme boundaries and act as normal markedness constraints do. Faithfulness constraints, on the other hand, can protect morpheme-internal underlying information while allowing changes at boundaries. These approaches are demonstrated in sections 3.1 and 3.2 and later discussed in section 3.3. While each approach has some advantages, the faithfulness model is clearly superior.

### 3.1 Faithfulness Approach (M-IDENT)


The faithfulness approach requires faithfulness constraints which protect morpheme-internal features, but not those at morpheme boundaries. In this respect, the constraints are very similar to Landman's (2003) M-Contiguity approach (that is, they have a similar effect). Her M-Contig constraints penalize disruptions of contiguity (i.e. deletion or epenthesis) morpheme-internally, but not at morpheme boundaries. The constraints I propose are similar in that they enforce identity between input and output morpheme-internally, but not at boundaries. Because of the similarity to M-Contig constraints, and the importance of morphology in them, these new identity constraints are known as M-IDENT constraints. This constraint family is defined as in (18).

- (18) M-IDENT[ $\alpha$ ] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [ $\pm \alpha$ ] feature


The Korean Palatalization example is formalized in the M-IDENT framework in (19) and (20).

- (19) a) M-IDENT[ant] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to [ $\pm$ ant]  
 b) PAL - Assign one \* for each [+ant -cont] segment before a [+high -back -cons] segment  
 c) IDENT[ant] - Assign one \* for each segment in the output which does not match its input correspondent with respect to [ $\pm$ ant]

- (20) a) **Palatalization at morpheme boundaries**

/hɛ+dod+i/	M-IDENT[ant]	PAL	IDENT[ant]
a.  [hɛdodʒi]			*
b. [hɛdodi]		*! W	L

- b) **No Palatalization morpheme-internally**

/madi/	M-IDENT[ant]	PAL	IDENT[ant]
a.  [madi]		*	
b. [madʒi]	*! W	L	* W

The M-IDENT constraint family offers an account of morpheme-internal preservation of feature values, but not prevention of epenthesis or deletion. Conversely, Landman's (2003) M-CONTIG constraint family prevents morpheme-internal deletion or insertion, but does not enforce featural identity between inputs and outputs. The two constraint families conspire to account for boundary-sensitive processes involving both insertion/deletion and featural alternations.

While M-IDENT and M-CONTIG constraints have similar practical aims, M-IDENT constraints are formally more similar to positional faithfulness approaches (e.g. Casali 1996, 1997; Beckman 1997), as they both directly reference (morpho-)phonological positions in a way that M-CONTIG constraints do not. Similarly, Casali's (1996) approach extends simple MAX constraints to target certain positions like M-IDENT constraints extend simple IDENT (see 21) constraints to target certain positions.

- (21) IDENT[ $\alpha$ ] - Assign one \* for each segment in the output which does not match its input correspondent with respect to the [ $\pm \alpha$ ] feature.

A crucial point arises in the formulation of M-IDENT constraints (or more generally, in a faithfulness-based model). That is, faithfulness constraints must be able to target *non-morpheme-peripheral* material. There are two ways this might be done - one which requires such reference *only in the input* (as is the case with M-IDENT), and the other which targets such material in the output.


The first option is preferable because it results in a simpler overall model. Referring to morphological structure in the output requires the presence of morpheme boundaries, introducing an additional representational element to the output which is otherwise unnecessary. Morphological structure is already available in the input as the result of lexical selection. This is a rather uncontroversial point, and even theoretical frameworks which strictly limit the ability of constraints to refer to non-phonological information (e.g. Stratal OT) allow for certain types of constraints which require access to some morphological structure (specifically, prosodic alignment constraints). So, under this model, faithfulness constraints may refer to morphological structure in the input only.

## 3.2 Markedness Approach


The obvious potential alternative to the faithfulness approach is one which relies on markedness constraints. An example of this approach applied to Korean Palatalization is shown in (22) and (23). The morphology-sensitive markedness constraint is (22a), and can be understood to be a morphology-sensitive version of the general markedness constraint PAL (22c).

- (22) a) \*[+ant]+i - Assign one \* for each [+ant -cont] segment before a [+high -back -cons] segment when separated by + (a morpheme boundary) in the output
- b) IDENT[ant] - Assign one \* for each segment in the output which does not match its input correspondent with respect to [±ant]
- c) PAL - Assign one \* for each [+ant -cont] segment before a [+high -back -cons] segment

- (23) a) **Palatalization at morpheme boundaries**

/hɛ+dod+i/	*[+ant]+i	IDENT[ant]	PAL
a.  [hɛ+dodʒ+i]		*	
b. [hɛ+dod+i]	*! W	L	* W

- b) **No Palatalization morpheme-internally**

/madi/	*[+ant]+i	IDENT[ant]	PAL
a.  [madi]			*
b. [madʒi]		*! W	L

The markedness constraints under this approach may freely refer to morpheme boundaries as they refer to other information such as featural content. The morphology-sensitive constraints penalize patterns that are generally marked, but only when they occur at morpheme boundaries (like \*[ant]+i vs. PAL).

## 3.3 Discussion

There are a number of advantages the M-IDENT faithfulness model has over the markedness model. The first of these is one of representational simplicity. The markedness approach refers to morpheme boundaries as

conditioning environments, and since markedness constraints refer only to the output, it requires that morpheme boundaries be present in the output. There is no such requirement under the M-IDENT approach, and morpheme boundaries can be eliminated from the output as a representational necessity. In this respect, the faithfulness approach allows for the necessary influence of morphology on phonology, while still maintaining some degree of modularity. The phonological input contains some morphological information, which is only available to constraints that refer to the input (i.e. faithfulness constraints), and the output is purely phonological. This is not the case with the markedness approach, in which the output of the phonological grammar includes morphological and phonological information.

Another advantage of M-IDENT over the markedness approach is that it is more specifically constrained. It only posits one family of straight-forwardly defined constraints (i.e. the M-IDENT family), while the markedness approach introduces a new representational element with no principled limit on how it may be referred to in constraints. The markedness constraint for any given process is a completely ad hoc constraint including a morpheme boundary. On the other hand, under the faithfulness approach, the markedness constraints involved are generally independently motivated (e.g. PAL for Korean Palatalization), and the faithfulness constraint is one from a simple family of constraints similar to the IDENT and M-CONTIG family of constraints.

The faithfulness approach also coincides with a number of other approaches in assigning a special role to faithfulness constraints with regard to phonology-morphology interaction. These approaches include: ANCHOR constraints (McCarthy and Prince 1995, 1999; Lubowicz 2002, 2003), M-Contiguity (Landman 2003), and constraint indexation approaches (McCarthy and Prince 1995; Itô and Mester 1999; Alderete 1999; Smith 1997) (though (Pater 2000) questions whether only faithfulness constraints are indexed). These various approaches can handle different sorts of phonology-morphology interaction, and can be united by the generalization that only faithfulness constraints refer to morphology. The markedness approach to boundary-sensitive phonology misses this potential unification of accounts of different sorts of morphology-phonology interaction. The M-IDENT faithfulness approach thus provides for a more constrained phonological grammar which is subject to the influence of morphology in a specific way - through faithfulness constraints.

The markedness idea is not entirely without advantages. In some Natural Language Processing (NLP) approaches to phonotactics and morphotactics, constraint grammars consisting of essentially only markedness

constraints are induced based on evidence from corpora (e.g. Hayes and Wilson 2008). These constraints incorporate local information to form constraints against certain patterns (much like the \*[+ant]+i constraint above). So, a markedness model is potentially useful in machine learning or NLP applications, but ultimately less desirable in the context of theoretical linguistics.

In many ways, the M-IDENT faithfulness approach is a superior extension to current phonological theory. It is more simple representationally, not requiring the presence of morpheme boundaries in the phonological output. It also is more well constrained and less ad hoc than the alternative markedness approach. These facts, together with the idea that only faithfulness constraints incorporate morphological information, lead to a more modular grammar, the modules of which interact in specific ways, rather than an essentially totally entwined phonology and morphology. For these reasons, the M-IDENT faithfulness approach is the approach pursued in this thesis.

The M-IDENT constraint family alone is not a simple panacea for all cases of boundary-sensitive phonology, but rather part of a broader model which allows a specific expansion of the power of faithfulness constraints. Under this model, faithfulness constraints may refer to morphology in the input only. Morpheme boundaries are not present in the output, and markedness constraints may refer only to phonological information. Because of the special role this model assigns to faithfulness constraints with respect to morphology, it is called the M-Faithfulness model.

This approach includes a number of other models which have been proposed, including M-Contiguity (Landman 2003). The M-Contiguity constraint family, like the M-IDENT family, refers to morphology in input representations. Similarly, constraints such as R-ANCHOR(stem,  $\sigma$ ) refer to morphological information in the input. These two types of constraints are both permitted under the M-Faithfulness approach. It is also worth noting that certain other approaches (Inkelas and Zoll 2007; Bermúdez-Otero 2013) strictly forbid any constraints which refer to morphological information.

The Local Constraint Conjunction model (Lubowicz 2002) is also compatible with the M-Faithfulness model. Conjunction has been implicated in various phenomena other than morphologically-conditioned phonology, such as other positional phonology (e.g. German final-devoicing in Itô and Mester 2003) and OCP effects (e.g. aspiration in Sanskrit roots in Itô and Mester 1996). So, since faithfulness constraints like

R-ANCHOR are compatible with M-Faithfulness, and conjunction is independently motivated, the Local Conjunction account of boundary-sensitive phonology is compatible with M-Faithfulness. Local Conjunction alone isn't enough to account for all cases of boundary-sensitive phonology, but can be supplemental to M-IDENT and M-Contiguity in the explanation of boundary-sensitive phonology.

One major question which remains is what effect the statement that faithfulness constraints can refer to non-morpheme-peripheral material has on the faithfulness system as a whole. The proposed M-IDENT constraint family can be thought of as an extension to the well-known IDENT family which incorporates this ability. It must be determined whether this ability is limited to the M-IDENT constraint family in particular, or whether it is more pervasive throughout the faithfulness system. It is, for instance, certainly possible to imagine similarly localized MAX or DEP constraints<sup>1</sup>.

Consider the hypothetical language data given in (24) (assume for simplicity that no complex onsets are permitted). This would prove an interesting case to examine to evaluate whether MAX constraints must be similarly localized.

	<b>Underlying</b>	→	<b>Surface</b>
(24)	/anʃk+ta/		[anʃ.ta] (NOT: [an.ta])
	/olk+nu/		[olk.nu] (NOT: [ol.nu])

This language deletes a segment at a boundary to partially satisfy a markedness constraint (\*COMPLEXCODA), even though deleting two segments at the boundary would further satisfy this constraint. Deleting both segments causes one M-MAX violation, but no M-I-CONTIG violations. The failure of just M-I-CONTIG and the success of the localized M-MAX constraint is shown in (26) (with constraints defined as in (25)).

- (25)
- a) M-I-CONTIG - The portions of the input standing in correspondence and belonging to the same morpheme form contiguous strings.
  - b) \*COMPLEXCODA - Assign one \* for each segment in the coda of a syllable beyond the first
  - c) M-MAX - Assign one \* for each non-morpheme-peripheral segment in the input without an output correspondent

---

<sup>1</sup>Note that these do have an effect distinct from M-CONTIG constraints - M-CONTIG constraints allow any amount of insertion or deletion adjacent to a boundary, while MAX or DEP constraints would introduce segment-by-segment violations

(26) a) **M-I-CONTIG is unsuccessful**

/anʃk+ta/	M-I-CONTIG	*COMPLEXCODA
• a. [an.ta]		
b. [anʃk.ta]		**
c. [anʃ.ta]		*

b) **M-MAX is successful**

/anʃk+ta/	M-MAX	*COMPLEXCODA
a. [an.ta]	*!	
b. [anʃk.ta]		**!
☞ c. [anʃ.ta]		*

This example does raise some tangential issues, particularly in the gradient definition of \*COMPLEXCODA. Such gradient definitions are not uncontroversial, and have been argued against (McCarthy 2003). This example does seem to hinge on the existence of such a gradient constraint, as the winning candidate is winning only because it violates \*COMPLEXCODA less severely than a losing candidate. In any case, this debate over gradient constraints does bear on the question of whether only M-IDENT constraints can be so localized or whether other faithfulness constraints may as well.

Ultimately, the question as to whether such cases exist is an empirical one which must be answered through further investigation into typology and the examination of more case studies. If they do exist, then there is some support for the existence of faithfulness constraints other than M-IDENT which target non-morpheme-peripheral material in the same way. For now, the default assumption (supported somewhat by McCarthy's argument against gradient constraints) must be that only M-IDENT constraints refer to morphology in this way, and this assumption should be relaxed if empirical investigation necessitates it.

