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 \( \text{IDENT}_{\sigma'}(F) \).

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

<table>
<thead>
<tr>
<th>Language:</th>
<th>( \sigma' ) includes:</th>
<th>( \sigma'' ) includes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>ij, i, e, `e, æ, uw, \“, ow, \ø, å, oj, åj, åw, v</td>
<td>Only ( { ) in non-final unstressed syllables</td>
</tr>
<tr>
<td>Brazilian Portuguese</td>
<td>i, e, é, u, o, \ø, a</td>
<td>i, u, e, o, a</td>
</tr>
<tr>
<td>(Wetzels n.d.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nancowry</td>
<td>Oral and nasal vowels</td>
<td>Only oral i, u, a</td>
</tr>
<tr>
<td>(Radhakrishnan 1981)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copala Trique (Hollenbach 1977)</td>
<td>Fortis &amp; lenis stops</td>
<td>Only lenis stops</td>
</tr>
<tr>
<td></td>
<td>Oral and laryngeal C’s</td>
<td>Only oral C’s</td>
</tr>
<tr>
<td></td>
<td>Eight tones</td>
<td>Three tones</td>
</tr>
<tr>
<td>Chamorro (Topping 1968)</td>
<td>i, e, æ, u, o, a</td>
<td>i, U, `</td>
</tr>
<tr>
<td>Guaraní</td>
<td>Oral and nasal vowels</td>
<td>Nasal vowels only before nasal segments</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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, $\text{IDENT}-\sigma'(F)$ (2), is high-ranking.

(2) $\text{IDENT}-\sigma'(F)$

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 $\text{IDENT}(F)$ of McCarthy & Prince (1995), and universally dominates it, as shown in (3).

(3) Stressed syllable faithfulness subhierarchy

$\text{IDENT}-\sigma'(F) \gg \text{IDENT}(F)$

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 $*V_{\text{nasal}}$, which penalizes nasal vowels.

(4) Positional limitations on phonemic nasal vowels

$\text{IDENT}-\sigma'(\text{nasal}) \gg *V_{\text{nasal}} \gg \text{IDENT}(\text{nasal})$

The ranking of $\text{IDENT}-\sigma'(\text{nasal}) \gg *V_{\text{nasal}}$ 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 $*V_{\text{nasal}} \gg \text{IDENT}(\text{nasal})$ 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 $*V_{\text{nasal}}$. For example, if the harmony-favoring constraint $\text{ALIGN}-L(\text{nasal})$ is substituted for $*V_{\text{nasal}}$ 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.
Positional triggering and blocking of nasal harmony

\[ \text{IDENT} \sim'(' \text{nasal}) \rightarrow \text{ALIGN-L(nasal)} \rightarrow \text{IDENT}(\text{nasal}) \]

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 \([\pm\text{ATR}]\) contrasts, I will show that the interaction of \text{IDENT} \sim'(' \text{ATR}) with a variety of segmental markedness constraints generates a common form of vowel reduction. In addition, we will see that the grammar of \([\pm\text{ATR}]\) reduction will produce, via ranking permutation, all of the patterns of \([\text{ATR}]\) 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 \text{IDENT} \sim'(' \text{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 \text{IDENT} \sim'(' \text{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

<table>
<thead>
<tr>
<th>Language</th>
<th>In main stressed (\sigma:)</th>
<th>In unstressed (\sigma:)</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>(\text{i, i, ej, } \acute{\text{a}}, \text{æ, uw, }\acute{\text{o}}, \text{ow, }\grave{\text{o}}, \text{a, oj, }\acute{\text{aj}, }\grave{\text{aw, }}\text{}})</td>
<td>(\text{}}\text{in non-final unstressed syllables}</td>
</tr>
<tr>
<td>Brazilian Portuguese (Wetzels n.d.)</td>
<td>(\text{i, e, é, u, o, }\acute{\text{o}}, \text{a})</td>
<td>(\text{i, u, e, o, a})</td>
</tr>
<tr>
<td>Catalan: Central</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Majorcan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western (Hualde 1992; Prieto 1992)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Servigliano Italian (Nibert 1991);</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Italian (Flemming 1993)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mantuan Italian (Miglio 1997)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamorro (Topping 1968)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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\(^1\) 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 \( \text{IDENT}^{-\sigma}(F) \), rather than \( \text{IDENT}^{-\text{INS}} \) or \( \text{IDENT}^{-\sigma} \).

(7) Unstressed vowel reduction subhierarchy, schematic
\[
\text{IDENT}^{-\sigma}(F) \rightarrow M \rightarrow \text{IDENT}(F)
\]

Here, \( M \) is a variable over featural or segmental markedness constraints such as \( ^*\text{LABIAL} \), \( ^*[-\text{high}, -\text{low}] \), \( ^*\text{[Coronal, +low]} \), 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 \( \text{IDENT}(F) \); 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, \( \text{[ATR]} \) contrasts among the mid vowels are leveled in unstressed syllables, but preserved under stress. By examining the interaction of \( \text{IDENT}^{-\sigma}(\text{ATR}) \) with the markedness constraints responsible for restricting the distribution of \( [\pm\text{ATR}] \), 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 \( [\pm\text{ATR}] \) 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

<table>
<thead>
<tr>
<th>Dialect:</th>
<th>Reduction Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western (Hualde 1992)</td>
<td></td>
</tr>
<tr>
<td>i (\emptyset) i</td>
<td></td>
</tr>
<tr>
<td>e, (\hat{\prime}) (\emptyset) e</td>
<td></td>
</tr>
<tr>
<td>u (\emptyset) u</td>
<td></td>
</tr>
<tr>
<td>o, (\emptyset) o</td>
<td></td>
</tr>
<tr>
<td>a (\emptyset) a</td>
<td></td>
</tr>
<tr>
<td>Eastern (Central) (Prieto 1992)</td>
<td></td>
</tr>
<tr>
<td>i (\emptyset) i</td>
<td></td>
</tr>
<tr>
<td>e, (\hat{\prime}), a (\emptyset) (\)</td>
<td></td>
</tr>
<tr>
<td>u, o, (\emptyset) u</td>
<td></td>
</tr>
<tr>
<td>Eastern (Majorcan) (Prieto 1992)</td>
<td></td>
</tr>
<tr>
<td>i (\emptyset) i</td>
<td></td>
</tr>
<tr>
<td>e, a, (\hat{\prime}) (\emptyset) (\)</td>
<td></td>
</tr>
<tr>
<td>u (\emptyset) u</td>
<td></td>
</tr>
<tr>
<td>o, (\emptyset) o</td>
<td></td>
</tr>
<tr>
<td>(\hat{\prime}) (\emptyset) e</td>
<td></td>
</tr>
</tbody>
</table>

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~iw ‘river’ r~iw’t ‘river, dim.’
néw ‘snow’ nél’\ ‘snow, dim.’
m’¬ ‘honey’ nél’\ ‘honey, dim.’
pål‘ ‘shovel’ pál’\ ‘shovel, dim.’
r~ø’? ‘wheel’ r~u?’\ ‘wheel, dim.’
món‘ ‘monkey, fem.’ mun’\ ‘monkey, fem. dim.’
kúr‘ ‘cure’ kur’\ ‘cure, dim.’

b. Majorcan Catalan

r~iw ‘river’ r~iw’t ‘river, dim.’
néw ‘snow’ nél’\ ‘snow, dim.’
m’¬ ‘honey’ nél’\ ‘honey, dim.’
pål‘ ‘shovel’ pál’\ ‘shovel, dim.’
r~ø’? ‘wheel’ r~o?’\ ‘wheel, dim.’
món‘ ‘monkey, fem.’ mon’\ ‘monkey, fem. dim.’
kúr‘ ‘cure’ kur’\ ‘cure, dim.’
Unstressed vowel reduction in Catalan dialects, continued

c. Western Catalan

\[ \begin{align*}
\text{r-fw} \quad & \text{’river’} & \text{r-iwèt} \quad & \text{’river, dim.’} \\
\text{nèw} \quad & \text{’snow’} & \text{newèta} \quad & \text{’snow, dim.’} \\
\text{p’s} \quad & \text{’weight’} & \text{pezèt} \quad & \text{’weight, dim.’} \\
\text{pàla} \quad & \text{’shovel’} & \text{palèta} \quad & \text{’shovel, dim.’} \\
\text{r-ø’?a} \quad & \text{’wheel’} & \text{r-ø?èta} \quad & \text{’wheel, dim.’} \\
\text{sò~r} \quad & \text{’sun’} & \text{solèt} \quad & \text{’sun, dim.’} \\
\text{búr~o} \quad & \text{’dumb’} & \text{bur~èt} \quad & \text{’dumb, dim.’} \\
\end{align*} \]

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, \( \text{N}_{\text{ON-LOW}}/\text{ATR} \) (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

\[ \text{I}_{\text{IDENT-}\sigma'(\text{ATR})} \gg [\text{–low, –ATR}] \gg \text{I}_{\text{IDENT}(\text{ATR})} \]

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

<table>
<thead>
<tr>
<th></th>
<th>Front</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>High:</td>
<td>i</td>
<td>u</td>
</tr>
<tr>
<td>Mid:</td>
<td>[+]ATR</td>
<td>e</td>
</tr>
<tr>
<td></td>
<td>[−ATR]</td>
<td>‘</td>
</tr>
<tr>
<td>Low:</td>
<td>a</td>
<td></td>
</tr>
</tbody>
</table>

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 $H_{IH}/A_{TR}$ and $L_{LO}/R_{TR}$, shown in (12).

