POSITIONAL FAITHFULNESS

A Dissertation Presented

by

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ABSTRACT

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There are a variety of phonological asymmetries exhibited by segments which appear in perceptually or psycholinguistically prominent positions such as roots, root-initial syllables, stressed syllables, and syllable onsets. In such positions, segmental or featural contrasts are often maintained, though they may be neutralized in non-prominent positions. Segments in prominent positions frequently trigger phonological processes such as assimilation, dissimilation and vowel harmony; conversely, they often block or resist the application of these processes. The goal of this dissertation is to develop a theory of positional faithfulness which will both generate and explain the range of positional asymmetries attested in natural language phonology.

Chapter 1 introduces the notion of positional privilege, as well as the fundamental aspects of Optimality Theory. Positional faithfulness constraints are introduced and demonstrated in an analysis of onset/coda asymmetries in Catalan voice assimilation.
I argue that positional faithfulness provides an explanation for the attested onset/coda asymmetries that is not afforded by licensing alternatives.

Faithfulness in root-initial syllables, a position in which prominence derives largely from psycholinguistic (rather than phonetic) properties, is considered in Chapter 2. Particular attention is given to the analysis of vowel harmony in Shona, and to the phonology of consonantal place in Tamil.

Chapter 3 is devoted to the domain of stress, showing once again that positional faithfulness constraints unify and explain a wide range of phonological asymmetries associated with the positional prominence. The core of the chapter is an analysis of nasal harmony in Guaraní; vowel reduction in Catalan is also examined.

In Chapter 4, I turn to positional privilege effects which are sensitive to the distinction between root and affix. Such cases provide further support for positional faithfulness theory.

Finally, in Chapter 5, a different type of positional faithfulness effect, that of positional maximization, is examined. I argue that constraints which favor maximal packing of prominent constituents are necessary. Such constraints are crucial in cases of prominence-driven ambisyllabicity, as in Ibibio. Positional MAX constraints also account for the appearance of complex syllable margins in prominent positions, though complex margins may be excluded elsewhere in the language.

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CHAPTER 1

ASPECTS OF POSITIONAL FAITHFULNESS THEORY

1.1 Introduction: Positional Privilege in Phonology

There is a small inventory of privileged linguistic positions which play a central role in the phonological systems of the world's languages. Privileged positions (1a) are those positions which enjoy some perceptual advantage in the processing system, via either psycholinguistic or phonetic prominence, over the complement of non-privileged positions (1b).

(1)	a. Privileged positions	b. Non-privileged positions
	• Root-initial syllables	• Non-initial syllables
	• Stressed syllables	• Unstressed syllables
	• Syllable onsets	• Syllable codas
	• Roots	• Affixes, clitics, function words
	• Long vowels	• Short vowels

Positions which are psycholinguistically prominent are those which bear the heaviest burden of lexical storage, lexical access and retrieval, and processing: root–initial syllables, roots and, to some degree, final syllables (see Chapter 2 and Steriade 1993c for relevant discussion). By contrast, medial syllables and functional elements such as inflectional affixes, clitics and closed-class items, though important, play a lesser role in the organization of the lexicon. Phonetic prominence may be instantiated by many different physical cues, including increased duration or amplitude, pitch extrema, release bursts, etc. (See Kingston 1985, 1990; Steriade 1993c, 1995 and Kirchner 1996 for recent examinations of perceptual cues and their role in phonology.) Positions of phonetic prominence include stressed syllables, syllable onsets, long vowels and possibly final syllables.

Positional privilege is not determined solely on perceptual grounds, however. While there is a functional unity to the class of privileged positions, there is also a phonological unity: positional privilege is manifested in three distinct, but closely related, patterns of phonological asymmetry (2).

(2) Phonological asymmetries diagnostic of positional privilege
- Positional maintenance of contrasts which are neutralized elsewhere

• Positional triggering of phonological processes
• Positional resistance to processes which apply elsewhere

I will show, in this and subsequent chapters, that each of these phonological asymmetries arises from a single pattern of constraint interaction in an Optimality Theoretic grammar (Prince & Smolensky 1993, McCarthy & Prince 1993a,b) , one in which *positional faithfulness constraints* crucially dominate context-free faithfulness and markedness constraints. Before turning to the analysis, however, let me consider each of the diagnostic asymmetries in (2) in greater detail.

The first of these phenomena, typically discussed under the heading of positional neutralization, is the most familiar, documented in many languages for many different positions of privilege. (See, for example, Trubetzkoy 1939; Bach 1968; Haiman 1972; Ringen 1975; Kiparsky 1981, 1988; Goldsmith 1985, 1989, 1990; Kingston 1985, 1990; Itô 1986, 1989; Lombardi 1991; Steriade 1979, 1982, 1993c, 1995; and a host of others.) In cases of positional neutralization, some contrast or contrasts are maintained only in a prominent position. Outside of that position, the inventory is a less-marked subset of the full inventory attested in positions of privilege; the contrast in question is neutralized in favor of an unmarked value. The reverse pattern, in which the full inventory appears in a non-prominent position and an unmarked subset is restricted to the prominent position, is rarely, if ever, attested.

Positional neutralization is most obvious, perhaps, when it occurs in morphologically derived environments, where there are overt alternations to highlight the neutralization process; however, this positional restriction on the distribution of constrast is robustly documented in many languages. One example of positional neutralization can be found in the vowel height harmony system of Shona verbs. Shona, a Bantu language of Zimbabwe, has a common, five-vowel inventory: {i,e,u,o,a}. In verbs, vowel height is fully contrastive in root-initial syllables, as shown in (3); all five vowels occur freely. However, vowel height in non-initial syllables is severely restricted; non-initial mid vowels may surface only if preceded by an initial mid vowel (4).

(3) Initial syllable: Vowel height varies freely

pera	‘end’
tsveta	‘stick’
sona	‘sew’
ipa	‘be evil’
iuàa	‘come out’
bvuma	‘agree’
iata	‘hold’
shamba	‘wash’

(4) Non-initial syllables: Height is restricted

Mid vowel in s_1		*Non-mid vowel in s_1*	
tonhor-	‘be cold’	buruk-	‘dismount’
pember-	‘dance for joy’	simuk-	‘stand up’
bover-	‘collapse inwards’	turikir-	‘translate’
		charuk-	‘jump over/across’
		tandanis-	‘chase’

There are no Shona verb roots in which mid vowels follow either low or high vowels. Only the peripheral vowels *i*, *u* and *a* are contrastive in non-initial syllables. (For an analysis of the Shona facts, see Chapter 2.) This type of positional neutralization, displaying sensitivity to the root-initial syllable, is extremely common in languages which exhibit vowel harmony, being attested in a genetically diverse array of languages and language families including Bantu, Kwa, Uralic, Altaic, and Finno-Ugric. Not attested are languages in which a full array of vowels appear outside of the root-initial syllable, while only the peripheral vowels appear in initial syllables.

A second example of positional neutralization, also familiar, is that of unstressed vowel reduction. In languages which exhibit reduction of unstressed vowels, the full inventory is permitted to surface under stress. In the absence of stress, however, the vowel inventory is restricted to a set which is less marked on either the articulatory or acoustic dimension. English is one example of reduction in articulatory markedness; non-final unstressed vowels in English are restricted to [\][1] (Chomsky & Halle 1968, Bolinger 1981, Flemming 1993, Burzio 1994), a vowel which is arguably devoid of any place specifications or articulatory targets (Anderson 1982, Odden 1991, Browman & Goldstein 1992). An example of reduction to an inventory

1 In unstressed final syllables, [ij] and [oU] may occur. Some dialects permit unstressed [I] in both final and medial syllables.

which is arguably less marked acoustically may be found in Western Catalan (as well as a number of other regional Romance dialects) (Hualde 1992, Prieto 1992). In syllables which bear primary stress, Western Catalan exhibits the seven-vowel inventory shown in (5).

(5) Western Catalan vowels, stressed syllables

		Front		Back
High:		i		u
Mid:	[+ATR]	e		o
	[–ATR]	´		ø
Low:			a	

However, outside of the primary stress position, the vowel inventory of Western Catalan is limited to a triangular five-vowel system, with the [ATR] contrast among the mid vowels being lost. This inventory can be characterized as less marked than that of the stressed syllables, as it is composed of fewer vowels separated by greater perceptual distance (Liljencrants & Lindblom 1972, Lindblom 1986, Flemming 1995) . Representative data are provided in (6), with alternating vowels in boldface.

(6) Unstressed vowel reduction, Western Catalan (Prieto 1992: 567–568)

r~íw	‘river’	r~iwét	‘river, dim.’
néw	‘snow’	newéta	‘snow, dim.’
p´'s	‘weight’	p**e**zét	‘weight, dim.’
pála	‘shovel’	paléta	‘shovel, dim.’
r~**ø**'?a	‘wheel’	r~**o**?éta	‘wheel, dim.’
só"	‘sun’	solét	‘sun, dim.’
búr~o	‘dumb’	bur~ét	‘dumb, dim.’

Here, as in the Shona case, it is the position of perceptual prominence which is accorded phonological privilege, permitting a wider variety of vowels than the less prominent, unstressed syllables. (A full analysis of Catalan vowel reduction is provided in Chapter 3.) I know of no cases of “stressed vowel reduction”, in which the inventory in stressed syllables is a subset of that in the unstressed syllables. In circumstances of positional neutralization, it is always the perceptually non-prominent position which undergoes reduction, while the prominent positions preserve a full range of contrasts.

The second phonological diagnostic of positional privilege is the triggering of phonological processes. Segments which appear in privileged positions frequently serve as the triggers of phonological processes such as vowel harmony, place assimilation, laryngeal feature assimilation, and dissimilation of various sorts. In the realm of vowel harmony, cases of positional triggering arise in languages which exhibit root-governed vowel harmony (in which the vowels of the root determine the vocalism of any affixes, whether prefixes or suffixes; Tangale (Hulst & Weijer 1995) is one such example), and in those which have initial-syllable governed harmony. In the latter class of examples, it is the vowel of the root-initial syllable which determines the vocalism of any subsequent root vowels, as well as that of affixal vowels, via progressive assimilation. Numerous vowel harmony systems fall into this category; they include the height harmony system of Shona and other Bantu languages, ATR harmonies in a variety of African and Tungusic languages, and the palatal and labial harmonies of the Uralic and Altaic languages. (See Hulst & Weijer 1995 and the extensive prior vowel harmony literature cited therein for additional details.)

Positional triggering is also robustly attested in clusters of consonants comprised of a coda and following onset; canonical cases include place assimilation (Steriade 1982, 1993c, 1995; Itô 1986, 1989; Padgett 1991, 1995b) and laryngeal assimilation (Kingston 1985, 1990; Cho 1990; Lombardi 1991, 1995a, 1996a,c). One example occurs in Diola Fogny, a language of West Africa. In Diola Fogny, coda nasal consonants undergo assimilation in place to a following obstruent or nasal, as shown in (7).

(7) Place assimilation in Diola Fogny (Sapir 1965: 16; Itô 1986: 56)

a.	/ni-gam-gam/	∅	niga˜gam	‘I judge’
	/pan-ji-maµj/	∅	paµjimaµj	‘you (pl.) will know’
	/ku-bøñ-bøñ/	∅	kubømbøñ	‘they sent’
	/na-ti:˜-ti:˜/	∅	nati:nti:˜	‘he cut (it) through’
b.	/na-mi:n-mi:n/	∅	nami:mmi:n	‘he cut (with a knife)’
	/ni-ma˜-ma˜/	∅	nimamma˜	‘I want’
	/ni-˜an-˜an/	∅	ni˜a˜˜an	‘I cried’

In these data, the segment which appears in onset position triggers the process of place assimilation; the features of the non-onset consonant are lost. This is true also of obstruent-obstruent clusters which exhibit voice assimilation (Lombardi 1991, 1995a, 1996a,c) and place assimilation or gemination (Mohanan 1993). Processes which are triggered exclusively by elements in non-prominent positions (such as voice or place assimilation triggered only by coda consonants, or vowel harmony triggered only by affixes), without an overriding functional motivation, are virtually unattested.

The final phonological diagnostic of positional privilege is that of resistance to phonological processes, a phenomenon closely related to positional triggering of processes. Segments which appear in privileged positions such as onsets or stressed syllables often fail to undergo an otherwise regular phonological process, such as assimilation or dissimilation. In one class of cases, exemplified by the Diola Fogny data above, this failure of privileged positions to alternate appears almost unworthy of mention; given a process affecting two-member consonant clusters, one must be target and one must be trigger. If the onset segment is the trigger of assimilation, as seen above, it cannot also be the undergoer. This line of argumentation obscures an important generalization, however: segments in prominent positions very rarely undergo phonological processes, *even in cases in which they do not serve as triggers.*

One striking example of this latter variety of positional resistance can be found in Zulu, a Bantu language of South Africa. In morphologically complex Zulu forms in which a labial consonant + *w* sequence arises (the passive and the locative), there is a process of dissimilation which causes the affected labial consonant to surface as a palatal or palato-alveolar (Doke 1954, 1969; O'Bryan 1974; Ohala 1978; Khumalo 1987; Beckman 1994a) .[2] The process is unbounded, affecting the rightmost labial, even if that labial is not syllable-adjacent to the triggering *w* . The affected labial consonants are themselves never the trigger of dissimilation. Some examples are given in (8).

[2] The outcome of dissimilation is affected by both the manner and the laryngeal specification of the targeted labial consonant, with the voiceless aspirate [p^h] surfacing as a fricative [ß], and the other oral stops appearing as affricates. There are no non-affricated oral palatal stops in the Zulu inventory.

(8) Labial dissimilation in Zulu (Beckman 1994a)

io**ph**a	'Tie!'	uyaio**ß**iswa	'he is being made to tie'
		iyaio**ß**elwa	'it is being tied for someone'
°u**ph**ek'a	'Suffer!'	k'u°u**ß**ek'wa	'it is being suffered'
se**i**´nza	'Work!'	iyase**ê'**´nzwa	'it is being worked'
ßu**m**ayela	'Preach!'	iyaßu**µ**elelwa	'it is being preached'
Tgo**b**oza	'Dip!'	iyaTgo**Ê**ozwa	'it is being dipped'
kʰu**m**ula	'Undress!'	uyakʰu**µ**ulelwa	'she is being undressed for'

The dissimilation process fails to apply in one circumstance, when the target labial is contained in the initial syllable of the root.[3] This is shown in (9).

(9) Root-initial exceptionality (Beckman 1994a)

phuza	'Drink!'	iya**ph**uzwa	'it is being drunk'
bala	'Write!'	iya**b**alwa	'it is being written'
iuta	'Collect!'	iya**i**utwa	'it is being collected'

Another striking example of positional resistance occurs in the nasal harmony system of Guaraní (Tupí: Paraguay). In Guaraní, [nasal] spreads to the left from a stressed nasal vowel, or from the closure phase of a prenasal stop (which need not be in a stressed syllable). The process is unbounded, affecting all preceding unstressed syllables, as shown in (10). (Nasal harmony spans are underlined.)

(10) Guaraní nasal harmony (Gregores & Suárez 1967)

/ro + ᵐbo + pora~ˈ] ∅ [r~o~mo~po~r~a~ˈ]
I-you + CAUS + nice
'I embellished you'

/a+yÌei+ ⁿdupa~ˈ/ ∅ [a~n~e~înnu~pa~ˈ]
I + REFL + beat
'I beat myself'

/ⁿdo+ro+ⁿdupa~ˈ + i/ ∅ [no~r~o~nu~pa~ˈîn]
not+I-you + beat + NEG
'I don't beat you'

/ro + ᵐbo + ©ʷatá/ ∅ [r~o~ᵐbo©ʷatá]
I-you + CAUS + walk
'I made you walk'

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[3] A small number of Zulu verb roots are of the form VC, rather than the canonical CVC. Dissimilation is blocked in these roots, though the root consonant is arguably not a member of the root-initial syllable. These facts merit further consideration, as they suggest that the root-initial syllable is initiated by the first consonant in the root, rather than the first segment in the root. Thanks to David Odden for reminding me of the relevant data.

However, nasal harmony is blocked by a preceding stressed syllable, even when the vowel in that syllable is oral; prominent positions resist the application of an otherwise regular phonological process.

(11) Stressed syllables block the propagation of nasal harmony
/a^m^ba.apóro~rey‡ú/ ∅ [÷a~^m^ba÷apòro~re~y‡ú]
'if I work you come'

/roy‡otopapá^m^baro~roxóvara~'/ ∅ [roy‡otopapàma~r~o~ro~xòv~a~r~a~']
'if now we meet all of us, we'll have to go'

Additional examples of positional resistance are discussed in Hume (1995) and Cole (1996), and in subsequent chapters of this dissertation.

The phonological asymmetries outlined above do not constitute a random collection of positional oddities, but rather a closely related constellation of facts which cluster around a single generalization: segments in prominent positions are resistant to alternation. The functional motivation for this resistance is clear; phonological contrasts are preferentially maintained in prominent positions because these positions are exactly those which take priority in perception and processing.

This functional motivation finds grammatical expression in the form of Optimality Theoretic *positional faithfulness* constraints (inspired by the positional PARSE(F) constraints of Selkirk 1994) which require segments in prominent positions to be preferentially *faithful* to the feature specifications of their underlying counterparts. Positional faithfulness constraints have the general form schematized in (12).

(12) IDENT-*Position*(F)
Let β be an output segment in a privileged position P and α the input correspondent of β. If β is [γF], then α must be [γF].
"Correspondent segments in a privileged position must have identical specifications for [F]."

When (12) is spelled out with specific perceptually prominent positions, the result is a set of positional faithfulness constraint families (IDENT-ONSET(F), IDENT-σ_1(F), IDENT-σ'(F), and so on). Through interaction with the other constraints which are contained in the grammar, these constraint families are responsible for the wide array of positional asymmetries summarized above.

In particular, there is a single pattern of constraint interaction which accounts for each of these asymmetries. This pattern is schematized in (13), where F represents any phonological feature and 𝐂 any alternation-favoring constraint which crucially affects the distribution of F (*LABIAL, *VDOBSTR, ALIGN-R(ATR), etc.).

(13) Ranking schema, positional phonological asymmetries
IDENT-*Position*(F) » 𝐂 » IDENT(F)

The ranking of 𝐂 in the midst of the featural faithfulness constraint hierarchy (originally employed by Selkirk 1994 in an examination of positional PARSE(F) constraints), crucially above the context-free faithfulness constraint, is responsible for generating all three varieties of prominence-sensitive phonological asymmetry mentioned above: positional maintenance of contrasts neutralized elsewhere, positional triggering of phonological processes, and positional resistance to phonological alternation. This approach allows for the unification of a wide variety of related positional phenomena under a single analytic umbrella: positional faithfulness. Previous approaches, both derivational and constraint-based, have failed to recognize the unity of these positional phenomena, employing a mixed bag of constraints and stipulative restrictions in rule formalism to achieve the diverse effects of positional privilege, without explaining these effects.

The goal of this dissertation is to develop a theory of positional faithfulness which will both generate and explain the range of positional asymmetries attested in natural language phonology. I begin, in this chapter, with a demonstration of the workings of positional faithfulness theory in the familiar domain of onset/coda asymmetries, focusing on voice assimilation in Catalan. In Chapter 2, I examine positional privilege accorded to root-initial syllables, a position in which prominence derives largely from psycholinguistic (rather than phonetic) properties. Chapter 3 is devoted to the domain of stress, showing once again that positional faithfulness constraints unify and explain a wide range of phonological asymmetries associated with the presence or absence of stress. In Chapter 4, I turn to privilege effects which are sensitive to the distinction between root and affix. Finally, in Chapter 5, a different type of positional effect, that of positional maximization, is analyzed.

1.2 Theoretical Background: Optimality and Correspondence

Optimality Theory (Prince & Smolensky 1993, McCarthy & Prince 1993b) is a framework in which the emphasis is not on a sequence of ordered rules by which an input is transformed into a surface form, but rather on the interaction of violable universal constraints which determine the well-formedness of output forms. The task of the analyst is therefore not to determine what rules apply and in what order in a given language, but instead to determine the ranking of constraints which will generate all and only the surface phonological patterns of a language.

The OT grammar consists of three components (Prince & Smolensky 1993) : *Gen*, *Con* and *Eval*. The first, *Gen*, is a function which associates an input string with a potentially infinite set of output candidates consistent with that string. Incorporated in *Gen* are the representational primitives of linguistic form (features and prosodic constituents, for example), as well as any inviolable constraints on linguistic structure. These inviolable constraints include the invariant properties of feature geometry and prosodic organization (for example, root nodes dominate features, syllables dominate moras, feet dominate syllables, etc.). Subject to these inviolable principles, *Gen* may improvise freely on the input string; possible phonological improvisations include the addition of structure (features, association lines, root nodes, syllabification, etc.), deletion of structure, and reordering of input segments.

Departing from earlier work in OT (Prince & Smolensky 1993; McCarthy & Prince 1993a,b) , I will adopt the Correspondence theory of faithfulness set out in McCarthy & Prince (1995) . McCarthy & Prince note that a wide range of parallels exist between requirements on base-reduplicant identity in reduplicative morphology on the one hand, and requirements of input-output faithfulness in phonology on the other. Generalizing over the two domains, McCarthy & Prince propose that candidate sets come from *Gen* with a correspondence function expressing the dependency of the output on the input (or of the reduplicant on the base).[4]

(14) Correspondence (McCarthy & Prince 1995)
Given two related strings S_1 and S_2, Correspondence is a relation ¬ from the elements of S_1 to those of S_2. An element α S_1 and any element β S_2 are referred to as *correspondents* of one another when $\alpha \neg \beta$.

Gen is free to impose any correspondence relation, or none at all, on the elements of S_2. The choice among candidates which exhibit various S_1-S_2 correspondence relations will be determined by their satisfaction or violation of the constraints which make up the second component of the grammar, *Con*.

Con is a set of violable constraints, common to all languages, but ranked on a language-particular basis.[5] The constraints which comprise *Con* fall into three broad categories: markedness constraints, faithfulness constraints, and alignment constraints.[6] Markedness constraints assess the well-formedness of linguistic structure at a variety of levels, including featural, segmental and syllabic. Such constraints are ideally grounded (Archangeli & Pulleyblank 1994a) , in the sense that they reflect the articulatory or acoustic (in)compatibility of various features, or the perceptual difficulties associated with certain configurations. Some examples of markedness constraints are given in (15).

(15) Markedness constraints
*P_L/Lab: *[Labial]
"Consonants should not be labial." (Prince & Smolensky 1993: chapter 9)

*$V_D O_{BSTR}$: *[voice, –sonorant]
"Obstruents must not be voiced." (Lombardi 1996a, Alderete 1997a, Itô & Mester 1997)

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4 The correspondence relation is extended further, to pairs of output strings within a morphological paradigm in recent work by Benua (1995, 1997), Buckley (1995), McCarthy (1995), Kager (1995) and Burzio (1997) . See also the discussions of paradigm uniformity in Burzio (1994), Orgun (1994), Flemming & Kenstowicz (1995), and Kenstowicz (1996) .

5 I assume here a strict dominance hierarchy, following Prince & Smolensky (1993). Work on variation in OT (Reynolds 1994; Zubritskaya 1994, 1997; Nagy & Reynolds 1997; Ringen 1997; Anttila, in preparation) suggests that the requirement of total ordering must ultimately be relaxed, with variable ranking being permitted.

6 More constraint types may be necessary, and the classification of constraints is not always obvious. (For example, the NON-FINALITY constraint of Prince and Smolensky 1993 is a sort of anti-alignment constraint.)

ONSET: $*_\sigma[V$
"Every syllable has an onset." (Prince & Smolensky 1993: 25)

Implicational relations which hold among more and less marked structure are encoded by means of markedness constraints and their relative rankings; structures which are more marked cross-linguistically are regulated by constraints which are higher-ranking than those which penalize relatively less marked elements.

Faithfulness constraints regulate the exactness of the correspondence between two strings (input and output, base and reduplicant, or output and output), penalizing deviations from the original string. The improvisational whims of *Gen* are reined in by the faithfulness constraints, which penalize a variety of changes including addition or deletion of features and segments, changes in the linear order of segments and fusion of segments. Representative Correspondence-based faithfulness constraints are shown in (16).[7] (A more extensive list is provided in McCarthy & Prince 1995.)

(16) A faithfulness constraint sampler

MAX
Every segment in S_1 has a correspondent in S_2. (Phonological deletion is not permitted.)

DEP
Every segment in S_2 has a correspondent in S_1. (Phonological insertion is not permitted.)

[7] The constraints in (16) take the place of the faithfulness constraints employed in the earlier, representational approach to faithfulness (Prince & Smolensky 1993; McCarthy & Prince 1993a,b). In that theory, deleted segments were maintained in outputs forms as unprosodized material, violating PARSE-Segment. Epenthesized segments could be recognized as featureless prosodic nodes, violating FILL-Segment. Featural faithfulness was regulated by a variety of constraints including PARSE-Feature, FILL-Feature (Prince & Smolensky 1993), and constraints on the placement of association lines (see Pulleyblank 1993, 1994 and Itô, Mester & Padgett 1995 for examples). Some empirical differences between the two approaches to faithfulness are discussed in McCarthy & Prince (1995).

IDENT(F)
Correspondent segments in S_1 and S_2 have identical values for some feature [F].[8] (Features may not be changed.)

Faithfulness constraints, or their equivalent, are essential to any theory of phonology, for without them, all inputs would converge on a single unmarked output. (This is the “fallacy of perfection”, discussed in McCarthy & Prince 1994a and McCarthy 1997 .)

The final category of constraints which comprise *Con* is that of alignment constraints, which require the coincidence of edges of various phonological and/or morphological constituents (McCarthy & Prince 1993a). The constituents to be aligned may be drawn from the set of morphological or syntactic categories (affix, root, stem), prosodic categories (syllable, foot, prosodic word, etc.), or the set of distinctive features.[9]

(17) Alignment, general schema (McCarthy & Prince 1993a: 2)

ALIGN(Cat_1, $Edge_1$, Cat_2, $Edge_2$) $=_{def}$
$\forall Cat_1\ \exists Cat_2$ such that $Edge_1$ of Cat_1 and $Edge_2$ of Cat_2 coincide.
Where
Cat_1, Cat_2 PCat ≈ GCat
$Edge_1, Edge_2$ {Right, Left}

---

8 I follow McCarthy & Prince (1995) in adopting the segmentally -mediated IDENT approach to featural faithfulness. As McCarthy & Prince themselves suggest (p. 265), it is possible that features, in addition to segments, are in correspondence. This featural correspondence approach to faithfulness has been advocated in a variety of recent works, including Lamontagne & Rice (1995), Lombardi (1995b), McCarthy (1995) . While featural correspondence may ultimately be required, I do not adopt it here, largely because positional faithfulness constraints can capture the effects outlined in §1.1 only if formulated in segmental terms. Consider the positional MAX(Place) of Padgett (1995b) :

(i) MAX_{REL}(Place): Let S be a [+release] output segment. Then every place feature in the input correspondent of S has an output correspondent in S.

Without the intervention of the segmental unit S, the intended effect (output retention of the input place features of segments which are [+release]) is impossible to achieve with a MAX formulation, for it is the segmental anchor for the features which is crucial in establishing that *positional* faithfulness is at play. In the absence of the segmental mediator, the constraint in (i) will require simply that input features of a particular variety surface in a prominent position, as in (ii):

(ii) MAX_{REL}(Place): For all *x*, *x* {Coronal, Dorsal, Labial, Pharyngeal}, if *x* is present in the input, it must have an output correspondent on a segment which is [+release].

In many cases, such a constraint will lead to positional *unfaithfulness*, as it requires that input features be realized on a syllable onset in output, regardless of the input specification of the onset segment. As the segmental mediator of the features *must* be retained in (i) in order to account for the positional generalizations under discussion, I have chosen to retain the more direct segmental formulation of positional IDENT constraints.

9 Featural alignment was originally suggested in Kirchner (1993) , and further developed in numerous works, including Pulleyblank (1993, 1994), Akinlabi (1994, 1995), Archangeli & Pulleyblank (1994b), Beckman (1994b), Itô & Mester (1994), Cole & Kisseberth (1995a,b,c), and Ringen & Vago (1995a,b).

The effects of alignment constraints proposed in the literature include the edgemost placement of affixes (prefix vs. suffix; McCarthy & Prince 1993a), the placement of stress feet (McCarthy & Prince 1993a), iterative footing (McCarthy & Prince 1993a, citing personal communication from Robert Kirchner), directional syllabification (Mester & Padgett 1993) , and triggering of featural spreading processes, including vowel harmony (Kirchner 1993 and much subsequent work; see note 8).

Weighing the array of output candidates provided by *Gen* against the ranked constraint inventory *Con*, the final component of the grammar, *Eval*, will select that output which is optimal. *Eval* is a function which assesses output candidates and orders them according to how well they satisfy the constraint system of the language in question. The actually occurring output form is that candidate which best satisfies the constraint system, where best satisfaction is determined by minimal violation.

To illustrate what is meant by "minimal violation", I will consider some canonical patterns of constraint violation. Assume a hypothetical *Con*, containing only two constraints, A and B, ranked such that A takes precedence over B (A»B). For some (hypothetical) input /in_k/, *Gen* will provide a number of possible outputs, along with the correspondence relation which characterizes the mapping between output and input. Among these outputs will be the actual output associated with /in_k/ (call this $Candidate_1$) and at least one competitor ($Candidate_2$). There are a number of violation patterns which may be associated with the selection of $Candidate_1$ as optimal. Perhaps the simplest is that of constraint conflict, illustrated in the constraint tableau in (18). In this and subsequent tableaux, the constraints are arrayed in the top row, with left-to-right order reflecting dominance relations. A solid line separating two constraint columns indicates a fixed ranking between the two constraints in question. (A dotted line is used when no fixed ranking can be established.) Candidate outputs appear in the left-hand column, underneath the input. Constraint violations are marked by "*".

(18) Constraint conflict

$/in_k/$	A	B
a. ☞ $Cand_1$		*
b. $Cand_2$	*!	

In this scenario, $Cand_1$ is optimal (indicated by the "☞") because its closest competitor violates a constraint (A) which $Cand_1$ itself does not violate, and that constraint is higher-ranking than the highest-ranked constraint (B) violated by $Cand_1$. (The shading here emphasizes the irrelevance of the constraint B to the overall outcome; A is sufficient to rule out $Cand_2$. A loser's cells are shaded afer the fatal confrontation; the winner's, when there are no more competitors.) This is the pattern of violation which establishes that constraints conflict, and must be crucially ranked with respect to one another. Were the reverse ranking (B»A) to hold, $Cand_2$ would be selected as optimal.

Other patterns of constraint violation are possible, of course. Assuming the same hypothetical language, consider a second input, $/in_j/$. *Gen* admits a set of output candidates, including the two shown in (19).

(19) Constraint tableau, A » B, but no constraint conflict

$/in_j/$	A	B
a. ☞ $Cand_1$		
b. $Cand_2$		*!

Here, the optimal candidate actually violates neither A nor B, while its closest competitor violates B. Either ranking of A and B would result in $Cand_1$ being optimal; only the evidence of conflict from (18) provides conclusive evidence that the ranking is fixed at A»B. Another pattern of violation in which there is no evidence of ranking is demonstrated in (20), where both candidates violate the highest-ranked constraint, A.

(20) Constraint tableau, A » B; no constraint conflict

$/in_i/$	A	B
a. ☞ $Cand_1$	*	
b. $Cand_2$	*	*!

The violations of A cancel one another out, effectively ruling A irrelevant in determining which of $Cand_1$ and $Cand_2$ will be optimal. The selection is therefore given over to the next constraint in the hierarchy, B. As $Cand_2$ violates B and $Cand_1$ does not, $Cand_1$ is selected as optimal. Here, as before, $Cand_1$ is selected as optimal because it exhibits minimal violation; its nearest competitor, $Cand_2$, violates some constraint which is ranked higher than that constraint uniquely violated by $Cand_1$.

As a final example of minimal violation and candidate evaluation, consider the tableau in (21). Here a fourth input, /in_h/, is assumed, along with the outputs $Cand_1$ and $Cand_2$.

(21) Constraint tableau, A » B; no constraint conflict

/in_h/	A	B
a. ☞ $Cand_1$	*	
b. $Cand_2$	**!	

As the shading indicates, constraint B is irrelevant in this scenario, as the choice between the candidates is made by higher-ranking A. Both candidates violate A, but the non-optimal $Cand_2$ incurs more violations than the optimal $Cand_1$. One of $Cand_2$'s violations of A is cancelled out by the A violation which $Cand_1$ incurs, but $Cand_2$ incurs an additional violation of A which is *not* matched by $Cand_1$. This extra violation is fatal.[10]

The fundamental components of an Optimality Theoretic grammar, and their interaction, have now been described. There is one important corollary of Optimality Theory on which I will dwell before turning to the analysis of positional privilege effects in phonology; this is the principle of Richness of the Base (Prince & Smolensky 1993: 191). Richness of the Base is the claim that the set of inputs with which a grammar must contend is universal to all languages, and not restricted by language-specific limitations on possible underlying forms. This is because the constraints of *Con* are universal to all languages, and it is the different ranking permutations of these constraints which are the sole source of intra-linguistic variation. Different ranking permutations will converge on (potentially) different surface inventories of grammatical forms, filtering out all illformed patterns. On this view, "the lexicon of a language is a sample from the

[10] This pattern of violation, along with the three which precede it, falls under the purview of Prince & Smolensky's *harmonic ordering of forms*, which is formally defined and explicated in Prince & Smolensky (1993: 68–76).

inventory of possible inputs; all properties of the lexicon arise indirectly from the grammar, which delimits the inventory from which the lexicon is drawn" (Tesar & Smolensky 1996).

Richness of the Base follows from the strict output orientation of OT, but it has important ramifications for the elimination of redundancy in the phonological component of grammar. It has long been noted that phonological generalizations hold not only of morphologically complex forms, but also of underived lexical items. (See, for example, Halle 1959, 1964; Chomsky & Halle 1968; Kiparsky 1973, 1982; Lightner 1973; Shibatani 1973; Skousen 1973; Kaye 1974; Kenstowicz & Kisseberth 1977; Churma 1988; Myers 1991.) However, the characterization of restrictions on morpheme structure in a rule-based theory of phonology raises a variety of problems, as Kenstowicz & Kisseberth (1977) discuss. Among these is the Duplication Problem: if morpheme structure constraints are formally distinct from phonological rules, the grammar necessarily requires two separate mechanisms to account for a single set of phonological generalizations. (See Kenstowicz & Kisseberth 1977, and, for more extensive discussion, Ringen 1975.) OT avoids the Duplication Problem because, as discussed above, apparent restrictions on the structure of the underlying representations arise in the same way as restrictions on the structure of derived surface forms: from the interaction of output well-formedness constraints. This means that both static, morpheme-internal positional restrictions on the distribution of features (such as the requirement that non-initial vowels in Shona verb roots harmonize in height with the initial vowel) and active positional neutralizations (belied by phonological alternations, such as coda devoicing, place assimilation or reduction of unstressed vowels) derive from a single grammar, a single pattern of constraint interaction.

The notion of a universal set of inputs from which all languages must draw raises the question of what underlying forms are assumed by the learner of some specific language. Richness of the Base does not commit us to a universal set of underlying forms; there is a distinction to be made here between possible *input forms* and plausible *underlying representations* for actual lexical items. In general, many different inputs may converge on a particular output form, but only that input which diverges minimally from the output will be selected by the language learner as the lexical representation.[11] In Optimality Theory, the principle of Lexicon Optimization (Prince & Smolensky 1993, Itô, Mester & Padgett 1995) is proposed as a means of determining the correct underlying representation.

(22) Lexicon Optimization (formulation from Itô, Mester & Padgett 1995)

Of several potential inputs whose outputs all converge on the same phonetic form, choose as the real input the one whose output is the most harmonic.

Given a choice of inputs which yield the same surface result, the language learner will select as the underlying representation that input which most closely resembles the output form.

With the basic tools of Optimality Theory in hand, I will now turn to an illustration of the ways in which the positional privilege effects outlined in §1.1 will be analyzed in such a grammar. For purposes of demonstration, I will concentrate here on coda/onset asymmetries in the occurrence of the feature [voice]. In subsequent chapters, positional privilege effects associated with root-initial syllables, stressed syllables and roots will be examined.

1.3 Coda/Onset Asymmetries in Phonology

The best documented, and since Itô's (1986) dissertation, the most extensively investigated, cases of positional privilege in phonology have been those involving syllable onsets. Onsets are the prototypical "strong licensors", to adopt the parlance of prosodic licensing theories of featural distribution (Kingston 1985, 1990; Itô 1986, Goldsmith 1989, Lombardi 1991, Wiltshire 1992); in many languages, they admit a more marked segmental inventory than do non-onset positions. By contrast, coda consonants in such languages exhibit a pervasive pattern of unfaithfulness to underlying structure, frequently undergoing neutralization to some type of default segment, or assimilating to a following onset.

Phonetically, consonants which appear in syllable onset position, preceding a sonorant, are perceptually privileged by virtue of their release (a point originally made, for laryngeal features, in Kingston 1985, 1990). Much of the acoustic information which signals the presence

[11] The degree of abstractness permissible in underlying representation has been extensively debated in the generative phonological literature. Kiparsky's (1968) Alternation Condition represents one well-known approach to abstractness; Kenstowicz & Kisseberth (1977) review the issue in some detail.

of contrastive consonantal features such as laryngeal state and place of articulation is carried in the segmental release burst. In coda position, and in the initial consonants of onset consonant clusters, positions which lack release bursts in many languages, reliable cues to phonological contrast are dramatically reduced.[12] In the positional faithfulness theory of contrast and neutralization (first applied to coda/onset asymmetries by Lombardi 1995a,b, for laryngeal features, and Jun 1995 and Padgett 1995b, for place features), the perceptual prominence of syllable onsets is cashed out in the form of enhanced phonological faithfulness, instantiated by the three aspects of positional privilege outlined in §1.1 above: licensing of contrasts, triggering of phonological processes, and resistance to phonological processes.[13]

Syllable onsets differ from syllable codas in permitting a broader range of phonological features and contrasts to surface. There are, for example, many languages in which the contrast between voiced and voiceless obstruents is instantiated only in onset position, with coda obstruents undergoing neutralization. German is a well-known case of this type; all coda obstruents in German must be voiceless, though onsets may be voiced or voiceless.

(23) German coda neutralization (data from Lombardi 1991)

Voiced in onset		Voiceless in coda	
run.[**d**]e	'round (pl.)'	run[**t**]	'round (sg.)'
Run.[**d**]ung	'rounding, labialization'	Run[**t**].bau	'rotunda'
lö.[**z**]en	'to loosen' lo[**s**].bar	'solvable'	
Lö.[**z**]ung	'solution'	Lö[**s**].lich	'soluble'
We.[**g**]e	'way (dat.)'	We[**k**]	'way (nom.)'
We.[**g**]elager	'highway robber'	We[**k**]bereiter	'pioneer'

Coda neutralization of this type is robustly attested for laryngeal features (Lombardi 1991), and for consonantal place features as well (Steriade 1982; Prince 1984; Itô 1986, 1989; Goldsmith 1989; Wiltshire 1992; Itô & Mester 1993, 1994; Zec 1995). Languages which exhibit coda

[12] Some languages are more permissive in their release possibilities, permitting either word-final consonants, or all consonants, to be released. French is one case in which all consonants, including those in coda position, are released (Selkirk 1982).

[13] Early acknowledgments of the importance of release in phonology may be found in McCawley (1967) and Selkirk (1982). More extensive recent work on the phonology of release appears in Steriade (1992, 1993a,b,c). For positional faithfulness analyses in which release is relevant, see Lombardi (1995a,b; 1996a) and Padgett (1995b).

neutralization of place features typically require a coda to be homorganic to the following onset consonant, or to belong to a default place of articulation. One such example is Lardil, which permits only coronal sonorants and nasals which share place of articulation with a following onset (Hale 1973, Itô 1986, Wilkinson 1988).

Onsets, in addition to permitting a broader range of contrasts than do codas, exhibit triggering of and resistance to phonological processes (two sides of a single positional privilege coin). Codas, on the other hand, are affected by phonological processes in many languages. This asymmetry of affectedness is perhaps best demonstrated by cases of voice and place assimilation. While there are many languages such as German which exhibit only coda neutralization of voicing or other laryngeal features, there are many which have both neutralization and assimilation within consonant clusters. For example, Polish displays syllable-final devoicing, and voice assimilation, as well. Underlyingly voiced obstruents must devoice in coda position, unless followed by a voiced obstruent (24a). Similarly, voiceless obstruents are necessarily voiced when followed by a voiced obstruent (24b).

(24) Polish neutralization and assimilation (Lombardi 1991: 57)

a.	z'a[b]a	‘frog’	z'a[pk]a	‘small frog’
	ró[zg]a	‘rod’	ró[ßêk]a	‘small rod’
	wo[d]a	‘water’	wo[tk]a	‘vodka’
b.	pro[c']ic'	‘request (v.)’	pro[z'b]a	‘request (n.)’
	li[ê]yc'	‘count’	li[dz'b]a	‘numeral’
	wies[ßê]yc'	‘prophesy’	wie[z'dz'b]a	‘prophecy’

Assimilation in these data, and in a host of comparable cases (including Dutch, Catalan, Yiddish, Sanskrit, and Romanian) is regressive, proceding from onset consonants to the preceding codas.

The prevalence of regressive assimilation in heterosyllabic clusters is not limited to laryngeal features, but extends to place assimilation as well, affecting sonorant-obstruent, obstruent-obstruent and sonorant-sonorant clusters. For example, as we saw in (7) above (repeated in (25) below), nasal consonants in Diola Fogny assimilate in place of articulation to following obstruents and nasals:

(25) Place assimilation in Diola Fogny (Sapir 1965: 16; Itô 1986: 56)

a.	/ni-gam-gam/	∅	niga˜gam	‘I judge’
	/pan-ji-maµj/	∅	paµjimaµj	‘you (pl.) will know’
	/ku-bøñ-bøñ/	∅	kubømbøñ	‘they sent’
	/na-ti:˜-ti:˜/	∅	nati:nti:˜	‘he cut (it) through’
b.	/na-mi:n-mi:n/	∅	nami:mmi:n	‘he cut (with a knife)’
	/ni-ma˜-ma˜/	∅	nimamma˜	‘I want’
	/ni-˜an-˜an/	∅	ni˜a˜˜an	‘I cried’

Nasal stops frequently undergo place assimilation, particularly to contiguous stop consonants (and less frequently to fricatives and glides; (Padgett 1991, Mohanan 1993, Jun 1995)). Other consonant classes may undergo place assimilation, but none equal the crosslinguistically robust assimilatory behavior of the nasals (Mohanan 1993:72). The inherent susceptibility of nasals to place assimilation may be called upon to explain the onset triggering in (25a), but the data in (25b) make it clear that assimilation is not merely a matter of the nasal taking on the place features of a contigious consonant. In (25b), where the onset and coda segments are both nasals, either progressive or regressive assimilation should be possible, yet only regressive assimilation occurs. This is true also of obstruent-obstruent clusters which exhibit voice assimilation (Lombardi 1991, 1995a, 1996a,c) (exemplified by the data in (24) above) and place assimilation or gemination (Mohanan 1993). In all of these cases, the features of the onset consonant are maintained, and those of the coda consonant are forfeited, a generalization that is not captured in directional theories which assume leftward spreading rules (or ALIGN-L constraints). Were a simple directionality parameter involved, we would expect find roughly equal numbers of progressive and regressive assimilation processes. However, aside from specialized circumstances such as post-nasal voicing (Itô, Mester & Padgett 1995; Lombardi 1995a, 1996c; Pater 1996), progressive assimilation in consonant clusters is virtually unattested, an asymmetry not explained in directional spreading theories.

While there are attested cases in which assimilation proceeds from non-privileged to privileged position, these cases are comparatively rare, and typically motivated by specific phonetic considerations.[14] Processes which are triggered exclusively by elements in non-prominent positions (such as voice or place assimilation triggered only by coda consonants, or vowel harmony triggered only by affixes), without an overriding functional motivation, are virtually unattested.[15] In a positional faithfulness analysis, the absence of progressive assimilation processes is explained: assimilation is regressive in heterosyllabic clusters because onset features must be preserved, by virtue of high-ranking IDENT-ONSET(F) constraints. (This point is also made and discussed in Lombardi 1995a, 1996a,c and Padgett 1995b.)

These onset faithfulness constraints, initially proposed by Lombardi (1995a,b) and Padgett (1995b), require that [+release] segments adhere to their input feature specifications.[16] For example, the privileged status of onset voiced obstruents in German and Polish results from the positional constraint in (26).

(26) IDENT-ONSET(voice)

For all segments *x*, *y*, where *x* Input, *y* Output and *y* is syllabified in onset position, if *x* ¬ *y*, then *y* is [voice] iff *x* is [voice].

"Onset segments and their input correspondents must agree in voicing."

A violation of this constraint will be incurred by any onset segment which differs from its input correspondent in voicing; when high-ranking, IDENT-ONSET(voice) places a premium on

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[14] See Lombardi (1996c) for an examination, within positional faithfulness theory, of some circumstances in which progressive assimilation can arise. An additional example is presented in Chapter 4.

[15] One class of counterexamples can be found in regional Romance dialects which exhibit metaphony, a type of vowel harmony in which unstressed final high vowels trigger raising of stressed vowels—a case in which the non-prominent position is always the trigger. There is arguably a functional motivation behind this process, as well, for the final high vowels in question are inflectional affixes in a position which is often subject to lenition and deletion cross-linguistically. By triggering raising of stressed vowels, the features associated with these inflectional categories are rendered more perceptible. (See Kaun 1995 for this general approach to harmony.) Such cases may be analyzed as involving a type of positional maximization similar to that discussed in Chapter 5; see also Cole & Kisseberth (1995c), Zoll (1996a,b; 1997) for recent OT treatments of prominent phonological targets.

[16] In light of the discussion of consonantal release above, a constraint couched solely in terms of onset position is an oversimplification, as not all onset consonants have an equally privileged status. In onset clusters, it is the presonorant consonant which takes priority over other members of the cluster. To be precise, (26) should be formulated to refer to segments which are specified as [+release] in output forms. (For more on the importance of phonetic cues in determining the distribution of phonological contrast, see Kirchner 1996 and works cited therein.)

As the examples I will consider below do not involve complex onset clusters, I will retain the simpler onset formulation here. See Padgett (1995b) for examples of positional faithfulness analyses in which the more specific notion of release is crucial.

faithfulness in onset position. Through domination of constraints which penalize marked structures such as voiced obstruents, IDENT-ONSET(voice) will permit those marked structures to occur in onset position. By contrast, the context-free IDENT(voice) (the constraint which regulates faithfulness in codas), when subordinated to markedness constraints, will result in the elimination of marked structure in coda position. Exactly this pattern of constraint interaction is characteristic of languages such as German, Dutch and Catalan, in which codas and onsets exhibit asymmetries in the distribution of voiced obstruents. In the next section, I will analyze one such case, Catalan, in detail.

1.3.1 Case Study: Catalan Coda Neutralization

1.3.1.1 Language Background

Catalan is a Romance language spoken in eastern Spain, the Balearic Islands (including Majorca and Minorca), southeastern France and in Sardinia (Hualde 1992). There is a contrast in the language between voiced and voiceless obstruents; this contrast is neutralized in word-final position, and more generally, in coda position. All obstruents are voiceless before a pause. This is demonstrated in (27) below, where the obstruents appear in onset position in the lefthand column, and in pre-pausal coda position on the right. While the voicing contrast is maintained in onset position, only voiceless obstruents appear in coda position. (Syllable boundaries are marked with ".", and alternating stops appear in boldface.)

(27) Final devoicing in Catalan[17] (Hualde 1992)

/p/	tí.p\	'satiated (f.)'	típ	'satiated'
/b/	Òó.**?**	'wolf (f.)'	Òó**p**	'wolf (m.)'
/t/	gá.t\	'cat (f.)'	gát	'cat (m.)'
/d/	\.sti.má.**?**\	'beloved (f.)'	\.sti.má**t**	'beloved (m.)'
/k/	pø'.k\	'little (f.)'	pø'k	'little (m.)'
/g/	\.mí.©\	'friend (f.)'	\.mí**k**	'friend (m.)'
/ê/	\.ski.êá	'to splash'	\.skíê	'splash (m)'
/Ê/	mí.**Ê**\	'half (f.)'	mí**ê**	'half (m.)'
/f/	bu.fá	'to blow'	búf	'puff of air (m.)'
/s/	gó.s\	'dog (f.)'	gós	'dog (m.)'
/z/	fr\n.s´'.**z**\	'French (f.)'	fr\n.s´'**s**	'French (m.)'
/ß/	bá.ß\	'low (f.)'	báß	'low (m.)'
/? /	bø'.**?** \	'mad (f.)'	bø'**ê**	'mad (m.)'

In addition to the coda neutralization process which is exhibited in the examples of devoicing above, there is a process of voice assimilation which applies in obstruent-obstruent clusters. Underlyingly voiceless obstruents surface as voiced when followed by a voiced obstruent; voiced obstruents devoice preceding a voiceless consonant. This is shown in (28), where surface variants which differ from their underlying counterparts in voicing appear in boldface.

(28) Voicing assimilation in Catalan clusters (Hualde 1992)

	Singleton C		*C + Voiceless C*		*C + Voiced C*	
/p/	káp	'no'	káp turó	'no hill'	km**b** dí\	'no day'
/b/	Òó?	'wolf (f.)'	Òó**p**p\tít	'small wolf'	Òóbdulén	'bad wolf'
/t/	gát	'cat'	gáttr\nkíl	'quiet cat'	gá**d**dulén	'bad cat'
/k/	pø'k	'little'	pø'ktéms	'little time'	pø'**g**dú	'a little hard'
/g/	\mí©	'friend (f.)'	\mí**k** p\tít	'little friend'	\míg dulén	'bad friend'
/ê/	míê	'half'	míê pá	'half bread'	mí**Ê** ?í\	'half day'
/f/	búf	'blow'	búf p\tít	'small blow'	bú**v** ?iári	'daily blow'
/s/	gós	'dog'	gós p\tít	'little dog'	gó**z** ?láw	'blue dog'
/z/	gríz\	'gray (f.)'	grí**s** p\tít	'pale gray'	gríz ?l\?é˜	'bluish gray'

Positional privilege effects are apparent in three aspects of the Catalan voicing system, highlighted in the data above. First, the contrast between voiced and voiceless obstruents is neutralized in syllable coda position, but not in onset position. Second, in cases of assimilation, it is the consonant in onset position which triggers spreading of laryngeal features. A third indicator of positional privilege, related to the second, is the fact that it is the coda consonants, rather than

[17] In Catalan, voiced stops undergo a lenition process between continuants, and the prepalatal /? / affricates in word-final position. These changes are orthogonal to the voicing alternations in question.

those in onset position, which undergo assimilation. They surface with different voice values than their input correspondents, while those segments in onset position are always faithful.

These three patterns of positional privilege reflect the high-ranking positional faithfulness constraint, IDENT-ONSET(voice), repeated in (29) below.

(29) IDENT-ONSET(voice)
For all segments *x*, *y*, where *x* Input, *y* Output and *y* is syllabified in onset position, if *x* ¬ *y*, then *y* is [voice] iff *x* is [voice].
"Onset segments and their input correspondents must agree in voicing."

An onset segment which differs from its input correspondent in voicing will violate (29); when high-ranking, IDENT-ONSET(voice) places a premium on faithfulness in onset position.

Merely ranking IDENT-ONSET(voice) near the top of the constraint hierarchy is insufficient to account for the coda/onset asymmetries in Catalan phonology, however. In order for positional voicing effects to be in evidence, featural faithfulness in positions other than the onset (regulated by the context-free IDENT(voice)) must be subordinated to some constraint or constraints which demand alternation. Positional effects thus arise when the ranking schema in (30) holds in the grammar:

(30) Positional privilege ranking schema, Catalan
IDENT-ONSET(voice) » $\mathbb{C}$ » IDENT(voice)

Here $\mathbb{C}$ represents some constraint or constraints which regulate the distribution of the feature [voice]. These, through domination of IDENT(voice), will lead to voicing alternations in positions other than the syllable onset.

In Catalan, there are two such constraints which compel voicing alternations. The first is a segmental markedness constraint, *VDOBSTR, which penalizes the combination of [–sonorant] and [voice]. This constraint reflects the cross-linguistic markedness of voiced obstruents, relative to their voiceless counterparts. *VDOBSTR, by domination of IDENT(voice), will prevent voiced obstruents from occurring contrastively in coda position. However, because the markedness constraint is dominated by the positional constraint, IDENT-ONSET(voice), obtruents in onset position will be unaffected. Coda neutralization is the end result of this ranking, shown in (31).

(31) Coda neutralization ranking
IDENT-ONSET(voice) » *VDOBSTR » IDENT(voice)

The second constraint which instantiates **C** in (30) is the assimilation-favoring AGREE(voice) (Lombardi 1996a; see Padgett 1995b for discussion of the related SPREAD(Place)).

(32) AGREE(voice)
Let *x* and *y* range over contiguous [–sonorant] segments. For all *x*,*y*, if *x* is [voice], then *y* must be [voice].
"Obstruents in a cluster must agree in voicing."[18]

Via domination of IDENT(voice), AGREE(voice) will compel coda obstruents to be unfaithful to their input values of [voice] if followed by obstruents with which they do not agree in voicing. IDENT-ONSET(voice), being ranked higher than IDENT(voice), will prevent onset consonants from undergoing any alternation.

(33) Voice assimilation subhierarchy
IDENT-ONSET(voice), AGREE(voice) » IDENT(voice)

Voice assimilation, triggered by onset consonants, is the result of the ranking in (33). The combination of this ranking with the coda neutralization subhierarchy of (31) will generate the full complement of positional voicing effects in Catalan, as I shall shortly demonstrate. I will begin with an examination of the distribution of voiced and voiceless obstruents in segmental inventories, both in Catalan and in other languages of the world.

1.3.1.2 The Distribution of Obstruents

Before proceeding with the analysis of Catalan coda neutralization, it is important to understand the ways in which marked elements may be distributed in entire inventories, and the

[18] This constraint is formulated with reference to clusters in order to prevent [voice] assimilation from occurring between obstruents and sonorants. As Lombardi (1995a) notes, voice assimilation between obstruents appears to be restricted to clusters; voice assimilation never crosses intervening vowels, suggesting that the spreading imperative is local. Obstruent-sonorant voicing interactions tend to arise only between words (as in Sanskrit; Lombardi 1991) or in highly specific circumstances, such as postnasal voicing (Itô, Mester & Padgett 1995, Pater 1996), where the phonetic motivation for assimilation is similarly specialized. The constraints and constraint interactions which generate such assimilations are likely to differ from those which result in assimilation in obstruent clusters. While the formulation in (32) would benefit from further refinement, it will be sufficient for my purposes. See Itô, Mester and Padgett (1995), Lombardi (1995a, 1996a) and Pater (1996) for discussion of voicing interactions among segments of different major classes.

ways in which constraint interaction will derive these patterns. Cross-linguistic surveys such as Maddieson (1984) have shown that voiced obstruents are less common than voiceless obstruents. Languages which include voiced obstruents in the inventory invariably also have a series of plain or aspirated voiceless obstruents, but the reverse is not true. Voiced obstruents imply voiceless ones, but a language may contain only voiceless obstruents without being ill-formed.

In an OT grammar, this type of implicational markedness relationship among segments can be reflected directly, by means of constraints and constraint ranking. For example, Prince & Smolensky (1993) argue that the phenomenon of coronal unmarkedness (Paradis & Prunet 1988, 1989, 1991; McCarthy & Taub 1992; Kaun 1993; Smolensky 1993; McCarthy 1994, *inter alios*) reflects a universally fixed ranking of place markedness constraints, as in (34).

