

THE PHONETICS AND PHONOLOGY OF CORONAL MARKEDNESS AND UNMARKEDNESS

by

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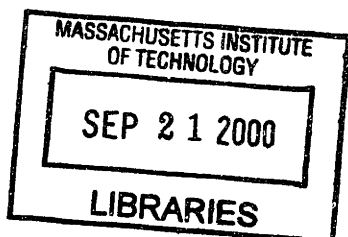
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Abstract

This thesis investigates place feature restrictions in oral and nasal stop consonants with a special focus on the asymmetrical behavior of coronal and noncoronal stops. Two conflicting patterns of place restriction in outputs are attested: *coronal unmarkedness* and *coronal markedness*. This thesis shows that coronal unmarkedness is truly a default pattern of place restriction. Coronal unmarkedness is not confined to specific segmental contexts or to languages with a particular inventory structure. In addition, the coronal unmarked pattern is attested through diverse phonological processes such as assimilation, place neutralization, segmental and featural deletion, metathesis, vowel syncope and morpheme structure constraints. This follows from the context-free place markedness hierarchy proposed by Prince and Smolensky (1993). These constraints can conjoin freely with any context-specific constraints. Such conjunction predicts neutralization to coronal place to be attested in any position where place contrast reduction is found. On the other hand, although coronal markedness is also attested through diverse phonological processes such as assimilation, place neutralization, segmental and featural deletion, metathesis and morpheme structure constraints, it is found only in nonprevocalic positions and only in languages without a sub-coronal place contrast. I propose that unlike the default markedness constraint hierarchy, the reversed markedness hierarchy is projected from a perceptibility scale of place features and is therefore context-specific. I argue that a coronal stop in nonprevocalic position in a single-coronal language is perceptually less salient than noncoronal stops in corresponding positions due to a preferential weakening of tongue body articulation for coronal stops in these positions. Also discussed in this thesis is the effect of nasality of stops on the degree of place restrictions. A nasal stop tends to allow fewer place contrasts than an oral stop and a stop followed by an oral stop tends to allow fewer place contrasts than one followed by a nasal stop. Finally, previous approaches to coronal versus noncoronal asymmetry—Coronal Underspecification, Underspecification by Constraints and Perceptually Grounded Faithfulness Constraints—are discussed and their inadequacy is demonstrated.

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*To my parents,
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Chapter 1 Introduction

There has been a recent rise in a more phonetically grounded approach to phonology (Hayes 1996; Steriade 1997, 1999abc, 2000). The idea that the explanation for at least some phonological phenomena should be sought in the physical properties of sound production and perception is not new (Archangeli and Pulleyblank 1994; Basbøll 1981; Bladon 1986; Browman and Goldstein 1986, 1988, 1989, 1990ab, 1991a, 1992a; Calabrese 1995; Kawasaki 1982; Keyser and Stevens 1997; Liljencrants and Lindblom 1972; Lindblom 1982, 1983, 1990, 1992; Lindblom, MacNeilage and Studdert-Kennedy 1983; Manuel 1991; Ohala 1974ab, 1975, 1986, 1990ab, 1995 among others; Stevens 1972; Stevens and Keyser 1989; Stevens, Keyser and Kawasaki 1986). However, it is only with the advent of phonetically grounded Optimality Theory, whose main proponents include Boersma (1997, 1998), Flemming (1995), Hayes (1996), Jun (1995), Kirchner (1998), Silverman (1995), Steriade (1997, 1999abc) and Wright (1996), that the phonetic explanation for phonological processes has taken up a more central status in the field. It is claimed that speech is a balancing act seeking a midpoint between conflicting demands of articulatory economy and perceptual saliency. The new perspective seems to promise a better understanding of certain phonological processes that received a rather unsatisfactory treatment from former theories that did not take into account the possible role of phonetics (cf. Steriade 1997). This has prompted many researchers to look at various phonological phenomena from a new viewpoint (Côté 1997, 1999, 2000; Hume 1997ab, 1998; Ní Chiosáin and Padgett 1997, 1999 among others). This is the context in which the current thesis can be situated.

This thesis is about the place feature restrictions found in stop consonants. It is commonly the case that of all featural contrasts that are possible in a language as a whole, only a subset are found in certain specific contexts of the language. The job of phonologists is to uncover the system that lies behind this pattern of restrictions. Here, I pursue the hypothesis that certain aspects of place restriction patterns are better understood when one takes into account the saliency of the perceptual cues for place features in different contexts.

Consonants are categorized into three types depending on the primary articulator that forms the constriction: Labial, Coronal and Dorsal. 99.7% of the languages in Maddieson's (1984) survey have at least a three-way place contrast for stop consonants (p.31). However, it is often the case that the contrast is diminished in certain positions. The restrictions come about either as a form of morpheme structure constraint or as a result of segmental processes. It has been repeatedly noted in the literature that coronal consonants often behave differently from labial or dorsal consonants when there is a restriction in place feature licensing in certain contexts, and that coronal place has a special status among oral places of articulation (contributions in Paradis and Prunet 1991a among others).

The most prominent among approaches to the asymmetry between coronal and noncoronal consonants is the *Coronal Underspecification* approach. It ascribes the special status of coronal place to its representational peculiarity (Avery and Rice 1989ab; Beland and Favreau 1991; Davis 1991; Kiparsky 1985; Marotta 1993; Paradis and Prunet 1989ab, 1991b, 1994; Rice 1992, 1996; Rice and Avery 1991; Stemberger 1991; Stemberger and Stoel-Gammon 1991; Yip 1991). More recently, partly due to conceptual and empirical

problems with the representational approach (cf. McCarthy and Taub 1992; Mohanan 1991; Steriade 1995), the focus has shifted away from representations. Rather, hierarchies of place markedness constraints have been proposed to account for the coronal versus noncoronal asymmetry (Prince and Smolensky 1993; Smolensky 1993). The hierarchy mandates that the markedness constraint against noncoronal place is universally ranked above the markedness constraint against coronal place.

In general, coronal consonants have fewer distributional restrictions and are more likely to be licensed in contexts of place contrast reduction. This is in line with the prediction of the fixed markedness constraint ranking of Prince and Smolensky (1993). On the other hand, a conflicting distributional restriction is found in certain other contexts, where coronal consonants are selectively eliminated. Taking the markedness hierarchy of Prince and Smolensky (1993) as a point of departure, I will refer to the cases where coronal consonants are preferentially lost or avoided as *the reversed markedness pattern (coronal markedness)*. The cases where coronal consonants are preferentially maintained in the output will be referred to as *the default markedness pattern (coronal unmarkedness)*. It is specifically these seemingly conflicting patterns of coronal markedness and coronal unmarkedness that I investigate in this thesis. What is not discussed in this thesis is the asymmetry of labial versus nonlabial place or dorsal versus nondorsal place that are reported in some languages. Also the asymmetry among different coronal places (alveolar versus dental, for example) will not be discussed (cf. Steriade 2000).

The empirical basis for this thesis is a survey of distributional restrictions on coronal and noncoronal stop consonants which I conducted. The results of the survey

suggest that the reversed markedness pattern occurs only in nonprevocalic positions and only in languages that do not contrast sub-coronal places for stops. The definition of sub-coronal place contrast will be provided later. On the other hand, the default markedness pattern does not have such restrictions. It is not confined to particular segmental contexts such that it is attested in any phenomena of place contrast reduction regardless of whether they are conditioned by particular segmental contexts (e.g., coda condition in Finnish) or not (e.g., inventory restrictions in Chipewyan).

(1) Coronal markedness versus Coronal unmarkedness

Context of place restriction		Coronal marked	Coronal unmarked
Nonprevocalic (C or #)	Single coronal language	Yes (Chapter 3)	Yes (Chapter 4.2.1)
	Multiple coronal language	No	Yes (Chapter 4.2.2)
Not conditioned by segmental contexts		No	Yes (Chapter 4.1)

This result suggests that coronal markedness is phonetically motivated and is found only in a very specific context where it is motivated by a perceptibility scale. On the other hand, the coronal-unmarked pattern is ubiquitous, that is, it is not restricted to particular contexts. To account for this generalization, I propose that there are two separate hierarchies of place markedness constraints. The two hierarchies make conflicting demands leading to variation between coronal markedness and coronal unmarkedness.

The first hierarchy is the context-free markedness hierarchy proposed by Prince and Smolesnky (1993), given in (2). It requires that the markedness constraint against noncoronal place rank above the constraint against coronal place universally. Since we are not dealing with asymmetry between labial and dorsal places, throughout the thesis I will use [PERIPHERAL] as a cover term for [LABIAL] and [DORSAL]. Thus, *PL[PER] is meant to represent two separate constraints, *PL[LAB] and *PL[DOR].

(2) *PL[PER] » *PL[COR]

It is unclear to me what the phonetic grounds for this hierarchy might be, if it is phonetically grounded at all. One possibility is that it is articulatorily motivated; the tongue tip/blade gesture is considered the swiftest and probably the least costly from an articulatory point of view. However, as we will see, not only alveolar or dental stops, but also alveopalatal and retroflex stops show unmarked behavior in multiple coronal languages. The alveopalatal and retroflex stops are relatively complex segments articulatorily, and it is unlikely that these coronal consonants are articulatorily less costly than labial or dorsal consonants. Also, as far as I know, there is no evidence that coronal consonants are in general perceptually more salient than noncoronal consonants. The lack of evidence for phonetic grounding suggests that there is a purely formal component in grammar that is not functionally motivated and that Prince and Smolensky's hierarchy is from the formal component of grammar. However, I will remain agnostic about the nature of this constraint hierarchy and simply note that the constraints are context-free.

In addition to this default hierarchy, I propose that a separate markedness hierarchy is projected from the perceptibility scale given in (3); the place cues for a coronal stop in nonprevocalic positions in languages without sub-coronal contrasts are much weaker than the cues for noncoronal stops in corresponding positions.

$$(3) \quad \text{PL[PER]}/\begin{array}{c} \text{[+STOP]} \\ | \\ \emptyset \end{array} \sim V \succ \text{PL[COR]}/\begin{array}{c} | \\ \text{[+STOP]} \\ \emptyset \end{array} \sim V^1$$

Following Steriade (1997), I assume that, given some perceptibility scales, families of corresponding OT constraints are projected, with constraints against a perceptually less salient configurations outranking constraints against perceptually more salient configurations. This perceptibility scale is projected as the markedness constraint hierarchy in (4). This hierarchy makes the opposite demand from the default hierarchy in (2) ; it requires that the markedness constraint against coronal place rank above the constraint against noncoronal place in this particular position.

$$(4) \quad * \text{PL[COR]}/\begin{array}{c} | \\ \text{[+STOP]} \\ \emptyset \end{array} \sim V \gg * \text{PL[PER]}/\begin{array}{c} \text{[+STOP]} \\ | \\ \emptyset \end{array} \sim V$$

The two hierarchies in (2) and (4) are crucially different in that the former constraints are context-free while the latter constraints are context-specific. It is inevitable that the grounded constraints are context-specific since it is only in that specific context that the relevant perceptibility scale holds. The implication of this difference is that through constraint conjunction (cf. Smolensky 1995) with other context-specific markedness constraints, the default hierarchy is applicable to any context for which a context-specific place markedness constraint is motivated. This accounts for the omnipresence of the coronal unmarked pattern. On the other hand, the grounded

¹ The symbol ‘>’ is used to denote perceptibility scale throughout the thesis. $A \succ B$ means that A is perceptually more salient than B. $\sim V$ means except for V; thus, the context of the perceptibility scale in (3) is nonprevoclic position. Finally, the notation, $\begin{array}{c} | \\ \text{[+STOP]} \\ \emptyset \end{array}$, means that the scale is only applicable when there is

no sub-coronal contrast in the language and as a result, coronal place does not have a dependent feature. See section 2.2 for a discussion regarding contrastive specification of features dependent on [Coronal].

constraints in their original forms are defined by specific contexts. Since constraint conjunction can only render a constraint more specific but not less specific, the grounded hierarchy can never apply to contexts other than what it is specified for (i.e., nonprevocalic positions in languages without sub-coronal contrasts).

My survey also shows that aside, from the choice between coronal markedness and coronal unmarkedness, independent perceptual factors further influence the degree of place restriction found in different positions. In particular, nasal stops have more severe place restrictions than oral stops. Also, other things being equal, a stop consonant followed by an oral stop has more severe place restrictions than a stop consonant followed by a nasal stop. Another pair of place markedness constraint hierarchies, given in (5) and (6), are proposed and they will be motivated on perceptual grounds in Chapter 3.

$$(5) \quad *PL[\alpha]/\underline{\quad} \begin{smallmatrix} [+NAS] \end{smallmatrix} \gg *PL[\alpha]/\underline{\quad} \begin{smallmatrix} [-NAS] \end{smallmatrix}$$

$$(6) \quad \begin{array}{c} *PL[\alpha]/\underline{\quad} \begin{smallmatrix} [-NAS] \\ [+NAS] \end{smallmatrix} \\ \downarrow \\ *PL[\alpha]/\underline{\quad} \begin{smallmatrix} [+NAS] \\ [+NAS] \end{smallmatrix} \\ \downarrow \\ *PL[\alpha]/\underline{\quad} \begin{smallmatrix} [-NAS] \\ [-NAS] \end{smallmatrix} \\ \downarrow \\ *PL[\alpha]/\underline{\quad} \begin{smallmatrix} [+NAS] \\ [-NAS] \end{smallmatrix} \end{array}$$

The rest of the thesis is organized as follows. In Chapter 2, I start with cases of coronal markedness. I provide phonetic grounds for markedness reversal and explain why the reversed markedness pattern is restricted only to nonprevocalic positions in languages without a sub-coronal place contrast. In Chapter 3, I present OT analyses for cases of

reversed markedness that employ the perceptually grounded markedness constraints. In Chapter 4, I discuss cases of coronal unmarkedness. I show that unlike coronal markedness, the default markedness pattern is not restricted to nonprevocalic contexts. I also show that coronal unmarkedness is found both in languages with sub-coronal contrasts and in languages without sub-coronal contrasts. OT analyses are provided that employ the context-free place markedness constraints. In Chapter 5, previous accounts of coronal versus noncoronal asymmetry are reviewed and their inadequacy is demonstrated. Finally, Chapter 6 provides a conclusion.

Chapter 2 Coronal markedness : phonetic grounding


2.1 *Markedness reversal : overview*

It is a widely accepted generalization that coronal place has a special status among oral places of articulation (contributions in Paradis and Prunet 1991a among others). To account for the special behavior of coronal consonants observed in the literature, Prince and Smolensky (1993) proposed a fixed hierarchy of markedness constraints.

(7) *PL[PER] » *PL[COR]

This hierarchy predicts that, other things being equal, coronal consonants are more likely to appear in the output than noncoronal consonants, as the simple tableau in (8) shows. When two candidates are equivalent in all respects, except that one contains a coronal consonant (candidate a.) while the other contains a labial (i.e., noncoronal) consonant (candidate b.), the noncoronal candidate will always be less optimal than the coronal candidate due to the fixed ranking of the place markedness constraints in (7).

(8) Hypothetical

	*PL[PER]	*PL[COR]
a.  ...t... [Cor]		*
b. ...p... [Lab]	*!	

This is the correct description for many of the coronal versus noncoronal asymmetry phenomena, as we will see in Chapter 4. It has also been observed, however, that in place assimilation, coronal consonants are preferentially targeted over noncoronal consonants (Kiparsky 1985; Cho 1990; Mohanan 1993; Jun 1995). For example, in Yakut,

coronal nasals and stops assimilate to the place of following stops, as shown in (9)a., but labial or dorsal nasals and stops do not assimilate, as the examples in (9)b. illustrate (Krueger 1962; Wetzels 1989; Jun 1995).

- | | | | | | | |
|-----|----|-----------------|---|---------------------------|-----------------|-------------------|
| (9) | a. | <i>at-KA</i> | → | <i>akka</i> | | 'horse, DAT.' |
| | | <i>aan-KA</i> | → | <i>aanŋa</i> ² | | 'door, DAT.' |
| | b. | <i>sep-KA</i> | → | <i>sepke</i> | <i>*sekke</i> | 'tool, DAT.' |
| | | <i>tobuk-TA</i> | → | <i>tobukta</i> | <i>*tobutta</i> | 'knee, PART.' |
| | | <i>ilim-KA</i> | → | <i>ilimŋe</i> | <i>*ilinye</i> | 'net, DAT.' |
| | | <i>tiŋ-TA</i> | → | <i>tiŋne</i> | <i>*tiinne</i> | 'squirrel, PART.' |

In the wake of assimilation, only noncoronal stops are found in preconsonantal position. As has been repeatedly pointed out, the markedness hierarchy fails to account for the asymmetrical place assimilation found in numerous languages including Yakut, where it is the ostensibly unmarked coronal place that is preferentially lost (Smolensky 1993; Kiparsky 1994; Fonte 1995; Alderete *et al.* 1996). Rather, the hierarchy predicts that if there is any asymmetry in place assimilation, coronal consonants will be less likely to be assimilated than noncoronal consonants. The tableaux in (10) and (11) illustrate this point.

Let us assume that place assimilation is driven by place markedness constraints, which essentially promote reduction of place specifications in the output (cf. Beckman 1998). Thus, if coronal consonants were to undergo assimilation, the markedness constraint against a coronal place, *PL[*COR*], would dominate the faithfulness constraint against place feature deletion, MAX(PL[*α*]), as illustrated in (10). The faithful candidate, *atka* (a.), contains a [Coronal] feature in addition to [Dorsal] and violates the markedness constraint against coronal place, *PL[*COR*]. The candidate with place assimilation, *akka*

² Independent of the place assimilation, progressive assimilation in voicing, nasality and laterality applies (Wetzel 1989).

(b.), on the other hand, contains only a single place feature [Dorsal] and does not violate *PL[*COR*]. Thus, even though *akka* violates the faithfulness constraint MAX(PL[α]), due to the low ranking of the faithfulness constraint, MAX(PL[α]), *akka* rather than **atka* is chosen as optimal.

(10) Yakut /at-KA/ → *akka* ‘horse, DAT.’³

	/at-KA/ / \ [Cor][Dor]	*PL[<i>COR</i>]	MAX(PL[α])
a.	<i>atka</i> / \ [Cor][Dor]	*!	
b.	<i>akka</i> V [Dor]		*

According to the markedness hierarchy, *PL[*PER*] universally dominates *PL[*COR*]. If *PL[*COR*] dominates the faithfulness constraint MAX(PL[α]), by transitivity, *PL[*PER*] should also dominate the faithfulness constraint, as shown in (11). Therefore, the markedness constraint against the noncoronal place feature, *PL[*PER*], dominates MAX(PL[α]) and assimilation is forced.

³ I assume that the direction of place assimilation is restricted to be regressive due to the positional faithfulness constraint for onset position, MAX(PL[α])/ONSET (cf. Beckman 1998) and do not consider candidates with progressive assimilation.

(11) Yakut /sep-KA/ → *sepke* **sekke* 'tool, DAT.'

	/sep-KA/ / \ [Lab][Dor]	*PL[PER]	*PL[COR]	MAX(PL[α])
a.	<i>sepke</i> / \ [Lab][Dor]	*!		
b. ⁴	<i>sekke</i> \\ [Dor]			*

As a result, it is incorrectly predicted that in all languages where coronal consonants are targets of assimilation (e.g., Yakut), dorsal and labial consonants will also be targets of assimilation. In other words, according to Prince and Smolensky's markedness hierarchy, it is impossible to have a language where only coronal consonants undergo place assimilation while noncoronal consonants remain unassimilated. I will refer to cases like Yakut assimilation, where coronal consonants are preferentially eliminated in the output while corresponding noncoronal consonants are maintained, as *the reversed markedness pattern*. The goal of the current chapter is to define the conditions where the reversed markedness pattern is found and to provide a formal analysis. A discussion of the default markedness pattern will be found in Chapter 4.

In order to determine the conditions under which markedness reversal may arise, I conducted a survey of distributional restrictions on stop consonants, focusing on the distribution of nasal and oral stop consonants only. In the following discussion, all statements about coronal place versus noncoronal place should be understood as regarding only stop consonants. The reason for this restriction is that we are interested in the

⁴ The dark hand represents a candidate that is chosen by the constraint ranking but is not an actual output.

asymmetry among different place features, and in general only stop consonants show contrasts in oral places in most languages.⁵

From my survey, the cases that show the reversed markedness are listed in (12). The survey reveals, first, that assimilation is not the only process to exhibit the reversed markedness pattern. In some languages, segmental deletion or place feature deletion (i.e., debuccalization or place neutralization) applies only to coronal stops, leaving only noncoronal stops in the relevant positions. In other languages, metathesis applies to intervocalic stop consonant sequences when the first stop is coronal. This is best understood as a restriction against a coronal stop in preconsonantal position. Also, in many languages, coronal markedness is attested as a static Morpheme Structure Constraint.

(12) Cases of coronal markedness

Assimilation	: Catalan, Dutch, English, German, Keley-I, Lithuanian, Polish, Toba Batak, Yakut, Inuit, Latin
Deletion	: Attic Greek, Catalan, Chickasaw, English, Korean, Lithuanian, Polish, Ripurian German
Metathesis	: Attic Greek, Cebuano Bisayan, Leti, Moa, Tagalog
MSC	: Mishmi, Kana, English, Attic Greek

There are two overarching characteristics that are shared by the diverse phenomena that exhibit the reversed markedness pattern. First, the context where the place restriction occurs is either in preconsonantal or word-final position.⁶ As might be

⁵ Dorsal place, however, is often missing from the nasal stop inventory in many languages. Some languages also have place contrasts on fricatives and glides but they show different restriction patterns from those of stops. I leave the place restrictions in fricatives or glides for future research.

⁶ Dixon (1980) and Hamilton (1993a, 1996) claim that in Australian languages, labial or dorsal consonants are less marked than coronal consonants in prevocalic positions (word-initial position and post-consonantal, prevocalic position). However, the examination of data in Hamilton (1996)'s survey shows that no Australian language in his survey allows only noncoronal consonants in word-initial position to the exclusion of all coronal consonants. Although the full contrasts among coronal consonants are often not available in this position, at least one or more coronal consonants are always allowed in this

expected, all cases of assimilation that exhibit coronal markedness target coronal stops in preconsonantal or word-final position, but never in prevocalic position. In addition, deletion of coronal consonants (or coronal place feature) is also found in preconsonantal or word-final position and never in prevocalic position; metathesis is triggered by coronal consonants in preconsonantal position and not in prevocalic position; and finally, it is the preconsonantal or word-final position that shows the reversed markedness pattern in Morpheme Structure Constraints. Secondly, no language with sub-coronal contrasts exhibits reversal of markedness.⁷ A definition of sub-coronal contrast will be provided in the following section.

I propose that coronal stops are marked in this specific context because they are perceptually weaker than noncoronal stops in this particular context. Following Steriade (1997), I assume that, given independent phonetically grounded perceptibility scales, families of corresponding markedness constraints are projected into the phonological component. Given the perceptibility scale [Per] > [Cor] in this position, the grammar

position. I assume that the reduction in sub-coronal contrasts is due to a high-ranking constraint that regulates a paradigmatic contrast among coronal consonants (cf. Flemming 1995's MINDIST), and not due to the markedness of coronal consonants as a whole relative to noncoronal consonants. For word-medial prevocalic position (i.e., C₂ in VC₁C₂V), there are 33 languages that only allow noncoronal consonants in this position. This may seem like overwhelming evidence for coronal markedness in prevocalic position. But, with the exception of two languages, Limilngan and Bandjalang, all of these languages restrict the preceding consonant, C₁, to coronal consonants. I assume that the restriction against coronal consonants in prevocalic position of these Australian languages is due to an OCP-type constraint against two heterorganic coronal places in adjacent segments, not due to a high-ranking markedness constraint against coronal consonants in prevocalic position.