(12) ATR-markedness constraints, high and low vowels

$H_{IH}/A_{TR}: \ast[+\text{high}, −ATR]$

$L_{LO}/R_{TR}: \ast[+\text{low}, +ATR]^2$

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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 I_{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  
H_{HIGH}/ATR, L_0/R_{TR} \gg I_{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]

\[
\begin{array}{|c|c|c|c|}
\hline
\text{\textipa{/uØ/}} & \text{\textipa{\textquotesingle eye\textquotesingle}} & \text{L_0/R_{TR}} & \text{H_{HIGH}/ATR} & \text{I_{IDENT}(ATR)} \\
\hline
\text{a. } & \text{uØ} & \text{ } & \text{ } & \text{ } & \text{ } \\
\hline
\text{b. } & \text{uØ} & \text{ } & \text{!} & \text{!} & \text{!} \\
\hline
\end{array}
\]

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 I_{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 [\textipa{A}] here and throughout.)

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

\[
\begin{array}{|c|c|c|c|}
\hline
\text{\textipa{/kø'za/}} & \text{'thing'} & \text{L_0/R_{TR}} & \text{H_{HIGH}/ATR} & \text{I_{IDENT}(ATR)} \\
\hline
\text{a. } & \text{kø'za} & \text{ } & \text{ } & \text{ } & \text{ } \\
\hline
\text{b. } & \text{kø'za} & \text{!} & \text{!} & \text{!} \\
\hline
\end{array}
\]

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]

\[
\begin{array}{|c|c|c|c|}
\hline
\text{\textipa{/uØ/}} & \text{L_0/R_{TR}} & \text{H_{HIGH}/ATR} & \text{I_{IDENT}(ATR)} \\
\hline
\text{a. } & \text{uØ} & \text{ } & \text{ } & \text{!} \\
\hline
\text{b. } & \text{uØ} & \text{!} & \text{!} & \text{!} \\
\hline
\end{array}
\]

This is the scenario in which the correct ranking of H_{HIGH}/ATR and I_{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 $LO/RTR \succ IDENT(ATR)$.

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

<table>
<thead>
<tr>
<th>Input</th>
<th>$LO/RTR$</th>
<th>$HI/ATR$</th>
<th>$IDENT(ATR)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. $A^-O$</td>
<td>$O$</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. $A^O$</td>
<td>$*$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 $IDENT(\sigma'(ATR))$. 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.

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3 The ranking of $IDENT(\text{high})$ and $IDENT(\text{low})$ 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 $/\emptyset$ 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 $IDENT(\text{high})$ and $IDENT(\text{low})$ 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

<table>
<thead>
<tr>
<th>High</th>
<th>Front</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td></td>
<td>u</td>
</tr>
<tr>
<td>Mid</td>
<td>e</td>
<td>o</td>
</tr>
<tr>
<td>Low</td>
<td>a</td>
<td></td>
</tr>
</tbody>
</table>

b) [–ATR] only

<table>
<thead>
<tr>
<th>High</th>
<th>Front</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid</td>
<td>´</td>
<td>Ø</td>
</tr>
<tr>
<td>Low</td>
<td>a</td>
<td></td>
</tr>
</tbody>
</table>

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) \( \text{NONLOW}/\text{ATR}: *[-low, –ATR] \)
    \( \text{NONHIGH}/\text{RTR}: *[-high, +ATR] \)

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 \( \text{HIGH}/\text{ATR} \), are a subset of the [–low, –ATR] vowels (which violate \( \text{NONLOW}/\text{ATR} \)). 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)  H\textsc{igh}/\textsc{atr} » N\textsc{on}\textsc{low}/\textsc{atr} \\
      L\textsc{ow}/\textsc{rtr} » N\textsc{on}\textsc{high}/\textsc{rtr}

As always, different vowel inventories will be generated based upon the relative ranking of these constraints and the relevant faithfulness constraint, IDENT(ATE). While the ranking of HI\textsc{GH}/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 [\textsc{´}], 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 [\textsc{i}]. 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 descendents 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, .Elements{',} \, ø, a\} inventory appears to be the most common 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 N\_\text{ON\_HIGH}/R\_\text{TR} and N\_\text{ON\_LOW}/A\_\text{TR} 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.)

\[(22)\]

<table>
<thead>
<tr>
<th></th>
<th>Front</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>High:</td>
<td>i</td>
<td>u</td>
</tr>
<tr>
<td>Mid:</td>
<td>e</td>
<td>o</td>
</tr>
<tr>
<td>Low:</td>
<td>ø</td>
<td>a</td>
</tr>
</tbody>
</table>

Only mid vowels display a contrast

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 N\_\text{ON\_LOW}/A\_\text{TR} and N\_\text{ON\_HIGH}/R\_\text{TR}.

\[(23)\]

\[
\text{IDENT(} \text{ATR) } \gg \text{N}_{\text{ON\_LOW}}/ \text{A\_TR, N}_{\text{ON\_HIGH}}/ \text{R\_TR}
\]

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

\[(24)\]

\[
\text{H}_{\text{HIGH}}/ \text{A\_TR, L}_{\text{LOW}}/ \text{R\_TR} \gg \text{IDENT(} \text{ATR)}
\]

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

\[(25)\]

\[
\text{H}_{\text{HIGH}}/ \text{A\_TR, L}_{\text{LOW}}/ \text{R\_TR} \gg \text{IDENT(} \text{ATR) } \gg \text{N}_{\text{ON\_LOW}}/ \text{A\_TR, N}_{\text{ON\_HIGH}}/ \text{R\_TR}
\]
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 I_DENT(high) and I_DENT(low) dominate I_DENT(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 I_DENT(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]

<table>
<thead>
<tr>
<th>/l/</th>
<th>H_l/ATR</th>
<th>L_l/RTR</th>
<th>I_l(D_ATR)</th>
<th>N_ONL_l/ATR</th>
<th>N_ONH_l/RTR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>i</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>i</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>/A/</th>
<th>H_l/ATR</th>
<th>L_l/RTR</th>
<th>I_l(D_ATR)</th>
<th>N_ONL_l/ATR</th>
<th>N_ONH_l/RTR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>A</td>
<td></td>
<td>*!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>a</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

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 ranking. Mid vowels must be fully faithful in the output.

(28) [–ATR] mid vowels remain [–ATR]

<table>
<thead>
<tr>
<th>/l/</th>
<th>H_l/ATR</th>
<th>L_l/RTR</th>
<th>I_l(D_ATR)</th>
<th>N_ONL_l/ATR</th>
<th>N_ONH_l/RTR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>`</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>e</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>/A/</th>
<th>H_l/ATR</th>
<th>L_l/RTR</th>
<th>I_l(D_ATR)</th>
<th>N_ONL_l/ATR</th>
<th>N_ONH_l/RTR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>`</td>
<td></td>
<td>*!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>e</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

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, $N_{\text{ON LOW}/\text{ATR}}$; 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 $I_{\text{DENT( ATR )}}$ and $N_{\text{ON LOW}/\text{ATR}}$ has been altered.