(34) Place markedness subhierarchy
*DORSAL, *LABIAL » *CORONAL

Under such a ranking, coronal consonants will be favored over both velars and labials because the markedness constraint which is violated by a coronal is lowest in the hierarchy. In circumstances such as epenthesis, in which faithfulness to underlying feature specification is irrelevant, coronal consonants will be selected as optimal, as shown in (35). In this grammar, the syllable structure constraint ONSET dominates the anti-epenthesis constraint DEP, requiring a consonant to be inserted in the onset of a vowel-initial syllable. The relative ranking of the place markedness constraints ensures that it is a coronal consonant which will be epenthesized, as in (35c).[19]

[19] Lombardi (1997) gives a recent analysis of consonantal epenthesis and place markedness in OT.

(35) Coronals are least marked

/a/	ONSET	*DORSAL	*LABIAL	*CORONAL	DEP
a. ka		*!			*
b. pa			*!		*
c. ☞ ta				*	*
d. a	*!				

In this theory, segments which are more marked in the classical Praguian sense are literally more marked in the grammar (Smolensky 1993), as they incur violations of higher-ranking constraints than do less marked elements (or more violations of the same constraints).

The fixed ranking schema is one means by which featural or segmental markedness relationships are encoded in an OT grammar. However, the relative markedness of voiced and voiceless obstruents is arguably captured in a different manner, due to the nature of the feature in question, [voice]. If [voice] is a privative, rather than equipollent, feature (as suggested by Mester & Itô 1989 and Cho 1990 and argued extensively by Lombardi 1991), there can be no markedness constraint which penalizes voiceless obstruents. Not surprisingly, it is impossible to formulate constraints which make direct reference to the markedness of voiceless obstruents if there is no [–voice] specification to penalize. Under the privative [voice] hypothesis, the only markedness constraint which can regulate voicing in obstruents is *VDOBSTR :

(36) *VDOBSTR[20]
*[–son, voice]

Given such a constraint, voiced obstruents will always be more marked, formally, than voiceless obstruents; only the voiced obstruents can violate a markedness constraint which regulates the distribution of [voice].

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[20] Recent analyses which retain equipollent [voice] include Rubach (1990,1996), Rubach & Booij (1990), and Lombardi (1996b), who argues that binarity is necessary in the postlexical phonology. Should binary voicing prove to be necessary, the implicational relationship between voiced and voiceless obstruents could be encoded in the grammar by means of a fixed ranking of markedness constraints parallel to the place hierarchy in (34): *[–son, +voice] » *[–son, –voice]. I will assume privative [voice] throughout the subsequent discussion, but the analysis of Catalan which appears below will not be adversely affected if equipollent [voice] is adopted.

It is the relationship of markedness constraints to faithfulness constraints which will ultimately determine the character of a language's phonological inventory. The relevant faithfulness constraint here is that which regulates the mapping between input [voice] and output [voice]. Faithfulness constraints reflect the intuition that phonological alternations are costly, occurring only under duress (that is, under compulsion by a higher-ranking constraint). (Derivational generative phonology captures the same intuition by means of the convention on rule formulation and application: anything which is not explicitly mentioned in a phonological rule remains unchanged by the application of that rule. Faithfulness is the norm, rather than the exception.)

(37) IDENT(voice)
For all segments *x*, *y*, where *x* Input and *y* Output, if *x*←*y*, then *y* is [voice] iff *x* is [voice].
"Correspondent segments must agree in voicing."

This constraint will be violated by any deviation from the input specification, whether the deviation involves the addition or subtraction of a [voice] specification. Complete identity of specification between input and output is the only configuration which will satisfy (37).[21] The grammar also contains IDENT-ONSET(voice), a positional faithfulness constraint which regulates the occurrence of [voice] :

(38) IDENT-ONSET(voice)
For all segments *x*, *y*, where *x* Input, *y* Output and *y* is syllabified in onset position, if *x* ¬ *y*, then *y* is [voice] iff *x* is [voice].
"Onset segments and their input correspondents must agree in voicing."

This more specific faithfulness constraint is violated only if a segment in onset position differs in voicing from its input correspondent; featural divergences in coda consonants do not incur violations of (38).

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21 Compare this symmetrical IDENT formulation with the PARSE/FILL featural faithfulness of Kirchner (1993) and Prince & Smolensky (1993), and the correspondence-based MAX/DEP model of featural faithfulness mentioned in McCarthy & Prince (1995) and explored in numerous subsequent works. See also the alternative, asymmetrical formulations of segmentally mediated featural faithfulness constraints proposed in Orgun (1995) and Pater (1996).

To demonstrate how the interaction of markedness and faithfulness constraints will generate various obstruent inventories, including that of Catalan, I will work through each of the logically possible ranking interactions of (36), (37), and (38). There are six ranking permutations in all; they are listed in (39).

(39) Possible permutations of Ident(voice), Ident-Onset(voice) and *VdObstr
a. *VdObstr » Ident-Onset(voice) » Ident(voice)
b. *VdObstr » Ident(voice) » Ident-Onset(voice)

c. Ident-Onset(voice) » Ident(voice) » *VdObstr
d. Ident(voice) » Ident-Onset(voice) » *VdObstr
e. Ident(voice) *VdObstr » Ident-Onset(voice)

f. Ident-Onset(voice) » *VdObstr » Ident(voice)

Though there are six permutations of the three constraints under consideration, they yield only three distinct patterns of contrastive voicing in obstruents: a complete absence of voiced obstruents in any position (39a,b), completely free distribution of voiced obstruents in all positions (39c,d,e), and voiced obstruents only in onset position (39f).

Consider first a language which does not permit voiced obstruents to occur at all, regardless of syllabic position. Hawaiian is such a case; the only obstruents in the Hawaiian inventory are voiceless. This gap reflects a grammar in which voice markedness constraints are given top priority; marked structure is avoided at all costs.[22] The combination of [voice, –son] is simply not permitted to appear in surface forms of Hawaiian, regardless of how the segments may be specified underlyingly. It is impossible to be faithful to [voice] in the context of a [–sonorant] segment, no matter where in the syllable it occurs. Such a prohibition on marked structure reflects a constraint ranking in which all relevant faithfulness constraints are dominated by the pertinent markedness constraints. One such ranking is that of (39a): *VdObstr » Ident-Onset(voice) » Ident(voice). Under this ranking, input voiceless obstruents are rendered faithfully in the output, as in (40).

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22 Marked structure in the dimension of obstruent voicing, that is. There are many dimensions of phonological markedness, and these dimensions may be assessed independently of one another. The avoidance of markedness in one dimension does not imply that marked structure of all sorts must be similarly penalized.

(40) Voiceless obstruents are faithful

	/ka/	*VDOBSTR	IDENT-ONSET(voice)	IDENT(voice)
a. ☞	ka			
b.	ga	*!	*	*

In the case of a voiceless input consonant, unfaithfulness serves no purpose, as it results in more marked structure which is garnered without motivation. By comparison, the fully faithful (40b) incurs neither markedness nor faithfulness violations.

By contrast, if the input contains a voiced obstruent, this grammar will not only permit, but in fact require, unfaithfulness. This is true even if the voiced obstruent in question is syllabified in onset position, as shown in (41).

(41) No voiced obstruents in inventory

	/ga/	*VDOBSTR	IDENT-ONSET(voice)	IDENT(voice)
a.	ga	*!		
b. ☞	ka		*	*

The top-ranked markedness constraint *VDOBSTR compels unfaithfulness in voicing—under this constraint ranking it is impossible to arrive at a surface inventory which includes voiced obstruents.[23] Language learners will not posit underlying voiced obstruents, as the grammar will never allow them to surface. This is Prince & Smolensky's (1993) principle of Lexicon Optimization, discussed in §1.2: in the absence of paradigmatic alternations, if two (or more) inputs converge on the same output form, the underlying form selected by the learner will be that with the most harmonic mapping from input to output. This is shown in the "tableau des tableaux" in (42).

(42) Evaluating outputs of possible input forms

[23] Outcomes other than (41b) are possible, depending upon the relative ranking of other faithfulness constraints. For example, if IDENT(sonorant) and IDENT(nasal) are ranked below IDENT(voice), the optimal output would contain a voiced nasal sonorant, rather than a voiceless obstruent. The crucial point remains: the ranking of markedness over some relevant faithfulness constraint or constraints results in the omission of marked structure from the surface inventory.

Input	Output	*VDOBSTR	IDENT-ONSET(voice)	IDENT(voice)
a. ☞ /ka/	☞ ka			
b. /ga/	☞ ka		*!	*

Full faithfulness is maintained when input (42a) is selected as the underlying form. By contrast, if (42b) is chosen, a less harmonic input-output mapping is required, with violations of both IDENT-ONSET(voice) and IDENT(voice). Input (42a) is therefore the preferred underlying form.

Exactly the same result, a prohibition on voiced obstruents, obtains from the constraint ranking in (39b): *VDOBSTR » IDENT(voice) » IDENT-ONSET(voice). Whenever a markedness constraint dominates all relevant faithfulness constraints, the contrastive occurrence of marked structure is prohibited; the relative ranking of the positional and context-free constraints is utterly irrelevant in this circumstance.[24]

(43) No voiced obstruents in inventory

/ga/	*VDOBSTR	IDENT(voice)	IDENT-ONSET(voice)
a. ga	*!		
b. ☞ ka		*	*

Just as in (41), voiced obstruents are prevented from surfacing by the ranking of markedness over faithfulness constraints.

From the languages in which a complete prohibition on marked structure is enforced, I turn to the opposite type of language, one in which marked structure is freely distributed. English is one example of a language which permits a contrast between voiced and voiceless obstruents in both onset and coda position.[25] Unrestricted, contrastive distribution of marked structure implicates a grammar in which faithfulness constraints are of paramount importance. Retention of input specifications takes precedence, under such a ranking, over considerations of markedness.

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24 However, under pressure from a higher-ranking constraint, allophonic distributions of marked structure can be forced. For example, if a constraint requiring intervocalic voicing were to dominate *VDOBSTR in either (39a) or (39b), voiced obstruents would occur predictably between vowels.

25 English does exhibit restrictions on voicing within onset and coda clusters; one well-known case is the required voicing assimilation in plural, past tense and third person singular present endings. There is an extensive literature addressing this assimilation; relevant works include Harms (1973), Greenberg (1978), Mester & Itô (1989), Cho (1990) and Lombardi (1991, 1996b). This restriction on voicing in tautosyllabic clusters does not vitiate the contrastive status of voicing in English obstruents in general.

There are three ranking permutations which yield free contrastive distribution of [voice]; they are (39c,d,e), repeated in (44a,b,c) below.

(44) Free occurrence of [voice] on obstruents

a. Ident-Onset(voice) » Ident(voice) » *VdObstr
b. Ident(voice) » Ident-Onset(voice) » *VdObstr
c. Ident(voice) *VdObstr » Ident-Onset(voice)

Because the context-free constraint Ident(voice) dominates *VdObstr in all three rankings, faithfulness to input voicing must be respected in every syllabic position—even though greater segmental markedness will result. Here, as in the Hawaiian case above, the relative ranking of Ident(voice) and Ident-Onset(voice) will have no impact on the possible outcomes of the grammar.

Consider first the ranking in (44a). As shown in (45) and (46), this constraint hierarchy will require full faithfulness in voicing for all obstruents.

(45) Voiceless obstruents in inventory

/kot/	Ident-Onset(voice)	Ident(voice)	*VdObstr
a. ☞ kot			
b. got	*!	*	*
c. god	*!	**	**

Here, as before, voicing of underlyingly voiceless obstruents serves no purpose; marked structure is gratuitously generated in (45b,c) at the expense of higher-ranking faithfulness constraints. The fully faithful (45a) is optimal. Full faithfulness is also optimal in the case of an input containing voiced obstruents, as in (46).

(46) Voiced obstruents occur freely

/god/	Ident-Onset(voice)	Ident(voice)	*VdObstr
a. kot	*!	*	
b. got		*!	*
c. kod	*!	*	*
d. ☞ god			**

In this case, fidelity is required by the grammar. No devoicing is possible in any position, for, although such devoicing yields better satisfaction of *VdObstr, that constraint is dominated by both [voice] faithfulness constraints. Violation of these higher-ranking constraints, as in (46a,b,c), is fatal. All else being equal, input voicing specifications must always be preserved in this grammar.

The same state of affairs holds for both of the remaining ranking permutations shown in (44).

(47) Contrastive voiced obstruents; ID(voice) » ID-ONSET(voice) » *VDOBSTR

/god/	IDENT(voice)	IDENT-ONSET(voice)	*VDOBSTR
a. kot	*!	*	
b. got	*!		*
c. kod	*!	*	*
d. ☞ god			**

(48) Contrastive voiced obstruents; ID(voice) *VDOBSTR » ID-ONSET(voice)

/god/	IDENT(voice)	*VDOBSTR	IDENT-ONSET(voice)
a. kot	*!		*
b. got	*!	*	
c. kod	*!	*	*
d. ☞ god		**	

Under each of these rankings, faithfulness to input voicing is of paramount importance; syllabic affiliation is irrelevant. Voiced obstruents are therefore contrastive in both onset and coda position. This result obtains, as a comparison of (46), (47) and (48) demonstrates, regardless of the relative ranking of IDENT(voice) and IDENT-ONSET(voice). All that is necessary is that the context-free constraint dominate *VDOBSTR; this will ensure that contrastive voiced obstruents are freely permitted.

This class of cases, and the preceding permutations which yield the complete absence of voiced obstruents, demonstrate that, while the addition of a positional faithfulness constraint does increase the number of possible ranking permutations (in this case, from two (2!) to six (3!)), the set of optimal outcomes is not correspondingly increased. The five ranking permutations in (39a-e) yield only two distinct outcomes: a complete absence of contrastive voiced obstruents, or free occurrence of voiced obstruents. All of the rankings in which the general IDENT(voice) dominates the specific IDENT-ONSET(voice) converge on optimal output candidates which can be generated by a different, specific » general ranking. Given this non-distinctness of results, there is no reason to assume free ranking of positional and context-free constraints; further, if the ranking is fixed in Universal Grammar as in (49), the problem of learning constraint rankings in the acquisition process will be considerably simplified.

(49) IDENT-POSITION(F) » IDENT(F)

As a working hypothesis, I will henceforth assume that this specific » general ranking schema is held constant in UG; further investigation may, of course, reveal a need for free rerankability of positional and context-free constraints.[26]

Only one additional permutation of the three constraints now remains to be examined, namely the permutation in which the markedness constraint *VDOBSTR intervenes between the two faithfulness constraints, as in (39f), repeated in (50).

(50) Positional neutralization ranking
IDENT-ONSET(voice) » *VDOBSTR » IDENT(voice)

Under this ranking, the distribution of [voice] on obstruents is free only in the syllable onset. Outside of the privileged onset position, the more marked voiced obstruents are disfavored; instead, voiceless obstruents are preferred. This is a canonical pattern of positional neutralization, instantiated by coda devoicing in Catalan; the ranking in (50) generates this pattern without incident.

In Catalan, both voiceless and voiced obstruents are permitted to occur in onset position without alteration of their input specifications. This is demonstrated in tableaux (51) and (52) below.

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26 Lombardi (1996a) argues that the facts of voice assimilation in Swedish require such a ranking reversal, and suggests that (49) is the default ranking in UG, but may be subject to reranking.

(51) Contrastive voiceless obstruents in onset

/gos-a/ 'dog (f.)'	IDENT-ONSET(voice)	*VDOBSTR	IDENT(voice)
a. gó.z\	*!	**	*
b. ☞ gó.s\		*	

Voicing of the underlying /s/, as in (51a), serves no purpose. No high-ranking constraint compels the change from voiceless to voiced, and the resulting violation of IDENT-ONSET(voice) is fatal. The fully faithful (51b) is optimal. Parallel results obtain in the case of an input voiced obstruent, as in (52).

(52) Contrastive voiced obstruents in onset

/griz-a/ 'gray (f.)'	IDENT-ONSET(voice)	*VDOBSTR	IDENT(voice)
a. ☞ grí.z\		**	
b grí.s\	*!	*	*

Here, when the normal syllabification algorithm of the language yields onset syllabification of the underlying voiced obstruent, fidelity to input voicing is essential.[27] The preceding tableaux show that, in onset position, the distribution of [voice] on obstruents is identical to that of English—reasonably so, as the ranking which determines onset distribution in Catalan is entirely parallel to that of English: faithfulness » markedness. The difference between the two cases lies in the ranking of the context-free constraint IDENT(voice). Because it is dominated in the Catalan grammar by *VDOBSTR, a crucial difference emerges: voiced obstruents are not contrastive outside of the onset in Catalan.

[27] Catalan obeys the Onset First Principle of Clements & Keyser (1983) (also known as the CV-rule or the Maximal Onset principle; see Kahn 1976, Steriade 1982, Itô 1986 and Blevins 1995) favoring onset (rather than coda) syllabification of a single intervocalic consonant. In OT terms, this result is accomplished by the constraints ONSET and NOCODA, which prohibit coda syllabification of such consonants. (See Prince & Smolensky 1993, Ch. 6 for extensive discussion and motivation of these constraints.) Both constraints must dominate *VDOBSTR in order to prevent [grís.\] from being selected as optimal. This specific case seems to reflect a more general tendency, namely that violation of constraints which affect syllabification and higher-level prosodic structure is not often compelled by strictly featural constraints such as *VDOBSTR. Prosodic reorganization (such as a deviation from the default syllabification scheme) is not typically motivated by the spectre of featural markedness or faithfulness violations, suggesting that constraints on prosodic structure such as NOCODA and ONSET (usually) dominate constraints on subsegmental organization. Thanks to Rolf Noyer and John McCarthy for raising and discussing this issue with me.

(53) Obstruents in coda position must neutralize

/griz/ 'gray (m.)'	IDENT-ONSET(voice)	*VDOBSTR	IDENT(voice)
a. gríz		**!	
b. ☞ grís		*	*

In this case, highest-ranking IDENT-ONSET(voice) is simply not relevant, as the obstruent in question is syllabified in coda position. Both candidates satisfy IDENT-ONSET(voice), pushing the decision down to the markedness constraint, *VDOBSTR. It is here that (53a) is fatally eliminated; the candidate which contains two voiced obstruents is more marked than the devoicing candidate. Without the protection of IDENT-ONSET(voice), the coda obstruent must devoice, as in the optimal (53b).[28] Obstruents which are voiceless in the input, of course, remain voiceless in coda position.

As the preceding examples have shown, the positional constraint IDENT-ONSET(voice) accounts, via constraint interaction, for the syllabification-based laryngeal neutralization pattern of Catalan (and numerous other languages which exhibit the same effects). The ranking of IDENT-ONSET(voice) over *VDOBSTR results in the presence of contrastive [voice] on obstruents in syllable onset position. Conversely, the dominance of *VDOBSTR over IDENT(voice) prevents the occurrence of voiced obstruents outside of the onset position; the less marked voiceless obstruents are favored. The resulting pattern is a canonical case of positional neutralization: marked phonological elements are permitted if and only if they appear in a favored position, the syllable onset. While the specific case at hand is one of coda

[28] Here, as in (52) above, there is an alternative candidate which is not considered, namely one in which a vowel is epenthesized in final position in order to yield onset syllabification of the root-final obstruent, and to preserve the input voicing of that obstruent: [grí.z\]. Such a candidate can never be the optimal form for the masculine form, indicating that one or more of the constraints violated by the epenthesis candidate must dominate *VDOBSTR. Minimally, the epenthesis candidate violates DEP; this constraint is consequently ranked above *VDOBSTR in (i) below. Under this ranking, coda syllabification of the root-final consonant, and devoicing of that obstruent, will be optimal.

(i) Root-final obstruents are not "rescued" by epenthesis

/griz/ 'gray (m.)'	DEP	ID-ONSET(voice)	*VDOBSTR	ID(voice)
a. gríz			**!	
b. ☞ grís			*	*
c. grí.z\	*!		**	

neutralization, the same general ranking schema produces parallel results for other prominent positions such as root-initial syllables and stressed syllables, as subsequent chapters will show.

1.3.1.3 Voicing in Obstruent Clusters

Coda devoicing is not the only phenomenon in Catalan which exhibits evidence for the privileged status of syllable onsets. In heterosyllabic obstruent clusters, there is a process of voicing assimilation which renders coda consonants identical in laryngeal specification to the following onset consonant. Illustrative data are repeated in (54); it is important to note that the process applies to both voiced and voiceless obstruents. Crucially, it affects only those obstruents which appear in coda position; onset segments are not altered. Interestingly, when a voiced coda consonant is followed by a voiced onset, both consonants retain their voicing in the output form—coda voicing is faithfully preserved in just this circumstance.

(54) Voicing assimilation in Catalan clusters

	Singleton C		*C + Voiceless C*		*C + Voiced C*	
/p/	káp	‘no’	káp turó	‘no hill’	krá**b** dí\	‘no day’
/b/	Òó?\	‘wolf (f.)’	Òó**p**p\tít	‘small wolf’	Òóbdulén	‘bad wolf’
/t/	gát	‘cat’	gáttr\nkíl	‘quiet cat’	gá**d**dulén	‘bad cat’
/k/	pø'k	‘little’	pø'ktéms	‘little time’	pø'**g**dú	‘a little hard’
/g/	\mí©\	‘friend (f.)’	\mí**k** p\tít	‘little friend’	\míg dulén	‘bad friend’
/ê/	míê	‘half’	míê pá	‘half bread’	mí**Ê** ?í\	‘half day’
/f/	búf	‘blow’	búf p\tít	‘small blow’	bú**v** ?iári	‘daily blow’
/s/	gós	‘dog’	gós p\tít	‘little dog’	gó**z** ?láw	‘blue dog’
/z/	gríz\	‘gray (f.)’	grí**s** p\tít	‘pale gray’	gríz ?l\?é˜	‘bluish gray’

In all of the above clusters, the coda consonant takes on the voicing of the following onset, regardless of whether that onset is voiced or voiceless. In the case of a voiceless-voiced input sequence, the assimilation process is actually adding marked structure, and adding it in the non-privileged coda position. Without the involvement of AGREE(voice) (32), ranked above *VDOBSTR, spreading of [voice] cannot be optimal, as shown in (55). (“💣” marks an incorrect optimal candidate, one which is not an actual output form.)

(55) Assimilation is impossible

/gos blaw/ 'blue dog'	IDENT-ONSET(voice)	*VDOBSTR	IDENT(voice)
a. ☞ gós ꞁláw		**	
b. góz ꞁláw		***!	*
c. gós pláw	*!	*	**

The markedness constraint *VDOBSTR incurs one violation for each pairing of [–son, voice] which appears in a candidate; (55b) contains three voiced obstruents. The candidate in which coda neutralization has occurred, (55a), contains only two voiced obstruents and is therefore incorrectly selected as the optimal candidate.

In order for (55b) to be optimal, assimilation in obstruent clusters must receive a higher priority than the avoidance of marked structure. Put in terms of constraints, the assimilation constraint AGREE(voice) must dominate *VDOBSTR. By transitivity of ranking, AGREE(voice) will also dominate IDENT(voice).

(56) Assimilation ranking, Catalan
AGREE(voice) » *VDOBSTR » IDENT(voice)

AGREE(voice) is violated by any cluster of obstruents which differ in their voicing, for the constraint requires that, if any obstruent in a cluster is specified [voice], all obstruents in the cluster must be. The constraint, repeated from (26) above, is formulated as in (57).

(57) AGREE(voice)
Let *x* and *y* range over contiguous [–sonorant] segments. For all *x*,*y*, if *x* is [voice], then *y* must be [voice].
"Obstruents in a cluster must agree in voicing."

There are two means of satisfying AGREE(voice), given an input cluster such as /td/ or /dt/ which is disharmonic in voicing: [voice] may spread to all members of the cluster (58a)[29], or it may be eliminated entirely (58b).

(58) a. b.

[29] Note that the formulation in (57) does not require that the obstruents in the cluster be multiply-linked to a single [voice] specification, but merely that they all be specified equivalently for [voice]. Separate [voice] specifications in (58a) would also satisfy AGREE(voice). I know of no evidence, such as geminate inalterability effects (as in Kenstowicz & Pyle 1973, Steriade 1982, Schein & Steriade 1986, Hayes 1986a,b), which would support one structure over the other in Catalan.

Both strategies are employed in Catalan voice assimilation, but it is Ident-Onset(voice) which determines which of the two will apply in a particular instance. Ident-Onset(voice) requires faithfulness to input voicing in onset position, as we have already seen. In cluster situations, where agreement in voicing is also required, high-ranking Ident-Onset still favors faithfulness to the onset's voicing specification. The full hierarchy is given in (59). (Ident-Onset(voice) and Agree(voice) are never violated by an optimal candidate, as we will see, and therefore cannot be ranked with respect to one another.)

(59) Onset privilege ranking, Catalan
Ident-Onset(voice), Agree(voice) » *VdObstr » Ident(voice)

The end result is regressive assimilation, triggered by the obstruent in onset position, regardless of whether that obstruent is voiceless or voiced.

Let us consider the effects of the hierarchy in (59) in some detail, beginning with a disharmonic voiced-voiceless input sequence. One such example appears in the tableau in (60) below.

(60) Voiced-voiceless input sequence; voiceless cluster is optimal

/griz p\tit/ 'pale gray'	Agree(voice)	Id-Onset(voice)	*VdObstr	Id(voice)
a. gríz p\tít	*!		**	
b. ☞ grís p\tít			*	*
c. gríz ?\tít		*!	***	*

Because Agree(voice) is high-ranking, the optimal output must contain a consonant cluster which is uniformly voiced or voiceless; complete faithfulness to the input, as in (60a), is impossible. The voiceless cluster in (60b) is optimal because *VdObstr » Ident(voice), and because the input /z/ is not protected by Ident-Onset(voice). The alternative, (60c), does satisfy Agree(voice), but does so at the expense of Ident-Onset(voice). The interaction of

AGREE(voice) and IDENT-ONSET(voice) with the remaining constraints thus converges on the candidate in which the coda consonant is devoiced.[30]

The next combination of interest is that of a voiced-voiced input sequence. Clusters of this type are permitted by the grammar to surface intact, again due to the effects of IDENT-ONSET and AGREE. This is shown in (61).

(61) Voiced-voiced input sequence; voiced cluster is optimal

/Òob dulen/ 'bad wolf'	AGREE(voice)	ID-ONSET(voice)	*VDOBSTR	ID(voice)
a. Òóp dulén	*!		*	*
b. ☞ Òób dulén			**	
c. Òóp tulén		*!		**

Full faithfulness is compulsory, given this input; voicing must be retained on both the coda and the onset consonant in the cluster. It is not necessary to assume that a single [voice] specification is shared by both voiced consonants in (61b); merely that both consonants in the cluster agree, and that the onset consonant determines the laryngeal state of the entire cluster.

Finally, consider the outcome of the grammar in the event of a disharmonic voiceless-voiced consonant sequence, as in (62).

(62) Voiceless-voiced input sequence; voiced cluster is optimal

/gos blaw/ 'blue dog'	AGREE(voice)	ID-ONSET(voice)	*VDOBSTR	ID(voice)
a. gós ʔláw	*!		**	
b. ☞ góz ʔláw			***	*
c. gós pláw		*!	*	*

Because AGREE(voice) is dominant over IDENT(voice), the fully faithful (62a) is doomed in this grammar. Assimilation must occur; the only question is in which direction it will proceed. Markedness considerations alone would favor (62c), in which the cluster is composed of only voiceless obstruents, yet this candidate is not the actual output. High-ranking IDENT-ONSET(voice) ensures that assimilation is regressive, as in (62b); the voicing specification of the

30 The neutralization of the coda consonant before a voiceless onset gives the effect of regressive spreading of [–voice], without actually requiring a [–voice] specification to be present. This is exactly the result obtained in Mester & Itô (1989), Cho (1990), Lombardi (1991) and subsequent works which combine privative [voice] with either positional licensing or positional faithfulness. See §1.3.2 below for further discussion.

onset obstruent must be identical to that of its input correspondent. The result is a voiced obstruent in non-privileged coda position, seemingly in conflict with the generalization that devoicing is required in the non-privileged coda position. Yet it is precisely the non-privileged status of the coda, reflected in lowest-ranked IDENT(voice), which yields this result, as well as the other coda/onset asymmetries attested in Catalan clusters.

In consonant clusters, [voice] specifications must agree, even at the expense of faithfulness to the input, because AGREE(voice) dominates IDENT(voice). There are three different means of achieving this required agreement when the input contains a voiced obstruent:

(63) Mechanisms by which AGREE(voice) is satisfied, Catalan obstruent clusters

Input C_1C_2	Output C_1C_2	Change	Violation
Vd, Vls	Both Vls	Deletion of [voice] from C_1	IDENT(voice)
Vd, Vd	Both Vd	Full faithfulness to input	—
Vls, Vd	Both Vd	Regressive spread of [voice] from C_2	IDENT(voice)

In the event that unfaithfulness is required to satisfy AGREE(voice), it is always the coda obstruent, rather than the onset, which is unfaithful. This is because IDENT-ONSET(voice) » IDENT(voice); under this ranking, coda consonants will always be more susceptible to alternation (all else being equal). Crucially, the positional faithfulness analysis does not specify that voiced obstruents in coda position are impossible; it simply says that onsets are held to higher standards of faithfulness than are codas. When voicing is required by some high-ranking constraint such as AGREE(voice), codas are free to be voiced. What is not possible in this analysis is the displacement of the onset's features. This is an important point of departure from previous, licensing-based analyses of the coda/onset asymmetry, a point I will discuss in the next section.

1.3.2 Previous Analyses: Positional Licensing

In the literature, the prevailing alternative to the positional faithfulness analysis of coda/onset asymmetries is that of positional *licensing* (Itô 1986, 1989; Goldsmith 1989, 1990; Lombardi 1991; Wiltshire 1992; Bosch & Wiltshire 1992; Itô & Mester 1993, 1994, 1997; Flemming 1993; Steriade 1995; Zoll 1996a,b, 1997). The positional licensing approach assumes that all phonological features must be licensed by virtue of association to some prosodic position which is a legitimate licensor. In the case of onset/coda asymmetries, the onset is the position of licensing; marked feature specifications are prohibited or severely restricted in coda position.

There are two basic implementations of positional licensing theory. The first, proposed in Itô (1986, 1989), is a negative constraint which prohibits some marked feature specification or specifications from appearing in the coda. This is the Coda Condition shown in (64), where the proscribed feature is [voice].

(64) Coda Condition (CODACOND)

In Itô's (1986, 1989) application of the Coda Condition, a feature which is linked to both coda and onset is exempt from the constraint, by virtue of Hayes' (1986b) Linking Condition. Under the Linking Condition, association lines in the structural description of a rule or constraint must be interpreted as exhaustive. Thus, if the Coda Condition is formulated with a single association line, as in (64), structures in which the prohibited feature is multiply linked will not constitute a violation; only a [voice] specification which is exhaustively linked to a coda consonant will incur a violation of the Coda Condition. A [voice] specification which is shared between a coda and the following onset does not constitute a fatal violation of the Coda Condition, on this interpretation.

A more recent OT interpretation of the Coda Condition appears in Itô & Mester (1997), where it is proposed that CODACOND is actually the conjunction of two primitive constraints, NOCODA and *VDOBSTR. (See Smolensky 1995 for development of the formal mechanism of constraint conjunction.) The resulting conjoined constraint, a separate entity ranked above both component constraints, is violated only if the two component constraints are both violated by some candidate. This approach derives the Linking Condition effect, exempting multiply-linked features from violation, by formulating NOCODA as a feature-to-syllable left-alignment constraint, where the onset affiliation of the multiply-linked place or laryngeal specification satisfies a requirement for alignment of consonantal features at the left edge of a syllable (Itô & Mester 1994).[31]

An alternative to the negative formulation of CODACOND can be found in the positive licensing constraint of Lombardi (1991).[32] Rather than prohibiting the combination of coda and [voice], Lombardi's Voice Constraint requires that any [voice] feature which is present be licensed by association to a pre-sonorant onset consonant, as in (65):

(65) Licensing configuration for [voice]

Only [voice] specifications which appear in this configuration will be successfully licensed. Crucially, a [voice] specification which is multiply-linked beween a coda and the following onset, as in (66), is licensed; the [voice] feature in question is linked to an onset consonant which precedes a tautosyllabic sonorant, and is therefore *parasitically* licensed (Lombardi 1991:43).

(66) Multiple linking satisfies licensing requirement

In this approach, a feature need only be licensed, through association, by *some* element in the prosodic structure; the feature need not be licensed by *every* segment to which it is associated. Association to an onset is sufficient to license a [voice] specification which is shared with a preceding coda, though the coda itself cannot independently license [voice].

Abstracting away from the various formal differences between the negative licensing formulation of CODACOND and the positive statement of the Voice Constraint, the core notion in both approaches is the same: certain marked features, such as [voice], are not permitted to

31 NOCODA is satisfied by features shared between a coda and a following onset because alignment need not be *crisp*, according to Itô & Mester (1994). The affiliation of the features to an onset consonant, which is leftmost in a syllable, is sufficient to satisfy the left-alignment constraint, even though the same features are affiliated with a coda consonant which is rightmost in a syllable. See Itô & Mester (1994) for a careful examination of crisp and non-crisp alignment.

32 A positive licensing theory, one employing full prosodic templates with both rich and impoverished licensing capabilities spelled out for various prosodic positions, is developed in Goldsmith (1989, 1990), Wiltshire (1992) and Bosch & Wiltshire (1992). The effects of this templatic approach are essentially identical to those of Lombardi (1991), who differs in not employing explicit syllabification templates.

stand alone in coda position. My chief concern here is with an OT implementation of positional licensing, whether the relevant constraints are formulated in positive or negative terms. For demonstration purposes, I will adopt the positive formulation in the subsequent discussion. However, the problems exhibited by licensing analyses are not unique to the positive constraint formulation; they affect the negative CodaCond as well, as I will show in Chapter 2.

Crucially, neither variety of licensing can account for the pervasive regressive direction of assimilation in consonant clusters; both the positive and negative licensing formulations require only that a [voice] feature be associated to some onset position. The origin of the [voice] specification in question is irrelevant in licensing theory; either progressive or regressive assimilation will result in a well-formed structure, satisfying both the licensing requirement and the assimilation constraint. The choice between progressive and regressive assimilation candidates is thus remanded to the markedness constraint *VdObstr, which will always favor a voiceless outcome—a result not consistent with the actual facts of Catalan. By contrast, the positional faithfulness analysis predicts that spreading will regress from onset to coda, because the features of the onset are preferentially maintained, due to high-ranking Ident-Onset(voice). Both voiced and voiceless clusters are permitted, with voicing crucially determined by the voicing of the onset.

Assuming an OT adaptation of Lombardi's Voice Constraint, let us consider how the facts of Catalan will be analyzed. A working formulation is given in (67).

(67) VocCon
For all *x*, *x* = [voice] and all *y*, *y* a [–son] segment such that *x* is associated to *y*, *x* must be licensed. *x* is licensed if *y* precedes a tautosyllabic sonorant.

The neutralization of voicing contrasts in coda position arises because [voice] cannot be licensed on coda consonants. In constraint ranking terms, VocCon must dominate Ident(voice); proper licensing of [voice] takes priority over faithfulness. The result of this ranking is shown in (68).

(68) Coda devoicing, positional licensing theory

/griz/ 'gray (m.)'	VOCCON	IDENT(voice)	*VDOBSTR
a. gríz	*!		**
b. ☞ grís		*	*
c. krís		**!	

High-ranking VOCCON requires that the coda [voice] specification, which is not in a licensed configuration, be deleted, as in the optimal (68b). Neutralization at all positions, as in (68c), is ruled out by the ranking of IDENT(voice) over *VDOBSTR. Without the positional IDENT-ONSET(voice) in the grammar, this ranking is essential; with the reverse ranking, no voiced obstruents would be permitted at all—devoicing would be required even in the onset position. The ranking in (68) does not force this outcome, and therefore derives the same pattern of results as the positional faithfulness analysis developed in the preceding section.

Differences in the two theories emerge when the focus is shifted from simple positional neutralization to cases of voice assimilation. Here, as above, it will be necessary to assume high-ranking AGREE(voice), compelling assimilation. Crucially, AGREE(voice) must dominate IDENT(voice) (and by transitivity of ranking, *VDOBSTR), as in (69).

(69) Positional licensing grammar, Catalan
VOCCON, AGREE(voice) » IDENT(voice) » *VDOBSTR

This ranking will indeed compel voice assimilation in obstruent clusters, but it cannot accurately predict the direction of assimilation. It will, in fact, predict that all disharmonic clusters surface as uniformly voiceless. This is, of course, the desired result in the case of an input voiced-voiceless sequence.

(70) Voiced-voiceless input; voiceless cluster results

/griz p\tit/ 'pale gray'	AGREE(voice)	VOCCON	IDENT(voice)	*VDOBSTR
a. gríz p\tít	*!	*!		**
b. ☞ grís p\tít			*	*
c. gríz ?\tít			*	**!*

The fully faithful candidate (70a) fatally violates AGREE(voice), as it contains a disharmonic cluster. Of the remaining two candidates, the one containing a voiceless cluster (70b) is selected as optimal by lowest-ranking *VDOBSTR; (70b) and (70c) tie on all other constraints of relevance.

Allowing the segmental markedness constraint to determine the outcome of assimilation bears no bad fruit in the case above, but it has disastrous consequences when the other logically possible disharmonic input is considered. This is the case of a voiceless-voiced input sequence. The actual Catalan output is one in which the cluster is uniformly voiced, but this grammar is incapable of deriving the correct result, as shown in (71).

(71) Voiceless-voiced input; incorrect candidate is optimal

/gos blaw/ 'blue dog'	AGREE(voice)	VOCCON	IDENT(voice)	*VDOBSTR
a. gós ʔláw	*!			**
b. góz ʔláw			*	**!*
c. ☞ gós pláw			*	*

With only these constraints, the positional licensing analysis is doomed to failure, as the candidate with the fewest *VDOBSTR will always be optimal in cases in which voice assimilation is required.

One obvious solution to the problem posed above is a modification of the assimilation constraint, abandoning AGREE(voice) in favor of a directional constraint, as in (72).

(72) ALIGN([voice], L, PWd, L)
For all *x*, *x* = [voice], there exists a *y*, *y* a PWd, such that the left edge of *x* and the left edge of *y* coincide.

Via interaction with constraints demanding locality of spreading, and prohibiting the multiple linking of [voice] between obstruents and vowels (see Itô, Mester & Padgett 1995 for one proposal), ALIGN-L will presumably generate the correct results. However, this approach misses the key generalization concerning consonantal assimilation patterns: onset features are preserved and spread in assimilation contexts. A parametrized spreading constraint as in (72) does not explain why assimilation in consonant clusters is almost exclusively regressive; it merely stipulates the direction of spread. Positional licensing, augmented with ALIGN-L, must explain why the corresponding ALIGN-R constraint (73) is rarely, if ever, attested in natural language.

(73) ALIGN([voice], R, PWd, R)
For all x, x = [voice], there exists a y, y a PWd, such that the right edge of x and the right edge of y coincide.

This question does not arise in positional faithfulness theory: there is neither ALIGN-R(voice) nor ALIGN-L(voice). Regressive assimilation follows straightforwardly from the presence of IDENT-ONSET(voice) in the grammar.

1.3.3 Conclusions

Western Catalan, like many of the world's languages, exhibits a positional restriction on the occurrence of voiced obstruents: they are contrastive only in syllable onset position. In coda position, the voicing of obstruents is entirely predictable. In the positional faithfulness analysis presented in §1.3.1, this asymmetry between coda and onset positions follows from the interaction of the positional and context-free faithfulness constraints with the markedness constraints which disfavor voiced obstruents and disharmonic obstruent clusters, as summarized in (74).

(74) Summary: Constraint interactions governing Catalan obstruents

Ranking	Result
*VDOBSTR » IDENT(voice)	Free-standing coda obstruents must be voiceless.
IDENT-ONSET(voice) » *VDOBSTR	Onset obstruents may be voiced or voiceless.
AGREE(voice) » *VDOBSTR	Clusters agree in voicing, even if voiced obstruents are derived from underlying voiceless segments.
AGREE(voice) » IDENT(voice)	Clusters agree in voicing, even if deviations from the underlying [voice] specifications are required.
IDENT-ONSET(voice) » IDENT(voice)	When unfaithfulness is compelled, coda obstruents, rather than onsets, will be unfaithful.

The subordination of context-free faithfulness to all other constraints in the relevant constraint subhierarchy forces coda obstruents to undergo neutralization (when isolated) or assimilation (when in a cluster). By contrast, high-ranking IDENT-ONSET(voice) protects obstruents in onset position from undergoing either neutralization (thereby permitting the full range of voicing contrasts in onset position) or assimilation (thus generating invariant regressive assimilation). As we have seen, no other pattern of positional asymmetry is possible with such a grammar—and, contrary to the predictions of the positional licensing approach considered in §1.3.2, other patterns of positional asymmetry are rarely, if ever, attested. In Chapter 2, I turn to cases of privilege which key on root-initial syllables, demonstrating both the advantages of positional faithfulness theory and the shortcomings of positional licensing.

CHAPTER 2

ROOT-INITIAL FAITHFULNESS

2.1 Introduction

Positional asymmetries in feature distribution at the syllabic level are well-known from the work of Steriade (1982), Itô (1986, 1989), Goldsmith (1989, 1990) and Lombardi (1991), among others. Syllable onsets typically permit more, and more marked, segments than do syllable codas. While investigations of syllable-level asymmetries have been numerous and fruitful, phonological asymmetries associated with other structural positions have largely been overlooked.

Root-initial syllables constitute one such case. Phonologically, initial syllables exhibit all of the asymmetrical behaviors typical of "strong licensers": they permit a wide range of marked segments, trigger directional phonological processes, and resist the application of otherwise regular alternations. In this chapter, I will argue that the phonologically privileged status of root-initial syllables arises from high-ranking initial-syllable faithfulness constraints. Such constraints encompass all three aspects of phonological privilege which are displayed by initial syllables. I begin with a survey of initial syllable privilege effects.

2.2 Initial Syllable Privilege

2.2.1 Psycholinguistic Evidence

One source of evidence for initial-syllable positional privilege may be found in the domain of lexical access and language processing. There is a considerable body of psycholinguistic research which indicates that word-initial material, either spoken or written, plays a key role in lexical access, word recognition and speech production. Some of this evidence is outlined in (1) below. (See Hall 1988, 1992; Hawkins & Cutler 1988 for further examples and discussion of the relevant literature.)

(1) Initiality effects in processing[1]

- Utterance-initial portions make better cues for word recognition and lexical retrieval than either final or medial portions (Horowitz *et al.* 1968; Horowitz *et al.* 1969; Nooteboom 1981)
- Initial material is most frequently recalled by subjects in a tip-of-the-tongue state (Brown & McNeill 1966)
- Word onsets are the most effective cues in inducing recall of the target word in tip-of-the-tongue states (Freedman & Landauer 1966)
- Mispronunciations are detected more frequently in initial positions than in later positions (Cole 1973; Cole & Jakimik 1978, 1980)
- Mispronunciations in word onsets are less likely to be fluently replaced in a speech shadowing task than errors in later positions (Marslen-Wilson 1975; Marslen-Wilson & Welsh 1978)

From evidence of this type, Hawkins and Cutler (1988: 299) conclude that the temporal structure of lexical entries is "of paramount importance" in the lexicon. They further "suggest that the pervasiveness of onset salience, expressing itself not only in auditory comprehension but in reading as well, and in parallel effects in speech production, argues that the importance of the temporal structure of words in their mental representation extends beyond the auditory access code." In this context, the predictions of Nooteboom (1981: 422) take on particular significance: "...lexical items will generally carry more information early in the word than late in the word. In phonological terms one would predict that (i) in the initial position there will be a greater variety of different phonemes and phoneme combinations than in word-final position, and (ii) word initial phonemes will suffer less than word final phonemes from assimilation and coarticulation rules."

Nooteboom's predictions appear to be borne out cross-linguistically. There are many examples of phonological behavior which turn on the root-initial/non-initial syllable distinction. I turn to an overview of such examples in §2.2.2.

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[1] In the literature cited here, the distinction between word-initial and root-initial is not systematically explored—in many, it is difficult to determine whether only unprefixed forms, or both prefixed and unprefixed words, were used as stimuli. The processing of prefixal morphology is an interesting and complex matter. See Hall (1992) for a useful summary and discussion of the issues.

2.2.2 Phonological Evidence of Positional Privilege

Phonological asymmetries between root-initial and non-initial syllables are well-documented in the descriptive and generative phonological literature. Positional neutralization of vocalic contrasts outside of the root-initial syllable is particularly common in languages which exhibit vowel harmony, and is robustly attested in a variety of languages and language families including Turkic, Tungusic, Mongolian, Finno-Ugric, and Bantu. (Many cases of non-initial vowel neutralization are documented and/or discussed in Trubetzkoy 1939; Bach 1968; Haiman 1972; Ringen 1975; Kiparsky 1981, 1988; Clements & Sezer 1982; Goldsmith 1985; Steriade 1979, 1993c, 1995; Hulst & Weijer 1995, to mention only a few.) In languages that exhibit non-initial neutralization of vowel contrasts, the vowel inventory in non-initial syllables is typically a subset of the full vowel inventory appearing in root-initial syllables. Furthermore, membership in the non-initial inventory is not random: non-initial vowels are generally less marked than, or identical to, the members of the vowel inventory which appear in root-initial syllables.

One language which exhibits this pattern of positional neutralization is Shona, a Bantu language of Zimbabwe. In Shona verbs, vowel height may vary freely in root-initial position, as in (2). However, vowel height in non-initial syllables is severely restricted; non-initial mid vowels may surface only if preceded by an initial mid vowel.

(2) Initial vowel height varies freely

pera	‘end’
tsveta	‘stick’
sona	‘sew’
ipa	‘be evil’
iuàa	‘come out’
bvuma	‘agree’
iata	‘hold’
shamba	‘wash’

(3) Non-initial height is restricted

tonhor-	‘be cold’	buruk-	‘dismount’
pember-	‘dance for joy’	simuk-	‘stand up’
bover-	‘collapse inwards’	turikir-	‘translate’
		charuk-	‘jump over/across’
		tandanis-	‘chase’

There are no Shona verbs in which mid vowels follow either low or high vowels. Only the peripheral vowels *i*, *u* and *a* are contrastive in non-initial syllables.

Positional restrictions on inventory are not limited to the realm of vowel features. In many languages, consonantal contrasts are confined to root-initial syllables. Representative examples of both vocalic and consonantal positional neutralization are displayed in (4) below.

(4) Root-initial/non-initial inventory asymmetries

Language:	**Inventory includes:**	**Initial** s **:**	**Non-initial** s **:**
Tuva (Turkic) (Krueger 1977)	Plain & glottalized vowels	Both plain & glottalized vowels	No glottalized vowels
Turkic family (Comrie 1981; Kaun 1995)	Round & unround vowels	Round & unround vowels	Round vowels only via harmony with a round initial
Hungarian (C. Ringen, personal communication)	High & mid front rounded vowels	High & mid front rounded vowels	Mid front rounded vowels only after front rounded vowels
!Xóõ (Bushman) (Traill 1985)	Click & non-click consonants	Click & non-click consonants	No clicks
Tamil (Dravidian) (Christdas 1988; Bosch & Wiltshire 1992)	High, mid & low vowels Round & unround vowels Linked & independent POA in coda position	High, mid & low vowels Round & unround vowels Linked & independent POA in coda position	No mid vowels No round vowels Only linked POA in coda position
Malayalam (Dravidian) (Wiltshire 1992)	Labial, Dorsal & a variety of Coronal consonants	Independent place of articulation in coda position	Place of articulation in coda must be shared by following onset
Dhangar-Kurux (Dravidian) (Gordon 1976)	Oral & nasal vowels Long & short vowels	Oral & nasal vowels Long & short vowels	No nasal vowels No long vowels
Shona (Bantu) (Fortune 1955) (many other Bantu languages exhibit parallel facts)	High, mid & low vowels	High, mid & low vowels	Mid only via harmony with a mid in the initial syllable
Shilluk (Nilotic) (Gilley 1992) Doyayo (Niger-Congo) (Wiering & Wiering 1994)	Plain, palatalized & labialized consonants Voiceless, voiced & implosive consonants Labiovelar stops (k·p, g·b)	Plain, palatalized & labialized consonants Voiceless, voiced & implosive consonants Labiovelar stops	No palatalized or labialized consonants No implosives (i. à) No labiovelar stops
Bashkir (Turkic) (Poppe 1964)	High, mid & low vowels	High, mid & low vowels	No high vowels

Further examples may be found in many languages of diverse genetic affiliation.

In addition to permitting a wider range of more marked segments, root-initial syllables frequently act as triggers of phonological processes such as vowel harmony, or preferentially fail to undergo an otherwise regular process. Palatal and/or rounding harmony in many Altaic languages can be characterized as spreading triggered by the root-initial syllable. Shona height harmony (and numerous other examples of height harmony in Bantu languages) also falls into this category; harmony is initiated by a segment in the privileged root-initial syllable. The second phenomenon, in which segments in the root-initial syllable fail to undergo a process, is instantiated in Tamil, where codas of initial syllables do not undergo place assimilation, and in Zulu, in which root-initial consonants fail to undergo an otherwise regular process of dissimilation. Further examples of initial syllable resistance can be found in Leti, an Austronesian language, and Korean. Hume (1996) discusses the occurrence of metathesis in the Austronesian language Leti. In Leti, metathesis is a pervasive strategy employed in the satisfaction of a variety of phrase-level prosodic structure constraints. However, while metathesis applies freely to word-final sequences, it never applies in root-initial environments. Finally, Kang (in preparation) (cited in Hume 1996) reports on a process of glide deletion in Seoul Korean which applies at a significantly higher rate in non-initial syllables than in initial syllables.

In this chapter, I will argue that both initially-determined positional neutralization and initially-triggered or -blocked phonological processes result from a high-ranking positional faithfulness constraint, IDENT-σ_1(F), formulated as in (5).

(5) IDENT-σ_1(F)
Let β be an output segment in the root-initial syllable, and α its input correspondent.
If β is [γF], then α must be [γF].
"An output segment in σ_1 and the input correspondent of that segment must have identical feature specifications."

This constraint belongs in the same family as the familiar IDENT(F) of McCarthy & Prince (1995), and universally dominates it, as shown in (6).

(6) Universal ranking, initial syllable faithfulness subhierarchy
IDENT-σ_1(F) » IDENT(F)

Non-initial neutralization of contrast arises when some markedness constraint or constraints intervene in the ranking shown in (6). For example, the absence of mid vowels outside of root-initial syllables results from the ranking shown in (7), where the intervening markedness constraint is *MID (*[-high, –low]).

(7) Positional limitations on phonemic mid vowels
IDENT-σ_1(high) » *MID » IDENT(high)

The ranking of IDENT-σ_1(high) » *MID will result in the preservation of underlying height contrasts in root-initial syllables. Conversely, the ranking *MID » IDENT(high) prohibits preservation of input mid vowels outside of the root-initial syllable.

The other two privileged behaviors exhibited by root-initial syllables, triggering of phonological processes and blocking of phonological processes, derive from the same basic pattern of ranking shown in (7). In an OT grammar, phonological processes are manifested when some markedness constraint dominates a faithfulness constraint, thereby forcing an alternation. For example, nasal harmony may result from the ranking of ALIGN(nasal) » IDENT(nasal), place assimilation from the ranking SPREAD(Place) » IDENT(Place) (Padgett 1995b), and so on.

Initial-syllable triggering *and* blocking of phonological processes such as nasal harmony and place assimilation derive from the ranking schema in (8) below, where **M** represents any markedness constraint.

(8) Initial-syllable triggering and blocking schema
IDENT-σ_1(F) » **M** » IDENT(F)

The ranking of IDENT-σ_1(F) » **M** renders any element in the root-initial syllable immune to the application of the phonological process characterized by the ranking of **M** » IDENT(F). An example of this type will be presented in §2.3 below.

The remainder of the chapter is organized as follows. In §2.3, I examine the role of IDENT-σ_1(F) in characterizing Shona height harmony. In Shona, contrastive mid vowels occur only in root-initial syllables; elsewhere, they arise predictably through harmony. This pattern derives from the ranking schema in (8). Section 2.4 provides an analysis of Tamil, a language which exhibits multiple reflexes of high-ranking IDENT-σ_1(F). In Tamil, as in Shona, mid vowels are limited to root-initial syllables. Furthermore, coda consonants in initial syllables may have an independent place of articulation, those codas of non-initial syllables may not. We will see that high ranking IDENT-σ_1(F) constraints are again the key to characterizing both the distribution of both vowel height and of coda place of articulation in Tamil. The key findings of the chapter are summarized in §2.5.

2.3 Positional Neutralization and Harmony in Shona

2.3.1 Data and Generalizations

Shona is a Bantu language spoken primarily in Zimbabwe; it belongs in Area S, according to the classification system of Guthrie (1967). The descriptive and generative literature on Shona is extensive, particularly in the realm of tonal phonology. (Notable generative works on Shona tone include Myers 1987 and Odden 1981.) Our focus here will not be on the tonal properties of Shona, but rather on the distribution of vowel height in the verbal system.

The distribution of the feature [high] in Shona verbs is a classic example of positional neutralization accompanied by vowel harmony: the mid vowels *e* and *o* in Shona verbs are contrastive only in root-initial syllables.[2] They appear in subsequent syllables only when preceded by a mid vowel in root-initial position. A string of height-harmonic Shona vowels is therefore firmly anchored in the root-initial syllable.[3]

Shona has a three-height vowel system comprised of five surface vowels. The vowels of Shona and the surface feature specifications assumed are shown in (9) below. (Unless otherwise noted, the data and generalizations which follow are drawn from Fortune 1955, who describes

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2 In the interest of internal consistency, I have adopted the term "root" in the discussion of Shona, rather than "radical", which is commonly used in the Bantuist literature.

3 The discussion and analysis which follow are restricted to Shona, for largely practical reasons. The same basic pattern of height distribution occurs in many other Bantu languages which have a five-vowel inventory (e.g., Kinyarwanda (Kimenyi 1979), Lamba (Kenstowicz & Kisseberth 1979: 72), and the analysis presented here can be extended to such cases straightforwardly.

the Zezuru dialect of Shona. Tone and vowel length have been omitted throughout; length occurs only in penultimate syllables, as a reflex of stress.)

(9)

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

In Shona, as in most languages with triangular vowel systems, the low vowel is inert with respect to vowel harmony; *a* systematically fails to pattern with the [–high] vowels *e* and *o*: The appearance of a root-initial *a* does not permit subsequent mid vowels (indicating that the [–high] specification of *a* is not available for linkage to a subsequent non-low vowel). Furthermore, the distribution of [–high] *a* is free, not restricted to the initial syllable as are the [–high] mid vowels. The relative freedom of the low vowel will emerge from constraint interaction, as shown in §2.3.3 below.[4]

While the distribution of *a* is free in Shona verbs, the occurrence of high and mid vowels is subject to certain limitations. Verb *stems* are composed of a verb *root* and any number of optional derivational *extensions*; verb roots are primarily CVC in shape, but polysyllabic roots are not uncommon. In the initial syllable of a verb stem, there are no restrictions on the occurrence of vowel features. However, in non-initial syllables (whether in the root or in an extension), only [round], [back] and [low] may vary freely. The value of the feature [high] is determined by the height of a preceding vowel: mid vowels may appear non-initially only if preceded by a mid vowel. In order for a string of mid vowels to be licit, the leftmost vowel must appear in a root-initial syllable. (Thus, a sequence *CeCe*, where *C* = any consonant, is not possible if preceded by a root-initial high or low vowel: **CiCeCe*, **CaCeCe*.) High vowels

[4] No phonological theory of vowel height features that I am aware can adequately explain the widespread failure of low vowels to interact with high or mid vowels in height-sensitive processes. (Rare exceptions include various examples of vowel coalescence (de Haas 1988), Romance metaphony (Calabrese 1988, Hualde 1989):, and Woleian raising (Sohn 1971, 1975).) If the low vowels are represented with the same features as vowels of other heights, this asymmetry in behavior is unexpected. The issue of vowel height representation is, however, orthogonal to the characterization of non-initial neutralization. See Clements (1991), Steriade (1995) for relevant discussion of this issue.

may appear non-initially if the vowel of the preceding syllable is either high or low, but never if the preceding vowel is mid. This is summarized for $\#\sigma_1\sigma_2$ sequences in (10), where $\#\sigma_1$ indicates a root-initial syllable.