⁷ A possible exception to this generalization is found in Southern dialects of Vietnamese (Thompson 1959, 1967, Rice 1996). Historically, after certain vowels, coronal stops (*t*, *n*) merged with dorsal stops (*k*, *ŋ*) in final position and this constitutes an instance of markedness reversal. Unlike Hanoi dialects where the earlier contrast between apical and retroflex oral stops (*t* versus *ʈ*) is lost, however, the contrast is maintained in Southern dialects. This is a potential instance of coronal markedness in a language with sub-coronal contrast. However, according to Thompson (1967, p8), the retroflex stop is described as an

projects the corresponding markedness hierarchy $*[COR] \gg *[PER]$. However, since the perceptibility scale holds true only in the specific context iterated above, the reversed markedness constraint hierarchy is applicable only in this context, as shown in (13). This is in contrast to the default markedness pattern which is not restricted to particular contexts, as we will see in Chapter 4.

$$(13) \quad *PL[COR]/\begin{array}{c} \text{---} \\ | \\ \emptyset \end{array} \begin{array}{c} \text{---} \\ [+STOP] \end{array} \sim V \gg *PL[PER]/\text{---} \begin{array}{c} \text{---} \\ [+STOP] \end{array} \sim V$$

The rest of the chapter is organized as follows. First, in section 2.2, I provide a definition of *sub-coronal contrast* and a contrastive underspecification of the [Coronal] dependent features [Distributed] and [Anterior]. In section 2.3, I discuss the phonetic underpinnings of the proposed grounded constraints. Specifically, I show why the perceptibility of coronal stops is particularly weak in nonprevocalic positions in single-coronal languages.

2.2 *Sub-coronal contrast and contrastive specification*

Before we go into the discussion of how sub-coronal contrast affects the perceptibility of a coronal consonant, I will provide a working definition of *sub-coronal contrast*. I assume that a language has sub-coronal place contrasts if the following conditions are met:

affricate, and not as a pure stop. For discussion regarding the definition of sub-coronal contrast, see the next section.

- (14) a. The phoneme inventory of the language includes two or more stop consonants whose constrictions are made solely with the coronal articulator (tongue tip/tongue blade).
 b. The contrasting coronal stop consonants differ in terms of point of constriction but are otherwise identical in terms of other features such as voicing, nasality and continuancy.

By these criteria, all Australian languages contrast sub-coronal place for stops. For example, Lardil has a six-way contrast in oral and nasal stops and among the six places, four are coronal. The Lardil stop inventory is given in (15). Two of the coronal places involve the tongue blade (*lamino-dental* and *lamino-alveolar*) and the other two are made with the tongue tip (*apico-alveolar* and *apico-dorsal*).

(15) Lardil stop inventory (Hale 1973)

Labial	Lamino-Dental	Apico-Alveolar	Apico-Dorsal	Lamino-Alveolar ⁸	Velar
p	t̪	t	ɽ	c	k
m	ɱ	n	ɳ	ɲ	ŋ

Similarly, Dravidian languages contrast a retroflex stop with a dental or alveolar stop. Some languages of this family also have an additional contrast between a dental stop and an alveolar stop. This is illustrated by the stop inventory of Tamil.

(16) Tamil stop inventory (Christadas 1988)

Labial	Dental	Alveolar	Retroflexed	Palatal	Velar
p	t̪	t	ɽ	c j	k
m		n	ɳ	ɲ	(ŋ)

Steriade (1986), Mester (1986), Sagey (1986), McCarthy (1988), Yip (1989) Clements and Hume (1995) and Hall (1997) propose that sub-coronal places are distinguished from each other by [Distributed] and [Anterior] features that are dependent on [Coronal], as shown in (17). [Distributed] distinguishes coronal consonants based on

the active articulators involved; [+Distributed] consonants (dental and alveopalatal) make a constriction with the tongue blade (i.e., they are laminal) while [-Distributed] consonants (alveolar and retroflex) make a constriction with the tongue tip (i.e., they are apical). [Anterior] makes a distinction based on the place of constriction along the passive articulator; dental and alveolar consonants ([+Anterior]) make a constriction in the anterior part of the roof of the mouth, while retroflex and alveopalatal consonants ([-Anterior]) make a constriction further back in the mouth.

(17)

Alveolar /t/ Place [Coronal] / \	Dental /t̪/ Place [Coronal] / \	Retroflex /ɖ/ Place [Coronal] / \	Alveopalatal /c/ Place [Coronal] / \
[-Dist][+Ant]	[+Dist][+Ant]	[-Dist][-Ant]	[+Dist][-Ant]

However, Gnanadesikan (1993) and Hamilton (1993b) show that the natural class predicted by [Anterior] is not justified; there is no phonological evidence that dental and alveolar consonants ([+Anterior]) or retroflex and alveopalatal consonants ([-Anterior]) are grouped together. Here I adopt Hamilton's (1993b) proposal and assume that [Anterior] is not a direct dependent of [Coronal] but a dependent of [Distributed], which is in turn a dependent of [Coronal]. Thus, the feature [Anterior] distinguishes alveolar consonants from retroflex consonants, and dental consonants from alveopalatal consonants, without grouping either dental and alveolar together or retroflex and alveopalatal together. According to this assumption, the four coronal places are represented as in (18).

⁸ Lamino-alveolar stops are transcribed as /tʲ, nʲ/ in Hale (1973).

(18)

Alveolar	Retroflex	Dental	Alveopalatal
/t/	/ɖ/	/t̪/	/t͡ʃ/
Place	Place	Place	Place
[Coronal]	[Coronal]	[Coronal]	[Coronal]
[-Dist]	[-Dist]	[+Dist]	[+Dist]
[+Ant]	[-Ant]	[+Ant]	[-Ant]

In contrast, some languages have a very simple coronal stop inventory with only a single series of coronal stops, either alveolar or dental. These languages include Dutch (/t, d, n/ : Kooij 1990), German (/t, d, n/ : Hawkins 1990), Inuit (/t, n/ : Bobaljik 1996), Latin (/t, d, n/ : Coleman 1990), Lithuanian (/t, d, n/ : Kenstowicz 1972), Mishmi (/t, d, n/ : Rhee 1998 based on Sastry 1984), Tagalog (/t, d, n/ : Schachter 1990), and Toba Batak (/t, d, n/ : Hayes 1986).

Some of these languages contrast a palatal stop with a dental or alveolar stop but for our purposes this is not considered a sub-coronal place contrast. Following Keating (1987), I assume that a palatal consonant is a complex segment where a long constriction is made involving both coronal and dorsal articulators. Hence palatal stops are specified both for [Coronal] and [Dorsal] features as shown in (19), and the coronal articulator is not the sole articulator forming the constriction. Thus, the condition in (14)a. rules out a palatal stop from constituting a sub-coronal contrast with another coronal consonant, since there is no contrast that is specifically sub-coronal.

(19)

Palatal
/ɟ/
Place
/ \
[Coronal][Dorsal]

Therefore, the contrast between an alveolar or dental nasal /n/ and a palatal nasal /ɲ/ found in Catalan (Hualde 1992), Yakut (Wetzels 1989) and Kana (Ikoro 1996) does not constitute a sub-coronal contrast. However, note that in Australian languages, stops that are usually referred to as ‘palatal’ in the Australianist literature are articulated further forward in the oral cavity than the sounds traditionally called palatal in other languages. They “involve contact of the blade of the tongue along a very broad band over the postalveolar and alveolar regions and show a considerable amount of overlap with the alveolars along the passive articulator” (Hamilton 1993b, p.130). These Australian stops are better referred to as post-alveolar, palato-alveolar or alveopalatal stops rather than as palatal stops (Hamilton 1993b, Butcher 1995, Ladefoged and Maddieson 1996).

In addition, coronals that contrast in place and manner do not fall under the definition in (14). Languages such as Catalan (Hualde 1992), Chickasaw (Gordon *et al.* 1997), English (Finegan 1990), Keley-I (Hohulin and Kenstowicz 1979), Korean (Sohn 1987) and Yakut (Wetzels 1989) contrast dental or alveolar oral stops with a nonanterior oral stop /ʃ/, variously referred to as palatal, prepalatal, alveolopalatal or post-alveolar. However, the nonanterior stop /ʃ/ in these languages is an affricate, not a pure stop. Thus, the place distinction is not the sole basis of contrast between these stops. By condition b. of (14), the contrast between these affricates with other coronal stops does not constitute a sub-coronal place contrast. Similarly, in Leti, /d/ is alveolar while /t/ is dental, but they also contrast in terms of voicing (Hume 1997a, p.c.). Therefore, these stops do not form a sub-coronal place contrast by our definition. In Catalan, the oral stops /d, t/ are described as dental while the nasal stop /n/ is described as alveolar (Hualde 1992). This distinction

likewise does not count as sub-coronal place contrast by our definition since the stops differ in nasality.

Now, the question arises as to whether coronal stops in single coronal languages are specified for coronal dependent features or not. For example, it has been traditionally thought that English stop consonants are apico-alveolar while French stop consonants are lamino-dental. However, Dart (1991, 1998) shows that in both languages there is wide inter-speaker variation both in terms of place of articulation (dental versus alveolar) and point of constriction on the tongue (laminal versus apical). The tables in (20) are from Dart (1998) and they summarize the result of her studies based on palatograms and linguagrams from 21 French speakers and 20 American speakers.

(20) Place of articulation and point of lingual contact for /t,d,n/ in French and English
French (Dart 1998, TABLE XVI-XVII)

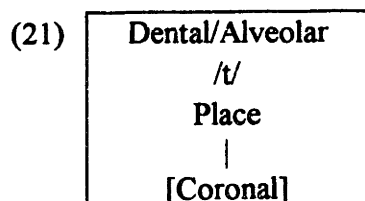
	Dental	Alveolar	Postalveolar
Apical	11	34	0
Apicolaminal	47	8	0
Laminal	16	21	0

English

	Dental	Alveolar	Postalveolar
Apical	10	81	7
Apicolaminal	3	4	0
Laminal	8	6	0

In the French data, despite the traditional description that coronal stops are lamino-dental, almost half of the tokens (63: 46%) are produced as alveolar, and tokens are almost evenly distributed along the three lingual categories (apical : 33% ; apicolaminal : 40% ; laminal : 27%). The English data are less heterogeneous and in fact 68% of the tokens are produced as apicoalveolar. However, a significant number (18%) of the tokens are dental, and 18% of the tokens are not apical. It is striking too that there are as many as 7 tokens that are produced as postalveolar.

Dart's results show that, contrary to the traditional descriptions of these coronal stops, the coronal stops in French and English are not uniformly dental or alveolar, or laminal or apical. Based on these phonetic facts, I assume that the coronal-dependent place features [Distributed] and [Anterior] are not specified for coronal stops in English and French, and presumably also in other languages that do not have sub-coronal place contrast for stops, as shown in (21).



In short, I assume that coronal dependent features [Distributed] and [Anterior] are contrastively underspecified. However, note that this is not the kind of *temporary* underspecification of features that has been criticized by Mohanan (1991) and Steriade (1995). Rather, I assume that the coronal stops in single coronal languages are unspecified for coronal dependent features not only in the underlying representation or at the lexical level, but that the underspecification is sustained into the postlexical and phonetic levels as well.

2.3 No contrast and no vocalic release : conditions of markedness reversal

The markedness reversal is found only in nonprevocalic positions in languages without a sub-coronal place contrast. Above I argued for different representations for coronal consonants in languages with a sub-coronal contrast and those without. In this section, I will seek a phonetic explanation for why place markedness reversal is found only

in nonprevocalic positions in single-coronal languages. I propose that coronal stops are more marked than noncoronal stops in these positions because the coronal stops are perceptually weaker than noncoronal stops in these positions. The perceptual weakness of coronal stops in these positions is attributed to the preferential weakening of tongue body articulation for coronal stops. There are three components to this proposal: (a) it is only in nonprevocalic positions but not in prevocalic position that the articulatory weakening is found; (b) the tongue body articulation for coronal stops is more likely to be weakened than the lip articulation for labial stops or the tongue body articulation for dorsal stops; (c) it is only in single-coronal languages that the tongue body articulation for coronal stops is preferentially weakened. I will address each of these questions in turn.

2.3.1 Nonprevocalic position as locus of articulatory weakening

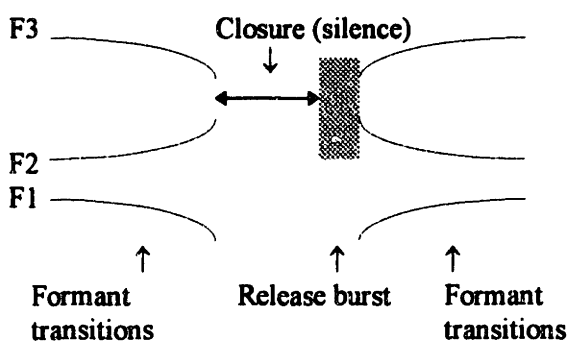
It has been repeatedly noted by many researchers that various articulatory weakening phenomena are attested in nonprevocalic positions in contrast to prevocalic positions (Krakow 1999). In general, a tighter constriction is made in prevocalic position than in nonprevocalic position; the tongue tip height for alveolar stops, tongue dorsum height for velar stops, and lip constriction for bilabial stops all have greater value in prevocalic position than in nonprevocalic position (Browman and Goldstein 1995, Keating 1995). Also, there is some evidence that suggests that speakers make more precise articulations near the CV as opposed to the VC interface (Ohala and Kawasaki 1984). The question arises : why are nonprevocalic positions prone to articulatory weakening in comparison to prevocalic positions?

The answer to this question can be found in Kohler's (1990, 1992) hypothesis that the modification of articulator gestures is controlled by perceptual factors such that "[w]hat is not very distinctive for a listener anyway may be reduced by a speaker more easily to yield to the principle of economy of effort." Under this hypothesis, the articulatory weakening of nonprevocalic consonants relative to those in prevocalic position follows from the fact that the perceptual cues for place features in nonprevocalic positions is in general weaker than those in prevocalic position. Now, let us review evidence for the perceptual weakness of place cues in nonprevocalic positions relative to those in prevocalic position.

There are two types of place cues for an oral stop: formant transitions and a release burst (Lieberman and Blumstein 1988, Olive *et al.* 1993, Johnson 1997, Stevens 1998). The transitions of the second formant (F2), and to a lesser degree, the third formant (F3), provide information regarding the place of articulation. They reflect the changes in the vocal tract configuration as the closure for the stop is made out of a vowel or the closure for the stop is released into a vowel. All formant frequencies decrease near the closure for labial stops. For velar stops, there is a convergence of F2 and F3 near the closure. Finally, for coronal stops, both F2 and F3 tend to rise as the closure is made. During the closure for an oral stop, intraoral air pressure builds up, and when the occlusion is released, a noise is generated at the location of constriction. The noise is filtered by the cavity in front of the constriction and the spectrum of this noise burst provides information regarding the place of articulation; a spectral peak is found in the mid-frequency (F2 or F3) range for dorsal stops and in the high-frequency (F4 or F5) range for coronal stops, while there is no spectral peak associated with labial stops. There

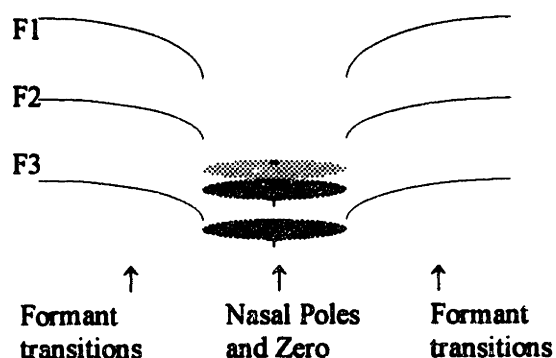
are no segment-internal place cues for an oral stop since there is only silence during its closure. (22) schematically illustrates the acoustic cues found near the closure and release of a dorsal oral stop.

(22) Schematic illustration of acoustic events surrounding dorsal stop closure and release



The place feature of a nasal stop is also cued by formant transitions into and out of a neighboring vowel. Unlike oral stops, however, during the closure for nasal stops, the airflow continues through the nasal channel. Thus, the intraoral air pressure does not build up and no release burst is generated at the release of a nasal stop. On the other hand, the sound radiated from the nose during the closure of the nasal stop (i.e., nasal murmur) provides some cues for the place of articulation. During the nasal murmur, the vocal tract forms a side branch and introduces an anti-formant. The frequency of the anti-formant depends on the length of the side branch, which is determined by the location of the oral constriction. The frequency of the zero is lowest for labial stops, intermediate for coronal stops and the highest for dorsal stops.

(23) Schematic illustration of acoustic events surrounding labial nasal stop closure and release



However, not all of these cues are available for stops in every position. Nor is the auditory saliency of these cues the same in every position. In general, the cues for stops in prevocalic position are better than the cues for stops in nonprevocalic position either in terms of the number of cues or the quality of cues.

For oral stops, place cues from both the formant transitions and the release burst are available in prevocalic position. On the other hand, in nonprevocalic position, depending on whether or not the stop is preceded by a vowel, the formant transition cues may or may not be available. Also, unlike at the release of stop closure, no burst is found at the closure of a stop.⁹ In many languages, stops that are not followed by a vowel are not audibly released or are only optionally released (cf. Rhee 1998, Henderson and Repp 1982). Thus the burst cues are absent or inconsistent, if present, for stops in nonprevocalic positions.

Place cues for nasal stops are also not equal for prevocalic and nonprevocalic positions. It has been observed that the velum is lower at the implosion of a nasal stop (at VN juncture) than it is at the release of a nasal stop (at NV juncture). As a result, prenasal

vowels are very often more nasalized than postnasal vowels (Ushijima and Sawashima 1972 cited by Manuel 1991, Ali *et al.* 1971 cited by Repp and Svastikula 1988, Krakow 1989). This difference affects the quality of place cues in the formant transitions; when the velopharyngeal opening is small, as is the case at the release of a nasal stop, the opening of the oral constriction abruptly switches the principal sound output to the mouth opening. Since the nasal murmur tends to have weak energy in the F2 region, especially for labial and coronal stops, as a result of the sudden shift of the point where sound is radiated, the amplitude in the F2 region suddenly increases. Since the transition of F2 is an important cue for place of articulation, the sudden increase in F2 amplitude improves the cues for place of articulation (Manuel 1991, Stevens 1998). On the other hand, if the velum is substantially lowered, as is the case at the implosion of a nasal stop, regardless of the opening or closing of the oral constriction, a high percentage of the sound energy will go through the nasal passage. Thus, at the transition from a vowel to a nasal stop, the spectral change is less salient. This nasalization of the vocalic transition into a nasal consonant makes the formant movement less distinct. Therefore, the place cues from the formant transitions will be less salient.

Aside from the difference in the acoustic quality of the cues in prevocalic versus nonprevocalic positions, there is evidence that the human auditory system perceives the cues in these positions differently. According to Delgutte and Kiang (1984) and other literature cited in Wright (1996), there is a marked burst of activity of the auditory nerve fibers in response to the onset of a stimulus signal. In other words, the same acoustic

⁹ Occasionally, however, a noise burst is found at dorsal closure (Stevens 1999, p.559).

signal is perceived more saliently by the auditory system if it comes after a period of silence. Therefore, acoustic cues found at the release of a stop into a following vowel (CV juncture) are registered particularly saliently by the auditory system since they follow a period of silence (i.e. stop closure). However, no such onset boost effect is found for corresponding cues at the implosion of a stop (VC juncture). According to various perception studies, listeners' perception is influenced more by CV cues than VC cues (Wang 1959, Malecôt 1958, Repp 1978, Fujimura *et al.* 1978, Dorman, Raphael and Lieberman 1979, Streeter and Nigro 1979, Schouten and Pols 1983 and Ohala 1990b). Thus, the place cues for stop consonants are more salient in prevocalic position than in nonprevocalic position.

There is overwhelming evidence that the perceptual cues for place features are better in prevocalic position than in nonprevocalic position, either in terms of number of cues or the quality of cues, as (24) summarizes. By Kohler's (1990, 1992) hypothesis that speakers conserve their effort on what is already nonsalient, it is not surprising to find articulatory weakening in the perceptually less salient nonprevocalic positions.

(24) Comparison of place cues for stops in prevocalic and nonprevocalic positions

Segmental context	Cues for oral stops	Cues for nasal stops
Prevocalic	<ul style="list-style-type: none"> • CV transitions • release burst 	<ul style="list-style-type: none"> • CV transitions • nasal murmur
Nonprevocalic	<ul style="list-style-type: none"> • VC transitions (if postvocalic) • <i>inconsistent</i> or <i>no</i> release burst 	<ul style="list-style-type: none"> • <i>nasalized</i> VC transitions (if postvocalic) • nasal murmur

2.3.2 The tongue body gesture in coronal stop articulation

In the previous section, I proposed that articulatory weakening is commonly attested in nonprevocalic positions because the perceptual cues for place features are weak

in those positions. I propose that not all articulatory gestures are equally likely to weaken in nonprevocalic position. Rather, gestures that do not have featural status are more likely to be weakened than those that have featural status. The tongue body articulation for coronal stops is therefore more prone to weakening due to its nonfeatural status. As a result of weakening of the tongue body gesture for coronal stops, coronal stops are perceptually less salient than noncoronal stops in the same position.

Coronal stops are stops produced with the coronal articulator (tongue tip/blade) making a constriction somewhere on the roof of the mouth. A simulation study by Manuel and Stevens (1995) shows that what we consider to be “typical” coronal transitions, whereby F2 and F3 rise toward the closure for coronal stops, are due to the movement of the tongue body. The tongue body has a certain canonical position that it assumes when a coronal consonant is produced and as the slow tongue body articulator moves into the position for a neighboring vowel, the formant transitions that we observe emerge. On the other hand, the transitions due to the movement of the tongue tip/blade itself are very brief. Note that even though the tongue body has some canonical position related to coronal stop production, coronal stops are not specified for dorsal place features, since there is no separate articulatory target for the tongue body. I assume that this kind of noncontrastive gesture without featural status, that is, the tongue body movement in coronal consonant production, will be preferentially lost in the context of articulatory reduction.¹⁰

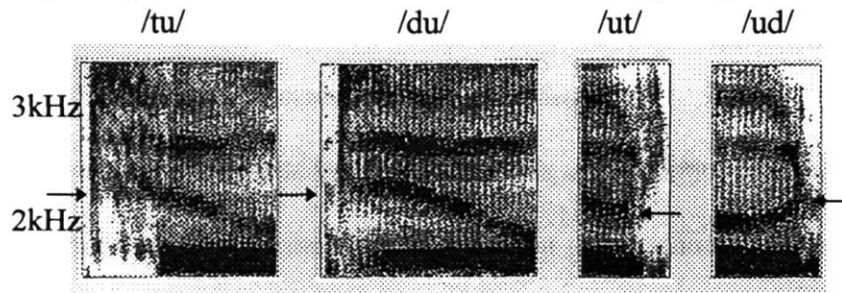
¹⁰ Another explanation for the selective weakening of tongue body gesture for coronal stops has been suggested to me by Ken Stevens (p.c.): the tongue body position is used to aid in the positioning of the tongue blade so that the proper burst is produced; but this is not needed if there is no burst for (coronal) stops in nonprevocalic positions.

On the other hand, the primary transition cues for dorsal stops come from the tongue body movement, which clearly has featural status. As for labial stops, lips and jaw movement are both responsible for formant transitions. Jaw movement for labial stops has the same nonfeatural status as the tongue body gesture for coronal stops. But, unlike the tongue body fronting gesture for coronal stops, raising of the jaw is essential in making a lip closure. Note that the tongue body fronting is not essential for making contact between the tongue tip/blade and the roof of mouth. In fact, from Dart's (1998) data on English coronal stop articulation, a substantial number of tokens (6%) were produced as apical postalveolar. This suggests that the tongue body was not fronted for articulation of these tokens of coronal stops.

In English, a "typical" coronal F2 transition is found in prevocalic position, but in nonprevocalic positions, the transition seems to be weakened. (25) shows that in English, the VC transition into a coronal stop (not followed by a vowel) is not a mirror image of the CV transition out of a coronal stop. While the F2 movement going from the coronal consonant into the vowel is relatively robust and clear, there is little movement in F2 value in the transition from the vowel to a following coronal stop. (F2 is marked by an arrow.) This would be a natural consequence of a weakening of the tongue body articulation for the coronal consonant in nonprevocalic position.

(25) CV versus VC coronal transition

(Spectrograms from Olive *et al.* 1993; the arrows [YJK])



Since the tongue tip/blade gesture is the quickest of the three major articulators (Kuehn and Moll 1976), without the robust cues that come from tongue body movement, the coronal place cues from the vocalic transitions are minimal.¹¹ This is especially the case when the coronal consonant is followed by another consonant. Byrd (1992) and Zsiga (1994) showed that in cases of extensive gestural overlap, the acoustic effect of the gesture for the second consonant C_2 in $V_1C_1C_2V_2$ (where C_1 is coronal) is present in the nonadjacent vowel, V_1 . This means that when the tongue body movement for the coronal consonant C_1 is weakened, although not eliminated, as in English, the preceding vowel V_1 will be dominated by the cues for the second consonant C_2 .¹² Then both V_1C and CV_2 transitions will be dominated by the signals for C_2 , resulting in the perception of $V_1C_2V_2$ or $V_1C_2C_2V_2$.