(30) Ranking for a five-vowel inventory, no non-low [–ATR] vowels

$H_{\text{HIGH}/\text{ATR}}, L_{\text{LOW}/\text{RTR}} \gg N_{\text{ON LOW}/\text{ATR}} \gg I_{\text{DENT( ATR )}} \gg N_{\text{ON HIG}/\text{RTR}}$

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

<table>
<thead>
<tr>
<th>/i/</th>
<th>$H_{\text{HIGH}/\text{ATR}}$, $L_{\text{LOW}/\text{RTR}}$, $N_{\text{ON LOW}/\text{ATR}}$</th>
<th>$I_{\text{DENT( ATR )}}$, $N_{\text{ON HIG}/\text{RTR}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>$\ast$</td>
<td>$\ast$</td>
</tr>
</tbody>
</table>
| b.  | e | $\ast$ | $\ast$

(32) [+ATR] mid vowels are unaffected

<table>
<thead>
<tr>
<th>/ɛ/</th>
<th>$H_{\text{HIGH}/\text{ATR}}$, $L_{\text{LOW}/\text{RTR}}$, $N_{\text{ON LOW}/\text{ATR}}$</th>
<th>$I_{\text{DENT( ATR )}}$, $N_{\text{ON HIG}/\text{RTR}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>$\ast$</td>
<td>$\ast$</td>
</tr>
<tr>
<td>b.</td>
<td>e</td>
<td>$\ast$</td>
</tr>
</tbody>
</table>

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 $I_{\text{DENT( ATR )}}$ to $N_{\text{ON LOW}/\text{ATR}}$.

The other common five-vowel pattern, in which all non-high vowels are [–ATR] (i, u, ɛ, 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
N_{ON}_{HIGH}/RT_{R} must dominate I_{DE\text{N}(ATR)} (which itself must dominate N_{ON}_{LOW}/A_{TR} in order to allow input ’ and ø to surface intact).

(33)  Ranking for a five-vowel inventory, no non-high [+ATR] vowels

\( H_{HIGH}/A_{TR}, L_{LOW}/R_{TR} \gg N_{ON}_{HIGH}/R_{TR} \gg I_{DE\text{N}(ATR)} \gg N_{ON}_{LOW}/A_{TR} \)

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

<table>
<thead>
<tr>
<th>/e/</th>
<th>H_{HIGH}/A_{TR}</th>
<th>L_{LOW}/R_{TR}</th>
<th>N_{ON}<em>{HIGH}/R</em>{TR}</th>
<th>I_{DE\text{N}(ATR)}</th>
<th>N_{ON}<em>{LOW}/A</em>{TR}</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>+</td>
<td>’</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b.</td>
<td>e</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

(35)  [–ATR] mid vowels are unaffected

<table>
<thead>
<tr>
<th>/i/</th>
<th>H_{HIGH}/A_{TR}</th>
<th>L_{LOW}/R_{TR}</th>
<th>N_{ON}<em>{HIGH}/R</em>{TR}</th>
<th>I_{DE\text{N}(ATR)}</th>
<th>N_{ON}<em>{LOW}/A</em>{TR}</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>+</td>
<td>’</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b.</td>
<td>e</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

The nine-vowel pattern \{i, I, u, U, e, ’, ø, a\} is derived by means of another simple permutation of the constraint subhierarchies developed above. In this case, I_{DE\text{N}(ATR)} must be moved in the rankings above all of the ATR markedness constraints, with the exception of L_{LOW}/R_{TR}. Crucially, I_{DE\text{N}(ATR)} must dominate H_{HIGH}/A_{TR} 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

\( L_{LOW}/R_{TR} \gg I_{DE\text{N}(ATR)} \gg H_{HIGH}/A_{TR} \gg N_{ON}_{HIGH}/R_{TR}, N_{ON}_{LOW}/A_{TR} \)

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, ø, 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 $\text{HIGH}/\text{ATR}$ dominate the more general $\text{NONLOW}/\text{ATR}$. But to generate $[i]$ and $[u]$, the faithfulness constraint $\text{IDENT}(\text{ATR})$ must dominate $\text{HIGH}/\text{ATR}$ and, by transitivity of ranking, $\text{NONLOW}/\text{ATR}$.

(37) Ranking required to generate [--ATR] high vowels (assuming specific » general is fixed)

$$\text{IDENT}(\text{ATR}) \gg \text{HIGH}/\text{ATR} \gg \text{NONLOW}/\text{ATR}$$

However, under the ranking in (37), the [--ATR] mid vowels [´] and [$\emptyset$] 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

<table>
<thead>
<tr>
<th></th>
<th>$\text{HIGH}/\text{ATR}$</th>
<th>$\text{ATR}$</th>
<th>$\text{NONLOW}/\text{ATR}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>$i$</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b.</td>
<td>$i$</td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

(39) [--ATR] mid vowels are also unaffected

<table>
<thead>
<tr>
<th></th>
<th>$\text{HIGH}/\text{ATR}$</th>
<th>$\text{ATR}$</th>
<th>$\text{NONLOW}/\text{ATR}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>$\acute{e}$</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b.</td>
<td>$e$</td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

With $\text{IDENT}(\text{ATR})$ ranked above all markedness constraints that penalize [--ATR] in non-low vowels, there can be no $[i]$ without $[\acute{e}]$. Even allowing a reversal of the default ranking, with $\text{NONLOW}/\text{ATR}$ dominating $\text{IDENT}(\text{ATR})$, will not produce the desired outcome, as the ranking $\text{NONLOW}/\text{ATR} \gg \text{IDENT}(\text{ATR}) \gg \text{HIGH}/\text{ATR}$ would prohibit both high and mid [--ATR] vowels.

To the extent that inventories such as $\{i, i, u, U, \acute{e}, \emptyset, a\}$ 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 $\{i, i, u, U, \acute{e}, \emptyset, a\}$. This system can be produced if the [--ATR]-demanding constraints $\text{LOW}/\text{RTR} \gg \text{NOMHIGH}/\text{RTR}$ are ranked above $\text{IDENT}(\text{ATR})$ (and by transitivity of ranking, above $\text{HIGH}/\text{ATR} \gg \text{NONLOW}/\text{ATR}$) 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, ɪ, 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, ɪ, ʊ, 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

\[
\begin{array}{cccccc}
\text{HIGH/ATR, LOW/ATR} & \text{IDENT(ATR)} & \text{NONLOW/ATR} \\
\text{a.} & +ı & - & - & * \\
\text{b.} & +ı & - & - & * \\
\text{c.} & +ı & - & - & * \\
\end{array}
\]

This ranking will permit the [–ATR] mid vowels [ɨ] and [ø] to occur freely in any syllable. The crucial constraint relationship which allows these [–ATR] vowels to occur is the ranking of

As there is no subset/superset relationship which holds between HIGH/ATR (which penalizes [+high, –ATR]) and NONHIGH/ATR (penalizing [–high, +ATR]), it is reasonable to assume that no fixed ranking should obtain between these constraints. Factorial typology thus predicts that the {i, ɪ, u, ʊ, ø, a} inventory should be attested, and attested with greater frequency than the impossible {i, ɪ, u, ʊ, e, o, a} system considered above. In the absence of relevant data at present, I will leave this matter for future investigation.
I_{DE}NT(ATR) above the markedness constraint N_{ON}L_{OW}/A_{TR}, 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 I_{DE}NT(ATR) of (40) is replaced by the stress-sensitive I_{DE}NT-σ’(ATR) of (41). The revised constraint subhierarchy is shown in (42) below.

(41) I_{DE}NT-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
H_{IGH}/A_{TR}, L_{OW}/R_{TR} » I_{DE}NT-σ’(ATR) » N_{ON}L_{OW}/A_{TR}, N_{ON}H_{IGH}/R_{TR}

This ranking will generate exactly the desired inventory in positions of stress. Note that I_{DE}NT-σ’(ATR) must be dominated by H_{IGH}/A_{TR} and L_{OW}/R_{TR}; 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 Cabrè & Kenstowicz 1995 and Rosenthandall 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

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT-FORM: TROCHEE</td>
<td></td>
</tr>
<tr>
<td>FT ⊇ σ_s σ_w</td>
<td></td>
</tr>
<tr>
<td>ALIGN-FT-RT</td>
<td></td>
</tr>
<tr>
<td>ALIGN(FT, R, PWd, R)</td>
<td></td>
</tr>
<tr>
<td>FT-BIN: σ</td>
<td>Feet must be binary under syllabic analysis.</td>
</tr>
<tr>
<td>HEAD-MAX (McCarthy 1995; Alderete 1996, 1997b)</td>
<td></td>
</tr>
<tr>
<td>If α is a prosodic head and α ∈ Domain(f), then f(α) is a prosodic word.</td>
<td></td>
</tr>
<tr>
<td>WEIGHT-BY-POSITION (WBP)</td>
<td></td>
</tr>
<tr>
<td>Coda consonants must be moraic.</td>
<td></td>
</tr>
<tr>
<td>WEIGHT-TO-STRESS (WTS)</td>
<td></td>
</tr>
<tr>
<td>Heavy syllables must be stressed.</td>
<td></td>
</tr>
<tr>
<td>PARSE-σ</td>
<td>Syllables must be parsed into feet.</td>
</tr>
</tbody>
</table>