(10)

σ_2 ∅

		i	u	e	o	a
$\#\sigma_1$	i	v	v			v
¬	u	v	v			v
	e		v	v		v
	o			v	v	v
	a	v	v			v

Shaded cells in the table indicate non-occurring vowel sequences. Mid vowels may not follow either high or low vowels, while high vowels may not follow mid. This is true both within verb roots and between roots and extensions in derived forms. (The sole exception to this generalization is found in the sequence *#CeCu*; non-initial round vowels harmonize in height with a preceding vowel only if the vowels agree in rounding. This is manifested in the absence of *#CeCo* sequences and the presence of *#CeCu,* as indicated in (10). I will ignore this gap in the remaining discussion; a full analysis is provided in Beckman 1997)

Data instantiating these distributional generalizations are given in (11)-(16) below. In (11), representative examples of polysyllabic verb roots are provided. (Many of the polysyllabic roots in the language are likely to have been derived from root + extension combinations at an earlier point in the history of the language; such forms appear to have been lexicalized to varying degrees in the synchronic grammar. Others are related to nouns or ideophones. Wherever possible, I have excluded transparently derived roots from the list in (11).) There are no polysyllabic roots which fail to conform to the generalizations shown in (10) above.

(11) Polysyllabic roots exhibit vowel harmony[5]

tonhor-	'be cold'	Fi	chenjer-	'be wise'	M
nonok-	'dally, delay'	Fo7	chember-	'grow old'	M
nonot-	'scold, abuse'	H	verer-	'move stealthily'	M
korokod-	'itch (nostril)'	H	vereng-	'read; count'	M
gobor-	'uproot'	Fo7	pember-	'dance for joy'	H
bover-	'collapse inwards'	H	nyemwerer-	'smile'	Fo7
kobodek-	'become empty'	H			
pofomadz-	'blind (trans.)'	Fo5	zendam-	'lean w/support at side or back'	H
pofomar-	'be blind'	H	chenam-	'bare teeth angrily'	H
chonjomar-	'sit w/buttocks & soles of feet on ground'	H			
fungat-	'embrace'	D	bvinar-	'fade'	H
pfugam-	'kneel'	Fo7	findam-	'tangle (intr.)'	H
ruram-	'be straight,'	Fo7	minaik-	'wriggle'	H
buruk-	'dismount'	Fo7	simuk-	'stand up'	Fo7
dukup-	'to be small'	H	simudz-	'lift'	Fi
kumbir-	'ask for'	M	kwipur-	'uproot'	H
turikir-	'translate'	Fi	svetuk-	'jump'	Fo5
			serenuk-	'water (gums of mouth)'	H
charuk-	'jump over/across'	H	tandanis-	'chase'	Fi
ganhur-	'limit, demarcate'	H	kwazis-	'greet'	Fo7
katuk-	'flicker (flame)'	H			

An exhaustive list of the verbal extensions, both productive and unproductive, is given in (12).

5 Data sources are abbreviated as follows: D = Doke (1967), Fi = Fivaz (1970), Fo5 = Fortune (1955), Fo7 = Fortune (1967), H = Hannan (1981), M = Myers (1987). Data are given in the Standard Shona Orthography of Hannan (1981), though phonetic transcription is retained for the implosives and the velar nasal. The correspondence between orthography and pronunciation is generally very close. However, note that sv = labialised alveolar fricative [s^w], tsv = labialised alveolar affricate [ts^w], sh = voiceless palato-alveolar fricative [ß], ch = voiceless palato-alveolar affricate [ê] and v = voiced bilabial continuant [?] (described as a fricative by Fortune 1955, but as an approximant by Hannan 1981 and Pongweni 1990). Vowel length (which is noncontrastive and appears only in the penultimate syllable, as a reflex of stress) and tone are omitted throughout.

Not all of these sources focus on the Zezuru dialect, but all of the roots cited are found in Zezuru, according to Hannan (1981).

(12) Shona verbal extensions (Doke 1967: 66–67)

-w, -iw/-ew	Passive	
-ir/-er	Applicative	
-ik/-ek	Neuter	
-is/-es, -y	Causative	
-idz/-edz	"	
-is/-es, -isis/-eses	Intensive	
-irir/-erer	Perfective	(from Fortune 1955; Doke says that the perfective does not exist in Shona)
-an	Reciprocal	
-uk/-ok, -uruk/-orok	Reversive	
-ur/-or, -urur/-oror	"	
-aur	Extensive	
-at	Contactive (not productive)	
-am, -ar	Stative (not productive, according to Doke)	

In (13)-(16), I give examples of derived root + extension combinations, taken from Fortune (1955). The (a) forms show surface mid vowels in extensions, while the (b) forms give extensions with surface high vowels. Alternating vowels are italicized.

(13) Root + applicative extension

a.	pera	‘end’	per-*e*ra	‘end in’
	tsveta	‘stick’	tsvet-*e*ra	‘stick to’
	sona	‘sew’	son-*e*ra	‘sew for’
	pona	‘give birth’	pon-*e*ra	‘give birth at’
b.	ipa	‘be evil’	ip-*i*ra	‘be evil for’
	iata	‘hold’	iat-*i*ra	‘hold for’
	vava	‘itch’	vav-*i*ra	‘itch at’
	svetuka	‘jump’	svetuk-*i*ra	‘jump in’
	pofomadza	‘blind’	pofomadz-*i*ra	‘blind for’

(14) Root + neuter extension

a.	gona	‘be able’	gon-*e*ka	‘be feasible’
	vere˜ga	‘count’	vere˜g-*e*ka	‘be numerable’
	che˜geta	‘keep’	che˜get-*e*ka	‘get kept’
b.	kwira	‘climb’	kwir-*i*ka	‘easy to climb’
	bvisa	‘remove’	bvis-*i*ka	‘be easily removed’
	tarisa	‘look at’	taris-*i*ka	‘easy to look at’

(15) Root + perfective suffix

a.	pota	‘go round’	pot-*e*r*e*ra	‘go right round’
	cheka	‘cut’	chek-*e*r*e*ra	‘cut up small’
	seka	‘laugh’	sek-*e*r*e*ra	‘laugh on and on’
b.	pinda	‘pass’	pind-*i*r*i*ra	‘to pass right through’
	iuàa	‘come out’	iuà-*i*r*i*ra	‘to come out well’

(16) Root + causative suffix

a.	tonda	‘face’	tond-*e*sa	‘make to face’
	sho˜ga	‘adorn self’	sho˜g-*e*sa	‘make adorn’
	oma	‘be dry’	om-*e*sa	‘cause to get dry’
b.	bvuma	‘agree’	bvum-*i*sa	‘make agree’
	shamba	‘wash’	shamb-*i*sa	‘make wash’
	pamha	‘do again’	pamh-*i*sa	‘make do again’
	cheyama	‘be twisted’	cheyam-*i*sa	‘make be twisted’

The data in (11)-(16) demonstrate that high and mid vowels in Shona are not freely distributed in the verbal system. Rather, the height of the root-initial vowel determines the height of any subsequent non-low vowels. If the initial vowel is [-high, +low], following [–low] vowels must share that [–high] specification; if the initial vowel is [+high], only the [+high] vowels *i* and *u* may appear subsequently. Forms such as *ceyamisa* ‘make be twisted’ and *pofomadzira* ‘blind for’ demonstrate that the low vowel *a* is opaque to harmony, constituting a barrier to the extension of a multiply-linked [high]. Following a low vowel, no further mid vowels may appear; instead, the typologically less marked high vowels are invariably found. The analysis of these facts is given in section 2.3.2.

2.3.2 Preliminaries: Markedness and Faithfulness Constraints in OT

The distribution of vowel height in Shona, and in many other Bantu languages with comparable harmony systems, is characteristic of positional neutralization. The distinction between high and mid vowels is maintained in root-initial syllables, giving a three-way height contrast, but high and mid vowels are not contrastive outside of the root-initial syllable. This positional restriction on segmental constrastiveness results from the interaction of featural markedness and faithfulness constraints, in the same way that language-wide inventory restrictions arise through markedness/faithfulness interaction (Prince & Smolensky 1993: Chapter 9).

I follow the proposals of Prince & Smolensky (1993) and Smolensky (1993), who argue that universal harmony scales, each of which encodes the relative markedness of all features along a particular dimension such as place of articulaton or height, are reflected in the grammar by means of corresponding constraint subhierarchies. Various surveys of vowel inventory structure (Crothers 1978, Disner 1984) indicate that the presence of mid vowels in an inventory implies the presence of high and low vowels, while the reverse is not true. The universal harmony scale which reflects this implication is given in (17), with the corresponding constraint dominance hierarchy in (18).

(17) Height markedness: Harmony Scale
High, Low > Mid

(18) Height markedness: Dominance Hierarchy[6]
*MID » *HIGH, *LOW

The constraints in (18) are instantiated as in (19)–(21) below.[7]

(19) *MID: *[–high, –low]

(20) *HIGH: *[+high, –low]

(21) *LOW: *[–high, +low]

In addition to featural markedness constraints, UG includes a set of faithfulness constraints which regulate exactness of input-output identity in vowel height specifications. The faithfulness constraints relevant to the analysis of Shona are divided into two distinct types. The first type is instantiated in the context-free IDENT constraints of (22).

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6 The relative markedness of high and low vowels is not clear. Jakobson (1941) and Greenberg (1966) both propose an *a* > *i* > *u* implicational hierarchy, with the low vowel implied by the high front vowel. However, Disner (1984) suggests a hierarchy of {*i*, *a*} > {*e*, *o*} > *u*, based on the frequency of missing vowels in the 43 defective vowel systems in the UPSID inventory; here there is no implicational relationship between the high front and low vowels. Also, both high and low vowels are found as default segments cross-linguistically. (For example, *a* is the epenthetic vowel in Axininca Campa (Payne 1981) and Makkan Arabic (Abu-Mansour 1987), while high vowels are epenthetic or default segments in a variety of languages, including Yoruba (Pulleyblank 1988), Zulu (Beckman 1992), Nancowry (Radhakrishnan 1981) and various Arabic dialects (Itô 1989).) Given this indeterminacy, it seems likely that the ranking of *HIGH and *LOW must be subject to cross-linguistic variation.

7 For the sake of convenience, I adopt the Chomsky & Halle (1968) features for vowel height. For alternatives, see Clements (1991), Schane (1984), Selkirk (1991a,b). Steriade's (1995) discussion of Bantu height harmony is also relevant; she proposes a perceptual feature [nonperipheral] (supplementary to the articulatory features [high] and [low]) which characterizes mid vowels. [nonperipheral] may be indirectly licensed in non-initial syllables, via multiple linking.

(22) IDENT(high)
Let α be an input segment and β its output correspondent.
If α is [γhigh], then β must be [γhigh].
"An input segment and its output correspondent must have identical specifications for the feature [high]."

IDENT(low)
Let α be an input segment and β its output correspondent.
If α is [γlow], then β must be [γlow].
"An input segment and its output correspondent must have identical specifications for the feature [low]."

The second type of featural faithfulness constraint is a root-initial faithfulness constraint, as shown in (23). It is the dispersion of height faithfulness according to position which is responsible for the asymmetrical distribution of high and mid vowels in Shona.

(23) IDENT-σ_1(high)
Let β be an output segment in the root-initial syllable, and α its input correspondent.
If β is [γhigh], then α must be [γhigh].
"An output segment in σ_1 and the input correspondent of that segment must have identical specifications for the feature [high]."

Because syllabification is reliably present only in output strings, the constraint is formulated with an output "focus", in contrast to the context-free constraints of (22). In both cases, however, violations are incurred by any input-output mismatch in feature specifications; IDENT(high) and IDENT-σ_1(high) are both violated equally by deletion of underlying specifications and by insertion of non-input values. Through interaction with the markedness constraints in (19)-(21), the constraints in (22)–(23) generate the surface patterns of height distribution which are attested in Shona.

2.3.3 Analysis: Positional Neutralization and Harmony

As outlined in Chapter 1, the positional restrictions on phonological inventory which are characteristic of positional neutralization result from the ranking schematized in (24).

(24) Positional neutralization ranking schema
IDENT-*Position*(F) » *F » IDENT(F).

This simple ranking permits the contrastive occurrence of a feature, F, in some prominent position; outside of that position, the ranking of *F above IDENT(F) rules out contrastive occurrences of F. In Shona, all three vowel heights are contrastive in root-initial syllables, calling for the ranking in (25).

(25) IDENT-σ_1(high), IDENT(low) » *MID » *HIGH, *LOW

The context-free IDENT(low) is high-ranking because (i) low vowels are free to occur in initial syllables, and (ii) in non-initial syllables, only the low vowel *a* is completely unfettered in its distribution. Low vowels do not raise, and non-low vowels do not lower; IDENT(low) is always satisfied.[8]

High and mid vowels are not distinctive non-initially; instead, they are predictable according to the height of a preceding vowel. Verbs containing a mid vowel in the root-initial syllable consist entirely of mid vowels, while the vowels in verbs whose initial syllable contains a high vowel are uniformly high. There are no verbs of the shape *CiCeC* or *CeCiC* in Shona. Further, if the root-initial syllable contains a low vowel, subsequent vowels may not be mid: **CaCeC*.[9] These facts, taken together, argue for the ranking in (26).

(26) IDENT-σ_1(high), IDENT(low) » *MID » *HIGH » IDENT(high)

The correctness of these rankings will be demonstrated in the following sections.

2.3.3.1 Vowel Height in Initial Syllables

I begin by demonstrating that the proposed ranking permits the full range of height contrasts in root-initial syllables. Because IDENT-σ_1(high) and IDENT(low) dominate all of the featural markedness constraints, height specifications in the initial syllable will never deviate from their input values in order to better satisfy featural markedness constraints. This is shown in

8 For the sake of simplicity, I have omitted the positional constraint IDENT-σ_1(low) throughout the discussion. Under the ranking in (25), positional IDENT-σ_1(low) can have no visible effect in the grammar.

9 The Final Vowels constitute an exception to this generalization: a mid vowel *e may* appear after a low or high vowel *just in case* it is the mood-marking Final Vowel characteristic of Bantu verbal morphology. In Shona, final -*e* marks a number of different moods, including subjunctive, negative habitual and potential. The resistance of the Final Vowels to height harmony may reflect a high-ranking constraint which penalizes the loss of morphological distinctions (see the discussion of MORPHDIS in McCarthy & Prince 1995), or a domain restriction on constraint applicability. I will not attempt to resolve this issue here.

tableaux (27)–(29) below, where only the initial syllable is evaluated against the constraint hierarchy. Tableau (27) shows that mid vowels are permitted in initial syllables.[10]

(27) Initial mid vowels are permitted

/cheyam-a/	IDENT-σ_1(high)	IDENT(low)	*MID	*HIGH	*LOW
a. ☞			*		
b.	*!			*	
c.		*!			*

IDENT(low) must dominate *MID in order to prevent lowering of an input mid vowel, as in (27c). Note that the lowered output satisfies IDENT-σ_1(high), as the mid and low vowels are both [–high]. Now we turn to an initial high vowel example in (28).

(28) Initial high vowels are permitted

/bvis-a/	IDENT-σ_1(high)	IDENT(low)	*MID	*HIGH	*LOW
a.	*!		*		
b.☞				*	
c.		*!			*

Here again, the ranking prohibits deviations from underlying height specifications in the initial syllable; the fully faithful (28b) is optimal. Finally, the case of an initial low vowel is illustrated in (29).

(29) Initial low vowels are permitted

/shamb-a/	IDENT-σ_1(high)	IDENT(low)	*MID	*HIGH	*LOW
a.		*!	*		
b.	*!	*!		*	
c. ☞					*

10 I assume that vowel features are organized along the lines suggested in Odden (1991), Clements (1991), and Clements & Hume (1995), with a vowel place node that dominates two dependent class nodes, Color and Aperture. Where relevant to constraint satisfaction, I will explicitly show an Aperture node (Clements 1991, Clements & Hume 1995); otherwise, I omit it in the interest of simplicity.

As expected, the faithful (29c) is optimal. Vowel height ranges freely over high, mid and low in the root-initial syllable, due to high-ranking initial syllable faithfulness.

2.3.3.2 Height in Non-initial Syllables

The ranking displayed in (27)–(29) generates the full range of height contrasts in the initial syllable, but it does not characterize the neutralization of the high-mid contrast in non-initial syllables. The latter arises from the ranking *MID » *HIGH » IDENT(high). This ranking, when combined with the higher-ranking faithfulness constraints IDENT-σ_1(high) and IDENT(low), will ensure that only low or high vowels may follow an initial syllable containing a low or high vowel. This is illustrated with initial low vowels in (30) and (31), where hypothetical inputs are assumed.

(30) No mid vowels after initial low

/CaCeC/	IDENT-σ_1(high)	ID(low)	*MID	*HIGH	*LOW	ID(high)
a.			*!		*	
b.			*!		*	
c.☞				*	*	*
d.		*!			**	

The input low-mid sequence is prohibited, whether the low and mid vowels have separate specifications of [–high] (30a) or share a single [–high] (30b). This is due to the marked character of mid vowels. Each of the two candidates fatally violates *MID, by virtue of the [–high, –low] combination instantiated on the second vowel; the parasitism of the mid vowel on the [–high] of initial *a* cannot rescue it from a violation of *MID. This is because *MID penalizes a feature combination, rather than an individual feature; in each case, the marked combination of [–high, –low] is instantiated. Candidate (30d), in which the non-initial vowel surfaces as low *a*, is also ruled out, in this case by IDENT(low).[11] This leaves (30c), in which "default" [+high] is

[11] A candidate parallel to (30d), but with a single, multiply-linked VPlace or Aperture node, would fare just as poorly on IDENT(low). In both cases, the input [–low] of the second vowel is changed to [+low] in the output form.

specified on the non-initial vowel, as optimal. Mid vowels may not follow a low vowel; an input mid vowel in this position will be realized as a [+high] vowel. Given an input with a low-high sequence, the candidate (30b) will also be preferred by the grammar. Of the non-low vowels, only those which are [+high] may follow *a*.

A non-initial low vowel is also permitted after an initial low vowel, as shown in (31).

(31) Low vowel licit after initial low

/CaCaC/	IDENT-σ_1(high)	ID(low)	*MID	*HIGH	*LOW	ID(high)
a.		*!	*		*	
b.		*!		*	*	*
c.					**!	
d.☞					*	
e.					**!	

Any deviation from the input low vowels incurs a fatal violation of IDENT(low), as in candidates (31a,b). A comparison of (31c-e) reveals that multiple-linking of identical specifications under a single Aperture node is preferred to a sequence of independent Aperture nodes. "Vacuous" vowel harmony is optimal, because IDENT(low) is not violated by multiple-linking, and because multiple linking of the Aperture node better satisfies the markedness constraint *LOW. Such markedness constraints, which penalize feature combinations, are best satisfied when only a single token of the feature combination is instantiated in the representation, as in (31d). In such a configuration, there is a single class node which dominates the complex of features under consideration.

The feature-driven character of *F constraint evaluation was pointed out in McCarthy & Prince (1994a), and plays an important role in the Itô & Mester (1994) analysis of Lardil. In Shona, markedness reduction is also achieved via multiple-linking, though the linking in question involves superordinate class nodes, rather than single features such as Coronal or Labial. This is because the markedness constraints which drive multiple-linking are sensitive to the presence of multiple cooccurring features, and multiple features are organized according to feature class.[12] To give a unified formal characterization of constraint violation and satisfaction for featural markedness constraints of both the Lardil and Shona types, I propose the principle of Feature-Driven Markedness, as in (32). (See also Beckman 1997.)

(32) Feature-Driven Markedness

Let S denote a set of features {α, β, γ, ...} and *S a markedness constraint prohibiting the cooccurrence of the members of S.

*S receives one violation-mark for each node N, where
- N dominates all features in S *and*
- there is no node M such that N dominates M and M also dominates all features in S.

For a singleton feature markedness constraint such as *CORONAL, where S = {Coronal}, the node N in (32) = Coronal, on the assumption that domination is a reflexive relation (Wall 1972, Bach 1974, Cushing 1978, Johnson 1978, Pullum & Zwicky 1978). One violation-mark for *CORONAL would therefore be assessed for each occurrence of the feature Coronal in an output form; multiple feature specifications incur multiple violations of markedness constraints, while multiple linkings of a single feature do not. For example, a place-linked nasal+consonant cluster such as *nd* incurs only one violation of *CORONAL; the same cluster, when not place-linked, will incur two *CORONAL violations.

(33) a. One *CORONAL violation b. Two *CORONAL violations

This is exactly the sense in which place markedness violations are assessed in Itô & Mester (1994) and a host of other recent works, including Alderete *et al.* (1996); Beckman (1995, 1996), Lombardi (1995a,b) and Padgett (1995a,b).

In the case of markedness constraints which evaluate feature combinations, such as *[–high, +low], (*LOW), *[–high, –low] (*MID), etc., (32) calls for violations to be assessed for

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12 A treatment of Shona which adheres to the Feature Class Theory of Padgett (1995a,b), in which there are no geometric class nodes, will be somewhat different in character. Combinatory featural markedness constraints (*[F,G]) cannot be better satisfied by multiple-linking of a superordinate class node (versus multiple linking at the level of the individual features F, G), as there are no superordinate class nodes in FCT. A comparison of the two approaches is orthogonal to the matter at hand.

each discrete node which immediately dominates the relevant feature set. In the case of *LOW, the dominant node in question is the Aperture node. This distinguishes the harmonizing (31d) from the sequence of singly-linked identical vowels in (31c), and from the candidate with multiple Aperture nodes (31e). Feature-driven markedness effectively favors multiple-linking at higher levels of structure, in the case of feature coöccurrence constraints.[13]

With this understanding of featural markedness constraints, we turn to examples in which the initial syllable contains a high vowel. We saw above that the presence of a preceding low vowel will permit only high or low vowels in subsequent syllables. The same is true when the initial vowel is high; the constraint hierarchy permits only high or low vowels following an initial high vowel.

(34) Low vowel licit after initial high

/CiCaC/	IDENT-σ_1(high)	ID(low)	*MID	*HIGH	*LOW	ID(high)
a. ☞				*	*	
b.		*!	*	*		
c.		*!		**		*
d.		*!		*		*

Here, the identity of the input low vowel is protected by high-ranking IDENT(low). Because the constraint dominates *LOW, no change in underlying [+low] specifications is possible, regardless of their position within the word. With an input low vowel in the second syllable, only an output low vowel in that position is possible.

A high vowel is also permitted after a high vowel in the initial syllable. Consider the tableau in (35), where a sequence of input high vowels is examined.

[13] See also the UNIQUE family of constraints proposed by Benua (1996), discussed in §2.3.4 below. UNIQUE constraints prohibit multiple-linking of phonological elements at various levels of structure from feature to class node. For example, UNIQUE(high) is violated by a multiply-linked [high] specification, while UNIQUE(Aperture) is violated by a shared Aperture node.

(35) High vowel licit after initial high

/CiCiC/	IDENT-σ_1(high)	ID(low)	*MID	*HIGH	*LOW	ID(high)
a.				**!		
b.☞				*		
c.			*!			*
d.		*!			*	*

No deviation from the input high-high sequence is permitted. (35d) is ruled out by the violation of IDENT(low) incurred by the output *a*, and (35c) fatally violates *MID. Because *MID dominates the context-free IDENT(high), mid vowels are generally ruled out, unless protected by IDENT-σ_1(high). Of the remaining candidates, (35b) is favored by virtue of the single *HIGH violation it incurs. Due to the feature-driven nature of markedness assessment (32), multiple-linking is again favored.

Because IDENT(high) is very low-ranking, the ranking of *MID shown in (35) will rule out full faithfulness to an input high-mid sequence, just as it ruled out (35c) above. This is demonstrated in (36).

(36) Mid vowel illicit after initial high

/CiCeC/	IDENT-σ_1(high)	ID(low)	*MID	*HIGH	*LOW	ID(high)
a.				**!		*
b. ☞				*		*
c.			*!			
d.		*!			*	
e.	*!		*			*

Here, just as in (35), the output candidate with two high vowels which share an Aperture node (36b) is optimal, even though the input here includes a mid vowel. The height of the initial vowel is never subject to change (as in (36e)), due to undominated IDENT-σ_1(high). With a necessarily invariant vowel in the initial syllable, height harmony is forced in subsequent syllables by the ranking of the markedness constraints in the midst of the IDENT(high) subhierarchy.

There are three consequences of the proposed constraint ranking that have been established thus far. First, vowel height in initial syllables is fully contrastive and may vary freely. Second, height in non-initial syllables is limited to high or low when preceded by a low initial vowel. This is a kind of "emergence of the unmarked" effect (McCarthy & Prince 1994a): if the vowels cannot be of identical height (i.e., if the input contains a low-high or low-mid sequence), then only the less marked of the non-low vowels may occur in non-initial position. (Recall that complete identity of height features is prevented in such cases by high-ranking IDENT(low).) Finally, height in non-initial syllables is restricted to high or low when preceded by a high initial vowel. Input mid vowels may not surface in this environment because of the ranking of *MID » IDENT(high); height harmony is the result.

Now we can turn to the distribution of vowel height following an initial mid vowel. Only mid or low vowels may immediately follow an initial mid vowel; high vowels do not appear in this position.[14] Thus, we find forms such as *ce˜geta* 'keep', *sho˜gesa* 'make adorn', *ponera* 'give birth at', *pofomadza* 'blind' and *ceyama* 'be twisted', but not **ce˜gita*, **ponira*, or other comparable examples. It is clear that non-low vowels must agree in height, while the low vowels may occur freely. These restrictions also follow from the constraint hierarchy presented above. The tableau in (37) illustrates the simple case of a low vowel appearing after an initial mid vowel.

(37) Low vowel licit after initial mid

/CeCaC/	IDENT-σ_1(high)	ID(low)	*MID	*HIGH	*LOW	ID(high)
a. ☞			*		*	
b.		*!	*			
c.		*!	*	*		*
d.	*!			*	*	*

High-ranking IDENT(low) and IDENT-σ_1(high) combine forces to rule out any unfaithful surface rendering of the input vocalism in this case. The low vowel may not be raised, as in (37b,c), due to undominated IDENT(low); the initial mid vowel cannot be raised because of undominated IDENT-σ_1(high). (The initial vowel cannot be lowered, either, again because of IDENT(low).) The fully faithful (37a) is optimal—low vowels may occur freely after mid vowels.[15]

The more interesting case to examine is the prohibition on a high vowel following an initial mid. The constraint ranking established above will correctly generate height harmony, given an input sequence of mid + high. This is illustrated in (38).

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14 With the exception noted above, that round *u* does not harmonize with a preceding *e*. An analysis of this gap is presented in Beckman (1997).

15 Here, as in (30), the outcome is not affected if the mid and low vowel share only [–high].

(38) Height harmony from a mid + high sequence

/CeCiC/	IDENT-σ_1(high)	ID(low)	*MID	*HIGH	*LOW	ID(high)
a.		*!	*		*	*
b.☞			*			*
c.			*	*!		
d.			**!			*
e.	*!			*		*

Candidates (38a,e) fail on undominated height faithfulness constraints, (38a) because the input high vowel is lowered in the output, thereby violating IDENT(low). (38e) fails because the initial mid vowel surfaces as a high vowel in the output, thus incurring a violation of IDENT-σ_1(high). This leaves (38b,c,d) as contenders. Candidate (38d) exhibits apparent height harmony, in that the input high vowel has been lowered to mid. However, the existence of two discrete height specifications in this candidate results in a fatal violation of *MID. (38b) and (38c) tie on *MID, but the fully faithful (38c) incurs a fatal violation of *HIGH that (36b) does not suffer. This establishes the crucial ranking *HIGH » IDENT(high).

In order to complete the analysis of the distribution of height following initial mid vowels, we must examine forms such as *pofomadzira* 'blind for' and *cheyamisa* 'make be twisted'. In these words, a high vowel appears in the verbal extensions after the low *a*, although the initial vowel is mid; the pattern *CeCaCe* does not occur This is a regular property of height distribution in Shona, and is explained in much the same way as the absence of *CaCeC* sequences in general. This is shown in (39).[16]

[16] Candidates which incur violations of the No Crossing Constraint (Goldsmith 1976) are not considered; I assume that line crossing is universally ill-formed and therefore not admitted in any candidates.

(39) Low vowels are opaque to harmony

/CeCaCiC/	ID-σ_1(high)	ID(low)	*MID	*HIGH	*LOW	ID(high)
a.☞			*	*	*	
b.			**!		*	*
c.		*!	*			*

Either candidate in which the [–high] of the initial mid vowel is multiply-linked to the rightmost vowel fatally violates some high-ranking constraint. In the case of (39c), the relevant constraint is IDENT(low); raising the intervening vowel from low to mid minimizes violations of *MID, but fails on the higher-ranking faithfulness constraint. The linking in (39b) incurs two violations of *MID, as there are two distinct instances of [-high, –low], dominated by two Aperture nodes. Candidate (39a), with only one *MID violation, is optimal; only [+high] non-low vowels may follow *a*. Low vowel opacity results from high-ranking IDENT(low), and from the role of *MID in limiting the distribution of mid vowels. Sharing only [–high] with a preceding low vowel does not save a mid vowel from fatally violating *MID.

2.3.4 <u>Conclusions and Implications</u>

The preceding discussion has demonstrated that positional neutralization of height contrasts in Shona verbs arises through the interaction of markedness and faithfulness constraints. The privileged licensing status of the root-initial syllable results from high-ranking IDENT-σ_1(high), which forces input-output correspondence in the root-initial position, even for the more marked mid vowels. This is due to the ranking of IDENT-σ_1(high) above both of the featural markedness constraints *MID and *HIGH.

The crucial role of the positional faithfulness constraint IDENT-σ_1(high) emerges most clearly when we compare the effects of the proposed ranking on two similar classes of input, shown in (30) and (37). In one case, that of (30), a low-mid sequence (CaCeC) occurs in the input. Such inputs can never surface intact; the non-initial vowel must emerge as a high vowel.

(Thus, the language includes roots such as *charuk-*, *tandanis-* and *ganhur-*, but no comparable forms containing mid vowels: **charok-*, **tandanes-*, **ganhor-*, etc.). By contrast, the opposite ordering of vowels (mid-low) may surface without incident: for example, input /cheyam-/ corresponds to output *cheyam-*. Each of the faithful output types, schematically *CaCeC* and *CeCaC*, fares equally well on the markedness constraints *MID and *LOW. It is the *location* of the marked mid vowel which is crucial in differentiating the two forms: a free-standing mid vowel is permitted if and only if it occurs in the root-initial syllable.

Positional faithfulness is crucial to an account of this difference; it cannot be derived by replacing IDENT-σ_1(high) with a high-ranking ALIGN(high) constraint. To see this, consider the constraint in (40) below, and its application in tableaux (41) and (42). (For the purposes of demonstration, I assume that the remaining constraints and their rankings are fixed.)

(40) ALIGN([high], L, Root, L)[17]
“Every [high] specification must be left-aligned with a root.”

Such a constraint will favor sharing of [–high] between mid and low vowels, regardless of their input position. This derives the correct results in the case of a mid-low input, as in (41).

(41) [–high] is multiply linked

Input:	ALIGN-L(high)	ID(lo)	*MID	*HIGH	*LOW	ID(high)
a.	*!		*		*	
b.		*!	*			
c. ☞			*		*	

Candidate (41c), in which [–high] is shared by all output vowels, fares best in this circumstance, as there are no [high] specifications which are not left-aligned. Each of the other plausible output candidates fails on a high-ranking constraint, either ALIGN-L or IDENT(low).

17 For representative examples of the use of ALIGN(F) constraints in the analysis of harmony phenomena, see Kirchner (1993), Akinlabi (1994, 1995), Pulleyblank (1993, 1994), Ringen & Vago (1995a, b), Beckman (1994b) and Cole & Kisseberth (1995a,b).
I consider only ALIGN-LEFT here, as the initial position of the mid vowel is what is at issue.

Now consider a case in which the order of the two input vowels is reversed, as in (42).

(42) Low-mid input sequence

Input:	Align-L(high)	Id(low)	*Mid	*High	*Low	Id(high)
a.	*!		*		*	
b.		*!	*			
c. 💣			*		*	

In this scenario, the constraint hierarchy incorrectly selects candidate (42c). There is no possible ranking of the constraints which can correctly select (41c), but rule out (42c). By constrast, positional faithfulness accounts for the asymmetry, protecting a free-standing mid vowel if and only if it originates in the root-initial syllable.[18]

Turning now to inputs containing only mid or high vowels, I have shown that the persistence of initial values of [high] through vowel harmony follows from the ranking of both of the markedness constraints *Mid and *High above Ident(high), and from the feature-driven character of markedness constraint evaluation. Following the principle of Feature-Driven Markedness (32), multiple instances of a node or feature incur more violations than a single instance of a node or featur e. In Shona, a single multiply-linked Aperture node dominating some combination of [high] and [low] is more harmonic than two or more individual Aperture nodes dominating the same feature specifications. Thus, feature sharing occurs whenever possible, resulting in uniform height in the output; input *e...i* surfaces as *e...e* (38), while underlying *i...e* surfaces as *i...i* (36).

The markedness constraints themselves, rather than a harmony-favoring constraint such as Align(high) or Share(high), favor multiple-linking in Shona. The key role of the markedness constraints in Shona harmony highlights an important point: the absence of feature-sharing in

18 Positional faithfulness differs from positional licensing in this regard, in that a positional licensing approach favors movement of offending features or segments to privileged positions without regard for their place of origin.

languages which do not exhibit vowel harmony cannot be derived simply by assuming low-ranking ALIGN(F) constraints. Other constraints in the grammar, such as featural markedness constraints, will also favor multiple linking as a means of best satisfaction of the constraint hierarchy; this is the case in Shona. Low-ranking of ALIGN(F) alone cannot guarantee that feature-sharing will be ruled out. Rather, UG must contain a constraint or constraints banning multiple-linking; when such constraints dominate the relevant markedness constraints (such as *LOW, *CORONAL, ALIGN(high), etc.), we have a language which does not permit multiple-linking as a means of reducing featural markedness. With the opposite ranking, multiple-linking is allowed, in order to minimize violation of featural markedness or alignment constraints.

Following Benua (1996), I assume that the constraint which penalizes multiple-linking is UNIQUE, shown in (43) below.[19]

(43) UNIQUE
$\forall x$, x a feature or class node, x must have a unique segmental anchor y.

In a language such as Shona, which permits multiple linking of features, UNIQUE is dominated by the harmony-driving constraints, as shown in (44) below.

(44) Dominated UNIQUE permits multiple-linking

/CeCiC/	ID-σ_1(high)	*MID	*HIGH	*LOW	UNIQUE	ID(high)
a.☞		*			*	*
b.		*	*!			
c.		**!				*

In candidate (44a), one violation is incurred by each Aperture node which is multiply-linked; because there is one Aperture node which is shared, one violation is assessed. By contrast,

[19] Because a language may prohibit one type of multiple linking, such as the linking of vowel features in vowel harmony, but permit another (e.g., coda place assimilation), different UNIQUE(F) constraints may be required to regulate the linking of different feature classes. This is the approach adopted in Benua (1996), where both UNIQUE(F) and UNIQUE(Class) constraints are proposed.

UNIQUE differs from earlier proposals in which multiple-linking is regulated (e.g. the Multiple Linking Constraint of Selkirk 1991a and the UNIFORM(F) constraint of Kaun 1995), in that UNIQUE is not sensitive to the featural content of the segments to which a feature is linked.

there are no UNIQUE violations in candidates (44b,c). Candidate (44a) is optimal because UNIQUE is dominated by both *MID and *HIGH; multiple linking is optimal.

Conversely, if UNIQUE » *HIGH, multiple linking will be prohibited. Under such a ranking (characteristic of a language other than Shona), candidate (44b), with the unmarked [+high] vowel in the non-privileged position, is optimal. This is shown in (45).

(45) High-ranking UNIQUE prohibits multiple-linking

/CeCiC/	ID-σ_1(high)	*MID	UNIQUE	*HIGH	*LOW	ID(high)
a.		*	*!			*
b. ☞		*		*		
c.		**!				*

Candidate (45b) is optimal, due to the absence of multiply-linked nodes; (45a) fatally violates UNIQUE. The pattern of vowel height distribution in (45b) is typical of positional neutralization without harmony: a relatively marked element is permitted in a privileged position, such as the initial syllable, but cannot be created in other positions via multiple-linking. Such patterns are common cross-linguistically, and arise from high-ranking markedness constraints, along with high-ranking UNIQUE. One example of such a system, Tamil, will be examined in detail in §2.4. In Tamil, as in Shona, mid vowels are contrastive only in root-initial syllables. However, Tamil does not permit multiple-linking of height features, by virtue of high-ranking UNIQUE.

2.4 Initial Syllable Effects in Tamil

2.4.1 Introduction

Tamil, a South Dravidian language spoken in India and Sri Lanka, illustrates a number of interesting and complex initial-syllable faithfulness effects at the level of features, and at the level of syllable structure. Tamil root-initial syllables differ from their non-initial counterparts in permitting features and/or feature combinations that may not occur non-initially. For example, though high, mid and low short vowels may occur in root-initial syllables, only high and low vowels may occur non-initially. Similarly, short round vowels are limited to initial syllables; elsewhere, only unrounded vowels occur. Finally, only initial syllable codas may have a place of articulation, one which is Coronal, which is independent from that of the following syllable onset. Codas in non-initial syllables must be homorganic to a following onset.[20]

I will argue in the following sections that each of these positional restrictions arises from the interaction of a high-ranking IDENT-σ_1 constraint with a variety of markedness constraints, and with the other faithfulness constraints provided in UG. The neutralization of vowel height distinctions, for example, is a result of the ranking IDENT-σ_1(high) » *MID » IDENT(high), just as in Shona.

The analysis of the initial/non-initial asymmetry in coda point of articulation will demonstrate the interaction of *two* types of positional faithfulness constraints. One is the familiar IDENT-σ_1(F), and the second is IDENT-ONSET(F). As we saw in Chapter 1, IDENT-ONSET(F) calls for enhanced faithfulness in syllable onsets, positions which are perceptually privileged by virtue of their release (a point originally made, for laryngeal features, in Kingston 1985, 1990).[21] Much of the acoustic information which signals the presence of contrastive consonantal features such as laryngeal state and place of articulation is carried in the segmental release burst. In coda position, where release bursts are typically absent[22], reliable cues to phonological contrast are dramatically reduced. In the positional faithfulness theory of contrast and neutralization which is proposed here, syllable onsets, which are perceptually prominent by virtue of their release burst, are a locus of enhanced faithfulness. Enhanced onset faithfulness, via IDENT-ONSET(F), has two effects. High-ranking IDENT-ONSET(F) permits a broad range of phonological contrasts in onset position, and it renders onsets resistant to many phonological processes. Codas, lacking release,

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20 There is an additional asymmetry which is discussed in Chapter 5: Initial syllables may have complex codas, but non-initial syllables are permitted only one coda consonant.

21 As noted in Chapter 1, "IDENT-ONSET" is something of a simplification here, as consonants in complex onset clusters often do not have uniform release properties. In many languages, onset consonants are released only if they precede a tautosyllabic sonorant. (See Kingston 1985, 1990 and Lombardi 1991 for discussion.) Although formulation as IDENT-RELEASE may be more precise, I will retain the nomenclature of IDENT-ONSET here, as the further subtleties of the onset vs. release distinction are not relevant in Tamil. (There are no complex onsets in the language.)

22 But see Selkirk (1982) for discussion of French, where coda consonants are released.

are accorded no special faithfulness properties; consequently, codas often display a reduced segmental inventory, relative to onsets, and often undergo assimilation. (See Lombardi 1995a,b; Padgett 1995b; Jun 1995 for recent OT applications of onset faithfulness in the analysis of assimilation and neutralization, and Steriade 1993c for related discussion of segmental release and its relevance to positional neutralization. Early works recognizing the importance of release in phonological representation include McCawley 1967 and Selkirk 1982.)

The specific positional faithfulness constraints which account for the Tamil coda asymmetries are IDENT-σ_1(Place) and IDENT-ONSET(Place).[23] These constraints favor output maintenance of underlying Place contrasts in onsets, and in root-initial syllables. Through interaction with the place markedness subhierarchy of Prince & Smolensky (1993), and with the syllable markedness constraint NOCODA (favoring open CV syllables), exactly the Tamil pattern of facts is generated. A significant result emerges from this investigation: a distinct Coda Condition on consonantal place of articulation (Itô 1986; Goldsmith 1989, 1991; Itô & Mester 1993, 1994; Lombardi 1995b) is unnecessary. The effects of the Coda Condition arise from the interaction of positional faithfulness, featural markedness and NOCODA.

The remainder of this section is organized as follows. I begin with an overview of the consonant and vowel inventories of the language, and then turn to an analysis of the positional neutralization and positionally-determined allophony in the vowel system in §2.4.3. A positional faithfulness analysis of coda consonants is presented in §2.4.4, and contrasted with markedness-based approaches to coda licensing in §2.4.5.

2.4.2 Language Background

Before considering the details of the Tamil analysis, a few words regarding the language and the data sources are in order. The primary source of data and generalizations for recent work on Tamil phonology is Christdas (1988), who describes her own dialect, spoken in the Kanniyakumari district, at the southern edge of the Indian state of Tamilnadu. Christdas' data

[23] Here I assume that constraints may regulate entire *feature classes*, though nothing crucially hinges on this assumption. See Padgett (1995a,b) for a discussion of feature classes and their role in Optimality Theoretic constraints.

form the basis of the investigation of syllable structure conducted by Schafer (1993), and for a variety of studies conducted by Wiltshire (Bosch & Wiltshire 1992; Wiltshire 1992, 1994, 1995, 1996). Christdas' forms are supplemented in the latter cases by Wiltshire's field notes, in which data are drawn from Tamil speakers native to the central and northern regions of Tamilnadu.

2.4.2.1 Segmental Inventory

Tamil, like many of the languages of India, has an elaborate consonant system in which many places of articulation are contrastive. The underlying consonant inventory, as described by Christdas (1988), is given in (46) below. Geminates (stops and non-rhotic sonorants) may also occur contrastively.

(46) Tamil consonant phonemes[24]

	Labial	Dental	Alveolar	Retroflex	Palatal	Velar
Stops	p	t5	t	?	c j	k
Contin.			s	Í		
Nasals	m		n	¯	ñ	
Laterals			l	Æ		
Rhotics			@ r~	Ä		
Approx	ä				y	

The surface inventory of segments in Tamil is somewhat more extensive. Although voicing is not contrastive in the language, voiced and partially voiced allophones of the obstruents do appear in surface representation. Additionally, there are palatalized velar sounds (represented here as post-palatal, in accord with Christdas' terminology), and nasals occur predictably at the dental and velar places of articulation. In general, the voiced continuant allophones of the stops appear intervocalically, while the voiced stop allophones occur after a nasal.

24 I have slightly modified the transcription system employed by Christdas; retroflex segments are represented with single characters, rather than with the subdot diacritic. Also, the use of underlining to indicate alveolar place of articulation has been abandoned. The bridge diacritic is used for the dental segments, and three distinct characters are used to represent the three rhotic segments.

(47) Tamil surface consonants

	Labial	Dental	Alv.	Retrofl.	Palatal	Post-Pal.	Velar	Glottal
Stops	p b	t5 d8	t d	? Î	c j	k’	k g	÷
Contin.	?	?	s	Í		ç	x	
Nasals	m	n8	n	¯	ñ		˜	
Laterals			l	Æ				
Rhotics			@ r~	Ä				
Approx.	w ä				y			

The vowel system of Tamil is relatively simple; there are five underlying vowel qualities, each of which may be long or short. The relative tenseness of the mid vowels varies with length.[25]

(48) Tamil vowels

	Front	Back
High:	i, ii	u, uu
Mid:	e, ee	o, oo
Low:		a, aa

In non-initial syllables, short /i/ and /u/ are pronounced as [I] and [}], respectively; short /a/ is realized as [é], described by Christdas (1988: 176) as fronted and non-low.[26] The short mid vowels /e/ and /o/ simply do not occur outside of the root-initial syllable. Of the long vowels, apparently only /aa/ occurs with regularity outside the initial syllable (Christdas 1988: 174).

2.4.3 Vowel Features and Positional Faithfulness

2.4.3.1 Introduction

I will begin with an analysis of vowel feature distribution in non-initial syllables, confining the discussion to the short vowel system.[27] There are two properties of the short vowel system which are of interest. First, as noted above, short mid vowels are not permitted outside of root-

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25 There appears to be a tense/lax variation correlated with length in each of the long/short vowel pairs. Wiltshire (1994, 1995, 1996) consistently transcribes /a/ as [v], /u/ as [U] and /i/ as [I] in initial syllables, and as [\], [I] and [}] elsewhere. Underlying long vowels are transcribed by Wiltshire as short, but tense: /oo/ = [o], /ii/ = [i], etc.

Increased duration is also a property of the phonologically long vowels. Balasubramanian (1980: 463) measured vowel duration for phonologically short and long vowels in a variety of syllable structures. For all of the vowels measured, the long vowel had a duration approximately twice that of the corresponding short vowel.

26 Asher (1985: 218) characterizes /a/ in final syllables as [\], "half-open to open".

27 In the absence of definitive data regarding long vowel distribution, no reliable analysis can be provided.

initial syllables in Christdas' dialect of Tamil; there are no roots which contain a non-initial *e* or *o*. While the words in (49a) are well-formed, there are no Tamil words like those in (49b).

(49)	a.	Mid vowels in σ_1 (Christdas 1988:176)		b.	No mid vowels outside σ_1
		t´@}	'street'		*tu@´
		p´@é	'room'		*pa@´
		køs}	'mosquito'		*kusø
		pø@I	'fry'		*pi@ø

Short *e* and *o* are rare or non-existent in the grammatical morphemes, as well, at least in Christdas' dialect.[28] This is clearly a categorical restriction: vowels in non-initial syllables must be drawn from the periphery of the vowel height continuum, avoiding the more marked mid vowels *e* and *o*.

In addition to positional neutralization of vowel height, the short vowels also exhibit contextual allophony: vowel variants in non-initial syllables are lax and centralized. The high back vowel, realized as round *u* in initial syllables, is unrounded *}* in non-initials. Phonemic *i* and *a* are similarly reduced; the various surface realizations of the vowels are shown in (50) below.

(50) Tamil vowel realizations

Initial σ	Non-initial σ
i	I
u	}
a	é
´	–
ø	–

This type of contextual allophony, here linked to the initial/non-initial syllable distinction, is of a different character from the sort of positional neutralization that characterizes the distribution of height features in Tamil. No contrasts are being lost or eliminated; there is simply a contextually determined variation in the realization of the vowels of the high and low vowels. I will return to a

28 Asher (1985) shows a final *e* in many of the case markings where Christdas gives underlying /ay/, surface é. Asher indicates a regional bias toward the speech of the North Arcot District of Tamilnadu, and it is not clear whether the transcriptions reflect phonemic or phonetic forms. Asher indicates that /e/ rarely occurs in word-final position for North Arcot speakers, and is frequently replaced by *a*.

There is one reliable source of non-initial *e*, even in Christdas' forms. Underlying /an/ surfaces as [e~] in phrase-final position, by virtue of a final nasal deletion process. In other dialects, this behavior is paralleled by final /am/, which surfaces as [ø~]. The coronality and labiality of the nasals are apparently absorbed by the preceding vowel under deletion or coalesence, resulting in the otherwise impermissible surface mid vowels.

discussion of this type of allophony in §2.4.3.3 below, after providing an analysis of the positional neutralization of vowel height.

2.4.3.2 <u>Positional Neutralization of Height Contrasts</u>

In Tamil, the absence of contrastive mid vowels in non-initial syllables derives from the interaction of the same faithfulness and markedness constraints which were relevant in Shona. These are repeated in (51) below.

(51) Faithfulness and markedness constraints, Tamil height system

IDENT(high)
Correspondent segments in output and input have identical values for the feature [high].

IDENT(low)
Correspondent segments in output and input have identical values for the feature [low].

IDENT-σ_1(high)
A segment in the root-initial syllable in the output and its correspondent in the input must have identical values for the feature [high].

*MID: *[–high, –low]

*HIGH: *[+high, –low]

*LOW: *[–high, +low]

Through constraint interaction, the constraints in (51) will result in the restricted distribution of mid vowels in Tamil. In this language, just as in Shona, the constraint subhierarchy which is relevant is the positional neutralization subhierarchy schematized in (52). The specific instantiation which accounts for the Tamil facts is given in (53).

(52) Positional neutralization subhierarchy, general schema
IDENT-*Position*(F) » *F » IDENT(F)

(53) Positional neutralization subhierarchy, Tamil
IDENT-σ_1(high) » *MID » IDENT(high)

The application of the ranking in (53) will be demonstrated in the following discussion.

The most basic fact to be accounted for is the free distribution of vowel height in root-initial syllables. High, mid and low vowels are all permitted in this position. This indicates that IDENT-σ_1(low), IDENT-σ_1(high) » *MID » *HIGH, *LOW; faithfulness to vowel height specifications in the root-initial syllable takes precedence over markedness considerations. Examples for each of the three heights are given in tableaux (54)-(56) below.

(54) Initial mid vowels are permitted

/te@uä/	Ident-σ_1(high)	Ident-σ_1(low)	*Mid	*High	*Low
a. ☞			*	*	
b.	*!			**	
c.		*!		*	*

Either raising (54b) or lowering (54c) of the input mid vowel will better satisfy the markedness constraint *Mid, but at the expense of the high-ranking positional faithfulness constraints. Mid vowels are therefore licit in initial syllables. As tableaux (55) and (56) show, high and low vowels are also licit in this context.

(55) Initial high vowels are licit

/ci@iy/ 'laugh'	Ident-σ_1(high)	Ident-σ_1(low)	*Mid	*High	*Low
a. ☞				**	
b.	*!		*	*	
c.	*!	*!		*	*

Here again, the ranking prohibits deviations from underlying height specifications in the initial syllable; the fully faithful (55a) is optimal. Finally, the case of an initial low vowel is illustrated in (56).

(56) Initial low vowels are permitted

/ma@am/ 'tree'	Ident-σ_1(high)	Ident-σ_1(low)	*Mid	*High	*Low
a. ☞					**
b.	*!	*!		*	*
c.		*!	*		*

As expected, the faithful (56a) is optimal. No deviations in height are permitted in root-initial syllables, regardless of the input height.

The situation in non-initial syllables is somewhat different. While high and low vowels are permitted in this position, mid vowels are not. This restriction on mid vowel distribution implicates the positional neutralization ranking shown in (57).

(57) IDENT-σ_1(high), IDENT-σ_1(low) » *MID » IDENT(high), IDENT(low)

The freedom of high and low vowels to occur in non-initial syllables derives from the ranking of IDENT(high) and IDENT(low) above the markedness constraints *HIGH and *LOW. These vowels are not positionally restricted in distribution, even following an initial mid vowel. The elaborated constraint subhierarchy in (58) will account for this distribution.

(58) IDENT-σ_1(high), IDENT-σ_1(low) » *MID » ID(high), ID(low) » *HIGH, *LOW

In the remainder of this section, I will demonstrate the consequences of (58), beginning with the restriction on mid vowels.

Just as in Shona, mid vowels are not contrastive in non-initial syllables in Tamil. This follows very simply from the ranking of *MID above IDENT(high), as shown in (59) below. (A hypothetical root is considered.)

(59) Non-initial mid vowels are prohibited

/pu@e/	IDENT-σ_1(high)	IDENT-σ_1(low)	*MID	ID(high)	ID(low)
a.			*!		
b. ☞				*	
c. ☞					*

The violation of high-ranking *MID in (59a) is fatal. Input mid vowels in non-initial syllables will surface as either high or low, depending upon the relative ranking of the context-free IDENT(high) and IDENT(low) constraints. Under such circumstances, the principle of Lexicon Optimization (Prince & Smolensky 1993) favors input representations which do not include mid vowels in non-initial syllables. In essence, the language learner will never posit inputs like that in (59). An input high or low vowel in the second syllable will always yield a more harmonic input-output mapping for such forms.

In contrast to the mid vowels, high or low vowels are permitted outside of the initial syllable. This is due to the ranking of IDENT(high), IDENT(low) above the markedness constraints *HIGH, *LOW. The consequences of the full ranking are demonstrated in (60), where the input includes a non-initial high vowel.

(60) Non-initial high vowels are permitted

/munÍiy/	IDENT-σ_1(high), IDENT-σ_1(low)	*MID	ID(high)	ID(low)	*HIGH	*LOW
a. ☞					**	
b.		*!	*		*	
c.			*!	*!	*	*

Any lowering of the input high vowel in the second syllable incurs a fatal constraint violation. Candidate (60b) violates *MID, and (60c) violates both of the context-free faithfulness constraints. There is no motivation from a higher-ranking markedness constraint to deviate from the input height specification; the fully faithful (60a) is optimal.

The behavior of non-initial low vowels is exactly parallel to that of the high vowels, as shown in (61) below.

(61) Non-initial low vowels are permitted

/ma@am/ 'tree'	IDENT-σ_1(high), IDENT-σ_1(low)	*MID	ID(high)	ID(low)	*HIGH	*LOW
a. ☞						**
b.			*!	*!	*	*

c.		*!		*		*

Here, again, full faithfulness is optimal, as there is no constraint dominating Ident(high), Ident(low) which would favor an unfaithful output.

Thus far, I have demonstrated that the constraint subhierarchy in (58) will allow high and low vowels to occur in any structural position, due to the ranking Ident(high), Ident(low) » *High, *Low. Mid vowels are also correctly permitted in initial syllables, but prohibitted in non-initial syllables. This follows from the ranking Ident-σ_1(high), Ident-σ_1(low) » *Mid » Ident(high), Ident(low). However, there is one class of candidates that has not been examined thus far: those in which the height features of a non-initial mid vowel are shared with a mid vowel in the initial syllable, as in (62) below.

(62)

This configuration is not licit in Tamil, though it is well-formed in Shona. Vowel harmony is not possible in Tamil.

The distinction between Shona, which permits height harmony, and Tamil, which does not, lies in the relative ranking of the Unique constraint. In Shona, Unique is dominated by the markedness constraints *Mid and *High, which themselves dominate Ident(high); the result (as shown in (38) above) is that feature-sharing is preferred to multiple individual vowel gestures. By contrast, Unique is high-ranking in Tamil. Sharing of vowel features is not tolerated, even if feature-sharing would reduce markedness violations. In tableau (63), I examine a hypothetical input which contains a sequence of mid vowels.

(63) High-ranking UNIQUE prohibits multiple-linking

/pe@eya/	*MID	UNIQUE	ID(low)	ID(high)	*HIGH	*LOW
a.☞	*			*	*	*
b.	**!					*
c.	*	*!				*

Candidate (63b), in which there are two independent mid vowels, incurs two violations of *MID. The remaining candidates, (63a) and (63b), tie on *MID. However, the candidate which invokes multiple linking, (63c), is ruled out by high-ranking UNIQUE.[29] Candidate (63a), which displaces an input mid vowel with an output high vowel, is optimal. Vowel harmony is not possible in this grammar.