(26) compares the place cues for coronal stops and noncoronal stops. To summarize, in prevocalic position the coronal and noncoronal stops both carry sufficient place cues equally, but in nonprevocalic positions the tongue body articulation may be weakened for coronal stops, especially when it is noncontrastive. This weakens the VC

¹¹ This may further motivate the weakening of the tongue tip/blade gesture itself and may explain why English nonprevocalic coronal stops often fail to make a full constriction (cf. Dart 1998, Jun 1996).

transition cues for the coronal stops and causes the imbalance in the perceptibility of coronal stops and noncoronal stops.

(26) Comparison of coronal versus noncoronal place cues

Phonetic contexts	Coronal stops	Noncoronal stops
Prevocalic	<ul style="list-style-type: none"> • CV transitions • burst / nasal murmur 	<ul style="list-style-type: none"> • CV transitions • burst / nasal murmur
Nonprevocalic	<ul style="list-style-type: none"> • <i>little F2, F3 movement in VC transitions (if postvocalic)</i> • weak or no burst / nasal murmur 	<ul style="list-style-type: none"> • VC transitions (if postvocalic) • weak or no burst / nasal murmur

Previous accounts of coronal markedness did not take into account the role of the tongue body gesture in acoustic cues for coronal place. Rather, Browman and Goldstein (1990b) and Byrd (1992) argued that coronal stops are perceptually weaker than other stops because, due to the quickness of tongue tip/blade articulator, the coronal gesture is easily hidden by a neighboring consonantal gesture. On the other hand, Kohler (1990) argued that because the tongue tip/blade gesture requires finer articulatory control than dorsum or lip gestures, it is more likely to be neglected in contexts of articulatory weakening. However, Manuel and Stevens (1995) show that the tongue body gesture accounts for most of the so-called coronal transitions, and any approach to coronal markedness that does not take into account the role of tongue body movement for coronal stop production is inadequate.

¹² This is the case in Byrd's (1992) and Zsiga's (1994) studies, but they only studied a context where V₁ is a front vowel, which is not expected to have a positive F2 transition for coronal consonants anyway.

2.3.3 Lack of sub-coronal contrast as a condition of articulatory weakening

The question then arises: why is the kind of gestural weakening that is found in English restricted to languages without sub-coronal contrasts? The answer to this question is that, unlike in single-coronal languages, such as English, the tongue body position has a contrastive function for coronal stops in languages that contrast sub-coronal places. Thus, the tongue body articulation for coronal stops is not subject to the preferential weakening that its English counterpart is prone to.

The idea that talkers make an effort to ensure that what contrasts in their language remains distinct in the acoustic output so that the listeners can understand them is not new (Martinet 1952; Öhman 1966; Lindblom 1983; Stevens, Keyser and Kawasaki 1986; Manuel 1987, 1990, 1999). When there is a contrast to be maintained, speakers are forced to be more accurate or extreme in speech production and this leads to a minimization of phonetic variation for a particular sound, both in terms of random variation and in terms of contextual variation. Since what is contrastive differs from language to language, different patterns of acoustic outputs are expected depending on the pattern of phonemic contrasts in the language. Many studies have shown that the phonetic realization of a sound is affected by the system of contrasts that it participates in in different languages (Manuel 1987; Utman and Blumstein 1994; Jongman, Blumstein and Lahiri 1985). Manuel (1987) compared vowel-to-vowel coarticulations in two Bantu languages with five distinctive vowels (*i, e, a, o, u* : Shona and Ndebele) and another Bantu language with seven distinctive vowels (*i, e, ε, a, ɔ, o, u* : Sotho). Her data show that the more crowded the

vowel space, the less extensive the coarticulatory effect. In other words, the coarticulatory variation is restricted such that it does not impinge on the space of contrasting segments in the language.

Utman and Blumstein (1994) compared the labiodental fricative [f] of English and Ewe. In Ewe, [Strident] plays a distinctive role in contrasting [f] from [ɸ], but in English there is no contrast between [f] and [ɸ]. As a result, [f] is on average more strident in Ewe than in English, presumably to preserve the contrast between the two labial fricatives in Ewe.

Jongman, Blumstein and Lahiri (1985) found that the burst amplitude for alveolar stops is larger than the burst amplitude for dental stops in Malayalam, which contrasts the two coronal consonants. The two consonants are very well segregated in terms of burst amplitude relative to a following vowel: 91.8% of the data was correctly classified by this criterion. On the other hand, in English and Dutch, where there is no contrast between alveolar and dental stops, although the coronal stop is generally described as alveolar and dental respectively only 68.2% and 63.2% of the data, respectively, were classified correctly by the same criterion. These studies all show that when a sound is in contrast with another sound, it is forced to have a more specific target in production such that it can be sufficiently distinctive from the sound it contrasts with.

Phonetic studies of languages that phonemically contrast different sub-coronal places show that the formant values in vocalic transitions provide one of the most important cues for the sub-coronal place distinction. This implies that the overall tongue shape, including the tongue body position, plays a crucial role in the contrast of different

coronals (dental, alveolar, alveopalatal, retroflex) (Ohala 1974b; Stevens and Blumstein 1975; Stevens, Keyser and Kawasaki 1986; Dart 1991; Manuel 1995). Comparison of an alveolar consonant and a dental consonant in Malayalam shows that the former has a slightly higher F2 value at the edge of the transition than does the latter. An alveopalatal consonant has a very high F2 value while a retroflex consonant has a very low F3 and F4 value. This led Stevens *et al.* (1986) to propose that the tongue body feature acts as an enhancement feature for coronal contrasts. Gnanadesikan (1993) goes a step further and proposes that the [Back] feature is not simply an enhancement feature but a distinctive one in languages with sub-coronal contrasts. On the other hand, Wiltshire and Goldstein (1997) argue that the invariant tongue body position of a Tamil dental stop they found in their EMMA (Electromagnetic midsagittal articulometer) study is a by-product of restrictions on the tongue tip/blade position and orientation rather than a result of a separate target for the tongue body. Although these studies disagree on the exact status of the tongue body articulation in these consonants, what is certain is that the overall tongue shape including not only the tongue tip/blade but also the tongue body is important for the contrast of these different coronal consonants.

If phonetic variation is restricted by phonological contrast, in multiple coronal languages it will be important to achieve the acoustic target of appropriate formant values (and hence the articulatory target of the tongue body gesture) accurately for each coronal stop in order to prevent possible confusion between different coronals. This is different for coronal stops in single coronal languages, where no contrast between different coronal places is to be maintained. Such precise realization of formant value targets is not

necessary. Consequently more variation in formant values and corresponding tongue body position is expected in those languages.

I assumed above that the tongue body articulation for coronal stops in single-coronal languages is prone to weakening because it does not have a featural status and its contrastive function is minimal. But, in multiple-coronal languages, the tongue body articulation for coronal stops has a contrastive function and there is no reason to expect that it should be preferentially weakened.

In this section I argued that a coronal stop is perceptually less salient than a noncoronal stop only in nonprevocalic positions in single-coronal languages because the tongue body articulation accompanying coronal stop articulation is preferentially weakened in this position due to its noncontrastive status. Thus, we can now set up a perceptibility scale of place features in (27), which ranks noncoronal place features for stops in nonprevocalic positions above coronal place without dependent features in the same nonprevocalic positions. The markedness constraint hierarchy in (28) is projected via contraposition from this perceptibility scale. Since we are dealing only with stop consonants in this thesis, the [+Stop] specification will be omitted for convenience in the rest of thesis.

$$(27) \quad \text{PL[PER]}/\begin{array}{c} \text{---} \\ \text{[+STOP]} \end{array} \sim V \succ \text{PL[COR]}/\begin{array}{c} | \\ \text{[+STOP]} \\ \emptyset \end{array} \sim V$$

$$(28) \quad * \text{PL[COR]}/\begin{array}{c} | \\ \text{[+STOP]} \\ \emptyset \end{array} \sim V \gg * \text{PL[PER]}/\begin{array}{c} \text{---} \\ \text{[+STOP]} \end{array} \sim V$$

So far, I have not distinguished preconsonantal position from absolute final position and have referred to them together as nonprevocalic, representing it as $\sim V$ in the

constraints for convenience. However, the perceptibility of place features in these two contexts are not identical and the two positions often show different place restriction patterns.

I will assume that there are two versions of the hierarchy in (28), one regarding preconsonantal positions and one regarding absolute final positions. These hierarchies are given in (29). I will refer to either of these hierarchies as appropriate.

- (29) a. $*\text{PL}[\text{COR}]/_ \text{C} \gg * \text{PL}[\text{PER}]/_ \text{C}$
 $\quad \quad \quad |$
 $\quad \quad \quad \emptyset$
- b. $*\text{PL}[\text{COR}]/_ \# \gg * \text{PL}[\text{PER}]/_ \#$
 $\quad \quad \quad |$
 $\quad \quad \quad \emptyset$

Chapter 3 Coronal markedness : data and analyses

Now that we have derived the perceptually grounded markedness constraint hierarchy in (30), we are ready to tackle individual cases of markedness reversal.

$$(30) \quad *PL[\underset{\substack{| \\ \emptyset}}{COR}] / __ C, \# \gg *PL[PER] / __ C, \#$$

In many languages, various processes such as metathesis, assimilation and deletion selectively target coronal stops in preconsonantal or word-final position. None of the languages that show this pattern contrasts sub-coronal places for stops. I will discuss cases of the reversed markedness pattern resulting from each of these processes in turn. First, assimilation-induced reversal cases are discussed in 3.1. Section 3.2 presents cases of markedness reversal in deletion processes including segmental deletion, debuccalization and place neutralization. Section 3.3 discusses cases of metathesis that exhibit coronal markedness. Finally, section 3.4 discusses the effect of nasality on place restriction patterns, with special focus on cases of coronal markedness.

3.1 *Place assimilation*

Place assimilation often preferentially targets coronal stops (Kiparsky 1985, Cho 1990, Mohanan 1993, Jun 1995 among others). As a result of preferential coronal assimilation, coronal consonants fail to surface faithfully in preconsonantal position while noncoronal consonants maintain their place specification. As we demonstrated in the previous chapter for Yakut, Prince and Smolensky's markedness constraint hierarchy fails to account for markedness reversal in place assimilation. I will first present additional

cases of place assimilation that yield markedness reversal and then provide an OT analysis employing grounded markedness constraints. Most cases of assimilation discussed in this section come from Jun (1995). I will start by reviewing the Yakut facts.

3.1.1 Data

Yakut

In Yakut, stem-final coronal consonants assimilate in place to following noncoronal stops, as shown in (31)a., but labial or dorsal nasals and stops do not assimilate, as shown in (31)b. (Krueger 1962, Wetzels 1989, Jun 1995).¹³ As can be seen from the stop inventory given in (32), Yakut does not have sub-coronal place contrasts and dental stops are the only coronal stops in the inventory.

- (31) a. *kuorat-Plt* → *kuorappit* 'town, POSS. 1 PL.'
at-KA → *akka* 'horse, DAT.'
aan-Plt → *aammit* 'door, POSS. 1 PL.'
aan-KA → *aanyga* 'door, DAT.'
- b. *sep-KA* → *sepke* **sekke* 'tool, DAT.'
sep-TA → *septe* **sette* 'tool, PART.'
ilim-KA → *ilimye* **ilinye* 'net, DAT.'
olom-TA → *olomno* **olonno* 'ford, PART.'
tünük-Plt → *tünükpüt* **tünüppüt* 'window, POSS. 1 PL.'
tobuk-TA → *tobukta* **tobutta* 'knee, PART.'
tiiŋ-Plt → *tiiŋmit* **tiimmit* 'squirrel, POSS. 1 PL.'
tiiŋ-TA → *tiiŋna* **tiinna* 'squirrel, PART.'

(32) Yakut stop inventory (Wetzels 1989)

Bilabial	Dental	Palatal	Velar
p b	t d	č ʃ	k g
m	n	ɲ	ŋ

¹³ Independent of place assimilation, progressive assimilation in voicing, nasality and laterality applies (Wetzel 1989).

Catalan

In Catalan, only coronal stops optionally assimilate to the place of a following consonant (Mascaro 1976, Kiparsky 1985, Avery and Rice 1989b, Hualde 1992 and Jun 1995). The examples in (33) illustrate that coronal stops, both nasal and oral, undergo assimilation, but labial and dorsal stops do not.¹⁴ Catalan does not have sub-coronal place contrasts, as shown in the stop inventory of the language given in (34).¹⁵

- (33) a. *son pocs* → *som pocs* 'they are few'
son grans → *soŋ grans* 'they are big'
set mans → *sem mans* 'seven hands'
set cases → *sek cases* 'seven houses'
- b. *som dos* → *som dos* **sondos* 'we are two'
cap casa → *cap casa* **cakkasa* 'no house'
tiŋ pa → *tiŋ pa* **timpa* 'I have bread'
pok pa → *pok pa* **poppa* 'few bread'

(34) Catalan Stop inventory (Hualde 1992)

Bilabial	Dental	Alveolar	Prepalatal	Palatal	Velar
p b	t d		č (j)		k g
m		n		ɲ	

English

In English casual speech, coronal stops and nasals assimilate to the place of a following consonant while noncoronal stops and nasals do not, as shown in (35)a. and b.,

¹⁴ In the Majorcan dialect, labial and velar oral stops also undergo assimilation (*cap vert* → *kav vɔrt* 'green heard', *poc pa* → *pɔp pa* 'little bread') (Hualde 1992 based on Veny 1989, p.90).

¹⁵ In the standard dialect of Catalan, palatal nasal consonants are not subject to assimilation, unlike coronal nasals; but for speakers of the Majorcan dialect and for some speakers of the Barcelona dialect, the palatal nasal assimilates to a following consonant, producing a sequence of glide plus assimilated nasal (*qn passat* → *ajm pasat* 'past year', *qn que ve* → *ajŋ kaʒe* 'coming year') (Hualde 1992, pp.395-396). I assume that this results from the separation of the coronal component and the dorsal component of the palatal nasal into two segments.

respectively (Avery and Rice 1989b, Mohanan 1993, Jun 1995). English also does not contrast sub-coronal place, as shown in the stop inventory of English given in (36).

- (35) a. *late kiss* → *leyt kis* ~ *leyk kis*
meat ball → *mi:t bəl* ~ *mi:p bəl*
man made → *mæn meyd* ~ *mæm meyd*
in Kingston → *in kiŋstən* ~ *iŋ kiŋstən*
 b. *leap quickly* → *li:p kwikli* **li:k kwikli*
home town → *howm tawn* **hown tawn*
sicktoads → *sik towdz* **sittowdz*
ping pong → *piŋ poŋ* **pim poŋ*

(36) English Stop Inventory (Finegan 1990)

Bilabial	Alveolar	Palatal	Velar
p b	t d	ç ʝ	k g
m	n		ŋ

German

Similarly, in German only coronal stops, both nasal and oral, assimilate to the place of a following or a preceding consonant, as shown in (37)a. and b., respectively. On the other hand, labial and dorsal stops do not undergo assimilation, as shown in (37)c. (Kohler 1990, p.86, Jun 1995) German is interesting in that both regressive assimilation and progressive assimilation are found. But, note that progressive assimilation to coronal consonants is blocked if the nasal stop is in prevocalic position, as shown in (37)d. Like all the other cases with the reversed markedness pattern, German does not contrast sub-coronal places for stop consonants, as the stop inventory in (38) shows.

- (37) a. *mitbringen* → *mi[**pb**]ringen* 'to bring along'
mitkommen → *mi[**kk**]ommen* 'to come with'
mitmachen → *mi[**pm**]achen* 'to join'
Bahnpreise → *Bah[**mp**]reise* 'train fares'
ankommen → *a[**ŋk**]ommen* 'to arrive'
anmelden → *a[**mm**]elden* 'to register'

b.	<i>ebən</i> ¹⁶	→	<i>e[bm]</i>		‘even’
	<i>trockən</i>	→	<i>tro[kŋ]</i>		‘dry’
c.	<i>Packpapier</i>	→	<i>Pa[kp]apier</i>	<i>*Pa[pp]apier</i>	‘wrapping paper’
	<i>zurücknehmen</i>	→	<i>zurü[kn]ehmen</i>	<i>*zurü[tn]ehmen</i>	‘to resign’
	<i>rangmäßig</i>	→	<i>ra[ŋm]äßig</i>	<i>*ra[mm]äßig</i>	‘by rank’
	<i>abtreten</i>	→	<i>a[pt]reten</i>	<i>*a[tʰ]reten</i>	‘to retire’
	<i>abnehmen</i>	→	<i>a[pn]ehmen</i>	<i>*a[tn]ehmen</i>	‘to lose weight’
	<i>rumkriegen</i>	→	<i>ru[mk]riegen</i>	<i>*ru[ŋk]riegen</i>	‘to win over’
	<i>langem</i>	→	<i>la[ŋm]</i>	<i>*la[ŋŋ], *la[mm]</i>	‘long’
d.	<i>ebənə</i>	→	<i>e[bŋ]ə</i>	<i>*e[bm]ə</i>	‘even’
	<i>trockənə</i>	→	<i>tro[kn]ə</i>	<i>*tro[kŋ]ə</i>	‘dry’

(38) German Stop Inventory (Hawkins 1990)

Bilabial	Dental/Alveolar	Velar
p b	t d	k g
m	n	ŋ

Inuit

Dorais’s (1986) cross-dialectal survey of Inuit shows that in every dialect, the second member of a consonant cluster is unrestricted in its place of articulation, but dialects differ in terms of the possible first consonant in a cluster. In the Thule/Polar Eskimo (PE) dialect and the Aivilik (AI) dialect, the first consonant in a heterorganic cluster can be a stop of any place except for coronal (*ukpik* ‘snow owl’, *imnaq* ‘cliff’), but coronal-initial clusters in other dialects (Whles-Dimedé, Qawiaraq, Malimiut, Alaska North Slope, Sigliq, Boothia Peninsula Netsilik, Copper, Caribou(CO)) appear as assimilated (AI: *miqqukka* ~ CO: *mitqutka* ‘my, many, body hair’) (Bobaljik 1996). The Inuit languages do not contrast sub-coronal places for stops as shown in (39).

¹⁶ An independent process of schwa deletion applies.

(39) Inuit Stop Inventory (Based on Bobaljik 1996)

Bilabial	Dental	Velar	Uvular
p	t	k	q
m	n	ŋ	

Latin

In Latin also, an assimilation process selectively affects dental stops (Marotta 1993). In a sequence of oral stops, if the first stop is a coronal stop as in (40)a., regressive place assimilation takes place, but if the first stop is a noncoronal stop, as in (40)b., assimilation does not apply. In a sequence of nasal stops, regressive place assimilation applies only to coronal-initial sequences, but not to noncoronal-initial sequences, as shown in (41)a. and b., respectively. In a sequence of oral stop plus nasal stop, assimilation in nasality applies independently. Here also, place assimilation occurs only to coronal-initial sequences but not to noncoronal-initial sequences, as shown in (42)a. and b., respectively. Latin does not contrast different sub-coronal places for stops, as shown in (43), which conforms with our claim that the reversed markedness pattern is found only in languages without sub-coronal contrasts.

- (40) a. **-tc-* → *siccus* cf. *sitis*
 **hod-ce* → (*hocc* →) *hoc*
 tod-per → *topper*
 b. *lactis, octo*
 rup-tus, captus
- (41) a. *in-molo* → *immolo*
 in-mortalis → *immortalis*
 b. *amnis, contemno, omnis, damnum*

- (42) a. **caid-mentom* → (**caemmentum* →) *caementum* cf. *caedere*
 b. **sop-nos* → *somnus*
**scab-num* → *scammum* cf. *scabillum*
**Sab-nio-* → *Samnium* cf. *Sabini*
**dek-nos* → *dignus*¹⁷
**leg-nom* → *lignum*

(43) Latin Stop Inventory (Coleman 1990)

Bilabial	Dental	Velar
p	t	k, k ^w
b	d	g
m	n	

Toba Batak

In Toba Batak, a sequence of consonants within words or across word boundaries undergoes various changes in casual speech. Among these changes, regressive place assimilation applies only to a coronal nasal /n/, as shown in (44)a., but not to labial or dorsal nasals, as shown in (44)b. (Hayes 1986). Nasals denasalize by an independent process. Voiceless stops do not undergo regressive assimilation and all voiceless stops are optionally glottalized before another consonant regardless of place of articulation (*pitpit* ~ *piʔpit* ‘with closed eyes’, *ganup taon* ~ *ganuʔ taon* ‘every year’, *halak batak* ~ *halaʔ batak* ‘Batak person’). The stop inventory of Toba Batak given in (45) is simple and there is no sub-coronal place contrast for stops.

- (44) a. *baoa an peddek* → *baoa ap peddek* ‘that man is short’
soŋon gottina → *soŋog gottina* ‘in exchange’
 b. *maŋinum tuak* → *maŋinup tuak* **maŋinut tuak* ‘drink palm wine’
manan pulpen → *manak pulpen* **manap pulpen* ‘or a pen’

¹⁷ /ŋ/ is written as <gn>.

(45) Toba Batak Stop Inventory (Hayes 1986)

Bilabial	Alveolar	Velar
p b	t d	k g
m	n	ŋ

Keley-I

In Keley-I, a coronal nasal /n/ assimilates to the place of a following consonant while a labial nasal /m/ does not (Hohulin and Kenstowicz 1979, Jun 1995). Thus, the realization of the coronal nasal in the infix /-in-/ varies depending on the following consonant, as shown in (46)a., but the labial nasal in the infix /-um-/ remains constant regardless of the following consonant, as shown in (46)b. The stop consonant inventory of Keley-I is given in (47); there is no sub-coronal place contrast.

- (46) a. *in + kebet* → *k-im-bet* 'scratch'
in + tekuk → *s-iŋ-kuk* 'shout'
- b. *um + teled* → *ʔum-tetled* **ʔun-tetled* 'sting'
um + kebed → *ʔum-kekbed* **ʔuŋ-kekbed* 'scratch'

(47) Keley-I Stop Inventory (Hohulin and Kenstowicz 1979)

Bilabial	Alveolar	Palatal	Velar
p b	t d	č ʝ	k g
m	n		ŋ

Lithuanian

In Lithuanian, the dental nasal /n/ assimilates to the place of a following stop or affricate, as shown in (48)a., but the labial nasal /m/ does not assimilate, as shown in (48)b. (Kenstowicz 1972, Jun 1995). Also, no sub-coronal place contrast is found for stop consonants, including nasal stops.

- (48) a. *sénbernis* → *sémbernis* 'old fellow' cf. *sėnas* 'old'
pĩnkite → *pĩŋkite* 'plait' IMP. PL. cf. *pĩna* 'plait' 3 PRES.
 b. *tėmti* → *tėmti* **tenti* 'darken' cf. *tėmo* 'darken' 3 PST.
tėmkite → *tėmkite* **teŋkite* 'darken' IMP. PL.

(49) Lithuanian Stop Inventory (Kenstowicz 1972)

Bilabial	Dental	Velar
p b	t d	k g
m	n	

Polish

In Polish, a coronal nasal optionally undergoes place assimilation before a stop both within and across a word boundary, as shown in (50)a., but a labial nasal does not undergo assimilation, as shown in (50)b. (Czaykowska-Higgins 1988, 1992). The stop inventory of Polish is given in (51); no sub-coronal place contrast is found for nasal stops.

- (50) a. *funkacja* ~ *fʊŋkacja* 'function'
pan # buk ~ *pam # buk* 'Lord God'
 b. *komtur* **kontur* 'commander of Teutonic Knights'
klamka **klaŋka* 'doorknob'

(51) Polish Stop Inventory (Stone 1990)

Bilabial	Palatalized Bilabial	Dental	Alveolar	Pre-Palatal	Post-Palatal	Velar
p b	p' b'	t d			k' g'	k g
		ts dz	tʃ dʒ	tɕ dʑ		
m	m'	n		n' ¹⁸		

3.1.2 Analyses

Now, let us take Yakut as an example and see how the perceptually grounded markedness constraints (repeated below as (52)) deal with markedness reversal in

assimilation. Recall that Yakut does not have sub-coronal place contrasts and the coronal stops are not specified for coronal-dependent features. Thus, the markedness constraint against coronal place in (52) is applicable to coronal stops in Yakut.

$$(52) \quad *PL[COR]/_ C \gg *PL[PER]/_ C$$

$$\quad \quad \quad |$$

$$\quad \quad \quad \emptyset$$

By ranking the faithfulness constraint against place feature deletion, MAX(PL[α]), below the markedness constraint against the preconsonantal coronal stop, place assimilation applies to a coronal stop, as shown in (53). The faithful candidate **sotpopun* (a.) fatally violates the markedness constraint against a preconsonantal coronal stop. So the candidate with place assimilation (b.), which violates the lower-ranking place feature faithfulness constraint, is chosen.