## CHAPTER 4

### CASE STUDIES

In this chapter, a number of case studies involving boundary-sensitive processes are presented. The M-Faithfulness model accounts for each of these cases successfully, while previous models can each account for some, but not all of them. The case studies, along with successful M-Faithfulness analyses are presented in section 4.1. The failures of previous models are shown in sections 4.2-4.4.

#### 4.1 M-Faithfulness Analyses

##### 4.1.1 Banoni

###### 4.1.1.1 Data and Generalizations

One interesting case of boundary-sensitive phonology which cannot be explained by Coloured Containment (i.e. it is not assimilation) nor Local Constraint Conjunction (i.e. there is not the requisite stem-syllable misalignment) comes from Banoni (Lincoln 1976; Crowley et al. 2002). In Banoni, there is a phonological process in which any vowel deletes between two instances of [n], but only when the two [n]s belong to different morphemes. In other words, /...nV+nV/ sequences surface as [...nnV], while tautomorphemic [nVn] sequences are allowed - see (27).

- (27)    a) [nana] - 'this'  
          b) [sanana] - 'road'

The morpheme which triggers this process is the 3SG possessive suffix on nouns /-na/, as it is the only [n]-initial suffix in Banoni. When this morpheme attaches to noun-stems (these always end in a vowel) whose final consonant is /n/, the vowel deletion occurs. The stem-final vowel always surfaces when the 3SG suffix is attached to stems whose final consonant is not /n/. Additionally, the stem-final vowels are truly stem-final (i.e. they cannot be analyzed as part of the suffix), as the inflectional paradigm is identical regardless of what the stem-final vowel is. Both of these facts are demonstrated in (28).

(28) Inflectional paradigm for possessives

[tope:]	‘my head’	[kasi:]	‘my brother’
[tope-m]	‘your(sg) head’	[kasi-m]	‘your(sg) brother’
[tope-na]	‘his head’	[kasi-na]	‘his brother’
[tope-mam]	‘our(excl) head’	[kasi-mam]	‘our(excl) brother’
[tope-ra]	‘our(incl) head’	[kasi-ra]	‘our(incl) brother’
[tope-mi]	‘your(pl) head’	[kasi-mi]	‘your(pl) brother’
[tope-ri]	‘their head’	[kasi-ri]	‘their brother’
[tsibo:]	‘by myself’	[su:]	‘my breast’
[tsibo-m]	‘by yourself’	[su-m]	‘your(sg) breast’
[tsibo-na]	‘by himself’	[su-na]	‘his breast’
[tsibo-mam]	‘by ourselves(excl)’	[su-mam]	‘our(excl) breast’
[tsibo-ra]	‘by ourselves (incl)’	[su-ra]	‘our(incl) breast’
[tsibo-mi]	‘by yourselves’	[su-mi]	‘your(pl) breast’
[tsibo-ri]	‘by their self’	[su-ri]	‘their breast’

For noun stems whose final consonant is [n], the final vowel surfaces in all forms except for the 3SG (which are the ones which exhibit the vowel deletion process). Paradigms for several noun stems which undergo this process are shown in (29).

(29) Paradigms for noun-stems with vowel deletion

[tsina:]	‘my mother’	[punu:]	‘my hair’
[tsina-m]	‘your(sg) mother’	[punu-m]	‘your(sg) hair’
<b>[tsin-na]</b>	‘his mother’	<b>[pun-na]</b>	‘his hair’
[tsina-mam]	‘our(excl) mother’	[punu-mam]	‘our(excl) hair’
[tsina-ra]	‘our(incl) mother’	[punu-ra]	‘our(incl) hair’
[tsina-mi]	‘your(pl) mother’	[punu-mi]	‘your(pl) hair’
[tsina-ri]	‘their mother’	[punu-ri]	‘their hair’

Instead of the expected forms \*[tsina-na] for ‘his mother’ and \*[punu-na] for ‘his hair’, the stem-final vowel deletes between two instances of [n].


#### 4.1.1.2 M-Faithfulness Analysis

The only relevant markedness constraint violated by the competitor [tsinana] is \*nVn, which cannot be used to rule out this candidate, or else all /nVn/ sequences would reduce to [nn]. This is not the case, as the examples in (27) show. The method of restricting the process to morpheme boundaries used in Local Constraint Conjunction (namely, stem-syllable anchor constraints) does not work in Banoni, and so it cannot capture the boundary-sensitive nature of the pattern. The anchor constraint in this example, in fact prefers the losing candidate rather than the winning one (later shown in 69).


Banoni is a case which is susceptible to an analysis using M-Contiguity constraints. The morpheme-final vowel deletion to satisfy \*nVn does not violate the MORPHEME-I-CONTIG constraint, because the deletion does not disrupt the contiguity of segments within the morpheme, while deletion in tautomorphemic strings does. In other words, MORPHEME-I-CONTIG prevents deletion in forms like /sanana/ → [sanana] - ‘road’ but not in forms like /tsina+na/ → [tsinna] - ‘his mother’. This is demonstrated in the tableaux in (31).

- (30) a) \*nVn - assign one \* for each vowel present between two [+nasal +anterior] consonants.  
b) MAX-V - assign one \* for each vowel present in the input with no output correspondent

- (31) a) **Vowel deletion in heteromorphemic strings**

/tsina+na/	MORPHEME-I-CONTIG	*nVn	MAX-V
a.  [tsinna]			*
b. [tsinana]		*!	

b) **No deletion in tautomorphic strings**

/sanana/	MORPHEME-I-CONTIG	*nVn	MAX-V
a.  [sanana]		*	
b. [sanna]	*!		*

Landman's M-Contiguity model can successfully explain the process in Banoni because the process involves a disruption of contiguity (in this case, deletion) that is allowed at morpheme boundaries, but not morpheme-internally. So, in a case like /tsina+na/ (31a), the deletion process takes place to satisfy \*nVn, because the deleted vowel is morpheme-peripheral. In /sanana/ - (31b) - the deletion cannot take place, because the vowel to be deleted is not morpheme-peripheral.

Other accounts of boundary-sensitive phonology are not successful. Coloured Containment has no way to explain the boundary-sensitivity of the process because the vowel deletion cannot be described as spreading (see section 4.2). Local Conjunction fails because the faithful candidate which must be ruled out does not have a stem-syllable misalignment (see section 4.3).

## 4.1.2 Macuxi

### 4.1.2.1 Data and Generalizations

Macuxi also has an interesting boundary-sensitive phonological process which is not amenable to an explanation within Coloured Containment or Local Constraint Conjunction frameworks. Macuxi short vowels optionally reduce to [ə] before a morpheme boundary (Carson 1982). Data illustrating this process is given in (32).

(32) Macuxi Vowel Reduction

a)	/erama	+	ki/	→	[eraməki]
	‘see’		imp		“look!”
<hr/>					
b)	/pati	+	pɪ/	→	[patəpɪ]
	‘strike’		actual		“strike”
<hr/>					
c)	/pe	+	pɪŋ/	→	[pəpɪŋ]
	adv		neg		“not”
<hr/>					
d)	/po	+	ta/	→	[pəta]
	loc		‘at’		“at”
<hr/>					
e)	/seuru	+	puti/	→	[seurəputi]
	‘talk’		iter		“bark”
<hr/>					
f)	/siriri	+	pe/	→	[sirirəpe]
	‘soon’		adv		“today”


The vowel reduction process in Macuxi is similar to Banoni in that it is a reduction process at a morpheme boundary. It is, however, unlike Banoni, in that it is not one of segmental deletion and so M-Contiguity constraints offer no help for this case, as the vowel reduction process does not disrupt contiguity in any way. This is a case in which M-IDENT constraints can be of use.

#### 4.1.2.2 M-Faithfulness Analysis

The Macuxi vowel reduction requires a markedness constraint (or perhaps several different markedness constraints) against non-schwa vowels, along with M-IDENT constraints to protect morpheme-internal vowels. The approach here uses \*ExtremeV for the sake of simplicity, but in reality it may be useful to break it down into several individual markedness constraints against high vowels, low vowels, front vowels, and rounded vowels (after, e.g. (Becker and Potts 2011; Hall 2011; Kager 1999)). Because reduction to [ə] involves more than one featural change (it may involve as many as 4 changes - in [±high], [±low], [±back], and [±round]), a collection of several M-IDENT constraints is needed. In practice, most examples will only require the action of one or two constraints, so other M-IDENT constraints are omitted from the tableaux in (34-36) in the interest of space (though, all are technically needed in most examples - see the ranking in (37) and related discussion).


- (33) a) \*ExtremeV - Assign one \* for each [-cons] segment in the output which is not [-high -low -round +back]
- b) M-IDENT[high] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [±high] feature
- c) M-IDENT[low] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [±low] feature
- d) M-IDENT[back] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [±back] feature
- e) M-IDENT[round] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [±round] feature
- (All M-IDENT constraints abbreviated M-I , and all IDENT constraints abbreviated ID in tableaux)

(34) Morpheme-final /u/ reduction (involves M-IDENT[round] & M-IDENT[high])

/seuru+puti/	M-I[round]	M-I[high]	*ExtremeV	ID[round]	ID[high]
a.  [seurəputi]			****	*	*
b. [seuruputi]			*****! W	L	L
c. [seurəpəti]	*! W	* W	*** L		


The stem-final vowel (/u/ in this case) may reduce to schwa in order to improve incrementally on \*ExtremeV compared to the faithful candidate (34b). Further incremental improvement on \*ExtremeV by reducing another vowel to ə is blocked by the highly ranked M-IDENT constraints, because other vowels are not at morpheme boundaries. Similarly in (35), the morpheme final /e/ reduces to [ə] to improve on \*ExtremeV without violating M-IDENT.

(35) Morpheme-final /e/ reduction (involves M-IDENT[back])

/pe+pɪŋ/	M-I[back]	*ExtremeV	ID[back]
a.  [pəpɪŋ]		*	*
b. [pepɪŋ]		**! W	L

Finally, /a/ also reduces at a morpheme boundary without violating M-IDENT[low] to improve on \*ExtremeV relative to the faithful candidate. Other vowels can't reduce similarly because of highly ranked M-IDENT constraints.

(36) Morpheme-final /a/ reduction (involves M-IDENT[low])

/erama+ki/	M-I[low]	*ExtremeV	ID[low]
a.  [eraməki]		***	*
b. [eramaki]		****! W	L
c. [erəmaki]	*! W	** L	** W

Note that the M-IDENT constraints not depicted in tableaux still must be highly ranked to protect other vowels in the forms. For instance, M-IDENT[high] must be present to prevent the [i] in /pe+piŋ/ from reducing to [ə]. The ranking shown in (37) summarizes the total ranking necessary.

	M-IDENT[high]		IDENT[high]
(37)	M-IDENT[low]	>> *ExtremeV >>	IDENT[low]
	M-IDENT[back]		IDENT[back]
	M-IDENT[round]		IDENT[round]

Macuxi vowel reduction is a process which cannot be explained by Coloured Containment (section 4.2), Local Conjunction (section 4.3), or Stratal OT (section 4.4). The new model incorporating M-IDENT constraints does successfully handle this case, by preventing reducing in morpheme-internal vowels, while allowing it at boundaries.

### 4.1.3 Anywa Intervocalic Stop Voicing and Deletion

#### 4.1.3.1 Data and Generalizations

Anywa has two series of stops (voiced, voiceless) at five places of articulation (labial, dental, alveolar, palatal, velar) (Reh 1996). In general, these stops contrast on the basis of voicing, as shown in (38).

- (38)
- [abΛtʰ] - 'maize' :: [apΛt] - 'spoons'
  - [odiek] - 'hyena' :: [otiel] - 'elbow'

- [ad<sup>ɨ</sup>ul<sup>ʌ</sup>] - 'cooked corncob' :: [at<sup>ɨ</sup>uul<sup>ʌ</sup>] - 'island'
- [agool<sup>ʌ</sup>] - 'porch' :: [akool<sup>ʌ</sup>] - 'certain plant for making salt'

(Reh 1996:24)

Three different processes take place in morpheme-final stops such that voicing is predictable in this position. Word-final stops are always voiceless - this is similar to other processes of final obstruent devoicing in many languages and is not analyzed here. Intervocalic morpheme-final stops are voiced if labial, dental, or alveolar, and deleted if palatal or velar. Pre-consonantal morpheme-final stops are described by Reh as "...initially pronounced voiced and then rapidly devoiced..." (1996:30). Incidentally, the only consonant-initial suffixes in Anywa are the first person plural exclusive /-wa/ and the third person plural /-gi/ pronominal suffixes on verbs. These processes are summarized and examples are given in (39).