Tamil, like Shona, is an example of positional neutralization of vowel height. Mid vowels are contrastive in initial syllables, but not in non-initial positions. This basic restriction arises from the positional neutralization subhierarchy given in (64) below.

(64) Positional neutralization of height

IDENT-σ_1(high), IDENT-σ_1(low) » *MID » IDENT(high)

The two languages differ in whether mid vowels are ever possible in non-initial syllables. In Shona, the ranking of UNIQUE below the markedness constraints *MID and *HIGH ensures that multiple-linking is possible, and in fact, required. Conversely, vowel harmony is ruled out in Tamil, due to the ranking of UNIQUE » *HIGH.

2.4.3.3 Contextual Allophony

In the preceding section, I focused on the distribution of mid vowels in non-initial syllables. Before turning to the behavior of coda consonants in Tamil, a few words concerning the contextual allophony of high and low vowels are warranted. As noted in §2.4.3.1 above, the

[29] UNIQUE must minimally dominate *HIGH in order to prohibit multiple linking; it may also dominate *MID, though there is no evidence which bears directly on this question.

high and low vowels have lax and centralized allophones in non-initial syllables. This is shown in (65) below.

(65) Tamil vowel allophones

Initial σ	Non-initial σ
i	I
u	}
a	é

The Tamil pattern of contextual allophony is similar to other patterns which are quite common crosslinguistically. While some of the contexts by which allophony is determined do overlap with the set of privileged positions, many other determinants of contextual allophony have little or no connection to phonological privilege. In many cases, the conditioning are arguably phonetic, rather than phonological, involving CV or VC coarticulation, low-level variations in duration, etc. A partial list of allophony-determining contexts is given in (66) below.

(66) Some contextual determinants of vocalic allophony

- Initial/non-initial σ (Tamil)
- Stressed/unstressed σ
- Long/short vowel (Hungarian a: vs. ø, e: vs. ´)
- Closed/open σ (Javanese)
- Preceding or following uvular C
- Preceding or following pharyngeal C
- Preceding or following retroflex C (English)

Although the context which determines the Tamil allophony shown in (65) is initial vs. non-initial syllable, this type of variation differs in several respects from the positional neutralization of the mid/non-mid contrast discussed in the preceding section. First and foremost, no phonological contrasts are being neutralized in (65); the high vs. low and front vs. back contrasts are fully maintained. Second, the vowel inventories which occur in initial and non-initial syllables do not stand in the superset/subset relation which is characteristic of positional neutralization. The (non-high) vowels which occur in non-initial syllables are *not* a relatively less marked subset of the vowels in initial syllables. Instead, they are an entirely distinct set of allophones, and arguably a more marked set. It is important to note that the reduced vowel variants which appear non-initially *cannot* appear in initial syllables. There are two different requirements imposed on the surface vowel system of Tamil: first, non-mid vowels in initial syllables must be peripheral {i, u, a}, and second, subsequent vowels must be non-peripheral {I, }, é}. No mixing of the two sets is permitted.

To see how such a pattern of allophony may be generated, I will assume that the peripheral vowels bear vowel Place features along the lines of Clements (1991), Clements & Hume (1995). Front *i* is Coronal, round *u* Labial and low *a* Pharyngeal. If the non-initial vowels are characterized by loss of Place features, the contextual variants in non-initial syllables can be generated by the ranking in (67), where *Place* is a variable over the three peripheral place features.

(67) Non-initial syllable allophony
IDENT-σ_1(Place) » *PLACE » IDENT(Place)

The application of this ranking is shown in (68).

(68) Place is prohibited in non-initial syllables

/te@uä/	IDENT-σ_1(Place)	*PLACE	IDENT(Place)
a.		*!	
b. ☞ t´@}			*

The constraint hierarchy will correctly select the place-less vowel allophones in non-initial syllables, regardless of whether the input vowels bear place or not. This is the pattern characteristic of allophonic alternations in OT; see McCarthy & Prince (1995) and Kirchner (1995) for discussion.

However, when we turn to the initial syllable allophony, a complication arises. Here, IDENT-σ_1(Place) must be dominated by some constraint *forcing* initial syllables to bear place specifications. Not only must the grammar permit vowels to have a place specification in the initial syllable, but it must prohibit placeless vowels in this position.[30] From a rich base, the constraint hierarchy must converge on outputs which have Place-ful initial syllables. An input *}*, *I* or *é* which is in the root-initial syllable must acquire a place specification, at the expense of

30 This is true even if the distinction between peripheral and non-peripheral is characterized by some means other than place features. For example, if the reduced vowels involve less articulatory effort (following recent work by Kirchner), the constraint hierarchy must include a constraint requiring more or maximal effort in initial syllables.

IDENT-σ_1(Place). This, too, is characteristic of an allophonic alternation: surface output is fixed, regardless of the input vowel quality. While the exact character of the Tamil alternation is somewhat unclear, it is instructive, as it demonstrates that positional faithfulness may be overridden by other constraints. Tamil coda consonants provide an additional example in which positional faithfulness may be dominated by other constraints in the hierarchy. It is to this example that I now turn.

2.4.4 Tamil Coda Consonants

2.4.4.1 Introduction

Turning from the relatively simple domain of vowel feature restrictions, I will now consider the distribution of coda consonants in Tamil. As we shall see, the language exhibits two overlapping but distinct patterns of coda behavior which crucially rely positional distinctions. Both patterns involve restrictions on the distribution of place features which are independently attested in other languages.

Outside of the initial syllable, Tamil codas are severely restricted; they must be homorganic to a following onset. (Both geminates and place-linked sonorants are permitted.) Illicit structures are syllabified via epenthesis. This scenario is familiar from Itô (1986, 1989) and Goldsmith (1989, 1990); Japanese and Ponapean are two languages which exhibit this pattern.

Tamil codas are also restricted in initial syllables, but less than in non-initial syllables. In particular, it is possible to have a coronal sonorant in the initial syllable coda; its place of articulation need not be shared with a following onset. This is an example not only of partial positional neutralization, but also of positional resistance to phonological processes: coronal codas in the initial syllable do not undergo place assimilation, though non-coronal segments do. Like the pattern of coda distribution in non-initial syllables, the Tamil initial-syllable facts are independently attested in entire languages. Lardil and Selayarese share this type of syllable structure, with minimally marked segments permitted in coda position.[31] The interest of Tamil

[31] Selayarese differs slightly, in that it allows only free-standing ÷ in coda position. This, too, is arguably a minimally marked segment (see Lombardi 1995b,1997 for recent discussion).

lies in the fact that it combines two different types of coda restriction, and that the distinction between the two arises from the initial/non-initial dichotomy. As we will see, positional faithfulness theory predicts exactly the Tamil pattern of behavior. Different privileged positions permit varying degrees of marked structure, and varying degrees of resistance to the process of place assimilation. Both facts arise from the interaction of positional faithfulness constraints with independently motivated featural markedness constraints.

Before turning to the details of the analysis, some background information will be helpful. Tamil permits a wide range of possible syllable shapes, ranging from a simple CV to the superheavy CVVCC. (Onsets are required, and are never complex.) There are two facts about initial syllable codas which merit attention in the context of positional faithfulness. First, only initial syllables permit a coda consonant with an independent place of articulation; in subsequent syllables, any coda segment must be homorganic to a following consonant. Examples of simplex codas with an independent place of articulation are shown in (69); *in all cases, the independent coda is a coronal sonorant*.[32,33]

(69) Independent POA[34]

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[32] Balasubramanian (1980) and Wiltshire (1995) list forms in which the initial syllable is closed by a non-coronal obstruent which is not homorganic to a following onset. (Examples: *ßvkti* ‘strength’, *bvkt\r}* ‘disciple’, *vé?ko~* ‘modesty’ (Wiltshire 1995).) These are clearly incompletely assimilated borrowings from Sanskrit. I do not know whether such forms occur in Christdas’ dialect, or how many such forms there may be.

[33] It is not clear whether the palatal *ñ* may appear freely in initial syllable codas; I have not located any forms of this type. The dental nasal appears only in syllable onsets, suggesting that the markedness of the coronals may be stratified, with apical coronals being less marked than laminals. The appearance of free-standing retroflex coronals in the initial syllable coda suggests that, at least for some languages, coronals other than the plain alveolar or dental series may regulated by the simple *CORONAL constraint (rather than a higher-ranking constraint against complex coronals). (Non-alveolar coronals are also possible in Lardil codas.) Alternatively, these distributional facts may indicate, contra the proposals of Prince & Smolensky (1993), that constraints against complex segments do not always outrank constraints against simplex segments. I will leave this issue for future research.

[34] The surface forms shown here and throughout reflect a variety of regular phonological processes tangential to our concerns. These include post-nasal voicing, intervocalic lenition (/k/ ∅ [x] or [©], /t/ ∅ [r~], /p/ ∅ [ä]) and phrase-final sonorant deletion. For an analysis of the latter, see Wiltshire (1996).

/t5eyäam/	[t5e**y**.ää̃]	'god'	PC: 230
/aa@äam/	[÷aa**@**.ää̃]	'eagerness'	PC: 231
/maa@kaÄiy/	[maa**@**.xé.ÄI]	a month	PC: 231
/munÏiy/	[mu**n**.ÏI]	'teacher'	PC: 234
/tunpam/	[tu**n**.bã]	'sorrow'	PC: 234
/na¯pan/	[n8 a**¯**.bã]	'friend'	PC: 234
/anp/	[÷a**n**.b}]	'love'	PC: 157

Second, initial syllables permit complex codas, as shown in (70); non-initial syllables may have simplex codas only.

(70) Coda clusters in initial syllables (Christdas 1988: 247)

/ayppaciy/	[÷a**y**p.pé.sI]	a month
/payt5t5iyam/	[pa**y**t5.t5I.yã]	'madness'
/aykkiyam/	[÷a**y**k.kI.yã]	'unity'
/aa@ppaa??am/	[÷aa**@**p.paa?.?ã]	'tumult'
/maa@t5t5aa¯?am/		[maa**@**t5.t5aa¯.Îã] place name
/a@t5t5am/	[÷a**@**t5.t5ã]	'meaning'
/äaaÄkkay/	[äaa**Ä**k.ké]	'life'

Though I will postpone the analysis of these complex codas until Chapter 5, one fact about the data in (70) is relevant to the discussion here. The first consonant in each of the complex codas is a coronal sonorant which is not homorganic to the following coda obstruent.

Outside of the initial syllable, Tamil employs various means of avoiding the syllabification of a coda consonant with an independent place of articulation. If C_1 in a C_1C_2 cluster is a sonorant, place assimilation is the favored strategy by which coda place is avoided. For example, if a nasal segment abuts a non-nasal by virtue of morpheme concatenation or compounding, the nasal assimilates in place of articulation; morpheme-internally, there are no heterorganic nasal+consonant sequences outside of the initial syllable.

(71) Nasal place assimilation

/ma@am + kaÆ/	[ma@é˜gé]	'trees'	PC: 192
/ma@am + t5aan/	[ma@én8d8 ã]	'tree (emphatic)'	"
/pasan8 + kaÆ/	[pasé˜gé]	'children'	CW (1995)
/ma@am # kot5t5i/	[ma@é˜køt5t5I]	'woodpecker'	PC: 193
/koÆam # t5oo¯?I/	[køÆén8 t5o¯ÎI]	'tool for dredging ponds'	PC: 192

Laterals must undergo place assimilation when they precede a coronal obstruent (72). When the following segment is a non-coronal obstruent, epenthesis occurs (73).[35]

(72) Laterals undergo place assimilation (Christdas 1988:319)

/äayal + t5aan/	[äayél5d8 ãã]	'field (emphatic)'
/kappal + t5aan/	[kappél5d8 ãã]	'ship (emphatic)'
/pat5il + t5aan/	[pat5Il5d8 ãã]	'answer (emphatic)'

(73) No assimilation to non-coronal segments (Christdas 1988:319, 331)

/äayal + kaÆ/	[äayél}ké]	'fields'
/kappal + kaÆ/	[kappél}ké]	'ships'
/pat5il + kk/	[pat5Il}kké]	'answer (dative)'
/payi@ + kaÆ/	[payI@}xé]	'crops'
/pot5a@ + kaÆ/	[pøt5é@}xé]	'bushes'
/t5amiÄ + kk/	[t5amIÄ}kk}]	'Tamil (dative)'

Epenthesis is also obligatory when rhotics concatenate with other consonants; they never assimilate, even to coronals, and generally cannot participate in linked structures (Christdas 1988: 265).

Finally, underlying obstruent+obstruent clusters are resolved via epenthesis; assimilation or segmental deletion are not possible. Some examples are given in (74).

(74) Epenthesis in obstruent + obstruent clusters

/kaat5 + kaÆ/	[kaad8 }xé]	'ears'	PC: 289
/kaat5 + kk/	[kaad8 }kk}]	'ear (dative)'	
/kamp + kaÆ/	[kamb}xé]	'sticks'	PC: 289
/kamp + kk/	[kamb}kk}]	'stick (dative)'	
/pan8 t5 + kaÆ/	[pan8 d 8 }xé]	'balls'	PC: 289
/pan8 t5 + kk/	[pan8 d 8 }kk}]	'ball (dative)'	
/kayat + kaÆ/	[kayér~}xé]	'ropes'	PC: 302
/kayat + kk/	[kayétt}kk}]	'rope (dative)'	
/kat5ap + kaÆ/	[kad8éä}xé]	'doors'	PC: 306
/kat5ap + kk/	[kad8 éä}kk}]	'door (dative)'	

There are no morpheme-internal clusters of obstruents which are not geminates.

[35] Unfortunately, Christdas provides few data which demonstrate the result of concatenating a nasal+sonorant or lateral+sonorant sequence. (C_1C_2 sequences, whether hetero- or tautosyllabic, must generally be of falling sonority, so such sonorant+sonorant combinations are not likely to syllabify as clusters in most cases.) Interestingly, an *initial* syllable ending in a lateral may precede an onset ä (all examples include the nominalizing suffix *-äiy*; Christdas 1988: 240): *kaläiy* 'education', *keeÆäiy* 'question', *tooläiy* 'defeat'. There are also two examples in which a stem-final lateral takes on the nasality of a following nasal: /uÆÆ-may/ ∅ [u¯may] 'truth', /nall-may/ ∅ [nanmay] 'goodness'. On the basis of such limited data, no conclusive analysis can be generated.

For convenience, the strategies employed in resolving illicit C_1C_2 sequences are summarized in (75) below.

(75) Summary: Syllabifying illicit consonant clusters

C_1	C_2	Result	Example
Nasal	Obstr.	Place assimilation	/ma@am+kaÆ/ ∅ ma@é˜gé
Lateral	Coronal obstr.	Place assimilation	/äayal+t5aan/ ∅ äayél5d8 ãã
Lateral	Non-coronal obstr.	Epenthesis	/äayal+kaÆ/ ∅ äayél}ké
Rhotic	Any consonant	Epenthesis	/payi@+t5aan/ ∅ payi@}d8 ãã
Any obstr.	Any consonant	Epenthesis	/kaat5+kaÆ/ ∅ kaad8 }xé

With the distributional facts firmly in hand, we can turn to an analysis of the coda asymmetries shown above. There are two basic properties of Tamil syllable structure that must be accounted for. In initial syllables, only Coronal, the least marked place, is permissible in coda position. In non-initial syllables, all places are prohibited. This dual division of initial versus non-initial, and of Coronal versus non-Coronal, is captured by the interaction of positional faithfulness with the Place markedness subhierarchy (Prince & Smolensky 1993). The restriction on non-initial codas results from the ranking in (76); no place of articulation, no matter how marked, is permitted in the coda here:

(76) Ranking for Tamil non-initial codas

IDENT-ONSET(PLACE) » *DORSAL, *LABIAL » *CORONAL » IDENT(PLACE)

Offending segments must assimilate, or be syllabified in onset position (via epenthesis). Overlaid on this positional neutralization ranking is the initial syllable constraint IDENT-σ_1(Place), dominating *CORONAL. This ranking, shown in (77), permits free-standing Coronals in just this privileged position.

(77) Ranking for all Tamil coda asymmetries

ID-ONSET(PLACE) » *DORSAL, *LABIAL » IDENT-σ_1(PLACE) » *CORONAL » IDENT(PLACE)

In the next section, echoing the discussion of onset/coda asymmetries in Chapter 1, I will show that the behavior of codas in non-initial syllables arises from the basic ranking IDENT-ONSET(PLACE) » *DORSAL, *LABIAL » *CORONAL » IDENT(Place). Then, in Section 2.4.4.3, I will demonstrate that the initial syllable behavior is captured by the simple addition of the positional faithfulness constraint IDENT-σ_1(Place), as shown in (77).

2.4.4.2 Non-initial Syllables

As the data in §2.4.4.1 demonstrate, non-initial syllables display a pattern of behavior typically attributed to the Coda Condition, a constraint forbidding coda place of articulation (Itô 1986, 1989; Goldsmith 1989, 1990; Itô & Mester 1993, 1994): consonants may not appear in a syllable coda unless they are linked to a following onset. Thus, while the range of Place contrasts permitted in syllable onset position is broad, encompassing six points of articulation, the range of Place contrasts in coda position is maximally restricted. No contrasts are permitted in non-initial codas. Coda place of articulation is predictable on the basis of the following onset consonant.

This is a pattern of positional neutralization, exactly parallel to the distribution of vowel height in Shona and Tamil. In a privileged position (here, the syllable onset), the full set of consonantal places is permitted; outside the privileged position, the value of Place is always determined by linking to the protected place features of the onset. The same basic pattern of constraint ranking that generated Shona vowel harmony will account for place-linking in Tamil codas. This basic pattern is outlined in (78) below.

(78) Neutralization schema
IDENT-*Position*(F) » **M** » IDENT(F)

In Shona, height harmony triggered by the initial syllable results from the ranking of IDENT-σ_1(high) » *MID, *HIGH » IDENT(high), where **M** = *MID, *HIGH. In Tamil, the relevant faithfulness constraints are IDENT-ONSET(Place) and IDENT(Place), as shown in (79).[36]

(79) IDENT-ONSET(Place)
A segment in the onset of a syllable and its input correspondent must have identical Place specifications.
IDENT(Place)
Correspondent segments have identical Place specifications.

[36] Here I again adopt the proposal of Padgett (1995a, b), that constraints may refer to feature classes (though I retain the geometric organization of feature classes). *Place* ranges over all of the consonantal place features.

The markedness constraint **M** of (78) is instantiated in Tamil by Prince & Smolensky's (1993) Place markedness subhierarchy, which assesses the relative markedness of consonantal place of articulation. The positional neutralization subhierarchy for Tamil is thus as in (80). (For the sake of brevity, I use *PLACE as a convenient shorthand for the Place markedness subhierarchy of *LABIAL, *DORSAL » *CORONAL. Nothing in the analysis of non-initial syllables crucially hinges on this decision.)

(80) Positional neutralization of Place in Tamil, non-initial σ
IDENT-ONSET(Place) » *PLACE » IDENT(Place)

Place-linking triggered by an onset consonant follows from the constraint ranking shown in (80). Coda consonants assimilate to the place of a following onset consonant because *PLACE » IDENT(Place); reduction of output place specifications is more harmonic than complete faithfulness to input values. By contrast, onsets trigger spreading (rather than undergoing it) because of the ranking IDENT-ONSET(place) » *PLACE. Faithfulness to onset place specifications is paramount, and takes precedence over the imperative to minimize place specifications in the output.

To illustrate the effects of (80), we turn now to the behavior of nasals in non-initial codas. Nasal + obstruent clusters which span non-initial syllables are always homorganic. This is true of both root-internal and derived clusters; examples of derived clusters are repeated in (81) below.

(81) Nasal place assimilation
/ma@am + kaÆ/ [ma@é˜gé] 'trees' PC: 192
/ma@am + t5aan/ [ma@én8d8 ã] 'tree (emphatic)' "
/pasan8 + kaÆ/ [pasé˜gé] 'children' CW (1995)
/ma@am # kot5t5i/ [ma@é˜køt5t5I] 'woodpecker'
PC: 193
/koÆam # t5oo¯?/ [køÆén8 t5o¯Î I] 'tool for
dredging ponds' PC: 192

In each case, the stem-final nasal has assimilated to the place of the following onset consonant.

One basic point is foregrounded by the data above: NOCODA, which favors open CV syllables, must be dominated by MAX, the anti-deletion constraint. Segments are not simply deleted in order to avoid a NOCODA violation; closed syllables occur quite regularly. This is shown in (82).

(82) MAX » NOCODA

/pasan8 + kaÆ/	MAX	NOCODA
a. ☞ pa.sé˜.gé		*
b. pa.sé.xé	*!	

The actually occurring (82a) incurs a violation of NOCODA, but this violation is rendered irrelevant by the dominant MAX. The opposite ranking would favor uniformly open syllables, effectively ruling out all coda consonants.

The pair of candidates in (82) provides evidence for an additional ranking: MAX » IDENT(Place). Place assimilation is preferred to segmental deletion.

(83) MAX » IDENT(Place)

/pasan8 + kaÆ/	MAX	IDENT(Place)
a. ☞ pa.sé˜.gé		*
b. pa.sé.xé	*!	

The actual surface form violates IDENT(Place), a constraint which is satisfied by candidate (83b). The IDENT(Place) violation does not matter, however, due to high-ranking MAX; (83a) is optimal.

I have so far established that MAX is high-ranking, preventing segmental deletion; I will henceforth omit MAX-violating candidates from consideration. But why is (83a), *pa.sé˜.gé*, preferred to a candidate *pa.sén8 .gé*, which satisfies both MAX and IDENT(Place)? Some constraint or constraints, dominating IDENT(Place), must favor place assimilation. The relevant set of constraints can be found in the place markedness subhierarchy of Prince & Smolensky (1993):

(84) Place markedness subhierarchy[37]
*DORSAL, *LABIAL » *CORONAL

[37] Prince & Smolensky (1993) do not impose a ranking on *LABIAL and *DORSAL, and there is no evidence in the phonology of Tamil coda syllabification to suggest any relative ranking. Consequently, I leave the constraints unranked throughout; nothing crucial hinges on this decision.

The ranking in (84) is arguably universal, and favors Coronal over the more marked Labial and Dorsal articulations. The effects of this ranking frequently emerge in situations of epenthesis, where coronal consonants are more common than either labial or velar segments.[38] Reflexes of place markedness are also apparent when the subhierachy is sandwiched in between two distinct faithfulness constraints, such as MAX$_{IO}$ and MAX$_{BR}$ in cases of reduplication[39], or (as in Tamil), between IDENT-ONSET(Place) and IDENT(Place). In the latter case, the ranking IDENT-ONSET(Place) » *DORSAL, *LABIAL » *CORONAL » IDENT(Place) accounts for the mutability of coda consonants (and the invariance of onset consonants).

Proceeding in step-wise fashion, let us begin at the bottom of the Tamil constraint subhierarchy. The dominance of the place markedness constraints over IDENT(Place) will favor place-sharing between coda and onset (just as the ranking of *MID and *HIGH over IDENT(high) favors height-sharing in Shona). Consider the candidates in tableau (85) below. (Hereafter, *PLACE violations will be indicated segmentally, to aid in reading the tableaux.)

(85) *PLACE » IDENT(Place)

/pasan8 + kaÆ/	*LAB	*DORS	*COR	IDENT(Place)
a. ☞ pa.sé˜.gé	p	˜g	s	*
b. pa.sén8 .gé	p	g	s, n8 !	

Each independent place specification receives one violation mark for the relevant *PLACE constraint, according to the principle of Feature-Driven Markedness (see (32) above). Therefore, the independent Coronal place of articulation of the coda consonant in the fully faithful (85b) incurs a fatal violation of *CORONAL. The place assimilation in (85a) avoids this violation, by reducing the Coronal, Dorsal sequence of input /n8 -k/ to a single output Dorsal specification. The IDENT(Place) violation which results from place assimilation is irrelevant, due to the subordination of this constraint to the place markedness subhierarchy.

[38] Lombardi (1995b,1997) argues that (84) should be amended to include lowest-ranking *PHARYNGEAL. One fact that such an amendment can capture is the preponderance of epenthetic ÷ cross-linguistically. Pharyngeal, being the least-marked place of articulation, is the epenthetic segment *par excellence*.
[39] See Alderete *et al.* (1996) for the application of this idea to reduplicative segmentism in Tübatulabal and Nancowry.

As (85) shows, the ranking of *DORSAL, *LABIAL » *CORONAL » IDENT(Place) favors assimilation, rather than a faithful output rendering of all input places. However, the ranking in (85) does not successfully select between the actual surface form (85a) and another possible alternative, *pa.sén8 .d8 é*. In this candidate, place assimilation results in removal of an offending *DORSAL violation, in favor of a less-marked Coronal cluster. Such a candidate would be favored by the constraint subhierarchy of (85), but it is not the actually occurring form.

The forms in question, *pa.sé˜.gé* (85a) and *pa.sén8 .d8 é* both exhibit nasal place assimilation, but they differ in the *direction* of assimilation. In the actual Tamil form, *pa.sé˜.gé* a *coda* consonant assimilates to the following onset; in the unattested *pa.sén8 .d8 é*, the *onset* assimilates to the preceding coda. It is the subordination of the onset's place features to those of the preceding coda in *pa.sén8 .d8 é* which is fatal to such a candidate. Padgett (1995b) reminds us that place assimilations typically proceed from onset to coda; the features of the released segment are preferentially maintained in output forms. In the theory of positional faithfulness developed here, this finding can be incorporated naturally: onset features are preserved, by virtue of high-ranking IDENT-ONSET(Place). As Padgett (1995b) observes, the direction of spreading, from onset to coda, is a natural consequence of the faithfulness asymmetry between onsets and codas, and need not be stipulated independently.

IDENT-ONSET(Place), ranked above the place markedness subhierarchy, accounts for the optimality of (85a) (as well as the non-optimality of a maximally unmarked candidate such as *ta.sén8 .d8 é*, which contains only Coronal consonants). This is shown in (86) below.

(86) IDENT-ONSET(Place) » *PLACE » IDENT(Place)

/pasan8 + kaÆ/	ID-ONSET(Place)	*LAB	*DORS	*COR	IDENT(Place)
a. ☞ pa.sé˜.gé		**p**	**˜g**	**s**	*
b. pa.sén8 .d8 é	*!	**p**		**s, n8d8**	*
c. ta.sén8 .d8 é	**!			**t, s, n8d8**	**

High-ranking IDENT-ONSET prevents wholesale changes in onset place of articulation, initiated in the interest of minimizing markedness, as in (86c). More to the point, it also prevents the coda-to-onset assimilation of (86b). The ranking in (86) has the result that *only* coda segments may undergo assimilation, as in (86a). It should be clear from the preceding discussion that the ranking in (86) will compel place-sharing for any nasal+obstruent cluster, regardless of the nasal's input place specification.

The ranking of IDENT-ONSET(Place) » *PLACE ensures that onset place specifications are not lost in order to satisfy the imperative for minimal markedness. Optimality Theory, with its focus on free ranking permutation, predicts that the opposite ranking is possible: *PLACE » IDENT-ONSET(Place). However, this ranking seems not to be attested; there is no language in which onset contrasts are neutralized to glottal stop or a minimally marked coronal consonant, though this is the pattern predicted by such a ranking. Speakers of such a language would presumably be at a considerable communicative disadvantage. In light of such extra-grammatical considerations, I assume that the ranking IDENT-ONSET(Place) » *PLACE is fixed in UG.

Harkening back to the earlier discussion of prohibitions on multiple-linking, I pause now to consider the relative ranking of UNIQUE in the grammar of Tamil as a whole. This constraint militates against multiply-linked features in autosegmental representation. The vowel height features in Tamil are not permitted to be multiply linked; there is no height harmony or feature sharing in the vowel system of this language. As I argued above, UNIQUE must dominate the height markedness constraints *HIGH and *LOW, in order to prohibit multiple linking of an mid vowel to subsequent syllables. However, in the consonant system, multiple linking of place features is permitted. UNIQUE is violated in order to achieve better satisfaction of the *PLACE constraints, indicating that *LABIAL, *DORSAL » *CORONAL » UNIQUE.

(87) *PLACE » UNIQUE

/pasan8 + kaÆ/	ID-ONS(Place)	*LAB	*DORS	*COR	UNIQUE	ID(Place)
a. ☞ pa.sé˜.gé		p	˜g	s	*	*
b. pa.sén8 .xé		p	x	s, n8 !		*

UNIQUE must be dominated by *CORONAL, and by transitivity of ranking, *LABIAL and *DORSAL, in order to ensure that (87a) is optimal. The vowel height markedness constraints

*HIGH and *LOW are ranked below UNIQUE in the constraint hierarchy; the result being permissible multiple linking of consonantal place features, but not of the vowel height features.

Two questions remain to be answered before we move on to the treatment of non-nasal segments: What is the relative ranking of MAX and the place markedness subhierarchy, and where does the anti-epenthesis constraint DEP fit into the ranking developed thus far? Just as MAX must dominate NOCODA (82), MAX must also dominate the *PLACE constraints; the opposite ranking would favor segmental deletion as a means of achieving minimal markedness.

(88) MAX » *PLACE

/pasan8 + kaÆ/	MAX	*LAB	*DORS	*COR	IDENT(Place)
a. ☞ pa.sé˜.gé		**p**	**˜g**	**s**	*
b. pa.sé.xé	n8 !	**p**	**x**	**s**	

The reverse ranking, *PLACE » MAX, favors (88b), and even more radically reduced candidates.

The answer to the second question cannot be determined by examining nasal codas. Comparing a hypothetical candidate such as *pa.sé.n8 }.xé*, where epenthesis occurs, with the actual output form (88a), there is no valid ranking argument to be drawn. The epenthesis candidate incurs two constraint violations that the real form does not. This is shown in (89), where DEP is arbitrarily displayed in the ranking.

(89) No ranking of DEP and *PLACE

/pasan8 + kaÆ/	DEP	*LAB	*DORS	*COR	IDENT(Place)
a. ☞ pa.sé˜.gé		p	˜g	s	*
b. pa.sé.n8 }.xé	*!	p	x	s, n8!	

Even if DEP were dominated by the place markedness subhierarchy, the additional *CORONAL violation incurred by (89b) would be fatal. In order to determine the ranking of DEP, we must turn our attention to the behavior of lateral and obstruent segments.

Recall that the laterals assimilate to following coronal obstruents, but not to other places of articulation. This selective assimilation can be attributed to high-ranking feature cooccurrence constraints. In Tamil, as in most languages of the world, non-coronal laterals are not permitted.[40] This restriction on the inventory of segments can be enforced by the constraints LATCOR and IDENT(lateral) in (90) below.

(90) LATCOR
[lateral] ∅ [Coronal]
"Lateral segments must be Coronal."[41]

IDENT(lateral)
An input segment and its output correspondent must agree in their specification of the feature [lateral].

LATCOR and IDENT(lateral) must dominate all of the place faithfulness constraints in order to ensure that an input velar lateral is mapped on to an output coronal lateral, as in (91). ("L" represents a velar lateral.)

(91) LATCOR, IDENT(lateral) » IDENT-ONSET(Place) » IDENT(Place)

/La/	LATCOR	IDENT(lateral)	IDENT-ONSET(Place)	IDENT-(Place)
a. La	*!			
b. ☞ la			*	*
c. ˜a		*!		

LATCOR must dominate IDENT-ONSET(Place), and by transitivity of ranking, the place markedness subhierarchy. This will prevent place assimilation to a non-coronal obstruent, as shown in (92) below for the input /äayal + kaÆ/, 'fields'. High-ranking IDENT-ONSET will rule out assimilation of the obstruent to the lateral.

(92) Assimilation to a non-Coronal is prohibited

/äayal + kaÆ/	LATCOR	ID(lat)	ID-ONS(Place)	*LAB, *DORS	*COR	ID(Place)
a. 💣 äa.yél.gé				**ä, g**	**y,l**	
b. äa.yéL.gé	*!			**ä, Lg**	**y,**	*
c. äa.yél.dé			*!	**ä**	**y, ld,**	*
d. äa.yé˜.gé		*!		**ä, ˜g**	**y**	*

Each of candidates (92b-d) is ruled out by a high-ranking constraint, leaving (92a) as the optimal form. However, (92a) is not the actually occurring surface form in this case. Rather, epenthesis occurs, yielding *äa.yé.l}.xé*. This candidate and (92a) fare equally well with respect

[40] Contrastive velar laterals have been reported for a handful of languages in New Guinea (Melpa, Mid-Waghi, Kanite and Yagaria), Africa (Kotoko) and North America (Comox) (Ladefoged & Maddieson 1996).
[41] Dickey (1996) argues that laterals are complex [Coronal, Dorsal] sounds, rather than [lateral] segments. It is unclear how the effects of the implicational constraint in (90) can be captured in such a theory.

to the place markedness subhierarchy, but differ with respect to two other constraints: NOCODA and DEP. The relevant violations are shown in the chart in (93) below.

(93) NOCODA is relevant in selecting the optimal candidate

Candidate	*DORS	*LAB	*COR	NOCODA	DEP
äa.yél.gé	**g**	**ä**	**y, l**	*	
äa.yé.l}.xé	**x**	**ä**	**y, l**		*

The two candidates tie on each of the *PLACE constraints, making these constraints irrelevant to the choice of the optimal candidate. This leaves NOCODA and DEP, and here there is a clear ranking argument to be made here: NOCODA » DEP. When high-ranking LATCOR and IDENT-ONSET(Place) conspire to prevent place assimilation, as in the case at hand, epenthesis is the result. Insertion of non-underlying material is tolerated in order to achieve less marked syllable structure. However, the relative ranking of NOCODA and DEP with respect to the place markedness subhierarchy cannot be determined.

The preceding discussion has demonstrated that epenthesis is preferred when place assimilation cannot occur. However, the constraint hierarchy in (92) does allow for place assimilation when a sequence of lateral+coronal obstruent occurs in the input. This case will also provide an argument for the ranking of NOCODA with respect to the place markedness subhierarchy: NOCODA must be dominated by *CORONAL, and by transitivity of ranking, by *LABIAL and *DORSAL. The reduction of place markedness via multiple linking takes precedence over the achievement of open syllables. Because epenthesis does not reduce place markedness, it is dispreferred when place assimilation is possible, *even though the anti-epenthesis constraint DEP is ranked below NOCODA.* This is shown in (94) below.

(94) Assimilation to a Coronal obstruent is required

/äayal + t5aan/	LATCOR	ID-ONS	*LAB, *DORS	*COR	NOCODA	DEP	ID(Place)
a. ☞äa.yél5.d8 ãã			ä	y,l5d8	*		
b. äa.yé.l}.d8 ãã			ä	y, l, d8 !		*	

Candidate (94b) fares better on NOCODA than (94a), but worse on *CORONAL. The optimality of (94a) indicates that *CORONAL » NOCODA.

Thus far, the analysis has accounted for the behavior of nasals and laterals which are followed by obstruents in the input. (The rhotics and the sonorants *ä* and *y* never assimilate to a following obstruent, probably due to a combination of restrictions on place/stricture and syllable contact interactions. See Padgett 1991 for relevant discussion.) The following ranking relationships have been established:

(95) Interim ranking summary

Now we turn our attention to C_1C_2 sequences in which the segments are of equal or falling sonority; that is, sequences of two obstruents, two sonorants, or an obstruent followed by a sonorant. Such sequences can never be syllabified as coda and onset, regardless of their place of articulation; even homorganic clusters such as *nl*, *¯Æ*, etc. cannot be successfully syllabified. Christdas (1988) attributes this gap in the inventory of coda-onset sequences to the Syllable Contact Law (Hooper 1976, Murray & Vennemann 1983, Clements 1990). A formulation is provided in (96) below.

(96) SYLLABLE CONTACT LAW (SCL)
In a sequence $VC_1.C_2V$, the sonority value of C_1 = the sonority value of C_2

A full formulation of SCL in within Optimality Theory would take us far beyond the scope of this dissertation.[42] For the purposes of expediency, I will adopt (96), with the additional provision that sequences of consonantal root nodes are the relevant units over which SCL is evaluated. Geminates, which are underlyingly moraic consonants with a single root node, vacuously satisfy SCL.[43] (I assume that *Gen* admits only one basic geminate structure, the single-root representation. No "pseudogeminates" like (97) are possible. To my knowledge, there are no theories of geminate structure which allow both single-root and two-root geminates to coexist.)

(97) Impermissible pseudogeminate

[42] The interested reader is referred to the pre-OT work of Clements (1990), and to Prince & Smolensky (1993) for related proposals and discussion.
[43] The single-root theory of geminates accounts for their unexceptional behavior with respect to SCL. But see Selkirk (1990) for an alternative view of geminate structure which assumes two root nodes.

In Tamil, SCL is never violated; the constraint must enter the realm of the high-ranking, along with MAX, LATCOR and IDENT(lateral). Crucially, SCL dominates both the *PLACE subhierarchy and DEP, and is dominated by MAX. Such a ranking will force epenthesis, rather than deletion, as a means of satisfying SCL, even at the expense of the *PLACE constraints. This will account for data such as those in (98), repeated from (74) above.

(98) Epenthesis in obstruent + obstruent clusters

/kaat5 + kaÆ/	[kaad8 }xé]	'ears'	PC: 289
/kaat5 + kk/	[kaad8 }kk}]	'ear (dative)'	
/kamp + kaÆ/	[kamb}xé]	'sticks'	PC: 289
/kamp + kk/	[kamb}kk}]	'stick (dative)'	
/pan8 t5 + kaÆ/	[pan8 d 8 }xé]	'balls'	PC: 289
/pan8 t5 + kk/	[pan8 d 8 }kk}]	'ball (dative)'	
/kat5ap + kaÆ/	[kad8éä}xé]	'doors'	PC: 306
/kat5ap + kk/	[kad8 éä}kk}]	'door (dative)'	

The occurrence of epenthesis in this context is required by the constraint ranking illustrated in tableau (99) below.

(99) Epenthesis in obstruent+obstruent sequences

/kat5ap+kaÆ/	MAX	SCL	ID-ONS	*LAB, *DORS	*COR	NOCODA	DEP	ID(Place)
a. ☞ ka.d8é.ä}.xé				**k, ä, x**	**d8**		*	
b. ka.d8ép.ké		*!		**k, p, k**	**d8**	*		
c. ka.d8 é.xé	*!			**k, x**	**d8**			

SCL correctly favors (99a) over the candidates in (99b,c). This comparison is not very interesting, however, because (99b) would lose to (99a) on the basis of NOCODA, even if SCL were low-ranking. The more interesting comparison is between (99a) and another candidate, *ka.d8 ék.ké*. In this candidate, underlying /k/ has been geminated via deletion of the input /p/, as shown in (100) below.

(100) Derived geminate

The derived geminate structure in (100) is a poor candidate because it violates MAX, a constraint that is otherwise respected in the language. (It also neutralizes a distinction between geminate and singleton consonants. While such alternations do occur in Tamil, they are restricted to a small number of morphological contexts; the weight distinction is not subject to phonological neutralization.) Consider the array of candidates in (101) below, where (101b) = (100).

(101) Gemination and deletion are non-optimal

/kat5ap+kaÆ/	MAX	SCL	ID-ONS	*LAB, *DORS	*COR	NOCODA	DEP	ID(Place)
a. ☞ ka.d8é.ä}.xé				**k, ä, x**	**d8**		*	
b. ka.d8ék.ké	*!			**k, kk**	**d8**	*		
c. ka.d8 é.xé	*!			**k, k**	**d8**			
d. ka.d8ép.ké		*!		**k, p, k**	**d8**	*		

Comparing candidates (101b,c), it is clear that (101c) would be favored if segmental deletion were a possible means of resolving SCL violations. The failure of both (101b) and (101c), and the success of (101a), confirms the ranking of MAX and SCL above the place markedness subhierarchy.

The final case to be considered is that of an input sonorant+sonorant sequence. Such sequences are resolved via epenthesis, just as obstruent+obstruent clusters are; this is due to high-ranking SCL. A hypothetical example is examined in (102) below.

(102) Hypothetical: sonorant + sonorant cluster

/kat5am+laÆ/	MAX	SCL	ID-ONS	*LAB, *DORS	*COR	NOCODA	DEP	ID(Place)
a. ☞ ka.d8é.m}.lé				**k,m**	**d8 ,l**		*	
b. ka.d8én.lé		*!		**k**	**d8 , nl**	*		*
c. ka.d8 é.lé	*!			**k**	**d8 , l**			
d. ka.d8ém.lé		*!		**k, m**	**d8 , l**	*		

This example shows clearly that SCL must dominate the place markedness subhierarchy. The opposite ranking, with *LABIAL, *DORSAL » SCL, would favor candidate (102b), in which the coda nasal assimilates to the following sonorant. Such sequences of sonorants do not occur in Tamil.

To sum up the results of this section, I have shown that the prohibition on independent place specifications in coda position results from the asymmetry between onset and coda faithfulness, which are separately assessed via IDENT-ONSET(Place) and IDENT(Place). Place assimilation derives from the ranking of the place markedness subhierarchy above IDENT(Place). *PLACE » IDENT(Place) yields place assimilation when possible; that is, when neither LATCOR nor SCL is violated. The high-ranking positional faithfulness constraint

IDENT-ONSET(Place) favors maintenance of contrastive information in onset position, meaning that codas are the targets (rather than the triggers) of place assimilation in such circumstances. Finally, under domination of MAX, the ranking *PLACE » DEP will result in epenthesis when assimilation is blocked. The final ranking summary for non-initial syllables is shown in (103) below.

(103) Final ranking summary

This set of constraints, crucially incorporating the positional faithfulness constraint, IDENT-ONSET(Place), is responsible for the patterns of coda assimilation and epenthesis which characterize non-initial syllables in Tamil. Minimization of place markedness is paramount—wherever possible, place assimilation occurs. In the event that assimilation is impossible, epenthesis occurs, resulting in less marked CV syllables. In the next section, I will show that the positional faithfulness constraint IDENT-σ_1(Place) interacts with the system in (103) to generate the independent Coronal place which is permitted in the coda of a root-initial syllable.

2.4.4.3 Initial Syllable Codas

In the preceding section, I established that the distribution of coda place features in non-initial syllables results from a prototypical positional neutralization ranking, as shown in (104).

(104) Positional neutralization of place distinctions, Tamil non-initial codas
IDENT-ONSET(Place) » *DORSAL, *LABIAL » *CORONAL » IDENT(Place)

Now we turn to initial syllable codas, whose behavior will be unified, via constraint ranking, with that of codas in non-initial syllables. Like non-initial syllables, root-initial syllables in Tamil display an asymmetry in the segmental inventory permitted in onset and coda position. In initial syllables, some, but not all, places of articulation may occur independently in codas; in particular, free-standing coronal sonorants may occur in this position. As we have seen, codas in non-initial syllables are restricted to consonants which are homorganic to a following onset. The onset/coda and initial/non-initial asymmetries are summarized in (105) below.

(105) Two levels of distributional asymmetry in Tamil

Initial σ		Non-initial σ	
Onset	Coda	Onset	Coda
• All consonants	• C homorganic to following onset • Coronal sonorant	• All consonants	• C homorganic to following onset

The coda inventory in root-initial syllables is a more marked superset of the coda inventory in non-initial syllables: initial syllable codas may include an independent coronal place. This is literally more marked, as the coronal consonant in question will incur an additional *CORONAL violation not assessed to a coda which shares its place with the following onset.

This type of markedness asymmetry, with more marked elements being permitted in a privileged position, but not elsewhere, is a familiar diagnostic of positional neutralization. The Tamil pattern, involving an overlap of onset/coda and initial/non-initial asymmetries, is more complex than others we have examined thus far. However, this pattern is exactly what is predicted by positional faithfulness theory: high-ranking IDENT-σ_1(Place), dominating some markedness constraint, leads to the occurrence of more marked structure in root-initial syllables. Specifically, IDENT-σ_1(Place) fits into the ranking of (104) as shown in (106) below.

(106) Initial syllable faithfulness
ID-ONSET(Place) » *DORS, *LAB » **IDENT-s $_1$(Place)** » *CORONAL » ID(Place)

In the remainder of this section, I will demonstrate the application of the ranking in (106).

Representative examples of initial syllable codas are repeated in (107). Coda segments which bear an independent coronal place of articulation appear in boldface.

(107) Coda clusters in initial syllables (Christdas 1988: 247)

/ayppaciy/	[÷a**y**p.pé.sI]	a month
/payt5t5iyam/	[pa**y**t5.t5I.yã]	'madness'
/aykkiyam/	[÷a**y**k.kI.yã]	'unity'
/aa@ppaa??am/	[÷aa**@**p.paa?.?ã]	'tumult'
/maa@t5t5aa¯?am/	[maa**@**t5.t5aa¯.Îã]	place name
/a@t5t5am/	[÷a**@**t5.t5ã]	'meaning'
/äaaÄkkay/	[äaa**Ä**k.ké]	'life'

(108) Independent POA

/t5eyäam/	[t5e**y**.äã]	'god'	PC: 230
/aa@äam/	[÷aa**@**.äã]	'eagerness'	PC: 231
/maa@kaÄiy/	[maa**@**.xé.ÄI]	a month	PC: 231
/munÍiy/	[mu**n**.ÍI]	'teacher'	PC: 234
/tunpam/	[tu**n**.bã]	'sorrow'	PC: 234
/na¯pan/	[n8 a¯.bã]	'friend'	PC: 234
/anp/	[÷a**n**.b}]	'love'	PC: 157

The positional neutralization subhierarchy given in (106) is exactly what is needed to generate both the basic pattern of non-initial codas, illustrated in §2.3.4.2, and the more intricate facts of the root-initial syllables. Initial syllable codas are able to resist coda assimilation, while non-initial codas may not. This disparity calls for the initial-syllable faithfulness constraint shown in (109) below.

(109) IDENT-σ_1(Place)

Segments in the initial syllable of the output and their input correspondents must have identical Place specifications.

Through constraint ranking, IDENT-σ_1(Place) is able to provide a straightforward explanation of two asymmetries in Tamil. First, the separability of IDENT-σ_1(Place) and the context-free IDENT(Place) permits various markedness constraints, such as *CORONAL, to intervene in the ranking. This yields different levels of markedness in the two syllabic domains, initial and non-initial, with initial syllables permitting more marked structure than non-initials.

In addition, the intervention of IDENT-σ_1(Place) in the midst of the place markedness subhierarchy accounts for the Coronal restriction on initial syllable codas: *LABIAL, *DORSAL » IDENT-σ_1(Place) » *CORONAL. Labial and dorsal codas are prohibited in initial syllables, just as they are in subsequent positions. Codas which bear the minimally marked coronal place, however, are permitted, due to the ranking IDENT-σ_1(Place) » *CORONAL. The expansion of the initial syllable coda inventory to include only coronal is exactly what we expect, given a fixed universal ranking of place markedness in which coronal occupies the bottom rung. The effects of this ranking are shown in (110) and (111) below.

Through domination of *CORONAL, (109) will permit free-standing coronal place in the coda of a root-initial syllable. This is demonstrated in (110). (Recall that the Syllable Contact Law requires codas to be higher in sonority than following onset consonants, meaning that free-standing coronal obstruents will not be possible, even in initial syllables. The SCL is not shown in the following tableaux.)

(110) Coronal place is permitted

/tunpam/	ID-ONS	*LAB	*DORS	IDENT-σ_1(Place)	*COR	ID(Place)
a. ☞ tun.bã		b			**t, n**	
b. tum.bã		mb		*!	**t**	*

The initial syllable identity constraint correctly rules out candidate (110b), in which coda assimilation occurs. Because IDENT-σ_1(Place) » *CORONAL, faithfulness to the input coronal specification takes precedence over markedness reduction. Independent coronal in the coda is preferred to assimilation.[44]

Now consider the case of a non-coronal coda consonant, shown in (111). The positional faithfulness hierarchy of (110) will correctly require place assimilation in such a case.

(111) Labial or dorsal place is prohibited

/mam-kal/	ID-ONSET	*LAB	*DORS	ID-σ_1(Place)	*COR	ID(Place)
a. mam.gé		m,m!	g			
b. ☞ ma˜.gé		m	˜g	*		*

Although place assimilation in candidate (111b) incurs a violation of IDENT-σ_1(Place), the violation is irrelevant, due to the ranking *LABIAL, *DORSAL » IDENT-σ_1(Place). Labial and dorsal segments are not possible codas in the initial syllable.

I have shown in the discussion above that a number of complex interactions among syllabification, place of articulation and positional prominence in Tamil are captured via constraint ranking. The various positional effects and the constraint rankings which generate them are summarized in (112) below.

44 The candidate *tu.m}.äã*, with epenthesis into the root, is not shown here. By the ranking NOCODA » DEP established in the preceding section, such a candidate should be favored over the actual surface form, *tun.bã*. For discussion of these candidates and the relevant constraint which favors *tun.bã*, see Chapter 5.

(112) Summary: Positional effects in Tamil syllabification

a. Coda in non-initial σ shares place with a following onset:
*LAB,*DOR » *COR » ID(Place)

b. Coda in σ_1 can have independent coronal place:
IDENT-σ_1(Place) » *COR

c. Coda in σ_1 shares Lab/Dor with following onset:
*LAB,*DOR » ID-σ_1(Place) » *COR » ID(Place)

d. Codas (not onsets) undergo assimilation:
ID-ONSET(Place) » *LAB,*DOR » *COR » ID(Place)

Each of these effects is predicted by Positional Faithfulness Theory; separate constraints which assess faithfulness in privileged positions may be ranked above various markedness constraints, yielding a pattern of marked segments in privileged positions, but not elsewhere.

In the following section, I will consider an alternative approach to positional asymmetries in markedness. This is the familiar positional licensing analysis of coda place restrictions, which employs the Coda Condition of Itô (1986, 1989). We will see that the Coda Condition is redundant in a theory which includes Prince & Smolensky's place markedness subhierarchy. Furthermore, the Coda Condition alone cannot characterize positional effects such as the preference for onset-to-coda spreading in place assimilation. Positional faithfulness constraints are required to provide a full account of common patterns of onset/coda interaction.

2.4.4.4 Analytic Alternatives: Positional Licensing

As an alternative to positional faithfulness theory, we may consider a positional licensing analysis of onset/coda asymmetries. As discussed in Chapter 1, the positional licensing view of weak coda licensing, embodied in the work of Itô (1986, 1989), Goldsmith (1989, 1990), Lombardi (1991), Wiltshire (1992), Bosch & Wiltshire (1992), and Itô & Mester (1993, 1994), assumes that place specifications are prohibited or severely restricted in coda position. There are two basic implementations of positional licensing theory. The first, proposed in Itô (1986, 1989), is a negative constraint which prohibits coda place specifications. This is the Coda Condition shown in (113).

(113) Coda Condition (CODACOND)

In Itô's (1986, 1989) application of the Coda Condition, a feature which is linked to both coda and onset is exempt from the constraint, by virtue of Hayes' (1986b) Linking Constraint. Later formulations derive this effect by formulating the Coda Condition as a feature-to-syllable alignment constraint, where the onset affiliation of the multiply-linked place specification satisfies a requirement for alignment of consonantal place features at the left edge of a syllable (Itô & Mester 1994).

The well-formedness of such linked configurations is granted without special machinery by the Prosodic Licensing approach to positional asymmetries, developed in Goldsmith (1989, 1990), Wiltshire (1992) and Bosch & Wiltshire (1992). (See also the positive licensing formulation of laryngeal constraints in Lombardi 1991, explored in Chapter 1.) Prosodic Licensing theory characterizes onset/coda asymmetries in licensing by means of syllable templates which incorporate positive licensing statements. In languages such as Tamil, in which codas may not bear an independent place specification, the coda position in the syllable template is endowed with only limited licensing capabilities. The onset, by contrast, licenses a full range of features. A typical syllable template for such a language is shown in (114) below.

(114) Weak coda licensing, Prosodic Licensing theory

In this theory, a feature need only be licensed, through association, by *some* element in the prosodic structure; the feature need not be licensed by *every* segment to which it is associated. Association to an onset is sufficient to license a place specification which is shared with a preceding coda, though the coda itself cannot license place features.

Abstracting away from the various formal differences between the negative licensing of the Coda Condition and the positive statements of Prosodic Licensing theory, the core notion in both approaches is the same: certain marked features, such as place of articulation, are not licensed in coda position. My chief concern here is with an OT implementation of positional markedness, whether the relevant constraints are formulated in positive or negative terms. Having explored the positive formulation of positional licensing in the discussion of Catalan voicing in Chapter 1, I will examine the negative, CODACOND approach in subsequent discussion. However, the flaws encountered by the negative, CODACOND formulation are also found in a positive licensing analysis, as we have seen. Licensing theory alone cannot account for the pervasive onset-to-coda direction of spreading in place assimilation contexts; it requires only that a place feature be associated to some onset position. The origin of the place feature in question is irrelevant in licensing theory; either progressive or regressive assimilation results in a well-formed structure. By contrast, positional faithfulness constraints predict that spreading will proceed from onset to coda, because the features of the onset are preferentially maintained. Directionality follows from positional faithfulness, but must be stipulated in licensing theory.

Assuming an OT formulation of CODACOND in the spirit of Itô (1986, 1989), in which multiply-linked place specifications satisfy CODACOND, let us consider the role of CODACOND in the grammar of Tamil. I will first focus on the distribution of place features in non-initial syllables. Recall that Tamil non-initial syllables may not have independent place features; nasal codas assimilate to a following onset in order to avoid an independent coda place of articulation. This suggests that CODACOND » IDENT(Place). Furthermore, the fact that assimilation is preferred to either epenthesis or deletion in Tamil indicates that MAX, DEP » IDENT(Place). Consider the tableau in (115).

(115) Preliminary ranking: MAX, DEP, CODACOND » IDENT(Place)

/pasan8 + kaÆ/	MAX	DEP	CODACOND	IDENT(Place)
a. ☞ pa.sé˜.gé				*
b. pa.sé.xé	n8			
c. pa.sén8 .gé			n8	
d. pa.sé.n8 }.xé		}		

CODACOND is successful in distinguishing among the candidates in (115).

However, there is an additional candidate with place assimilation which must be considered, as shown in (116).

(116) Onset assimilation is favored by the grammar

/pasan8 + kaÆ/	Max	Dep	CodaCond	Ident(Place)
a. ☞ pa.sé˜.gé				*
b. ☞ pa.sén8 .d8 é				*

The CodaCond grammar has no means of choosing between the actual surface form (116a), and the alternative (116b), in which the onset /k/ has assimilated to the coda's place of articulation. Furthermore, if we consider place markedness, (116b) is arguably optimal, as it contains a Coronal cluster, rather than a more marked dorsal. If the burden of evaluation is placed squarely on the shoulders of the place markedness subhierarchy, the results will be disastrous for the language as a whole. This is because the markedness subhierarchy will favor the least marked configuration in every case, with no regard for direction of spreading. In order to prevent such an outcome, the features of the onset must take precedence over the features of the coda—we need Ident-Onset(Place). Thus, even if CodaCond is available in the grammar, positional faithfulness is absolutely essential in deriving the correct outputs. Any positional markedness approach which denies licensing of place in codas cannot account for the directionality of assimilation in cases like Tamil without adopting the positional faithfulness constraint Ident-Onset(Place).[45]

2.5 Conclusions

Root-initial syllables have a privileged status in human language processing; they play a key role in lexical access, speech production and lexical storage. Being salient in this way, root-initial syllables are equipped to convey a wide range of marked features and segments. In this chapter, I have argued that this perceptual salience is exploited directly in the phonological component of the grammar, by means of positional faithulness constraints which assess input-output faithfulness in root-initial syllables.