(53) Yakut /sot-popun/ → *soppopun* 'we do clean'¹⁹


	/sot-popun/ / \ [Cor][Lab]	*PL[COR]/_ C ∅	MAX(PL[α])
a.	sotpopun / \ [Cor][Lab]	*!	
b.	soppopun \/ [Lab]		*

On the other hand, when a labial stop consonant is followed by a heterorganic consonant, no change occurs. This result is obtained when the place feature faithfulness constraint outranks the markedness constraint against a preconsonantal noncoronal stop,


¹⁹ The prepalatal nasal undergoes nasal assimilation but only when the consonant is decomposed into a palatal glide and a nasal sequence. Czykowska-Higgins (1992) argues that the pre-palatal nasal /n'/ is best represented as a complex segment with both coronal and dorsal place.

as in (54). Although the faithful candidate, *sepke*, violates the markedness constraint against a preconsonantal noncoronal stop, it is chosen over the candidate with place assimilation, **sekke*, since the latter violates a higher-ranking faithfulness constraint. Similarly, a coronal nasal stop is subject to assimilation but noncoronal nasal stops are not, as shown in (55) and (56), respectively.

(54) Yakut /sep-KA/ → *sepke* **sekke* 'tool'

	/sep-KA/ / \ [Lab][Dor]	*PL[COR]/__ C Ø	MAX(PL[α])	*PL[PER]/__ C
a. 	sepke / \ [Lab][Dor]			*
b.	sekke \\ [Dor]		*!	


(55) Yakut /aan-KA/ → *aanŋa* 'door, DAT.'²⁰

	/aan-KA/ / \ [Cor][Dor]	*PL[COR]/__ C Ø	MAX(PL[α])	*PL[PER]/__ C
a.	aanŋa / \ [Cor][Dor]	*!		
b. 	aanŋa \\ [Dor]		*	

¹⁹ Again, I assume that the direction of place assimilation is restricted to be regressive due to the positional faithfulness constraint for onset position, MAX(PL)/ONSET (cf. Beckman 1998), and do not consider candidates with progressive assimilation.

²⁰ An independent process of progressive assimilation in nasality applies.

(56) Yakut /ilim-kA/ → *ilimɣe* **iligɣe* ‘net, DAT.’

	/ilim-kA/ / \\ [Lab][Dor]	*PL[<small>COR</small>]/__ C ∅	MAX(PL[α])	*PL[<small>PER</small>]/__ C
a. 	ilimɣe / \\ [Lab][Dor]			*
b.	iligɣe \\/ [Dor]		*!	

3.2 Deletion

The previous section presented assimilation processes that selectively target coronal stops. Now we turn to coronal markedness in deletion processes. Coronal stops are also often the preferred targets of segment deletion, place debuccalization, or place neutralization. As a result of the preferential deletion of coronal place or a coronal segment, coronal consonants are less likely to appear in the output than noncoronal consonants in these positions. These constitute another instance of markedness reversal. This section reviews cases of preferential coronal deletion and shows that all the cases involve languages without sub-coronal place contrasts. It is also noted that preferential coronal deletion occurs in preconsonantal or word-final position, but not in prevocalic position.

3.2.1 Data

Attic Greek

In Attic Greek, the first stop in an oral stop cluster is restricted to noncoronal place. Furthermore, coronal stops delete when they are followed by another stop through morpheme concatenation, as illustrated in (57)a. (Steriade 1982, Itô 1986, Yip 1991).

Contrast this with the stability of noncoronal-initial stop clusters given in (57)a. Ancient Greek has the simple stop inventory shown in (58); there is no sub-coronal place contrast.

- (57) a. *CV-pe:tʰ-k-a* → *pepe:ka* 'I have persuaded'
CV-amut-k-a → *ɛ:muka* 'I have accomplished'
CV-komid-k-a → *kekomika* 'I have provided'
CV-ere:d-k-a → *ɛ:re:ka* 'I have propped'
- b. *oktɔ:* 'eight'
a.elptos 'unhoped for'
ederkʰtʰɛ:n 'I was seen'

(58) Stop inventory (Joseph 1990)

Bilabial	Alveolar	Velar
b p p ^h	d t t ^h	g k k ^h
m	n	

Korean

In Korean, complex codas and onsets are prohibited, and stem-final consonant clusters are simplified when they are not followed by a vowel-initial suffix (Kim 1984, Kenstowicz 1993, Ahn 1994, Iverson and Lee 1994, Kim 1996, Cho 2000). When both consonants are obstruents or both are sonorants, it is always the coronal consonant that is deleted. Examples are given in (59).²¹

- (59) /kaps/ *kaps-i* but *kap-kwa*, *kap-to* 'price'
 /salm/ *salm-i* but *sam-kwa*, *sam-to* 'life'

When the clusters consist of a sonorant and an obstruent (*ltʰ*, *lk*, *lp*, etc.), there is considerable variation in the choice of deleted segment (Iverson and Lee 1994, Cho 2000). Reportedly, in the Kyoungsang dialect, these clusters all reduce to [l] due to a constraint

²¹ Stem-final consonant clusters can contain at most one noncoronal consonant. Cf. section 1.1.2.

favoring a sonorant coda over an obstruent one (Iverson and Lee 1994).²² In the Seoul dialect, the picture is more complicated. The cluster *ltʰ* is reduced to [l] in over 96% of the tokens in Cho's (2000) survey. However, *lk* and *lp* clusters are realized in three different forms: no deletion, deletion of /l/, or deletion of /p, k/. This contrast is illustrated by the examples in (60).

- (60) a. /haltʰ-/ *haltʰ-a* but *hal-ta* **hatʰ-ta* 'to lick'
 b. /ilk-/ *ilk-ə* but *ilk-ta* ~ *il-ta* ~ *ik-ta* 'to read'
 /palp-/ *palp-a* but *palp-ko* ~ *pal-ko* ~ *pap-ko* 'to step on'

I assume that the variation is due to the unresolved conflict between the sonorancy factor and the place factor; the sonorancy consideration favors deletion of obstruents *p, k* while the place factor favors deletion of *l*. On the other hand, for *ltʰ* clusters, the deletion of *tʰ* is consistent with both factors. Korean does not contrast sub-coronal places, as can be seen from the stop inventory given in (61).

(61) Korean stop inventory (Sohn 1987)

Bilabial	Alveolar	Postalveolar	Velar
p p' pʰ	t t' tʰ	ɕ ɕ' ɕʰ	k k' kʰ
m	n		ŋ

Chickasaw

In Chickasaw, a nasal coda deletes and nasalizes a tautosyllabic vowel under certain conditions (Inkelas and Cho 1993 based on Munro and Ulrich 1985). What is interesting for our purposes is that in word-final position deletion and vowel nasalization occur only with /n/ but not with /m/, as shown in (62). Chickasaw does not contrast sub-coronal places for nasals, as can be seen from the stop inventory of the language in (63).

²² A survey by Kim (1996), however, shows that Kyungsang speakers also show variation in the

- (62) a. *cholhkan-a-n* → *cholhkanã* 'spider, OBJ.'
 fammi-ka-n → *fammikã* 'that he whips him D.S.'
 b. *apa-ta-m* → *apatam* **apatã* 'east-Q-past'

(63) Chickasaw stop inventory (Gordon, Munro and Ladefoged 1997)

Bilabial	Dental/Alveolar	Postalveolar	Velar	Glottal
p, b	t	č	k	ʔ
m	n			

Lithuanian

We saw in the previous section that only a coronal nasal, but not a labial nasal, assimilates to a following stop in Lithuanian. When a coronal nasal is followed by a consonant other than a stop, it is deleted, lengthening the previous vowel. Again, the deletion process only affects a coronal nasal but not a labial nasal, as shown in (64)a. and b., respectively (Kenstowicz 1972).

- (64) a. *sán-skambis* → *sá:skambis* 'harmony'
 sán-mokslas → *sá:mokslas* 'conspiracy'
 b. *krimsti* → **kri:sti* 'chew'
 grimzti → **gri:zti* 'sink'

Catalan

A word-final /n/ is deleted when immediately preceded by a stressed vowel, as can be seen in the alternations shown in (65) (Hualde 1992, pp. 404-406). However, the deletion process is not reported for other nasal consonants. Catalan does not contrast sub-coronal places for nasals, as was shown in (34).

- (65) MASC. SG. FEM. SG.
 ple *plena* 'full'
 catalá *catalana* 'Catalan'
 cosí *cosina* 'cousins'

realization of these clusters.

Polish

We have seen that in Polish, a coronal nasal optionally undergoes place assimilation before a stop both within and across a word boundary. On the other hand, if a coronal nasal is followed by a continuant consonant, it turns to a nasal glide [ɰ] by debuccalization, as shown in (66)a. The labial nasal also debuccalizes but only before another labial consonant and not before a nonlabial consonant, as shown in (66)b. In other words, debuccalization before a labial is motivated by the OCP against adjacent labial places but not by a general constraint against labial place in preconsonantal position.

- (66) a. *konflikt* ~ *koɰflikt* 'conflict'
 pan # *xce* ~ *paɰ* # *xce* 'the man wants'
- b. *tam* # *xodźi* ~ **taɰ* # *xodźi* 'there (he) walks'
 tam # *v'idźi* ~ *taɰ* # *v'idźi* 'there (he) sees'

English

In English, coronal stops are frequently reduced to a glottal stop (Lass 1976, Avery and Rice 1989b, Hayes 1992, Olive, Greenwood and Coleman 1993, among others). In American English, /t/ before a syllabic /n/ is often realized as a glottal stop, as in *bəʔn* 'button', *bæʔn* 'batten' and *kaʔn* 'cotton'. Debuccalization of coronal stops to a glottal stop is also reported for word-final position followed by a consonant-initial word, as in *hɪʔ ðə* 'hit the...', *kʌʔ flawɹz* 'cut flowers' and *ðæʔ wən* 'that one'. This is preferential deletion of a coronal place feature rather than the segment as a whole. Due to the preferential debuccalization of coronal stops, noncoronal stops are more likely to appear in the output than coronal stops. Again, English does not contrast sub-coronal place for stops.

Ripurian German

In the Ripurian dialects of German, stem-final coronal stops shifted to dorsal stops²³ and no coronal stops are found in this position (Noble 1983, Newton 1990, Rice 1996). This is in contrast to the standard dialects, where stops of all three places are found in this position (*p, b, t, d, k, g, m, n, ɲ*). In (67), Cologne forms are given which are representative of Ripurian dialects, along with New High German forms for comparison.²⁴ This is another instance where the coronal place is preferentially deleted. It differs from English is that in Ripurian German, [Dorsal] is inserted in place of the deleted [Coronal] feature.

(67)	New High German	Cologne	
	<i>braun</i>	<i>bruŋ</i>	'brown'
	<i>Wein</i>	<i>Wiŋ</i>	'wine'
	<i>Zeit</i>	<i>Zik</i>	'time'
	<i>Hunt</i>	<i>Honk, Huŋk</i>	'dog'

3.2.2 Analyses

The preferential deletion of coronal stops or a coronal feature has a solution similar to that for the preferential assimilation of coronal stops discussed in the previous section. This will be demonstrated with Chickasaw nasal deletion.

In Chickasaw, a nasal coda deletes and nasalizes a tautosyllabic vowel under certain conditions. In word-final position deletion and vowel nasalization target only /n/ but not /m/ (Inkelas and Cho 1993 based on Munro and Ulrich 1985). Chickasaw does not

²³ We assume that the reason coronal stops shift to dorsal stops rather than labial stops is that the coronal and dorsal places share a feature [Lingual] (cf. Clements and Hume 1995).

²⁴ The shift also occurs when the stem is followed by a vowel-initial suffix: *mein-e* → *miŋ* 'my', *schein-en* → *shiŋe* 'shine' etc. I assume that these forms are derived through Output-Output correspondence with

contrast sub-coronal places for nasals. Thus, the perceptually grounded markedness constraints, repeated in (68), are active in Chickasaw.

$$(68) \quad *PL[COR]/_ \# \gg *PL[PER]/_ \#$$

$$\quad \quad \quad |$$

$$\quad \quad \quad \emptyset$$

In (69), the word-final coronal nasal is deleted and the preceding vowel is nasalized. The faithful candidate, **cholkhanan*, violates a high-ranking markedness constraint against a word-final coronal stop without a dependent feature. On the other hand, the candidate with coronal deletion, *cholkhanā*, satisfies this markedness constraint, although it violates the lower-ranking featural faithfulness constraint against segmental deletion.

(69) Chickasaw /cholkhan-a-n/ → *cholkhanā* ‘spider, OBJ.’

	/cholkhan-a-n/ [Cor]	*PL[COR]/_ # ∅	MAX-C
a.	cholkhanan [Cor]	*!	
b.	cholkhanā		*

In contrast to the coronal nasal in (69), the word-final labial nasal in (70) does not delete. This is because the markedness constraint against a word-final labial stop ranks below the faithfulness constraint, MAX-C. Thus, the candidate with place deletion and vowel nasalization, **apatā*, is ruled out due to a fatal faithfulness constraint violation, and the faithful candidate, *apatam*, is selected as optimal.

isolation forms and do not constitute counterexamples to the claim that markedness reversal is confined to nonprevocalic position.

(70) Chickasaw /apa-ta-m/ → *apatam* **apatā* ‘east-Q-past’

/apa-ta-m/ [Lab]	*PL[COR]/__ # ∅	MAX-C	*PL[PER]/__ #
a. apa <i>apatam</i> [Lab]			*
b. <i>apatā</i>		*!	

3.3 Metathesis

What the assimilation and the deletion processes have in common is that they both involve deletion of some structure. Place assimilation deletes the place feature of a target segment and spreads the place feature of the trigger segment to the target segment. Segmental deletion involves deletion of a segment and, along with it, the place feature the segment bears. In debuccalization, only the place feature of a segment is deleted. In place neutralization, the place feature is deleted and another place feature is inserted. Thus, one may suggest that coronal markedness phenomena are the result of preferential deletion of the coronal place feature (cf. Kiparsky 1994 and Jun 1995). This is incorrect, however. Although assimilation and deletion processes comprise the majority of markedness reversal cases, they are not the only ones.

Bailey (1970) insightfully notes that sequences of apical and nonapical consonants are “marked” because these sequences often preferentially undergo various changes. A sequence of coronal stop followed by noncoronal stop is avoided via metathesis in ancient Greek. Historically, when an apical consonant is followed by a labial or a dorsal, metathesis applied: **tí-t(e)k-ō* > *tíkto*, **k*íd-pe* > *típte*, Att. inscr. *mesomnē* (cf. Hom. *mesódmnē*, from *-d(V)mVH₂). Blust (1979) presents additional examples of metathesis

motivated by a constraint against coronal-initial clusters, in this case from Austronesian languages (Tagalog, Cebuano Bisayan, Leti and Moa). In these languages, metathesis applies only to coronal-initial stop clusters and, as a result, coronal consonants are less likely to appear in preconsonantal position than are noncoronal consonants. Thus the reversed markedness pattern is found. I will discuss Tagalog in the current section. Cebuano Bisayan, Leti and Moa will be discussed later in the chapter.

Tagalog

According to Blust (1979), in Tagalog, consonant clusters have arisen through the loss of Proto-Austronesian **e* (=schwa) in the environment VC__CV (**ta-telu* > *tatló* ‘three’, **qiteluR* > *itlóg* ‘egg’, **baqeRu* > *bag?ú* ‘new’). In some cases simple roots that did not undergo syncope coexist and synchronic alternation is found (**kapet*, **kapet-an*, **kapet-en* > *kápit*, *kapt-án*, *kapt-ín* ‘grace, embrace’). Most clusters thus derived remain unchanged. If the first consonant of the cluster is a labial stop as in (71)a., or a dorsal stop as in (71)b., no change occurs.

(71)	a.	/pt/	<i>lupít</i>	<i>ka-lupt-án</i>	‘abhor’
		/pd/	<i>apíd</i>	<i>apd-án</i> , <i>apd-ín</i>	‘copulate’
		/pn/	<i>alípin</i>	<i>alipn-án</i>	‘slave’
		/mt/	<i>damít</i>	<i>damt-án</i>	‘clothes’
		/mn/	<i>lamán</i>	<i>lamn-án</i>	‘the inside: flesh’
	b.	/gt/	<i>higít</i>	<i>higt-án</i>	‘haul, pull’
		/kn/	<i>dikín</i>	<i>dikn-án</i>	‘roller’
		/ŋd/	<i>liḡíd</i>	<i>liḡd-án</i>	‘cover up, hide’
		/ŋn/	<i>táḡan</i>	<i>taḡn-án</i>	‘grasp’
		/gb/	<i>igíb</i>	<i>igb-án</i>	‘go for water’
		/km/	<i>tikím</i>	<i>tikm-án</i>	‘taste, try’

In contrast, coronal-initial clusters undergo further changes.²⁵ When the two consonants of the cluster are of the same nasality as in (72)a., metathesis applies. When the two consonants differ in nasality, the nasal consonant assimilates to the place of articulation of the oral stop. In (72)b., where the nasal precedes the oral stop, regressive assimilation applies, while in (72)c., where the oral stop precedes the nasal, progressive assimilation applies.

(72)	a.	/tp/	<i>atíp</i>	<i>apt-án, apt-in</i>	'roof'
		/nm/	<i>taním</i>	<i>tamn-án</i>	'to plant'
b.	/np/		<i>ganáp</i>	<i>gamp-án</i>	'fulfill, do duty'
			<i>panagínip</i>	<i>panagimp-án</i>	'dream'
	/nb/		<i>liníb</i>	<i>limb-án</i>	'to close up'
			<i>baníg</i>	<i>baŋg-án, baŋg-in</i>	'mat'
c.			<i>kiníg</i>	<i>pa-kiŋg-án</i>	'hear'
			<i>datín</i>	<i>datn-án, datn-in</i>	'arrive'

As has been pointed out by Blust (1979), a rule-based approach cannot explain why the set of disparate rules applies only to one particular sequence of consonants. What these rules have in common is the same functional goal of avoiding the marked sequence of coronal-noncoronal consonants. As various work in Optimality Theory has shown, a superior analysis requires the notion of an output constraint that various processes strive to satisfy. The progressive assimilation found in (72)c. is especially interesting since it is

²⁵ Although an /s/-initial cluster remains unchanged (*hasík ~ hask-án* 'sow (seed)'), /s/-initial clusters do not constitute a counterexample to the generalization. First of all, I focus on the place asymmetry in stop consonants only. In addition, the stability of /s/-initial clusters is expected from the hypothesis that the markedness reversal is motivated by the perceptual weakness of coronal stops in this position. Unlike coronal stops, the coronal fricative /s/ has strong perceptual cues (cf. Hura, Lindblom and Diehl 1992), and it is expected that the coronal fricative /s/ will behave differently from the coronal stops. However, there is a genuine exception to this generalization: *atbáy* 'illogical, unreasonable'. The sequence of a voiceless coronal stop and a voiced noncoronal stop is found only as a morpheme internal sequence and no synchronic alternation exists.

not the coronal stop that is targeted for assimilation but the nasal stop following it. This shows that it is the output constraint against a preconsonantal coronal stop place that is driving the processes and not the preferential deletion of coronal place as some previous approaches suggest (cf. Kiparsky 1994, Jun 1995). I will discuss the previous approaches in more detail in Chapter 5.

Now, let us turn to the analysis of the data. Tagalog has a simple stop inventory shown in (73) and there is no contrast of sub-coronal places. Thus, the coronal stops in Tagalog are not specified for coronal dependent features and the grounded markedness constraint in (74) is active.

(73) Tagalog stop inventory (Schachter 1990)

Labial	Dental	Velar	Glottal
p b	t d	k g	ʔ
m	n	ŋ	

$$(74) \quad *PL[COR]/_C \gg *PL[PER]/_C$$

$$\quad \quad \quad |$$

$$\quad \quad \quad \emptyset$$

The outline of the analysis is as follows. The markedness constraint against preconsonantal noncoronal place ranks below all relevant faithfulness constraints. Thus, no modification of the input form is motivated by this constraint. On the other hand, the faithfulness constraints are ranked below the markedness constraint against coronal place in preconsonantal position, and various changes occur, as shown in (75). The choice of repair strategy is determined by the ranking among faithfulness constraints. The changes that occur to coronal stop-initial clusters are summarized in (76).

²⁶ Another example of /tr/ undergoing progressive assimilation to [tn] is *teŋaq > (gi)-tna? 'middle'.

Perceptually, nasal consonants as a class are highly distinct from other consonants but they are very much confused among themselves (Wang and Fillmore 1961, Singh and Black 1966, Mohr and Wang 1968, Shockey and Reddy 1974 cited in Ohala 1975, House 1975 and Malecôt 1956). In prevocalic position, nasal stops do not have the release burst cues that oral stops have. In nonprevocalic position, some languages may release oral stops with an audible burst (Hindi, Georgian, Punjabi, Tamil, Afar, French etc.), but this is not possible with nasal stops. Although the nasal murmur during the closure provides additional place cues that oral stops do not have, the murmur makes only a minor contribution to place perception (Malecôt 1956, Carlson *et al.* 1972 cited in Hura *et al.* 1992, Nord 1976 cited in Jun 1995, and Recasens 1983). Moreover, as has been discussed in the previous chapter (2.3.1), the formant transitions at VN junctures are nonsalient due to the nasalization of the latter part of the vowel.

The perceptually grounded faithfulness constraint hierarchy in (78) accounts for the direction of place assimilation in nasal plus oral or oral plus nasal stop sequences. In (79), a sequence of a coronal nasal plus a dorsal stop turns into a homorganic cluster by regressive assimilation. The change occurs because the markedness constraint against a preconsonantal coronal stop without a dependent feature ranks high enough to force faithfulness violations. First, the faithful candidate, **bangan*, is ruled out by the fatal violation of the markedness constraint. Regressive assimilation, as in *banɡan*, rather than progressive assimilation, **bandan*, applies because of the relative ranking of the faithfulness constraints in (78). The moral of the analysis is that it is more important to preserve the place feature of an oral stop than to preserve the place feature of a nasal stop.

(79) Tagalog /banig-an/ → *baŋgan* 'mat'²⁸

	/banig-an/ / \ [Cor][Dor]	*PL[Cor]/__ C ∅	MAX(PL[α])/[-NAS] ²⁹	MAX(PL[α])/[+NAS]
a.	banigan / \ [Cor][Dor]	*!		
b. ✗	baŋgan V [Dor]			*
c.	bandan V [Cor]		*!	

When the first stop is oral and the second stop is nasal, the direction of assimilation shifts to progressive. In (80), a sequence of a coronal stop plus a noncoronal stop is repaired through assimilation since the markedness constraint against the coronal stop in this position is high-ranking. The faithful candidate (a.) is ruled out by a violation of this high-ranking markedness constraint. The direction of assimilation again follows from the relative ranking of the faithfulness constraints.

On the other hand, neither progressive nor regressive assimilation applies to a stop sequence when its first stop is noncoronal. This is due to the relatively low ranking of the markedness constraint against preconsonantal noncoronal stops. This constraint is dominated by the place faithfulness constraints and no change occurs. This is illustrated by (81) and (82).

²⁸ An independent process of vowel syncope applies and creates consonant clusters.

²⁹ The faithfulness constraints, MAX(PL[α])/____
[-NAS] and MAX(PL[α])/____
[+NAS] will be abbreviated as MAX(PL[α])/[-NAS] and MAX(PL[α])/[+NAS], for convenience.