(39) • Intervocalic:

- Labial, dental, alveolar stops are voiced morpheme-finally between vowels

\* /d<sup>ɨ</sup>ip/ → [d<sup>ɨ</sup>ip] - 'tail'

/d<sup>ɨ</sup>ip+i/ → [d<sup>ɨ</sup>ibi] - 'this tail'

(Reh 1996:30)

- Palatal and velar (Dorsal) stops are deleted morpheme-finally between vowels

\* /loot<sup>ɨ</sup>/ → [lo:t<sup>ɨ</sup>] - 'peg'

/loot<sup>ɨ</sup>+i/ → [lo:i] - 'pegs'

\* /ɲwɔɔk/ → [ɲwɔ:k] - 'he-goat'

/ɲwɔɔk+i/ → [ɲwɔ:i] - 'he-goats'

(Reh 1996:30)

- Absolute Final:

- All stops are voiceless in word-final position

- Preconsonantal:

- Stops are "...initially pronounced voiced and then rapidly devoiced..." (Reh 1996:30)

- \* /a+bab+gɪ/ → [abab̥gɪ]<sup>1</sup> - 'they felt for it'
- \* /a+cɛd+gɪ/ → [acɛd̥gɪ] - 'they wiped it off'
- (The only consonant-initial suffixes are the pronominal suffixes /-wa/ - '1PEX' and /-gɪ/ - '3P')


Analyses of the voicing of non-dorsal intervocalic stops is possible in Local Conjunction, Coloured containment, and Stratal OT frameworks (as well as M-Faithfulness). However, several of these subcases are problematic for models of boundary-sensitive phonology. Dorsal stop deletion proves to be problematic for Coloured Containment and Stratal OT, while the analysis of preconsonantal stops is problematic for Local Conjunction. The case of dorsal stop deletion is taken up here, and the preconsonantal case will be returned to in section (4.1.4).

#### 4.1.3.2 M-Faithfulness Analysis

Like Coloured Containment, Local Conjunction, and Stratal OT, the M-Faithfulness approach can successfully analyze the intervocalic voicing of non-dorsal stops. By using a markedness constraint which requires that adjacent segments agree with respect to [ $\pm$ voice], and M-IDENT[voice], the process is limited to morpheme boundaries. A markedness constraint against voiceless intervocalic stops might also be used, but instead using AGREE[voice] allows for a unified analysis of the intervocalic and preconsonantal cases in Anywa (this can be seen in more detail in section (4.1.4)). This can be seen in (40) and (41).


- (40) a) AGREE[voice] - Assign one \* for each pair of adjacent segments which do not have the same value of [ $\pm$ voice].
- b) M-IDENT[voice] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [ $\pm$ voice] feature

- (41) a) **Morpheme-final intervocalic stop voicing**

/d <sup>j</sup> ip+a/	M-IDENT[voice]	AGREE[voice]	IDENT[voice]
a.  [d <sup>j</sup> iba]			*
b. [d <sup>j</sup> ipa]		**! W	L

<sup>1</sup>The diacritic [̥] is used here to denote partial voicing.

b) **Morpheme-internal voiceless stops permitted**

/akɔlΛ/	M-IDENT[voice]	AGREE[voice]	IDENT[voice]
a.  [akɔlΛ]		**	
b. [agɔlΛ]	*! W	L	* W


M-Contiguity constraints can be used to explain the dorsal stop deletion pattern where some models (i.e. Coloured Containment, Stratal OT) fail (sections 4.2, 4.4). For an illustration of this, consider the constraints in (42) and tableaux in (43).

(42) a) \*VGV - Assign one \* for each [DORSAL -cont -son] segment between two [-cons] segments in the output (no intervocalic dorsal stops)


b) STEM-I-CONTIG<sup>2</sup> - (no stem-internal deletion)

c) MAX-C - Assign one \* for each [+cons] segment in the input with no output correspondent

(43) a) **Morpheme-final Intervocalic Dorsal Stop Deletion**

/loot <sup>h</sup> i/	STEM-I-CONTIG	*VGV	MAX-C
a.  [lo <sup>h</sup> i]			*
b. [lot <sup>h</sup> i]		*!	

b) **No Stem-internal Dorsal Stop Deletion**

/agɔlΛ/	STEM-I-CONTIG	*VGV	MAX-C
a.  [agɔlΛ]		*	
b. [aɔlΛ]	*!		*

## 4.1.4 Anywa Preconsonantal Stops

### 4.1.4.1 Data and Generalizations

The description provided by (Reh 1996) makes it unclear what the appropriate voicing value for morpheme-final preconsonantal stops is (see (39)). For the analyses of the preconsonantal morpheme-final stops presented here, the assumption is that the stops are phonologically [+voice] at the surface and the devoicing is a non-phonological process.

<sup>2</sup>The effect of MORPHEME-I-CONTIG would be identical here, and either could be used


#### 4.1.4.2 M-Faithfulness Analysis

The use of an AGREE constraint to motivate the intervocalic voicing in Anywa is also useful in explaining the preconsonantal condition. Since the only consonant-initial suffixes begin with /g/ and /w/ (both voiced), the same markedness constraint is of use. The necessary constraints are reproduced in (44). The tableaux in (45) include those showing intervocalic voicing (b), as well as the preconsonantal case (a) to show the unification of the two analyses.


- (44) a) AGREE[voice] - Assign one \* for each pair of adjacent segments which do not have the same value of [ $\pm$ voice].

- b) M-IDENT[voice] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [ $\pm$ voice] feature


- (45) a) **Morpheme-final preconsonantal stop voicing**

/dʒip+gɪ/	M-IDENT[voice]	AGREE[voice]	IDENT[voice]
a.  [dʒibgɪ]			*
b. [dʒipgɪ]		**! W	L

- b) **Morpheme-final intervocalic stop voicing**

/dʒip+a/	M-IDENT[voice]	AGREE[voice]	IDENT[voice]
a.  [dʒiba]			*
b. [dʒipa]		**! W	L

- c) **Morpheme-internal voiceless stops permitted**

/akɔlɔ/	M-IDENT[voice]	AGREE[voice]	IDENT[voice]
a.  [akɔlɔ]		**	
b. [agɔlɔ]	*! W	L	* W

### 4.1.5 Korowai /t/ → [l] Alternation

#### 4.1.5.1 Data and Generalizations


[t] and [l] contrast in general in Korowai, including in intervocalic position (as in (46)), but when /t/ appears in intervocalic position after a morpheme boundary, it surfaces as [l] (as in (47)) (van Enk and de Vries 1997).

- (46) a) [aytɔ:p] - 'place of whirlpool in the river' :: [aylɔ:p] - 'I want to close'  
b) [atu:n] - 'bow' :: [alu:n] - 'fire'  
c) [a:t<sup>ə</sup>le:] - 'I get' :: [a:l<sup>ə</sup>le:] - 'I build'
- (47) a) /sahku+tena/ → [sakhulena] - 'banana + little' → "a little banana"  
b) /khakhua+tale/ → [khakhualale] - 'witch + big' → "a big witch"  
c) /ate+to/ → [atelo] - 'father + FOC.' → "father"  
d) /mean+tena+tena/ → [meantenalena] - 'dog + little + little' → "little dogs"


#### 4.1.5.2 M-Faithfulness Analysis

Unlike the approach to Anywa morpheme-final voicing, an AGREE[son] constraint will not suffice as the markedness constraint in Korowai. Morpheme-initial /t/ becomes [+son] only when it is intervocalic, not when it follows other sonorants (e.g. [n]). So, a markedness constraint against intervocalic coronal [-son] segments is needed (as in (48a)). The constraints and tableaux in (48) and (49) demonstrate the M-IDENT analysis of this process.

- (48) a) \*VTV - Assign one \* for each [CORONAL -son] segment between two [-cons] segments in the output  
b) M-IDENT[son] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [±son] feature
- (49) a) /t/ → [l] **alternation morpheme-initially**

/ate+to/	M-IDENT[son]	*VTV	IDENT[son]
a.  [atelo]		*	*
b. [ateto]		**! W	L
c. [alelo]	*! W	L	** W

b) **No alternation morpheme-internally**

/atu:n/	M-IDENT[son]	*VTV	IDENT[son]
a.  [atu:n]		*	
b. [alu:n]	*! W	L	* W

In order to satisfy \*VTV, intervocalic /t/ may become [+son] at morpheme boundaries without violating M-IDENT[son]. Morpheme internal /t/ (/ate+to/ and /atu:n/) cannot become [l] without violating the highly ranked M-IDENT constraint, and so these do not alternate.

M-Faithfulness provides a successful analysis of Korowai /t/ → [l] alternation, as does Coloured Containment. Local Conjunction and Stratal OT both fail to account for this alternation.

#### 4.1.6 Korowai /p/ → [ɸ] alternation

##### 4.1.6.1 Data and Generalizations

There is a second boundary sensitive process in Korowai that is in some ways similar to the /t/ [l] alternation involving /p/ and [ɸ]. Like the previous process, [p] and [ɸ] contrast in general, including in intervocalic position (see (50)), but intervocalically before a morpheme boundary, /p/ surfaces as [ɸ] (see (51))

(50) a) [le:p] - 'ill' :: [le:ɸ] - 'tongue'

b) [xɔpe:] - 'the day before yesterday' :: [xɔɸe:l] - 'young male'

c) [p<sup>ə</sup>li:] - 'blunt' :: [ɸ<sup>ə</sup>li:] - 'fall'

(51) a) /wap+e+kha/ → [waɸekha] - 'that+tr+CONN.' → "that"

b) /ip+e+kha/ → [iɸekha] - 'this+tr+CONN.' → "this"


c) /khaim+khaup+an+e/ → [khaimkhaɸane] - 'house+inside+LOCATIVE+CONNECTIVE' → "in the house"

#### 4.1.6.2 M-Faithfulness Analysis


Like the /t/ → [l] alternation in Korowai, from a markedness standpoint it is not enough to say that consonants should agree in continuancy with the following segment. This predicts that /p/ should become [+cont] when followed by a [+cont] segment (including consonants), but it only does so when in intervocalic position. So, again a contextual markedness constraint is used instead of AGREE. This analysis is shown in (52) and (53).

- (52) a) M-IDENT[cont] - Assign one \* for each non-morpheme-peripheral segment in the output which does not match its input correspondent with respect to [±cont].
- b) \*VpV - Assign one \* for each [LABIAL -cont] segment between two [-cons] segments

- (53) a) **Alternation at morpheme boundary**

/wap+e+kha/	M-IDENT[cont]	*VpV	IDENT[cont]
a.  [wa <sup>h</sup> pekha]			*
b. [wapekha]		*! W	L

- b) **No alternation morpheme-internally**

/xɔpe:/	M-IDENT[cont]	*VpV	IDENT[cont]
a.  [xɔ <sup>h</sup> pe:]		*	
b. [xɔ <sup>h</sup> pe:]	*! W	L	* W

#### 4.1.7 Kashmiri

##### 4.1.7.1 Data and Generalizations

Kashmiri has three series of stops - voiceless, voiceless aspirated, and voiced (Wale and Koul 1997) - of which the two voiceless series are of interest here. These stops generally appear in all positions, including initial, final, and intervocalic, as shown in (54).

- (54) a) /p<sup>h</sup>/: [p<sup>h</sup>atun] - 'to drown' :: [sap<sup>h</sup>ed] - 'white' :: [pap<sup>h</sup>] - 'sin'
- b) /t<sup>h</sup>/: [t<sup>h</sup>od] - 'tall' :: [mat<sup>h</sup>un] - 'to rub' :: [sat<sup>h</sup>] - 'seven'
- c) /k<sup>h</sup>/: [k<sup>h</sup>anun] - 'to dig' :: [k<sup>h</sup>ɔk<sup>h</sup>ur] - 'hollow' :: [krak<sup>h</sup>] - 'cry'

- d) /p/: [pak<sup>h</sup>] - ‘walk’ :: [kapur] - ‘cloth’ :: [pop] - ‘ripe’
- e) /t/: [tarun] - ‘to cross’ :: [ratun] - ‘to catch’ :: [hot] - ‘throat’
- f) /k/: [kan] - ‘wear’ :: [k<sup>h</sup>okir] - ‘hen’ :: [tsok] - ‘sour’

(Wale and Koul 1997:295)

When stems ending in aspirates are suffixed with a vowel-initial suffix, the stem-final consonant becomes deaspirated. So, even though aspiration is contrastive in general (including intervocalically) in Kashmiri, stem-final intervocalic voiceless stops are predictably unaspirated. Several examples of this process are shown in (55).