Three predictions arise from the addition of Ident-σ_1 constraints to the grammar. First, root-initial syllables should exhibit a larger and more marked inventory of segments than non-

45 Related arguments are also advanced in Padgett (1995b).

initial syllables. Separately rankable IDENT-σ_1 and IDENT constraints will permit the intervention of inventory-defining featural markedness constraints, as schematized in (117).

(117) IDENT-σ_1(F) » *F » IDENT(F)

This is the subhierarchy which is characteristic of positional neutralization, and, as we have seen, there are numerous examples which instantiate this ranking. The distribution of vowel height in Shona and Tamil arises from just this ranking; other examples of initially-determined positional neutralization are listed in (5) above.

The second prediction of root-initial positional faithfulness is that root-initial syllables will trigger phonological processes. This, too, arises from the separability of IDENT-σ_1 and IDENT in the constraint hierarchy. Phonological processes such as assimilation and dissimilation arise when a markedness constraint such as *MID, *LABIAL or ALIGN(F) dominates a conflicting faithfulness constraint. For example, height harmony in Shona derives from the ranking in (118).

(118) Shona height harmony
*MID » *HIGH » IDENT(high)

Faithfulness is subordinated to the higher-ranking markedness constraints. In this system, spreading is triggered by the root-initial syllable, due to high-ranking IDENT-σ_1(high):

(119) IDENT-σ_1(high) » *MID » *HIGH » IDENT(high)

Initial syllables are immune to spreading; in fact they trigger vowel harmony, determining the height of subsequent vowels.

Finally, positional faithfulness constraints predict that segments in the privileged positions will exhibit resistance to the application of phonological processes. Once again, through dominance of the constraint subhierarchy which generates some phonological alternation, positional faithfulness constraints will render prominent positions immune to change. This is demonstrated for root-initial syllables in the Shona height harmony system, and also in Zulu, where root-initial labials fail to undergo labial palatalization. Tamil presents an example of positional resistance at two levels. Syllable onsets in Tamil fail to undergo place assimilation (by virtue of high-ranking IDENT-ONSET), though codas do not. Furthermore, the codas of root-initial syllables do not assimilate to following onsets, though codas in non-initial syllables do. This derives from high-ranking IDENT-σ_1(Place).

In the preceding sections, I have shown that the predictions of Positional Faithfulness Theory are robustly borne out in a variety of languages and language families. The distribution of marked segments and the behavior of root-initial syllables with respect to phonological processes stand as strong evidence in support of IDENT-σ_1 constraints. Furthermore, alternative analyses which attempt to characterize positional faithfulness phenomena in terms of positional markedness or licensing constraints cannot rise to the occasion. Such approaches must incorporate positional faithfulness constraints; this was demonstrated in the CODACOND analysis of Tamil presented in §2.4.4.4. The work of the Coda Condition, a positional markedness constraint, is accomplished independently by the place markedness subhierarchy of Prince & Smolensky (1993). In addition, IDENT-ONSET(Place) is required to explain the invariant coda-to-onset direction of assimilation in Tamil and numerous other languages. In subsequent chapters, I will adduce further evidence in support of Positional Faithfulness Theory, showing that both stressed syllables and roots are positions of enhanced faithfulness. In each case, we will see that only positional faithfulness can account for the patterns of behavior attested in the world's languages.

CHAPTER 3

FAITHFULNESS IN STRESSED SYLLABLES

3.1 Introduction

There are three disparate, but closely related, phonological behaviors which are diagnostic of positional privilege. They are, as we have seen in the preceding chapters, position-sensitive neutralization of contrast, positional triggering of phonological processes, and positional blocking of or exceptionality to phonological processes. In this chapter, I will turn to the domain of stress-based positional privilege, showing that all three phenomena are robustly attested in the languages of the world. In addition, we will see that all of these positional effects can and should be unified via the positional faithfulness constraint IDENT-σ'(F).

Languages which exhibit stress-based positional neutralization typically permit a segmental inventory in unstressed syllables which is a subset of the full inventory appearing in stressed syllables. Furthermore, membership in the unstressed subset of the inventory is not randomly determined: the members of this set are arguably less marked than the members of its complement set. Representative examples of stress-based positional neutralization are displayed in (1) below.

(1) Stress-based positional neutralization

Language:	s **' includes:**	s **° includes**
English	ij, ɪ, ej, ´, æ, uw, ¨, ow, ø, å, oj, åj, åw, v	Only \ in non-final unstressed syllables
Brazilian Portuguese (Wetzels n.d.)	i, e, é, u, o, ø, a	i, u, e, o, a
Nancowry (Radhakrishnan 1981)	Oral and nasal vowels	Only oral i, u, a
Copala Trique (Hollenbach 1977)	Fortis & lenis stops Oral and laryngeal C's Eight tones	Only lenis stops Only oral C's Three tones
Chamorro (Topping 1968)	i, e, æ, u, o, a	ɪ, ᴜ, \
Guaraní	Oral and nasal vowels	Nasal vowels only before nasal segments

The cases in (1) highlight an important generalization concerning stress-based positional neutralization: the inventory of segments in unstressed syllables is limited to either a set of peripheral vowels (a perceptually optimal/unmarked inventory; see Liljencrants & Lindblom 1972, Lindblom 1986, Flemming 1995, and Ní Chiosáin & Padgett 1997 for details), or a set of central, schwa-like vowels (often characterized as placeless (Anderson 1982), or articulatorily unmarked).

In addition to permitting a wider range of more marked segments, stressed syllables frequently act as triggers of phonological processes such as vowel harmony, or preferentially fail to undergo an otherwise regular process. Flemming (1993), in a survey of segmental interactions with stress, identifies a number of cases of the former type. Stressed syllables are the source of feature spreading in Guaraní nasal harmony, Southern Paiute voicing assimilation, Eastern Cheremis vowel harmony and Applecross Gaelic nasal harmony. Copala Trique (Hollenbach 1977) also has a nasal harmony process that is triggered by stressed vowels. The second type of system, in which stressed vowels fail to undergo a process, is instantiated by the harmony system of Guaraní, where stressed oral vowels fail to undergo nasal harmony, though unstressed vowels are regularly targeted.

In this chapter, I will argue that stress-based positional neutralization, stress-based triggering of processes and stress-based blocking of phonological processes result when the positional faithfulness constraint, IDENT-σ'(F) (2), is high-ranking.

(2) IDENT-σ'(F)

Output segments in a stressed syllable and their input correspondents must have identical specifications for the feature F.

This constraint belongs in the same family as the familiar IDENT(F) of McCarthy & Prince (1995), and universally dominates it, as shown in (3).

(3) Stressed syllable faithfulness subhierarchy

IDENT-σ'(F) » IDENT(F)

Stress-based neutralization of contrast arises when some markedness constraint or constraints intervene in the ranking shown in (3). For example, in a language such as Guaraní which exhibits neutralization of the nasal/oral contrast in unstressed syllables, the ranking in (4) obtains. Here, the markedness constraint which intervenes is $*V_{nasal}$, which penalizes nasal vowels.

(4) Positional limitations on phonemic nasal vowels

IDENT-σ'(nasal) » $*V_{nasal}$ » IDENT(nasal)

The ranking of IDENT-σ'(nasal) » $*V_{nasal}$ will have the result that any [nasal] specification present in a stressed syllable in the output must have been present on the input correspondent of that vowel; lexical contrasts in nasality are preserved under stress. Conversely, the ranking $*V_{nasal}$ » IDENT(nasal) prohibits preservation of input nasality in the absence of stress.

The second and third behaviors which are diagnostic of stress-based positional privilege, triggering of and resistance to phonological processes, arise from the same general ranking pattern shown in (4). However, in such cases, the intervening markedness constraint is not $*V_{nasal}$. For example, if the harmony-favoring constraint ALIGN-L(nasal) is substituted for $*V_{nasal}$ in (4), stressed nasal vowels will trigger leftward spreading of [nasal]. Furthermore, stressed oral or nasal vowels will resist the application of leftward spreading, while unstressed vowels will not. This is exactly the pattern that we find in Guaraní nasal harmony.

(5) Positional triggering and blocking of nasal harmony

IDENT-σ'(nasal) » ALIGN-L(nasal) » IDENT(nasal)

The remainder of the chapter is organized as follows. I begin with a close examination of one type of stress-based positional neutralization, the reduction of unstressed vowels. Focusing on the reduction of [±ATR] contrasts, I will show that the interaction of IDENT-σ'(ATR) with a variety of segmental markedness constraints generates a common form of vowel reduction. In addition, we will see that the grammar of [±ATR] reduction will produce, via ranking permutation, all of the patterns of [ATR] distribution which are common in vowel inventories cross-linguistically.

From simple cases of vowel reduction, I turn to the analysis of stress-based triggering and blocking of phonological processes in section 3.3. To demonstrate these aspects of positional privilege, I will examine the role of IDENT-σ'(nasal) in characterizing Guaraní nasal harmony, a language which exhibits all three of the positional faithfulness diagnostics: stress-based [nasal] distribution, stress-triggered nasal harmony *and* stress-based blocking of harmony. A single ranking schema, crucially incorporating high-ranking IDENT-σ'(nasal), accounts for all of the properties of the Guaraní system. The proposed analysis represents an advance over previous treatments of Guaraní harmony, as it requires neither aberrant stress feet nor restrictions on feature spreading or linking which are specific to stress systems. Furthermore, the positional faithfulness analysis unifies the stress-sensitive aspects of the harmony system with the stress-sensitive distribution of contrast, a result not obtained in earlier work. Before turning to the more involved example of Guaraní, I will begin with a case of simple stress-based neutralization: unstressed vowel reduction in Western Catalan.

3.2 Stress-based Positional Neutralization: Vowel Reduction

3.2.1 Introduction

Many languages with rich vowel systems exhibit a specific variety of stress-sensitive positional neutralization known in the phonological literature as vowel reduction. In cases of vowel reduction, the full inventory of vowels will appear in stressed syllables, but the inventory in unstressed syllables is limited to a less-marked subset of the inventory.[1] Vowel reduction is most evident when morpheme concatenation leads to a shift in the placement of stress in a word, and consequently, to overt alternations in vowel quality within a morphological paradigm. However there are examples of stress-sensitive vowel neutralization in which surface quality alternations are rare or non-existent; while not typically characterized as vowel reduction, these cases are analytically identical to the more familiar examples. (One such case is Nancowry; stress is always root- and word-final in Nancowry, and there is little, if any, suffixation. Stress placement is therefore static, but the range of contrasts exhibited by pretonic syllables is limited in the extreme, as indicated in (1) above.) Some typical examples of vowel reduction are shown in (6) below.

(6) Some examples of stress-based vowel reduction

Language:	**In main stressed s:**	**In unstressed s:**
English	ij, I, ej, ´, æ, uw, ¨, ow, ø, å, oj, åj, åw, \	\ in non-final unstressed syllables
Brazilian Portuguese (Wetzels n.d.)	i, e, é, u, o, ø, a	i, u, e, o, a
Catalan: Central	i, e, ´, u, o, ø, a	i, u, \
Majorcan	i, e, ´, u, o, ø, a, \	i, e, u, o, \
Western (Hualde 1992; Prieto 1992)	i, e, ´, u, o, ø, a	i, e, u, o, a
Servigliano Italian (Nibert 1991); Standard Italian (Flemming 1993)	i, e, ´, u, o, ø, a	i, e, u, o, a
Mantuan Italian (Miglio 1997)	i, y, e, ´, ø, u, o, ø, a	i, y, e, u, a
Chamorro (Topping 1968)	i, e, æ, u, o, a	I, U, \

Vowel reduction, like the other varieties of inventory-reducing positional neutralization examined in this dissertation, arises from the interaction of positional faithfulness constraints with featural and/or segmental markedness constraints. The faithfulness subhierarchy responsible for

[1] As noted above, "less-marked" may be defined in either acoustic or articulatory terms.

vowel reduction is the familiar positional neutralization subhierarchy, where the dominant positional faithfulness constraint is IDENT-σ'(F), rather than IDENT-ONS or IDENT-σ_1.

(7) Unstressed vowel reduction subhierarchy, schematic
IDENT-σ'(F) » **M** » IDENT(F)

Here, **M** is a variable over featural or segmental markedness constraints such as *LABIAL, *[-high, –low], *[Coronal, +low], and so on. The extent and nature of the reduction exhibited by a given language will depend upon which, if any, of the inventory-defining markedness constraints fill the ranking slot occupied by **M** in (7). In a language such as English, in which reduction in unstressed syllables results in the loss of essentially all place and height features, the entire set of featural markedness constraints must interrupt the featural faithfulness subhierarchy. Other, less extreme, cases of reduction will be characterized by a ranking in which only a subset of the featural markedness constraints dominates IDENT(F); reduction is only partial in such a scenario. In the following section, I provide an analysis of Western Catalan unstressed vowel reduction. In Western Catalan, [ATR] contrasts among the mid vowels are leveled in unstressed syllables, but preserved under stress. By examining the interaction of IDENT-σ'(ATR) with the markedness constraints responsible for restricting the distribution of [±ATR], I will show that positional faithfulness constraints may play a pervasive role in the grammar of a language, even when dominated. Crucial to this demonstration is a careful study of the constraints which regulate the occurrence of [±ATR] and the ways in which they interact to define vowel inventories in general.

3.2.2 Case Study: Western Catalan Reduction

3.2.2.1 Background

Catalan, like many of the other Romance languages (including Standard Italian and many of the regional dialects of Italian (Camilli 1929, Miglio 1997, Nibert 1991) and Brazilian Portuguese (Wetzels n.d.)), exhibits vowel reduction in unstressed syllables. Reduction of the full vowel system is found in unstressed syllables in each of Western, Eastern and Majorcan

Catalan. The slightly different patterns of reduction which occur in each of the dialects are shown in (8) below.

(8) Unstressed vowel reduction in Catalan dialects

Dialect:	**Reduction Pattern**		
Western (Hualde 1992)	i e, ´ u o, ø a	∅ ∅ ∅ ∅ ∅	i e u o a
Eastern (Central) (Prieto 1992)	i e, ´, a u, o, ø	∅ ∅ ∅	i \ u
Eastern (Majorcan) (Prieto 1992)	i e, a, \ u o, ø ´	∅ ∅ ∅ ∅ ∅	i \ u o e

Representative data illustrating these patterns of reduction are provided in (9). All of the reduction data in the righthand column are diminutive forms, taken from Prieto (1992:567–568).

(9) Unstressed vowel reduction in Catalan dialects

a. Central Catalan

r~íw	'river'	r~iw´'t	'river, dim.'
néw	'snow'	n\w´'t\	'snow, dim.'
m´'¬	'honey'	m\l´'t\	'honey, dim.'
pál\	'shovel'	p\l´'t\	'shovel, dim.'
r~ø'?\	'wheel'	r~u?´'t\	'wheel, dim.'
món\	'monkey, fem.'	mun´'t\	'monkey, fem. dim.'
kúr\	'cure'	kur´'t\	'cure, dim.'

b. Majorcan Catalan

r~íw	'river'	r~iw\'t	'river, dim.'
néw	'snow'	n\w\'t\	'snow, dim.'
m´'¬	'honey'	m\l\'t\	'honey, dim.'
pál\	'shovel'	p\l\'t\	'shovel, dim.'
r~ø'?\	'wheel'	r~o?\'t\	'wheel, dim.'
món\	'monkey, fem.'	mon\'t\	'monkey, fem. dim.'
kúr\	'cure'	kur\'t\	'cure, dim.'

(9) Unstressed vowel reduction in Catalan dialects, *continued*

c. Western Catalan

r~íw	'river'	r~iwét	'river, dim.'
néw	'snow'	newéta	'snow, dim.'
p´'s	'weight'	pezét	'weight, dim.'
pála	'shovel'	paléta	'shovel, dim.'
r~ø'?a	'wheel'	r~o?éta	'wheel, dim.'
só¬	'sun'	solét	'sun, dim.'
búr~o	'dumb'	bur~ét	'dumb, dim.'

In what follows, I will focus on vowel reduction in Western Catalan (WCa), a phenomenon which results from the interleaving of a single key markedness constraint, NONLOW/ATR (penalizing the combination of [–low, –ATR]), into a subhierarchy of positional and non-positional faithfulness constraints. The crucial ranking subhierarchy which determines the outcome of vowel reduction in Western Catalan is given in (10).

(10) Positional neutralization subhierarchy, Western Catalan
IDENT-σ'(ATR) » *[–low, –ATR] » IDENT(ATR)

This subhierarchy, through interaction with the other ATR markedness constraints which determine the distribution of [±ATR] in vowel inventories cross-linguistically, will result in the pattern of reduction which occurs in WCa. I turn now to an examination of the ATR markedness constraints and their interactions; from these interactions, the distribution of ATR in the vowel systems of the world (including, of course, Western Catalan) will be determined.

3.2.2.2 Preliminaries: ATR Markedness and Inventory Structure

Here, as in the preceding chapters, I adopt Prince & Smolensky's (1993) theory of inventory structure: the surface segmental inventory of a language results from the interaction of markedness and faithfulness constraints. The presence of a given segment *x* in a language indicates that faithfulness constraints which regulate some feature or features contained in *x* dominate markedness constraints which penalize the presence of those features. Conversely, the absence of a particular segment type indicates a ranking in which markedness constraints are dominant.

The vowel inventory of WCa stressed syllables is triangular, comprising seven vowels at three heights, with an ATR distinction among the mid vowels. This very common vowel inventory is shown in (11).

(11) WCa stressed vowels

		Front		Back
High:		i		u
Mid:	[+ATR]	e		o
	[–ATR]	´		ø
Low:			a	

The chief point of interest in the present context is the existence of an ATR contrast among the mid vowels, coupled with the absence of such a contrast among the high vowels. Through interaction with ATR faithfulness constraints, the markedness constraints which regulate the distribution of [±ATR] will generate this asymmetrical pattern (and, through ranking permutation, all other attested ATR/RTR patterns).

Following Archangeli & Pulleyblank (1994a), I assume that articulatorily grounded markedness constraints play a key role in determining the distribution of [±ATR] in vowel inventories. Archangeli & Pulleyblank observe that there is an articulatory antagonism between tongue height and tongue root retraction: the higher the tongue body is raised, the more difficult it is to achieve the pharyngeal narrowing associated with [–ATR] vowels. Tongue bunching and raising are often accompanied by tongue root advancement. The articulatory antagonism between raising and retraction is reflected in the significantly lower frequency of [+high, –ATR] vowels in the languages of the world (Maddieson 1984) and, Archangeli & Pulleyblank argue, is formally encoded in the grammar by means of the markedness constraints HI/ATR and LO/RTR, shown in (12).

(12) ATR-markedness constraints, high and low vowels
HIGH/ATR: *[+high, –ATR]
LOW/RTR: *[+low, +ATR][2]

[2] This formulation differs from, but is logically equivalent to, the conditional statements adopted in Archangeli & Pulleyblank (1994a).

In the grammar of languages such as Western Catalan, which lack both high [–ATR] vowels and low [+ATR] vowels, these markedness constraints must dominate the faithfulness constraint IDENT(ATR), as indicated in (13). Input high vowels, regardless of their value for [ATR], must surface as [+ATR]; conversely, low vowels must always surface as [-ATR].

(13) No ATR contrast among high or low vowels
HIGH/ATR, LO/RTR » IDENT(ATR)

The effects of the ranking in (13) can be seen below. Consider first the straightforward case of a high [+ATR] input vowel, as in (14).

(14) Input high [+ATR] vowels retain [+ATR]

/uÒ/ 'eye'	LO/RTR	HI/ATR	IDENT(ATR)
a. ☞ uÒ			
b. UÒ		*!	*

Here there is nothing to be gained by altering the original ATR specification. The fully faithful candidate (14a) satisfies both the dominant markedness constraint and the faithfulness constraint IDENT(ATR); the unfaithful (14b) satisfies neither. Parallel results obtain among the low vowels; when a [–ATR] low vowel is input to the mini-grammar of (13), no deviation from the input specifications can be optimal. (A [+low, +ATR] vowel is transcribed with [A] here and throughout.)

(15) Input low [–ATR] vowels retain [–ATR]

/køza/ 'thing'	LO/RTR	HI/ATR	IDENT(ATR)
a. ☞ kø'za			
b. kø'zA	*!		*

In contrast, if a high [–ATR] vowel is input to the grammar, unfaithfulness is optimal. This is shown, with a hypothetical input, in (16).

(16) Input [–ATR] high vowels lose [–ATR]

/UÒ/	LO/RTR	HI/ATR	IDENT(ATR)
a. ☞ uÒ			*
b. UÒ		*!	

This is the scenario in which the correct ranking of HI/ATR and IDENT(ATR) may be established, as this is a genuine case of constraint conflict. Each candidate violates one of the two constraints. Were the ranking to be reversed, candidate (16b), which retains its input [–ATR] specification, would be optimal. The absence of [–ATR] high vowels in this dialect of Catalan indicates that the ranking in (16) is the correct one. Similarly, the lack of [+ATR] low vowels in WCa implicates the ranking LO/RTR » IDENT(ATR).[3]

(17) Input [+ATR] low vowels lose [+ATR]

/AÒ/	LO/RTR	HI/ATR	IDENT(ATR)
a. ☞ aÒ			*
b. AÒ	*!		

The input values of [ATR] are antagonistic to the input height values in both (16) and (17) and, because the markedness constraints which penalize this antagonism dominate ATR faithfulness, these values may not be retained. Instead, they are changed to the values appropriate to the input height of the vowel in question, [+ATR] if the vowel is [+high] and [–ATR] if [+low].

While the [±ATR] contrast is not maintained in either the high or low vowels of WCa, it is retained among the mid vowels, provided that the mid vowels in question are stressed. This distributional generalization indicates that any markedness constraint which penalizes the occurrence of [–ATR] in mid vowels is dominated, in the grammar of WCa, by the positional ATR-faithfulness constraint IDENT-σ'(ATR). Whatever the relevant constraint ranking for WCa may be, permutations of that ranking must also generate the other inventories which are attested cross-linguistically. Thus, the constraint subhierarchy which yields the WCa vowel inventory in unstressed syllables should be able to produce a system in which mid vowels may only be [–ATR], and an inventory in which mid vowels must be [+ATR]. Before proceeding with the analysis of WCa unstressed syllables, a closer examination of the aforementioned vowel systems is warranted.

[3] The ranking of IDENT(high) and IDENT(low) is obviously relevant to the outcome of the mini-grammar in (13); if either constraint is ranked below IDENT(ATR), input I/U and A may surface as ´/ø and e in order to satisfy the higher-ranking faithfulness constraint. As WCa exhibits no height alternations in its reduction pattern, I will assume throughout that IDENT(high) and IDENT(low) dominate IDENT(ATR). For reasons of space, these rankings will be eliminated from subsequent tableaux and discussion.

Two common triangular vowel systems are given in (18). In the inventory of (18a), only [+ATR] mid vowels are possible (this is the vowel system of WCa unstressed syllables); the vowel system in (18b) permits only [–ATR] mid vowels.

(18) Mid vowel systems

a) [+ATR] only	Front	Back	b) [–ATR] only	Front	Back
High:	i	u	High:	i	u
Mid:	e	o	Mid:	´	ø
Low:	a		Low:	a	

These vowel systems share with the seven-vowel inventory of (11) the absence of any ATR contrast among the high and low vowels. However, they differ from the larger inventory in restricting the occurrence of [ATR] among the mid vowels. In order for the inventories of (18) to be generated via Prince & Smolensky's faithfulness/markedness interaction, there must be some markedness constraint or constraints which penalize the cooccurrence of [±ATR] with [–high] and/or [–low].

What are the relevant mid vowel markedness constraints? Again following the articulatory grounding hypothesis of Archangeli & Pulleyblank, I propose the constraints in (19) below.

(19) NonLow/Atr: *[–low, –ATR]
NonHigh/Rtr: *[–high, +ATR]

Each of these constraints is a more general version of one of the markedness constraints in (12) above, in the sense that the vowels penalized by the constraints in (12) are a subset of the vowels penalized by the constraints in (19). For example, [+high, –ATR] vowels, which violate High/Atr, are a subset of the [–low, –ATR] vowels (which violate NonLow/Atr). This is shown in the diagram on the left in (20); the corresponding subset/superset relationship among [+ATR] vowels is shown on the right.

(20) Subset/superset relations among violators of ATR markedness constraints

If the mid vowel markedness constraints of (19) were predicated on a single feature value (e.g. [-high]), the subset/superset relationship between these constraints and the more specific

HI/ATR and LOW/RTR could not be exploited. This subset/superset relationship among the segments which violate the constraints is important, as it will permit an [ATR] contrast among the mid vowels, even in the absence of a contrast in either the high or low vowels. Further, if a fixed ranking of specific » general is adopted, it should be impossible to generate contrasts in the high or low vowels without a corresponding mid vowel contrast (provided that there are mid vowels in the inventory at all)—a desirable result, as such inventories are very rare, if attested at all.[4] I propose that the rankings in (21) are, minimally, the default rankings provided in UG.

(21) HIGH/ATR » NONLOW/ATR
LOW/RTR » NONHIGH/RTR

As always, different vowel inventories will be generated based upon the relative ranking of these constraints and the relevant faithfulness constraint, IDENT(ATR). While the ranking of HIGH/ATR and LOW/RTR above the mid vowel constraints is arguably fixed, the ranking of these mid vowel constraints with respect to one another must be free.

To support this latter claim, let us turn to the evidence regarding the relative markedness of [+ATR] and [–ATR] mid vowels (and thus, the relative ranking of markedness constraints which regulate them). The evidence, at this point, is inconclusive. Maddieson (1984) reports that 83/317 in the UPSID database have [e], 116/317 have [´], and 113 have an indeterminate front mid vowel "e"; similar figures obtain for the back mid vowels. In the high vowels, by contrast, the numbers are much more lopsided: 271 [i] vs. 54 [ɪ]. Only if all of the indeterminate cases in the mid vowels can be assigned to the [–ATR] category is there an overwhelming preference for [–ATR] mid vowels comparable to the high [+ATR] vowel preference. At present, no preference in the mid vowels can be substantiated. Further, though Archangeli &

4 One apparent counterexample to this claim is the Bantu family, in which many languages exhibit a contrast among the high vowels, but not among the mid. This reflects the Proto-Bantu vowel inventory, which is reconstructed as a seven-vowel system with two super-high vowels, two high vowels and two mid vowels. Whether such vowel systems constitute a genuine counterexample remains to be seen. While the high/super-high contrast (and its historical decendents in modern Bantu languages) have been treated by many as reflecting an ATR contrast, there is a lack of consensus on this matter. Clements (1991) argues that a scalar height analysis should be adopted, while Zoll (1995) proposes that the super-high vowels are [+consonantal].

Pulleyblank (1994a) assert that an {i, u, ´, ø, a} inventory appears to be the most common 5 vowel inventory, the pattern {i, u, e, o, a} is also attested with some frequency (it appears to be the less common of the two, according to Archangeli & Pulleyblank). Given Maddieson's use of "e" and "o" for any case where the precise placement of the mid vowels in the vowel space is indeterminate, no firm conclusions about frequency and markedness may be drawn. Therefore, I will assume that NONHIGH/RTR and NONLOW/ATR may be freely reranked with respect to one another.

To demonstrate the workings of the ATR markedness constraint system, some specific vowel inventories must be examined. I begin with the triangular inventory of (22), in which an ATR contrast is maintained only in the mid vowel range; all low vowels are [–ATR], and high vowels are [+ATR]. (This is the inventory which appears in stressed syllables in WCa.)

(22) Only mid vowels display a contrast

		Front		Back
High:		i		u
Mid:	+ATR	e		o
	–ATR	´		ø
Low:			a	

The constraint ranking which is responsible for this inventory must crucially permit any input value of [ATR] to be reproduced in the output, provided that it occurs in concert with a [-high] or [–low] specification. IDENT(ATR) must therefore dominate NONLOW/ATR and NONHIGH/RTR.

(23) Ranking for contrastive [ATR] in mid vowels
IDENT(ATR) » NONLOW/ATR, NONHIGH/RTR

In order to prevent [–ATR] high vowels and [+ATR] low vowels, the rankings demonstrated in (13) above will also be retained:

(24) HIGH/ATR, LO/RTR » IDENT(ATR)

Given transitivity of constraint ranking, the subhierarchies of (23) and (24) may be intersected to yield the following:

(25) HIGH/ATR, LO/RTR » IDENT(ATR) » NONLOW/ATR, NONHIGH/RTR

Under this ranking, [ATR] contrasts in the high and low vowels will be obliterated, but maintained in the mid vowels. This is demonstrated in tableaux (26)-(29) below. (Throughout, I assume a ranking in which IDENT(high) and IDENT(low) dominate IDENT(ATR). Candidates in which the input height is altered are, as indicated in note 3, omitted from consideration.) The ranking of both HIGH/ATR and LOW/RTR over IDENT(ATR) ensures that vowels at the periphery of the height scale must conform to the unmarked [ATR] specification, regardless of the input feature value. This was demonstrated in (16) and (17) above, and is repeated in (26) and (27).

(26) Input [–ATR] high vowels become [+ATR]

/I/	HI/ATR	LO/RTR	ID(ATR)	NONLO/ATR	NONHI/RTR
a. I	*!			*	
b. ☞ i			*		

(27) Input [+ATR] low vowels become [–ATR]

/A/	HI/ATR	LO/RTR	ID(ATR)	NONLO/ATR	NONHI/RTR
a. A		*!			*
b. ☞ a			*		

Mid vowels, however, may retain their input [ATR] specifications, as ATR faithfulness takes precedence over featural markedness in this grammar. As tableaux (28) and (29) demonstrate, no changes in the [ATR] specification of mid vowels are required (or permitted) by this constraint rank ing. Mid vowels must be fully faithful in the output.

(28) [–ATR] mid vowels remain [–ATR]

/´/	HI/ATR	LO/RTR	ID(ATR)	NONLO/ATR	NONHI/RTR
a. ☞ ´				*	
b. e			*!		*

(29) [+ATR] mid vowels remain [+ATR]

/e/	HI/ATR	LO/RTR	ID(ATR)	NONLO/ATR	NONHI/RTR
a. ´			*!	*	
b. ☞ e					*

Via the ranking instantiated here, the seven-vowel system of (22) (and of WCa stressed syllables) is successfully generated. High and low vowels which bear antagonistic [ATR] values are destined to be unfaithful, but the mid vowels sail through the grammar unscathed.

From this common seven-vowel inventory, I turn to the two most common five-vowel systems of the world's languages. The triangular inventory of (18a), in which all non-low vowels are [+ATR], will be examined first. To arrive at such a language, in which {i, e, u, o, a} are the only possible vowels, ATR faithfulness must be overridden by the constraint which prohibits [–ATR] mid vowels, NonLow/Atr; no [–ATR] non-low vowels are permitted to surface. A simple reranking of the constraints in (25) will yield the correct results; this reranking is given in (30) below (where the specific » general ranking is preserved). Only the ranking of Ident(ATR) and NonLow/Atr has been altered.

(30) Ranking for a five-vowel inventory, no non-low [–ATR] vowels
High/Atr, Lo/Rtr » NonLow/Atr » Ident(ATR) » NonHigh/Rtr

As in the preceding example, the constraint subhierarchy in (30) will prohibit vowels at the periphery of the height dimension from bearing antagonistic [ATR] specifications. Only in the domain of the mid vowels does this ranking differ from the previous case; while (25) permitted the generation of both [+ATR] and [–ATR] mid vowels, (30) allows only [+ATR] variants to surface intact.

(31) [–ATR] mid vowels must be unfaithful

/´/	Hi/Atr	Lo/Rtr	NonLo/Atr	Id(Atr)	NonHi/Rtr
a. ´			*!		
b. ☞ e				*	*

(32) [+ATR] mid vowels are unaffected

/e/	Hi/Atr	Lo/Rtr	NonLo/Atr	Id(Atr)	NonHi/Rtr
a. ´			*!		
b. ☞ e					*

As (31) and (32) demonstrate, input vowels which are mid and [–ATR] are unfaithfully rendered as [+ATR] in the output, due to the subordination of the faithfulness constraint Ident(ATR) to NonLow/Atr.

The other common five-vowel pattern, in which all non-high vowels are [–ATR] (i, u, ´, ø, a), results from a slightly different permutation of the ranking in (25). In such an inventory, the combination of [–high, +ATR] is never faithfully reproduced in output forms. This indicates that

NonHigh/Rtr must dominate Ident(ATR) (which itself must dominate NonLow/Atr in order to allow input ´ and ø to surface intact).

(33) Ranking for a five-vowel inventory, no non-high [+ATR] vowels
High/Atr, Lo/Rtr » NonHigh/Rtr » Ident(ATR) » NonLow/Atr

The results of this ranking are demonstrated in tableaux (34) and (35), where it is clear that the grammar will permit only [–ATR] mid vowels to surface, even at the expense of ATR faithfulness.

(34) [+ATR] mid vowels must be unfaithful

/e/	Hi/Atr	Lo/Rtr	NonHi/Rtr	Id(Atr)	NonLo/Atr
a. ☞ ´				*	*
b. e			*!		

(35) [–ATR] mid vowels are unaffected

/´/	Hi/Atr	Lo/Rtr	NonHi/Rtr	Id(Atr)	NonLo/Atr
a. ☞ ´					*
b. e			*!	*	

The nine-vowel pattern {i, I, u, U, e, ´, o, ø, a} is derived by means of another simple permutation of the constraint subhierarchies developed above. In this case, Ident(ATR) must be moved in the rankings above all of the ATR markedness constraints, with the exception of Low/Rtr. Crucially, Ident(ATR) must dominate High/Atr in order to permit [–ATR] high vowels. This will yield output retention of input [+ATR] or [–ATR] on any vowel, save one which is [+low]. The necessary ranking is shown in (36).

(36) Ranking for a nine-vowel inventory, ATR contrast in all non-low vowels
Lo/Rtr » Ident(ATR) » High/Atr » NonHigh/Rtr, NonLow/Atr

The results of this hierarchy can be generated straightforwardly by manipulating the ranking of constraints in any of the preceding tableaux.

Finally, let us consider the unattested or very rare inventory {i, I, u, U, e, o, a}, which is unusual in permitting an ATR contrast among the high vowels, without a corresponding contrast among the mid vowels. Can this inventory be generated with the constraints under discussion above, assuming the default ranking of (21)? No, because the default ranking in (21) requires that the more restrictive HIGH/ATR dominate the more general NONLOW/ATR. But to generate [ɪ] and [ʊ], the faithfulness constraint IDENT(ATR) must dominate HIGH/ATR and, by transitivity of ranking, NONLOW/ATR.

(37) Ranking required to generate [–ATR] high vowels (assuming specific » general is fixed)
IDENT(ATR) » HIGH/ATR » NONLOW/ATR

However, under the ranking in (37), the [–ATR] mid vowels [´] and [ø] are also freely generated; the desired vowel inventory cannot be produced. Relevant examples are provided in tableaux (38) and (39).

(38) [–ATR] high vowels are unaffected

/ɪ/	ID(ATR)	HI/ATR	NONLO/ATR
a. ☞ ɪ		*	*
b. i	*!		

(39) [–ATR] mid vowels are also unaffected

/´/	ID(ATR)	HI/ATR	NONLO/ATR
a. ☞ ´			*
b. e	*!		

With IDENT(ATR) ranked above all markedness constraints that penalize [–ATR] in non-low vowels, there can be no [ɪ] without [´]. Even allowing a reversal of the default ranking, with NONLOW/ATR dominating IDENT(ATR), will not produce the desired outcome, as the ranking NONLOW/ATR » IDENT(ATR) » HIGH/ATR would prohibit both high and mid [–ATR] vowels. To the extent that inventories such as {i, ɪ, u, ʊ, e, o, a} are unattested, the failure of the above constraints to generate them is a positive result.[5] (The addition of a distinct markedness

[5] Note, however, that it *is* possible to generate a different inventory in which the sole ATR contrast resides in the high vowels, namely {i, I, u, U, ´, ø, a}. This system can be produced if the [–ATR]-demanding constraints LOW/RTR » NONHIGH/RTR are ranked above IDENT(ATR) (and by transitivity of ranking, above HIGH/ATR » NONLOW/ATR) in the hierarchy in (37). This is shown in the composite tableau below, where it is clear that only [–ATR] mid vowels will be admitted, though either [+ATR] or [-ATR] high vowels are possible.

constraint *[–high, –low, –ATR] above IDENT(ATR) » HIGH/ATR » NONLOW/ATR would, of course, permit the generation of the {i, I, e} non-low inventory—but constraints of this type will also increase the factorial typology, quite possibly resulting in substantial overgeneration. In the absence of evidence to suggest that such tri-featural markedness constraints are required, they should probably be avoided. However, see Chapter 5 for discussion of a case which may require such constraints.)

3.2.2.3 The Analysis of Western Catalan

Now, having explored the constraint interactions necessary to generate various vowel systems of the world's languages, I return to the analysis of Western Catalan. The vowel inventory in stressed syllables, as described above, consists of the seven vowels {i, e, ´, u, o, ø, a}. This vowel system can be produced, in cases where stress sensitivity is not at issue, with the constraint subhierarchy given in (40).

(40) Seven-vowel inventory, ATR contrast among mid vowels
HIGH/ATR, LO/RTR » IDENT(ATR) » NONLOW/ATR, NONHIGH/RTR

This ranking will permit the [–ATR] mid vowels [´] and [ø] to occur freely in any syllable. The crucial constraint relationship which allows these [–ATR] vowels to occur is the ranking of

---

/´/	LO/RTR	NONHI/RTR	ID(ATR)	HI/ATR	NONLO/ATR
a. ☞ ´					*
b. e		*!			
/e/	LO/RTR	NONHI/RTR	ID(ATR)	HI/ATR	NONLO/ATR
a. ☞ ´			*		*
b. e		*!			
/I/	LO/RTR	NONHI/RTR	ID(ATR)	HI/ATR	NONLO/ATR
a. ☞ I				*	*
b. i			*!		

As there is no subset/superset relationship which holds between HIGH/ATR (which penalizes [+high, –ATR]) and NONHIGH/RTR (penalizing [–high, +ATR]), it is reasonable to assume that no fixed ranking should obtain between these constraints. Factorial typology thus predicts that the {i, I, u, U, ´, ø, a} inventory should be attested, and attested with greater frequency than the impossible {i, I, u, U, e, o, a} system considered above. In the absence of relevant data at present, I will leave this matter for future investigation.

IDENT(ATR) above the markedness constraint NONLOW/ATR, which penalizes [–low, –ATR] vowels.

In WCa, vowels which are [–low, –ATR] are not free in their distribution; they are permitted to appear only in stressed syllables. Following the positional faithfulness analysis advocated here, this indicates that the correct ranking for WCa is one in which the IDENT(ATR) of (40) is replaced by the stress-sensitive IDENT-σ'(ATR) of (41). The revised constraint subhierarchy is shown in (42) below.

(41) IDENT-σ'(ATR)
Output segments in a stressed syllable and their input correspondents must have identical specifications for the feature [ATR].

(42) Revised constraint ranking, WCa stressed syllables
HIGH/ATR, LO/RTR » IDENT-σ'(ATR) » NONLOW/ATR, NONHIGH/RTR

This ranking will generate exactly the desired inventory in positions of stress. Note that IDENT-σ'(ATR) must be dominated by HIGH/ATR and LOW/RTR; were this not the case, we would find [–ATR] high vowels and [+ATR] low vowels in stressed syllables of Western Catalan. Antagonistic combinations of height and tongue root advancement/retraction are never permitted in this language, even in privileged stressed syllables.

In addition to the hierarchy in (42), we must consider the constraints which govern stress placement. Primary stress in Catalan falls on one of the final three syllables of the word; within that three-syllable window, stress placement is “by no means predictable” (Hualde 1992: 385–6). Still, some regularities are observed by a sizeable portion of the lexicon: words ending in a consonant usually bear final stress, while those words ending in a vowel typically have stress on the penultimate syllable. Secondary stresses, when they occur, are assigned in an alternating pattern, working back from the primary stress at the right edge of the word.[6] These facts suggest that feet in Catalan are trochaic and right-aligned, with monosyllabic trochees being

[6] Hualde (1992) says that phonologically non-significant secondary stresses do occur; Cabré & Kenstowicz (1995) state that Catalan lacks secondary stress, but argue for footing of syllables preceding the primary stress foot.

assigned to heavy final syllables. Lexical stresses must also be retained, creating exceptions to the default stress pattern. The analysis of stress in Spanish and Catalan is a thorny problem which has inspired a considerable literature (see Harris 1983, 1989, 1992; Roca 1986 for representative derivational analyses, as well as Cabré & Kenstowicz 1995 and Rosenthall 1994 for recent Optimality Theoretic treatments of stress in Spanish and Catalan). The details of Catalan stress placement are largely orthogonal to the point at hand; I will assume, for expositional purposes, a block of prosodic constraints compressed under the label STRESS; some of the key constraints subsumed under this label are given in (43).

(43) Constraints governing stress in Catalan

FT-FORM: TROCHEE
Ft ∅ σ_s σ_w

ALIGN-FT-RT
ALIGN(Ft, R, PWd, R)

FT-BIN: σ
Feet must be binary under syllabic analysis.

HEAD-MAX (McCarthy 1995; Alderete 1996, 1997b)
If α is a prosodic head and α Domain(f), then f(α) is a prosodic word.

WEIGHT-BY-POSITION (WBP)
Coda consonants must be moraic.

WEIGHT-TO-STRESS (WTS)
Heavy syllables must be stressed.

PARSE-σ
Syllables must be parsed into feet.

(44) Key rankings, Catalan stress constraints

Ranking	Consequence
HEAD-MAX » ALIGN-R-FT:	Lexical footing is preserved, even if misaligned.
FT-BIN » PARSE-σ	Lone final syllables may not be footed.
FT-FRM: TROCHEE » FT-BIN: σ	Final stress is footed as a degenerate foot, rather than as an iamb.
WSP, WBP » FT-BIN: σ	Final closed syllables must be stressed.

This block of constraints will force stress to be assigned in the manner described above, penalizing the loss of lexical stress and departures from the default stress pattern, in cases where no lexical stress is present. STRESS need not be crucially ranked with respect to the constraints in (42); whether high- or low-ranking, STRESS will not affect the distribution of [–ATR] mid vowels. I will return to this point below.

As noted above, both [+ATR] and [–ATR] mid vowels are permitted in stressed syllables in Western Catalan. In unstressed syllables, however, the [±ATR] contrast in the mid vowels is neutralized to [+ATR]; /´/ ∅ [e] and /ø/ ∅ [o]. This indicates that the ranking of the two lowest markedness constraints in (42) must actually be NONLOW/ATR » NONHIGH/RTR (as the [+ATR] mid vowels are the preferred variants in unstressed syllables), and that the non-positional IDENT(ATR) must fall between them. The complete ranking for WCa is given in (45).

(45) Final constraint ranking, Western Catalan
HI/ATR, LO/RTR » ID-σ'(ATR) » NONLO/ATR » ID(ATR) » NONHI/RTR, STRESS

This ranking will give the correct reduction results in unstressed syllables, as shown in (46)-(49). (The undominated HIGH/ATR and LOW/RTR are omitted to save space; candidates which violate these constraints aren't shown here, as the efficacy of this portion of the hierarchy in (45) has been demonstrated elsewhere in this chapter.)

Consider first the occurrence of [–ATR] mid vowels in stressed syllables.

(46) [–ATR] mid vowels are licit in stressed syllables

/p´z/ 'weight'	ID-σ'(ATR)	NONLO/ATR	ID(ATR)	NONHI/RTR
a. ☞ p´'s		*		
b. pés	*!		*	*

The [–ATR] mid vowel, though more marked than its [+ATR] counterpart by virtue of the ranking of NONLOW/ATR » NONHIGH/RTR, is nonetheless permitted to retain its input [ATR] specification, due to the dominant IDENT-σ'(ATR). Mid vowels may never deviate from their input specifications in stressed syllables. This is, of course, true of the [+ATR] mid vowels as well.

(47) [+ATR] mid vowels are licit in stressed syllables

/new/ 'snow'	ID-σ'(ATR)	NONLO/ATR	ID(ATR)	NONHI/RTR
a. n´'w	*!	*	*	
b. ☞ néw				*

In both cases, full faithfulness is optimal.

By contrast, those mid vowels which occur in unstressed syllables may be forced to unfaithfulness by the ranking in (45), as they are no longer protected by high-ranking IDENT-σ'(ATR), but only by the relatively low-ranking IDENT(ATR). In the case of [+ATR] mid vowels, even IDENT(ATR) will be sufficient to prevent unfaithfulness because the markedness constraint which penalizes these vowels is lowest-ranking; there is no unfaithful alternative which can defeat the faithful candidate.

(48) [+ATR] mid vowels are licit in unstressed syllables

/new-et-a/ 'snow, dim.'	ID-σ'(ATR)	NONLO/ATR	ID(ATR)	NONHI/RTR
a. ☞ ne(wéta)				**
b. n´(wéta)		*!	*	*

[+ATR] mid vowels in unstressed syllables do not neutralize to [–ATR] due to the high rank of NONLOW/ATR in the hierarchy. [+ATR] vowels stay [+ATR] in the output, no matter what position they appear in.

Unlike the [+ATR] vowels, [–ATR] mid vowels which fall in unstressed syllables *are* subject to neutralization, precisely because NONLOW/ATR dominates IDENT(ATR) and NONHIGH/RTR. Consider the example in (49) below, where an underlyingly [–ATR] mid front vowel is forced to surface as [+ATR].

(49) [–ATR] mid vowels must be unfaithful in unstressed syllables

/p´z-et/ 'weight, dim.'	ID-σ'(ATR)	NONLO/ATR	ID(ATR)	NONHI/RTR
a. p´zét		*!		*
b. ☞ pezét			*	**

The [–ATR] vowel in this example is no longer under the protection of high-ranking IDENT-σ'(ATR), as it falls outside of the position of stress, in this case the final closed syllable. The decision between the candidates in (49) is therefore submitted to lower-ranking constraints, in particular, NONLOW/ATR, which dominates IDENT(ATR). It is this ranking whch forces vowel neutralization; the faithful (49a) fails by virtue of its violation of NONLOW/ATR, and the less marked (49b) is therefore optimal.

Finally, let us examine the ranking of the prosodic constraint block STRESS, which (among other things) enforces the placement of stress on final closed syllables. In the case of the input in (49), /p´z-et/, STRESS will be violated by an output candidate which bears penultimate stress, as in [p´'zet]. Can such a violation be compelled by high-ranking IDENT-σ'(ATR), effectively moving stress in order to license an underlying segment which is marked? The answer is no, not even if all of the stress-determining constraints are placed at the bottom of the hierarchy, dominated by all featural faithfulness and markedness constraints:

(50) Stress may not shift to "license" [–low, –ATR]

/p´z-et/	ID-σ'(ATR)	NONLO/ATR	ID(ATR)	NONHI/RTR	STRESS
a. p´zét		*!		*	
b. ☞ pezét			*	**	
c. p´'zet		*!		*	**W-T-S**

Though the prosodic constraints are very low-ranking, IDENT-σ'(ATR) cannot compel their violation. Both the actual surface form (50b) and the form with illicit stress (50c) satisfy IDENT-σ'(ATR), rendering this constraint irrelevant to the decision between the two candidates. With the markedness/faithfulness ranking of (50), stress migration can never be compelled by the positional faithfulness constraint because STRESS is always satisfied by the actual output.

3.2.3 Faithfulness vs. Licensing I

In the preceding sections, I have shown how various ATR markedness constraints interact with the faithfulness constraints IDENT-σ'(ATR) and IDENT(ATR) to account for vowel reduction in Western Catalan. Simple permutations of the constraint rankings will generate not only the Catalan reduction pattern, but also a variety of common vowel inventories. At this point, however, our results do not differ from those which may be obtained via positional licensing, as in (51) (see Flemming 1993 for an instantiation of this approach to vowel reduction).

(51) Stress-based licensing of [–low, –ATR] ("LICENSE-´")
For all *x*, *x* a segment bearing the specification [–low, –ATR], *x* must be associated to a mora in a stressed syllable.

Suppose that this licensing constraint, rather than IDENT-σ'(ATR), is responsible for Catalan reduction; if (51) is substituted for IDENT-σ'(ATR) in the hierarchy in (45), comparable results will obtain.

(52) Vowel reduction hierarchy, positional licensing approach
HI/ATR, LO/RTR » LICENSE-´ » NONLO/ATR » ID(ATR) » NONHI/RTR, STRESS

The key comparison case is that of a [–ATR] mid vowel in an unstressed syllable; as (53) demonstrates, positional licensing will derive the same results in this scenario as positional faithfulness.

(53) Reduction is enforced by positional licensing

/p´z-et/	LIC-´	NONLO/ATR	ID(ATR)	NONHI/RTR	STRESS
a. p´zét	*	*		*	
b. ☞ pezét			*	**	
c. p´'zet		*!		*	**W-T-S**

However, while simple positional neutralization phenomena can be captured by either approach, other positional privilege effects will differentiate between the two analyses. It is the case of positional blocking of phonological processes which will prove to be the downfall of positional licensing, and it is to such a case that I now turn.

3.3 Guaraní Nasal Harmony

3.3.1 Introduction

Guaraní, a Tupí language of Paraguay and Bolivia, has excited considerable interest in the generative phonological literature due to the key role that stress plays in the language's regressive nasal harmony process. Generative analyses of Guaraní harmony include Lunt (1973), Rivas (1975), Sportiche (1977), Hart (1981), van der Hulst & Smith (1982), Poser (1982), Kiparsky (1985), Piggot (1992), Flemming (1993) and Steriade (1993b). The primary source of data from Paraguayan Guaraní is Gregores & Suárez (1967) (G&S).

Guaraní words consist of nasal and nonnasal spans, where the spans are delimited by stress placement (G&S, 68). Nasality spreads regressively from the nasal closure of a prenasal stop, or from a stressed nasal vowel. Spreading is blocked only by a stressed oral vowel, which itself initiates a span of orality to its left. Representative examples are given in (54); here and throughout, nasal spans are underlined.

(54) Nasal harmony in Guaraní (Poser 1982, Rivas 1975)

/umîn'+s‡a+©wá/	<u>u~mîn</u>'s‡a©wá	‘like those’
/re+xó+ta+ramo~'/	rexó<u>ta~r~a~mo~'</u>	‘if you go’
/a+y‡e+rendú/	<u>a~n~e~r~e~n</u>dú	‘I hear myself’

This distribution of nasality has led some authors to conclude that nasal harmony in Guaraní results from feature percolation through a right-headed metrical tree (Vergnaud & Halle 1978, Sportiche 1977), or, similarly, that the rule is restricted in application to the domain of an unbounded, right-headed foot (van der Hulst & Smith 1982, Flemming 1993, Steriade 1993b).

I will show that neither assumption is necessary or desirable, focusing on the twofold role of stressed syllable faithfulness in Guaraní phonology. Through interaction with markedness constraints, IDENT-σ'(nasal) governs the occurrence of contrastively nasal and oral vowels, and it also limits the applicability of nasal harmony, preventing harmony from applying to stressed oral vowels. The limited contrastive distribution of nasal vowels and the apparent “foot-bounded” character of Guaraní are intimately related in this analysis, by virtue of high-ranking IDENT-σ'(nasal).

As shown in the discussion of vowel reduction above, stress-based neutralization of contrast arises when some markedness constraint or constraints intervene between a stressed syllable faithfulness constraint and a context-free constraint. In Guaraní, the contrast which is neutralized is that of oral and nasal vowels. This result will be achieved by adopting the familiar positional privilege constraint subhierarchy, with IDENT-σ'(nasal) dominating the markedness constraint $*V_{nasal}$ to yield a contrast in stressed syllables. The contrast is restricted to stressed syllables via the placement of $*V_{nasal}$ above IDENT(nasal) in the ranking.

(55) Positional limitations on phonemic nasal vowels

IDENT-σ'(nasal) » $*V_{nasal}$ » IDENT(nasal)

The positional behaviors which distinguish Guaraní from the simple case of vowel reduction are the language’s stress-based triggering and blocking of nasal harmony. Both triggering and blocking arise from the same general ranking pattern shown in (55). However, in the case of Guaraní [nasal] spreading, the intervening markedness constraint is ALIGN-L(nasal), which favors left-to-right feature spreading, even at the expense of faithfulness to underlying [nasal] specifications. (ALIGN-L(nasal) must dominate IDENT(nasal), or no feature spreading will occur.)

(56) Positional limitations on phonemic nasal vowels
IDENT-σ'(nasal) » ALIGN-L(nasal) » IDENT(nasal)

Because the positional faithfulness constraint dominates the harmony-demanding ALIGN-L(nasal), stressed syllables will not be subject to nasal harmony; their input specifications will be preserved at all costs. Crucially, this means that only unstressed vowels may undergo harmony, triggered by fully faithful stressed vowels. Furthermore, stressed oral vowels will resist the application of [nasal] spreading, as these vowels must always retain their underlying specifications. By combining the positional triggering and blocking subhierarchy of (56) with the positional neutralization subhierarchy (55), all of the stress effects in Guaraní will result from the dominance of a single constraint, IDENT-σ'(nasal).

3.3.2 Data and Generalizations

The surface consonant and vowel systems of Guaraní are shown in (57) and (58) below.

(57) Guaraní consonant phones (Rivas 1975[7])

	Labial	Dental	Alveolar	Velar	Labiovelar	Glottal
vls. stops:	p	t		k	kw	÷
nasal stops:	mb/m	nd/n	y‡/ñ	˜g/˜	˜gw/˜w	
fricatives:		s	s‡	x		
sonorants:	v/v~	l/ln	r/r~	©/©~	©w/©~w	

(58) Guaraní vowel phonemes

	Front	Central	Back
High:	i î n	î î n	u u~

[7] Where Rivas (1975) uses *h*, I have adopted *x*; similarly, I use © for his ǥ. G&S say that [x] and [h] are in free variation, but select /x/ for the phonemic representation.

The voiced sonorants *v*, ©, and ©^{w} are all described as voiced frictionless spirants; *r* is a voiced alveolar flap.

Mid:	e e~		o õ
Low:		a ã	

The sonorants and nasal stops undergo nasal harmony. Both the oral and nasal variants of these sounds are provided in (57). Of particular interest among the consonants is the series which alternates between prenasal and fully nasal stops. It is likely that the nasal component of the prenasal stops is phonetically motivated, a means of facilitating vocal fold vibration in the stops (Henton, Ladefoged & Maddieson 1992, Iverson & Salmons 1996). This prenasal specification cannot be purely a phonetic effect, however (contra the proposals of Iverson & Salmons 1996, and Walker 1995 for comparable segments in other inventories), as the prenasals participate fully in the nasal harmony system of the language. In addition to the consonants, unstressed vowels also undergo nasalization in nasal spans; both the oral and nasal variants are given in (58). The oral/nasal distinction in the vowels is contrastive only in stressed syllables, as shown by the data in (59).

(59) Nasal vowels contrastive under stress

tupá	'bed'	tu~pa~'	'god'	Rivas (1975:136)
pirí	'rush'	pînr~în'	'to shiver'	"
mba÷é	'thing'	ma~÷e~'	'to see'	"
hu÷ú	'cough'	hu~÷u~'	'to be bland, soft'	G&S, 226
akî	'to be tender'	a~kîn'	'to be wet, moist'	G&S, 219
potí	'to be done for'	po~tîn'	'to be clean'	G&S, 239

As Rivas (1975: 136) points out, there are no forms in which contrastive nasality and stress are independent.[8] Words like the hypothetical forms in (60) are not permitted in Guaraní.