(80) Tagalog /datɪŋ-an/ → *datnan* ‘arrive’


	/datɪŋ-an/ / \ [Cor][Dor]	*PL[Cor]/__C Ø	MAX(PL[α])/[-NAS]	MAX(PL[α])/[+NAS]
a.	datɲan / \ [Cor][Dor]	*!		
b.	dakɲan ∨ [Dor]		*!	
c.	datnan ³⁰ ∨ [Cor]			*

(81) Tagalog /alipin-an/ → *alipnan* ‘slave’

	/alipin-an/ / \ [Lab][Cor]	MAX(PL[α])/[-NAS]	MAX(PL[α])/[+NAS]	*PL[PER]/__C
a.	alipnan / \ [Lab][Cor]			*
b.	alitnan ∨ [Cor]	*!		
c.	alipman ∨ [Lab]		*!	


³⁰ I assume that just as in nasal plus oral stop clusters, a homorganic sequence of oral and nasal stops is doubly linked to a single coronal place. Thus, in candidate c., [Coronal] itself is not followed by a consonant. Rather it is followed by a vowel and no violation of the markedness constraint against preconsonantal coronal stops is incurred.

(82) Tagalog /damit-an/ → *damtan* 'clothes'

	/damit-an/ / \ Lab Cor	MAX(PL[α])/[-NAS]	MAX(PL[α])/[+NAS]	*PL[PER]/__C
a. 	<i>damtan</i> / \ Lab Cor			*
b.	<i>dampen</i> V Lab	*!		
c.	<i>dantan</i> V Cor		*!	

So far, we have seen that when the two stops in a coronal-initial cluster differ in nasality, assimilation, not metathesis, applies to eliminate the coronal-initial cluster. Assimilation applies rather than metathesis to these clusters because the faithfulness constraint against place deletion (MAX(PL[α])) is dominated by the faithfulness constraint against metathesis (LINEARITY), as shown in (83).


(83) Tagalog /banig-an/ → *bagnan* 'mat'

	/banig-an/ / \ [Cor][Dor]	LINEARITY	MAX(PL[α])/[+NAS]
b. 	<i>bagnan</i> \\ [Dor]		*
c.	<i>banan</i> / \ [Dor][Cor]	*!	


When the two stops in the clusters are both nasal or both oral, however, metathesis rather than assimilation applies to coronal-initial clusters. I assume that the reason why assimilation does not apply to these sequences is that assimilation would result in geminate consonants, which are not allowed in Tagalog (Schachter 1972, Norvin Richards, p.c.). In Tagalog, a constraint against a geminate consonant (*GEMINATE) is undominated. Thus,

although the faithfulness constraint against metathesis (LINEARITY) outranks featural faithfulness constraints MAX(PL[α]), metathesis rather than assimilation applies to the nasal plus nasal or oral plus oral clusters. In (84), candidate a., **tanman*, which maintains the original ordering of the consonants, fatally violates the markedness constraint against a preconsonantal coronal stop. Candidate c., with assimilation, **tamman*, contains a geminate [mm], and this also incurs a fatal violation of *GEMINATE. As a result, the candidate with metathesis, *tamnan* (b.), is selected as optimal. The same analysis applies to coronal-initial oral stop sequences, as shown in (85).

(84) Tagalog /tanim-an/ → *tamnan* 'to plant'

	/tanim-an/ / \ [Cor][Lab]	*PL[COR]/__ C ∅	*GEMINATE	LINEARITY	MAX(PL[α])/[+NAS]
a.	tanman / \ [Cor][Lab]	*!			
b. 	tamnan / \ [Lab][Cor]			*!	
c.	tamman V [Lab]		*!		*

(85) Tagalog /atip-an/ → *aptan* 'roof'

	/atip-an/ / \ [Cor][Lab]	*PL[COR]/__ C ∅	*GEMINATE	LINEARITY	MAX(PL[α])/[-NAS]
a.	atpan / \ [Cor][Lab]	*!			
b. 	aptan / \ [Lab][Cor]			*!	
c.	appan V [Lab]		*!		*

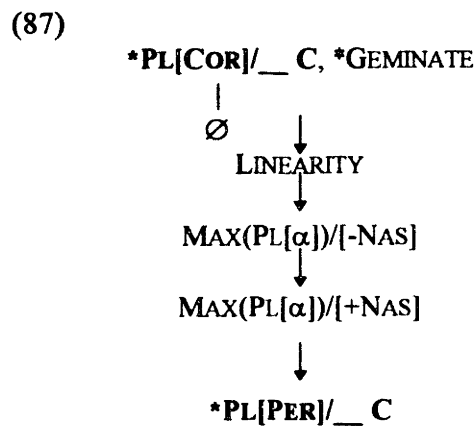
Again, metathesis occurs only to coronal stop-initial clusters. When the original ordering of the nasal-stop sequence is noncoronal plus coronal, no change occurs. This is demonstrated in (86). Here, metathesis incurs an unnecessary violation of high-ranking constraints, namely, the markedness constraint against a preconsonantal coronal stop and the faithfulness constraint against metathesis. Assimilation does not apply either since the assimilated candidate c., **lannan*, will create a geminate. It also violates the faithfulness constraint against featural deletion. Hence the faithful candidate, *lamnan*, is selected as optimal.

(86) Tagalog /iaman-an/ → *lamnan* **lanman* ‘the inside, flesh’

	/iaman-an/ / \ [Cor][Lab]	*Pl[Cor]/__ C ∅	*GEMINATE	LINEARITY	MAX(Pl[α])(+Nas)	*Pl[PER]/__ C
a. an	lamnan / \ [Lab][Cor]					*
b.	lanman / \ [Cor][Lab]	*!		*		
	lannan V [Cor]		*!		*	

To summarize, in Tagalog stop sequences that arise from vowel syncope undergo further changes only when the first stop is coronal but not when it is noncoronal. This is derived by ranking the markedness constraint against preconsonantal coronal stops above the relevant faithfulness constraints but ranking the markedness constraint against preconsonantal noncoronal stops below the relevant faithfulness constraints. Among the coronal stop-initial clusters, place assimilation applies when the two stops in the cluster differ in nasality. The direction of assimilation is always from the oral stop to the nasal stop regardless of the ordering of the two stops. This effect is derived by ranking the place

feature faithfulness constraint for oral stops above that for nasal stops. Finally, when the two stops in sequences agree in nasality, metathesis rather than assimilation applies. I proposed that this is due to a high-ranking constraint against a geminate in this language. This forces a violation of LINEARITY rather than the lower-ranking place faithfulness constraints. The constraint ranking of Tagalog is summarized in (87).



3.4 Morpheme Structure Constraints

Finally, the coronal markedness pattern is also attested as a form of static morpheme structure constraints.

Mishmi

In the Tibeto-Burman language Mishmi, nonprevocalic stops are not saliently released and only labial and dorsal stops (p' , k' , m and η) are found in this position (Rhee 1998 based on Sastry 1984). No data are provided for a synchronic alternation that attests this restriction. The stop inventory of Mishmi is given in (89) and there is no sub-coronal place contrast.

- (88) a. *papu* 'mushroom' *papap*⁷ 'monk'
 kape 'leech' *khleyk*⁷ 'earth'
 miya 'wife' *bum* 'a game trap'
 ɲare 'sin' *riŋ* 'sun'
- b. *taŋ* 'swallow' **t*⁷ : not attested nonprevocally
 nosa 'picture' **n*⁷ : not attested nonprevocally

(89) Mishmi stop inventory (Rhee 1998 based on Sastry 1984)

Labial	Coronal	Dorsal
p b	t d	k g
m	n	ŋ

Kana

Similar to Mishmi, in the Niger-Congo language Kana, only labial and dorsal stops are found in nonprevocalic positions, where stops are not saliently released (Rhee 1998 and Ikoro 1996). The stop inventory in (91) shows that Kana does not contrast sub-coronal places for stops.

- (90) a. *pe* 'get lost' *lob[p]*⁷ 'ten'
 ko 'name of village' *pag[k]*⁷ 'console'
 ma 'breast' *dam* 'husband'
 not attested prevocally *saŋ* 'anger'
- b. *tɔ* 'swallow' **t*⁷ : not attested nonprevocally
 ni 'elephant' **n*⁷ : not attested nonprevocally³¹

(91) Kana stop inventory (Ikoro 1996)

Labial	Alveolar	Palatal	Velar	Labial-Velar	Labialized Velar	Glottal
p b	t d		k g	kp gb	kw gw	ʔ
m	n	ɲ	ŋ		ŋw	

Assuming Richness of the Base (Smolensky 1996), static generalizations about morpheme structure are derived from the same constraint system that regulates the surface

³¹ The palatal nasal is also not allowed in nonprevocalic position.

phonotactics. Thus, a hypothetical input with a final /t/ will be eliminated in the output due to a violation of the markedness constraint against a final coronal stop without a dependent feature. This is illustrated in (92). But, an input with a final /p/ or /k/ will surface faithfully, as shown in (93).

(92) Mishmi Hypothetical /papat/ → *papa*

	/papat/ / \ [Lab][Lab][Cor]	*PL[COR]/__ # ∅	MAX-C
b.	papat / \ [Lab][Lab][Cor]	*!	
c.	papa / \ [Lab][Lab]		*

(93) Mishmi /papap/ → *papap* 'monk'

	/papap/ / \ [Lab][Lab][Lab]	*PL[COR]/__ # ∅	MAX-C	*PL[PER]/__ #
b.	papap / \ [Lab][Lab][Lab]			*
c.	papa / \ [Lab][Lab]		*!	

To summarize the sections 3.1 through 3.4, we have seen that the coronal markedness pattern is attested through diverse phenomena such as place assimilation, segmental/featural deletion, metathesis and Morpheme Structure Constraints. What all the cases of markedness reversal have in common is that the locus of restriction is either preconsonantal or word-final but never prevocalic. In addition, all the languages that show the markedness reversal phenomenon have a simple coronal inventory without a subcoronal place contrast for stop consonants. OT analyses based on a perceptually motivated markedness constraint hierarchy have been presented. By ranking the relevant

faithfulness constraints between the markedness constraint against coronal stops and the markedness constraint against noncoronal stops, the reversed markedness pattern was derived.

$$(94) \quad *PL[COR]/_ C, \# \gg \dots F \dots \gg *PL[PER]/_ C, \#$$

$$\begin{array}{c} | \\ \emptyset \end{array}$$

3.5 *Nasality and place cues*

In this section, I will show that in certain languages that exhibit coronal markedness in C_1 position of VC_1C_2V context, stops in C_1 position do not uniformly conform to the coronal markedness constraint. Rather, the degree of place restriction in C_1 position can vary depending on the nasality of the C_1 and C_2 .

First, the place restriction on C_1 is more severe when C_1 is nasal than when it is oral. I propose that this asymmetry between nasal and oral stops follows from the fact that the place cues for oral stops are more salient than those for nasal stops. The perceptibility scale in (95) is set up and this perceptibility scale is projected into a markedness constraint hierarchy in (96). The hierarchy mandates that it is worse to have a place contrast for nasal stops than to have a corresponding place contrast for oral stops.

$$(95) \quad Pl[\alpha]/[-Nas] \succ Pl[\alpha]/[+Nas]^{32}$$

$$(96) \quad *PL[\alpha]/[+NAS] \gg *PL[\alpha]/[-NAS]$$

Second, given the same nasality on C_1 , the place restriction is more severe when C_2 is oral than when it is nasal. The perceptual hierarchy in (95) is further elaborated depending on whether a following stop is nasal or oral; given a fixed nasality on C_1 , the

place cues on C_1 are better when C_2 is nasal than when it is oral. This expanded perceptibility scale in (97) is mapped onto a markedness constraint hierarchy, given in (98).

(97)

$$\text{Pl}[\alpha]/_____\text{[+Nas]} \succ \text{Pl}[\alpha]/_____\text{[-Nas]} \succ \text{Pl}[\alpha]/_____\text{[+Nas]} \succ \text{Pl}[\alpha]/_____\text{[-Nas]}$$

(98)

$$\begin{array}{c} * \text{PL}[\alpha]/_____\text{[-NAS]} \\ \downarrow \\ * \text{PL}[\alpha]/_____\text{[+NAS]} \\ \downarrow \\ * \text{PL}[\alpha]/_____\text{[-NAS]} \\ \downarrow \\ * \text{PL}[\alpha]/_____\text{[+NAS]} \end{array}$$

The constraints in (96) and (98) can conjoin with the reversed place markedness hierarchy, repeated in (99), to produce the cases where the restriction against a coronal stop in C_1 position is upheld only when the nasality of C_1 and C_2 is relevant.

$$\begin{array}{c} (99) \quad * \text{PL}[\text{COR}]/_____\text{C} \gg * \text{PL}[\text{PER}]/_____\text{C} \\ \quad \quad \quad | \\ \quad \quad \quad \emptyset \end{array}$$

I start the discussion with the effect of nasality of the stop housing the place feature on place restrictions (Section 3.5.1) and then factor in the effect of the nasality of the following stop (Section 3.5.2).

³² $\text{Pl}[\alpha]/_____\text{[Nas]}$ is abbreviated as $\text{Pl}[\alpha]/[\text{Nas}]$. The same convention is used for constraints throughout the thesis.

3.5.1 Internal context: nasal versus oral asymmetry

3.5.1.1 Background

It has been observed that in the consonant inventories of the world's languages, nasal stop systems in general have an equal number of or fewer place-of-articulation contrasts than corresponding oral stop systems (Ferguson 1966, Crothers 1975 and Maddieson 1984; Hamilton 1996 for Australian languages).³³ For example, many languages that contrast three places of articulation for oral stops (dorsal, labial and coronal) do not have the dorsal nasal phoneme (Chickasaw, Latin, Lithuanian, Leti etc.). In Australian languages, several languages have a gap in the coronal place contrast for nasal stops compared to the corresponding contrasts for oral stops. For example, Wembawemba contrasts four coronal oral stops in place of articulation (alveolar, dental, retroflex and alveopalatal) but nasal coronal stops have only a three-way contrast (alveolar, retroflex and alveopalatal) (Hamilton 1996, p.56). However, no Australian language has more contrasts for nasal stops than oral stops in place of articulation.

Also, the contextual neutralization of a place contrast is more prone to occur in nasal stops than oral stops. In Malayalam, a nasal stop is always homorganic to a following oral stop, as shown in (100)a. and b. No such restriction holds for an oral stop in the same position, as shown in (100)c. (Mohan and Mohan 1984, Mohan 1993).

(100) a.	<i>kamalam karɳɳu</i>	→	<i>kamalaŋ karɳɳu</i>	'Kamalam cried'
	<i>kamalam ɳaɳiccu</i>	→	<i>kamalaŋ ɳaɳiccu</i>	'Kamalam became fat'
	<i>kamalam caaɳi</i>	→	<i>kamalaŋ caaɳi</i>	'Kamalam jumped'
	<i>kamalam paraɳɳu</i>	→	<i>kamalam paraɳɳu</i>	'Kamalam said...'

³³ In many languages, however, palatal nasals are found even when there is no corresponding stop consonants, constituting an exception to the generalization (Maddieson 1984, p.65).

- b. *awan karɔŋɲu* → *awaŋ karɔŋɲu* 'he cried'
awan ɬatɪccu → *awaŋ ɬatɪccu* 'he became fat'
awan caaɬi → *awaŋ caaɬi* 'he jumped'
awan paraŋɲu → *awam paraŋɲu* 'he said (something)'
- c. *uɬkarɕam* 'progress'
sapɬam 'eight'
ɬiktam 'bitter'

I propose that the relative poverty of place contrasts in nasal stops compared to oral stops is due to the perceptual weakness of place cues in nasal stops. Recall from the previous section (p.69) that various studies suggest that the place cues for nasal stop consonants are perceptually less salient than those for oral stop consonants. Thus, we can set up the perceptibility scale in (101). Again, adopting the proposal by Steriade (1997)—for a given physical scale of perceptibility, a corresponding markedness constraint hierarchy is projected—we can project a hierarchy of place markedness constraints in (102) from the perceptibility scale in (101). According to this hierarchy, other things being equal, it is worse to have a place contrast for a nasal consonant than for an oral consonant. Thus, a place feature in a nasal consonant is less likely to surface in the output than a place feature in an oral consonant.

(101) $Pl[\alpha]/[-Nas] > Pl[\alpha]/[+Nas]$

(102) $*PL[\alpha]/[+NAS] \gg *PL[\alpha]/[-NAS]$

3.5.1.2 Data

In some languages, the processes that show the coronal markedness pattern apply only when the offending coronal stop is nasal but not when it is oral. In Dutch, place assimilation targets a coronal *nasal* stop but not a coronal *oral* stop. In Cebuano Bisayan,

metathesis and place assimilation apply obligatorily to coronal stop-initial clusters when the coronal stop is *nasal* but not when the coronal stop is *oral*. Similarly, in Leti, metathesis applies to coronal stop-initial clusters only when the stop consonant is nasal. Asymmetry between place restrictions in oral and nasal stops is summarized in (104).

(103) Nasal versus oral asymmetry in place restriction on C₁ in VC₁C₂V

		Dutch	Cebuano Bisayan	Leti
C ₁ = Noncoronal	C ₁ = Oral	Yes	Yes	Yes
	C ₁ = Nasal	Yes	Yes	Yes
C ₁ = Coronal	C ₁ = Oral	Yes	Yes	Yes
	C ₁ = Nasal	No	No	No

The asymmetry between coronal *oral* stops and coronal *nasal* stops found in these languages can be understood in perceptual terms. Place cues for coronal stops are in general perceptually weak in C₁ position, but the place cues for nasal coronal stops are even weaker than the place cues for oral coronal stops in this position. Thus, it is expected that place contrasts for oral coronal stops in C₁ position are more likely to be tolerated than the corresponding place contrasts for nasal coronal stops. Now, let us introduce the data from Dutch, Cebuano Bisayan and Leti.

Dutch

In Dutch, the coronal nasal /n/ assimilates to the place of following consonant across morpheme or word boundaries but the labial nasal /m/ does not, as shown in (104)a. and b. respectively (Trommelen 1984, p.55).

- (104) a. *in-brengen* → *im brengen* 'to bring in'
in-kopen → *in kopen* 'to purchase'
 b. *om-kopen* → *om kopen* **on kopen* 'to bribe'
om twee uur → *om twee uur* **on twee uur* 'at two o'clock'

A similar asymmetry is reported in Brussels Flemish, where coronal nasal /n/ assimilates in place of articulation to a following stop, as shown in (105)a., but assimilation does not apply when the nasal is labial, as shown in (105)b. (Jun 1995 based on De Vriendt and Goyvaerts 1989). An oral stop does not undergo assimilation even when it is a coronal stop /t/, as shown in (105)c.

- (105) a. *geen kussens* → *yi:ŋ kysəs* 'no cushions'
 b. *ik kom niet* → *ikom ni* **ikon ni* 'I am not coming.'
 c. *hij ziet het pakje* → *aəze:dət pakskə* **aəze:dəp pakskə* 'He sees the small parcel.'

Here, the restriction against a coronal stop in C₁ position does not apply uniformly to nasal and oral stops. Rather, only the coronal *nasal* stop is eliminated from C₁ position by assimilation process.

Cebuano Bisayan

In the previous section, we saw that coronal stop-initial clusters are actively eliminated by a combination of place assimilation and metathesis processes in Tagalog. Cebuano Bisayan, a language of the central Philippines related to Tagalog, shows a similar conspiracy of assimilation and metathesis to avoid coronal-noncoronal consonant clusters (Blust 1979). However, unlike in Tagalog, where all coronal stop-initial clusters are eliminated regardless of the nasality of the stops, in Cebuano Bisayan, coronal stop-initial clusters are variably allowed if the coronal stop is oral. The difference between the two languages is schematically summarized in (106).

(106) Place features allowed in C₁ in VC₁C₂V sequences : Tagalog versus Cebuano Bisayan

		Tagalog	Cebuano Bisayan
C ₁ = Noncoronal	C ₁ = Oral	Yes	Yes
	C ₁ = Nasal	Yes	Yes
C ₁ = Coronal	C ₁ = Oral	No	Yes
	C ₁ = Nasal	No	No

First, similar to Tagalog, when the first consonant of a cluster is labial as in (107)a. or dorsal as in (107)b., the cluster remains unchanged. In other words, there is no restriction against a noncoronal stop in C₁ position in these languages.

- (107) a. /pt/ *sáput* *s-al-apt-un* 'bad temper'
 /bt/ *lábut* *labt-an* 'concern'
 /bd/ *labád* *labd-un* 'for the head to ache'
 /mn/ *damán* *damn-un* 'talk, walk in one's sleep'
 /mt/ *humút* *pa-humt-i* 'sweet smelling'
 /md/ *humúd* *humd-unun* 'wet'
 tamúd *tamd-un* 'obey'
 b. /kt/ *lakát* *lakt-un* 'walk'
 /kd/ *lákad* *lakd-an* 'step over'
 /kp/ *dakúp* *dakp-an* 'arrest'
 /ɲn/ *báɲan* *baɲn-anan* 'tie a bunch of long things together'
 iɲún *iɲn-un* 'say, tell'
 /ɲt/ *púɲut* *ka-pu-puɲt-an* 'join things together by tying or pasting them'
 /ɲp/ *tuɲúp* *tuɲp-a* 'be exactly a certain quantity, time, etc.'

On the other hand, coronal stops are not freely allowed in C₁ position. Recall that in Tagalog, all coronal stop-initial clusters are actively eliminated through place assimilation and metathesis. In Cebuano Bisayan, on the other hand, coronal stop-initial clusters are obligatorily avoided only when the coronal stop is nasal. Coronal nasal initial clusters undergo metathesis or assimilation depending on the nasality of the following stop; when a coronal nasal is followed by another nasal, metathesis applies, as shown in

(108). When a coronal nasal is followed by an oral stop, regressive place assimilation applies, as shown in (109).

(108)	/nm/	<i>inum</i>	<i>imn-a</i>	‘drink’
		<i>tanúm</i>	<i>ka-tamn-an</i>	‘to plant’
	/nɲ/	<i>tunúɲ</i>	<i>tuɲn-a</i>	‘directly at a point’
		<i>únunɲ</i>	<i>uɲn-un</i>	‘stick to someone loyally’
(109)	/nb/	<i>tunúb</i>	<i>tumb-i</i>	‘step on’
		<i>anáɸ</i>	<i>aɲk-an</i>	‘son, daughter’
	/nk/	<i>tunúk</i>	<i>tuɲk-un</i>	‘thorn’
		<i>hinúɸ</i>	<i>hiɲg-an</i>	‘ripe’
		<i>tunúɸ</i>	<i>t-ul-uɲg-un</i>	‘sound of a musical instrument’

On the other hand, when a coronal oral stop is followed by another stop, it is not obligatorily eliminated. When the following stop is oral, as shown in (110), metathesis may apply but this is optional.³⁴ When the following stop is nasal, no change occurs, as shown in (111).

(110)	/tp/	<i>atúp</i>	<i>atp-an, apt-an</i>	‘roof’
	/tk/	<i>bitík</i>	<i>bitk-an, bikt-an</i>	‘catch with a noose or lasso’
		<i>gitík</i>	<i>gitk-anun, gikt-anun</i>	‘ticklish’
		<i>ítuk</i>	<i>hika-ikt-an</i>	‘provoke someone’
		<i>litík</i>	<i>litk-an, likt-an</i>	‘snap the fingers’
		<i>lutúk</i>	<i>lukt-un</i>	‘put the finger in’
(111)	/tm/	<i>gútum</i>	<i>hi-gutm-an</i>	‘hunger’
		<i>itúm</i>	<i>itm-an</i>	‘black’
	/tɲ/	<i>atáɲ</i>	<i>atɲ-i</i>	‘watch, keep an eye on’

In other words, the constraint against a preconsonantal coronal stop is fully active only when the coronal stop is nasal but only optionally active when it is oral.

³⁴ If the second stop is a voiced one, no change occurs (*kútub* → *k-in-utb-ana* ‘as far as a certain point in space or time’, *tutúb* → *tutb-an* ‘cover the mouth of a container’, *utúɸ* → *gi-utg-an* ‘for the penis to be erect’).

Leti

Blust (1979) also shows that a similar constraint against coronal-initial clusters is operative in another Austronesian language, Leti. Historically, some consonant clusters arose from metathesis of a final vowel and a preceding consonant: **lumut* > *lumtu*, **tenun* > *tennu* etc. Whenever nasals cluster as a result of vowel syncope, a labial nasal precedes a coronal nasal.³⁵ Examples are given in (112)a. As for oral stop clusters, due to the general loss of final **p* and **k*, there are only a small number of examples of coronal-noncoronal clusters. In the small number of examples available, however, metathesis fails to apply and the original order of the clusters is retained. Clusters remain unchanged also when a coronal oral stop is followed by a nasal stop, as shown in (112)c. Thus, Leti is another example where the restriction against coronal stop-initial clusters is operative only when the coronal stop is nasal but not when the coronal stop is oral.