- (55) a) [ta:p<sup>h</sup>] - ‘sunny’ :: /ta:p<sup>h</sup>+as/ → [ta:pas] - ‘in the sun’
- b) [sat<sup>h</sup>] - ‘seven’ :: /sat<sup>h</sup>+im/ → [sətim] - ‘seventh’
- c) [ak<sup>h</sup>] - ‘one’ :: /ak<sup>h</sup>+is/ → [əkis] - ‘to one’

#### 4.1.7.2 M-Faithfulness Analysis


Since Kashmiri deaspiration occurs intervocalically at a morpheme boundary, there must be a markedness constraint against [+spread glottis] segments between vowels, and since [±spread glottis] is the feature value changing, there must be an M-IDENT constraint over this feature. These constraints are given in (56), with tableaux in (57).

- (56) a) \*VT<sup>h</sup>V - Assign one \* for each [+spread glottis] segment between two [-cons] segments in the output
- b) M-IDENT[spread glottis] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [±spread glottis] feature (Abbreviated M-IDENT[sg])

- (57) a) **Deaspiration at a morpheme boundary**

/ta:p <sup>h</sup> +as/	M-IDENT[sg]	*VT <sup>h</sup> V	IDENT[sg]
a.  [ta:pas]			*
b. [ta:p <sup>h</sup> as]		*! W	L

b) **No Deaspiration morpheme-internally**

/sap <sup>h</sup> ed/	M-IDENT[sg]	*VT <sup>h</sup> V	IDENT[sg]
a.  [sap <sup>h</sup> ed]		*	
b. [saped]	*! W	L	* W

## 4.1.8 Sawai

### 4.1.8.1 Data and Generalizations

Sawai has a process in which /s/ surfaces as [tʃ] when preceded by, as Whisler (1992:11) describes it, a “non-liquid alveolar,” a set which includes [n, t, d, r]<sup>3</sup> Examples showing the application of this process may be seen in (58).

	Preceded by non-alveolar (no alternation)		Preceded by alveolar (alternation)
	[k+suŋ] - ‘1.pl+to enter’	vs.	[n+tʃuŋɛ] - ‘3.sg+to enter’
	[m+suŋɛ] - ‘2.sg+to enter’		[n+tʃuŋ] - ‘3.pl+to enter’
(58)	[k+sepe] - ‘1.sg+to bathe’	vs.	[n+tʃep] - ‘3.sg+to bathe’
	[k+sep] - ‘1.pl+to bathe’		[r+tʃepɛ] - ‘3.pl+to bathe’
	[k+solet] - ‘1.sg+to go upstream’	vs.	[r+tʃolet] - ‘3.pl+to go upstream’
	[f+soletɛ] - ‘2.pl+to go upstream’		[t+tʃoletɛ] - ‘1.pl+to go upstream’
	[k+sopɛn] - ‘1.sg+to go outside’	vs.	[r+tʃopɛn] - ‘3.pl+to go outside’

[tʃ] appears only as this allophone of /s/ in Sawai, and while (Whisler 1992) contains no instances of tau-morphemic alveolar-s sequences (nor alveolar-tʃ sequences), he does specifically describe the morpheme boundary as a conditioning factor in the process. Overall it is unclear whether the consonant alternation itself is conditioned by a morpheme boundary, or whether morpheme concatenation is the only situation in which the conditioning environment arises. For the discussion here, the assumption is that the consonant alternation is specifically conditioned by the morpheme boundary, as this most closely matches the description of (Whisler 1992). So for instance, the hypothetical input /tensa/ should surface as [tensa], not [tentʃa].


<sup>3</sup>[r] is understood to exist only as a free-variant of /d/ in Sawai (Whisler 1992:9-10), possibly explaining Whisler’s treatment of it as a non-liquid. Perhaps a more accurate description would be that the alternation takes place after non-*lateral* alveolars, rather than non-liquids.

#### 4.1.8.2 M-Faithfulness Analysis


In the case of Sawai, /s/ matches the preceding consonant in continuancy across morpheme-boundaries if the preceding consonant is also alveolar. So, the necessary markedness constraint must penalize consecutive alveolar segments which differ in continuancy (specifically sequences where the first is [-cont] and the second is [+cont]). In order to explain why /s/ becomes [tʃ] instead of [t], it must also be the case that IDENT[strident] outranks IDENT[ant]. The details of this analysis are shown in (59) and (60).

- (59) a) \*Ts - Assign one \* for each [+ant +cont] segment after a [+ant -cont] segment (no alveolar noncontinuant followed by [s])
- b) M-IDENT[cont] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [±cont] feature

- (60) a) **Alternation at a morpheme boundary**

/n+sep/	M-IDENT[cont]	IDENT[strident]	*Ts	IDENT[ant]
a.  [ntʃep]				*
b. [nsep]			*! W	L
c. [ntep]		*! W		L

- b) **No alternation morpheme-internally (in a hypothetical form)**

/tensa/	M-IDENT[cont]	IDENT[strident]	*Ts	IDENT[ant]
a.  [tensa]			*	
b. [tenta]	*! W	* W	L	
c. [tentʃa]	*! W		L	* W

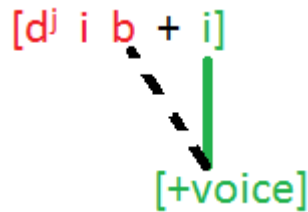
#### 4.1.9 Summary

The M-Faithfulness model provides the tools for successful analyses of all of the above case studies. While Coloured Containment, Local Constraint Conjunction, and Stratal OT can successfully analyze some of these cases, none of the three is successful on all of them. The failures of these models is demonstrated in the following sections.

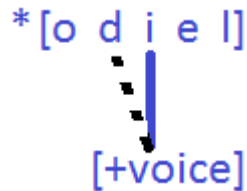
## 4.2 Cases where Coloured Containment fails

Coloured Containment can explain certain processes which are the result of spreading across morpheme boundaries. Consider, for instance, the intervocalic voicing of morpheme-final stops in Anywa (shown in (39) above). This process is well suited to a Coloured Containment analysis, as it can easily be described as spreading. The [+voice] feature associated with the suffix vowel may spread to the preceding consonant because the [+voice] feature is colored as the affix and the preceding consonant is colored as the root. So, the newly formed colorless association line links two elements of different colors, and ALTERNATION is not violated.

(61) a) /dʒip+i/ - 'this tail'



b) /otiel/ - 'elbow'




To formalize this approach, this paper follows (McCarthy 2011) in using a constraint called SHARE[voice] which motivates spreading<sup>4</sup>. The spreading is restrained by the ALTERNATION constraint of Coloured Containment. The general markedness constraint SHARE motivates spreading, while ALTERNATION ensures that spreading only happens at a morpheme boundary. Consider the constraints defined in (62) and the tableaux in (63). Under Coloured Containment, the constraint against deletion of features (in this case [-voice]) is PARSE- $\phi(\alpha)$ , which requires that "The morphological element  $\alpha$  must be incorporated into the phonological structure" (van Oostendorp 2006, 2007). This constraint requires that underlyingly specified information is in the phonological output.


<sup>4</sup>AGREE does not work here, as it only requires that adjacent segments have the same value of a feature, not that they actually share the feature.

- (62) a) SHARE[voice] - Assign one \* for each pair of adjacent segments that are not linked to the same token of [ $\pm$ voice] (definition taken from (McCarthy 2011))
- b) PARSE- $\phi$ [-voice] - Assign one \* for each [+voice] feature value present in the morphological structure but not the phonological structure (don't delete [+voice]).<sup>5</sup>
- c) ALTERNATION - Assign one \* for each association line linking two elements of color  $\alpha$  which is not also of color  $\alpha$  (Only spread across morpheme boundaries) (Adapted from (van Oostendorp 2006))

(63) a) **Spreading at morpheme boundaries**

/dʒip+i/	ALTERNATION	SHARE[voice]	PARSE- $\phi$ [-voice]
a.  [dʒibi]		**	*
b. [dʒipi]		***! W	L

b) **No spreading in tautomorphemic sequences**

/otiel/	ALTERNATION	SHARE[voice]	PARSE- $\phi$ [-voice]
a.  [otiel]		****	
b. [odiel]	*! W	*** L	* W

In (63a), a SHARE violation can be avoided by spreading [+voice] from the affix /-i/ to the underlying /p/ (as in (61a)) without violating the higher ranked ALTERNATION. If similar spreading is attempted in /otiel/ (as in (61b)) to avoid a SHARE violation, a new ALTERNATION violation is introduced, so no spreading occurs.

#### 4.2.1 Banoni

This vowel deletion process occurs only at morpheme boundaries (i.e. the deletion happens in (29) but not in (27)), and so is a boundary-sensitive phonological process and must be theoretically modeled as one (see section 4.1.1 for the previous discussion of this process). The way that Coloured Containment explains boundary-sensitive processes relies on those processes being explainable as spreading processes (like the Korean palatalization example). A deletion process such as the one in Banoni cannot be described as such. So, the key condition required to explain the process as a DEE within a Coloured Containment framework is not met.

<sup>5</sup>IDENT constraints are not compatible with Coloured Containment in general, but PARSE- $\phi$ [-voice] can be thought of as doing similar work as IDENT[voice] in this analysis.

If there were a general process wherein vowels were deleted between nasals, then there would be no need for the boundary sensitivity, and no requirement that the process be explainable as spreading. But, as (27) shows, it is a strictly boundary-sensitive process, so this approach is not possible, and Coloured Containment is left without a satisfactory explanation.

#### **4.2.2 Macuxi**

The crucial property of processes explainable as DEE within the Coloured Containment model is that they must involve spreading (assimilation). The Macuxi vowel reduction process (first discussed in section 4.1.2) cannot be described as such. The crucial features of the reduced vowel ([ə]), presumably [+back, -high, -low], cannot spread from any part of the affixes in (32). The consonant following the reduced vowel in each case in (32) does not have these crucial features, and nor does the following vowel (which is not reduced). In [seurəputi] - “bark” for instance, neither the [p] following the reduced vowel, nor the following [u] can be a source for the necessary features to spread from. So again, Coloured Containment has no explanation for the reduction process in Macuxi.

#### **4.2.3 Anywa Intervocalic Dorsal Stops**

While the intervocalic voicing of morpheme-final non-dorsal stops is well explained by Coloured Containment, the case of intervocalic morpheme-final dorsal stops is more problematic under a Coloured Containment analysis. Since the consonants are deleted rather than voiced (see section 4.1.3 for data and generalizations), a spreading analysis is not possible, so it would be difficult to confine the deletion process to a morpheme boundary. Intervocalic dorsal stops are not forbidden in general, but only at morpheme boundaries, so this problem prevents a successful account of Anywa intervocalic dorsal stop deletion.

#### **4.2.4 Summary**

Coloured Containment successfully analyzes boundary-sensitive phonological processes which can be described as spreading. For instance, morpheme-final intervocalic voicing in Anywa can be described as spreading of [+voice] from the affix vowel to the morpheme-final stop. This same idea can be extended to a number

of the other cases above (i.e. Korowai, Kashmiri, Sawai) to analyze them in Coloured Containment. Coloured Containment fails when such spreading analyses are not possible. So, in deletion processes like Banoni and Anywa, or non-spreading reduction cases like Macuxi, it fails.

### 4.3 Cases where Local Conjunction fails


Local Constraint Conjunction is successful in handling cases which involve a misalignment of stem and syllable edges. Specifically, when the faithful (losing) candidate not displaying some boundary-specific alternation involves a stem-syllable misalignment (whether or not the winning candidate does). For an illustration of this, consider again the Anywa intervocalic voicing of stops described in section 4.1.3 above. (Note: In this section, because of the importance of ANCHOR constraints, { and } are used to denote stem boundaries in tableau candidates).

Under a Local Conjunction model, the crucial candidates which must be ruled out are those with morpheme-final intervocalic voiceless stops (i.e. /dʒip+i/ → [dʒipi]), in the case of non-dorsal stops. This can be achieved using the constraints described in (64).


- (64)
- a) \*VTV - Assign one \* for each [-voice -cont] segment between two [-cons] segments (no intervocalic voiceless stops)
  - b) IDENT[+voice] - Assign one \* for each output segment which is not [+voice] whose input correspondent is [+voice]
  - c) R-ANCHOR(stem,  $\sigma$ ) - assign one \* for each segment at the right edge of a stem in the input whose correspondent in the output is not at the right edge of a syllable (this constraint is abbreviated as R-ANCHOR in tableaux)
  - d) [\*VTV & R-ANCHOR]<sub>Seg</sub>

These constraints, appropriately ranked, predict voicing of intervocalic morpheme-final stops, while protecting morpheme-internal voicing contrast. This is illustrated by the tableaux in (65).