[8] The crucial role of stress in the distribution of nasality is fatally overlooked in analyses of Guaraní which treat nasality as a morpheme-level feature, rather than as a property of individual segments (e.g.Lunt 1973, Piggott 1992). The surface forms of most Guaraní morphemes *are* exclusively oral or nasal, but there are a great many "disharmonic" morphemes which contain both oral and nasal spans. The morphemic nasal analysis fails to recognize that there *is* an underlying nasality contrast in vowels, at the segmental level, which emerges under stress, and that this contrast is the source of the disharmony. The disharmonic morphemes succumb to a completely regular phonological characterization: they always contain a stressed oral vowel which is preceded somewhere within the morpheme by a prenasal stop.

(60) Impossible Guaraní surface forms (Rivas 1975)

tu~pá
mbã÷é
pir~í
tupa'~
ma÷e~'

In addition to demonstrating the relationship between stress and distinctive vowel nasality, the systematic absence of forms like those in (60) highlights a restriction on the distribution of consonants. The fully nasal *m, n, ˜* cannot occur before an oral vowel, and the prenasals may not precede a nasal vowel. We will return to an analysis of this syllable-level distributional regularity in §3.2.3.3 below.

In addition to the syllable-internal restrictions on nasality discussed above, Guaraní exhibits a long-distance nasal harmony process, which may be characterized as follows. Nasality spreads to the left from the nasal closure of a prenasal stop, or from a stressed nasal vowel. Sonorants (both consonants and vowels) undergo harmony, and the voiceless obstruents are transparent; they appear in both oral and nasal spans. Spreading proceeds to the left, *up to but not including the next stressed vowel*. Examples are provided in (61).

(61) Nasal harmony in Guaraní (Rivas 1975)

a. Spreading from stressed vowels

/ro + mbo + porãˈ/ ∅ [r~o~mo~po~r~ãˈ] /a+y‡ei+ndupãˈ/ ∅ [a~n~e~înnu~pa~ˈ]
I-you + CAUS + nice I + REFL + beat
'I embellished you' 'I beat myself'

/ndo+ro+ndupãˈ+i/ ∅ [no~r~o~nu~pa~ˈîn][9]
not+I-you + beat + NEG
'I don't beat you'

b. Spreading from closure of voiced stop

/ro + mbo + ©watá/ ∅ [r~o~mbo©watá] /a + y‡e + rendú/ ∅ [a~n~e~r~e~ndú]
I-you + CAUS + walk I + REFL + hear
'I made you walk' 'I hear myself'

/ro + mbo + xendú/ ∅ [r~o~mo~xe~ndú]
I-you + CAUS + hear
'I made you hear'

9 It is clear that there is some rightward spreading of nasality from a stressed vowel to unstressed following vowels, as in this example and in forms given in (61c). Additional examples include cases such as [ãtînˈã] 'sneeze', [÷a~ˈ~ã] 'soul' and [nãînnu~pa~ˈîn] 'I don't beat him' (Rivas 1975:137). G&S (p.69) observe that in "unstressed final position, no contrast nasal versus nonnasal [sic] is possible, and the syllable(s) is (or are) to be assigned to the same span as the last nasal center or stressed syllable". Thus, from /mbe~ˈnda/ 'husband'' only [me~ˈnã] (and not [me~ˈnda]) is possible. This contrasts with /mbendaré/ 'widower', which is realized as [me~ndaré]. There is also "phonetically, a pattern of decreasing weak nasalization toward the stressed syllable, which is, of course, never nasalized" when an oral span follows a nasal span. This weak rightward nasalization is noted consistently in transcriptions, and sometimes appears to extend two syllables into the oral span (as in xãtãˈ înte~re in 61c below). Sonorant consonants are apparently not affected by this rightward nasalization; G&S consistently omit nasalization in the transcription of such sonorants, although a following vowel is shown with nasalization.

Opinions in the literature are divided on the phonological status of rightward nasal spreading in Guaraní. Flemming (1993) assumes that it is coarticulatory, as does Sportiche (1977). By contrast, Poser (1982) argues that the process is phonological. As this issue is not central to the question of positional faithfulness in the grammar, I will simply point out that, should the process be a phonological one, the rightward spreading effects can be achieved by means of a separately ranked ALIGN-R(nasal) constraint.

c. Spreading blocked by stressed vowels (G&S:69)

/las‡era÷1̂.iy‡aka~`xata~`.itereílaekʷélape/ ∅ [las‡era÷1̂ ÷înn~a~ka~` xa~ta~` înte~re í lae kʷélape]
'my child is just too stubborn at school'

/aᵐba.apóro~rey‡ú/ ∅ [÷a~ᵐba÷apóro~re~y‡ú][10]
'if I work you come'

/roy‡otopapáᵐbaro~roxóvara~`/ ∅ [roy‡otopapáma~r~o~ro~xóv~a~r~a~~`]
'if now we meet all of us,
we will have to go'

/ᵐba÷e`ᵐbîas‡1̂] ∅ [ᵐba÷e`ᵐbîas‡1̂]
'sadness'

3.3.3 Analysis

3.3.3.1 Preliminaries

In order to demonstrate the role of IDENT-σ'(nasal) in the grammar of Guaraní, I will need to first set out the key constraints which goven nasal harmony in the language. As our focus here is not on the analysis of nasal harmony systems in general, but rather the effects of positional faithfulness in a specific example of nasal harmony, I will set aside current debates regarding the correct treatment of transparent and opaque consonants in hamony spans[11] and the characterization of the constraints responsible for feature spreading (ALIGN(F) vs. SPREAD(F) vs. SHARE(F), etc.). For purposes of exposition, I will simply adopt a set of constraints which will result in the occurrence of nasal harmony; alternative analyses are possible, and will not impact significantly on the results presented below.

Central to the analysis of nasal harmony in Guaraní is the constraint which compels spreading of the feature [nasal]. Following a number of recent OT analyses of harmony (Kirchner 1993; Pulleyblank 1993, 1994; Akinlabi 1994, 1995; Archangeli & Pulleyblank 1994b, *inter alia*), I assume that the constraint in question is the nasal alignment constraint of (62).

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[10] This example, and the one which immediately follows, contain the conjunction/postposition /ramo~ˈ/, which has non-citation forms which bear either secondary stress or no stress at all. In the unstressed form, the morpheme is always realized as [ro~] or [r~o~], with vowel nasalization.

[11] At the heart of the debate is the question of whether voiceless consonants, when "transparent" to nasal harmony, are actually targeted by the harmony process, or are skipped. For extensive discussion and analysis of the issue, see Piggott (1992), Walker (1995, in preparation).

(62) ALIGN-L(nasal)

For all x, x a [nasal] specification, there is some y such that y is a PWd and x is aligned with the left edge of y.

"Every [nasal] specification must be aligned with the left edge of a prosodic word."

Through domination of the faithfulness constraint IDENT(nasal), ALIGN-L(nasal) will compel spreading of [nasal] from right to left.

ALIGN-L(nasal) is dominated by the locality constraint NOGAP (Kiparsky 1981, Levergood 1984, Archangeli & Pulleyblank 1994a, Itô, Mester & Padgett 1995).

(63) NOGAP

A feature F may not be linked to α and γ without also being linked to β, where β is a possible anchor for F.

Together, NOGAP and ALIGN-L(nasal) favor continuous spreading of [nasal] from right to left, with no segments being skipped.

Finally, I adopt the Walker's (1995) analysis of voiceless obstruent transparency in nasal harmony systems. Walker, following Pulleyblank (1989), proposes a family of nasal markedness constraints which display a universally fixed ranking: $*\text{OBSTRUENT}_{nasal}$ » $*\text{LIQUID}_{nasal}$ » $*\text{GLIDE}_{nasal}$ » $*\text{VOWEL}_{nasal}$. This hierarchy reflects the rarity of nasal obstruents cross-linguistically, but does not prohibit their creation. Through domination of the markedness constraint $*\text{OBSTRUENT}_{nasal}$ (and by transitivity of ranking, the remainder of the nasal markedness subhierarchy), NOGAP and ALIGN-L(nasal) ensure that voiceless obstruents undergo harmony, rather than blocking it.[12] The constraint subhierarchy responsible for leftward nasal harmony in Guaraní is summarized in (64) and demonstrated in (65).

12 Walker's analysis of harmony provides a uniform typology of possible transparent and opaque segments in nasal harmony systems, capturing the implicational relationships between undergoers and blockers in various nasal harmony languages. The analysis necessarily requires that seemingly transparent obstruents actually undergo nasal harmony in the phonology. See Walker (1995) for a proposed means of reconciling the phonological result with the well-documented phonetic incompatibility of nasality and obstruency discussed in Ohala (1975), Ohala & Ohala (1993) and Cohn (1993).

Other analyses of Guaraní are possible if strict locality is abandoned. As the characterization of segmental trasparency and opacity in nasal harmony systems is not central to this thesis, I will pursue the matter no further here.

(64) Nasal harmony constraints
NOGAP » ALIGN-L(nasal) » *OBSTRUENT$_{nasal}$, IDENT(nasal)

(65) Generating nasal harmony in Guaraní; hypothetical input

/apã/	NOGAP	ALIGN-L(nasal)	*OBSTRUENT$_{nasal}$	ID(nasal)
a. apã		*!*		
b. ãpã	*!			*
c. ☞ ãp̃ã			*	**

Full spreading of [nasal], even at the expense of faithfulness and markedness constraints, is favored by this grammar.

In addition to laying out the basic mechanism for generating nasal harmony, some remarks on the stress system of Guaraní are also in order. On the basis of on the descriptions given by Gregores & Suárez, the distribution of stress in Guaraní may be characterized as follows. Stress is lexical, falling on either of the final two syllables of a root. (Antepenultimate stress is apparently possible, but very rare.) Nearly all roots bear a lexical stress, as do most suffixes. Prefixes are always unstressed; clitics and postpositions seem to be stressed in some environments and unstressed in others. There is no quantity distinction in the vowels, and syllables are (nearly) always open. In compounds, both of the stresses on the roots are retained, with the rightmost stress being primary. In morphologically complex forms which include a stressed suffix, the suffix stress is primary, but the root may retain a secondary stress. Clashing stresses on adjacent syllables are not permitted.

Previous analyses of Guaraní (Sportiche 1977, Vergnaud & Halle 1978 and Flemming 1993) have posited unbounded right-headed feet to account for the stress pattern described above. Such an analysis is problematic for two reasons. First, a cross-linguistic examination of stress patterns and foot inventories yields little, if any, support for the existence of unbounded feet; such feet have been eschewed in the metrical literature since the work of Prince (1983). (See Hayes 1985, 1987, 1995; Prince 1985; McCarthy & Prince 1986 for discussion.) Second, the sole motivation for adopting this otherwise unattested foot type is to provide an account for the limitations of nasal harmony in the language; all of the authors cited above assume that [nasal] spreading is limited to the domain of the stress foot. Only syllables in the same foot with the triggering segment may be nasalized, according to these analyses, but it is the nasalization itself which is the sole diagnostic for unbounded foot structure.

This circularity, and the attendant podiatric malformities, are unnecessary. The facts of Guaraní are consistent with a straightforward trochaic analysis; the rhythmic constraint FTFORM: TROCHEE is undominated in the grammar. The limitation of stress to the final two syllables of a root or suffix arises from an undominated ALIGN-FT-RT constraint, which requires that every foot appear at the right edge of a morpheme.[13] The lexically-determined variation in stress placement (penultimate vs. final) arises from the ranking of ALIGN-FT-RT » FT-BIN, which allows for degenerate singleton feet at the right edge of a morpheme in cases of root-final stress and monosyllabic stressed suffixes. Crucial to the analysis is the prosodic faithfulness constraint HEAD-MAX (McCarthy 1995; Alderete 1996, 1997b), which requires segments which are prosodic heads in the input to have correspondents which are prosodic heads in output forms. Lexical stresses are preserved at the expense of foot form requirements, but not at the expense of right-alignment, because lexical stress is confined to the final two syllables of a root or suffix: ALIGN-FT-RT » HEAD-MAX. The constraints and their rankings are summarized in (66)–(67) below.

(66) Constraints governing stress in Guaraní

FT-FORM: TROCHEE
Ft $\varnothing$ σ_s σ_w

ALIGN-FT-RT
ALIGN(Ft, R, Morpheme, R)

FT-BIN
Feet must be binary under syllabic or moraic analysis.

HEAD-MAX
If α is a prosodic head and α Domain(f), then $f(\alpha)$ is a prosodic word.

---

13 Requiring right-alignment to a root will not work, because most of the suffixes of Guaraní are inherently stressed. Further refinement of the analysis may address this issue.

(67) Ranking summary, Guaraní

Ranking	Consequence
ALIGN-R-FT » HEAD-MAX:	Lexical footing which is not right-aligned cannot surface intact.
HEAD-MAX » FT-BIN:	An input lexical foot which is degenerate and right-aligned is preserved in the output as a degenerate foot.
FT-FORM: TROCHEE » FT-BIN	Final stress is footed as a degenerate foot, rather than as an iamb.

While the analysis of Guaraní stress sketched here can doubtless be refined, it is superior to the unbounded foot analyses which preceded it. Further, the positional faithfulness account of Guaraní harmony which makes possible this analysis of stress unifies the positional privilege effects of Guaraní with other cases of positional privilege documented here and elsewhere—making it possible to dispense with any stress-specific restrictions on multiple linking or spreading.

With this understanding of Guaraní stress placement, as well as the core constraints which are responsible for [nasal] spreading, the stage is set for an investigation of positional faithfulness in the language. The properties of the Guaraní harmony system which are relevant here are the role of stress in permitting contrastive nasality and orality in vowels, and the role of stress in delimiting the span of nasal harmony. I will argue that these two properties arise from a high-ranking IDENT-σ'(nasal) constraint. Through domination of the markedness constraint $*V_{nasal}$, IDENT-σ'(nasal) permits nasality contrasts in stressed syllables; through domination of ALIGN-L(nasal), IDENT-σ'(nasal) prevents stressed syllables from undergoing harmony, and prevents vacuous satisfaction of ALIGN-L(nasal) by denasalization of stressed vowels. I will begin by characterizing the stress-sensitive contrastive distribution of nasal and oral vowels in the language.

3.3.3.2 Inventory Facts I: The Distibution of [nasal] in Vowels

As we saw in section 3.2, stress-based neutralization of a featural contrast arises from the interaction of positional and context-free faithfulness constraints with some set of markedness constraints. In the case of Guaraní, it is the oral/nasal contrast which is neutralized in unstressed vowels; the relevant markedness constraint in this case is $*V_{nasal}$, and the faithfulness constraints are IDENT(nasal) and IDENT-σ'(nasal). The constraint subhierarchy which is responsible for generating the Guaraní pattern must also, through ranking permutation, permit other attested vowel inventories. Languages (such as English) which lack contrastive nasal vowels entirely are characterized by the constraint ranking in (68a). Those languages (such as Bengali) which permit contrastive nasal vowels exhibit the ranking in (68b).

(68) a. No contrastive nasal vowels
$*V_{nasal}$ » IDENT-σ'(nasal) » IDENT(nasal)
b. Nasal vowels occur freely
IDENT-σ'(nasal) » IDENT(nasal) » $*V_{nasal}$

The ranking (68a) will prohibit output nasal vowels, even if nasality is present in the input. This is demonstrated in (69).

(69) No nasal vowels in inventory

/tã/	$*V_{nasal}$	IDENT-σ'(nasal)	IDENT(nasal)
a. ta~'	*!		
b. ☞ tá		*	*

The candidate with a surface oral vowel (69b) is favored, although the input contains a nasal vowel, because the markedness constraint that prohibits nasal vowels, $*V_{nasal}$, dominates all of the faithfulness constraints, including the positional constraint, IDENT-σ'(nasal). Unmarkedness (vowel orality) takes precedence over faithfulness to lexical contrast.

The other constraint ranking, that of (68b), will favor output nasal vowels when [nasal] is present in the input. Tableau (70a) shows the result of an input nasal vowel under such a ranking; tableau (70b) demonstrates the result when the input vowel is oral.

(70) a. Nasal input vowel

/tã/	IDENT-σ'(nasal)	IDENT(nasal)	*V_{nasal}
i. ☞ taˈ~			*
ii. tá	*!	*	

b. Oral input vowel

/ta/	IDENT-σ'(nasal)	IDENT(nasal)	*V_{nasal}
i. taˈ~	*!	*	*
ii. ☞ tá			

Faithfulness to input nasality is paramount in this grammar, meaning that input nasal vowels are free to surface. The presence of stress on the output vowel is not the decisive factor in (70); (70a, i) and (70b, ii) would be optimal even in the absence of stress. The crucial ranking is that of faithfulness above markedness.

In Guaraní, the situation is more complex than in either of the grammars examined above. Nasal and oral vowels may contrast, but only in stressed syllables; elsewhere the contrast is neutralized. This distribution is generated by high-ranking IDENT-σ'(nasal) (71), placed in the familiar positional neutralization constraint subhierarchy as shown in (72) below.

(71) IDENT-σ'(nasal)
Output segments in a stressed syllable and their input correspondents must have identical specifications for the feature [nasal].

(72) Stress-determined neutralization subhierarchy
IDENT-σ'(nasal) » *V_{nasal} » IDENT(nasal)

The application of the subhierarchy in (72) is straightforward, and is shown in (73)–(74) below. In (73), the cooccurrence of stress and nasality is shown, with a surface nasal vowel being favored. (*The effects of nasal harmony are ignored for the moment*.)

(73) Nasal vowel in stressed syllable

/tupaˈ~/	IDENT-σ'(nasal)	*V_{nasal}	IDENT(nasal)
a. tupá	*!		*
b. ☞ tupaˈ~		*	
c. tu~pá	*!	*	*

The constraint hierarchy favors candidate (73b), in which the input nasality is preserved in the stressed syllable. Each of the other candidates fails on high-ranking IDENT-σ'(nasal), by dint of the loss of input nasality from the output stressed vowel. Nasal vowels which are in a lexically stressed syllable must surface as stressed nasal vowels in the output.

Next we consider a hypothetical input in which a nasal vowel does not coincide with lexical stress.

(74) Nasal vowel in unstressed syllable

/tu~pá/	IDENT-σ'(nasal)	*V_{nasal}	IDENT(nasal)
a. ☞ tupá			*
b. tupa~'	*!	*	**
c. tu~pá		*!	
d. tu~pa~'	*!	**	*

In this case, the input nasal vowel surfaces as oral, as in (74a). Candidates (74b) and (74d), in which the input nasal has moved or spread to the stressed vowel, fatally violate IDENT-σ'(nasal) because the stressed vowel is nasal in the output, but its input correspondent is oral. IDENT-σ'(nasal) is not relevant for this candidate; the stressed vowel and its input correspondent are identical with respect to [nasal]. The optimal (74a) also satisfies the markedness constraint *V_{nasal}, which is fatally violated by (74c).

The constraint hierarchy does not force stressed vowels to be nasal, regardless of the input—it only requires that a stressed vowel be nasal if its input correspondent is nasal, and oral if the input correspondent is oral. Marked lexical contrasts are preserved in Guaraní only in the prominent stressed syllable position, by virtue of a high-ranking positional faithfulness constraint. The prominence of stressed syllables and their capacity to support a broad range of lexical constrasts, relative to their unstressed counterparts, are closely related; this relationship is expressed through the constraint subhierarchy in (72).

Prior rule-based analyses of Guaraní do not capture this connection between prominence and inventory markedness. They must stipulate, as does Kiparsky (1985), that [nasal] is underlyingly specified only in stressed syllables, essentially making [±nasal] a diacritic of stress. There are two drawbacks to such an approach. One, parochial to nasal harmony, is that the analysis requires equipollent [nasal]. However, as argued in recent work by Steriade (1992;1993a,b), there is little evidence for phonologically active [–nasal]. For example, although there are many cases of harmony in which [+nasal] spreads (see Anderson 1976, Piggott 1992, Cole & Kisseberth 1995a, and Walker 1995 and references therein for examples), there are no documented cases in which [–nasal] behaves in a parallel fashion, denasalizing underlyingly nasal segments. A feature specification cannot be spread if it does not exist. Similarly, constraints enforcing dissimilarity or disharmony may target sequences of [+nasal] segments, but languages which enforce disharmony over both [±nasal] have not been identified. (Mazateco, for example, prohibits nasal sequences such as [na~], but allows [ta~], [na] and [ta]. In a language with [±nasal] disharmony, both [ta] and [na~] would be impossible, though [na] and [ta~] could surface (Steriade 1993b).) The absence of phonological processes which crucially make reference to [-nasal] suggests that a privative [nasal] feature is sufficient; analyses which require binary [nasal] must therefore be scrutinized carefully.[14]

The second, more serious, objection to the [nasal] underspecification approach arises from the reference to stress in the determination of underlying feature specifications. Looking only at languages such as Guaraní, in which stress is lexical, this reference to stress placement for underspecification of features seems unproblematic; if stress placement cannot be predicted, it must be specified in the lexicon, as must any unpredictable featural properties of the stressed syllables. However, in languages such as Nancowry (Austroasiatic; Radhakrishnan 1981) and Copala Trique (Otomanguean; Hollenbach 1977). which have predictable stress and specific contrasts which are limited to stressed syllables, no coherent underspecification analysis is

14 However, Smolensky (1993) follows a different approach to phonological inactivity, suggesting that it reflects violation of only low-ranking constraints. On this view, [–nasal] does not play a role in phonological processes because the constraints which refer to [–nasal] are ranked below constraints which refer to [+nasal]. For example, the absence of [–nasal] harmonies would result from a ranking in which ALIGN(+nasal) dominates ALIGN(–nasal). Under such a ranking, [+nasal] harmony would take precedence over [–nasal] harmony, as failure to spread [+nasal] would violate higher-ranking ALIGN(+nasal). Note, however, that the ranking of IDENT(nasal) must crucially always dominate ALIGN(–nasal) in order to prevent oral harmony from occurring; without this stipulation, it would be possible for a language to exhibit harmony of both values of [nasal]. Both the desirability and the efficacy of such rankings must be investigated further before this approach can be adopted as an alternative to [nasal] privativity.

possible. A key assumption of theories which adopt underspecification is the principle of Lexical Minimality, which asserts that the optimal lexical representation is that which encodes the least information. Crucially, no predictable information is permitted in underlying forms.[15] Herein lies the problem: [nasal] specifications are unpredictable in stressed syllables, and therefore must be provided in the lexical entry, but stress itself is completely predictable (being final in both languages) and *must not* be included in the lexical entry. Lexical specifications are thus dependent on derived, predictable properties of the output, properties which cannot be accessed in underlying forms. The underspecification approach to stress-based neutralization cannot provide a uniform analysis of both the Guaraní and Nancowry types of examples. In contrast, the positional faithfulness analysis is inherently output-driven, thus avoiding the difficulties which plague the derivational approach.

3.3.3.3 Inventory Facts II: The Distribution of [nasal] in Stops

Before turning to the analysis of long-distance harmony in Guaraní, I need to examine the distribution of the voiced stops. Recall that the voiced consonants in this language alternate predictably according to the nasality or orality of the following vowel. Sonorants are nasal preceding a nasal vowel or voiced stop, and oral otherwise. Similarly, there is no contrast between nasal and non-nasal voiced stops in Guaraní, either in stressed or unstressed syllables. Voiced stops are always partially nasalized in oral contexts, and fully nasal in nasal contexts; they alternate between *ᵐb* and *m*, *ⁿd* and *n*, etc. In effect, the surface realization of onset consonants in Guaraní covaries with the nasality of the following syllable nucleus. An examination of Guaraní words reveals a systematic division between licit syllables (which may occur in either stressed or unstressed position) and illicit syllables:

(75)	a. Licit syllables	b. Illicit syllables
	mã	ma
	ᵐba	ᵐbã
	r~ã	r~a
	ra	rã

[15] See Steriade (1995) for a recent evaluation of this principle, and of underspecification in general.

Roughly speaking, tautosyllabic segments must agree in nasality, though the nasal-oral sequence in ^{m}*ba* appears to be exceptional in this regard. The apparent exceptionality vanishes when the syllables are examined more closely, with attention to the closure and release phases of the segments involved. (I adopt the aperture-based representations of Steriade 1993a,b. Stop releases, vowels and approximants are all represented with an A_{max} aperture position; stop closures are A_0 positions.)

(76) Licit syllables of Guaraní

(77) Illicit syllables of Guaraní

In all of the illicit structures in (77), the release phase of the onset consonant differs from the following vowel in nasality; in the licit cases in (76), the consonant release and the following vowel agree with respect to nasality.

The conspicuous absence of syllable-internal nasal disharmony in Guaraní is mirrored in other languages of Central and South America; relevant examples include Apinayé (Anderson 1976), Parintintin (Hart 1981), Maxakalí (Gudschinsky et al., 1970) and Chiquihuitlan Mazatec (Jamieson 1977). (See Anderson 1976, Hart 1981 and Suárez 1983, and references therein, for further examples and discussion.) Syllable-internal nasal harmonies have also been documented in some dialects of Chinese, such as Chaoyang (Yip 1994), and in some languages of Africa (see Pulleyblank 1989 on Akan). The widespread occurrence of syllable-level nasality suggests a markedness constraint favoring agreement in CV and VC sequences.[16,17] Observing that the aperture positions of identical stricture are the positions which must have identical

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16 While many examples involve onset-nucleus agreement, some languages (such as Maxakalí and Apinayé) exhibit nasal harmony in VC sequences as well. I am unaware of any cases in which only VC sequences agree in nasality.

17 In his analyses of Guaraní and Southern Barasano, Piggott (1992) proposes a rule of Voice Fusion, by which the Spontaneous Voicing nodes of all segments within a given syllable are fused, with the SV node of the syllable head being dominant. This rule ensures that “a syllable must either be oral or nasal” (Piggott 1992: 55).

nasality (cf. (76) and (77) above), I will assume the constraint (formulated provisionally) in (78) below. UNIFORM(nasal) calls for agreement in nasality/orality in the stricturally uniform portions of the syllable, capitalizing on the finding that segments which are similar are more likely to interact. (See Hutcheson 1973; Selkirk 1988, 1993; Kiparsky 1988; Fu 1990; Padgett 1991; Lamontagne 1993; Pierrehumbert 1993; Itô, Mester & Padgett 1995; Frisch 1997 for discussion and proposals regarding the role of similarity in phonological interaction.)

(78) UNIFORM(nasal)
For all *x* and all *y*, where *x* and *y* identical aperture positions dominated by a single syllable node, *x* = [nasal] *y* = [nasal]
"Within a syllable, stricturally identical positions must be of uniform nasality."

This constraint will prohibit a tautosyllabic sequence of oral release + nasal vowel, or of nasal release + oral vowel; sequences of an approximant consonant and a tautosyllabic vowel will be similarly regulated.

UNIFORM(nasal), by forcing onset-nucleus agreement in nasality, addresses an interesting aspect of inventory structure in Guaraní and other languages with a chameleon-like series of voiced stops. Many authors, among them Steriade (1993b) and Walker (1995), assume a phonemic series of voiced or prenasal stops, with nasal variants derived by the application of nasal harmony. That is, /^{m}b/ or /b/ is realized as [m] before a nasal vowel, and as a prenasal [^{m}b] before an oral vowel.[18] The resulting inventory is quite unusual, typologically; these languages lack both a plain voiced oral stop series and a fully nasal series, opting instead for a set of prenasal contour segments.[19] This selection is particularly puzzling when viewed in

[18] Steriade (1993b) argues for the prenasal variant as the underlying form due to the alleged privativity of [nasal]; without a [–nasal] value, following oral vowels cannot spread their orality to a preceding fully nasal stop. However, spreading of [–nasal] is not required in a constraint-based analysis of the facts, as uniform specification can be defined over the presence or absence of a privative [nasal] specification.

[19] A search of the expanded UPSID database (Maddieson & Precoda 1992) reveals that only 19/451, or 4%, of the languages in the database, show a voicing contrast in the labial oral stops without a contrastive labial nasal stop. At least some of these cases (Maxacalí and Apinaye) exhibit the "chameleon" voiced series, alternating between nasal stops and (prenasal) voiced stops.

The absence of a phonemic distinction between oral and nasal consonants is very rare indeed, and the constraints which determine inventory structure should reflect this rarity. Thinking in terms of Flemming's (1995) work on contrast and inventory shape, the relevant MAINTAINCONTRAST constraint(s) must be very high-ranking in most grammars (though obviously able to be overridden in languages such as Guaraní).

terms of simplex vs. complex segments. Prenasal contour segments are crosslinguistically less frequent than either fully oral or fully nasal stops, a fact which must be reflected by means of markedness constraint ranking: *PRENASAL » *[–son, –cont, voice], *[+son, –cont, voice]. Given this ranking relation, along with an input such as (79a), the fully faithful candidate can triumph over (79b,c) only if there is some constraint which dominates *PRENASAL.

(79) a. Input prenasal b. Surface nasal c. Surface voiced stop

In Guaraní, the markedness constraint which dominates *PRENASAL, compelling the appearance of surface prenasal segments, is UNIFORM (nasal). Surface variation in the nasal stop series is induced by syllable-internal harmony requirements, rather than by some constraint favoring (highly-marked) contour segments. Guaraní data such as (80) highlight key aspects of the constraint ranking which must hold in the grammar of the language.

(80) Stops in oral and nasal contexts (Rivas 1975:135–136)

r~o~**m**o~**p**o~r~a~' 'I embellished you' r~o~**mb**o©watá 'I made you walk'

no~r~o~he~ndúi 'I don't hear you' **nd**orohaìhúi 'I don't love you'

Focusing on the boldface segments in (80), two points are clear. First, the voiced stops are always at least partially nasal, even in oral contexts. This suggests a high-ranking, phonetically-grounded constraint VOINAS, reflecting the fact that voicing is articulatorily facilitated by velum lowering (see Henton, Ladefoged & Maddieson 1992 and Iverson & Salmons 1996 for recent discussion of the connection between nasalization and voicing, and Itô, Mester & Padgett 1995 for the related constraint NASVOI).

(81) VOINAS
[voice, A_0] ∅ [nasal]
"A voiced stop must be nasal."

In Guaraní, this constraint takes priority over the markedness constraint *C_{nasal}, which penalizes nasal consonants; it forces the voiced stops to be minimally prenasal. It must also take precedence over *PRENASAL, the constraint which penalizes nasal contour segments; otherwise, prenasalization would not be possible.

The second point, related to the first, is that the voicing contrast in stops is always maintained in Guaraní. Voiced stops in oral contexts do not devoice in order to better satisfy VOINAS and $*C_{nasal}$, indicating that IDENT(voice) dominates both constraints. This is illustrated in (82), where either an oral or a nasal voiced stop could be the input.

(82) Input voiced stops do not devoice

/bo/, /mo/	IDENT(voi)	VOINAS	*PRENAS	$*C_{nasal}$
a. ^{m}bo			*!	*
b. bo		*!		
c. po	*!			
d. ☞ mo				*

As (82) shows, this constraint ranking rules out uniformly oral voiced stops, ruling in favor of the uniformly nasal stop of (82d). High-ranking IDENT(voice) and VOINAS ensure that the voiced stops will be minimally prenasal, with nasality on the closure, regardless of the input. *PRENASAL militates in favor of the fully nasal consonant.

Given Richness of the Base, a fundamental precept of Optimality Theory, both inputs, /mo/ and /bo/, must be possible inputs to the grammar, and both must converge on actually occurring surface forms of Guaraní. Because there are no fully oral voiced stops in the language, VOINAS must dominate IDENT(nasal). Under this ranking, input /bo/ can never surface as [bo], but is forced to surface as [mo], an impossible syllable of Guaraní, by the markedness constraint *PRENASAL. Input /mo/ is also incorrectly predicted to surface as [mo]. This is shown in (83) and (84) below. (Violations of IDENT(nasal) are reckoned in terms of individual aperture nodes in the following tableaux.[20] *PRENASAL » IDENT(nasal) on the assumption that prenasal stops

[20] This method of assessing faithfulness seems to be necessary for the following reason. If nasalization of a release position which is non-nasal in the input does not incur a faithfulness violation, there is no means of forcing input $^m b$ to remain $^m b$ in outputs, rather than surfacing as the fully nasal and less marked *m*. Such a result would be disastrous for languages which maintain a contrast between prenasal and nasal segments in the context of a following oral vowel.

are more marked than nasalized vowels; as we saw above, $*V_{nasal}$ » IDENT(nasal), so (by transitivity of ranking, *PRENASAL » IDENT(nasal).)

(83) Input voiced stops may not be faithful

/bo/	IDENT(voi)	VOINAS	*PRENASAL	IDENT(nasal)
a. ᵐbo			*!	$\mathbf{A_0}$
b. bo		*!		
c. po	*!			
d. ☞ mo				$\mathbf{A_0, A_{max}}$

(84) Input nasal stops must stay nasal

/mo/	IDENT(voi)	VOINAS	*PRENASAL	IDENT(nasal)
a. ᵐbo			*!	$\mathbf{A_{max}}$
b. bo		*!		$\mathbf{A_0, A_{max}}$
c. po	*!			$\mathbf{A_0, A_{max}}$
d. ☞ mo				

The optimal candidate in these tableaux is not actually attested in the language. A fully nasal [m] is possible only if the following vowel is also nasal; this is true of both stressed and unstressed syllables. Some additional constraint must be responsible for ruling out the [mo] sequence.

UNIFORM(nasal) is clearly relevant to these examples. Recall that UNIFORM(nasal) requires identity of [nasal] specification in a vowel (an A_{max} position) and the preceding tautosyllabic consonant release (also an A_{max} position). Candidates (83d) and (84d) violate UNIFORM(nasal) because the vowel and the preceding A_{max} position are not identical with respect to nasality; this violation will prove to be fatal. Confining our attention to stressed syllables, which are subject to the most stringent faithfulness requirements, it is clear that UNIFORM(nasal) must dominate IDENT(nasal), as onset consonants must be brought into conformity with the following vowels. Crucially, it is the nasality or orality of the vowel which is maintained; if unfaithfulness is necessary to satisfy UNIFORM(nasal), it is always the onset consonant which is altered. This suggests that IDENT-σ'(nasal) is actually a constraint on faithfulness in stressed syllable *heads*, the stressed vowels themselves.[21] The facts of nasal

[21] Alternatively, it may be necessary to assume dispersion of IDENT-σ' into head and non-head faithfulness constraints. Examples in which the onsets of stressed syllables exhibit positional faithfulness

harmony in Guaraní further support this conclusion, as onsets of stressed syllables, but crucially not stressed syllable nuclei, are affected by [nasal] spreading. Returning our attention to the syllable-internal distribution of [nasal], we can see that the hierarchy in (85) does generate the correct results.

(85) Nasal-oral sequences are not permitted

/mó/	VoiNas	Uniform(nasal)	Ident-σ'(nasal)	*PreNasal	Id(nasal)
a. ☞ ᵐbó				**ᵐb**	**A_{max}**
b. mó		*!			
c. mo~'			A_{max}!		**A_{max}**
d. bó	*!				**A_0, A_{max}**

The oral syllable (85a) is selected as optimal by this grammar, as its closest competitor (85c) incurs a fatal violation of Ident-σ'(nasal).

Similar results obtain when another disharmonic input is considered, namely the sequence of a prenasal stop followed by a nasal vowel, as in (86). Here, however, the fully nasal output will win, because Ident-σ'(nasal) favors retention of the vowel's input nasality.

(86) Prenasal-nasal sequences are not permitted

/ᵐbo~'/	VoiNas	Uniform(nasal)	Ident-σ'(nasal)	*PreNasal	Id(nasal)
a. ᵐbó			A_{max}!	**ᵐb**	**A_{max}**
b. ᵐbo~'		*!		**ᵐb**	
c. ☞ mo~'					**A_{max}**
d. mó		*!	A_{max}!		**A_{max}, A_{max}**

Here again the two candidates which respect Uniform (nasal) are distinguished by Ident-σ'(nasal), and the fully nasal (86c) is selected as optimal.

In order to verify that the grammar requires syllable-internal uniformity in all cases, the other logically possible permutations of consonant and vowel nasality in inputs are considered in (87)–(88).

effects would constitute evidence for such dispersion. Various dialects of Scots Gaelic, in which aspiration is contrastive only on consonants in stressed syllables (Børgstrom 1940, Flemming 1993), may be such a case.

(87) Prenasal-oral input

/ᵐbó/	VOINAS	UNIFORM(nasal)	IDENT-σ'(nasal)	*PRENASAL	ID(nasal)
a. ☞ ᵐbó				**ᵐb**	
b. ᵐbṍ		*!	A_{max}!	**ᵐb**	**A_{max}**
c. mṍ			A_{max}!		**A_{max}, A_{max}**
d. mó		*!			**A_{max}**

(88) Uniformly nasal input

/mṍ/	VOINAS	UNIFORM(nasal)	IDENT-σ'(nasal)	*PRENASAL	ID(nasal)
a. ᵐbó			A_{max}!	**ᵐb**	**A_{max}, A_{max}**
b. ᵐbṍ		*!		**ᵐb**	**A_{max}**
c. ☞ mṍ					

As expected, inputs which respect UNIFORM (nasal) are simply reproduced faithfully in the output.

Faced with this array of possibilities, the acquisition-minded reader may feel concern; what are the actual underlying forms in Guaraní? Here Prince & Smolensky's (1993) principle of Lexicon Optimization, stated in (89), will be called upon.

(89) Lexicon Optimization (formulation from Itô, Mester & Padgett 1995)
Of several potential inputs whose outputs all converge on the same phonetic form, choose as the real input the one whose output is the most harmonic.

Given a choice of inputs which yield the same surface result, the language learner will select as the underlying representation that input which most closely resembles the output form. Examining tableaux (85)–(88), we find that there are two phonetically distinct optimal outputs, and two inputs which converge on each output. The inputs and their output are arrayed in the tableaux des tableaux in (90) and (91).

(90) Evaluating outputs of possible input forms I

Input	Output	VOINAS	UNIFORM(nasal)	ID-σ'(nasal)	*PRENASAL	ID(nasal)
a. ☞/mo\~'/	☞ mo\~'					
b. /ᵐbo\~'/	☞ mo\~'					A_{max}!

(91) Evaluating outputs of possible input forms II

Input	Output	VOINAS	UNIFORM(nasal)	ID-σ'(nasal)	*PRENASAL	ID(nasal)
a. /mó/	☞ ᵐbó				ᵐb	A_{max}!
b. ☞ /ᵐbó/	☞ ᵐbó				ᵐb	

Lexicon Optimization rules in favor of the fully nasal input in (90), and the prenasal-oral input in (91). Each is the input to which the optimal output is most faithful. In the absence of surface alternations (e.g. for root-internal syllables), only uniformly oral or nasal syllables will be posited in underlying representation.

Having characterized the contrastive distribution of nasal vowels (§3.3.3.2), and the syllable-internal restrictions on nasality (§3.3.3.3), we can now turn to the role of IDENT-σ'(nasal) in the long-distance nasal harmony in Guaraní. The rankings which have been motivated thus far in the analysis are summarized in (92) below, with supporting data and tableaux cited where relevant.

(92) Interim ranking summary

a. IDENT-σ'(nasal) » $*V_{nasal}$
Nasal vowels occur contrastively in stressed syllables. (73)

b. $*V_{nasal}$ » IDENT(nasal)
Nasal vowels are not contrastive in unstressed syllables. (74)

c. VOINAS » *PRENASAL, IDENT-σ'(nasal) » IDENT(nasal)
All voiced stops are at least partially nasal, regardless of position or input nasality. (82, 83, 84)

d. UNIFORM(nasal), *PRENASAL, IDENT-σ'(nasal) » IDENT(nasal)
Syllable onsets and nuclei must agree in nasality. (85)–(88)

3.3.3.4 Regressive Nasal Harmony

Outside of stressed syllables, the orality or nasality of vowel and consonant segments is predictable. It is to the characterization of this predictable distribution that I now turn. As noted at the outset of this section, I will adopt an analysis of nasal harmony in which spreading is strictly local (by virtue of an undominated NOGAP constraint), and is driven by high-ranking ALIGN(nasal) constraints. In the case of Guaraní, the nasal harmony is primarily leftward. This indicates that ALIGN-L(nasal) is high-ranking. Crucially, however, ALIGN-L(nasal) must be dominated by IDENT-σ'(nasal), in order to derive the resistance of stressed oral vowels to regressive nasal harmony. This is a specific instantiation of the general schema for positional resistance to phonological processes, shown in (93); $\mathbb{C}$ is any structural markedness constraint:

(93) Positional resistance schema
IDENT-*Position*(F) » $\mathbb{C}$ » IDENT(F)

(94) Stressed syllable resistance to nasal harmony
IDENT-σ'(nasal) » ALIGN-L(nasal) » IDENT(nasal)

In (94), $\mathbb{C}$ is instantiated by the structural constraint ALIGN-L(nasal). The resulting constraint subhierarchy will compel nasal harmony, but will crucially prevent it from applying to stressed oral vowels. This is guaranteed by the ranking IDENT-σ'(nasal) » ALIGN-L(nasal). The opposite ranking would result in unbounded leftward nasal harmony, with both stressed and unstressed oral vowels undergoing nasal harmony.

To demonstrate the nasal harmony subhierarchy (94) in action, I will begin with a simple case of leftward nasal harmony which affects all preceding segments; an example of this type is *p~înr~în'* ‘to shiver’. The stress-restricted contrastive distribution of [nasal] in the language follows from the ranking IDENT-σ'(nasal) » $*V_{nasal}$ » IDENT(nasal), as we saw in (73) above. Within the syllable, nasal harmony is forced by the ranking of UNIFORM(nasal) above IDENT(nasal). The interaction of these two subhierarchies with ALIGN-L(nasal) is shown in (95). (No candidates which violate undominated NOGAP are considered.)

(95) Nasal harmony from stressed syllable

/pir~în'/	UNIFORM(nasal)	IDENT-σ'(nasal)	ALIGN-L(nasal)	*V_{nasal}	ID(nasal)
a. ☞ p~înr~în'				**	**
b. pirí		A_{max}!			**
c. pir~în'			**!	*	

Candidate (95b) is immediately ruled out by the loss of input nasality from the output stressed vowel and consonant. Of the remaining two, (95c) fatally violates ALIGN-L. Candidate (95a) is optimal. The fact that nasal harmony *does* apply in this context indicates that ALIGN-L(nasal) » *V_{nasal}; otherwise, no spreading of [nasal] from the stressed vowel would be possible.

Nasal harmony is also triggered by the nasal closure of a prenasal stop. This follows straightforwardly from the constraint hierarchy in (95), with nasal closure forced by undominated VOINAS. An example is given in tableau (96), for the form ãñe~r~e~ⁿdú 'I hear myself'.

(96) Nasal harmony from a prenasal stop

/a+y‡e+reⁿdú/	VOINAS	UNIFORM(nas)	ID-σ'(nasal)	ALIGN-L	*V_{nasal}	ID(nasal)
a. ☞ãñe~r~e~ⁿdú					***	*****
b. ay‡ereⁿdú				*!****		
c. ãñe~r~e~nu~'			A_{max}!		****	******
d. ay‡eredú	*!					*

ALIGN-L(nasal) requires that the nasality on the closure of the prenasal stop be spread to the left edge of the phonological word, in the same way that the nasal feature of a stressed nasal vowel must also be spread. Denasalization is not permitted, though it would result in better satisfaction of *V_{nasal} and IDENT(nasal), due to VOINAS.

Now we turn to a more complex case, in order to highlight the role of IDENT-σ'(nasal) in limiting the span of nasal harmony. As shown in the data in (61) above, nasal harmony is blocked by a stressed oral vowel: /re+xó+ta+ramo~'/ 'if you go' surfaces as [rexótãr~a~mo~'], not *[r~e~xo~'ta~r~a~mo~'] (Poser 1982:130). This follows from the ranking in (95) and (96), as tableau (97) will demonstrate.

(97) Stressed oral vowel blocks harmony

	/re+xó+ta+ramo~'/	IDENT-σ'(nasal)	ALIGN-L(nasal)	*V_{nasal}	ID(nasal)
b. ☞	rexót^{n}ãr~a~mo~'		****	***	****
c. mo~'	r~e~x~o~'t^{n}ãr~a~	*!		*****	********

Candidate (97a), which lacks nasal harmony entirely, is ruled out by ALIGN-L(nasal). Conversely, full alignment is prevented by high-ranking IDENT-σ'(nasal), as shown in (97b); the stressed oral vowel simply cannot be successfully nasalized. The optimal candidate, (97c), satisfies IDENT-σ'(nasal) and incurs fewer violations of ALIGN-L(nasal) than does (97a).

3.3.3.5 Summary

We have seen that the limited contrastive distribution of nasal vowels, as well as the stressed-based restrictions on nasal harmony, derived from a high-ranking IDENT-σ'(nasal) constraint. Both patterns of behavior follow from slightly different instantiations of the canonical positional faithfulness constraint subhierarchy schematized in (98) below.

(98) Positional faithfulness subhierarchy, schematic

IDENT-*Position*(F) » $\mathbb{C}$ » IDENT(F)

Depending on the nature of the constraint(s) $\mathbb{C}$ which intervene in (98), different patterns of positional faithfulness behavior are generated.

In Guaraní, positional restrictions on the distribution of phonemic nasal vowels (i.e. nasal vowels contrast only in stressed syllables) arise from the ranking of the segmental markedness constraint *V_{nasal} between the IDENT(nasal) constraints. $\mathbb{C}$ = *V_{nasal}.

(99) Positional limitations on phonemic nasal vowels

IDENT-σ'(nasal) » *V_{nasal} » IDENT(nasal)

In a parallel fashion, positional resistance to the application of a phonological process (i.e. stressed syllables block nasal harmony) results from the ranking of ALIGN-L(nasal) between the IDENT(nasal) constraints; $\mathbb{C}$ = ALIGN-L(nasal).

(100) Positional blocking of nasal harmony

IDENT-σ'(nasal) » ALIGN-L(nasal) » IDENT(nasal)

Guaraní is able to exhibit both types of positional behavior simultaneously because both of the relevant markedness constraints interrupt the faithfulness subhierarchy, and because ALIGN-L(nasal) dominates $*V_{nasal}$:

(101) A multiplicity of positional effects

IDENT-σ'(nasal) » ALIGN-L(nasal) » $*V_{nasal}$ » IDENT(nasal)

In characteristic OT fashion, ranking permutation will generate different patterns of nasal behavior. For example, if the intervening markedness constraints are reranked, the result will be a language which limits phonemic nasal vowels to stressed syllables but prohibits nasal harmony:

(102) Positional neutralization without harmony

IDENT-σ'(nasal) » $*V_{nasal}$ » ALIGN-L(nasal) » IDENT(nasal)

Exactly this pattern of behavior is attested in Nancowry, an Austroasiatic language of the Nicobar islands (Radhakrishnan 1981).

In the preceding sections, I have developed and applied an analysis of nasal distribution and nasal harmony in Guaraní which utilizes positional faithfulness constraints. Through constraint ranking, positional faithfulness is able to unify three distinct, but related, aspects of Guaraní phonology: stress-based restrictions on the distribution of contrastive nasality, stress-based triggering of nasal harmony, and stress-based blocking of the harmony process. Now I will return to a comparison of positional faithfulness and positional licensing. In the analysis of vowel reduction (§3.2.3), the two approaches provide the same empirical coverage, making them difficult to distinguish. However, as we will see, the stress-triggering and blocking effects in Guaraní nasal harmony highlight key differences in the theories, and provide a strong challenge to positional licensing.

3.3.4 Faithfulness vs. Licensing II

As I discussed in Chapters 1 and 2, feature licensing has been the prevalent analysis applied to positional asymmetries in phonology since the work of Itô (1986). Licensing theory recognizes that certain prosodic positions or contexts, such as syllable codas, are weak; they are incapable of supporting marked features or feature combinations. If marked features are to surface in a weak position (such as an unstressed syllable), they must be licensed by association to a strong position (such as a stressed syllable). Licensing analyses employ two types of constraints. One is a negative well-formedness constraint, familiar from the work of Itô (1986, 1989), Lombardi (1991) and Itô & Mester (1993, 1994) (among others), which penalizes the appearance of features in a weak position. Such constraints may be satisfied by parasitic licensing, which arises when the features in question are linked also to a strong position. A simplified version of the nasal licensing constraint for Guaraní is given in (103).

(103) Nasal licensing, negative formulation

The second type of licensing constraint which has appeared in the literature (Goldsmith 1989, 1990; Bosch & Wiltshire 1992; Wiltshire 1992; Flemming 1993; Steriade 1995) is a positive licensing constraint, which demands the appearance of the features in a strong position. Flemming's (1993) nasal licensing constraint for Guaraní is given below.

(104) Nasal licensing in Guaraní (Flemming 1993; see also Steriade 1995)

[+nasal] must be licensed:

(i) in at least one associated segment, by the presence of [–continuant] [JNB: permits prenasal consonants] or by association to a mora in a stressed syllable, and

(ii) in every segment by the presence of [+voice][22]

Either type of constraint will be satisfied by a [nasal] specification which is shared by a segment in an unstressed syllable and one which appears in a stressed position, regardless of the input source of that [nasal] specification. This is the crucial point of difference between licensing theory and positional faithfulness theory: positional faithfulness requires features which originate in prominent positions to remain in those positions, while licensing theory requires only that features be associated to a prominent position. This allows features to migrate into prominent positions, thereby altering their specifications.

[22] The second clause prohibits association of [nasal] to the voiceless stops, a departure from the positional faithfulness analysis presented earlier. This difference is not crucial to the comparison of the two theories.

Let us consider Flemming's analysis of Guaraní more closely. In addition to the licensing constraint of (104), Flemming also posits a rule of leftward spreading, which is necessary to account for nasal harmony.

(105) Nasal harmony
Spread [+nasal] to the left iteratively.

Although Flemming's analysis is formulated in a mixed model, combining both constraints and rules, it can easily be translated into a fully constraint-based framework, simply by treating nasal harmony as the product of constraint interaction.

(106) ALIGN-L(nasal) » *V_{nasal}, IDENT(nasal)

This subhierarchy will force leftward spreading of [nasal], at the expense of segmental markedness and featural faithfulness; this hierarchy, or one with comparable effects, is essential if feature spreading is to occur.

The combination of the constraint subhierarchy in (106) with the nasal licensing constraint of (104), properly ranked, will yield the OT equivalent of Flemming's analysis. What is the proper ranking of LICENSE(nasal)? The constraint must dominate *V_{nasal}, else no nasal vowels would ever be possible, even in stressed syllables. This is shown in (107).[23]

(107) Nasal vowel in stressed syllable

/tupa~'/	LICENSE(nasal)	*V_{nasal}	IDENT(nasal)
a. tupá			*
b. ☞ tupa~'		*	
c. tu~pá	*!	*	*

As in the positional faithfulness analysis, input nasality on stressed syllables is maintained in output forms. Minimally, then, the ranking in (108) is required.

(108) [nasal] licensing ranking, Guaraní
LICENSE(nasal), ALIGN-L(nasal) »*V_{nasal}, IDENT(nasal)

23 While *V_{nasal} » IDENT(nasal) is crucial in the positional faithfulness analysis, it need not be fixed in the licensing account. This is because the positional restriction on nasality is accomplished in the licensing analysis by the dominant LICENSE(nasal) constraint.

Now let us consider the treatment of nasal harmony in this theory. The blocking behavior of stressed oral vowels is problematic for licensing theory, regardless of the relative ranking of LICENSE(nasal) and ALIGN-L(nasal). This is because [+nasal] is licensed whenever it is associated to a stressed syllable, *regardless of its input source*. The underlying nasality/orality of the stressed vowel is irrelevant. Spreading of [+nasal] to a stressed oral vowel does not violate any constraint in the system, other than IDENT(nasal), and leads to better satisfaction of higher-ranking ALIGN-L(nasal). This is shown in (109), with the input /re+xó+ta+ramo~ˈ/.

(109) Stressed oral vowels cannot block harmony

/re+xó+ta+ramo~ˈ/	LICENSE(nasal)	ALIGN-L(nasal)	*V$_{nasal}$	ID(nasal)
a. rexòtãr~ãmo~ˈ		*!****	***	***
b. ☞ r~e~xo~ˋtãr~ãmo~ˈ			*****	******

Given these constraints, the licensing predicts maximal spreading of [+nasal] to any and all vowels, including those which are stressed. There is nothing in the system to block spreading onto a stressed oral vowel, and no reranking of LICENSE and ALIGN-L can address the problem.

This problem is not parochial to a constraint-based approach; it arises also in the derivational analysis proposed in Flemming (1993). In order to prevent spreading of [nasal] to stressed syllables, Flemming proposes a ban on multiple-linking across foot boundaries.

(110) Foot-bounded linking (Flemming 1993: 2)
[αF] cannot associate to two positions unless they are in the same foot.

If this constraint is added to the hierarchy in (109), ranked crucially above ALIGN-L(nasal), full spreading of [nasal] will be prevented, as shown in (111); foot structure is indicated with parentheses.

(111) Foot-bounded linking creates blocking effects

/re+xó+ta+ramo~ˈ/	FT-BNDLINK	LIC(nasal)	ALIGN-L(nasal)	$*V_{nasal}$	I_D(nasal)
a. ☞(rexò)(tãr~ãmo~ˈ)			*****	***	***
b. (r~e~xo~ˋ)(tãr~ãmo~ˈ)	*!			*****	******

With the inclusion of this domain-sensitive ban on multiple linking, the licensing theory can provide an empirically adequate analysis of the Guaraní facts, but the proposed account is not without disadvantages. First, in order for the ban on multiple linking to achieve the desired effect, namely the blocking of harmony by stressed syllables, Flemming must assume that feet in Guaraní are unbounded. Without this assumption, the ban is useless; if Guaraní feet are binary trochees, then nasal spreading must affect some syllables which are outside of the triggering foot (*ta*, in the example in (111)), but not others—crucially, those which are themselves stressed. However, as discussed above, the unbounded foot is a construct which finds little support in the metrical literature or in stress systems of the world's languages. Furthermore, the only evidence for foot structure is drawn from the limitations on harmony, the very behavior that the foot structure is posited to explain.

A second drawback to the licensing approach resides in the highly specific character of the ban on multiple-linking. Only in the domain of stress-based phenomena is there a demonstrated need for this type of constraint; in other cases of positional privilege, such as coda-onset asymmetries, there is no evidence of any prohibition on multiple linking across a domain boundary. Indeed, multiple linking across a syllable boundary appear to be the *favored* configuration in the coda-onset case. The ban on linking from foot to foot should be viewed with skepticism, as it sets stress-based positional asymmetries apart from those which are documented for other prominent positions. By contrast, the positional faithfulness analysis of Guaraní blocking unites the phenomenon with the other stress-based asymmetries in the language. Furthermore, the same pattern of constraint interaction extends without stipulation to other known cases of positional privilege, including onset/coda, root-initial/non-initial, and root/non-root asymmetries.

3.4 Conclusions

Stressed syllables are salient in human language, due to phonetic properties which set them apart from their unstressed counterparts. These properties include increased amplitude, increased duration, and, in many languages, the presence of fundamental frequency extrema. This phonetic salience equips stressed syllables with the ability to convey a wide range of marked features and segments. In this chapter, I have argued that this perceptual salience is exploited directly in the phonological component of the grammar, via positional faithulness constraints which assess input-output faithfulness in stressed syllables, exactly as we have seen in the cases of onset and initial-syllable faithfulness.

Three predictions arise from the addition of IDENT-σ' constraints to the grammar. First, stressed syllables should exhibit a larger and more marked inventory of segments than unstressed syllables. Separately rankable IDENT-σ' and IDENT constraints will permit the intervention of inventory-defining featural markedness constraints, as schematized in (112).

(112) IDENT-σ'(F) » *F » IDENT(F)

This is the subhierarchy which is characteristic of unstressed vowel reduction (as well as other varieties of stress-based positional neutralization) and, as we have seen, there are numerous examples which instantiate this ranking. The distribution of [±ATR] in Western Catalan, for instance, arises from just this ranking.