- (112) a. **inum* → *emnu* 'drink'
 **ianem* → *tomna* 'to plant'
 b. *patka* 'layer, level'
 utki 'mat'
 utku 'kind of louse'.
 c. *ma-qitem* *metma* 'black'

3.5.1.3 Analyses

The table in (113) summarizes the place restriction patterns in preconsonantal stop position in the three languages just discussed. Tagalog and Malayalam are added for comparison. Malayalam bans both coronal and noncoronal places for nasal stops, but for oral stops, both coronal and noncoronal places are licensed, in Malayalam, the restriction

³⁵ A dorsal nasal /ɲ/ became /n/ by an independent process, and hence there are no examples of metathesis in coronal-dorsal nasal clusters

against nasal place is fully active. In Tagalog, on the other hand, coronal stops are banned in preconsonantal position regardless of their nasality but noncoronal stops are freely allowed regardless of nasality; in Tagalog, the restriction against coronal place is fully active. Dutch, Cebuano Bisayan and Leti are less restrictive than the other two languages in that only the configurations that violate both restrictions (one against coronal place and one against nasal place) are banned.

(113) Nasal versus oral asymmetry in place restriction on C_1 in VC_1C_2V

		Malayalam	Tagalog	Dutch	Cebuano Bisayan	Leti
C_1 = Noncoronal	C_1 = Oral	Yes	Yes	Yes	Yes	Yes
	C_1 = Nasal	No	Yes	Yes	Yes	Yes
C_1 = Coronal	C_1 = Oral	Yes	No	Yes	Yes	Yes
	C_1 = Nasal	No	No	No	No	No

This is what Smolensky (1995) calls “banning the worst-of-the-worst.” Smolensky (1995) proposes that in order to single out and ban “the worst-of-the-worst” case, additional constraints are needed that are generated by “local conjunction of constraints.” Itô and Mester (1998) define local constraint conjunction as follows, based on Smolensky’s (1995) initial proposal

(114) Local Conjunction of Constraints (LCC)

- DEFINITION: Local conjunction is an operation on the constraint set forming composite constraints: Let C_1 and C_2 be members of the constraint set Con . Then their local conjunction $C_1 \&_{\delta} C_2$ is also a member of Con .
- INTERPRETATION: The local conjunction $C_1 \&_{\delta} C_2$ is violated if and only if both C_1 and C_2 are violated in some domain δ .
- RANKING (universal): $C_1 \&_{\delta} C_2 \gg C_1, C_2$

The idea behind this proposal is that it is worse to violate two constraints at the same time than it is to violate each of them separately. I will demonstrate how constraint conjunction can generate the worst-of-the-worst effect in Cebuano Bisayan preconsonantal restrictions while the original constraints cannot. We have two primary

constraints; the constraint in (115) bans a coronal stop before another consonant while the constraint in (116) bans an independent place feature linked to a nasal consonant.

(115) *PL[α]/__ C

|
Ø

(116) *PL[α]/[+NAS]

These primary constraints alone cannot single out and ban the configuration that violates both of these constraints. In order to allow configurations that violate only one of these constraints, each of these constraints should be dominated by relevant faithfulness constraints. First, the constraint against nasal place, (116), should rank below relevant faithfulness constraints. This prevents a labial or dorsal nasal in C₁ position from being eliminated, as the tableau in (117) shows.

(117) Cebuano Bisayan /pa-humut-i/ → *pahumti* 'sweet smelling'³⁶

/pa-humut-i/ / \ [Lab][Cor]		MAX(PL[α])	*PL[α]/[+NAS]
a. pa pahumti / \ [Lab][Cor]			*
b. pahunti V [Cor]	*!		

Similarly, a violation of the constraint against coronal stops, (115), is not fatal alone. Therefore, the constraint against a coronal stop should also rank below the faithfulness constraints. This is shown in (118). If the ranking were reversed, the *tm* cluster would be forced to change.

³⁶ An independent process of vowel syncope applies.

(118) Cebuano Bisayan /itum-an/ → *itman* 'black'

	/itum-an/ / \ [Cor][Lab]	MAX(PL[α])	*PL[COR]/__ C ∅
a. ✗	<i>itman</i> / \ [Cor][Lab]		*
b.	<i>itnan</i> V [Cor]	*!	

Since the constraint against coronal stops and the constraint against nasal place features should both rank below faithfulness constraints, neither constraint can force a coronal nasal-initial cluster to undergo any change. In (119), an incorrect output without any change from input to output is selected. With the primary markedness constraints alone, we end up with a ranking paradox.

(119) Cebuano Bisayan /tunub-i/ → *tumbi* 'step on'

	/tunub-i/ / \ [Cor][Lab]	MAX(PL[α])	*PL[COR]/__ C ∅	*PL[α]/[+NAS]
a. ✗	<i>tunbi</i> / \ [Cor][Lab]		*	*
b.	<i>tumbi</i> V [Lab]	*!		

What sets apart the candidate *tunbi* in (119) from the candidate *pahumti* in (117) or the candidate *itman* in (118) is that it violates both the markedness constraint against coronal stops and the markedness constraint against nasal place. To capture this effect, we can introduce a conjoined constraint that combines the two markedness constraints, given in (120). This constraint is violated by a *coronal nasal* in preconsonantal position only but

not by a coronal *oral* stop or a *noncoronal* nasal in preconsonantal position. Let us abbreviate this constraint as **nC* for convenience.

$$(120) \text{ *PL[COR]/} \frac{\text{ } }{ \begin{array}{c} | \\ \text{[+STOP, +NAS]} \\ \emptyset \end{array} } \text{ C } \quad (*nC)$$

The conjoined constraint can rank separately from the individual component constraints. By ranking this constraint above the faithfulness constraints, only the worst-of-the-worst case is repaired. This is shown in (121).

(121) Cebuano Bisayan /tunub-i/ → *tumbi* ‘step on’

	/tunub-i/ / \\ [Cor][Lab]	*nC	MAX(PL[α])	*PL[COR]/__ C ∅	*PL[α]/[+NAS]
a.	tunbi / \\ [Cor][Lab]	*!		*	*
b. en	tumbi V [Lab]		*		

Given two or more constraints that form a fixed hierarchy ($C_1 \gg C_2$), by the same technique of constraint conjunction, each of the constraints may conjoin with another constraint, C_α ($C_1 \&_\delta C_\alpha$, $C_2 \&_\delta C_\alpha$). It is a reasonable assumption that constraints generated by local conjunction must preserve the ranking of original constraints. This hypothesis is formulated by Spaelti (1997, cited in Itô and Mester 1998) as in (122).

(122) Universal Conjoined Constraint Ranking Hypothesis
 $\forall C_1, C_2, C_\alpha \in \text{Con} : \text{IF } C_1 \gg C_2, \text{ THEN } C_1 \&_\delta C_\alpha \gg C_2 \&_\delta C_\alpha$

Given this hypothesis, we can form a new hierarchy of markedness constraints in (125). This results from the conjunction of the coronal markedness constraint in (123) with the hierarchy regarding nasality in (124). The conjoined constraints will respect

Spaelti's hypothesis. They mandate that it is worse to have a coronal nasal stop *n* in C₁ position than to have a coronal oral stop *t* in C₁. Again, these constraints will be abbreviated as **nC* and **tC* below.

$$(123) \quad *PL[COR]/\underset{\substack{| \\ \emptyset}}{\quad} C$$

$$(124) \quad *PL[\alpha]/[+NAS] \gg *PL[\alpha]/[-NAS]$$

$$(125) \quad *PL[COR]/\underset{\substack{| \\ \emptyset}}{\quad} C \gg *PL[COR]/\underset{\substack{| \\ \emptyset}}{\quad} C \quad (*nC \gg *tC) \\ \quad \quad \quad [-NAS] \quad \quad \quad [+NAS]$$

Recall that, unlike in Cebuano Bisayan, where only coronal nasal stop-initial clusters are repaired, in Tagalog all coronal stop-initial clusters undergo change. The difference between Tagalog and Cebuano Bisayan comes from the different ranking of faithfulness constraints relative to the conjoined markedness constraints in (125). While in Tagalog, both markedness constraints rank above faithfulness constraints (MAX(PL[α]) and LINEARITY), in Cebuano Bisayan, only the markedness constraint against the coronal nasal stop outranks the faithfulness constraints. The restriction of coronal assimilation to nasals in Dutch and the restriction of metathesis to nasal clusters in Leti are also derived by the same constraint ranking as that in Cebuano Bisayan.

(126) Comparison of Tagalog and Cebuano Bisayan, Dutch and Leti

- Tagalog: **nC* » **tC* » LINEARITY, MAX(PL[α])
- Cebuano Bisayan, Dutch and Leti: **nC* » LINEARITY, MAX(PL[α]) » **tC*

In Leti, where metathesis selectively applies to coronal nasal-initial clusters, the constraint against coronal nasals in preconsonantal position outranks the faithfulness constraint against metathesis, LINEARITY. As a result, metathesis applies to *nm* clusters, as

shown in (127). On the other hand, the constraint against an oral coronal stop ranks below the faithfulness constraint, and metathesis does not apply. This is shown in (128).

(127) Leti **tanem* → *tamna* ‘to plant’

	/tanem/ / \ [Cor][Lab]	*nC	LINEARITY
a.	tanma / \ [Cor][Lab]	*!	
b.	tamna / \ [Lab][Cor]		*

(128) Leti /utki/ → *utki* ‘mat’

	/utki/ / \ [Cor][Dor]	LINEARITY	*tC
a.	utki / \ [Cor][Dor]		*
b.	ukti / \ [Dor][Cor]	*!	

Similarly, in Dutch place assimilation applies only to nasal coronal stops in preconsonantal position but not to oral coronal stops. This is also derived by ranking the faithfulness constraint, MAX(PL[α]), between the two conjoined markedness constraints. The faithfulness constraint is outranked by the constraint against *nasal* coronal stops in preconsonantal position and place assimilation applies, as shown in (129). On the other

hand, the faithfulness constraint outranks the constraint against *oral* coronal stops and no place assimilation applies.³⁷

(129) Dutch, *geen kussens* → *yi:ŋ kysəs* ‘no cushions’

	geen kussens / \ [Cor][Dor]	*nC	MAX(PL[α])
a.	yi:n kysəs / \ [Cor][Dor]	*!	
b.	yi:ŋ kysəs \ [Dor]		*

(130) Dutch *hij ziet het pakje* → *aəze:dət pakskə* ‘He sees the small parcel.’

	hij ziet het pakje / \ [Cor][Lab]	MAX(PL[α])	*tC
a.	aəze:dət pakskə / \ [Cor][Lab]		*
b.	aəze:dəp pakskə \ [Lab]	*!	

Now, let us go back to Cebuano Bisayan. Various changes that occur or fail to occur in coronal stop-initial clusters in the language are summarized in (131), repeated from above.

(131) Changes to coronal-noncoronal clusters in Cebuano Bisayan

C1 ↓ C2 →	Nasal Stop	Oral Stop
<i>n</i>	Metathesis	Regressive Assimilation
<i>l</i>	No change	Optional Metathesis

³⁷ Jun (1995) proposes that the asymmetry between nasal and oral stops in place assimilation is due to the faithfulness constraint hierarchy we introduced in (77).

MAX(PL[α])/____ » MAX(PL[α])/____
[-NAS] [+NAS]

For asymmetries found in assimilation processes, this is a possible analysis but this faithfulness hierarchy cannot account for the asymmetry between nasal and oral stops in metathesis found in Leti and Cebuano Bisayan. See Chapter 5 for discussion.

Just as in Tagalog, the clusters where two stops agree in nasality undergo metathesis while the clusters that consist of a nasal stop and an oral stop undergo assimilation. I assume that the choice between metathesis and assimilation as a repair strategy follows from the same constraint ranking that I proposed for Tagalog. The faithfulness constraint against metathesis (LINEARITY) ranks above the faithfulness constraint against place assimilation (MAX(PL[α])), and assimilation rather than metathesis applies for nasal plus oral clusters, as shown in (132).

(132) Cebuano Bisayan /tunub-i/ → *tumbi* 'step on'

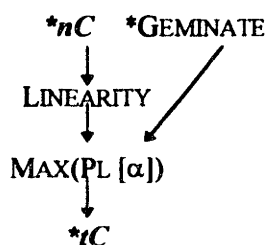
	/tunub-i/ / \ [Cor][Lab]	*nC	LINEARITY	MAX(PL[α])
a.	tunbi / \ [Cor][Lab]	*!		
b. nm	tumbi V [Lab]			*
c.	tubni / \ [Lab][Cor]		*!	

But, when both stops in the clusters are nasals as in /nm/, place assimilation would result in a geminate, [mm], and this violates a high-ranking constraint against geminates (*GEMINATE). Thus, despite that fact that LINEARITY ranks higher than the MAX(PL[α]), a violation of LINEARITY is forced, as (133) demonstrates. (134) summarizes the constraint ranking in Cebuano Bisayan established so far.

(133) Cebuano Bisayan /inum-a/ → *imna* 'drink'

	/inum-a/ / \ Cor Lab	*nC	*GEMINATE	LINEARITY	MAX(PL[α])
a.	inma /\ [Cor][Lab]	*!			
b.	imna / \ [Lab][Cor]			*	
c.	imma V [Lab]		*!		*

(134)



However, there is one facet of Cebuano Bisayan data I have been ignoring so far.

This is the fact that metathesis may optionally apply to oral stop clusters. But, no such optional application of a repair is found for oral stop plus nasal stop clusters. The two types of clusters are different in that in one the oral stop is followed by another oral stop (→ optional metathesis), while in the other, the oral stop is followed by a nasal stop (→ no change). This shows that the place restriction patterns also differ depending on the nasality of the following stop. It is to the effect of the nasality of following stops on the perceptibility of place cues that we turn now.

(135) Changes to coronal-noncoronal clusters in Cebuano Bisayan

C1 ↓ C2 →	Nasal Stop	Oral Stop
Nasal Stop	Metathesis	Regressive Assimilation
Oral Stop		Optional Metathesis

3.5.2 External context : nasal versus oral asymmetry

3.5.2.1 Background

In this section, I show that the place restriction pattern is not only affected by the nasality of the stop housing the place feature itself but also by the nasality of a following stop. Given the same nasality condition on C_1 , the place restriction on C_1 is more severe when C_2 is oral than when it is nasal. We have just seen that in Cebuano Bisayan, oral coronal stop-initial clusters may undergo optional repair processes depending on the nasality of the following stop.

Again I propose that the effect of C_2 nasality on a C_1 place restriction can be understood in perceptual terms. Studies have shown that under certain circumstances, listeners misidentify VC1C2V sequences as VC2V (Malecôt 1958, Wang 1959, Fujimura *et al.* 1978, Ohala 1990b, among others). The place cues for C_2 are perceptually more salient than the place cues for C_1 , and the weaker cues (the place cues for C_1) are dominated by the stronger cues (the place cues for C_2). The relative weakness of place cues for C_1 results in failure to identify C_1 . I conjecture that this type of domination of weaker cues (C_1) by stronger cues (C_2) will be more likely to occur if the dominating cues (C_2) are perceptually more salient.

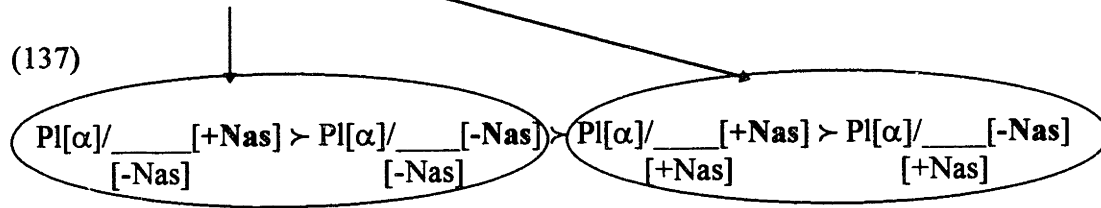
Recall from the previous section that various studies suggest that the place cues for nasal stop consonants are perceptually less salient than those for oral stop consonants. Even in prevocalic position, nasal stops lack the salient release burst cues that oral stops possess. Since the place cues for oral stops in C_2 position are more salient than those for corresponding nasal stops, according to my hypothesis, oral stops in C_2 will be more likely

to overshadow the place cues for a stop in C₁ than nasal stops in C₂ will be to overshadow the place cues for C₁.

Thus, I propose that the perceptual hierarchy in (136) is further elaborated depending on whether a following stop is nasal or oral; given a fixed nasality for C₁, the place cues for C₁ are better when C₂ is nasal than when it is oral. This expanded perceptibility scale in (137) is mapped onto a markedness constraint hierarchy, given in (138). To facilitate reading, the conjoined constraints in (138) will be abbreviated as in (139). For example, *NT should read “do not have an independent place feature on a nasal stop when it is followed by an oral stop.”

(136) $Pl[\alpha]/[-Nas] \succ Pl[\alpha]/[+Nas]$

(137)



(138)

* $Pl[\alpha]/_____-[-Nas]$
 $[+Nas]$
 \downarrow
 * $Pl[\alpha]/_____[+Nas]$
 $[+Nas]$
 \downarrow
 * $Pl[\alpha]/_____-[-Nas]$
 $[-Nas]$
 \downarrow
 * $Pl[\alpha]/_____[+Nas]$
 $[-Nas]$

(139) *NT » *NN » *TT » *TN

3.5.2.2 Cebuano Bisayan and Moa

Now, let us go back to the Cebuano Bisayan data. Recall that in Cebuano Bisayan, coronal stop-initial clusters behave differently depending on the nasality of C_1 , the coronal stop; if C_1 is nasal, metathesis or regressive assimilation apply obligatorily. But, when C_1 is oral, depending on the nasality of C_2 , a relevant repair may or may not apply. In other words, when C_1 is nasal, the restriction against a coronal stop is strictly enforced, regardless of the nasality of C_2 , but when C_1 is oral, the restriction may or may not be enforced depending on the nasality of C_2 .

(140) Changes to coronal-noncoronal clusters in Cebuano Bisayan

$C_1 \downarrow \quad C_2 \rightarrow$	Nasal Stop	Oral Stop
Nasal Stop	Metathesis	Regressive Assimilation
Oral Stop		Optional Metathesis

Now, given the markedness hierarchy in (139), we can derive the coronal restriction patterns found in Cebuano Bisayan. By local conjunction of the coronal markedness constraint in (141) with the constraints in (139), we generate a constraint hierarchy that entails that a restriction against coronals is more or less likely to be enforced depending on the nasality of C_1 and C_2 . The constraints in (142) are again given in abbreviated forms. The capital T and N denote an oral stop and a nasal stop, respectively, and the small t and n represent a coronal oral stop and a coronal nasal stop, respectively.

(141) *PL[COR]/__ C

|
∅


(142) * nT » * nN » * tT » * tN

Now, the constraint ranking in Cebuano Bisayan can be further refined by introducing the extended markedness hierarchy in (142). The first two constraints in


(142) ban a coronal nasal in preconsonantal position and these are strictly undominated.

Thus, a coronal nasal followed by an oral stop undergoes assimilation and a coronal nasal followed by a nasal stop undergoes metathesis, as shown in (143) and (144), respectively.

(143) Cebuano Bisayan /tunub-i/ → *tumbi* ‘step on’

	/tunub-i/ / \ [Cor][Lab]	*nT	MAX(PL[α])
a.	tunbi / \ [Cor][Lab]	*!	
b. 	tumbi V [Lab]		*



(144) Cebuano Bisayan /inum-a/ → *imna* ‘drink’³⁸

	/inum-a/ / \ Cor Lab	*nN	LINEARITY
a.	inma / \ [Cor][Lab]	*!	
b. 	imna / \ [Lab][Cor]		*

An oral coronal stop followed by another oral stop, on the other hand, optionally metathesizes. Following Antilla (1997), I assume that the variability in outputs is derived from variable ranking of constraints. The ranking between **tT*, which bans an oral coronal stop before another oral stop, and the faithfulness constraint against metathesis, LINEARITY, is variable and variable, outputs are produced. This is shown in (145). The dotted line in the tableau represents the variable ranking of the two constraints.


³⁸ Note that assimilation is ruled out by violation of a higher ranking constraint against a geminate.

(145) Cebuano Bisayan /atup-an/ → *atpan* ~ *aptan* 'roof'

	/atup-an/ / \ [Cor] [Lab]	* <i>tT</i>	LINEARITY
a. 	atpan / \ [Cor] [Lab]	*	
b. 	aptan / \ [Lab] [Cor]		*

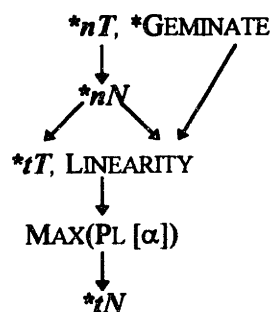
Finally, the fourth and final constraint in the hierarchy, **tN*, is ranked low and its effect is not visible; no change occurs to an oral coronal stop followed by a nasal. This is demonstrated in (146).

(146) Cebuano Bisayan /itum-an/ → *itman* 'black'

	/itum-an/ / \ [Cor] [Lab]	MAX(PL[α])	* <i>tN</i>
a. 	itman / \ [Cor] [Lab]		*
b.	itnan ∨ [Cor]	*!	

Thus, the contrast between the behavior of *tp* clusters and *tm* clusters follows from the separate ranking of constraints that govern these clusters. The final ranking of constraints is summarized for Cebuano Bisayan in (147).

(147)



Similarly in Moa, historically a cluster consisting of an oral stop plus an oral stop metathesized but a cluster consisting of an oral stop plus a nasal stop did not change. We saw in the previous section that in Leti, whenever nasals cluster as a result of vowel syncope, metathesis applies such that the labial nasal precedes the coronal nasal. The same is true for a related dialect of the same language, Moa, as shown in (148)a. Unlike Leti, however, sequences of oral stop consonants also metathesize such that coronal plus noncoronal clusters in Leti correspond to noncoronal plus coronal clusters in Moa. The examples in (148)b. demonstrate this. However, when an coronal oral stop is followed by a nasal stop as in (148)c., no change occurs. Thus, in Moa a preconsonantal coronal stop /t/ may or may not be tolerated depending on the nasality of the following stop. If the following stop is an oral stop, a change occurs, but if the following stop is nasal the cluster remains unchanged.

- (148) a. **inum* → *emnu* 'drink'
 **tanem* → *tamna* 'to plant'
 b. *pakta* (Leti: *patka*) 'layer, level'
 ukti (Leti: *utki*) 'mat'
 uktu (Leti: *utku*) 'kind of louse'.
 c. *ma-qitem* *metma* 'black'

Similar to Cebuano Bisayan, a sequence of an oral stop followed by another oral stop follows the reversed markedness pattern but a sequence of an oral stop followed by a nasal stop is permitted. Thus, in Moa, we have the following ranking.

- (149) **nN*, **tT* » LINEARITY » **tN*³⁹

³⁹ We do not have information about what happens to a cluster consisting of a coronal nasal plus an oral stop. The prediction is that that type of clusters will be eliminated by assimilation or metathesis since it violates a high-ranking constraint **nT*.

3.5.2.3 Additional cases : Attic Greek and English

Additional evidence for the combined effect of nasality of C_1 and C_2 on the place restriction of C_1 is also found in the morpheme structure constraint generalizations in English and Attic Greek. Depending on the nasality of C_1 and C_2 , three degrees of place restriction patterns are found in these languages. It is to these languages that we turn now.

English

In monomorphemic words of English, the first position of stop-stop sequences (i.e., preconsonantal position) is restricted in terms of possible place features (cf. Clements 1990, Yip 1991). The conditions can be cross-classified by the nasality of the preconsonantal stop itself (C_1) and the nasality of the following stop (C_2). When C_1 is a nasal stop and C_2 is an oral stop, the nasal stop is always homorganic to the following oral stop as in *whimper*, *winter*, and *wri[ŋ]kle*. No heterorganic sequences such as **nk*, **np*, or **mt* are attested. On the other hand, when the first stop is oral and the second stop is nasal, the oral stop can be of any place: witness *signify*, *open* and *button*.⁴⁰ Sequences that consist of only oral stops or only nasal stops fall between the two extremes and allow independent noncoronal place features preconsonantly, but coronal place is not allowed. Thus, *damnation* and *chimney* are possible but no **nm* sequences are found; *chapter*, *factor*, *abdomen* and *napkin* are possible but no **tk* or **tp* sequences are found. This is summarized schematically in (150).