- (65) a) **Morpheme-final Intervocalic Voicing**

/dʲip+i/	[*VTV & R-ANCHOR] <sub>Seg</sub>	IDENT[+voice]	*VTV	R-ANCHOR
a.  [{dʲi.b}i]		*		*
b. [{dʲi.p}i]	*! W	L	* W	*


b) **Morpheme-internal Voicing Contrast**

/otiel/	[*VTV & R-ANCHOR] <sub>Seg</sub>	IDENT[+voice]	*VTV	R-ANCHOR
a.  [{o.ti.el}]			*	
b. [{o.di.el}]		*! W	L	


The deletion of morpheme-final intervocalic dorsal stops can be explained in a similar way by using the few additional constraints shown in (66). This is demonstrated by the tableaux in (67).

- (66) a) \*DORSALSTOP - Assign one \* for each [DORSAL -cont -son] segment in the output (This is abbreviated \*DS in tableaux)
- b) MAX-C - Assign one \* for each [+cons] segment in the input without an output correspondent
- c) [\*DORSALSTOP & R-ANCHOR]<sub>Seg</sub>

(67) a) **Morpheme-final Intervocalic Deletion**

/lootʲ+i/	[*DS & R-ANCHOR]	MAX-C	*DS	R-ANCHOR
a.  [{lo:}.i]		*		*
b. [{lo:.tʲ}i]	*! W	L	* W	*

b) **Morpheme-internal non-Deletion**

/akɔlɒ/	[*DS & R-ANCHOR]	MAX-C	*DS	R-ANCHOR
a.  [{a.kɔ.lɒ}]			*	
b. [{a.ɔ.lɒ}]		*! W	L	

### 4.3.1 Banoni

An analysis of Banoni within a Local Constraint Conjunction framework would require there to be a stem-syllable boundary mismatch in order to capture the boundary-sensitivity of the process. Specifically, the competing candidate without vowel deletion must have a stem-syllable boundary mismatch. To take a specific

example, the candidate for /tsina+na/ - ‘his mother’ that must be ruled out is the fully faithful one, [tsi.na.na] (see section 4.1.1 for data and generalizations). Interestingly, the boundary mismatch is to the advantage of the losing candidate [tsinana] rather than [tsinna], which wins. For the posited conjoined constraint [ $*nVn$  & R-ANCHOR(stem,  $\sigma$ )] defined as in (68), the losing candidate which must be ruled out by the conjoined constraint ([tsinana]) has no violation because there is no stem-syllable mismatch. In order to correctly predict the output for /tsina+na/ and /sanana/, two different rankings of  $*nVn$  versus the two faithfulness constraints are needed (as shown in (69)).

- (68) a) R-ANCHOR(stem,  $\sigma$ ) - assign one \* for each segment at the right edge of a stem in the input whose correspondent in the output is not at the right edge of a syllable (this constraint is abbreviated as R-ANCHOR in tableaux)

- (69) a)  $*nVn \gg \text{MAX-V}$  and  $*nVn \gg \text{R-ANCHOR(stem, } \sigma)$

/tsina+na/	[ $*nVn$ & R-ANCHOR]	$*nVn$	MAX-V	R-ANCHOR
a. [tsi.na}.na]		*W	L	L
b. [tsin.}na]			*	*

- b)  $\text{MAX-V} \gg *nVn$  or  $\text{R-ANCHOR(stem, } \sigma) \gg *nVn$

/sanana/	[ $*nVn$ & R-ANCHOR]	$*nVn$	MAX-V	R-ANCHOR
a. [sa.na.na}		*		
b. [sanna}		L	*W	*W

In (69a),  $*nVn$  must dominate both faithfulness constraints to predict the correct output. In (69b), however, one of the two faithfulness constraints must dominate  $*nVn$ . No ranking can correctly predict the output for both input forms. The one possible way to save the analysis is to propose that  $*nVn$  is dominated by one of the faithfulness constraints, and that a conjoined constraint which is violated by [tsinana] is highly ranked. But, since the losing candidate in (69a) doesn't have any stem-syllable misalignment, no such conjoined constraint can rule it out.

### 4.3.2 Macuxi

Explaining this process (first discussed in 4.1.2 as a DEE within a Local Constraint Conjunction model) is also impossible. The crucial candidate which must be ruled out in this case is one without a reduced vowel (e.g. [seuruputi] for “bark”). This candidate does not have the requisite stem-syllable boundary mismatch to ensure the boundary-sensitivity of the process. The stem-affix boundary coincides with a morpheme boundary in each example, so no ANCHOR constraint is ever violated, and a conjoined constraint involving R-ANCHOR will never rule out the faithful candidate.

Consider for instance, /seuru+puti/ → [se.u.ru.]pu.ti]. The right edge of the stem falls in the same place as the right edge of a syllable, as is the case in all examples, and R-ANCHOR is not violated.

### 4.3.3 Anywa Preconsonantal Stops

While Coloured Containment and Stratal OT provide successful analyses of the preconsonantal case in Anywa, it poses an interesting problem for the Local Constraint Conjunction framework. The stem-syllable misalignment which is present in cases of intervocalic stops no longer exists (for data and generalizations, see 4.1.4). For instance, /dʲip+a/ surfaces as [dʲi.ba] - the [b] is at the right edge of the stem, but the left edge of a syllable. On the other hand, /dʲip+gɪ/ surfaces as [dʲiɓ.gɪ] - the stem and syllable boundaries coincide.

A conjoined constraint involving R-ANCHOR can never rule out the crucial candidate (i.e. [dʲipgɪ]), regardless of the conjoined markedness constraint, because this candidate doesn't have a R-ANCHOR violation. So, while Local Constraint Conjunction can satisfactorily explain the patterns involving morpheme-final intervocalic stops, it fails to explain the case of preconsonantal morpheme-final stops in Anywa.


Assuming the [w] of the /-wa/ suffix is syllabified with the preceding stop as an onset cluster (such clusters are generally permitted in Anywa), Local Conjunction is successful in accounting for such forms. The /-gɪ/ suffix is much more problematic. The constraints and tableaux in (70) and (71) demonstrate the success in /-wa/ forms and failure in /-gɪ/ forms.

- (70) a) \*TG - Assign one \* for each [-voice] segment before a [+voice] segment in the output
- b) IDENT[voice] - Assign one \* for each segment in the output which does not match its input


correspondent with respect to  $[\pm\text{voice}]$

c)  $[\text{R-ANCHOR}(\text{stem}, \sigma) \ \& \ *TG]_{\text{Seg}}$

(71) a) **Successful analysis of /-wa/ suffix**

/a+bap+wa/	[R-ANCHOR & *TG]	IDENT[voice]	*TG
a.  [a.ba.bwa]		*	
b. [a.ba.pwa]	*! W	L	* W

b) **Failed analysis of /-gi/ suffix**

/a+bap+gi/	[R-ANCHOR & *TG]	IDENT[voice]	*TG
a.  [a.bap.gi]			*
b. [a.bab.gi]		*! W	L

The case in (71b) is problematic because the conjoined constraint fails to rule out the faithful candidate.

There is no misalignment between morpheme and syllable boundaries, so R-ANCHOR is never violated.

#### 4.3.4 Korowai /t/ → [l] Alternation

Local constraint conjunction does not provide a satisfactory explanation for the /t/ → [l] process in Korowai (first presented in 4.1.5). Consider the form for "father", /ate+to/, which surfaces as [a.te.lo] the candidate which must be ruled out is [ateto], and the process must be localized to a morpheme boundary so the winning candidate isn't \*[a.le.lo] (it cannot simply be an intervocalic /t/ → [l] process). The problem with this is, the candidate which must be ruled out does not have the required stem-syllable misalignment. A constraint such as R-ANCHOR[stem,  $\sigma$ ] will never penalize this crucial candidate, so there is no way to localize the process to a morpheme boundary. For a demonstration of why this doesn't work, consider the constraints in (72) and tableaux in (73).

(72) a) \*VTV - Assign one \* for each [-son] segment between two [-cons] segments in the output

b) IDENT[son] - Assign one \* for each segment in the output which does not match its input correspondent with respect to the  $[\pm\text{son}]$  value

c)  $[\text{R-ANCHOR}(\text{stem}, \sigma) \ \& \ *VTV]$  - (Abbreviated  $[\text{R-ANCHOR} \ \& \ *VTV]$  in tableaux)

In order to ensure only morpheme-initial /t/ alternates, the conjoined constraint should be highly ranked, and IDENT[son] should outrank \*VTV. Under this ranking, no /t/ alternates, because the conjoined constraint cannot punish the crucial losing candidate (this is shown in (73a)). If instead \*VTV outranks IDENT[son], the /t/ alternation is not limited to cases at morpheme boundaries (this is shown in (73b)).

(73) a) **Erroneous lack of alternation (correct output: [atelo])**

/ate+to/	[R-ANCHOR & *VTV]	IDENT[son]	*VTV
a. <sup>u</sup> [ateto]			**
b. [atelo]		*!	*
c. [alelo]		**!	

b) **Erroneous overapplication of alternation (correct output: [atelo])**

/ate+to/	[R-ANCHOR & *VTV]	*VTV	IDENT[son]
a. <sup>u</sup> [alelo]			**
b. [atelo]		*!	*
c. [ateto]		**!	

## 4.4 Cases where Stratal OT fails

Stratal OT can handle a number of boundary-sensitive processes through the use of phonological cycles. One analytical trick which makes a number of analyses possible is one which relies on a stem-level despecification process, and later word-level contextual defaults for the analysis of featural changes. This allows for processes that are (for instance) stem-final, but require contextual conditioning by word-level information. This method is used in Bermúdez-Otero's (2011) analysis of Quito Spanish s-voicing. It can also be used to explain the familiar Anywa intervocalic voicing process.

Under this analysis, there is a stem level process of domain-final delaryngealization, that is, domain-final stops lose their voicing specification and become unspecified for the [±voice] feature. Then, at the word level, these stops become specified for voicing through the assignment of contextual default values for the feature. See (74) for a demonstration of this process.

	Input:	[ <sub>WL</sub> [ <sub>SL</sub> d <sup>i</sup> ip]a]	[ <sub>WL</sub> [ <sub>SL</sub> ap <sup>Δ</sup> t]]
(74)	SL(final delaryngealization):	[d <sup>i</sup> iP]a]	[[ap <sup>Δ</sup> T]]
	WL(contextual defaults):	[d <sup>i</sup> iba]	[ap <sup>Δ</sup> t]

The stem-final [p] becomes delaryngealized to [P], which is unspecified for voicing at the stem level. Then, at the word level, it receives the [+voice] feature as a contextual default for intervocalic stops and surfaces as [b]. The stem-internal /p/ in /ap<sup>Δ</sup>t/ is allowed to surface as voiceless between vowels because it does not become delaryngealized.

#### 4.4.1 Banoni

The vowel deletion process in Banoni (see section 4.1.1) is conditioned by both material from the stem level and the word level. So, if the vowel deletion between two [n] is a stem level process, it erroneously fails to apply at boundaries, because the conditioning environment doesn't apply until word-level affixes are present. It also erroneously overapplies to morpheme-internal /..nVn../ sequences, resulting in a total prohibition on [nVn] in Banoni. If the vowel deletion process takes place at the word level, the same erroneous overapplication applies. These two unsuccessful approaches are shown in (75) and (76) respectively.

	Input:	[ <sub>WL</sub> [ <sub>SL</sub> tsina]na]	[ <sub>WL</sub> [ <sub>SL</sub> sanana]]
(75)	SL(Vowel Deletion):	[[tsina]na]	[[sanna]]
	WL:	☉[tsinana]	☉[sanna]

	Input:	[ <sub>WL</sub> [ <sub>SL</sub> tsina]na]	[ <sub>WL</sub> [ <sub>SL</sub> sanana]]
(76)	SL:	[[tsina]na]	[[sanana]]
	WL(Vowel Deletion):	[tsinna]	☉[sanna]

#### 4.4.2 Macuxi

A stratal OT analysis is unsuccessful because the vowel reduction process (see section 4.1.2) takes place in both stems and prefixes. Consider an analysis under which there is a domain-final vowel reduction process at the stem level, as described in (77). This can predict the correct outputs for some of the forms such as (32f) -

/siriri+pe/ → [sirirəpe], but struggles to correctly predict the correct outputs for cases like (32d). These are shown in (78) - including two different cases for (32d), one with /po-/ as a stem-level prefix, and one with /po-/ as a word-level prefix.

(77) **Final Vowel Reduction (FVR)** - Stem-final vowels in the input become [ə].