The second prediction of stress-based positional faithfulness is that stressed syllables will trigger phonological processes. This, too, arises from the separability of IDENT-σ' and IDENT in the constraint hierarchy. Phonological processes such as assimilation and dissimilation arise when a markedness constraint such as *MID, *LABIAL or ALIGN(F) dominates a conflicting faithfulness constraint. For example, nasal harmony in Guaraní derives from the ranking in (113).

(113) Guaraní nasal harmony
ALIGN-L(nasal) » *V_{nasal} » IDENT(nasal)

Faithfulness is subordinated to the higher-ranking markedness constraints. In this system, spreading is triggered by the stressed syllable, due to high-ranking IDENT-σ'(nasal):

(114) IDENT-σ'(nasal) » ALIGN-L(nasal) » $*V_{nasal}$ » IDENT(nasal)

Finally, positional faithfulness constraints predict that segments in stressed syllables will exhibit resistance to the application of phonological processes. Once again, through dominance of the constraint subhierarchy which generates some phonological alternation, positional faithfulness constraints will render prominent positions immune to change. This is demonstrated by the stressed syllables of Guaraní; whether they bear primary or secondary stress, they fail to undergo nasal harmony, due to high-ranking IDENT-σ'(nasal).

In the preceding sections, I have shown that the predictions of positional faithfulness theory, demonstrated for syllable onsets in Chapter 1 and for initial syllables in Chapter 2, are borne out in the domain of stress as well. The distribution of marked segments and the behavior of stressed syllables with respect to phonological processes stand as strong evidence in support of IDENT-σ' constraints. Furthermore, alternative analyses which attempt to characterize positional faithfulness phenomena in terms of positional licensing constraints cannot rise to the occasion. As we saw in the licensing analysis of Guaraní in §3.3.4, in the absence of positional faithfulness, it is necessary to adopt a stress-specific ban on multiple linking, as well as an unmotivated analysis of stress placement. By contrast, the faithfulness analysis adopted here requires no special assumptions, either in the domain of foot structure or multiple linking, providing further evidence for the correctness of positional faithfulness as a general means of accounting for positional asymmetries in phonology.

CHAPTER 4

ROOT FAITHFULNESS

4.1 Introduction

In the preceding chapters, I have examined positional privilege effects in a variety of positions which are defined either partially or entirely in phonological terms. Positional faithfulness effects are also exhibited by root morphemes, a category in which membership is determined solely by morphological criteria. The dispersion of faithfulness constraints along root/non-root lines, originally proposed and developed by McCarthy & Prince (1994b, 1995), has been applied to both featural and segmental faithfulness constraint families.

Cross-linguistically, root morphemes exhibit a more extensive and more marked inventory of segments, and of prosodic structures, than do affixes and content morphemes. Examples of such asymmetries, accounted for with high-ranking root faithfulness constraints, include the restriction of Arabic pharyngeal consonants to roots (McCarthy & Prince 1995:365), the absence of contrastive [back] specifications on affixes in Turkish, Hungarian, Finnish and a number of other Uralic and Altaic languages (Steriade 1993c, 1995; McCarthy & Prince 1995:365; Ringen 1997; Ringen & Vago 1997), and the limitation of laryngealized stops to roots in Cuzco Quechua (Parker 1997). A more complex case of morphologically dispersed faithfulness can be found in Japanese, where the accent patterns of nouns exhibit greater variety and more contrasts than do those of verbs; Smith (1996) proposes that this distinction is enforced by a ranking of noun faithfulness over verb faithfulness, with a necessary dispersion of root faithfulness constraints according to lexical category. In a related vein, Urbanczyk (1996) argues that reduplicative affixes in Lushootseed fall into two classes, those which pattern with roots, and those which pattern with the clearly affixal, non-reduplicative morphemes in the language. Those affixes which are root-like exhibit more marked syllable structure (allowing codas) than do the "true" affixes (prohibiting codas).

Root morphemes also exhibit privileged behavior in the presence of phonological alternations, triggering or failing to undergo processes which affect affixes. Perhaps the most familiar examples are cases of root-controlled vowel harmony, in which the values of a particular feature are spread from root to affix, but not vice versa. The familiar palatal and labial harmonies of Turkish, Finnish, Hungarian and a host of related languages fall into this class. Derived environment effects on the application of featural spreading rules have also been attributed to high-ranking root faithfulness constraints by Selkirk (1995). The dominance of root properties emerges in stress systems as well. In one case, that of Cupeño, stress clash between inherently stressed morphemes is resolved in favor of the lexical stress on the root, regardless of the linear position of the lexical stresses in question (Alderete 1997b). (That is, root stress "wins" over both prefix and suffix stress, though inherent affix stress does surface in the presence of an unaccented root.)

There is psycholinguistic evidence for the hegemony of roots over affixes, as well. A variety of recognition studies have provided support for the claim that lexical storage and access are root, rather than affix, based. Some of this evidence is summarized in (1).

(1) Processing evidence for root prominence

- Regularly inflected forms have a priming effect on root comparable to effect of bare root itself (Stanners et al 1979, Kempley & Morton 1982, Fowler et al 1985). For example, presentation of "pouring" facilitates later recognition of "pour" to the same extent that prior presentation of the bare root itself does.
- Same/different judgments are faster for roots than for inflections (Jarvella & Meijers 1983). Subjects can more quickly determine that "pouring" and "poured" contain the same root than they can determine that "kissed" and "poured" contain the same inflectional affix.
- Morphologically complex words are recognized more quickly following the presentation of another word containing the same root, but prior presentation of an affix does not produce the same effect (Emmorey 1989). For example, recognition of "permit" is facilitated by prior presentation of "submit", but the prior presentation of "submit" does not speed the recognition of "subscribe".

The importance of roots in processing, as opposed to affixes and non-root function items, is mirrored in the grammar in the form of positional faithfulness constraints which are sensitive to root membership. I turn now to an examination of the role of featural IDENT-ROOT constraints in a number of languages.

4.2 Contrast Maintenance in Roots

4.2.1 Introduction

As we have seen in the preceding chapters, positional maintenance of contrast is one type of positional privilege effect which can be captured via high-ranking positional faithfulness constraints. Syllable onsets, root-initial syllables and stressed syllables all resist the neutralization of contrast which is characteristic of non-prominent positions in a great many languages. Roots also exhibit this positional maintenance of contrast, relative to affixes and function words. In many languages, affixes and function words "underexploit the phonetic possibilities available" (Willerman 1994: 16), systematically excluding segments which are robustly attested in roots in the languages in question.

This asymmetry has not escaped notice; Bolinger & Sears (1981:58) observed that, "System morphemes (as opposed to content morphemes) might be said to lack phonetic bulk. As a class, they are usually insignificant in terms of their small number of phonemes and their lack of stress." Focusing specifically on clicks, Swadesh (1971: 130) reported that, "The unusual thing about the click languages is that these sounds are part of ordinary verbs, nouns, and adjectives...In fact, the number of Hottentot major roots beginning in clicks runs to about 70 percent of the total; interestingly, demonstratives, pronouns, and particles do not have them."

These observations are borne out in a number of statistical and descriptive studies of open/closed class distinctions. For example, Willerman (1994) examined the pronoun paradigms of 32 typologically diverse languages, comparing the incidence of segments in pronouns with their overall frequency of use in the language at large. She identified significant deviations from the predicted frequency of occurrence for a number of articulatory variables. Clicks, affricates, uvulars, ejectives and secondarily articulated consonants all occurred with *less* than predicted frequency (relative to their rate of occurrence in roots) in the pronoun paradigms examined; bilabials, glottals, nasals and approximants occurred with *greater* than predicted frequency. Working with an independently developed scale of articulatory simplicity/complexity, Willerman found that the infrequently occurring segments were those which are relatively more complex. Conversely, the segments that are overrepresented in pronominal paradigms are typically the most simple, from an articulatory standpoint.

There are a number of root/affix asymmetries of this sort which have been documented in descriptions of specific languages. Some representative cases are listed in (2).

(2) Root-based positional neutralization effects

Language:	**Roots contain:**	**Affixes contain:**
Arabic (McCarthy & Prince 1995)	A variety of consonants, including the pharyngeals ¿ and ?	No pharyngeals
German (Bach 1968)	A wide range of segments, including affricates, palatal and velar fricatives, front rounded vowels	Inflectional suffixes contain only {s, t, n, r, \}
!Xóõ (Traill 1985)	An extremely large consonant inventory, including clicks at several places of articulation, with several accompaniments	Grammatical morphemes contain only {b, t, k, s, n, l}
Cuzco Quechua (Parker & Weber 1996)	Plain, ejective and aspirated stops	Only plain stops
Zulu, Xhosa (Doke 1990)	Plain, voiced, nasal and aspirated clicks at three places of articulation	No clicks

The examples in (2), along with a variety of similar cases, arise from the interaction of IDENT-ROOT(F) and IDENT(F) with featural and segmental markedness constraints in the familiar positional privilege ranking pattern illustrated in (3).

(3) Positional privilege ranking, roots
IDENT-ROOT(F) » **C** » IDENT(F)

The ranking of IDENT-ROOT(F) over some constraint or constraints **C** which favor phonological alternation in the feature F will ensure that that feature is faithfully realized within the root. However, subordination of the context-free IDENT(F) constraint will result in neutralization of contrast in non-root morphemes—a pattern of interaction which is familiar from the examination of positional faithfulness effects in preceding chapters.

4.2.2 Case Study: Southern Bantu Clicks

As an example, let us consider the distribution of clicks in Zulu and Xhosa, two Bantu languages of South Africa. The inventories of both languages contain clicks at three places of articulation: dental [|], post-alveolar [!] and lateral [||]. Contrasts in nasality and phonation type are also realized among the clicks. In Zulu and Xhosa, clicks may appear within roots (in initial or non-initial syllables), but never occur in affixes. Some examples of Zulu roots containing clicks are given in (4); Xhosa examples appear in (5).

(4) Some Zulu clicks (Beckman 1994a)

|upʰa	'trap!'
|ula	'sing!'
˜|oma	'praise!'
!ʰasa	'slap!'
g|oboza	'dip!'

(5) Xhosa clicks (Ladefoged 1993)

úku-|ʰóla	'to pick up'
ukú-||ʰoia	'to arm oneself'
ukú-˜!ola	'to climb up'
ukú-˜||iia	'to put on clothes'
ukú-˜£||ó˜£||a	'to lie on back knees up'

Click consonants are distinguished from non-clicks by the airstream mechanism which is used in their production. Clicks are produced with an ingressive velaric airstream [IVA], while most consonants are produced with an egressive pulmonic airstream. Assuming, for the purposes of demonstration, that clicks bear a feature [IVA], the distributional restriction on clicks in Zulu and Xhosa derives from the constraints in (6), with the ranking in (7).

(6) Click constraints, Zulu and Xhosa

IDENT-ROOT(IVA)
Let β be an output segment contained in a root, and α the input correspondent of β. If β is [γIVA], then α must be [γIVA].
"A root segment and its output correspondent must have identical specifications for the feature [IVA]."

IDENT(IVA)
Let α be an input segment and β its output correspondent. If α is [γIVA], then β must be [γIVA].
"An input segment and its output correspondent must have identical specifications for the feature [IVA]."

*IVA
"No ingressive velar airflow."

(7) Root faithfulness ranking, Zulu and Xhosa

IDENT-ROOT(IVA) » *IVA » IDENT(IVA)

The ranking of IDENT-ROOT(IVA) above *IVA in (7) will allow clicks to occur freely within the root, as shown in (8). Any deviations from the input airstream specification of a root consonant will result in a fatal violation of IDENT-ROOT(IVA).

(8) Clicks are permitted in roots

/úku-|hóla/	IDENT-ROOT(IVA)	*IVA	IDENT(IVA)
a. ☞ úku|hóla		*	*
b. úkukhóla	*!		

Candidate (8b), in which the more marked ingressive airstream mechanism of the input click has been replaced by an egressive pulmonic airstream specification, incurs a fatal violation of IDENT-ROOT(IVA). The faithful (8a) is optimal. Parallel results obtain for any input click, provided that it is sponsored by a root morpheme.

In the affixal arena, however, a different picture emerges. There are no Zulu or Xhosa affixes which contain clicks, and the grammar must account for this distributional regularity. The constraint subhierarchy in (7) will prohibit the surface occurrence of clicks in affixes, even if clicks are present in the input. This is demonstrated in (9), with a hypothetical, click-containing prefix. A click is also assumed in the root, to more directly illustrate the contrast between root and affix behavior.

(9) Clicks are prohibited in affixes

/ú!u-|hóla/	IDENT-ROOT(IVA)	*IVA	IDENT(IVA)
a. ú!u|hóla		**!	
b. ☞ úku|hóla		*	*
c. ú!ukhóla	*!	*	*
d. úkukhóla	*!		**

Candidates (9c,d) are ruled out by their fatal violations of IDENT-ROOT(IVA); input root clicks must remain clicks in the output. Of the two remaining candidates, (9b) is optimal; it incurs fewer violations of the markedness constraint *IVA than does the fully faithful (9a). Under this ranking, so long as root faithfulness is satisfied, the decision is passed to the markedness constraint—and the markedness constraint will always rule in favor of less marked structure. Clicks in affixes, which are not protected by IDENT-ROOT, must be unfaithfully rendered in the output.

The Southern Bantu clicks present a straightforward example of root-based positional maintenance of contrast. Here, there is no evidence to suggest that IDENT-ROOT(IVA) is crucially dominated by any constraint which impacts on the distribution of clicks. However, there are languages which both exhibit root faithfulness effects and give evidence that root faithfulness constraints are crucially dominated. One such case is that of glottalized and aspirated stops in Cuzco Quechua.

4.2.3 OCP Effects in Cuzco Quechua

Cuzco Quechua exhibits a number of interesting root-based effects in the distribution of glottalized and aspirated stops. There are three series of stops in the phonetic inventory: plain, glottalized and aspirated. According to Parker & Weber (1996) and Parker (1997), the glottalized and aspirated stops of the language are subject to a number of restrictions in their distribution. Glottalized and aspirated stops occur only in roots; they never surface in affixes. Furthermore, only one laryngealized segment is permitted within a given root; glottalized and aspirated segments may not cooccur. These generalizations suggest a role for root faithfulness, but one in which root faithfulness is subordinated to the OCP. The constraints listed in (10) are central to the analysis:[1]

(10) Laryngealization constraints, Cuzco Quechua

IDENT-ROOT(glottis)
Let β be an output segment contained in a root, and α the input correspondent of β. If β is [γcg], then α must be [γcg]. If β is [γsg], then α must be [γsg].
"A root segment and its output correspondent must have identical specifications for the features [constricted glottis] and [spread glottis]."

IDENT(glottis)
Let α be an input segment and β its output correspondent. If α is [γcg], then β must be [γcg]. If α is [γsg], then β must be [γsg].

---

[1] For a complete, and slightly different, positional faithfulness analysis of Cuzco Quechua, the reader is referred to Parker (1997). There it is argued that the features [constricted glottis] and [spread glottis] are floating in underlying representation, and that featural MAX constraints (MAX-ROOT(constricted glottis) and MAX-ROOT(spread glottis) are required to account for the full range of CQ facts. This seems likely to be correct, but a full examination of the IDENT(F)/MAX(F) distinction is beyond the scope of this dissertation. I will leave this as a matter for future research; the choice of floating vs. associated features will not undermine the point at hand.

“An input segment and its output correspondent must have identical specifications for the features [constricted glottis] and [spread glottis].”

*[cg]
“No constricted glottis”

*[sg]
“No spread glottis”

OCP: Glottis
“Adjacent glottal specifications are prohibited”[2]

The limitation of laryngealized stops to roots calls for the ranking shown in (11). Glottalized or aspirated stops may surface in roots, but they may never occur in affixes; this is achieved by the placement of the markedness constraints *[cg] and *[sg] in the midst of the faithfulness constraints which regulate these features.

(11) Positional neutralization subhierarchy, Cuzco Quechua
IDENT-ROOT(glottis) » *[cg], *[sg] » IDENT(glottis)

In a manner entirely parallel to the case of clicks in Southern Bantu, (11) will permit laryngealized segments only in roots. This is shown in (12)–(14).

(12) Glottalized stops are permitted in roots

/t’anta/ ‘bread’	IDENT-ROOT(glottis)	*[sg]	*[cg]	IDENT(glottis)
a. ☞ t’anta			*	
b. tanta	*!			*
c. tant’a	*!*		*	**

(13) Aspirated stops are permitted in roots

/pʰatay/ ‘explode’	IDENT-ROOT(glottis)	*[sg]	*[cg]	IDENT(glottis)
a. ☞ pʰatay		*		
b. patay	*!			*
c. patʰay	*!*	*		**

In each of these cases, the fully faithful candidate is optimal; no deviations from input laryngealization are permitted, due to high-ranking IDENT-ROOT(glottis). Compare this with the case in (14), where the input includes a hypothetical suffix containing an aspirated stop. ([-kuna] is a pluralizing suffix in the language.)

[2] This formulation is obviously preliminary. See Itô & Mester (1996) and Alderete (1997a) for recent OT treatments of the OCP. Note that Cuzco Quechua has voiced obstruents only in Spanish loanwords. In the core vocabulary , it is probably sufficient to state the OCP over laryngeal specifications (assuming privativity).

(14) Aspirated stops are not permitted in affixes

/tanta-k^{h}una/	IDENT-ROOT(glottis)	*[sg]	*[cg]	IDENT(glottis)
a. tantak^{h}una		*!		
b. ☞ tantakuna				*
c. t^{h}antakuna	*!	*		**

Under this constraint ranking, the fully faithful (14a) can never be optimal, for it incurs a markedness violation not assessed the neutralizing candidate (14b). Because *[sg] dominates the context-free constraint IDENT(glottis), the neutralizing candidate wins. Candidate (14c) shows that aspiration cannot be shifted back onto the root; IDENT-ROOT(glottis) prevents migration of this sort.

As noted above, laryngealized consonants are not permitted to cooccur within a root. This restriction holds across laryngeal features; the language has no roots which contain combinations of glottalized and aspirated segments. Nor does it permit multiple instances of glottalization or aspiration. This fact is not captured by the constraint ranking presented above, for the ranking of IDENT-ROOT(glottis) above the markedness constraints *[cg] and *[sg] predicts that any number of laryngealized segments may surface in a root. This is illustrated, with a hypothetical input, in (15).

(15) Multiple laryngealized segments are permitted

/p^{h}at'ay/	IDENT-ROOT(glottis)	*[sg]	*[cg]	IDENT(glottis)
a. 💣 p^{h}at'ay		*	*	
b. patay	*!*			**
c. p^{h}atay	*!	*		*

Candidate (15a) incorrectly surfaces intact, with two laryngealized segments. Competing candidates in which one or both laryngealized segments have been neutralized fatally violate undominated IDENT-ROOT(glottis).

In order to prevent the surface occurrence of candidates such as (15a), a constraint or constraints which penalize multiple laryngealized consonants must dominate IDENT-ROOT(glottis). Parker & Weber (1996) and Parker (1997) argue that the responsible constraint is the Obligatory Contour Principle (Leben 1976; Goldsmith 1976; McCarthy 1979, 1986; Mester 1986; Odden 1986, 1988). Localized to laryngeal specifications, the OCP will prevent the cooccurrence of [cg] and [sg], as well as preventing the cooccurrence of multiple instances of either of the individual features. When IDENT-ROOT(glottis) is dominated by this OCP over laryngeal specifications, the correct results obtain. This is illustrated in (16), where the hypothetical root from (15) is taken as input.

(16) Multiple laryngealized segments are prohibited

/p^hat’ay/	OCP	IDENT-RT(glottis)	*[sg]	*[cg]	IDENT(glottis)
a. p^hat’ay	*!		*	*	
b. patay		**!			**
c. ☞ p^hatay		*	*		*

In the event that multiple laryngealized segments are input to the grammar, only one will be permitted to surface, even though all of the segments in question may be affiliated with the root.[3] This is due to the ranking of the OCP above the root faithfulness constraint IDENT-ROOT(glottis). While this constraint, ranked above the markedness constraints *[cg] and *[sg], does play an important role in restricting laryngealized segments to roots, it is itself trumped by a higher-ranking constraint. This general ranking configuration, C_i » IDENT-ROOT » C_j » IDENT, must obtain in any language which permits a feature or segment to occur within roots, but only in specific, limited circumstances. OCP languages present one class of such cases, but other constraints, including other positional faithfulness constraints, may fill the C_i slot in this ranking schema. I turn to such a case in §4.3.

4.3 A Case Study in Positional Interactions: Ibibio Consonant Assimilation

4.3.1 Introduction

Having examined a wide range of positional faithfulness effects in a variety of positions, I will close the discussion of featural positional faithfulness effects with a discussion of Ibibio consonant clusters. Consonant assimilation effects in Ibibio provide evidence for the relative ranking of three sets of positional faithfulness constraints. Crucially, both the IDENT-ROOT and

[3] The laryngealized segment which survives in the output is always the leftmost one. See Parker & Weber (1996) and Weber (1997) for an account of this generalization.

IDENT-ONSET constraints which are relevant must be low-ranking, with only IDENT-σ_1 ranked above the markedness constraints which favor phonological alternation.

Ibibio is a Nigerian language which, according to Greenberg (1963), belongs in the Benue Congo branch of the Niger-Congo family. It is further classified as a Lower-Cross language of the Cross-River subfamily. The verbal system of Ibibio exhibits a number of interesting positional privilege effects. These effects are most clearly seen in the behavior of consonants clusters, which are always homorganic. This is true both of root-internal clusters, and of clusters formed by the concatenation of roots and suffixes. (Most of the verbal morphology of Ibibio is suffixal, with suffixes imposing a variety of prosodic requirements on the base. See Akinlabi & Urua 1993 for extensive discussion of the templatic requirements imposed by Ibibio affixes.)

Verb roots in Ibibio are typically monosyllabic, and may have CV, CVC or CVVC shapes.[4] Representative examples are given in (17).

(17) Monosyllabic verb roots (Akinlabi & Urua 1993)

wà	‘sacrifice’	wàt	‘paddle’	wààk	‘tear’
sé	‘look’	dép	‘buy’	déép	‘scratch’
kpø`	‘carry’	kø`˜	‘knock (on the head)’	kø`ø`˜	‘hang up (a dress)’
nø`	‘give’	dóm	‘bite’	fáák	‘wedge between 2 obj.’
dá	‘stand’	dát	‘take/pick up’	µø`ø`n	‘crawl’

Synchronically underived disyllabic verb roots are also attested in the language. Such roots may have the form CVCCV, CVVCV, or CVCV, as illustrated in (18).

(18) Disyllabic verb roots (Akinlabi & Urua 1993: 4)

dáppá	‘dream (vb.)’	fáá˜á	‘argue’	sà˜á	‘walk’
dámmá	‘be mad’	yø'ø'˜ø'	‘plaster a wall’	sárá	‘comb’
dø'kkø'`	‘tell’	yèèmé	‘wilt’	bø'©ø'	‘overtake’
tèmmé	‘explain’	dàárá	‘rinse’	fè©é	‘run’

[4] The absence of a contrast between surface CVV and CV roots is striking. Akinlabi & Urua (1993) discuss various analytic alternatives, including the suggestion that CV forms are derived from bimoraic CVV by a rule of post-lexical truncation. No clear conclusions are reached, but the discussion makes it clear that the CV structures are not restricted to phrase-final position. This is not obviously a case of final shortening, though such an analysis may be possible, given additional information about the syntax of the language. I will not provide an analysis of this gap in the root inventory.

As the leftmost examples in (18) illustrate, root-internal consonant clusters are always composed of identical segments; no differences in place or manner of articulation are permitted. This pattern holds of derived root+suffix combinations, as well, as illustrated in the data below. The monomorphemic examples of (18), repeated in (19), are contrasted with root+negative suffix cases in (20). All data are taken from Akinlabi & Urua (1993).

(19) Ibibio consonant clusters, monomorphemic words

	dá**pp**á	'dream (vb.)'
	dá**mm**á	'be mad'
	dø'**kk**ø'	'tell'
	bà**kk**á	'divide'
	tè**mm**é	'explain'

(20) Ibibio consonant clusters, negative verb forms

a.	í-dép-**p**é	'he is not buying'	dép	'buy'
	í-bót-**t**ó	'he is not molding'	bót	'mold'
	í-µèk-**k**é	'he is not shaking'	µèk	'shake'
	n'-nám-**m**á	'I am not performing'	nám	'do/perform'
	n'-kø``**-˜**ø'	'I am not knocking'	kø`˜	'knock'
cf.				
b.	˜'-kàà-©á	'I am not going'	ka‡	'go'
	n'-séé-©é	'I am not looking'	sé	'look'
	n'-dóó-©ó	'I am not'	dó	'be (copula)'
	...dáppá-**k**é	'...not dreaming'	dáppá	'dream'
	...dø'kkø'-**k**é	'...not telling'	dø'kkø'	'tell'

Several interesting points emerge from a study of the forms above. The data in (19), illustrative of a general pattern in polysyllabic roots, indicate that IDENT-ROOT must be dominated by a constraint or constraints favoring total assimilation in consonant clusters. Though there are no overt alternations in (19), the grammar must be able to explain the absence of non-geminate clusters within roots. Only if faithfulness within the root is subordinated to higher-ranking markedness constraints can this result be achieved. One possible ranking is sketched in (21).

(21) Only geminate clusters within roots
*PLACE, *MANNER » IDENT-ROOT(Place), IDENT-ROOT(Manner)[5]

[5] Parallel to the discussion of voice assimilation in Chapter 1, we might adopt SHARE(Place) and SHARE(Manner) as alternatives to *PLACE and *MANNER above. Though the choice may have important consequences cross-linguistically, it will not be crucial to the discussion here.

With the opposite ranking of faithfulness and markedness constraints, we would expect to find a full range of place and manner specifications on either consonant in an internal cluster. That such a range of clusters is not found indicates that the ranking in (21) must hold—but this ranking does not indicate which of the root consonants determines the final outcome. Based on the discussion of onset faithfulness in Chapter 1, the prediction is clear: high-ranking IDENT-ONSET should ensure that place and manner features spread regressively from the onset of the second syllable to the coda of the first. Because monomorphemic verb roots never exhibit alternations in root-internal clusters, it would appear that we have no evidence to contradict this prediction of onset faithfulness.

However, counterevidence is provided by the behavior of consonant clusters in derived forms. Consider the data in (20), repeated in (22). In these data, the suffix-initial consonant alternates between a complete copy of the preceding consonant, as in (22a), and a dorsal [k] or [©][6], as in (22b).

(22) Ibibio consonant clusters, negative verb forms

a.	í-dép-**p**é	'he is not buying'	dép	'buy'
	í-bót-**t**ó	'he is not molding'	bót	'mold'
	í-µèk-**k**é	'he is not shaking'	µèk	'shake'
	n'-nám-**m**á	'I am not performing'	nám	'do/perform'
	n'-kø`˜-˜ø'	'I am not knocking'	kø`˜	'knock'
cf.				
b.	˜'-kàà-©á	'I am not going'	ka‡	'go'
	n'-séé-©é	'I am not looking'	sé	'look'
	n'-dóó-©ó	'I am not'	dó	'be (copula)'
	...dáppá-**k**é	'...not dreaming'	dáppá	'dream'
	...dø'kkø'-**k**é	'...not telling'	dø'kkø'	'tell'

Here, assimilation is overt, and clearly progressive. The suffix-initial consonant assimilates in place and manner of articulation to the preceding root-final consonant, suggesting (*contra* Chapter 1) a ranking of IDENT-CODA (Place, Manner) » IDENT-ONSET(Place, Manner). Such a ranking would dramatically increase the typology of consonant assimilation, predicting an unattested incidence of progressive spreading—an undesirable result. Furthermore, this move is

6 See Chapter 5 for an account of the *k*.© alternation.

unnecessary; a single generalization will both account for the aberrant direction of assimilation here, and the full incidence of consonant contrasts in the monomorphemic cases of (19) above. In both cases, it is the initial syllable of the root which is exhibiting privileged behavior—allowing contrasts in place and manner which are not attested elsewhere, and triggering (rather than undergoing) assimilation. Though IDENT-ROOT(Place, Manner) and IDENT-ONSET(Place, Manner) must be low-ranking, the initial syllable faithfulness constraints crucially must dominate the markedness constraints responsible for generating assimilation.

(23) Constraint subhierarchy, Ibibio consonant assimilation

IDENT-σ_1(Pl., Man.) » *PLACE, *MANNER » IDENT-RT(Pl, Man), IDENT-ONS(Pl, Man)

This ranking will account for all of the consonant distribution effects outlined above, as I will show in §4.3.2.

4.3.2 Analysis

I will begin with an analysis of consonant distribution in monomorphemic verb roots. While non-contiguous consonants may differ from one another (24a), consonant clusters must always exhibit complete identity (24b).

(24) Consonant distribution in monomorphemes

a.	wàt	'paddle'	wààk	'tear'
	dép	'buy'	déép	'scratch'
	kø`˜	'knock (on the head)'	kø`ø`˜	'hang up (a dress)'
	dóm	'bite'	fáák	'wedge between 2 obj.'
	dát	'take/pick up'	µø`ø`n	'crawl'
b.	dáppá	'dream (vb.)'		
	dámmá	'be mad'		
	dø'kkø'	'tell'		
	bàkká	'divide'		
	tèmmé	'explain'		

This identity requirement, an extreme version of the classic Coda Condition effects examined in Chapters 1 and 2, is an important diagnostic of constraint ranking, for it indicates that faithfulness to input place and manner cannot be paramount in the grammar. While faithfulness in root-initial syllables remains an imperative, as indicated by the range of contrasts permitted in (24), faithfulness in non-initial syllables must be subordinated to markedness constraints which favor assimilation. Following the general outline of place assimilation presented in the Tamil analysis of Chapter 2, I will assume that place and manner assimilation derive from featural markedness constraints, for which *PLACE and *MANNER will serve as shorthand labels. The now-familiar positional privilege subhierarchy in (25) will generate the attested distributional asymmetries.

(25) IDENT-σ_1(Place), IDENT-σ_1(Mn) » *PLACE, *MANNER » ID(Place), ID(Mn)

This is demonstrated in the following tableaux.

Consider first the distribution of consonants in monosyllabic verb roots, as in (26).

(26) Free distribution in root-initial CVC syllables

/dóm/	ID-σ_1(Pl), ID-σ_1(Mn)	*PLACE	*MANNER	ID(Place), ID(Mn)
a. ☞ dóm		**d, m**	**d, m**	
b. dón	*!	**d, n**	**d, n**	*
c. dób	*!	**d, b**	**d, b**	*
d. dód	**!	**d, d**	**d, d**	**
e. dó˜	*!	**d, ˜**	**d, ˜**	*

In the case of a monosyllabic root, complete faithfulness is required by high-ranking IDENT-σ_1(Place) and IDENT-σ_1(Manner). There is no neutralization to a default place (arguably Dorsal in Ibibio) or manner in the coda, and no spreading of features from onset to coda.[7] Those candidates which deviate from the input are ruled out by fatal violations of IDENT-σ_1(Place) and/or IDENT-σ_1(Manner).

The polysyllabic roots provide a more interesting test case for the ranking in (25). Here, unfaithfulness is necessitated, as not all of the input consonants can be protected by the IDENT-σ_1 constraints. Consider the hypothetical root in (27).

[7] Such spreading is unlikely, in any event. Major class features, primary place features and laryngeal features typically do not spread over vowels. See Clements & Hume (1995), Itô, Mester & Padgett (1995), Ní Chiosáin & Padgett (1997) for discussion.

(27) C_2 in clusters must assimilate; hypothetical root

/dápná/	Id-σ_1(Pl), Id-σ_1(Mn)	*Place	*Manner	Id(Place), Id(Mn)
a. dáp.ná		d, p, n!	d, p, n	
b. dát.ná	*!	**d, tn**	**d, t, n**	*
c. dáp.má		d, pm	d, p, m!	*
d. dán.ná	*!*	**d, nn**	**d, nn**	**
e. ☞ dáp.pá		d, pp	d, pp	**

The candidate which exhibits total progressive assimilation, (27e), is optimal. Assimilation must progress from coda to onset, contrary to the cross-linguistically more robust regressive pattern. Due to the premium placed on initial syllable faithfulness, progressive assimilation is favored here, though onset faithfulness must necessarily be violated in the optimal output. Though, as I demonstrated in Chapter 1, Ident-Onset » Ident will generally favor regressive assimilation in heterosyllabic clusters, this effect can be overridden by higher-ranking constraints. (See Lombardi 1996c for additional discussion of this point.)

Implicit in the discussion of (27) is an important point: the onset faithfulness constraints, Ident-Onset(Place) and Ident-Onset(Manner), cannot dominate the place and manner markedness constraints. Were they to do so, a full range of place and manner contrasts would be generated in all onsets, as shown in (28). (The onset constraints are arbitrarily ranked above the initial syllable constraints, though the relative ranking of the two sets has no bearing on the outcome.)

(28) High-ranking Ident-Onset does not permit assimilation

/dápná/	Id-Ons(Pl), Id-Ons(Mn)	Id-σ_1(Pl), Id-σ_1(Mn)	*Place	*Manner	Id(Place), Id(Mn)
a. 💣 dáp.ná			**d, p, n**	**d, p, n**	
b. dát.ná		*!	**d, tn**	**d, t, n**	*
c. dáp.má	*!		**d, pm**	**d, p, m**	*
d. dán.ná		*!*	**d, nn**	**d, nn**	**
e. dáp.pá	*!*		**d, pp**	**d, pp**	**

Only the fully faithful (28a) can satisfy both the onset and initial syllable faithfulness constraints, and it will therefore be incorrectly selected as optimal. This result persists even when the initial syllable faithfulness constraints are ranked highest in the hierarchy. The precise character of the assimilation-favoring markedness constraints is also irrelevant to the final outcome; Spread(Place) and Spread(Manner) will have no greater impact on the outcome so long as they, too, are ranked below the onset constraints. Ident-Onset(Place) and Ident-Onset(Manner) must fall below these markedness constraints in order to account for these root-internal restrictions on consonant distribution.

(29) Id-σ_1(Pl, Mn) » *Place, *Manner » Id-Ons(Pl, Mn) » Id(Pl, Mn)

With the onset constraints low-ranking, as in (29), the correct results obtain. This is shown in (30).

(30) Ident-Onset is low-ranking

/dápná/	Id-σ_1(Pl), Id-σ_1(Mn)	*Place	*Manner	Id-Ons(Pl), Id-Ons(Mn)	Id(Place), Id(Mn)
a. dáp.ná		d, p, n!	d, p, n		
b. dát.ná	*!	**d, tn**	**d, t, n**		*
c. dáp.má		d, pm	d, p, m!	*	*
d. dán.ná	*!*	**d, nn**	**d, nn**		**
e. ☞ dáp.pá		d, pp	d, pp	**	**

When the Ident-Onset constraints fall below the markedness constraints in the hierarchy, they are irrelevant to the outcome, as (30) demonstrates. The optimal candidate, (30e), is chosen by its relatively unmarked status, even though onset faithfulness violations are necessarily incurred.

A parallel finding obtains when we consider the ranking of Ident-Root(Place) and Ident-Root(Manner). When ranked above the markedness constraints, the root faithfulness constraints would prohibit any deviations from the input place and manner specifications. This is shown in (31), where the Ident-Root constraints are arbitrarily ranked above the initial syllable faithfulness constraints.

(31) High-ranking IDENT-ROOT does not permit assimilation

/dápná/	ID-RT(Pl), ID-RT(Mn)	ID-σ_1(Pl), ID-σ_1(Mn)	*PL	*MN	ID-ON(Pl), ID-ON(Mn)	ID(Place), ID(Mn)
a. ☞ dáp.ná			**d, p, n**	**d, p, n**		
b. dát.ná	*!	*	**d, tn**	**d, t, n**		*
c. dáp.má	*!		**d, pm**	**d, p, m**	*	*
d. dán.ná	*!*	**	**d, nn**	**d, nn**		**
e. dáp.pá	*!*		**d, pp**	**d, pp**	**	**

Here, as in the case of high-ranking IDENT-ONSET, the correct results cannot be obtained. So long as IDENT-ROOT(Place) and IDENT-ROOT(Manner) are ranked above the markedness constraint subhierarchies, no restrictions on root consonants will be possible. The root faithfulness constraints must be dominated in order to generate the correct range of surface forms in Ibibio.

(32) Final ranking, positional faithfulness in Ibibio
ID-σ_1(Pl, Mn) » *PLACE, *MANNER » ID-RT(Pl, Mn), ID-ONS(Pl, Mn) » ID(Pl, Mn)

This ranking extends straightforwardly to the derived root+suffix combinations of (22), repeated in (33) below.

(33) Ibibio consonant clusters, negative verb forms

a.	í-dép-**p**é	'he is not buying'	dép	'buy'
	í-bót-**t**ó	'he is not molding'	bót	'mold'
	í-µèk-**k**é	'he is not shaking'	µèk	'shake'
	n'-nám-**m**á	'I am not performing'	nám	'do/perform'
	n'-kø`˜-˜ø'	'I am not knocking'	kø`˜	'knock'
cf.				
b.	˜'-kàà-©á	'I am not going'	ka‡	'go'
	n'-séé-©é	'I am not looking'	sé	'look'
	n'-dóó-©ó	'I am not'	dó	'be (copula)'
	...dáppá-**k**é	'...not dreaming'	dáppá	'dream'
	...dø'kkø'-**k**é	'...not telling'	dø'kkø'	'tell'

Here, the underlying suffix-initial dorsal consonant assimilates completely in place and manner to the preceding consonant. This is parallel to the behavior of root-internal consonant clusters, and follows from the constraint subhierarchy of (32).

(34) Assimilation in derived forms

/nám-ká/	ID-σ_1(Pl), ID-σ_1(Mn)	*PL	*MN	ID-RT(Pl), ID-RT(Mn)	ID-ON(Pl), ID-ON(Mn)	ID(Place), ID(Mn)
a. nám.ká		n, m, k!	n, m, k			
b. nám.˜á		n, m, ˜!	n, m˜		*	*
c. nám.pá		n, mp	n, m, p!		*	*
d.☞ nám.ma		n, mm	n, mm		**	**
e. ná˜.ká	*!	**n, ˜k**	**n, ˜, k**	*		*
f. nák.ká	*!*	**n, kk**	**n, kk**	**		**

Candidates (34e,f) are ruled out by violations of the undominated IDENT-σ_1 constraints; no regressive assimilation is possible. Of the remaining candidates, (34d) is optimal because it incurs the fewest *PLACE and *MANNER violations. Total assimilation is favored, even at the expense of IDENT-ONSET violations.

4.3.3 Conclusions

The distribution of consonant contrasts in Ibibio verbs constitutes an interesting test case for an elaborated array of featural positional faithfulness constraints. In this language, faithfulness in root-initial syllables is paramount, taking precedence over markedness constraints which favor consonant assimilation. Crucially, faithfulness constraints which regulate onsets and roots at large are necessarily low-ranking, trumped by the markedness constraint subhierarchies *PLACE and *MANNER. It is clear from this discussion that featural faithfulness constraints specific to many different positions of prominence may interact in the same grammar, producing interesting results. In the next chapter, I will shift the focus from the featural to the segmental, examining the interaction of positional MAX constraints with other constraints in the grammar.

CHAPTER 5

PROMINENCE MAXIMIZATION

5.1 Introduction

In the preceding chapters of this dissertation, I have shown that positional faithfulness constraints are essential to the analysis of three distinct but related asymmetries in phonological behavior: positional neutralization, positional resistance to phonological processes, and positionally-determined triggering of phonological processes. Positional privilege, in the guise of enhanced faithfulness, holds of a variety of different structural positions. In Chapter 2, I discussed positional faithfulness in root-initial syllables and syllable onsets, focusing on Shona and Tamil. Stressed syllable faithfulness effects were highlighted in Chapter 3, and in Chapter 4, I considered root/affix asymmetries in light of positional faithfulness.

All of the cases examined above involve high-ranking positional IDENT(F) constraints, which regulate the *featural* faithfulness of segments which appear in the privileged positions. In this chapter, I will provide evidence for a different type of positional faithfulness constraint, positional MAX, which regulates *segmental* deletion.[1] The extension of positional faithfulness to the MAX constraint family provides evidence for the symmetrical structure of the faithfulness constraint system — positional faithfulness is not limited to the realm of featural identity, but extends as well to constraints against phonological deletion. The pervasiveness of positional faithfulness is further instantiated by the relativized DEP constraints of Alderete (1995), which require that elements in a prominent position in the output have an input correspondent.

The MAX constraint family requires complete correspondence of input and output representations, militating against deletion of input material. The context-free formulation of MAX given in McCarthy & Prince (1995) is shown below.

(1) MAX
Every element of S_1 has a correspondent in S_2.
Domain($\leftarrow$) = S_1

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[1] Positional MAX constraints, with a slightly different character, are also explored in Casali (1997).

The context-free constraint (1) militates against segmental deletion in the input-output or output-output relation, or against non-copying in reduplication.

The cases to be examined in this chapter call out for positional variants of (1), as schematized in (2).

(2) MAX-*Position*
Every element of S_1 has a correspondent in some position P in S_2.
Domain($\leftarrow$) = S_1

Positional MAX constraints do not simply favor full correspondence between S_1 and S_2; they favor full correspondence, with all S_2 correspondents appearing in a privileged position. In essence, positional MAX constraints favor maximal packing of input structure into a prominent output position.[2] Such output maximization occurs in a number of cases in which non-canonical prosodification is associated with positional prominence, as in English ambisyllabicity, which is determined largely by stress placement.

I will begin in by examining the interaction of the syllable markedness constraint NOCODA with a MAX-*Position* constraint. As we will see, when MAX-*Position* » NOCODA, prominent positions are maximally filled with input segments, even at the expense of a canonical CV.CV syllabification. The resulting syllabifications are not consistent with the principle of Onset First/Maximal Onset (Kahn 1976; Steriade 1982; Selkirk 1982; Clements & Keyser 1983), either because an intervocalic consonant is affiliated with coda rather than onset

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2 An alternative formulation of positional MAX constraint is also possible, and perhaps necessary:

(i) MAX-*Position*
Any element appearing in position P in S_1 has a correspondent in position P in S_2.
Domain($\leftarrow$) = S_1

This formulation differs crucially from that in (2) by requiring only that segments in prominent positions in S_1 appear in the same prominent position in S_2; it does *not* require that all S_1 segments appear in S_2. For example, MAX-ONSET, formulated as in (i), will require that any segment which has an onset syllabification in S_1 retain that onset syllabification in S_2. By contrast, the (2) formulation of MAX-ONSET will require that all segments have an onset syllabification, regardless of their prosodic affiliation (or lack thereof) in S_1.

While positional MAX constraints formulated on the template in (i) are unexceptional in cases of output-output correspondence in which syllabification is necessarily present in both strings, they are potentially problematic for input-output relations, as syllabification and prosodic structure cannot be assumed to be present in the input. In the absence of input prosodic structure, constraints of the (i) variety will be irrelevant. The extent to which such constraints are necessary is a matter for future research; I will not address it here.

(CVC.V) or because the consonant is ambisyllabic, affiliated with both coda and onset. In §5.5, I consider the interaction of positional MAX with *COMPLEX, the constraint which prohibits complex syllable margins. Through domination of *COMPLEX, positional MAX will generate otherwise illicit complex codas or onsets in prominent syllables. This will be demonstrated with an analysis of Tamil, which allows complex codas only in root-initial syllables, due to the ranking of MAX-σ_1 » *COMPLEX. Before turning to the case studies of positional MAX, I will review syllable theory in OT.

5.2 Background: Syllable Structure in Optimality Theory

An explanatory theory of syllabification and syllable typology is one focal point of Prince & Smolensky's (1993) exposition of Optimality Theory. The key observation concerning syllable typology, made by Jakobson (1962), is that a markedness relation holds among the syllable shapes attested cross-linguistically: onsetless syllables are more marked than syllables with onsets, and closed syllables stand in a similar relation to open syllables. There are languages which have only open syllables, or syllables with onsets, but there are no languages in which all syllables lack an onset, or are closed. The distributional possibilities are summarized in (3) below (adapted from Prince & Smolensky: 85). Each cell represents a possible language type.

(3) Jakobsonian syllable typology

		Onsets:	
		required	optional
Codas:	forbidden	CV	(C)V
	optional	CV(C)	(C)V(C)

Prince & Smolensky (1993) argue that this typology of syllable shapes reflects the interaction of two syllable markedness constraints of UG: ONSET and NOCODA. Together with basic faithfulness constraints, ONSET and NOCODA derive exactly the attested syllable inventories. The core constraints which generate the Jakobsonian typology are shown in (4) below. (I have adapted the Prince & Smolensky constraints to the Correspondence Theoretic model assumed here, replacing their PARSE and FILL with MAX and DEP, respectively.

Following McCarthy & Prince (1993b), I adopt "NOCODA" in place of Prince & Smolensky's nomenclature, –COD.)

(4) Basic syllable typology: Relevant constraints

Markedness:	Faithfulness:
ONSET: Syllables must have onsets.	MAX: Every segment in S_1 has a correspondent in S_2.
NOCODA: Syllables must not have a coda.	DEP: Every segment in S_2 has a correspondent in S_1.

Through interaction, the constraints in (4) generate the four-way array of languages diagrammed in (3). This is schematized in (5), adapted from Prince & Smolensky. (𝔽 represents the set of faithfulness constraints {MAX, DEP}, and F_n denotes a member of this set.)

(5) Deriving the Jakobsonian typology

		Onsets: ONSET » F_i	**Onsets:** 𝔽 » ONSET
Codas:	NOCODA » F_j	CV	(C)V
	𝔽 » NOCODA	CV(C)	(C)V(C)

The domination of faithfulness by markedness constraints favors unmarked syllable structure, while the opposite ranking permits the more marked syllable shapes to occur. Notably, there is no ranking of the four constraints in (4) which will generate only the marked syllable shapes (for example, only VC, but not CV and CVC). For more extensive discussion, see Prince & Smolensky (1993: Chapter 6).

The OT constraints which provide the basic account of syllable typology also derive a well-known aspect of syllabification, the principle of Onset First (also known as Maximal Onset) originally noted by Kahn (1976:41); see also Steriade (1982), Selkirk (1982), Clements & Keyser (1983) and Itô (1986).

(6) Onset Maximization
"In the syllable structure of an utterance, the onsets of syllables are maximized, in conformance with the principles of basic syllable composition of the language." (formulation due to Selkirk 1982:359)

In derivational theories of syllabification, the principle in (6) governs the order in which segments are associated to syllables. Wherever possible, consonants must be associated to a syllable node to the right, rather than to the left. (See, for example, the Onset First Principle of Clements & Keyser 1983: 37.) This will account for the finding that intervocalic consonants are typically onsets, rather than codas. The syllabification in (7a) is preferred to that of (7b), almost universally.

(7) a. b.

In the OT treatment of syllable theory developed in Prince & Smolensky (1993), the onset maximizing structure in (7a) is favored, due to the nature of the constraints contained in UG. The markedness constraints ONSET and NOCODA both rule in favor of (7a), and against (7b). In fact, given the mini-inventory of constraints in (5), the syllabification in (7b) *cannot* be generated. Consider the chart in (8), where the constraints are not crucially ranked.

(8) Onset maximization is always favored[3]

	/CVCV/	NOCODA	ONSET	MAX	DEP
a. ☞	CV.CV				
b.	CVC.V	*	*		

No matter what the ranking of the four constraints may be, the syllabification in (8a) will always be favored by the grammar. There is no constraint in the system which can compel the syllabification in (8b). This is an impressive result: an alleged universal of syllabification follows from independently motivated markedness constraints. ONSET and NOCODA, which account for the implicational relations which hold among syllables of various shapes, also favor onset maximization.

Unfortunately for the OT theory sketched above, onset maximization in ...VCV strings is not an inviolable universal of syllabification. The phonological and descriptive literature is replete with examples of syllabifications of ...VCV strings that do not respect the principle of

[3] Given a /CVCV/ input. Many more constraints will be relevant to the syllabification of intervocalic clusters; these include the SYLLABLE CONTACT LAW (see the discussion of Tamil in Chapter 2), SONORITY SEQUENCING and *COMPLEX. Given the appropriate ranking of such constraints with ONSET and NOCODA, a non-maximal onset may be favored by the grammar.

onset maximization. In one set of cases, intervocalic consonants are *ambisyllabic*; they syllabify in both coda and onset position. This is shown in (9).

(9) Ambisyllabicity

English is perhaps the best-known example of ambisyllabicity in the phonological literature, though others have been documented.

In a second set of cases, the intervocalic consonant in a ...VCV string syllabifies only as the coda of the leftmost syllable, as in (10). (Selkirk 1982 argues for this treatment of English, as well.)

(10) Coda-only syllabification

Representative examples of both types of case are listed in the table below.

(11) Violations of Onset Maximization, ...VCV input string

Language:	**OM violation:**	**Diagnostic(s):**
English (Kahn 1976, Selkirk 1982)[4]	C in V_1CV_2 is ambisyllabic *if V_1 is stressed.*	C is not aspirated, though syllable-initial obstruents in English are aspirated If C is /t, d/, flapping occurs
Danish (Borowsky et al. 1984, Clements & Keyser 1983)	Medial C in V_1CV_2 is ambisyllabic *if V_1 is stressed*.	Lenited allophone of C appears in V1CV2, *otherwise only in coda position* Grave allophone of V_1 occurs in V_1CV_2 if C is grave; *otherwise only in a syllable closed by grave C* Stød (glottalization) is realized on sonorant C in V_1CV_2; *otherwise only on a sonorant coda C*
Efik (Welmers 1973, Clements & Keyser 1983)	C in V_1CV_2 is ambisyllabic.	Centralized, closed-syllable allophones of vowels appear as V_1 in V_1CV_2 C is flapped
Ibibio (closely related to Efik) (Akinlabi & Urua 1993)	C in ...V_1CV_2 is ambisyllabic, *if V_1 is in the root-initial syllable.*	Centralized, closed-syllable allophones of vowels appear as V_1 in V_1CV_2 C is lenited
Scots Gaelic (several dialects, incl. Lewis & Barra) (Børgstrom 1940, Clements 1986)	C in #(C)V_1CV_2 is syllabified as a coda. *Stress is initial.*	Observation and transcription by Børgstrom (1940) Native speakers report VC.V syllabification (Børgstrom 1940)

4 Selkirk (1982) argues that the consonants in question are not ambisyllabic, but exhaustively syllabified in the coda of the leftmost syllable. Regardless of which analysis is correct, the principle of Onset Maximization is violated by the surface syllabification.

In each of the cases above, the failure of onset maximization is correlated with positional prominence: stressed or root-initial syllables attract a following consonant into coda position. These ambisyllabic and coda-only intervocalic consonants violate NOCODA, but maximize the number of input segments which surface in the stressed or root-initial syllable. In this chapter, I will argue that the prosodic maximization of privileged positions results from a high-ranking positional MAX constraint. For example, Ibibio ambisyllabicity arises from high-ranking MAX-σ_1, which favors maximal syllabification of root-initial syllables:

(12) MAX-σ_1
$\forall x$, x S_1, y such that y S_2, $x \leftarrow y$ and y appears in the root-initial syllable.
"Every element of the input has a correspondent in the root-initial syllable in the output."

The candidate which best satisfies (12) will be that in which all input segments have output correspondents in the root-initial syllable. Danish ambisyllabicity derives from a similar constraint, MAX-σ', which favors packing of stressed syllables.

In the absence of such a constraint, an ambisyllabic or coda-only syllabification can never be optimal. The markedness constraints ONSET and NOCODA favor simple CV syllabification, in accordance with the principle of onset maximization; ambisyllabicity and coda-only affiliations of a consonant deviate from the preferred open syllable pattern.

(13) CV.CV syllabification only

/CVCV/	NOCODA	ONSET
a.☞		
b.	*	*!
c.	*!	

As in (8) above, the coda-only syllabification in (13b) can never be optimal, as both ONSET and NOCODA are violated. The ambisyllabic consonant in (13c) satisfies ONSET, but violates NOCODA. The simple CV.CV syllabification of (13a) should always be selected by such a grammar. However, high-ranking MAX-σ_1 or MAX-σ' can militate in favor of (13b) or (13c), as schematized in (14) below. (MAX-σ_1 is assumed for the purposes of illustration.)

(14) MAX-σ_1 overrides onset maximization

/CVCV/	MAX-σ_1	NOCODA	ONSET
a.	C!, V		
b.	V	*	*
c.	V	*	

The choice between (14b) and (14c) will rely on the relative ranking of ONSET and a syllable-level instantiation of the constraint UNIQUE, which requires segments to have a single syllabic host (Benua 1996; see the discussion of featural UNIQUE in Chapter 2 above).[5] If ONSET » UNIQUE-σ, (14b) will be optimal; the opposite ranking will favor (14c). The key point, however, is that high-ranking MAX-σ_1 favors maximally filled initial syllables, a pattern which otherwise cannot be optimal.

In the next section, I will present the analysis of Ibibio ambisyllabicity, showing that MAX-σ_1 crucially dominates NOCODA, forcing a consonant which follows the nucleus of the root-initial syllable to be ambisyllabic. In §5.4, I will examine stress-related violations of onset maximization in Scots Gaelic, arguing that they arise from high-ranking MAX-σ'.

5.3 Ibibio ambisyllabicity: Evidence for Root-Initial Maximization

As noted in Chapter 4, Ibibio is a Nigerian language, belonging in the Benue Congo branch of the Niger-Congo family. Ibibio is closely related to Efik, another language of Nigeria which exhibits similar ambisyllabicity phenomena; see Welmers (1973) and Clements & Keyser (1983) for discussion. I have focused on Ibibio here because the data presented in Akinlabi & Urua (1993) are more extensive than the Efik data available elsewhere. (The analysis developed by Akinlabi & Urua 1993 differs substantially from the account presented below; for details, the reader is referred to the original source.)

Ibibio presents evidence for the interaction of positional faithfulness constraints of several types, and at several levels. As I showed in Chapter 4, the ranking

5 See also the discussion of CRISPEDGE in Itô & Mester (1994).

Ident-σ_1(Place,Manner) » Ident-Root(Place,Manner), Ident-Onset(Place,Manner) » Ident(Place,Manner) must hold in Ibibio; this ranking is responsible for the assimilation of syllable onsets to preceding codas in the root-initial syllable, contrary to the usual pattern of coda-to-onset assimilation found crosslinguistically. Turning our attention to a different set of facts from the language, we will see that Max-σ_1 is also high-ranking.

Verb roots in Ibibio are typically monosyllabic, and may have CV, CVC or CVVC shapes.[6] Representative examples are given in (15).

(15) Monosyllabic verb roots (Akinlabi & Urua 1993)

wà	'sacrifice'	wàt	'paddle'	wààk	'tear'
sé	'look'	dép	'buy'	déép	'scratch'
kpø`	'carry'	kø`˜	'knock (on the head)'	kø`ø`˜	'hang up (a dress)'
nø`	'give'	dóm	'bite'	fáák	'wedge between 2 obj.'
dá	'stand'	dát	'take/pick up'	µø`ø`n	'crawl'

The preceding forms show examples of each of the non-high vowels in the language. The vowel system of Ibibio is composed of six vowel qualities, symmetrically arrayed at three heights:

(16) Ibibio vowel system

High:	i		u
Mid:	e		o
Low:		a	ø

Much of the interesting evidence for ambisyllabicity in the language derives from the behavior of the high vowels. Before turning to the ambisyllabicity data, a brief excursus on the vowel inventory and allophonic alternations will be necessary.