(44) Key rankings, Catalan stress constraints

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEAD-MAX » ALIGN-R-FT:</td>
<td>Lexical footing is preserved, even if misaligned.</td>
</tr>
<tr>
<td>FT-BIN » PARSE-σ</td>
<td>Lone final syllables may not be footed.</td>
</tr>
<tr>
<td>FT-FRM: TROCHEE » FT-BIN: σ</td>
<td>Final stress is footed as a degenerate foot, rather than as an iamb.</td>
</tr>
<tr>
<td>WSP, WBP » FT-BIN: σ</td>
<td>Final closed syllables must be stressed.</td>
</tr>
</tbody>
</table>

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. \textsc{STRESS} need not be crucially ranked with respect to the constraints in (42); whether high- or low-ranking, \textsc{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]; /ˈ/ [e] and /ø/ [o]. This indicates that the ranking of the two lowest markedness constraints in (42) must actually be \textsc{NONLOW/ATR} » \textsc{NONHIGH/RTR} (as the [+ATR] mid vowels are the preferred variants in unstressed syllables), and that the non-positional \textsc{IDENT}(ATR) must fall between them. The complete ranking for WCa is given in (45).

(45) Final constraint ranking, Western Catalan

\textsc{HIGH/ATR}, \textsc{LOW/RTR} » \textsc{IDENT}(ATR) » \textsc{NONLOW/ATR} » \textsc{IDENT}(ATR) » \textsc{NONHIGH/RTR}, \textsc{STRESS}

This ranking will give the correct reduction results in unstressed syllables, as shown in (46)-(49). (The undominated \textsc{HIGH/ATR} and \textsc{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

<table>
<thead>
<tr>
<th></th>
<th>\textsc{ID-σ′(ATR)}</th>
<th>\textsc{NONLOW/ATR}</th>
<th>\textsc{IDENT}(ATR)</th>
<th>\textsc{NONHIGH/RTR}</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. #p<code>z/ </code>weight'</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. pès</td>
<td>#!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

The [–ATR] mid vowel, though more marked than its [+ATR] counterpart by virtue of the ranking of \textsc{NONLOW/ATR} » \textsc{NONHIGH/RTR}, is nonetheless permitted to retain its input [ATR] specification, due to the dominant \textsc{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

<table>
<thead>
<tr>
<th>/new/ `snow'</th>
<th>\textsc{ID-σ′(ATR)}</th>
<th>\textsc{NONLOW/ATR}</th>
<th>\textsc{IDENT}(ATR)</th>
<th>\textsc{NONHIGH/RTR}</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. n`w</td>
<td>#!</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. #n`ew</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>
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 \( \text{IDENT}-\sigma'(\text{ATR}) \), but only by the relatively low-ranking \( \text{IDENT}(\text{ATR}) \). In the case of [+ATR] mid vowels, even \( \text{IDENT}(\text{ATR}) \) 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

<table>
<thead>
<tr>
<th>/new-\text{-e}-\text{t}-\text{a}/ ‘snow, dim.’</th>
<th>( \text{ID}-\sigma'(\text{ATR}) )</th>
<th>( \text{NONLOW}/\text{ATR} )</th>
<th>( \text{ID}(\text{ATR}) )</th>
<th>( \text{NONHIGH}/\text{RTR} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ( # ) ne(wéta)</td>
<td></td>
<td>*</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>b. n’(wéta)</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[+ATR] mid vowels in unstressed syllables do not neutralize to [–ATR] due to the high rank of \( \text{NONLOW}/\text{ATR} \) 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 \( \text{NONLOW}/\text{ATR} \) dominates \( \text{IDENT}(\text{ATR}) \) and \( \text{NONHIGH}/\text{RTR} \). 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

<table>
<thead>
<tr>
<th>/\text{p’z-e}-\text{t}/ ‘weight, dim.’</th>
<th>( \text{ID}-\sigma'(\text{ATR}) )</th>
<th>( \text{NONLOW}/\text{ATR} )</th>
<th>( \text{ID}(\text{ATR}) )</th>
<th>( \text{NONHIGH}/\text{RTR} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ( # ) p’zét</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. p’zét</td>
<td>*</td>
<td>*</td>
<td>**</td>
<td></td>
</tr>
</tbody>
</table>

The [–ATR] vowel in this example is no longer under the protection of high-ranking \( \text{IDENT}-\sigma'(\text{ATR}) \), 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, \( \text{NONLOW}/\text{ATR} \), which dominates \( \text{IDENT}(\text{ATR}) \). It is this ranking which forces vowel neutralization; the faithful (49a) fails by virtue of its violation of \( \text{NONLOW}/\text{ATR} \), and the less marked (49b) is therefore optimal.
Finally, let us examine the ranking of the prosodic constraint block $S_{\text{TRESS}}$, which (among other things) enforces the placement of stress on final closed syllables. In the case of the input in (49), $/p'z\text{-}et/$, $S_{\text{TRESS}}$ will be violated by an output candidate which bears penultimate stress, as in $[p'zet]$. Can such a violation be compelled by high-ranking $\text{IDENT-}\sigma'(\text{ATR})$, 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” $[\text{–low, –ATR}]$

<table>
<thead>
<tr>
<th></th>
<th>/p'z\text{-}et/</th>
<th>$\text{IDENT-}\sigma'(\text{ATR})$</th>
<th>$\text{NONL0/ATR}$</th>
<th>$\text{IDENT(\text{ATR})}$</th>
<th>$\text{NONHI/RTR}$</th>
<th>$S_{\text{TRESS}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>p'zet</td>
<td>*!</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>p'zet</td>
<td>*!</td>
<td>*</td>
<td>**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>p'zet</td>
<td>*!</td>
<td>*</td>
<td>W-T-S</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Though the prosodic constraints are very low-ranking, $\text{IDENT-}\sigma'(\text{ATR})$ cannot compel their violation. Both the actual surface form (50b) and the form with illicit stress (50c) satisfy $\text{IDENT-}\sigma'(\text{ATR})$, 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 $S_{\text{TRESS}}$ 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 $\text{IDENT-}\sigma'(\text{ATR})$ and $\text{IDENT(\text{ATR})}$ 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 $[\text{–low, –ATR}]$ (“LICENSE–")

For all $x$, $x$ a segment bearing the specification $[\text{–low, –ATR}]$, $x$ must be associated to a mora in a stressed syllable.
Suppose that this licensing constraint, rather than $I_{\text{DENT}}\cdot \sigma'(\text{ATR})$, is responsible for Catalan reduction; if (51) is substituted for $I_{\text{DENT}}\cdot \sigma'(\text{ATR})$ in the hierarchy in (45), comparable results will obtain.

(52) Vowel reduction hierarchy, positional licensing approach

\[ H_{\text{ATR}} \big/ L_{\text{RTR}} \rightarrow \text{LICENSE} \cdot \rightarrow N_{\text{ONLO}} \big/ A_{\text{TR}} \rightarrow I_{\text{D}}(\text{ATR}) \rightarrow N_{\text{ONH}} \big/ R_{\text{RTR}} \rightarrow \text{STRESS} \]

The key comparison case is that of a $[-\text{ATR}]$ 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

<table>
<thead>
<tr>
<th>/p'z-ct/</th>
<th>$L_{\text{IC}}$</th>
<th>$N_{\text{ONLO}} \big/ A_{\text{TR}}$</th>
<th>$I_{\text{D}}(\text{ATR})$</th>
<th>$N_{\text{ONH}} \big/ R_{\text{RTR}}$</th>
<th>$S_{\text{TRESS}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. p'zét</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. +pezét</td>
<td></td>
<td></td>
<td>*</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>c. p'z'zet</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
<td>W-T-S</td>
</tr>
</tbody>
</table>

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 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)

\[ \text{umín’}+s‡a+ôwá/ \quad \text{u-mín’}s‡aôwá ‘like those’} \\
\[ \text{re+xó+ta+ramo~/} \quad \text{rexóta-r-a-mo~ ‘if you go’} \\
\[ \text{a+y‡e+re+ndú/} \quad \text{a-n-e-r-e-ndú ‘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, \(\text{IDENT-σ’(nasal)}\) 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 \(\text{IDENT-σ’(nasal)}\).

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 \(\text{IDENT-σ’(nasal)}\) dominating the markedness constraint \(\text{*V_{nasal}}\) to yield a contrast in stressed syllables. The contrast is restricted to stressed syllables via the placement of \(\text{*V_{nasal}}\) above \(\text{IDENT(nasal)}\) in the ranking.