		[ <sub>WL</sub> [ <sub>SL</sub> siriri]pe]	[ <sub>WL</sub> po[ <sub>SL</sub> ta]	[ <sub>WL</sub> [ <sub>SL</sub> pota]
(78)	Stem-Level(FVR)	[[sirirə]pe]	[po[tə]]	[[potə]]
	Word-Level	[sirirəpe]	*[potə]	*[potə]
			(Expected = [pəta])	(Expected = [pəta])

This analysis fails because in reality the vowel reduction process is a morpheme-final one rather than a stem-final one. Stratal OT cannot generate this pattern because it specifically forbids constraints which refer to morpheme boundaries.

#### 4.4.3 Anywa Intervocalic Dorsal Stops

The intervocalic dorsal stop deletion is more problematic for Stratal OT than the intervocalic voicing process. If the intervocalic dorsal deletion process (see section 4.1.3) happens at the stem level, then the conditioning environment doesn't exist, and the process erroneously does not apply. Furthermore, dorsal stops between vowels would be forbidden in general, not only at morpheme boundaries. If the stop deletion occurs at the word level, the process also erroneously overapplies, forbidding intervocalic dorsals in general. These problems are shown in (79).

	Input:	[ <sub>WL</sub> [ <sub>SL</sub> lo:tʰ]i]	[ <sub>WL</sub> [ <sub>SL</sub> akɔlɒ]]
(79)	a)		
	SL(Intervocalic Dorsal Deletion)	[[lo:tʰ]i]	[[akɔlɒ]]
	WL	*[lo:tʰi]	*[akɔlɒ]
	Input:	[ <sub>WL</sub> [ <sub>SL</sub> lo:tʰ]i]	[ <sub>WL</sub> [ <sub>SL</sub> akɔlɒ]]
	b)		
	SL	[[lo:tʰ]i]	[[akɔlɒ]]
	WL(Intervocalic Dorsal Deletion)	[lo:i]	*[akɔlɒ]

#### 4.4.4 Korowai /t/ → [l] Alternation

Stratal OT does not provide a satisfactory explanation for the /t/ → [l] alternation in Korowai (presented in 4.1.5). Since the alternation is a domain-initial one, and Stratal OT specifies stem, word, and phrase-level cycles, it must occur at the beginning of one of these domains. The alternation, however, does not occur initially in any of these three domains (at least not in general). In (47c) for instance, the alternating consonant is affix-initial, but either stem-medial or stem-external (but not stem-initial), and word- and phrase-internal. In other words, the conditioning environment without making explicit reference to morpheme boundaries because it does not occur at the periphery of a Stratal OT cycle domain.

Despite being somewhat similar to Anywa intervocalic voicing, it is crucially different in a way that makes a Stratal OT analysis impossible. In Anywa, the stem-final delaryngealization analysis is successful because the alternating consonant always occurs stem-finally, and Stratal OT can reference this position without explicit mention of morpheme boundaries through its use of triggered cycles. The alternation in Korowai does not occur in such a position, and so an analogous analysis is not possible.

#### 4.4.5 Kashmiri

While on the surface the Kashmiri deaspiration process (shown in section 4.1.7) looks extremely similar to one such as Anywa stem-final intervocalic voicing, it is different in one crucial way that makes it less amenable to a similar underspecification analysis. That is, it is not predictable whether word-final stops are aspirated or unaspirated, while in Anywa word-final stops are predictably voiceless. So, such an underspecification analysis cannot accurately predict the output for uninflected forms.

If we assume a stem-level process which removes specification for [±spread glottis] for stem-final stops, followed by a word-level process which provides contextual default values, certain forms can be correctly predicted. For instance, forms with stem-final aspirates inflected with vowel-initial suffixes can receive the contextual default value of [-spread glottis] for intervocalic stops. This fails when uninflected stems are considered. There can be no word-final default specification because word-final aspiration is not predictable. If the default specification for word-final stops is [-spread glottis], then all bare stems ending in aspirated stops are wrongly predicted. See (80) for a demonstration of this failure.

Input:		$[\text{wL}[\text{sLtap}^{\text{h}}]\text{as}]$	$[\text{wL}[\text{sLtap}^{\text{h}}]]$	$[\text{wL}[\text{sLpop}]]$
(80)	SL(Underspecification)	$[[\text{taP}]\text{as}]$	$[[\text{taP}]]$	$[\text{poP}]$
	WL(Contextual Defaults)	$[\text{tapas}]$	$\text{☉}[\text{tap}]$	$[\text{pop}]$

If instead the default specification for word-final stops is [+spread glottis], then the wrong prediction is made for bare stems ending in unaspirated stops. In either case, neither choice of contextual defaults renders the correct prediction for all inputs.

#### 4.4.6 Summary

Stratal OT provides successful accounts of some cases of domain-peripheral processes. In particular, it is successful on processes which involve featural changes in these positions (like Anywa intervocalic voicing). Deletion processes like that in Banoni are not subject to the same underspecification analysis and present difficulties for Stratal OT. The specific restriction that constraints may not refer to extraphonological information cripples its ability to handle certain boundary-sensitive processes.

## CHAPTER 5

### DISCUSSION

Several points regarding M-Faithfulness, especially in relation to broader phonological theory, remain to be considered. First, it must be framed in relation to the other models discussed in this thesis. There are differing degrees of formal incongruence between the M-Faithfulness model and the Stratal OT, Coloured Containment, and Local Conjunction models. This question is taken up in section 5.1. Another remaining question is how to address cases which do not submit easily to an M-Faithfulness analysis, as all case studies discussed in chapter 4 do. Maale, one such case, is presented in 5.2, and a potential resolution is suggested. Finally, there are a number of similarities between the M-Faithfulness model and Positional Faithfulness approaches. The interaction between M-Faithfulness and Positional Faithfulness, as well as formal similarities between the two models are addressed in section 5.3.

#### **5.1 Relation to Other Models**

The M-Faithfulness model is different from some other models considered here in important theoretical ways. Stratal OT relies on the existence of multiple (morpho-)phonological cycles to explain some boundary-sensitive phenomena, while the M-Faithfulness model operates in a single step with fully parallel evaluation. Coloured Containment uses the idea of morphological coloring and does away with the widely-preferred Correspondence Theory (McCarthy and Prince 1995) in favor of Containment Theory (van Oostendorp 2006, 2007). Local Constraint Conjunction (Lubowicz 2002, 2003) itself is not incompatible with the M-Faithfulness model, but may serve as an important part of it.

### 5.1.1 Stratal OT

The defining characteristic of a Stratal OT model is its use of phonological cycles triggered by morphological constituents of increasing size. This is used to handle a number of cases of boundary-sensitive phonology. With processes such as Anywa morpheme-final intervocalic stop voicing, the voicing is confined to a morpheme boundary because it occurs in a position which is domain-final in one cycle. This allows the model to enforce underspecification domain-finally in this cycle, and grant surface voicing values in a later cycle. The cycles are crucial to the model in a such a case, the process cannot be handled in one parallel step in Stratal OT.

In the M-Faithfulness model, however, the idea of morpho-phonological cycles is one which introduces an unnecessary complication. The M-Faithfulness account of boundary-sensitive processes takes place in one single step with fully parallel evaluation, and cycles are superfluous.

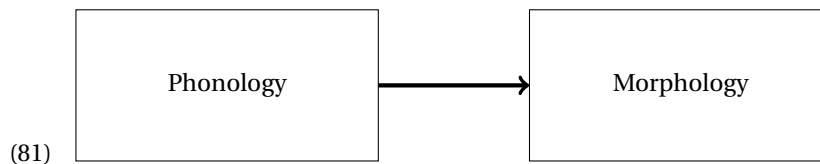
The cost of eliminating the cycle, at least with respect to boundary-sensitive phonology, is that the restriction that OT constraints cannot contain extraphonological information must be abandoned. Some phonological models, including Cophonology models (e.g. Inkelas and Zoll 2007), of which Stratal OT can be considered a specific implementation, strictly and explicitly limit the ability of constraints to refer to non-phonological information. Inkelas and Zoll state this restriction thusly: "All constraints within a given cophonology are *purely phonological*; no constraint directly refers to morphological context" (2007:133 - emphasis mine). Cophonology models propose the existence of different cophonologies which apply to different constructions. The decision of what cophonology a given construction belongs to may fall to one of two factors - type of morphological construction, or lexical class. Stratal OT provides a specific conception of the decision of what constructions belong to each cophonology, and the serial nature of the three cophonologies it posits.

Like Inkelas and Zoll, Bermúdez-Otero states a specific restriction on constraints in Stratal OT: "In line with its modular approach to the morphosyntax-phonology interface, Stratal OT imposes strict limits on the ability of phonological constraints to refer to extraphonological information" (Bermúdez-Otero 2013). This restriction is given in more detail by Bermúdez-Otero (2012) as an adaptation of the Indirect Reference Hypothesis (Inkelas 1989): "A phonological constraint may not refer to syntactic, morphological, or lexical information unless to require alignment between designated prosodic units and the exponents of designated syntactic

(word-syntactic or phrase-syntactic) nodes" (Bermúdez-Otero 2012:74).

What the case studies presented here show is that this restriction is too strong. Stratal OT fails to account for several cases of boundary-sensitive phenomena, because there is no way to reference morphology in constraints. Relaxing this restriction slightly to allow faithfulness constraints to refer to morphological structure in the input allows for the explanation of all case studies for which Stratal OT provides no satisfactory explanation.

This relaxation of the Indirect Reference Hypothesis does not deal a crippling blow to the modularity which Stratal OT hopes to preserve. Traditional grammatical views of modularity, and indeed that endorsed by Bermúdez-Otero (2012) envision grammatical modules (i.e. phonology, morphology, syntax, etc.) as mostly autonomous pieces which interact with each other via interfaces. This can be envisioned as shown in (81), wherein boxes represent modules, and arrows represent interfaces (diagram modeled after (Bermúdez-Otero 2012:42)).



Such a model requires a conception of how the two modules interface. Under a Stratal OT approach part of this interface depends on the triggering of cycles (i.e. this is how morphology can affect phonology). An alternative view of this interface is provided by M-Faithfulness, wherein faithfulness constraints can provide a link between phonology and morphology. The two parts of grammar are still largely modular, but they interface in a specific way - through faithfulness constraints.

### 5.1.2 Coloured Containment

The M-Faithfulness model is incompatible with Coloured Containment for a different reason. No explicit prohibition on constraints referring to morphological content is made under Coloured Containment, so constraints like M-IDENT don't pose a problem in this respect. In fact, some prominent Coloured Containment constraints (e.g. ALTERNATION) do, in a sense, refer to morphology in a similar way (i.e. morphemes form constituents in the input). The incompatibility arises from the fact that M-IDENT constraints operate strictly

under the correspondence framework (i.e. McCarthy and Prince 1995). Containment Theory (Prince and Smolensky 1993), and its expansion by Oostendorp (2006; 2007) posit a different relationship between input segments and output segments than does Correspondence Theory. Under Coloured Containment, segments in the input do not stand in correspondence with segments in the output, but rather morphemes are in correspondence. This makes the M-IDENT definition impossible to implement within Coloured Containment.

- (82) a)  $\text{PARSE-}\phi(\alpha)$  - The morphological element  $\alpha$  must be incorporated into the phonological structure  
(no deletion)
- b)  $\text{PARSE-}\mu(\alpha)$  - The phonological element  $\alpha$  must be incorporated into the morphological structure  
(no insertion)
- (van Oostendorp 2007:40)

The question of M-Faithfulness, specifically M-IDENT constraints, to some extent depends on the question of Containment versus Correspondence. This is perhaps still an unresolved question. Though Correspondence has enjoyed widespread support, some (Oostendorp) have challenged Correspondence as being computationally too powerful. These arguments are not rehashed here, as they are ultimately tangential to the

topic at hand. It is worth noting, however, that the final resolution of the question of faithfulness (Correspondence vs. Containment) bears on the validity of the M-Faithfulness theory as it is, in its present incarnation, incompatible with Containment Theory.

### 5.1.3 Local Constraint Conjunction

Local Constraint Conjunction as an explanation for boundary-sensitive phenomena is not inconsistent with M-Faithfulness. It relies crucially on: 1) ANCHOR constraints which refer to morphology in the input, and 2) conjunction of constraints. The first of these is entirely acceptable in M-Faithfulness, as ANCHOR constraints are faithfulness constraints which refer to morphology only in the input. The second of these points, conjunction of constraints, is more of a theory-external question, as far as M-Faithfulness is concerned.