⁴⁰ Sequences of an oral stop followed by a nasal stop are rare in English, presumably because these sequences violate the Sonority Sequencing Principle. Here, following Yip (1991), I include sequences where the nasal is syllabic. The /t/ in *button* is usually debuccalized in American English, as has been

(150) Place restriction on C1 in stop sequences (English)

		Less restricted →	
Less restricted ↓	C1↓ C2→	Oral	Nasal
	Nasal	Homorganic only	Noncoronal only
	Oral	Noncoronal only	Any

Attic Greek

The same gradience in place restriction patterns is also found in Attic Greek. The data come from Steriade (1982) and Yip (1991). In sequences of stop plus stop within a word, the number of independent place features licensed in the first stop position differs depending on the nasality of the two stop consonants. When C1 is nasal and C2 is oral, only homorganic clusters are possible, as shown in (151)a. On the other hand, when C1 is oral and C2 is nasal, C1 can be of any place. This is shown by the examples given in (151)b.

- (151) a. *pep^hant^he* 'you have been revealed'
p^het^henktos 'uttered'
pemptos 'sent'
- b. *tm̥ɛ:tos* 'cut'
pneq: 'to breather'.
ekse:melgmenon 'pressed out (of milk)'

When stops in sequences are both nasal stops or are both oral stops, only noncoronal place is allowed for the first stop. Thus, *ŋm* or *mn* sequences are attested, as shown in (152)a., but no sequences of **nm* or **nŋ* are found. Also, for oral stop clusters, sequences of labial plus coronal or dorsal plus coronal stops are found, as shown in (152)b., but no sequences of **tk*, **tp* etc. are possible. We have seen in section 3.1.2

discussed before. But, be advised that we are concerned here with generalizations on the morpheme structure, and the debuccalization in the output is not relevant.

(p.59) that when a coronal stop is followed by another stop, deletion applies. In sum, Attic Greek stop clusters show the same place restriction pattern found in English.

- (152) a. *zp^ht^heymai* 'voice'
mnɛ:mɔ:n 'mindful'
 b. *pemptos* 'sent'
t^helktron 'charm'
bdeluros 'disgusting'
kte:nɔ 'to kill'

(153) Place restriction on C1 in stop sequences (Attic)

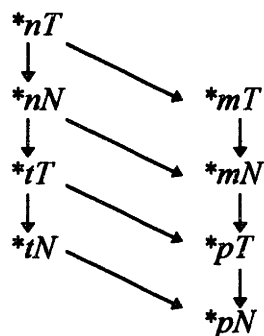
		Less restricted →	
Less restricted ↓	C1↓ C2→	Oral	Nasal
	Nasal	Homorganic only	Noncoronal only
	Oral	Noncoronal only	Any

To capture the gradience in place restrictions found in Attic Greek and English, we can further expand the nasality hierarchy in (154), repeated from (142), by conjoining it with the reversed markedness hierarchy in (155). According to Spaelti's (1997) hypothesis (p.91), the ranking of the original constraint hierarchies will be preserved, and the web of constraints represented in (156) is generated. The constraints are again represented in abbreviated form in (156). The small letters *p* and *m* are cover terms for noncoronal oral stops and noncoronal nasal stops, respectively. The arrows represent strict rankings.

(154) **nT* » **nN* » **tT* » **tN*

(155) **PL[COR]/__ C* » **PL[PER]/__ C*
 |
 ∅

(156)



Again, assuming Richness of the Base, I assume that generalizations about morpheme structure are derived from the same constraints that regulate the surface patterns. In English and Attic Greek, when C_1 is nasal and C_2 is oral, neither coronal nor noncoronal place is independently licensed for C_1 . Thus, the markedness constraints $*nT$ and $*mT$ are undominated and crucially dominate relevant faithfulness constraints.

(157) $*nT \gg *mT \gg \mathbf{F} \Rightarrow$ *winter, wimper, wrinkle* but $*nk, *mt$ etc.

As for clusters of nasal stop plus nasal stop, only noncoronals are allowed in the first position. Thus, the constraint against a coronal stop in this position, $*nN$, must outrank relevant faithfulness constraints, but the constraint against a noncoronal stop in this position, $*mN$, is dominated by faithfulness constraints.

(158) $*nN \gg \mathbf{F} \gg *mN \Rightarrow$ *chimney, damnation* but $*nm$

Clusters of oral stop plus oral stop follow the same restriction as nasal stop clusters: the first position of oral stop clusters is restricted to noncoronals only. Thus, the ranking in (159) holds.

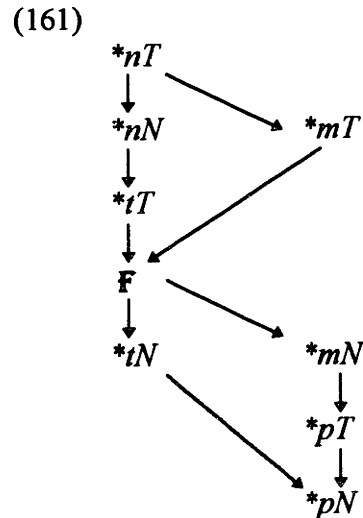
(159) $*tT \gg \mathbf{F} \gg *pT \Rightarrow$ *chapter, actor, napkin* but $*tk, *tp$

Finally, a cluster of oral stop plus nasal stop is the least restricted in possible place features for C_1 . C_1 can be of any place and the markedness constraints against place

features in this position, $*tN$ and $*pN$, are both dominated by faithfulness constraints and inactive.

(160) $F \gg *tN \gg *pN \quad \rightarrow \quad \text{open, button, signify}$

To summarize, the place restriction patterns in preconsonantal position (C_1) vary depending on the nasality of C_1 and C_2 in Attic Greek and English. This effect is modeled by conjunction of place markedness constraints with the nasality constraint hierarchy. The ranking of these conjoined constraints relative to faithfulness constraints for Attic Greek and English is summarized in (161).



In the current section, we discussed cases where the restriction against independent place features in preconsonantal position (C_1) is variably enforced depending on the nasality of a following stop C_2 as well as the nasality of the stop itself (C_1). We focused especially on variability of the restriction against coronal stops in this position. We proposed that these restriction patterns can be understood when one takes into account the effect of nasality on the perceptual salience of place cues. A series of markedness

constraint hierarchies have been projected from the perceptibility scale and also through conjoining these hierarchies with each other.

Chapter 4 Coronal unmarkedness

In this chapter, I will demonstrate that the coronal-unmarked pattern is ubiquitous and is truly a default pattern. Unlike the limited contexts in which the reversed markedness pattern is found, the contexts that exhibit coronal *un*markedness are not necessarily restricted to a specific segmental position (such as nonprevocalic position), nor are they restricted to languages with a particular inventory structure. The omnipresence of the coronal unmarked pattern follows from the context-free markedness constraint hierarchy (P&S) that treats coronal place as unmarked by default. These constraints act as meta-constraints from which further markedness constraints are generated through local conjunction (cf. Smolensky 1995). Since the markedness constraints themselves are context-free, they are potentially applicable to any phenomena that might involve a place feature restriction. Given any context-sensitive place markedness constraint that prohibits a place feature in context X ($*PL[\alpha]/X$), the conjunction of this constraint with Prince and Smolensky's markedness constraints ($*PL[PER] \gg *PL[COR]$) will generate a new hierarchy of context-sensitive place markedness constraints ($*PL[PER]/X \gg *PL[COR]/X$). Thus, for any context X, where a constraint against a place feature in that position $*PL[\alpha]/X$ is warranted, we expect to find the coronal unmarkedness pattern attested in some language.

In the first part of the chapter (4.1), I will discuss various cases of coronal unmarkedness whose contexts are not defined as nonprevocalic position. In the second part (4.2), I will discuss cases of coronal unmarkedness whose contexts are defined as

nonprevocalic and show that the coronal unmarked pattern is attested regardless of whether the coronal inventory of the language contrasts sub-coronal places or not.

4.1 Context-free coronal unmarkedness

In this section, I will present evidence that coronal consonants behave as unmarked relative to noncoronal consonants even in positions that are not preconsonantal or word-final. This contrasts with the reversed markedness pattern we discussed in the previous chapter; the reversed markedness pattern is restricted exclusively to nonprevocalic position, i.e., preconsonantal or word-final position. (162) provides a list of coronal unmarkedness cases discussed in this section along with the markedness constraints that account for the pattern.

(162)

- | | |
|---|--|
| • Inventory favors coronal over noncoronal consonants | $*\text{PL}[\text{PER}] \gg * \text{PL}[\text{COR}]$ |
| • Epenthetic consonants are more likely to be coronal | $*\text{PL}[\text{PER}] \gg * \text{PL}[\text{COR}]$ |
| • Coronal consonants are often immune to The OCP | $*\text{PL}[\text{PER}]^2 \gg * \text{PL}[\text{COR}]^2$ |
| • Coronal consonants may participate in vocalic spreading | $*\text{PL}[\text{PER}, \text{X}] \gg * \text{PL}[\text{COR}, \text{X}]$ |

4.1.1 Inventory generalizations

According to Maddieson (1984), if a language has any voiceless stop, it always has /t/, and if a language has any nasal, it always has /n/, with only a few exceptions in over 300 languages surveyed.⁴¹ For example, unlike Korean, which contrasts a coronal nasal with one or more noncoronal nasals (/n, m, ŋ/), Tlingit, Chipewyan, Wichita, Yuchi and S. Anbiquara have only one primary nasal consonant and it is an alveolar or dental nasal. Since these languages as a whole restrict nasal consonants to coronal place only, the

⁴¹ However, this does not hold for voiced stops. /b/ is the most common voiced stop in the inventories of languages.

restriction pattern is not confined to a nonprevocalic position. The choice of coronal nasal as the sole nasal in these language is derived from Prince and Smolensky's (1993) context-free markedness hierarchy.

(163) *PL[PER] » *PL[COR]

By the assumption of Richness of the Base (Smolensky 1996), the limitations on segmental inventory are considered outputs from a rich base, not as a stipulated restriction on input. This allows one to derive inventory generalizations from the same set of constraints that regulate surface alternations. In Korean, where the nasal stop inventory contrasts three places (labial, dorsal and coronal), the faithfulness constraint on place feature, MAX(PL[α]), dominates the place markedness constraints. As a result, a coronal nasal and noncoronal nasals faithfully surface in the output. This is shown for a labial nasal in (164).

(164) Korean: /m/ → m

	/m/ [Lab]	MAX (PL[α])	*PL[PER]	*PL[COR]
a. m [Lab]			*	
b. n [Cor]		*!		*

On the other hand, in Chipewyan, where the inventory contains only a coronal nasal but no labial or dorsal nasal, the markedness constraint against labial place ranks above the faithfulness constraint MAX(PL[α]). Therefore, a hypothetical input /m/ will be neutralized to [n], as shown in (165), or to some other output which does not contain [m], depending on the ranking of other constraints.

(165) Chipewyan: Hypothetical /m/ → n

	/m/ [Lab]	*PL[PER]	MAX (PL[α])	*PL[COR]
a.	m [Lab]	*!		
b.	n [Cor]		*	*

4.1.2 Epenthesis

Among consonants with supralaryngeal places, coronal consonants are the preferred epenthetic consonants (Lombardi 1997).⁴² Axininca Campa is probably the most well-known case of coronal epenthesis through recent discussion in McCarthy and Prince (1993). Hiatus across a stem-suffix boundary is resolved by /t/ epenthesis (*i + N + koma + i* → *iŋkomati* ‘he will paddle’) (Payne 1981). In Tunica, phrase-final words are required to end in a consonant, and in most cases of vowel-final words, /n/ is inserted (*hatika* ‘again’ → *hatikan*, phrase-finally) (Hass 1940). In a language game in Fula, the first two consonants in a word are reversed (*saare* → *raase* ‘concession’) but when the first two consonants are identical, the second consonant is replaced by /n/ (*baaba* → *baana* ‘father’) (Bagemihl 1989). In Odawa, a hiatus across a personal prefix and a stem is resolved by /t/ epenthesis (*ki-akat-i* → *kitakaci* ‘you are shy’) (Piggot 1980). In Amharic, /t/ is used to fill the last template position in certain biliteral roots (/fj/ ‘consume’ → *fäjjä* but *fäjto*, *mäffjät*). Also, certain verbal suffixes that appear as [u] after a consonant appear as [w]

⁴² Lombardi (1997) shows that a glottal consonant is by far the most frequent choice for consonantal epenthesis. Since I am concerned with the asymmetry among supralaryngeal places, the prevalence of glottal consonants as epenthetic elements is not relevant.

after a nonround vowel, but as [t] after [o, u] (MASC. OBJ. /u/ : *läbsa-w* ‘her having dressed him’ but, *läbso-t* ‘his having dressed him’) (Broselow 1984). In French, a coronal consonant is often added at the juncture between a stem and a derivational suffix. Some examples are *tabatière* [tabatʲer] ‘tobacco pouch’ from *tabac* [taba] ‘tobacco’, *clouter* [klute] ‘to stud with nails’ from *clou* [klu] ‘nail’, *bazarder* [bazarder] ‘to get rid of’ from *bazar* [bazar] ‘bazaar’, *pianoter* [pjanote] ‘to strum on the piano’ from *piano* [pjano] ‘piano’ and *fer blantier* [ferblātje] ‘tinker’ from *fer blanc* [ferblā] ‘tin’ (Tranel 1981).⁴³

Note that coronal epenthesis is not restricted to any specific segmental contexts. In many cases, the epenthetic element appears in prevocalic position, while in others, as in Tunica, it appears in nonprevocalic position. This contrasts with the reversed markedness pattern, which is found only in nonprevocalic positions.

The preference for a coronal consonant over a noncoronal consonant as an epenthetic element follows naturally from the place markedness hierarchy. In Axininca Campa, for example, an ONSET violation across stem and suffix boundary is fixed by epenthesis of coronal stop /t/, not labial or dorsal stops /p, k/ (McCarthy 1993, Smolensky 1993). The markedness constraint against onsetless syllables, ONSET, forces epenthesis. The three candidates in (166) b.-d. do equally well for the purpose of avoiding an ONSET violation. So, the choice comes down to the place markedness constraint hierarchy. Candidate (b) with coronal stop epenthesis is chosen since it violates the low ranking constraint of the hierarchy, *PL[*COR*].

⁴³ I thank Michael Kenstowicz for pointing out the French phenomena to me and Marie-Hélène Côté for

(166) Axininca Campa /i-N-koma-i/ → *ijkomati* ‘he will paddle’

	/i-N-koma-i/ [Dor][Lab]	ONSET	*PL[PER]	*PL[COR]
a.	ij.ko.ma.i V [Dor][Lab]	*!	**	
b. ☞	ij.ko.ma.ti V \ [Dor][Lab][Cor]		**	*
c.	ij.ko.ma.pi V \ [Dor][Lab][Lab]		***!	
d.	ij.ko.ma.ki V \ [Dor][Lab][Dor]		***!	

4.1.3 Coronal transparency

Coronal consonants are also special in that vowel features may be allowed to spread across coronal consonants but not across labial or dorsal consonants in some languages. According to Paradis and Prunet (1989b), in Guere, a single morpheme cannot contain more than one non-high vowel. Thus, morphemes with two high vowels, or with one high vowel and one non-high vowel, are found, but a morpheme with two non-high vowels is unattested, as shown in (167). There are two exceptions to this generalization. One is CVV stems with two identical vowels (cf. (168)). The other is CVCV stems where the intervening consonant is a coronal (cf. (169)). Paradis and Prunet (1989b) propose that the two non-high vowels in these apparent exceptions are doubly linked to a single set of vowel place features and this double linking of vowel features is possible only through a coronal consonant.

referring me to Tranel (1981).

(167)

V1↓ V2→	[+High]	[-High]
[+High]	<i>nimi</i> ‘animal’, <i>būi</i> ‘ashes’	<i>nime</i> ‘bird’, <i>ciã</i> ‘learn!’
[-High]	<i>zegu</i> ‘chameleon’, <i>boũ</i> ‘foot’	<i>*zegu</i> , <i>*boũ</i>

(168) *baa* ‘manioc’ *yee* ‘to dry’

(169) *wadɔ* ‘to wash’ *bede* ‘to hang’ *duɗu* ‘chest’
sodɔ ‘lose weight!’ *podɔ* ‘mud’

According to Paradis and Prunet (1989b), in Fula vowel spreading occurs only across coronal consonants. In verbal inflections, for example in suffixes of V(V)CV(V) type, vowels are all identical if the intervening consonant is /t/ (-*oto* ‘I₃M’, -*ete* ‘I₃P’, -*ata* ‘I₄A’, -*otoo* ‘I₄M’, -*etee* ‘I₄P’) but not if the consonant is /m/ (-*iima* ‘P₃M’).


According to McCarthy (1993, 1994), in Bedouin Arabic a short /a/ vowel in a non-final open syllable is raised ɔ → [i] (/sakan/ → *sikan* ‘he dwelled’). The raising is blocked when the low vowel is next to a guttural consonant, presumably because the [Pharyngeal] feature of the guttural consonant spreads to the vowel (/hajar/ → *hajar* **hijar* ‘he abandoned’, /saʔal/ → *saʔal* **siʔal* ‘he asked’). The raising is also blocked when the low vowel is followed by a coronal consonant (*l, n, r*) and another low vowel /a/ (/ʃanag/ → *ʃanag* **ʃinag* ‘he beheaded’, /jalas/ → *jalas* **jilas* ‘he sat’). On the other hand, if the intervening consonant is a labial or a dorsal, the raising is not blocked (/taga:samaw/ → *tiga:simaw* ‘they shared’). A similar blocking of vowel raising is reported for Rwaili Arabic (Kaun 1993, based on Parkinson 1993). Likewise, in the Southern Italian dialect Davoli, stressed vowels copy a following unstressed vowel across non-geminate sonorant

coronal consonants /l, r, n, d/: *fuori* ‘abroad’ [hɔʔrɜ], *luna* ‘moon’ [luʔnɜ], *stella* ‘star’ [stiʔdʒ], *coltello* ‘knife’ [kurteʔdu] (Marotta and Savoia 1991).⁴⁴

McCarthy (1994) proposes that the apparent transparency of coronal consonants to vowel spreading is due to the low ranking of a coronal place markedness constraint. This again shows that the coronal unmarkedness phenomenon is not restricted to nonprevocalic position, unlike the reversed markedness phenomenon.

Here, I review McCarthy’s (1994) analysis of Bedouin Arabic vowel raising.⁴⁵ In Bedouin Arabic, a short /a/ vowel in a non-final open syllable is raised to [i]. The vowel raising is motivated by the markedness constraint against a syllable-final low vowel, *V/[PHAR]]_σ. By raising *a* to *i*, a violation of *V/[PHAR]]_σ is avoided, as shown in (170).⁴⁶ The constraint against a high vowel in an open syllable *V/[Hi]]_σ is dominated by *V/[PHAR]]_σ and this ranking chooses a high vowel over a low vowel, forcing vowel raising.

(170) Bedouin Arabic /sakan/ → *sikan* ‘he dwelled’

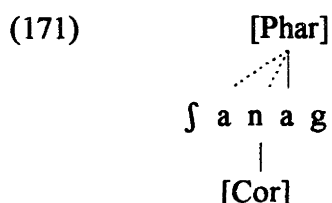
/sakan/ / \ [Phar] [Phar]		*V/[PHAR]] _σ	*V/[Hi]] _σ
a.	sakan / \ [Phar] [Phar]	*!	
b. 	sikan / \ [Hi] [Phar]		*

⁴⁴ I thank Michael Kenstowicz for referring me to this case.

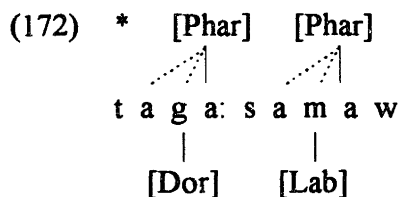
⁴⁵ I reformulated some parts of the analysis introducing constraint conjunction but the spirit of the analysis remains the same.

⁴⁶ For details of vowel raising contexts, readers are referred to McCarthy (1993).

Raising, however, is blocked when the low vowel is followed by a coronal consonant (*l, n, r*) and another low vowel /a/. McCarthy (1994) proposes that here the coronal consonants are not *transparent* to vocalic spreading. Rather, the [Pharyngeal] feature of the second low vowel spreads *through* the coronal consonant, as shown in (171). In other words, the intervening coronal consonants participate in the spreading process and they form complex segments specified for both [Coronal] and [Pharyngeal].



On the other hand, the option of spreading [Pharyngeal] through an intervening consonant as in (172) is not available when the consonant is labial or dorsal. If a [Pharyngeal] feature spreads through an intervening labial or dorsal feature, a complex segment specified for [Pharyngeal] and [Dorsal] or [Labial] will be created and this configuration is prohibited.



A constraint against a complex segment, *PL[α , X], is assumed. The reason that a violation of this constraint by coronal segments is tolerated while a violation of the constraint by noncoronal segments is not is again found in Prince and Smolensky's context-free markedness. Through local conjunction of *PL[α , X] with the context-free markedness constraints, we can derive the following constraint hierarchy. The conjoined

constraints inherit the ranking of context-free markedness constraints. This hierarchy dictates that it is worse to have a complex noncoronal segment than to have a complex coronal segment.

(173) *PL[PER, X] » *PL[COR, X].

By ranking the constraint against vowel raising *V/[Hi]]_σ, in between the two constraints in (173), the different behavior of coronal versus noncoronal segments in vowel raising is accounted for. When the intervening consonant is coronal as in (174), candidate b. with vowel raising violates *V/[Hi]]_σ while candidate c., which creates a complex coronal through vowel spreading, violates *PL[COR, X]. Since candidate c. violates a lower-ranking constraint than candidate b., candidate c. is chosen and vowel raising is blocked.


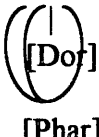
(174) Bedouin Arabic /ʃanag/ → ʃanag ‘he beheaded’

	/ʃanag/ / \ [Phar][Cor][Phar]	*V/[PHAR]] _σ ⁴⁷	*V/[Hi]] _σ	PL[COR, X].
a.	ʃanag / \ [Phar][Cor][Phar]	*!		
b.	ʃinag / \ [Hi][Cor][Phar]		*!	
c. ^{EF}	ʃanag () [Cor] [Phar]			*

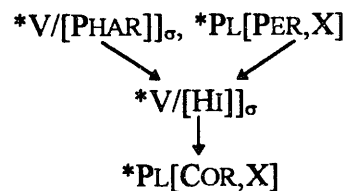
⁴⁷ This constraint is not violated by a doubly linked [Pharyngeal] in c.

On the other hand, $*\text{PL}[\text{PER}, \text{X}]$ dominates $*\text{V}[\text{Hi}]]_{\sigma}$, and when the intervening consonant is noncoronal as in (175), spreading the [Pharyngeal] feature through the consonant creates a complex dorsal segment (candidate c.). This candidate is ruled out due to its violation of high ranking $*\text{PL}[\text{PER}, \text{X}]$. Instead, vowel raising applies (candidate b.). A similar explanation is applicable to other cases of apparent coronal transparency. Finally, (176) summarizes the constraint ranking of Bedouin Arabic.

(175) Bedouin Arabic /sakan/ \rightarrow *sikan* 'he dwelled'

	/sakan/ / \\ [Phar][Phar]	$*\text{V}[\text{PHAR}]]_{\sigma}$	$*\text{PL}[\text{PER}, \text{X}]$	$*\text{V}[\text{Hi}]]_{\sigma}$
a.	sakan / \\ [Phar][Phar]	*!		
b. 	sikan / \\ [Hi][Phar]			*
c.	sakan  [Phar]		*!	

(176)



4.1.4 The Obligatory Contour Principle

The Obligatory Contour Principle (OCP) prohibits identical elements in a given domain (cf. Leben 1973, Goldsmith 1976). When applied to Place features, it prohibits homorganic segments from appearing in a given domain (McCarthy 1986, Yip 1989).

The OCP often selectively affects noncoronal consonants, providing another case of coronal unmarkedness that is truly context-free, since it does not depend on the position of coronals in segmental contexts. In Tashlhiyt Berber (Alderete 1997), Akkadian (McCarthy 1981, Yip 1988, based on Von Soden 1969) and the Cantonese Chinese secret language, La-mi (Yip 1982, 1988), the OCP is active for labial place and prohibits more than one labial consonant in a word. If through morphological operations, two or more labials were to come together in a word, the OCP forces one of the labial consonants to be changed into a coronal. This coronalization occurs even when there is another coronal consonant in the word. Obviously, here the OCP is not active for coronal place.