(55) Positional limitations on phonemic nasal vowels

\(\text{IDENT-σ’(nasal)} \gg \text{*V_{nasal}} \gg \text{IDENT(nasal)}\)

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 $A_{\text{ALIGN}}$-L(nasal), which favors left-to-right feature spreading, even at the expense of faithfulness to underlying [nasal] specifications. ($A_{\text{ALIGN}}$-L(nasal) must dominate $I_{\text{IDENT}}$(nasal), or no feature spreading will occur.)

(56) Positional limitations on phonemic nasal vowels

\[ I_{\text{IDENT}} - \sigma'(\text{nasal}) \gg A_{\text{ALIGN}}$-L(nasal) $\gg I_{\text{IDENT}}$(nasal) \]

Because the positional faithfulness constraint dominates the harmony-demanding $A_{\text{ALIGN}}$-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, $I_{\text{IDENT}} - \sigma'(\text{nasal})$.

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\textsuperscript{7})

<table>
<thead>
<tr>
<th></th>
<th>Labial</th>
<th>Dental</th>
<th>Alveolar</th>
<th>Velar</th>
<th>Labiovelar</th>
<th>Glottal</th>
</tr>
</thead>
<tbody>
<tr>
<td>vls. stops:</td>
<td>p</td>
<td>t</td>
<td></td>
<td>k</td>
<td>kw</td>
<td>ñ</td>
</tr>
<tr>
<td>nasal stops:</td>
<td>mb/m</td>
<td>nd/n</td>
<td>y/ỹ/ñ</td>
<td>ɝ/ɝ’</td>
<td>ɜ/ɜ’/w</td>
<td>ɜ/ɜ’/w</td>
</tr>
<tr>
<td>fricatives:</td>
<td>s</td>
<td>sʃ</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sonorants:</td>
<td>v/ʃ~</td>
<td>l/ɭl</td>
<td>r/ɭ~</td>
<td>ɹ/ɹ~</td>
<td>ɹ/ɹ~</td>
<td>ɹ/ɹ~</td>
</tr>
</tbody>
</table>

(58) Guaraní vowel phonemes

<table>
<thead>
<tr>
<th></th>
<th>Front</th>
<th>Central</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>High:</td>
<td>ɪ ɪ̃</td>
<td>ɪ ɪ̃</td>
<td>u  ũ</td>
</tr>
</tbody>
</table>

\textsuperscript{7} Where Rivas (1975) uses $h$, I have adopted $x$; similarly, I use $\emptyset$ for his $\emptyset$. G&S say that $[x]$ and $[h]$ are in free variation, but select $/x/$ for the phonemic representation.

The voiced sonorants $v$, $\emptyset$, and $\emptyset’w$ are all described as voiced frictionless spirants; $r$ is a voiced alveolar flap.
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

<table>
<thead>
<tr>
<th>Word</th>
<th>Meaning</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>tupá</td>
<td>‘bed’</td>
<td>Rivas (1975:136)</td>
</tr>
<tr>
<td>tu–pa–</td>
<td>‘god’</td>
<td></td>
</tr>
<tr>
<td>pirí</td>
<td>‘rush’</td>
<td></td>
</tr>
<tr>
<td>pîr–iîn</td>
<td>‘to shiver’</td>
<td></td>
</tr>
<tr>
<td>mba–é</td>
<td>‘thing’</td>
<td></td>
</tr>
<tr>
<td>ma–ítîs</td>
<td>‘to see’</td>
<td></td>
</tr>
<tr>
<td>hu–ú</td>
<td>‘cough’</td>
<td>G&amp;S, 226</td>
</tr>
<tr>
<td>hu–úû</td>
<td>‘to be bland, soft’</td>
<td></td>
</tr>
<tr>
<td>akî</td>
<td>‘to be tender’</td>
<td>G&amp;S, 219</td>
</tr>
<tr>
<td>a–káîn</td>
<td>‘to be wet, moist’</td>
<td></td>
</tr>
<tr>
<td>potî</td>
<td>‘to be done for’</td>
<td>G&amp;S, 239</td>
</tr>
<tr>
<td>po–iîn</td>
<td>‘to be clean’</td>
<td></td>
</tr>
</tbody>
</table>

As Rivas (1975: 136) points out, there are no forms in which contrastive nasality and stress are independent. 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.
Impossible Guaraní surface forms (Rivas 1975)

(60) tu-pá
    mbá-ê
    pir-í
    tupá-ê
    má-ê

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).
Nasal harmony in Guaraní (Rivas 1975)

a. Spreading from stressed vowels

\[
\begin{align*}
/\text{ro + m} & \text{bo + porâ}/ & [\text{ro~mo~po~r~ã}] & /a+y\ddot{\text{e}}+\text{dupã}/ & [\text{a~n~e~n~mu~pa~}] \\
& \text{I-you} + \text{CAUS} + \text{nice} & \text{I} + \text{REFL} + \text{beat} & \text{‘I embellished you’} & \text{‘I beat myself’} \\
& \text{not-I-you} + \text{beat} + \text{NEG} & & \text{‘I don’t beat you’} & \\
\end{align*}
\]

b. Spreading from closure of voiced stop

\[
\begin{align*}
/\text{ro + m} & \text{bo} + \text{w} \text{atá}/ & [\text{ro~m} \text{bo} \text{w} \text{atá}] & /a+y\ddot{\text{e}}+\text{rendú}/ & [\text{a~n~e~r~e~n~dú}] \\
& \text{I-you} + \text{CAUS} + \text{walk} & \text{I} + \text{REFL} + \text{hear} & \text{‘I made you walk’} & \text{‘I hear myself’} \\
& \text{I-you} + \text{CAUS} + \text{hear} & & \text{‘I made you hear’} & \text{‘I made you hear’} \\
\end{align*}
\]

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 [ãtîn’ã] ‘sneeze’, [÷a~‘ã] ‘soul’ and [nãînnu~pa~‘în] ‘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~’nda/ ‘husband’ only [m e~’nã] (and not [me~’nda]) is possible. This contrasts with /mbe~dârê/ ‘widower’, which is realized as [me~’dârê]. 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 xatã ‘tâ~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.

---

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 [ãtîn’ã] ‘sneeze’, [÷a~‘ã] ‘soul’ and [nãînnu~pa~‘în] ‘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~’nda/ ‘husband’ only [m e~’nã] (and not [me~’nda]) is possible. This contrasts with /mbe~dârê/ ‘widower’, which is realized as [me~’dârê]. 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 xatã ‘tâ~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.

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c. Spreading blocked by stressed vowels (G&S:69)

\[ \text{las} \text{ERA} \text{L} \text{Y} \text{TARA} \text{X} \text{A} \text{TAR} \text{E} \text{R} \text{LAE} \text{K} \text{WELAPE} \] \[ \emptyset \]

‘my child is just too stubborn at school’

\[ \text{ambi} \text{A} \text{PO} \text{RO} \text{REY} \text{Y} \text{U} \] \[ \emptyset \]

‘if I work you come’

\[ \text{roy} \text{TO} \text{PO} \text{PA} \text{PAM} \text{BARO} \text{ROXOVARA} \] \[ \emptyset \]

‘if now we meet all of us, we will have to go’

\[ \text{mba} \text{E} \text{MBIA} \text{S} \text{EU} \] \[ \emptyset \]

‘sadness’

3.3.3 Analysis

3.3.3.1 Preliminaries

In order to demonstrate the role of IDENT-\(\sigma\) (nasal) in the grammar of Guaraní, I will need to first set out the key constraints which govern 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 harmony spans\(^\text{11}\) 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).

\(^{10}\) This example, and the one which immediately follows, contain the conjunction/postposition /ramo-\'/, 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 \( x, \) 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 \( \alpha \) and \( \gamma \) without also being linked to \( \beta \), where \( \beta \) 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: *OBSTRUENT_{nasal} » *LIQUID_{nasal} » *GLIDE_{nasal} » *VOWEL_{nasal}. This hierarchy reflects the rarity of nasal obstruents cross-linguistically, but does not prohibit their creation. Through domination of the markedness constraint *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 Guarani 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 Guarani are possible if strict locality is abandoned. As the characterization of segmental transparency and opacity in nasal harmony systems is not central to this thesis, I will pursue the matter no further here.
(64) Nasal harmony constraints
\[ \mathcal{NOG}_{\text{AP}} \gg \text{ALIGN-L(nasal)} \gg \text{*OBSTRUENT}_{\text{nasal}}, \text{IDENT(nasal)} \]

(65) Generating nasal harmony in Guaraní; hypothetical input

<table>
<thead>
<tr>
<th>/apâ/</th>
<th>(\mathcal{NOG}_{\text{AP}})</th>
<th>(\text{ALIGN-L(nasal)})</th>
<th>(\text{*OBSTRUENT}_{\text{nasal}})</th>
<th>(\text{IDENT(nasal)})</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. apâ</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| b. ãpâ | | | | *
| c. ãp~ã | | | | **

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 \( F_T \text{FORM: TROCHEE} \) is undominated in the grammar. The limitation of stress to the final two syllables of a
root or suffix arises from an undominated \( \text{ALIGN}-F_T-R_T \) 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 \( \text{ALIGN}-F_T-R_T \succ F_T-B_{IN} \), 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
\( \text{HEAD-MAX} \) (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:
\( \text{ALIGN}-F_T-R_T \succ \text{HEAD-MAX} \). The constraints and their rankings are summarized in (66)–(67)
below.