If conjunction is well-motivated and must be a part of the grammar, then Local Constraint Conjunction accounts of boundary-sensitive phonology are entirely consistent with M-Faithfulness. If conjunction is not allowed, then Local Conjunction accounts are not acceptable. Conjunction appears to be independently motivated, and has been proposed as an explanation for a number of phenomena, including positional phonological patterns (Lubowicz 2002, 2003; Itô and Mester 2003), OCP effects (Itô and Mester 1996; Smolensky 1995), sonority profiles in syllables (Smolensky 1995), and "gang up" effects (Smolensky 1995; Kirchner 1996). Again, the arguments for or against conjunction are not reproduced here, but allowing for it, the Local Conjunction analysis of boundary-sensitive phonology is not so much a competing explanation to M-Faithfulness as a part of it.

If Local Conjunction were sufficient to handle all cases of boundary-sensitive phonology, then M-Faithfulness would represent an unnecessary complication. But, since Local Conjunction cannot account for a number of cases discussed earlier, M-Faithfulness is not an unnecessary complication, but rather a needed extension. As it happens, Local Conjunction is also necessary for M-Faithfulness, as the case of Maale in the following section demonstrates. So, though M-Faithfulness is largely incompatible with both Stratal OT and Coloured Containment, it is not incompatible with Local Conjunction, and the two serve as complementary pieces.

## 5.2 Maale

In Maale, there is a boundary-sensitive alternation which presents an interesting challenge to theories of morphology-phonology interaction. The process appears on the surface to be a morpheme-final one, but the alternating consonant is not *underlyingly* morpheme-final.

Maale has a process in which morpheme-final /ts, c(c)/ glottalize to [s', c']<sup>1</sup>, at least in nouns (Amha 2001). Examples of this alternation may be seen in (83). These two pairs of sounds contrast in general in Maale, as shown in 84).

			[f'ooc'o] - 'guests'
	[f'oocci] - 'guest'	vs.	[f'ooc'ello] - 'guest (F:ABS)'
			[f'ooc'atsi] - 'guest (M:ABS)'
<hr/>			
			[mis'o] - 'the tree (DF:ABS)'
(83)	[mitsi] - 'tree'	vs.	[mis'a] - 'the tree (DF:NOM)'
			[mis'ontsi] - 'the trees (PL:DF:NOM)'
<hr/>			
	[megets'i] - 'bone'	vs.	[meges'o] - 'bones'
<hr/>			
	[mucci] - 'language'	vs.	[muc'o] - 'languages'

(Amha 2001:22)

- (84)
- [k'as'a] - 'itching (skin disease)' :: [katsa] - 'food'
  - [k'os'itsi] - 'to be disappointed in someone' :: [k'otsi] - 'fever'
  - [βec'c'-] - 'wake up (itr.)' :: [βecc'-] - 'wake someone (tr.)'

(Amha 2001:18)

The alternation occurs in morpheme-final position, and because the syllable structure of Maale permits only CV(V)(C) syllables, the stops undergoing the alternation are not underlyingly morpheme-final, but rather become morpheme-final when a vowel-initial suffix is added. The stem-final vowel deletes because there would otherwise be an onsetless syllable. For instance, for the underlying form /mitsi+o/, the potential output

<sup>1</sup>(Amha 2001) describes all four segments involved as voiceless sibilant stops, so despite the transcription as [s'], it is assumed to be [-cont]. The sole difference between the two members of each pair of alternating stops is taken to be that /ts, c/ are [-constricted glottis] and [s', c'] are [+constricted glottis].

\*[mi.tsi.o] is not allowed because the final syllable has no onset. The deletion of the stem-final vowel results in the well-formed output [mi.s'o] (along with the consonant alternation). The forms with the consonant alternation always have the stem-final vowel deletion.

This process poses problems for several of the models considered in this thesis. As seen in the following discussion, Stratal OT does not provide a successful account. Coloured Containment does permit an analysis which, though mechanically successful, relies on a highly unusual markedness constraint referring to unparsed material as a conditioning context. Local Constraint Conjunction is the only model which provides a truly satisfying account of the alternation in Maale. Interestingly, the interaction of the Maale alternation and the coincident vowel deletion (for hiatus resolution) also makes an analysis using M-Faithfulness constraints impossible.

### 5.2.1 M-Faithfulness

Maale, uniquely among the cases considered here, presents a challenge for the M-Faithfulness model. The consonant which alternates is not underlyingly morpheme-peripheral, so M-IDENT constraints would wrongly protect it. The failure of an analysis relying purely on M-IDENT constraints is shown in (86) using the same constraints as above, together with M-IDENT[constricted glottis], defined in (85). The Maale alternation, however, shows the importance of Local Conjunction to the M-Faithfulness model. Local Conjunction successfully analyzes Maale, and no aspect of the analysis violates the principles of M-Faithfulness, so the analysis is ultimately compatible with the M-Faithfulness model.

- (85)
- a) M-IDENT[constricted glottis] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [ $\pm$ constricted glottis] feature
  - b) ONSET - Assign one \* for each syllable in the output without an onset.
  - c) \*[ts, c] - Assign one \* for each [+strident, -constricted glottis] segment in the output.

	megets <sup>u</sup> i+o	ONSET	M-IDENT[cg]	*[ts,c]	IDENT[cg]
(86)	● a. [me.ge.tso]			*	
	b. [me.ge.s'o]		*! W	L	* W
	c. [me.ge.ts.i.o]	*! W	L	*	L

The alternating consonant can only be considered morpheme-final after vowel deletion has taken place, meaning M-IDENT constraints still consider it morpheme-internal because no morpheme boundaries are present in the output. Though M-IDENT constraints alone cannot account for the process in Maale, Local Conjunction does successfully analyze it. Nothing required by the Local Conjunction analysis is incompatible with the M-Faithfulness model - R-ANCHOR constraints are acceptable because faithfulness constraints may refer to morphological information in the input. Conjunction itself is useful not only in the explanation boundary-sensitive phonology, but in other phenomena as well (e.g. positional devoicing in German - (Itô and Mester 2003)). So, allowing for conjunction, Local Conjunction analyses are compatible with the M-Faithfulness model, and since Local Conjunction does fail on a number of cases (Banoni, Macuxi, Anywa preconsonantal stops, Korowai /t/ → [l] alternation) which M-Faithfulness does account for, it does not provide an unnecessary complication, but rather a necessary extension.

### 5.2.2 Stratal OT

Similarly, an analysis of the Maale glottalization pattern in Stratal OT is not possible. If the vowel deletion preceded the consonant alternation as a stem-level process, and the consonant alternation were a domain-final effect, then perhaps an analysis would be possible, but this does not work. The vowel deletion is motivated by syllable structure, and cannot occur until the root is affixed, but at this point, the conditioning environment (domain-final) is no longer met. (87) demonstrates why this analysis fails.

	Input:	[ <sub>WL</sub> [ <sub>SL</sub> megets <sup>u</sup> i]]	[ <sub>WL</sub> [ <sub>SL</sub> megets <sup>u</sup> i+o]]
(87)	Stem-Level(Vowel Deletion):	[megets <sup>u</sup> i]	[megetso]
	Word-Level(Consonant Alternation):	[megets <sup>u</sup> i]	[megetso]
	Final Result:	[megets <sup>u</sup> i]	●[ <sup>u</sup> megetso]

The consonant alternation fails to apply because the conditioning environment for the vowel deletion obliterates the conditioning environment for the consonant alternation. Once the affix is added, resulting in the final vowel deletion, the consonant is no longer domain-final, so the consonant alternation does not occur. The unaffixed form, /megets/ correctly surfaces with no vowel deletion or consonant mutation.

If the vowel deletion is instead a domain-final deletion rather than one motivated by syllable structure, and both the consonant alternation and vowel deletion occur during the stem cycle, then the correct output for affixed forms can be generated, but the bare stems surface incorrectly. This is shown in (88).

Input:	[ <sub>WL</sub> [ <sub>SL</sub> megets]]	[ <sub>WL</sub> [ <sub>SL</sub> megets]o]
Stem-Level(Vowel Deletion):	[megets]	[[megets]o]
(88) Stem-Level(Consonant Alternation):	[meges']	[[meges']o]
Word-Level:	[meges']	[meges'o]
Final Result:	◌ <sup>u</sup> [meges']	[meges'o]

While each of these approaches can correctly predict the output form for either the affixed form or the unaffixed form, neither approach can correctly predict the output form in both cases. The reason for this failure is that the consonant which undergoes the alternation is never domain-final, unless the morpheme is a phonological domain, which Stratal OT explicitly forbids. The vowel deletion process which would make the consonant domain-final is itself conditioned by the addition of an affix which then guarantees that the alternating consonant is not domain-final.

### 5.2.3 Coloured Containmentment

The traditional Coloured Containmentment account of boundary-sensitive phonological effects relies on being able to explain those effects as spreading. The phonological change involved in the Maale consonant alternation is from [-constricted glottis] to [+constricted glottis]. If some value of the [ $\pm$ constricted glottis] feature were spreading from the affix vowel to the newly stem-final consonant, it would be expected to be [-constricted glottis], not [+constricted glottis], so the spreading account would predict the opposite change (i.e. /s, c' /  $\rightarrow$  [ts, c]), but not the change as it actually occurs.

Another aspect of Coloured Containmentment, however, may prove useful in the explanation of this process.

According to Containment Theory (Prince and Smolensky 1993; van Oostendorp 2006, 2007), every element of the input is present in the output. The phonology may mark some elements as unparsed, or somehow unpronounceable. While still present in the output of phonology, unparsed segments are deleted by the interface between phonology and phonetics, and ultimately not pronounced. Because of this, the stem-final vowel deletion in Maale (which always accompanies the consonant mutation) results in the presence of an unparsed vowel. So, instead of a morpheme-final consonant alternation, it is a consonant alternation conditioned by the presence of an unparsed vowel. This is formalized using the constraints in (89) and can be seen in the tableaux in (90).

The constraint against insertion of a morpheme-external feature (in this case, [+constricted glottis] in the Coloured Containment model is  $\text{PARSE-}\mu(\alpha)$ , which says that (according to van Oostendorp 2006, 2007) "The phonological element  $\alpha$  must be incorporated into the morphological structure." This is a constraint against the insertion of phonological elements, because inserted elements are colorless, and not a part of morphological structure.


- (89) a)  $\text{PARSE-}\mu([+\text{constricted glottis}])$  - Assign one \* for each [+constricted glottis] feature which is not part of the morphological structure (i.e. an inserted feature) - (Abbreviated  $\text{PARSE-}\mu[\text{cg}]$  in tableaux)
- b)  $*\text{tsUnparsedV}$  - Assign one \* for each [+ant -constricted glottis] segment before an unparsed vowel
- c)  $\text{PARSE-}\phi(V)$  - Assign one \* for each [-cons] segment which is part of the morphological structure but not in the phonological structure (i.e. a deleted vowel)

The markedness constraint  $*\text{tsUnparsedV}$ <sup>2</sup> is highly unusual and seemingly ad hoc, but necessary to motivate the alternation seen in Maale. This undesirable property of the Coloured Containment analysis is not totally damning, as the phonological process involved is phonetically somewhat unusual, and it is likely any constraints-based analysis of Maale will require an atypical markedness constraint.


- (90) a) **Consonant alternation in affixed form**

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<sup>2</sup>In tableaux, parsed elements are shown in parentheses, and unparsed elements are not.

/megetsio/	ONSET	*tsUnparsedV	PARSE- $\phi$ (V)	PARSE- $\mu$ (cg)
a.  [(me.ge.s')i(o)]			*	*
b. [(me.ge.ts.i.o)]	*! W		L	L
c. [(me.ge.ts)i(o)]		*! W	*	L


b) **No alternation in unaffixed form**

/megetsio/	ONSET	*tsUnparsedV	PARSE- $\phi$ (V)	PARSE- $\mu$ (cg)
a.  [(megetsio)]				
b. [(meges'i)]				*! W
c. [(meges')i]			*! W	


## 5.2.4 Local Constraint Conjunction

Because vowel deletion occurs at the right edge of the stem in each form with the boundary-sensitive consonant alternation, these forms will always have a R-ANCHOR[stem,  $\sigma$ ] violation. This makes the process amenable to an analysis within a local constraint conjunction framework. The markedness constraint conjoined with R-ANCHOR for this case is a more complicated issue. Because the alternation is not a phonetically common one, the markedness constraint involved will appear to be phonetically implausible (91d), but this is not a problem unique to a local constraint conjunction approach, but rather a more general one.