The high vowels *i* and *u* exhibit a common allophonic alternation: in open syllables and long vowels, they surface as [+ATR] [i] and [u], but in closed syllables, they are lax and centralized. (Short open syllables may occur both medially and finally; see fn. 6.) Here I adopt

6 The absence of a contrast between surface CVV and CV roots is striking. Akinlabi & Urua (1993) discuss various analytic alternatives, including the suggestion that CV forms are derived from bimoraic CVV by a rule of post-lexical truncation. No clear conclusions are reached, but the discussion makes it clear that the CV structures are not restricted to phrase-final position. This is not obviously a case of final shortening, though such an analysis may be possible, given additional information about the syntax of the language. I will not provide an analysis of this gap in the root inventory.

the transcriptions employed by Akinlabi & Urua (1993); *v* is described as being centralized, delabialized and lowered, relative to *u*.

(17) Allophonic variants of high vowels (Akinlabi & Urua 1993:8)

kùùk	'shut doors'	kv`k	'shut (door)'
dùùt	'drag many things'	dv`t	'drag'
bîî̀k	'be wicked many times'	bɪ`k	'be wicked'
fîî̂p	'suck on s.t.'	fɪ'p-pé	'remove sucked obj. from the mouth'
wúúk	'drive s.t. in'	wv'k-kø'	'remove an obj. driven in'
dî	'come'	dɪ'p	'hide'
kpî̀	'cut'	bɪ't	'spread a mat'
		dv'k	'enter'
		kv'p	'cover (with lid)'

(18) Impossible Ibibio surface forms

*CvvC	*CuC
*CɪɪC	*CiC
*Cv	
*Cɪ	

These alternations are entirely regular, and parallel to cases of closed-syllable laxing found in other languages such as Klamath (Blevins 1993) and Javanese (Benua 1996).[7] This allophony reflects a high-ranking markedness constraint which forbids [+ATR] vowels in closed syllables, as in (19).

(19) CHECKEDRTR

CHECKEDRTR must dominate the articulatorily grounded HIGH/ATR constraint of (20), as well as the faithfulness constraint IDENT(ATR). (See Chapter 3 for extensive discussion of the grounded constraints on height/ATR combinations.)

(20) HIGH/ATR: *[+high, –ATR]

The ranking of CHECKEDRTR » HIGH/ATR will force high vowels in closed syllables to be [–ATR], though high [–ATR] vowels are crosslinguistically more marked than high [+ATR] vowels. This is demonstrated in (21).

[7] The lowering and unrounding effect is perhaps more unusual, and suggestive of the contextual allophony exhibited in Tamil (see Chapter 2). As these aspects of closed syllable vocalism are tangential to the main point, that high vowel have lax allophones in closed syllables, I will not pursue the matter further here.

(21) Retraction in closed syllables

/dî̇p/	CHECKEDRTR	HIGH/ATR	IDENT(ATR)
a. dî̇p	*!		
b. ☞ dɪ̇p		*	*

This ranking of CHECKEDRTR and HIGH/ATR will not affect the realization of high vowels in open syllables, however:

(22) [+ATR] vowels in open syllables

/dî/	CHECKEDRTR	HIGH/ATR	IDENT(ATR)
a. ☞ dî			
b. dɪ'		*!	*

Candidate (22a), with a [+ATR] high vowel, is preferred in this configuration. Laxing is unmotivated in open syllables, and hence does not occur. [+ATR] high vowels will occur in this environment even if the input vowel is lax, due to the influence of HIGH/ATR » IDENT/ATR.

(23) Input [ATR] is irrelevant

/dɪ/	CHECKEDRTR	HIGH/ATR	IDENT(ATR)
a. ☞ dî			*
b. dɪ'		*!	

The unfaithful (23a) is optimal, rather than (23b), because the markedness constraint HIGH/ATR dominates the faithfulness constraint IDENT(ATR).

Long high vowels in Ibibio are invariably [+ATR]. This, too, may be attributed to a high-ranking structural markedness constraint which dominates IDENT(ATR); long high lax vowels in the input must surface as [+ATR] vowels in the output. There are no *Cɪɪ* or *Cʊʊ* forms in the language.

(24) LONG/ATR

Such a constraint is operative in other languages, as well; for example, English does not permit long lax vowels. LONG/ATR must dominate both IDENT(ATR) and CHECKEDRTR in order to yield the attested surface forms.

(25) Long high vowels are [+ATR]

/wúúk/	LONG/ATR	CHECKEDRTR	HIGH/ATR	IDENT(ATR)
a. ☞ wúúk		*		

b. wv'v'k	*!		*	*

Undominated LONG/ATR forces the long high vowel to surface as [+ATR], even in a closed syllable; CHECKEDRTR is violated in order to satisfy higher-ranking LONG/ATR, as in (25a). Even an input long [–ATR] high vowel cannot be faithfully reproduced in surface forms:

(26) Long [–ATR] vowels must be unfaithful[8]

/wv'v'k/	LONG/ATR	CHECKEDRTR	HIGH/ATR	IDENT(ATR)
a. ☞ wúúk		*		*
b. wv'v'k	*!		*	

Here, as above, LONG/ATR favors the [+ATR] variant of the high vowel.

The mid and low vowels apparently do not exhibit allophonic alternations of any kind in closed syllables, or under length. This absence of alternation is not predicted by the constraints examined thus far. In order to prevent tensing of *ø* and *a* under length, or laxing of *e* and *o* in closed syllables, the constraints in (27) must dominate LONG/ATR and CHECKEDRTR. Furthermore, through domination of IDENT(ATR), the constraints in (27) account for the basic shape of the vowel inventory: mid vowels are [+ATR] and low vowels are [–ATR].

(27) Mid and low vowel constraints

MID/ATR: *[–high, –low, –ATR][9]
LOW/RTR: *[+low, +ATR]

The effect of each constraint is shown in the tableaux below.

(28) Mid vowels must be [+ATR]

/w´´/	MID/ATR	LONG/ATR	CHECKEDRTR	HIGH/ATR	ID(ATR)
a. ☞ wee					*
b. w´´	*!	*			

8 The absence of forms such as (26b) in Ibibio makes it clear that we are not dealing with high-ranking IDENT-LONGV(ATR). While such a constraint would account for the absence of laxing in closed syllables, assuming a tense input, it cannot account for the lack of lax, long high vowels in the language.

9 This constraint represents a departure from the system of height/ATR constraints presented in Chapter 3. There, I suggested that constraints of this form are unnecessary to describe the behavior of vowel inventories. The facts of Ibibio do require that the mid vowels be treated distinctly from the high vowels, as their behavior in closed syllables is different. Simply ranking NONLOW/ATR » CHECKEDLAX » HIGH/ATR will not account for the allophony here, as this ranking would result in uniformly tense high and mid vowels in closed syllables. I am assuming MID/ATR for the purposes of demonstration here. As an alternative, we might consider a closed syllable laxing constraint which is sensitive to duration; as high vowel are intrinsically of shorter duration than mid vowels, they may be more susceptible to laxing in a closed syllable environment, where vowel duration is typically shorter than in open syllables. I leave this matter for further research.

/wek/					
a. ☞ wek			*		
b. w´k	*!				*

(29) Low vowels must be [–ATR] (small caps represent [+ATR] low vowels)

/waa/	Low/Rtr	Long/Atr	CheckedRtr	High/Atr	Id(Atr)
a. wAA	*!				
b. ☞ waa		*			*
/wAk/					
a. wAk	*!		*		
b. ☞ wak					*

In each case, the implicational markedness constraints select in favor of the actual output form, overriding the influence of the allophony-causing constraints Long/Atr and CheckedRtr.

This completes the basic outline of the Ibibio vowel inventory and the constraints which determine its makeup. The property of the system which is crucial to the discussion of positional maximization is the retraction of high vowels in closed syllables, implemented by the ranking of CheckedRtr » High/Atr » Ident(Atr). Keeping this distributional generalization in mind, consider the data in (30) below.

(30) [–ATR] high vowels in derived forms (Akinlabi & Urua 1993:37)

s$_I$'n	'put on (e.g. dress)'	s$_I$'né	'put on oneself'
d$_I$'p	'hide'	d$_I$'?é	'hide oneself'
fv'k	'cover (with cloth)'	fv'©ø'	'cover oneself'

In the left-hand column, the bare roots exhibit the allomorphy which is expected; high vowels are retracted in closed syllables. However, the vowels in the right-hand column are mysterious. In each CV_1CV_2 string, *V_1 is realized as the closed syllable allophone*. Yet the principle of onset maximization, derived from the interaction of the constraints NoCoda and Onset, predicts that both syllables should be open. The [–ATR] allophones of the high vowels should not appear in this context; rather, we expect **síné*, **dí?é* and **fú©ø'*. Because the words in question are derived forms, the data in (30) suggest that output-output faithfulness effects of the sort examined in Benua (1997) are relevant. Under such an analysis, the vowels in *d$_I$'?é*, *fv'©ø'* and similar words are [–ATR] by virtue of high-ranking Ident-OO(Atr), a constraint requiring identity between the base form (*d$_I$'p*, *fv'k*, etc.) and the related derived word.

However, such an analysis cannot be correct, because the same anomalous [-ATR] allophone appears in synchronically *underived* disyllabic roots. In (31), as above, the [–ATR] vowel seems to occur in an open syllable:

(31) [–ATR] high vowels in disyllabic roots (Akinlabi & Urua 1993:37)

fv`@ø' ‘pass by, surpass’
tv`nø' ‘discipline’
nI'©é ‘tickle’
fI'@é ‘forget’

Here there is no underived base word with a CVC shape that can enforce output-output identity. Rather, the high vowels are surfacing as though they are contained in closed syllables, because they *are* contained in closed syllables. The intervocalic consonant in the data above is *ambisyllabic*, parallel to the situation in Efik (Welmers 1973). This ambisyllabicity arises from high-ranking MAX-σ_1:

(32) MAX-σ_1
If α S_1, then there exists some β S_2 such that $\alpha \leftarrow \beta$ and β appears in σ_1.
“Every input segment has an output correspondent in the root-initial syllable.”

MAX-σ_1, through domination of NOCODA, will compel ambisyllabification of the intervocalic consonants in (31) and similar examples. This is shown in tableau (33) below, where MAX-σ_1 violations are assessed segmentally. (The ranking of MAX-σ_1 » ONSET is arbitrarily imposed for the sake of simplicity; reversing the ranking would not affect the end result.)

(33) MAX-σ_1 compels ambisyllabicity in Ibibio

/fi'té/	MAX-σ_1	ONSET	NOCODA
a.	t, e!		
b.	e	*!	*
c. ☞	e		*

Each of the candidates incurs at least one violation of MAX-σ_1. The interesting comparison here is between (33a) and (33c). The onset maximizing syllabification in (33a) suffers from two violations of MAX-σ_1, one for each input segment which is not dominated by the root-initial syllable. (33a) therefore cannot be optimal, because the ambisyllabic consonant of (33c) incurs only violation of MAX-σ_1. In addition, it satisfies ONSET by virtue of the ambisyllabic consonant, in contrast to (33b).

The [–ATR] realization of the high vowels in ambisyllabic contexts further demonstrates that MAX-σ_1 » HIGH/ATR, as shown in (34).

(34) [–ATR] vowels in ambisyllabic contexts

/fîté/	CHECKEDLAX	MAX-σ_1	HIGH/ATR
a. ☞		e	*
b.	*!	e	
c.		t, e!	

With ambisyllabicity enforced by high-ranking MAX-σ_1, the [–ATR] alternant of (34a) is predicted. However, were the ranking of MAX-σ_1 and HIGH/ATR reversed, the grammar would favor candidate (34c), with neither ambisyllabicity nor a [–ATR] high vowel.

Further evidence for the ambisyllabicity analysis, beyond the vowel allophony, may be found in the consonant system of the language. In Ibibio, "[t]he stops [p, t, k] are productively weakened to [?, @, ©] respectively in intervocalic position, comprising either second consonant of a disyllabic (CVCV) verb...or the final consonant of a closed syllable followed by any vowel initial morpheme..." (Akinlabi & Urua 1993:19). We have seen some examples of lenition above; additional forms are given in (320).

(35) Stop lenition (Akinlabi & Urua 1993:19)

a.	tò?ó	'make an order'		
	tɪ`@é	'stop'		
	fè©é	'run'		
b.	dwòp	'ten'	dwò? è bà	'twelve' (ten plus two)
	èfɪ't	'fifteen'	èfɪ'@ è nàà˜	'nineteen'(fifteen plus four)
	úfø`k	'house'	úfø`© î`bà	'two houses'

The forms in (35a) are underived disyllabic roots, and the forms in (35b) are phrases.[10] Consonant lenition occurs in both roots and derived forms, including phrasal contexts; in each case, the leniting consonant falls under the influence of high-ranking MAX-σ_1.

Crucially, however, lenition does not apply in *every* intervocalic context. It applies only to consonants which may be affected by MAX-σ_1: those which occur immediately following the first (or only) syllable of a root. Contrast the forms in (30), (31) and (35) with those below. Lenition does not apply to a root-initial intervocalic stop, as shown in (36).

(36) Lenition does not occur between prefix and root

é-táp	‘saliva’	*é@áp
é-tó	‘stick’	*é@ó
î̀-kø't	‘bush’	*î̀©ø't
ø`-kø'	‘fence’	*ø`©ø'

The failure of lenition is predicted by the analysis developed here: root-initial consonants satisfy MAX-σ_1 simply by being in the onset of the syllable. An ambisyllabic consonant here will incur a gratuitous violation of NOCODA (as well as violations of IDENT(continuant) and IDENT(voice)):

(37) Root-initial stops are not ambisyllabic

/é-táp/	MAX-σ_1	ONSET	NOCODA
a. ☞	e		*
b.	e		**!

Candidate (37a) is optimal; there is simply no motivation, in the form of a high-ranking constraint, for the ambisyllabic structure of (37b). Consequently, the additional violation of NOCODA which it incurs is fatal.

Lenition also fails to apply to stops which fall outside of the root-initial syllable window. This is highlighted by the behavior of negative verb forms. The negative in Ibibio is marked by a

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10 Although Akinlabi & Urua (1993) do not provide morpheme-by-morpheme glosses for these examples, I assume that the initial vowels of *eflt*, *uføk* and *iba* are prefixal, and that the *e* of ‘fifteen’ and ‘nineteen’ is a conjunction. Akinlabi & Urua (1993:19) do state that nouns are productively derived from verbs by prefixation of a vowel, and that they assume all initial vowels in nouns are prefixes.

CV suffix which requires a minimally bimoraic base.[11] When the verb root is monosyllabic, the suffix-initial consonant undergoes lenition as expected, even though the root vowel is long. (This shows that consonant ambisyllabicity is not a means of satisfying a bimoraic minimum on roots; it occurs even when the root is already bimoraic.) Representative data are given in (38).

(38) Monosyllabic root + negative suffix

sé	'look'	n'-séé-©é	'I am not looking'
nø`	'give'	n'-nø`ø`-©ø'	'I am not giving'
dó	'be (copula)'	n'-dóó-©ó	'I am not'
dá	'stand'	n'-dáá-©á	'I am not standing'

In the context of a disyllabic root, however, the consonant of the negative suffix does not lenite.

(39) Disyllabic root + negative suffix

dáppá	'dream'	...dáppá-ké	'...not dreaming'	*dáppa-©é
dámmá	'be mad'	...dámmá-ké	'...not being mad'	*dámmá-©é
sà˜á	'walk'	...sà˜á-ké	'...not walking'	*sà˜á-©é
kø'˜ø'	'choke'	...kø'˜ø'-ké	'...not choking'	*kø'˜ø'-©é

Lenition of an intervocalic consonant occurs if and only if the consonant in question is in the orbit of the root-initial syllable coda; otherwise, the input stop surfaces as a stop in the output.

This distribution of lenited stops constitutes additional evidence for the role of MAX-σ_1 in the grammar of Ibibio.[12] Ambisyllabicity, of which stop lenition is a diagnostic, is predicted to occur only if such a syllabification will better satisfy MAX-σ_1.[13] Beyond the initial syllable of the root, an ambisyllabic consonant cannot serve this purpose. Consider the tableau in (40).

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11 See Akinlabi & Urua (1993) for extended discussion of the prosodic requirements imposed by Ibibio affixes.

12 Akinlabi & Urua (1993) take these facts to indicate that the rule of lenition is foot-bounded, with a disyllabic trochee initiated by the root-initial syllable, noting that there is no stress prominence (presumably indicated by increased amplitude and duration) in the language. Phonological processes which appear to be restricted in application to the level of the foot are quite rare; it seems likely that all such effects may be subsumed under the rubric of positional faithfulness. (See the analysis of Guaraní in Chapter 3 for additional evidence in support of this claim.)

13 A coda-only analysis of Ibibio lenited stops, parallel to the analysis of English flaps offered in Selkirk (1982), is possible. Such an analysis requires that MAX-σ_1, UNIQUE-σ » ONSET. Under this approach, lenition would affect only coda consonants. In order to account for the absence of lenition in word-final codas, we must assume that lenition affects only released coda consonants, where release is possible only before a sonorant segment. Word-final coda consonants, not preceding a sonorant, are not released; therefore, they are not subject to lenition. Such an analysis raises the question of why only released segments should undergo a lenition process which renders them unfaithful to their input correspondents in [continuant] and [voice], particularly given the arguments in Lombardi (1995a), and Padgett (1995b) that

(40) No ambisyllabicity beyond σ_1

/sà˜á-ke/	MAX-σ_1	ONSET	NOCODA
a. ☞	a, k, e		*
b.	a, ©, e		**!

The two candidates tie on both MAX-σ_1 and ONSET, passing the decision to low-ranking NOCODA. Multiple ambisyllabic consonants, as in (40b), incur multiple, unmotivated violations of NOCODA. The intervocalic dorsal stop, which has no access to the root-initial syllable, has no motivation to syllabify ambisyllabically. Candidate (40a) is optimal.

The facts of Ibibio provide evidence that MAX-σ_1 is high-ranking in the grammar. The distribution of high vowel allophones, crucially related to syllable structure, indicates that the root-initial syllables are closed in forms such as *nI'©é* and *fv`@ø'*. Furthermore, the limited occurrence of lenited stops is predicted by the positional MAX analysis set out above: intervocalic consonants are lenited in just those contexts in which the consonant may better satisfy MAX-σ_1, by means of an ambisyllabic affiliation to higher-level prosodic structure.

The theory outlined here is not solely a theory of root-initial faithfulness, but rather a theory of faithfulness in a variety of prominent positions. Consistent with the broad purview of positional faithfulness theory, there is evidence in other languages that MAX-σ' plays an important role in generating syllabifications which are inconsistent with onset maximization.

5.4 Stressed Syllable Maximization in Scots Gaelic

Ibibio, and the closely-related language Efik, provide compelling evidence that MAX-σ_1 is enforcing an otherwise aberrant ambisyllabification of intervocalic consonants. Through domination of NOCODA, MAX-σ_1 forces root-initial syllables to be maximally filled with segmental material present in the input. We might expect, in a fully elaborated theory of positional MAX constraints, to find evidence of prosodic maximization in other privileged

faithfulness is preferentially enforced on [+release] segments. A full understanding of contextual allophony is beyond the purview of this dissertation, so I will leave this matter for future research.

positions. Just such evidence is provided by the phonology of Scots Gaelic, which shows stressed syllable maximization effects resulting from high-ranking MAX-σ'.

In Barra and Lewis Gaelic, two dialects of Scots Gaelic spoken in the Outer Hebrides, intervocalic consonants exhibit an unusual pattern of syllabification. Following a short vowel in the stressed initial syllable, an intervocalic consonant regularly syllabifies in coda position, rather than as an onset (Børgstrom 1940: 55).

(41) Coda syllabification of intervocalic consonants

bqødq. \x	'old man'
ar.an	'bread'
faL.u[14]	'empty'

Børgstrom's (1940) description makes it clear that the syllabification pattern in (41) is entirely regular. Intervocalic consonants are drawn into the stressed initial syllable, in violation of ONSET.

In contrast to the forms in (41), Børgstrom (1940) reports a second pattern of syllabification, exemplified in (42). (Examples are taken from Clements 1986, as well as from Børgstrom 1940.)

(42) Onset syllabification of intervocalic consonants?

ma.rav	'dead'
a.ram	'army'
ßa.Lak	'hunting'
ska.rav	'cormorant'
ø.røm	'on me'
bø.rø©	'Borg' (place name)

In each of these cases, the second vowel is an epenthetic copy of the first vowel. Underlying clusters of sonorant + heterorganic consonant are broken up by epenthesis, as Clements (1986) convincingly argues. Under such conditions, Børgstrom reports that the consonant in question syllabifies with the following syllable, rather than with the preceding.

We appear to have a simple surface contrast in syllabification, but the facts are slightly more complex. Børgstrom reports that native speakers treat examples such as (41) as

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[14] L represents a non-lenited dental lateral. Leniting consonant mutations are pervasive in all of the Gaelic languages; I will not address the contrast between lenited and non-lenited segments here.

disyllables, but data like those in (42) are considered to be *monosyllables*. Thus, Neil Sinclair, a Barra speaker, gave a syllable division between *N* and *a* in *fæ‹Nak* , where the second vowel is underlying[15]. In the case of *ßaLak*, where the second vowel is epenthetic, Sinclair indicated that "the *L* and the following *k* are so 'close together' that such a separation is impossible" (Børgstrom 1940: 153). Børgstrom concludes from this that "it is evident that for native speakers the type m[ara]v [with svarabhakti--JNB] is equivalent to a monosyllable."

The monosyllabic analysis of svarabhakti forms is further supported by the facts of stress and tone distribution. Words in Barra and Lewis Gaelic are permitted one stress, which falls regularly on the initial syllable. This stress is marked by a "rising (high) tone, while unstressed syllables have a low (falling) tone" (Børgstrom 1940: 53). In words containing a svarabhaktic vowel, the "tone is rising on both vowels, which are both regarded as stressed". This tone pattern is identical to that of long stressed vowels and diphthongs, which also bear high tone on both members.

These findings are further supported by the findings of Bosch & DeJong (1996), who recorded a native speaker of Barra producing both categories of words, those containing two vowels underlyingly (the *ar.an* type), and those containing a svarabhakti vowel (as in *a.ram*). Bosch & DeJong measured both the duration and the fundamental frequency of V_1 and V_2. In the words conforming to the canonical stress and syllabification pattern, they found that the duration of V_1 was greater than that of V_2, and that pitch declined rather sharply in V_2. By contrast, in the svarabhakti words, the duration of V_2 was equal to or greater than that of V_1—and pitch remained consistently high across both vowels, rather than decreasing on V_2. Bosch & DeJong suggest that the epenthetic vowel in the svarabhakti forms is the stress-bearer, in contrast to the standard initial syllable stress pattern. While the monosyllabism of the svarabhakti forms remains difficult to establish, Bosch & DeJong's data establish a difference in stress

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[15] Orthographic *feannag*, versus *sealg* for the following example. Svarabhakti vowels are nearly always ignored in the orthography.

placement in the two classes of words—a difference that correlates with different syllabification patterns for intervocalic consonants.

The canonical syllabification pattern for VCV sequences in Barra arises from the following ranking: Max-σ', Unique-σ » NoCoda, Onset. The ranking of Max-σ' over NoCoda is responsible for the association of the intervocalic consonant to the initial, stressed syllable; the ranking of Unique-σ over Onset yields an exhaustive coda syllabification, rather than an ambisyllabic consonant. (Compare this with the Ibibio case in §5.3 above.)

(43) Canonical syllabification pattern

/aran/	Max-σ'	Unique-σ	NoCoda	Onset
a. ☞	a, n		**	**
b.	a, n	*!	**	*
c.	r!, a, n		*	*

Violations of Max-σ' are incurred by every output segment which a) is the correspondent of an input segment, and b) does not appear in the stressed initial syllable. In candidates (43a) and (43b), there are two violations of Max-σ'; in the third candidate, there are three, and the third violation is fatal. Of the remaining two candidates, (43a) will be optimal, as it satisfies the constraint Unique-σ, which rules against ambisyllabicity by requiring that segments have a unique syllabic anchor.

In the svarabhakti cases, epenthesis occurs in heterorganic sonorant+consonant sequences, in order to prevent an illicit cluster. (The fact that epenthesis, rather than place assimilation or deletion, occurs indicates that Dep must be ranked below Max and Ident(Place); with higher-ranking Dep, epenthesis would not be the preferred repair strategy.) Stress in such forms falls on the epenthetic segment, rather than on the initial vowel. The intervocalic sonorant in these cases is syllabified in the onset of the second syllable precisely because the initial syllable does not bear the stress necessary to attract that consonant into the coda, via Max-σ'. In fact, the placement of stress on the epenthetic vowel reinforces the onset syllabification of the consonant, a syllabification favored by Onset and NoCoda. This is shown in (44) below.

(44) Svarabhakti syllabification pattern

/arm/	Max-σ'	Unique-σ	NoCoda	Onset
a.	a, r!		**	**
b.	a	*!	**	*
c. ☞	a		*	*

In this case, the canonical pattern, with exhaustive coda syllabification of the intervocalic sonorant (44a) is non-optimal because two of the output segments are excluded from the stressed syllable. Candidates (44b) and (44c) fare better, excluding only the initial vowel from the stressed syllable. Of these, (44c) is selected as optimal because it avoids the violation of Unique-σ incurred by (44b).

Through interaction with Onset, NoCoda and Unique-σ, Max generates the two patterns of syllabification in Barra Gaelic, and in fact predicts their occurrence. These two patterns cannot both be generated by the core array of OT syllable structure constraints, as I showed in §5.2 above. Furthermore, there is no obvious alternative available; alignment constraints do not seem to provide a principled solution. Consider, for example, the segment-to-word alignment constraint of (45):

(45) Align(segment, L, PWd, L)
"Every segment must be aligned at the left edge with a Prosodic Word."

Given two candidates, *ar.an* and *a.ran*, (45) can force coda syllabification only if violations are assessed in terms of the number of syllables which intervene between a given segment and the left edge of the prosodic word; counting the segments which intervene between a given segment and the left edge of the word will be useless in distinguishing competing syllabifications. Membership in the initial syllable must render a segment immune to violation in order to generate the correct result.

(46) Alignment forces prominence attraction?

/aran/	ALIGN-L
a. ☞	a_1: v r: v a_2: σ n: σ
b.	a_1: v r: σ! a_2: σ n: σ

Under this interpretation, the coda syllabification is indeed preferred—but this syllabification will also be selected in the svarabhakti cases, as an inspection of (46) should make clear. This approach will be forced to divide the lexicon into two classes which are subject to different constraint rankings in order to prevent forms such as *a.ram* from syllabifying as in (46).

A more obvious alternative, again invoking an ALIGN constraint, would require alignment of segments to stressed syllables. It is the coda syllabification of the intervocalic consonant in forms such as *ar.an* which is problematic for the core constraints of syllable theory in OT, and we will need a constraint compelling this result. It is not clear that either right or left alignment will be sufficient, however. The ALIGN-L formulation is examined in (47) below, with violations assessed in terms of segments which intervene between the left edge of the stressed syllable and the left edge of the segment in question.

(47) Left alignment

/aran/	ALIGN(seg, L, σ', L)
a.	a_1: | r: a_1 a_2: r, a_1 n: a_2, r, a_1
b.	a_1: | r: a_1 a_2: r, a_1 n: a_2, r, a_1

The two key competitors in (47) fare equally well with respect to left alignment; this constraint cannot choose between them. NOCODA would actually favor (47b) over (47a).

Right alignment of segments and stressed syllables appears to achieve the desired result, however, as the array in (48) demonstrates.

(48) Right alignment

/aran/	ALIGN(seg, R, σ', R)
a.	a_1: r r: v a_2: r, a_1 n: a_2, r, a_1
b.	a_1: $\vert$ r: a_1! a_2: r, a_1 n: a_2, r, a_1
/arm/	ALIGN(seg, R, σ', R)
c.	a_1: r, a_2, m r: a_2, m a_2: m m: $\vert$
d.	a_1: r, a_2, m r: a_2, m a_2: m m: $\vert$

Provided that we may assess violations on a segment-by-segment basis, the violation incurred by *r* in (48b) will be fatal, while the choice between candidates c and d will be made by NOCODA, as they tie with respect to ALIGN-R.

However, while an analysis employing alignment *is* possible, it is not without drawbacks. The ALIGN-R constraint required to generate the Barra pattern essentially requires coda syllabification, a kind of anti-NOCODA constraint. (Compare this with the alignment-based formulations of NOCODA and CODACOND in Itô & Mester 1994: ALIGN-R(σ, V) and ALIGN-L(C, σ), respectively.) Such an imperative for marked structure is somewhat unusual in the context of a theory which places a heavy emphasis on constraints against marked structure, and should be regarded with caution.

5.5 Tamil Complex Codas

5.5.1 Introduction

In the preceding sections, I examined cases of ambisyllabicity which derive from high-ranking positional MAX constraints. In each example, the syllabification of intervocalic segments differs from the canonical CV pattern favored by the syllable markedness constraints ONSET and NOCODA: consonants are drawn into the coda of a preceding syllable, rather than being exhaustively syllabified in onset position. Such a pattern can never be optimal in a theory which allows only ONSET, NOCODA and context-free MAX constraints, but follows straightforwardly from a theory incorporating MAX-*Position* constraints.

The influence of MAX-*Position* constraints on the surface syllabification of a language extends beyond the realm of simple violations of onset maximization in VCV sequences. For example, high-ranking MAX-σ_1 accounts for an asymmetry in the availability of complex codas in Tamil: root-initial syllables may have complex codas, but non-initial syllables may not. This disparity arises from the ranking of MAX-σ_1 above *COMPLEX, which itself dominates DEP. Tamil thus exhibits a wide range of positional faithfulness effects, due to high-ranking positional IDENT and positional MAX constraints.

In Chapter 2, I provided an extensive analysis of positional IDENT effects in Tamil phonology. There are two positional IDENT constraints which are sufficiently high-ranking to influence the phonology of the language: IDENT-ONSET(Place) and IDENT-σ_1(Place). The onset IDENT constraint, through domination of context-free IDENT(Place) and the place markedness subhierarchy, ensures that syllable onsets trigger place assimilation in coda-onset clusters; the relevant ranking is repeated in (49) below.

(49) Positional neutralization of place distinctions, Tamil non-initial codas
IDENT-ONSET(Place) » *DORSAL, *LABIAL » *CORONAL » IDENT(Place)

The second positional IDENT constraint which is high-ranking in Tamil, IDENT-σ_1(Place), prevents coronal codas in the root-initial syllable from assimilating to a following onset. This results in an independent coronal place specification in the root-initial syllable, via the ranking shown in (50).

(50) Initial syllable faithfulness

ID-ONSET(Place) » *DORSAL, *LABIAL » **ID-s 1(Place)** » *CORONAL » ID(Place)

This ranking forces place assimilation of dorsal or labial codas (even in the initial syllable), but prevents assimilation of a coronal consonant in the initial syllable.

Although we have seen compelling evidence that positional IDENT constraints are active in Tamil featural phonology, there is a positional effect at the level of syllable structure which has yet to be addressed. As noted above, root-initial syllables in Tamil may be larger than non-initial syllables: complex codas are permitted in this position, though they are not tolerated elsewhere. Representative data are repeated in (51).

(51) Complex codas in initial syllables (Christdas 1988: 247)

/ayppaciy/	[÷a**yp**.pé.sI]	a month
/payt5t5iyam/	[pa**yt5.**t5I.yã]	'madness'
/aykkiyam/	[÷a**yk**.kI.yã]	'unity'
/aa@ppaa??am/	[÷aa**@p**.paa?.?ã]	'tumult'
/maa@t5t5aa¯?am/	[maa**@t5**.t5aan=.d=ã]	place name
/a@t5t5am/	[÷a**@t**5.t5ã]	'meaning'
/äaaÄkkay/	[äaa**Äk**.ké]	'life'

In each case in (51), the complex coda is composed of a coronal sonorant and the first half of a following geminate. These initial syllables incur both a violation of NOCODA and a violation of *COMPLEX, the constraint which penalizes complex syllable margins (Prince & Smolensky 1993), but are admitted by the grammar as well-formed Tamil structures.

By contrast, there are no Tamil words with the shapes shown in (52).

(52) No complex codas in non-initial syllables

*CV.CV**CC**.CV
*CVC.CV**CC**.CV
*CV.CV.CV**CC**.CV
etc.

The contrast between the data in (51) and the non-occurring shapes in (52) may suggest a simple prohibition on heavy or superheavy non-initial syllables, perhaps enforced by the constraints in (53).

(53) Prohibiting weight non-initially?

(53) is a positional markedness constraint which penalizes marked structures that occur outside of some prominent position. Elsewhere in this dissertation, I have argued against such constraints; they are at best redundant, and at worst, inadequate to account for positional asymmetries of distribution. However, even if such constraints are permitted, those in (53) cannot account for the contrast in well-formedness that holds between (51) and (52). Both open and closed syllables containing long vowels are permitted in non-initial position, as demonstrated in (54). The coda consonant in a closed syllable may be either the first half of a geminate, or a sonorant homorganic to the following onset.

(54) Heavy non-initial syllables

÷aa@p.**paa?**.?ã	'tumult'	PC: 247	
maa@t5.**t5aan=**.d=ã		place name	"
pa.**laak**.k}	a tree (dative)	PC: 281	
pU.**r~aa**	'pigeon'	PC: 174	
÷ak.**kaa**.nI	'palm wine'	"	
tak.**kaa**.ÆI	'tomato'	"	
kaak.**kaa**	'crow'	"	
ti.**Îii@**	'suddenly (onomat.)'	"	
ka.**¯iir**	'clearly'	"	
äay.**suu**.@I	'smallpox'	"	

These data, and other similar forms, show clearly that heavy and superheavy syllables are licit in non-initial position. Root-initial syllables are not unique in licensing heavy or super-heavy syllables, but rather in permitting complex codas, in violation of *COMPLEX. Non-initial syllables respect *COMPLEX; a single coda consonant is all that is permitted in such syllables.

The pattern outlined in (51)-(54) above is yet a further example of a positional phonological asymmetry in Tamil, indicative of a high-ranking positional faithfulness constraint. In schematic form, the operative constraint subhierarchy is that shown in (55).

(55) Positional complex coda subhierarchy, schematic
FAITH-σ_1 » *COMPLEX » FAITH

In contrast to the cases of positional faithfulness examined in Chapter 2, the dominant FAITH-σ_1 of (55) cannot be IDENT-σ_1(Place). IDENT-σ_1(Place) is irrelevant in selecting among the actual form, ÷*ayp.pé.sI*, and non-occurring ÷*ap.pé.sI* and ÷*a.y}p.pé.sI* as the correct output for input

/ayyppaciy/. The contrast here is not between a form which satisfies IDENT-σ_1(Place) and those which violate it; *none* of these candidates violates IDENT-σ_1(Place).

(56) IDENT-σ_1(Place) is irrelevant

	/ayppaciy/	IDENT-σ_1(Place)
a.	÷ayp.pé.sI	v
b.	÷ap.pé.sI	v
c.	÷a.y}p.pé.sI	v

Rather, there is a segment-level resistance to any deletion or epenthesis which would reduce the number of input segments which are dominated by the root-initial syllable. The constraint responsible for this pattern is the now-familiar MAX-σ_1, which favors maximal syllabification of input segments to the root-initial syllable, even at the expense of NOCODA and *COMPLEX violations. Complex codas in the initial syllable are the result. Outside of the initial syllable, there is no positional constraint to enforce complex coda syllabification; either epenthesis or deletion is chosen to avoid the *COMPLEX violation. In the remainder of this section, I will develop fully the analysis of Tamil complex codas.

5.5.2 Tamil onsets

Our primary concern in this section is the complex coda asymmetry exhibited by initial and non-initial syllables of Tamil. In order to correctly characterize the behavior of intervocalic consonants and consonant sequences, however, an understanding of the constraints which govern Tamil onsets will be required. Following the discussion of syllable onsets, I turn to the analysis of coda clusters.

All Tamil syllables are alike in requiring an onset consonant. Vowel-initial roots are augmented with an onset glide that varies according to the quality of the underlying vowel. Front vowels take an epenthetic *y*, round vowels take *w*, and the low vowels take ÷ (Wiltshire 1994, 1995, 1996).[16]

[16] The precise character of the inserted glide is determined by the place of the initial vowel, due to the influence of the place markedness subhierarchy (cf. chapter 2). The epenthetic glide takes on the place features of the following vowel in order to minimize *PLACE violations. Further discussion of CV place-

(57) Initial glide insertion (Wiltshire 1994)

/iru??/	[yir}??}]	'darkness'
/ellaam/	[y´llãã]	'all'
/aacc/	[÷aacc}]	'happened'
/aasay/	[÷aas´]	'desire, hope'
/o??akam/	[wø??´xõ]	'camel'
/uusii/	[wuusii]	'needle'

Non-initial syllables are also required to have an onset consonant; there are no examples of word-internal hiatus in the language. As Wiltshire (1995, 1996) argues, facts such as these indicate that the syllable structure constraint ONSET dominates the anti-epenthesis constraint DEP.[17] This is illustrated in (58).

(58) ONSET » DEP

/uusii/	ONSET	DEP
a. uu.sii	*!	
b. ☞ wuu.sii		*

Glide epenthesis, as in (58b), is preferred to an onsetless syllable (58a).

That epenthesis, rather than deletion, is the preferred strategy for avoiding ONSET violations indicates that MAX » DEP.

(59) MAX » DEP

/uusii/	ONSET	MAX	DEP
a. uu.sii	*!		
b. ☞ wuu.sii			*
c. sii		*!	

Vowels are preserved, rather than deleted; candidate (59b) is optimal, although it incurs a violation of DEP. Each of the other candidates violates a higher-ranking constraint.

While Tamil syllables necessarily take an onset consonant, no further complexity at the onset level is permitted. There are no complex onsets in the language at all; syllables begin with exactly one consonant. This indicates that *COMPLEX, the constraint prohibiting multiple segments in syllable margins, must dominate a faithfulness constraint such as DEP. Inputs which

sharing which is motivated by the place markedness subhierarchy may be found in Alderete et al. (1996); see also Rosenthall (1994).

17 Wiltshire, working in a pre-Correspondence Theoretic framework, adopts the constraint FILL, from Prince & Smolensky (1993). I have updated the analysis in accordance with Correspondence Theory.

contain consonant sequences that might be syllabified in an onset position do not surface faithfully. This is shown in (60), where the input is a hypothetical Tamil word.

(60) *COMPLEX » DEP

	/kruul/	*COMPLEX	DEP
a.	kruul	*!	
b. ☞	ku.ruul		*

The candidate with epenthesis, (60b), is optimal. Candidate (60a) incurs a fatal violation of *COMPLEX.[18] Similar clusters, occurring word-internally, will be syllabified heterosyllabically, as we saw in Chapter 2.

The rankings which account for the behavior of syllable onsets in Tamil are summarized in the diagram in (61) below.

(61) Onset ranking summary

Lowest-ranking DEP permits glide epenthesis with vowel-initial roots, in order to satisfy high-ranking ONSET. The ranking of ONSET » DEP also prohibits internal hiatus. Finally, the domination of DEP by *COMPLEX rules out complex onsets in any position; epenthesis is preferable to an illicit onset cluster. No ranking of *COMPLEX, MAX and ONSET can be established at this point.

5.5.3 Codas in Non-initial Syllables

In the preceding section, I established the basic ranking which will derive the obligatorily simplex onsets of Tamil syllables. Now we turn our attention to the opposite end of the syllable, the coda. As we saw in Chapter 2, the inventory of permissible codas is tightly constrained in non-initial syllables. Coda consonants in this position must share place of articulation with the following onset. This is due to the ranking of *PLACE » IDENT(Place). The coda must also be of greater sonority than the following onset, due to the high-ranking SYLLABLE CONTACT LAW ((96) in Chapter 2). Consonants which cannot satisfy these high-ranking constraints may not be

[18] An additional candidate with deletion, as in *kuul*, is not considered. Such an outcome is possible if *COMPLEX » MAX. However, because (as established in Chapter 2) MAX » DEP, candidate (60b) will win over any candidate which satisfies * COMPLEX by means of segmental deletion.

syllabified as codas in non-initial syllables; an epenthetic vowel will render them onsets, where their features are protected via IDENT-ONSET(Place). Examples which demonstrate the behavior of potential coda consonants in non-initial syllables are repeated in (62)-(63) below; for full discussion, see Chapter 2. The place markedness subhierarchy is abbreviated here as *PLACE.

(62) Nasal assimilation in coda position

/pasan8 + kaÆ/	MAX	ID-ONSET	*PLACE	NOCODA	ID(Place)	DEP
a. ☞ pa.sé˜.gé			p, s, ˜g	*	*	
b. pa.sén8 .gé			p, s, n8 , g!	*		
c. pa.sé.n8 }.gé			p, s, n8 , g!			*
d. pa.sé.xé	*!		**p, s, x**			

Nasals (and laterals) assimilate wherever possible, due to high-ranking MAX and low-ranking IDENT(Place). In the event that assimilation is not possible, epenthesis results.

(63) Epenthesis in obstruent+obstruent sequences

/kat5ap+kaÆ/	MAX	SCL	ID-ONSET	*PLACE	ID(Place)	DEP
a. ☞ ka.d8 é.ä}.xé				**k, d8 , ä, x**		*
b. ka.d8 ép.ké		*!		**k, d8 , p, k**		
c. ka.d8 é.xé	*!			**k, d8 , x**		

As we have seen elsewhere, the constraint hierarchy employed in (62) and (63) will account for the behavior of simplex codas in these cases, and others as well.

However, the codas of non-initial syllables are further restricted, in a way which is not predicted by the constraint rankings above: only a single consonant may appear in the coda of a non-initial syllable. *COMPLEX, the constraint which penalizes the occurrence of multiple segments in a syllable margin, may not be violated in non-initial syllables. Input forms which contain sequences of three or more consonants cannot be fully syllabified without epenthesis, should the consonants in question fall outside of the initial syllable. This is illustrated with a hypothetical form in (64) below; as demonstrated in the discussion of onsets, *COMPLEX » DEP. (The featural IDENT constraints have been omitted for the sake of simplicity.)

(64) Epenthesis in triconsonantal clusters

/kat5a@mpa/	MAX	*COMPLEX	*PLACE	NOCODA	DEP
a. ka.t5é@m.pé		*!	k, t5, @, mp	*	
b. ka.t5é@.mpé		*!	k, t5, @, mp	*	
c. ka.t5ém.pé	*!		**k, t5, mp**	*	
d.☞ ka.t5é.@}m.pé			k, t5, @, mp	*	*

As (64) clearly shows, the ranking of *COMPLEX » DEP is crucial in ruling out non-initial complex codas. In the first two candidates, no segments have been added or deleted, resulting in a necessarily complex syllable margin in coda (64a) or onset (64b). The concomitant violations of *COMPLEX are fatal. Were DEP ranked above *COMPLEX, either (64a) or (64b) would be optimal, rather than (64d). Yet forms like (64a,b) never occur in Tamil. Triconsonantal clusters which fall outside of the initial syllable cannot ever be syllabified without epenthesis. This will be true if the consonants in question all belong to a single morpheme, as in (64), and also if the triconsonantal string arises through morpheme concatenation, as in (65). Hypothetical examples such as these show that *COMPLEX » *PLACE » DEP; better satisfaction of *PLACE is sacrificed in order to avoid a *COMPLEX violation.

(65) Epenthesis in derived triconsonantal clusters

/kat5a˜k-kaÆ/	MAX	*COMPLEX	*PLACE	NOCODA	DEP
a. ka.t5é˜g.gé		*!	**k, t5, ˜gg**	*	
b. ka.t5é˜.ggé		*!	**k, t5, ˜gg**	*	
c. ka.t5ék.ké	*!		**k, t5, kk**	*	
d.☞ ka.t5é.˜}k.ké			**k, t5, ˜, kk**	*	*

Just as in (64), epenthesis is favored by high-ranking *COMPLEX and MAX. Candidate (65d) is optimal, even though it incurs more *PLACE violations than any other candidate. Polysyllabic roots which end in consonant clusters cannot be faithfully syllabified when concatenated with a consonant-initial suffix. Epenthesis will always result from this grammar.

The preceding discussion demonstrates the constraint interaction which is required to account for the absence of complex codas in non-initial syllables. Complex codas and onsets are avoided by means of epenthesis, due to low-ranking DEP. The results of this section are integrated with those of the preceding discussion of onsets in (66).

(66) Interim ranking summary

5.5.4 Codas in Initial Syllables

The subgrammar of Tamil outlined in (66) above will correctly account for the absence of complex syllable onsets, and for the nonexistence of complex codas in non-initial syllables. However, it cannot generate complex codas in initial syllables; the positional faithfulness constraint MAX-σ_1 will be necessary to admit the data in (67).

(67) Complex codas in initial syllables (Christdas 1988: 247)

/ayppaciy/	[÷a**yp**.pé.sI]	a month
/payt5t5iyam/	[pa**yt5.**t5I.yã]	'madness'
/aykkiyam/	[÷a**yk**.kI.yã]	'unity'
/aa@ppaa??am/	[÷aa**@p**.paa?.?ã]	'tumult'
/maa@t5t5aa¯?am/	[maa**@t5**.t5aan=.d=ã]	place name
/a@t5t5am/	[÷a**@t**5.t5ã]	'meaning'
/äaaÄkkay/	[äaa**Äk**.ké]	'life'

In order to demonstrate that MAX-σ_1 is crucially high-ranking in Tamil, I provide the tableau in (68), where only the constraints of (66) are arrayed. (I assume that degemination is not a possible strategy; geminate/singleton contrasts are robustly maintained in Tamil.)

(68) Complex codas in initial syllables?

/äaaÄkkay/	MAX	*COMPLEX	*PLACE	NOCODA	DEP
a. äaaÄk.ké		*!	**ä, Ä, kk**	*	
b. 💣 äaa.Ä}k.ké			**ä, Ä, kk**	*	*

The candidate exhibiting epenthesis, (68b), is clearly optimal under this grammar. Yet, forms such as (68a) exist in the language and must be generated. *COMPLEX is dominated by a constraint which favors maximal syllabification of the root-initial syllable; that constraint is MAX-σ_1.

The effects of high-ranking MAX-σ_1 are shown in (69) below. The constraint must crucially dominate *COMPLEX:

(69) MAX-σ_1 » *COMPLEX

/äaaÄkkay/	MAX-σ_1	MAX	*COMPLEX	*PLACE	NOCODA	DEP
a. ☞ äaaÄk.ké	a, y	y	*	**ä, Ä, kk**	*	
b. äaa.Ä}k.ké	a, y, Ä!, kk	y		**ä, Ä, kk**	*	*

Candidate (69a), in which the initial syllable is maximally filled by input segments, is optimal; this is true even though *COMPLEX is violated. By contrast, (69b) satisfies *COMPLEX, but at the expense of MAX-σ_1. Maximization of the prominent root-initial syllable is paramount, although a marked complex coda must be admitted as a result.

High-ranking MAX-σ_1 will not influence the syllabification of consonant clusters which fall outside the purview of the root-initial syllable. This is shown in (70), where the hypothetical root of (64) is repeated.

(70) Non-initial clusters are not affected by MAX-σ_1

/kat5a@mpa/	MAX-σ_1	MAX	*COMPLEX	*PLACE	NOCODA	DEP
a. ka.t5é@m.pé	t5, a, @, m, p, a		*!	**k, t5, @, mp**	*	
b. ka.t5é@.mpé	t5, a, @, m, p, a		*!	**k, t5, @, mp**	*	
c. ka.t5ém.pé	t5, a, @, m, p, a	*!		**k, t5, mp**	*	
d.☞ ka.t5é.@}m.pé	t5, a, @, m, p, a			**k, t5, @, mp**	*	*

Each of the candidates ties with respect to MAX-σ_1; exactly the same segments are omitted from the initial syllable of the root, and packing more segments into the coda of the second syllable will not achieve better satisfaction of MAX-σ_1. Candidate (70d) is therefore optimal, by virtue of satisfying MAX and *COMPLEX, just as we saw in (64) above.

One additional remark is in order at this point. There is another relevant candidate which was not considered in (70) above: *kat5.é.@}m.pé*. This form fares better on MAX-σ_1 than any of the candidates considered above, yet it is not optimal. This shows that ONSET » MAX-σ_1. ONSET is an undominated constraint of the language, and cannot be sacrificed, even to MAX-σ_1.

We have now seen that MAX-σ_1 plays a central role in determining the possible syllable shapes of initial and non-initial syllables in Tamil. The constraint rankings which are relevant to the syllabification of the language are summarized in (71).[19]

(71)

The positional MAX constraint MAX-σ_1 will help to solve a mystery which was left outstanding at the close of Chapter 2: how can freestanding coronal codas be syllabified in the root-initial syllable? Consider the forms in (72).

(72) Independent POA

/t5eyäam/	[t5e**y**.äã]	'god'	PC: 230
/aa@äam/	[÷aa**@**.äã]	'eagerness'	PC: 231
/maa@kaÄiy/	[maa**@**.xé.Ä$_I$]	a month	PC: 231
/munÍiy/	[mu**n**.Í$_I$]	'teacher'	PC: 234
/tunpam/	[tu**n**.bã]	'sorrow'	PC: 234
/na¯pan/	[n8 a¯.bã]	'friend'	PC: 234
/anp/	[÷a**n**.b}]	'love'	PC: 157

In each case, the initial syllable coda contains a coronal consonant which is not homorganic to the following syllable onset. Neither dorsal nor labial codas are permitted to occur freely in initial syllable codas.

In Chapter 2, I showed that the freestanding coronal place specification of the codas in these data derives from the ranking given in (73) below. The rankings established in Chapter II are repeated, and the portion of the constraint hierarchy which permits initial syllable codas to be coronal, though not labial or dorsal, is enclosed in the dark box.

(73)

Crucially, IDENT-σ_1(Place) » *CORONAL, rendering faithfulness to the input coronal place of the coda consonant of paramount importance.

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19 The ranking of MAX-σ_1 » *COMPLEX, as shown in (71), predicts that complex onsets should be permitted in root-initial syllables. Input /CCV.../ should be syllabified as CCV, rather than CV.CV or VC.CV, in order to better satisfy MAX-σ_1. That such syllabifications do not occur indicates that *COMPLEX must be further dispersed into *COMPLEX-ONSET and *COMPLEX-CODA, not a surprising result.

In order to integrate MAX-σ_1 into the constraint hierarchy shown in (73), we must examine anew the forms in (72), as well as parallel inputs in which labial or dorsal segments are predicted to close the initial syllable. Consider first the tableau in (74). The comparison of interest is that of the actually occurring form (74a), and a candidate with epenthesis, as in (74b).

(74) Coronal codas?

/tunpam/	IDENT-σ_1(Place)	*COR	NOCODA	IDENT(Place)	DEP
a. tun.bã		t, n	*!		
b. 💣 tu.n}.ää		t, n			*

Epenthesis is actually favored by this grammar, incorrectly predicting that forms such as (74a) are ill-formed.

Though candidate (74b) appears to be problematic, the difficulty it poses is more apparent than real. The preceding discussion of complex codas has established that MAX-σ_1 » *COMPLEX, and that *COMPLEX » *PLACE. By transitivity of ranking, this entails that MAX-σ_1 » *PLACE, as shown in (71). Crucially, MAX-σ_1 also dominates NOCODA, by transitivity of ranking. The coronal coda of (74a) is therefore favored, even at the expense of NOCODA. This is demonstrated in (75).

(75) MAX-σ_1 » NOCODA

/tunpam/	MAX-σ_1	*DORS	*LAB	ID-σ_1(Place)	*COR	NOCODA	ID(Place)	DEP
a. ☞ tun.bã	p, a, m		b		**t, n**	*		
b. tu.n}.ää	n!, p, a, m		**ä**		**t, n**			*
c. tum.bã	p, a, m		mb	*!	**t**	*	*	

The correct candidate, (75a), is selected as the optimal form. (75b) better satisfies NOCODA, but the ranking of MAX-σ_1 » NOCODA renders this satisfaction irrelevant. Candidate (75c), in which the coda consonant assimilates to the following onset, is ruled out by high-ranking IDENT-σ_1(Place).

Not any coronal consonant may serve as the coda of a root-initial syllable, as we saw in Chapter 2. Only a sonorant coronal may appear in this position. Non-geminate obstruent codas are generally prohibited by the SYLLABLE CONTACT LAW (SCL), which rules out coda-onset sequences of equal or rising sonority. The absence of freestanding coronal obstruents in root-initial syllables shows that SCL dominates MAX-σ_1; coronal obstruent codas are illicit in any position. This is demonstrated in (76) below, where the input is a hypothetical root. (For discussion of the failure of place assimilation in such clusters, see Chapter 2.)

(76) SCL » MAX-σ_1

/tutpam/	SCL	MAX-σ_1	*DORS, *LAB	ID-σ_1 (Place)	*COR	NOCODA	ID(Place)	DEP
a. tut.pã	*!	**p, a, m**	**p**		**t, t**	*		
b. ☞ tu.?}.äã		**t, p, a, m**	**ä**		**t, ?**			*

Candidate (76a) fares better on MAX-σ_1 than does (76b), but it is not optimal, due to higher-ranking SCL. Epenthesis is favored; (76b) is optimal.

To complete the discussion of Tamil positional faithfulness, we must examine the outcome of the full constraint hierarchy when applied to inputs containing dorsal or labial consonants in the orbit of the root-initial syllable. Though the grammar will permit freestanding coronal codas in initial syllables, it will not allow other places of articulation to surface unscathed. MAX-σ_1 favors maximization of the root-initial syllable, but it does not require featural identity of the segments in the initial syllable. Featural faithfulness is assessed by the separately ranked constraint IDENT-σ_1(Place), which is dominated by the place markedness constraints *LABIAL and *DORSAL. This will force place assimilation of an input labial or dorsal consonant, even if it is parsed by the root-initial syllable. Consider the hypothetical input in (77).

(77) No free labial or dorsal codas

/tu˜pam/	MAX-σ_1	*DORS	*LAB	ID-σ_1 (Place)	*COR	NOCODA	ID(Place)	DEP
a. tu˜.bã	p, a, m	˜!	b		**t**	*		
b. tu.˜}.äã	˜!, p, a, m	˜	**ä**		**t**			*
c. ☞ tum.bã	p, a, m		mb		**t**	*	*	

Candidate (77b), in which there is epenthesis, is ruled out summarily by MAX-σ_1. This leaves (77a) and (77c). Of these, (77c) is optimal because it avoids the *DORSAL violation incurred by (77a). The ranking of *DORSAL, *LABIAL » IDENT-σ_1(Place) favors place assimilation of non-coronal codas, just as in Chapter 2; high-ranking MAX-σ_1 has no effect on this result.

5.5.5. Conclusions

To summarize, we have seen in this section that the positional MAX constraint MAX-σ_1 accounts for the distribution of complex codas in Tamil. Because MAX-σ_1 dominates *COMPLEX, complex codas are possible in initial syllables. The ranking of *COMPLEX » DEP forces epenthesis for any case in which satisfaction of MAX-σ_1 is not at issue; namely, when the complex clusters in question fall entirely outside of the root-initial syllable. I have also shown that, through interaction with the positional Identity constraints and the place markedness subhierarchy, high-ranking MAX-σ_1 accounts for the occurrence of freestanding coronal codas in initial syllables. Epenthesis, which would draw a coronal segment out of the root-initial syllable (in violation of MAX-σ_1), is optimal only under duress from a constraint which dominates MAX-σ_1; SCL and LATCOR are two such constraints. The final ranking summary for Tamil is given in (78) below.

(78) Final ranking summary, Tamil

The interaction of both positional IDENT and positional MAX constraints with the syllable and place markedness constraints correctly derives a complex pattern of initial-syllable privilege in this language. The extent to which these, and other positional faithfulness constraints, interact in the grammars of the world's languages, is an important avenue for future research.

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