(66) Constraints governing stress in Guaraní

\[
\begin{align*}
F_T-\text{FORM: TROCHEE} \\
F_t \not\in \sigma_s \sigma_w \\
\text{ALIGN}-F_T-R_T \\
\text{ALIGN}(F_t, R, \text{Morpheme}, R) \\
F_T-B_{IN} \\
\text{Feet must be binary under syllabic or moraic analysis.} \\
\text{HEAD-MAX} \\
\text{If } \alpha \text{ is a prosodic head and } \alpha \text{ Domain}(f), \text{ then } f(\alpha) \text{ is a prosodic word.}
\end{align*}
\]

\(^{13}\) 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.
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\textsubscript{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 Distribution 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 \( *V_{\text{nasal}} \) and the faithfulness constraints are \( \text{IDENT}(\text{nasal}) \) and \( \text{IDENT-}^{\sigma}(\text{nasal}) \). 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 entirely are characterized by the constraint ranking in (68b).

(68)  

a. No contrastive nasal vowels  
\[ *V_{\text{nasal}} \gg \text{IDENT-}^{\sigma}(\text{nasal}) \gg \text{IDENT}(\text{nasal}) \]

b. Nasal vowels occur freely  
\[ \text{IDENT-}^{\sigma}(\text{nasal}) \gg \text{IDENT}(\text{nasal}) \gg *V_{\text{nasal}} \]

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

<table>
<thead>
<tr>
<th>( /t\ddot{a}/ )</th>
<th>( *V_{\text{nasal}} )</th>
<th>( \text{IDENT-}^{\sigma}(\text{nasal}) )</th>
<th>( \text{IDENT}(\text{nasal}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ( \ddot{t}a^{-} )</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. ( \ddot{t}a )</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

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, \( *V_{\text{nasal}} \), dominates all of the faithfulness constraints, including the positional constraint, \( \text{IDENT-}^{\sigma}(\text{nasal}) \). 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.
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) » *Vnasal » 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

<table>
<thead>
<tr>
<th>/tupá/</th>
<th>IDENT-σ′(nasal)</th>
<th>*Vnasal</th>
<th>IDENT(nasal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b.</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c.</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>/tu-pá/</th>
<th>IDENT-σ′(nasal)</th>
<th>*V_nasal</th>
<th>IDENT(nasal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. tupá</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. tupa-</td>
<td>*!</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>c. tu-pá</td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>d. tu-pá</td>
<td>*!</td>
<td>**</td>
<td>*</td>
</tr>
</tbody>
</table>

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
constraints, 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 underlingly 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.  

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 possible.

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.\textsuperscript{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:

\begin{align*}
(75) & \quad a. \text{Licit syllables} & b. \text{Illicit syllables} \\
& \quad \begin{array}{c}
\text{mā} \\
\text{mba} \\
\text{r~ā} \\
\text{ra}
\end{array} & \begin{array}{c}
\text{ma} \\
\text{mbā} \\
\text{r~ā} \\
\text{rā}
\end{array}
\end{align*}

\textsuperscript{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 *mba* 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 $A_{\text{max}}$ 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.\(^6\),\(^7\) Observing that the aperture positions of identical stricture are the positions which must have identical

---
\(^6\) 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.

\(^7\) 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 structurally 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, \( x = [\text{nasal}] \) and \( y = [\text{nasal}] \)  
“Within a syllable, structurally 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, /mb/ or /b/ is realized as [m] before a nasal vowel, and as a prenasal [mb] 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

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\(^{18}\) 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 (Maxacali 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: *\(P_{\text{RENASAL}}\) » *\([-\text{son}, -\text{cont}, \text{voice}\] *\([+\text{son}, -\text{cont}, \text{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 *\(P_{\text{RENASAL}}\).

(79) a. Input prenasal b. Surface nasal c. Surface voiced stop

In Guaraní, the markedness constraint which dominates *\(P_{\text{RENASAL}}\), compelling the appearance of surface prenasal segments, is \textsc{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)

\[\text{r\textordmasculine o m\textordmasculine o r a }\] ‘I embellished you’
\[\text{r\textordmasculine o m\textordmasculine o @\textordmasculine t\textordmasculine a }\] ‘I made you walk’
\[\text{n\textordmasculine o r o h e n d\textordmasculine t\textordmasculine }\] ‘I don’t hear you’
\[\text{n\textordmasculine d\textordmasculine o r o h a h t\textordmasculine }\] ‘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 \textsc{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 & Padget 1995 for the related constraint \textsc{NasVoI}).

(81) \textsc{VoINAS}

\[[\text{voice, A}_0] \oslash [\text{nasal}]\]

“A voiced stop must be nasal.”

In Guaraní, this constraint takes priority over the markedness constraint *\(C_{\text{nasal}}\) which penalizes nasal consonants; it forces the voiced stops to be minimally prenasal. It must also take
precedence over \(^*\text{PRENASAL}\), 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 \(\text{VOI} \text{NAS}\) and \(^*\text{C}_{\text{nasal}}\), indicating that \(\text{IDENT(voice)}\) 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

<table>
<thead>
<tr>
<th>Input voiced stops do not devoice</th>
<th>/bo/, /mo/</th>
<th>IDENT(voi)</th>
<th>VOI\text{NAS}</th>
<th>^*\text{PRENASAL}</th>
<th>^*\text{C}_{\text{nasal}}</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>mbo</td>
<td>!</td>
<td></td>
<td>!</td>
<td>!</td>
</tr>
<tr>
<td>b.</td>
<td>bo</td>
<td>!</td>
<td></td>
<td>!</td>
<td>!</td>
</tr>
<tr>
<td>c.</td>
<td>po</td>
<td>!</td>
<td></td>
<td>!</td>
<td>!</td>
</tr>
<tr>
<td>d.</td>
<td>+mo</td>
<td>!</td>
<td></td>
<td>!</td>
<td>!</td>
</tr>
</tbody>
</table>

As (82) shows, this constraint ranking rules out uniformly oral voiced stops, ruling in favor of the uniformly nasal stop of (82d). High-ranking \(\text{IDENT(voice)}\) and \(\text{VOI} \text{NAS}\) ensure that the voiced stops will be minimally prenasal, with nasality on the closure, regardless of the input.

\(^*\text{PRENASAL}\) 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, \(\text{VOI} \text{NAS}\) must dominate \(\text{IDENT(nasal)}\). 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 \(^*\text{PRENASAL}\). Input /mo/ is also incorrectly predicted to surface as [mo]. This is shown in (83) and (84) below. (Violations of \(\text{IDENT(nasal)}\) are reckoned in terms of individual aperture nodes in the following tableaux.\(^{20}\) \(^*\text{PRENASAL}\) \(\text{\text{-}}\text{IDENT(nasal)}\) 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 \(^*\text{mb}\) to remain \(^*\text{mb}\) 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, \(^*V_{\text{nasal}} > \text{IDENT(nasal)}\), so (by transitivity of ranking, \(^*P_{\text{RENASAL}} > \text{IDENT(nasal)}\).)