- (91)
- a) ONSET - Assign one \* for each syllable in the output without an onset.
  - b) MAX-V - Assign one \* for each [-cons] segment in the input without an output correspondent.
  - c) \*[ts, c] - Assign one \* for each [+strident, -constricted glottis] segment in the output.
  - d) IDENT[constricted glottis] - Assign one \* for each segment in the output which does not match its input correspondent with respect to [ $\pm$ constricted glottis]. (Abbreviated IDENT in tableaux)
  - e) [R-ANCHOR[stem,  $\sigma$  & \*[ts, c]]<sub>AdjSeg</sub> - (Abbreviated [R-ANCHOR & \*[ts, c]] in tableaux)
- (92)
- a) **Alternation in affixed form**

/megetsio/	ONSET	[R-ANCHOR & *[ts, c]]	MAX-V	IDENT	*[ts, c]
a.  [me.ge.s'o]			*	*	
b. [me.ge.tso]		*!	*		*
c. [me.ge.tsi.o]	*!				*

b) **No alternation in unaffixed form**

/megetsio/	ONSET	[R-ANCHOR & *[ts, c]]	MAX-V	IDENT	*[ts, c]
a.  [me.ge.tsi]					*
b. [me.ge.s'i]				*!	
c. [me.ge.o]	*!				

The constraints in (91) ranked as shown in the tableaux in (92) correctly predict the output forms for both affixed (alternating) and unaffixed (non-alternating) inputs. The analysis relies on the unusual and phonetically undesirable \*[ts, c] constraint, but again, this is due to the nature of the process involved, not to any peculiar limitation of the local constraint conjunction approach.

Maale, unlike the other case studies considered, poses a problem for an M-Faithfulness account without constraint conjunction. Because the alternating consonant is not underlyingly morpheme-final (it is morpheme-final only once the vowel is deleted to resolve hiatus), it is wrongly protected by M-IDENT constraints. The Maale alternation identifies a potentially more general failing of M-IDENT constraints. When an alternation which appears to be morpheme-peripheral happens to segments which are underlyingly not peripheral, but become peripheral due to some other process (like vowel deletion in hiatus resolution, in the case of Maale), then the alternation is erroneously prevented by M-IDENT. This is specifically due to the ability of faithfulness constraints in the M-Faithfulness framework to refer to morphemes only in the input.

These cases will often be amenable to Local Conjunction analyses. If a segment which alternates appears to be morpheme-peripheral in the output, but isn't in the input, there are several ways this could have happened. Like in Maale, a peripheral deletion process may have occurred. Or a metathesis could have taken place involving morpheme-peripheral segments. In either case, a Local Conjunction analysis is possibly useful. Like in Maale, morpheme-final deletion always causes R-ANCHOR is always violated and can be used in a conjoined constraint to ensure boundary-sensitivity. If metathesis (admittedly typologically unusual) oc-

curs, then there is potential for ANCHOR constraints to be useful as well. Consider the completely hypothetical example in (93).

(93) /bənænzə + ti/ → [bənæ.nəz.ti]

If the final two segments of the stem /bənænzə/ undergo metathesis, then the stem-final /ə/ is not at the right edge of a syllable. So, R-ANCHOR[stem,  $\sigma$ ] is violated. In other words, the cases like Maale which have an apparent morpheme-peripheral effect which does not target morpheme-peripheral input segments are generally well-handled by Local Conjunction. The cases which are explanatory weaknesses of the M-Faithfulness model are explanatory strengths of the Local Conjunction model, and the two complement each other well. Ultimately it is an empirical question whether all such cases can be explained using Local Conjunction, or whether certain cases exist that result in an explanatory gap.

### 5.3 Positional Faithfulness

One point which must be addressed is that of other accounts of positional faithfulness, particularly from a typological perspective. A number of studies (Casali 1996, 1997; Beckman 1997) find that certain positions (morphological or prosodic) are privileged (cross-linguistically), in that they either resist general neutralization or reduction patterns or support a wider range of contrasts than other positions. Such positions include: word-initial position, in roots (versus affixes), in content (versus function) words, in stressed syllables, in root-initial syllables.

Interestingly, this generalization is partially at odds with several of the constraint families important to the M-Faithfulness model. Specifically, the M-Contig and M-IDENT families seem to privilege morpheme-internal material over peripheral material, while the typological generalizations suggest that word-initial and root-initial positions are both privileged. The M-Faithfulness constraint families offer no explanation for why initial positions are privileged and final positions are not - they are both peripheral, and thus exempted from the faithfulness requirements of M-IDENT.

In a broad sense, this initial privileging may exist for psycholinguistic and processing reasons (see Beckman 1997; Casali 1997 for more on this). More specifically, these effects must be grammatically modeled,

and the approach of both Casali and Beckman is to use positional faithfulness constraints. Consider several constraints posited by Casali (1997), reproduced in (94).

- (94) a) MAXWI - Every word-initial segment in the input must have a corresponding segment in the output
- b) MAXROOT - Every root segment in the input must have a corresponding segment in the output

The first of these, MAXWI is purely positional, and protects word-initial segments. The second refers to morphological information in the input only, in keeping with the restriction on faithfulness constraints in the M-Faithfulness model. Some constraints proposed by Beckman (1997) are slightly more problematic for M-Faithfulness. Take the constraint given in (95) for instance. This constraint requires reference to a root in the *output*, not only the input. Perhaps another formulation of this constraint is possible not requiring reference to morphology in the output, but in its current state it does not comply with the requirements of M-Faithfulness. Specifically, it requires reference to morphology in the *output*, not just the input, which is forbidden under the M-Faithfulness approach.

- (95) IDENT- $\sigma_1$ (hi) - A segment in the root-initial syllable in the output and its correspondent in the input must have identical values for the feature [high].

Assume for a moment that such an alternate formulation of IDENT- $\sigma_1$ (hi) does exist. Constraints proposed by Casali and Beckman, together with M-Faithfulness constraints predict a number of typological patterns. Consider the hypothetical example given in (96).

- (96) 1. \*HighV - Assign one \* for each [+high -cons] segment in the output
2. IDENT- $\sigma_1$ (hi) - A segment in the root-initial syllable in the output and its correspondent in the input must have identical values for the feature [high].
3. M-IDENT[high] - Assign one \* for each non-morpheme-peripheral segment in the input which does not match its output correspondent with respect to the [ $\pm$ high] feature
4. IDENT[high] - Assign one \* for each segment in the input which does not match its output correspondent with respect to the [ $\pm$ high] feature

There are a number of typological patterns predicted by this collection of constraints, shown in (97).

Pattern	Ranking
No high vowels allowed	*HighV >> IDENT- $\sigma_1$ (hi), M-IDENT[high], IDENT[high]
High vowels allowed only in root-initial syllables	IDENT- $\sigma_1$ (hi) >> *HighV >> M-IDENT[high], IDENT[high]
(97) High vowels allowed, except word-finally	IDENT- $\sigma_1$ (hi), M-IDENT[high] >> *HighV >> IDENT[high]
High vowels allowed in any context	IDENT- $\sigma_1$ (hi), M-IDENT[high], IDENT[high] >> *HighV
High vowels permitted except initially and finally	M-IDENT[high] >> *HighV >> IDENT- $\sigma_1$ (hi), IDENT[high]

It is an empirical question whether such patterns exist (not necessarily regarding high vowels specifically, but some analogous patterns). The first four all certainly exist (see (Beckman 1997) for examples of the second pattern, and Macuxi (this thesis) for an example of the third. The first and fourth patterns exist (this is trivial), the potentially more problematic case is the fifth - the case where high vowels are permitted only morpheme-internally.

This fifth case is less well-attested in the literature. Perhaps it does occur - consider for instance, [ʒ] in English (again, speaking not specifically of high vowels, but of the mathematical pattern in question). At least in some dialects it occurs medially, but never in initial or final position. But, if this has some other explanation and this typological pattern is truly not seen, then an explanation is required. One potential solution is that initial positions are *universally* privileged over morpheme internal ones (i.e. IDENT- $\sigma_1$ (hi) and M-IDENT[high] are universally ranked in that order). This guarantees that M-IDENT[high] can never outrank \*HighV unless IDENT- $\sigma_1$ (hi) also does, and so there is no bogus typological prediction. Again, it is an empirical question whether such patterns exist, but if they do, then the typological predictions of M-Faithfulness and other accounts of positional faithfulness are correct. If such patterns do not exist, then a universal ranking of certain constraints makes the correct typological predictions.

While the M-Contig and M-IDENT families don't directly predict the privileging of initial positions, they conspire with accounts of initial faithfulness (e.g. root-initial faithfulness in Beckman 1997 or MAXWI in

Casali 1997) to predict that morpheme-final effects should be more common than morpheme-initial ones. If M-IDENT and M-Contig constraints protect morpheme-internal material, and other positional faithfulness constraints protect word-initial segments, then the morpheme-final material is most subject to markedness constraints (i.e. the least protected by faithfulness), and the most likely to undergo some repair.

This prediction is borne out in the case studies in this thesis. Of the nine cases considered earlier, along with Maale (considered in 5.2), eight are morpheme-final processes, and only two are morpheme-initial (this is summarized in (98)).

(98)

Domain-Final Processes	Domain-Initial Processes
Banoni	
Macuxi	
Anywa Intervocalic Dorsals	
Anywa Intervocalic non-Dorsals	Sawai
Anywa Preconsonantal	Korowai /t/ → [l]
Korowai /p/ → [ɸ]	
Maale	
Kashmiri	

The case studies considered here overwhelmingly show a tendency for domain-final processes over domain-initial ones, agreeing with the prediction of M-Faithfulness constraint families and other research into positional faithfulness effects.

## CHAPTER 6

### CONCLUSION

#### 6.1 Directions for Further Research

There has been some amount of research into the psycholinguistic basis for positional faithfulness (see Smith 2002; Casali 1996, 1997 for overviews of some of this research). This research has generally targeted positions said to be prominent in terms of positional faithfulness, such as word-initial position, root-initial position, and in stressed syllables. Similar psycholinguistic inquiry into the psycholinguistic prominence of morpheme-internal versus morpheme-peripheral positions (though in certain cases, morpheme-peripheral positions do, of course, coincide with some other prominent positions).

One potential reason morpheme-internal information could be privileged over peripheral information, is the idea that morpheme form underlying units, and so, should not be altered unless forced to by material external to that morpheme (like an adjoining affix, for instance). This idea is central to the Coloured Containment framework, and can be seen in, for example, the ALTERNATION constraint. If changes to morphemes are driven by external material, then it follows that (at least in most circumstances) the parts of the morpheme most likely to change are those at the periphery (thus the faithfulness exemption at boundaries).

Pursuing this idea raises interesting questions with respect to positional prominence and typology of affixation. It is a general finding that initial positions are more prominent than morpheme-final positions (Beckman 1997; Casali 1996, 1997). It is also generally true that inflectional morphology overwhelmingly tends to be suffixing rather than prefixing (Dryer and Haspelmath 2011). So, if morpheme-peripheral positions are exempt from some types of faithfulness (e.g. M-IDENT), and suffixes are more common than prefixes, then the

prominence of initial positions may in fact be due in part to morphological typology. Further research into the interaction and competition between morphological typology, positional faithfulness, and M-Faithfulness would be beneficial.

## 6.2 Summary

This thesis has considered the interaction between phonology and morphology. In particular, it has addressed the handling of phonological processes which appear to be sensitive to morphological information - specifically morpheme boundaries.

A number of phonological theories have been advanced which attempt to explain such phonological processes. Notable among them are Stratal OT (Bermúdez-Otero 2011, 2012, 2013; Bermúdez-Otero and McMahon 2006; Kiparsky 2000), Coloured Containment (van Oostendorp 2006, 2007), and Local Constraint Conjunction (Smolensky 1993; Lubowicz 2002, 2003).

The first important contribution of this thesis is to show that none of these existing models can provide a satisfactory explanation for all existing cases of boundary-sensitive phonology. The case studies presented in chapter 4 demonstrate the failures of these existing models on actual language data.

The second contribution of this thesis is to present the new M-Faithfulness model (shown in chapter 3), which can successfully analyze cases problematic for other models of boundary-sensitive phonology. M-Faithfulness incorporates two essential ideas. One, it extends the notion of Landman's (2003) M-Contiguity approach that faithfulness constraints may target non-morpheme-peripheral information in the input. And two, faithfulness constraints (and only faithfulness constraints) may reference morphological information in the input (and only the input).

Also proposed is a new family of constraint, the M-IDENT constraint family. This constraint family marries the idea of featural identity between input and output (i.e. IDENT constraints) and the sensitivity to morphology proposed by M-Contiguity. With regard to this family of constraints in particular, psycholinguistic research, as well as research into the interaction between M-Faithfulness, positional faithfulness, and morphological typology are promising potential avenues of further inquiry.

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