(83) Input voiced stops may not be faithful

<table>
<thead>
<tr>
<th>/bo/</th>
<th>\text{IDENT( voi)}</th>
<th>\text{VOI\text{NAS}}</th>
<th>\text{\textsuperscript{*}P_{\text{RENASAL}}}</th>
<th>\text{IDENT(nasal)}</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. mbo</td>
<td></td>
<td></td>
<td>\textsuperscript{!}</td>
<td>(\Lambda_0)</td>
</tr>
<tr>
<td>b. bo</td>
<td></td>
<td>*!</td>
<td></td>
<td>(\Lambda_0)</td>
</tr>
<tr>
<td>c. po</td>
<td></td>
<td>*!</td>
<td></td>
<td>(\Lambda_0, \Lambda_{\text{max}})</td>
</tr>
<tr>
<td>d. mo</td>
<td></td>
<td>(\Lambda_0, \Lambda_{\text{max}})</td>
<td></td>
<td>(\Lambda_0, \Lambda_{\text{max}})</td>
</tr>
</tbody>
</table>

(84) Input nasal stops must stay nasal

<table>
<thead>
<tr>
<th>/mo/</th>
<th>\text{IDENT( voi)}</th>
<th>\text{VOI\text{NAS}}</th>
<th>\text{\textsuperscript{*}P_{\text{RENASAL}}}</th>
<th>\text{IDENT(nasal)}</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. mbo</td>
<td></td>
<td></td>
<td>\textsuperscript{!}</td>
<td>(\Lambda_{\text{max}})</td>
</tr>
<tr>
<td>b. bo</td>
<td></td>
<td>*!</td>
<td></td>
<td>(\Lambda_0, \Lambda_{\text{max}})</td>
</tr>
<tr>
<td>c. po</td>
<td></td>
<td>*!</td>
<td></td>
<td>(\Lambda_0, \Lambda_{\text{max}})</td>
</tr>
<tr>
<td>d. mo</td>
<td></td>
<td>(\Lambda_0, \Lambda_{\text{max}})</td>
<td></td>
<td>(\Lambda_0, \Lambda_{\text{max}})</td>
</tr>
</tbody>
</table>

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. \(\text{UNIFORM(nasal)}\) is clearly relevant to these examples. Recall that \(\text{UNIFORM(nasal)}\) requires identity of [nasal] specification in a vowel (an \(\Lambda_{\text{max}}\) position) and the preceding tautosyllabic consonant release (also an \(\Lambda_{\text{max}}\) position). Candidates (83d) and (84d) violate \(\text{UNIFORM(nasal)}\) because the vowel and the preceding \(\Lambda_{\text{max}}\) 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 \(\text{UNIFORM(nasal)}\) must dominate \(\text{IDENT(nasal)}\), 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 \(\text{UNIFORM(nasal)}\), it is always the onset consonant which is altered. This suggests that \(\text{IDENT-}\sigma'(nasal)\) is actually a constraint on faithfulness in stressed syllable heads, the stressed vowels themselves.\(^{21}\) The facts of nasal

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\(^{21}\) Alternatively, it may be necessary to assume dispersion of \(\text{IDENT-}\sigma'\) 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

<table>
<thead>
<tr>
<th>/mò/</th>
<th>Vo(NAS)</th>
<th>UNIFORM(nasal)</th>
<th>IDENT-σ'(nasal)</th>
<th>*PRENASAL</th>
<th>ID(nasal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. mò</td>
<td>mbó</td>
<td></td>
<td>mò</td>
<td>A_max</td>
<td>A_max</td>
</tr>
<tr>
<td>b. mó</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. mò~</td>
<td>*!</td>
<td>A_max!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. bó</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>/mbò~/</th>
<th>Vo(NAS)</th>
<th>UNIFORM(nasal)</th>
<th>IDENT-σ'(nasal)</th>
<th>*PRENASAL</th>
<th>ID(nasal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. mbó</td>
<td></td>
<td>A_max!</td>
<td>mò</td>
<td>A_max</td>
<td>A_max</td>
</tr>
<tr>
<td>b. mbò~</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. mbò~</td>
<td>*!</td>
<td>A_max!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. mó</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>/mbô/</th>
<th>VOINAS</th>
<th>UNIFORM(nasal)</th>
<th>IDENT-σ'(nasal)</th>
<th>#PRENASAL</th>
<th>ID(nasal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ≪</td>
<td>mbô</td>
<td>≠!</td>
<td></td>
<td>mbô</td>
<td>mbô</td>
</tr>
<tr>
<td>b. mbô~</td>
<td></td>
<td>≠!</td>
<td>A̅ₘₐₓ</td>
<td>mbô</td>
<td>Aₘₐₓ</td>
</tr>
<tr>
<td>c. mo~</td>
<td></td>
<td>≠!</td>
<td>A̅ₘₐₓ</td>
<td></td>
<td>Aₘₐₓ,Aₘₐₓ</td>
</tr>
<tr>
<td>d. ≪</td>
<td>mbo~</td>
<td></td>
<td></td>
<td></td>
<td>Aₘₐₓ</td>
</tr>
</tbody>
</table>

(88) Uniformly nasal input

<table>
<thead>
<tr>
<th>/mo~'/</th>
<th>VOINAS</th>
<th>UNIFORM(nasal)</th>
<th>IDENT-σ'(nasal)</th>
<th>#PRENASAL</th>
<th>ID(nasal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. mbô</td>
<td></td>
<td></td>
<td>Aₘₐₓ</td>
<td>mbô</td>
<td>Aₘₐₓ,Aₘₐₓ</td>
</tr>
<tr>
<td>b. mbô~</td>
<td></td>
<td>≠!</td>
<td>A̅ₘₐₓ</td>
<td>mbô</td>
<td>Aₘₐₓ</td>
</tr>
<tr>
<td>c. ≪</td>
<td>mo~</td>
<td></td>
<td></td>
<td></td>
<td>Aₘₐₓ</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>VOINAS</th>
<th>UNIFORM(nasal)</th>
<th>ID-σ'(nasal)</th>
<th>*PRENASAL</th>
<th>ID(nasal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. /mo~/</td>
<td>ːmo~'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A&lt;sub&gt;max&lt;/sub&gt;!</td>
</tr>
<tr>
<td>b. /mabo~/</td>
<td>ːmo~'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A&lt;sub&gt;max&lt;/sub&gt;!</td>
</tr>
</tbody>
</table>

(91) Evaluating outputs of possible input forms II

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>VOINAS</th>
<th>UNIFORM(nasal)</th>
<th>ID-σ'(nasal)</th>
<th>*PRENASAL</th>
<th>ID(nasal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. /mó/</td>
<td>ːmbó</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A&lt;sub&gt;max&lt;/sub&gt;!</td>
</tr>
<tr>
<td>b. /mbó/</td>
<td>ːmbó</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A&lt;sub&gt;max&lt;/sub&gt;!</td>
</tr>
</tbody>
</table>

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<sub>nasal</sub>
   Nasal vowels occur contrastively in stressed syllables. (73)

b. *V<sub>nasal</sub> » 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 N0GAP constraint), and is driven by high-ranking ALIGN(nasal) constraints. In the case of Guarani, 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); C is any structural markedness constraint:

(93) Positional resistance schema

\[ IDENT-Position(F) \gg C \gg IDENT(F) \]

(94) Stressed syllable resistance to nasal harmony

\[ IDENT-σ’(nasal) \gg ALIGN-L(nasal) \gg IDENT(nasal) \]

In (94), 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) \gg 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) \gg *V_{nasal} \gg 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 N0GAP are considered.)
Nasal harmony from stressed syllable

\[
\begin{array}{|c|c|c|c|c|c|}
\hline
\text{Candidate} & /\text{pir}^-\text{în}/ & \text{UNIFORM(nasal)} & \text{I}^\text{DENT}-\sigma'(nasal) & \text{ALIGN}-\text{L(nasal)} & \text{^*V}_\text{nasal} & \text{I} \text{d(nasal)} \\
\hline
a. & \text{pir}^-\text{în} & & & & \text{**} & \text{**} \\
\hline
b. & \text{piri} & & \text{A}_{\text{max}}! & & & \text{**} \\
\hline
c. & \text{pir}^-\text{în} & & \text{**!} & & & \text{*} \\
\hline
\end{array}
\]

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) \( \rightarrow^* \text{V}_\text{nasal} \); 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 VOI\text{NAS}. An example is given in tableau (96), for the form ãñe~r~e~n dú ‘I hear myself’.

\[
\begin{array}{|c|c|c|c|c|c|}
\hline
\text{Candidate} & /\text{a}+\text{y}^\text{z}^\text{e}+\text{re}^\text{n}^\text{dú}/ & \text{VOI\text{NAS}} & \text{UNIFORM(nasal)} & \text{I}^\text{DENT}-\sigma'(nasal) & \text{ALIGN-L} & \text{^*V}_\text{nasal} & \text{I} \text{d(nasal)} \\
\hline
a. & ãñe~r~e~n dú & & & & \text{***} & \text{******} \\
\hline
b. & ay\text{z}^\text{e}\text{readú} & & & & \text{*!****} & & \\
\hline
c. & ãñe~r~e~n dú & & \text{A}_{\text{max}}! & & \text{****} & \text{******} \\
\hline
d. & ay\text{z}^\text{e}\text{readú} & & \text{*!} & & & & \text{*} \\
\hline
\end{array}
\]

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\text{nasal} and I\text{DENT}(nasal), due to VOI\text{NAS}.

Now we turn to a more complex case, in order to highlight the role of I\text{DENT}-\sigma'(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: /\text{re}+\text{x}^\text{o}+\text{ta}+\text{ramo}~-'/ ‘if you go’ surfaces as [\text{rex}^\text{o}\text{t}^\text{ár}-a-\text{mo}~'], not *[\text{r}^-\text{c}^-\text{x}^-\text{o}^-\text{ta}^-\text{r}^-\text{a}^-\text{mo}^-'] (Poser 1982:130). This follows from the ranking in (95) and (96), as tableau (97) will demonstrate.
\( (97) \)

Stressed oral vowel blocks harmony

<table>
<thead>
<tr>
<th></th>
<th>( \text{IDENT}^{-}\sigma'(\text{nasal}) )</th>
<th>( \text{ALIGN}-\text{L(nasal)} )</th>
<th>( \ast V_{\text{nasal}} )</th>
<th>( \text{IP(nasal)} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>b.</td>
<td>( \text{rex}^\theta \text{t} \text{ã} \text{r} \text{~a} \text{<del>m} \text{o} \text{</del>} )</td>
<td>( \ast )</td>
<td>( \ast \text{**} )</td>
<td>( \ast \text{***} )</td>
</tr>
<tr>
<td>c.</td>
<td>( \text{r} \text{~e} \text{~x} \text{<del>o} \text{</del>} \text{t} \text{ã} \text{r} \text{~a} \text{<del>m} \text{</del>} )</td>
<td>( \ast \text{†} )</td>
<td>( \ast \text{****} )</td>
<td>( \ast \text{*******} )</td>
</tr>
</tbody>
</table>

Candidate (97a), which lacks nasal harmony entirely, is ruled out by \( \text{ALIGN}-\text{L(nasal)} \).

Conversely, full alignment is prevented by high-ranking \( \text{IDENT}^{-}\sigma'(\text{nasal}) \), as shown in (97b); the stressed oral vowel simply cannot be successfully nasalized. The optimal candidate, (97c), satisfies \( \text{IDENT}^{-}\sigma'(\text{nasal}) \) and incurs fewer violations of \( \text{ALIGN}-\text{L(nasal)} \) 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 \( \text{IDENT}^{-}\sigma'(\text{nasal}) \) 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

\[
\text{IDENT}^{-}\text{Position(F)} \supseteq \text{C} \supseteq \text{IDENT}(F)
\]

Depending on the nature of the constraint(s) \( \text{C} \) 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 \( \ast V_{\text{nasal}} \) between the \( \text{IDENT}(\text{nasal}) \) constraints. \( \text{C} = \ast V_{\text{nasal}} \).

\( (99) \) Positional limitations on phonemic nasal vowels

\[
\text{IDENT}^{-}\sigma'(\text{nasal}) \supset \ast V_{\text{nasal}} \supset \text{IDENT}(\text{nasal})
\]

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 \( \text{ALIGN}-\text{L(nasal)} \) between the \( \text{IDENT}(\text{nasal}) \) constraints; \( \text{C} = \text{ALIGN}-\text{L(nasal)} \).
(100) Positional blocking of nasal harmony
\[ \text{IDENT-}'(\text{nasal}) \succ \text{ALIGN-L(}\text{nasal}) \succ \text{IDENT(}\text{nasal}) \]

Guaraní is able to exhibit both types of positional behavior simultaneously because both of the relevant markedness constraints interrupt the faithfulness subhierarchy, and because \text{ALIGN-L(}\text{nasal}) \succ *V_{\text{nasal}} \succ \text{IDENT(}\text{nasal})

(101) A multiplicity of positional effects
\[ \text{IDENT-}'(\text{nasal}) \succ \text{ALIGN-L(}\text{nasal}) \succ *V_{\text{nasal}} \succ \text{IDENT(}\text{nasal}) \]

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
\[ \text{IDENT-}'(\text{nasal}) \succ *V_{\text{nasal}} \succ \text{ALIGN-L(}\text{nasal}) \succ \text{IDENT(}\text{nasal}) \]

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)

\[ [+\text{nasal}] \] must be licensed:

(i) in at least one associated segment, by the presence of \([-\text{continuant}] \] [JNB: permits prenasal consonants] or by association to a mora in a stressed syllable, and

(ii) in every segment by the presence of \([+\text{voice}]\)\(^{22}\)

Either type of constraint will be satisfied by a \([\text{nasal}]\) 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 \([\text{nasal}]\) 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 \([\text{nasal}]\) 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) \[ \text{ALIGN}-\text{L(nasal)} \rightarrow *V_{\text{nasal}}, \text{IDENT}(\text{nasal}) \]

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 L\text{LICENSE}(\text{nasal})? The constraint must dominate *V_{\text{nasal}}, else no nasal vowels would ever be possible, even in stressed syllables. This is shown in (107).

(107) Nasal vowel in stressed syllable

<table>
<thead>
<tr>
<th>/tupa~/</th>
<th>\text{L\text{LICENSE}(nasal)}</th>
<th>*V_{\text{nasal}}</th>
<th>\text{IDENT}(\text{nasal})</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. tupá</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. #tupa~</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>c. tua-pá</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

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

\text{LICENSE}(\text{nasal}), \text{ALIGN}-\text{L(nasal)} \rightarrow *V_{\text{nasal}}, \text{IDENT}(\text{nasal})

---

23 While *V_{\text{nasal}} \rightarrow \text{IDENT}(\text{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 LI\text{LICENSE}(nasal) and A\text{ALIGN}-L(nasal). This is because [+nasal] is licensed whenever it is associated to a stressed syllable, \textit{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 I\text{IDENT}(nasal), and leads to better satisfaction of higher-ranking A\text{ALIGN}-L(nasal). This is shown in (109), with the input /re+xó+ta+ramo~/.

\begin{tabular}{|c|c|c|c|}
\hline
/re+xó+ta+ramo~/ & LI\text{LICENSE}(nasal) & A\text{ALIGN}-L(nasal) & *V\text{nasal} & I\text{D}(nasal) \\
\hline
a. rexótãr~ãmo~' & *!**** & *** & *** \\
\hline
b. r~e~xo~ `tãr~ãmo~' & ***** & **** & ****** \\
\hline
\end{tabular}

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 LI\text{LICENSE} and A\text{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.

\begin{itemize}
\item Foot-bounded linking (Flemming 1993: 2)
\end{itemize}

\[\gamma F\] 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 A\text{ALIGN}-L(nasal), full spreading of [nasal] will be prevented, as shown in (111); foot structure is indicated with parentheses.
Foot-bounded linking creates blocking effects

(111) Foot-bounded linking creates blocking effects

<table>
<thead>
<tr>
<th></th>
<th>/re+xó+ta+ramo~ /</th>
<th>FT-BNDL(N)</th>
<th>LIC(nasal)</th>
<th>ALIGN-L(nasal)</th>
<th>*V&lt;sub&gt;nasal&lt;/sub&gt;</th>
<th>Ip(nasal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>$\tilde{\mathfrak{v}}$ (rexò)(tãr<del>ãmo</del>')</td>
<td>!</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>(r<del>e</del>xo~')(tãr<del>ãmo</del>')</td>
<td>*!</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
</tbody>
</table>

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 <em>favored</em> 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 faithfulness 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 I_DENT-σ' constraints to the grammar. First, stressed syllables should exhibit a larger and more marked inventory of segments than unstressed syllables. Separately rankable I_DENT-σ' and I_DENT constraints will permit the intervention of inventory-defining featural markedness constraints, as schematized in (112).

(112) I_DENT-σ’(F) » *F » I_DENT(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 I_DENT-σ' and I_DENT in the constraint hierarchy. Phonological processes such as assimilation and dissimilation arise when a markedness constraint such as *M_ID, *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 » I_DENT(nasal)
Faithfulness is subordinated to the higher-ranking markedness constraints. In this system, spreading is triggered by the stressed syllable, due to high-ranking $\text{IDENT}(\text{nasal})$:

(114) $\text{IDENT}(\text{nasal}) \gg \text{ALIGN}-\text{L(nasal)} \gg *V_{\text{nasal}} \gg \text{IDENT}(\text{nasal})$

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 $\text{IDENT}(\text{nasal})$.

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 $\text{IDENT}(\text{nasal})$ 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.