In Tashlhiyt Berber, only one labial consonant is allowed per stem. When a derivational prefix containing /m/ is added to a root including a labial, it dissimilates to [n]: /m-fara/ → *nfara* ‘disentangle, REF.’, /am-bur/ → *anbur* ‘remain celibate, AGENT.’; cf. *m-saggal* ‘look for, REF.’, *am-agur* ‘remain, AGENT.’. This change occurs even when the root contains a coronal consonant as in /m-b!dan/ → *nb!dan* ‘se séparer’, /am-jdam/ → *anjdam* ‘le contaminé’ showing that the OCP is inert for coronal place (Alderete 1997 based on Boukous 1987, Elmedlaoui 1992[1995] and Selkirk 1993). Likewise, Akkadian allows only one labial per root. When the nominal prefix *ma-* is added to a root including a labial, it dissimilates to *na-* (*napahr* ‘totality’, *neereb* ‘entrance’, *narkabt* ‘chariot’). Note that the coronalization applies even when the root already contains a coronal consonant. These phenomena comprise additional cases of coronal unmarkedness whose contexts are not restricted to specific segmental contexts, such as nonprevocalic position.

Alderete (1997) and Itô and Mester (1998) independently propose to formulate the OCP effect by self-local conjunction of markedness constraints. Specifically, Alderete (1997) formulates an OCP constraint against two independent labial place features in a stem as the local self-conjunction of *PL[LAB], shown in (177).

(177) *PL[LAB]²_{STEM}
: Ban any stem with two segments with independent Place specifications [Labial]
(Alderete 1997, p.11)

The reason that the OCP ban against identical place features is inert for coronal place is that the constraint created by self-conjunction of *PL[COR] ranks lower than one created by self-conjunction of *PL[LAB], maintaining the ranking of original meta-constraints. Thus, the following ranking holds.

(178) *PL[DOR]²_{STEM}, *PL[LAB]²_{STEM} » *PL[COR]²_{STEM} (Alderete 1997, p.12)

The ranking in (178) correctly chooses the delabialized form [n] of the prefix /m/ when the root contains a labial consonant even when the root contains another coronal consonant, as in /m-kaddab/ → *nkaddab* ‘consider a liar’, in Tashlhiyt Berber. In (179), the faithful candidate a., which contains two independent [Labial] features, violates the high-ranking OCP constraint on labial place, *PL[LAB]²_{STEM} while candidate b., which turns the labial nasal into a coronal nasal, violates the low-ranking OCP constraint on coronal place. Therefore, candidate b. is optimal.

(179) Tashlhiyt Berber /m-kaddab/ → nkaddab ‘consider a liar’

	/m-kaddab/ / √ \ [Lab][Cor][Lab]	*PL[LAB] ² _{STEM}	MAX(PL[α])	*PL[COR] ² _{STEM}
a.	m-kaddab / √ \ [Lab][Cor][Lab]	*!		
b.	n-kaddab / √ \ [Cor][Cor][Lab]		*	*

In this section, we saw that coronal unmarkedness is attested in various phenomena ranging from inventory restriction and epenthesis to the OCP and vocalic spreading. The cases discussed in this section show that unlike the reversed markedness pattern (i.e., coronal markedness), in some languages, the coronal unmarkedness pattern is truly context-free. OT analyses employing Prince and Smolensky’s context-free markedness constraints and their extension through local conjunction have been reviewed.

4.2 Coronal unmarkedness: nonprevocalic position

Because the default place hierarchy is independent of any particular context, we expect to find that it can conjoin with any context-specific constraint. Such conjunction predicts neutralization of place contrasts to coronal place in any weak contexts, including the nonprevocalic contexts in which the reversed markedness pattern is attested. This prediction is correct. It is the cases of default markedness in nonprevocalic position that I will discuss in this section. Furthermore, the default hierarchy makes no reference to sub-coronal distinctions. It predicts, therefore, that the existence of coronal unmarkedness in languages should be independent of the coronal inventory of that language. This prediction is also borne out, as the list of languages showing coronal unmarkedness in nonprevocalic position, given in (180), shows.

(180) Cases of coronal unmarkedness in nonprevocalic position

- Languages with sub-coronal contrasts : Lardil, Tamil, Nunggubuyu, Telugu etc.
- Languages without sub-coronal contrasts : Hindi (nasal), Sri Lanka Portuguese, Finnish, Attic Greek, Spanish

This again follows from the fact that Prince and Smolensky's markedness constraints are context-free. Through local conjunction of these constraints with any other context-sensitive place markedness constraint, Prince and Smolensky's coronal unmarkedness hierarchy is applicable to any context where a place restriction is found.

The current section is organized as follows. In 4.2.1, I derive the context-sensitive markedness hierarchy in (181) through local conjunction of Prince and Smolensky's markedness hierarchy and the constraint against nonprevocalic place features, $*PL[\alpha]/_ \sim V$.

(181) $*PL[PER]/_ \sim V \gg *PL[COR]/_ \sim V$

Then, I present cases of coronal unmarkedness in nonprevocalic position in languages *with* sub-coronal place contrasts for stops (4.2.2) and languages *without* sub-coronal contrasts (4.2.3), along with OT analyses of these phenomena.

4.2.1 Nonprevocalic position as the locus of place contrast reduction

Recall from section 2.3.1 (p.37) that the perceptual cues for place features in nonprevocalic position are relatively weaker than the corresponding cues in prevocalic position. We can posit the perceptibility scale of place features given in (182); the cues for place of articulation in prevocalic position are more salient than the cues for place of articulation in nonprevocalic position. We can convert this perceptibility scale into a markedness hierarchy in (183): it is worse to have an independent place feature in

nonprevocalic position than it is to have an independent place feature in prevocalic position.

(182) $Pl[\alpha]/_V \succ Pl[\alpha]/_ \sim V$

(183) $*PL[\alpha]/_ \sim V \gg *PL[\alpha]/_ V$

In many languages of the world, the constraint against a nonprevocalic place feature is undominated. For example, in Japanese, nonprevocalic consonants cannot be specified for an independent place feature (Itô 1986, Vance 1987, Trigo 1988, Cho 1990, Yip 1991). Consonants in preconsonantal position are always homorganic to a following consonant and the only consonant allowed in word-final position is a placeless nasal glide, *N*. Examples are given in (184).

- (184) a. *sensee* 'teacher'
kampai 'cheers'
gakkoo 'school'
kappa 'legendary being'
tossa 'impulsively'
minna 'everyone'
amma 'masseur'
- b. *sekkeN* 'soap'
zeN 'goodness'
hoN 'book'

So far, I have not distinguished preconsonantal position from word-final position and have referred to them together as nonprevocalic, representing them together as $\sim V$ for convenience. However, the perceptibility of place features in the two contexts is not identical, and the two positions often show different place restriction patterns. Unlike in Japanese, in Diola Fogny, the place restriction is active only for preconsonantal position but not for word-final position (Sapir 1965, Itô 1986, Yip 1991).

- (185) a. *mba* 'or' *famb* 'annoy'
ndaw 'man's name' *bunt* 'lie'
kaŋg 'be furthest away'
mañj 'know'
- b. *ni-gam-gam* → *nigaŋgam* 'I judge'
na-tiŋ-tiŋ → *natintiŋ* 'he cut through'
ku-boñ-boñ → *kubomboñ* 'they sent'

I will assume two separate versions of the constraint in (183), given in (186). Now, by conjoining these context-sensitive place markedness constraints with Prince and Smolensky's context-free markedness constraints, we can derive context-sensitive markedness constraint hierarchies in (187). I will refer to either of these hierarchies as appropriate in the following discussion.

(186) *PL[α]/__C, *PL[α]/__#

(187) a. *PL[PER]/__C » *PL[COR]/__C

b. *PL[PER]/__# » *PL[COR]/__#

The reversed markedness hierarchies that drive the coronal markedness pattern we discussed in the previous chapter are repeated below in (188). The two sets of hierarchies in (187) and (188) coexist and the ranking of these hierarchies relative to each other is not universally fixed. So, depending on the particular ranking chosen by individual languages, either a coronal markedness or unmarkedness pattern may be found in nonprevocalic position.

(188) a. *PL[COR]/__C » *PL[PER]/__C

|
 ∅

b. *PL[COR]/__# » *PL[PER]/__#

|
 ∅

The reader will be reminded that the perceptually grounded markedness constraints against coronal place in (188) are violated by a coronal consonant only in languages without sub-coronal contrasts and, thus, the reverse markedness pattern is predicted to occur only in languages without a sub-coronal contrast. But, the constraint hierarchies in (187) can be active regardless of the coronal contrasts in a language. Thus, we expect to find the coronal unmarkedness pattern both in languages with and without a sub-coronal place contrast. Now, equipped with the context-sensitive markedness hierarchies in (187), we can turn to individual cases of coronal unmarkedness in nonprevocalic position and their analyses.

4.2.2 Sub-coronal place contrasts and coronal unmarkedness

In this sub-section, I show that unlike the coronal markedness pattern, the coronal unmarked pattern is found in languages with sub-coronal place contrasts for stops. Coronal unmarkedness is attested in various processes such as segmental deletion, vowel syncope, place assimilation and static morpheme structure constraints.

4.2.2.1 Deletion

Lardil

Australian languages in general have multiple coronal contrasts in oral and nasal stops. All Australian languages contrast at least two sub-coronal places for stops, one apical and one laminal. In many, there are further contrasts between two apical stops (alveolar versus retroflex) and/or two laminal stops (dental versus alveo-palatal). According to Hamilton (1993b), in 36% of Australian languages, coronal stops have a

four-way contrast in place of articulation. As a survey by Hamilton (1996) shows, in Australian languages, if preconsonantal position or word-final position allows a noncoronal stop, then that position always allows coronal stops; in addition, a significant number of Australian languages allow only coronal consonants in preconsonantal⁴⁸ and word-final position.⁴⁹

Lardil is a well-known example of this restriction (Hale 1973, Wilkinson 1988). Lardil contrasts four places of articulation for coronal stops. The stop inventory of Lardil is given in (189). Only coronal consonants (except for lamino-dental consonants)⁵⁰ are allowed in the coda position and when a noncoronal consonant appears in word-final position, it is truncated, as shown in (190)a. No truncation occurs for a coronal stop in (190)b.

⁴⁸ Arabana, Alyawarra, Arrernte, Baagandji, Badimaya, Bardi, Bidyara, Bularnu, Diyari, Djabugay, Djaru, Dyirbal, Gaagudju, Garawa, Garlali, Gog-Narr, Gooniyandi, Gugada, Jiwarli, Kalaktungu, Kayardild, Kaytetye, Kitja, Kukatj, Kuku-Yalanji, Kuuku-Ya'u, Mantjiltjarra, Marrgany, Mbabarram, Muruwari, Nganyaywana, Ngawun, Ngiyambaa, Nhukunu, Nunggubuyu, Nyangumarta, Nyawaygi, Nyigina, Nyungar, Olkol, Panyjima, Payungug, Pintupi, Pitta-Pitta, Uradhi, Walmatjarri, Warlmanpa, Warumungu, Wembawemba, Yandruwanhdaha, Yankuntjatjarra, Yanyuwa, Yawuru, Yaygir, Yidiny, Yindjibarndi, Yukulta and Yuwaalarray.

⁴⁹ Bidyara-Gungabula, Yindjibarndi, Kalkagungu, Payungu, Uradhi, Marrgany-Gunya, Kuuku-Ya'u and Umpila, Ngiyambaa, Yuwaalaraay, Mantjiltjarra, Gaagudju, Kuku-Yalanji, Pintupi, Warumungu, Watjarri, Muruwari, Ngawun, Guugu-Yimidhirr, Jingli.

⁵⁰ A similar restriction of word-final position to coronal consonants except for lamino-dentals is found in many other Australian languages: Bidyara-Gungabula Yindjibarndi, Uradhi, Payungu, Kalkagungu and Ngawun (Hamilton 1996). The dispreference for lamino-dental consonants in this position is also found even when noncoronal stops are allowed in the position; languages such as Ritharrngu, Kitja, Djapu and Djambarrpuyngu allow consonants of all places of articulation in word-final position except lamino-dental. Following Hamilton (1996), I assume that this restriction is due to similarity of lamino-dental stops to apico-alveolar stops. In nonprevocalic positions, these stops are distinguished solely by VC transitions and this contrast is neutralized to an apico-alveolar. Thus, I assume that there is a high-ranking constraint that regulates a paradigmatic contrast of dental and alveolar stops. This constraint requires two contrasting sounds to have a minimum acoustic distance (cf. The MINDIST of Flemming 1995) and the contrast between dental and alveolar stops does not meet this requirement.

(189) Lardil stop inventory (Hale 1973)

Labial	Lamino-Dental	Apico-Alveolar	Apico-dorsal	Lamino-alveolar ⁵¹	Velar
p	t̪	t	ɬ	c	k
m	ɱ	n	ɳ	ɲ	ŋ

- (190)
- | | | | | |
|----|---------------------------|------------|----------|------------------|
| | | NOMINATIVE | | NONFUT ACC. |
| a. | /muʃkunima/ ⁵² | → | muʃkuni | ‘fighting stick’ |
| | /ɲaluk/ | → | ɲalu | ‘story’ |
| b. | /pirɲen/ | → | pirɲen | ‘woman’ |
| | /kentapal/ | → | kentapal | ‘dugong’ |
- cf. *muʃkunima-n*
cf. *ɲaluk-in*
cf. *pirɲen-in*
cf. *kentapal-in*

The asymmetry between coronal and noncoronal consonants in Lardil and other Australian languages follows from the markedness constraint hierarchy in (191). The relevant faithfulness constraints rank between the two markedness constraints, such that only noncoronal consonants are avoided in nonprevocalic position while coronal consonants remain stable.

- (191) *PL[PER]/__C, # » MAX-C » *PL[COR]/__C, #

In (192), when a stem ending in a noncoronal consonant /k/ appears in isolation, the noncoronal consonant is truncated. Due to a fatal violation of the markedness constraint against a word-final noncoronal place feature, the faithful candidate a. is ruled out. Candidate b., with truncation, is optimal, despite a violation of the faithfulness constraint against segmental deletion, MAX -C.

⁵¹ Lamino-alveolar stops are transcribed as /tʲ, nʲ/ in Hale (1973).

⁵² An independent process of final vowel deletion is at work.

(192) Lardil /ɲaluk/ → *ɲalu* 'story, NOM.' cf. *ɲaluk-in* NONFUT. ACC.

	/ɲaluk/ [Dor]	*PL[PER]/__#	MAX-C
a.	ɲaluk [Dor]	*!	
b.	ɲalu		*

On the other hand, no truncation applies to a stem ending in a coronal consonant.

In (193), the faithfulness constraint outranks the markedness constraint against a word-final coronal place; candidate b., with truncation, is ruled out due to its violation of the higher ranking faithfulness constraint. The faithful candidate is selected as optimal as a result.

(193) Lardil /pirɲen/ → *pirɲen* 'woman, NOM.'⁵³

	/pirɲen/ [Cor]	MAX-C	*PL[COR]/__#
a.	pirɲen [Cor]		*
b.	pirɲe	*!	

⁵³ Coronal consonants in multiple-coronal languages are specified for coronal dependent features as shown here, but I will not represent the dependent structure unless it is relevant for the discussion at hand.

/pirɲen/
|
[Cor]
|
[-Dist]
|
[+Ant]

4.2.2.2 Place assimilation

Nunggubuyu

Nunggubuyu is another example of an Australian language that shows the coronal unmarkedness pattern in nonprevocalic position (Heath 1984). In Nunggubuyu, place assimilation and segment deletion conspire to avoid a noncoronal stop in preconsonantal position. Nunggubuyu also contrasts four places of articulation for coronal stops, as shown in (194). The interdental nasal is quite rare and its phonemic status is only marginal.

(194) Nunggubuyu stop inventory (Heath 1984)⁵⁴

Labial	Interdental	Alveolar	Retroflexed	Lamino-alveolar	Velar
p	t̪	t	ɽ	c	k
m	(ɳ)	n	ɳ	ɲ	ŋ

Unlike Lardil, Nunggubuyu does not restrict the word-final position to coronal consonants.⁵⁵ Preconsonantal position, on the other hand, allows only coronal consonants.

(195) lists heterorganic morpheme-internal stop clusters attested in Nunggubuyu (Heath 1984, Hamilton 1996). Some examples are given in (196). As in Lardil, all coronal stops except (inter)dental stops are found preconsonantly, but labial or dorsal stops are not.⁵⁶

(195)	Alveolar-initial	Retroflex-initial	Laminoalveolar-initial
Nasal + Oral :	<i>np, nk, nc</i>	<i>ɳp, ɳk, ɳt, ɳc</i>	<i>ɲp, ɲk</i>
Nasal + Nasal :	<i>nm, nɳ</i>	<i>ɳm, ɳɳ, ɳɳ</i>	<i>ɲm, ɲɳ</i>
Oral + Oral :	<i>tp, tc</i>	<i>ɽp, ɽk, ɽt, ɽc</i>	<i>cp, ck</i>

⁵⁴ Heath (1984) transcribes the oral stops as voiced. However, as he notes, some of the stops are pronounced as fortis. I follow the convention adopted by Hamilton (1996) and transcribe the single series of oral stops in Australian languages with voiceless symbols.

⁵⁵ However, labial consonants /b, m/ are very rare and occur only in a handful of interjections (Heath 1984, p.19).

⁵⁶ The only exception to this generalization is a stem /la:ɳma/. While some speakers pronounce this stem with an /ɳm/ sequence, others have /la:ma(k)/.

- (196) a. AlveolarC *manpa* 'armband'
 munṡu 'shrub sp.'
 (*w*)*atpaṡ* 'grevillea'
 -*w*₂*atca-* 'to hit'
- b. RetroflexC *manṡpa* 'tree sp.'
 munṡma 'tree sp.'
 -*w*₁*aṡṡa-* 'to get bogged'
- c. LaminoalveolarC *maṡṡmaci* 'deserted (place)'
 -*w*₂*aṡṡkala-* '(fish) to move around'
 paṡpara 'mat'

The restriction of preconsonantal position to coronal consonants holds not only for morpheme-internal sequences but also for sequences across a morpheme boundary. When a velar stop would be followed by a heterorganic consonant across a morpheme boundary, various changes occur such that no velar stop is found before a heterorganic consonant. Labial stops /m, b/ do not occur in relevant positions. So, it cannot be shown whether they undergo these processes or not. Depending on whether the velar stop itself is a nasal or not and also whether the following stop is a nasal or not, a velar stop undergoes either assimilation or deletion. But no corresponding change occurs to a coronal stop followed by a heterorganic stop.⁵⁷

(197) Changes to velar stop-initial sequences

C1↓	C2→	nasal stop	oral stop
<i>ŋ</i>		deletion	assimilation
<i>k</i>		deletion	deletion

First, a velar nasal /ŋ/ assimilates to the place of articulation of a following oral stop except in artificially slow speech, as the examples in (198)a. demonstrate. But a

⁵⁷ Before a liquid, both velar and coronal stops are deleted.

coronal nasal remains unassimilated, as shown in (198)b.⁵⁸ Before a nasal consonant, a velar nasal /ŋ/ is deleted, but again, a coronal nasal remains, as shown in (199)a. and b., respectively.

If a velar stop /k/ is followed by another consonant, it always deletes regardless of the nasality of the following consonant, as (200)a. and (201)a. show. But coronal stops remain stable, as shown in (200)b. and (201)b.⁵⁹

(198)	a.	<i>kulmuŋ</i>	'belly'	<i>ama-kulmun-tuc</i>	LOCATIVE
				<i>ama-kulmum-pac</i>	PERGRESSIVE
				<i>ama-kulmuŋ-ciŋuŋ</i> ⁶⁰	RELATIVE
	b.	<i>man</i>	'group'	<i>man-payama</i> , * <i>mambayama</i>	'(group) to keep going'
		<i>ta:n</i>	'guts'	<i>ta:n-kara-kayi-</i> '-', * <i>ta:ŋkarakayi</i>	'to have a bellyache'
(199)	a.	<i>wulaŋ</i>	'blood'	<i>wula-miri</i>	'by means of blood'
		<i>ɬalamaŋ</i>	'broken-off branch'	<i>ɬalama-na-</i>	'to see broken-off branch'
	b.	<i>ɬaman</i>	'white emu down'	<i>ɬaman-miri</i>	'by means of white emu down'
		<i>naruŋ</i>	'basket'	<i>naruŋ-miri</i>	'by means of a basket'
		<i>ma:ɾɲ</i>	'snake'	<i>ma:ɾɲ-miri</i>	'by means of a snake'
(200)	a.	<i>-ninik-</i>	'soft'	<i>-nini-pi-</i>	V. DERIVATIVE
		<i>wuluk</i>	'honey-eating material'	<i>ama-wulu-tuc</i>	LOCATIVE
				<i>amawulu-ciŋuŋ</i>	RELATIVE
	b.			<i>amawulu-kuy</i>	ALLATIVE-DATIVE
		<i>mic</i>	PL.	<i>mic-pawan-ɲic</i>	'father and child dyad'
				<i>mic-kulmur</i>	'young circumcised men'
(201)	a.	<i>mantak-</i>	PL. COLLECTIVE.	<i>manta-maɾakaric</i>	'dangerous group'
				<i>manta-ŋɲɲmaa-</i>	'[all] examine each other'

⁵⁸ According to Heath (1984), /-w₂an-/ (B morpheme) is the only example where /n/ undergoes nasal assimilation or nasal deletion. However, the underlying form /n/ is posited based on a "maximally abstract analysis" (Heath 1984, pp.70-71).

⁵⁹ Alveopalatal consonants /y, ɲ, c/ are also deleted under certain conditions but the deletion is mainly restricted to before another *coronal* consonant, which is different from the general deletion process found for /k/. I assume that the deletion of alveopalatal consonants before another consonant is due to an OCP-type constraint against two adjacent [Coronal] specifications: *PL[*COR*]²_{ADJ}. I assume that corresponding constraints for noncoronal places are always satisfied because sequences of labial or dorsal consonants are always homorganic and they can be represented with a doubly linked place feature.

⁶⁰ Heath (1984) notes that sometimes, the velar nasal is realized as /n/ before /c/ rather than as /ɲ/.


b.	<i>yimpiṭ</i>	‘cypress (wood)’	<i>yimpiṭ-miri</i> ~ <i>yimpiṇ-miri</i> ⁶¹	‘by means of cypress (wood)’
	<i>-ṭuluc-</i>	‘shadow’	<i>-ṭuluc-na-</i> ~ <i>-ṭuluṇ-na-</i>	‘to see shadow’
	<i>-ḷuṭ-</i>	‘power(ful)’	<i>-ḷuṭ-ṇawi-</i> ~ <i>-ḷuṇ-ṇawi-</i>	‘to die after struggle’

The contrast between dorsal and coronal consonants follows when the faithfulness constraint against place assimilation, MAX(PL[α]), and the faithfulness constraint against segmental deletion, MAX-C, rank between the two markedness constraints in the context-sensitive default markedness hierarchy in (202).

(202) *PL[PER]/__C » MAX(PL[α]), MAX-C » *PL[COR]/__C

First, the place assimilation in dorsal nasal plus oral stop clusters is derived in (203). The faithful candidate a. has a dorsal nasal before another consonant, which fatally violates the markedness constraint against dorsal place. The candidate with nasal assimilation is selected as optimal.

(203) Nunggubuyu /ama-kulmuṇ-pac/ → *amakulmumpac* **amakulmuṇpac* ‘belly, PROG.’


	/ama-kulmuṇ-pac/ / \ [Dor][Lab]	*PL[PER]/__C	MAX(PL[α])
a.	<i>amakulmuṇpac</i> / \ [Dor][Lab]	*!	
b. 	<i>amakulmumpac</i> V [Lab]		*

On the other hand, the corresponding markedness constraint against a coronal consonant ranks below the faithfulness constraint. Therefore, no assimilation applies to

⁶¹ A stop followed by a nasal optionally nasalizes.

coronal nasal-initial clusters. In (204), the faithful candidate a. violates the constraint against a coronal stop, which ranks lower than the faithfulness constraint. The candidate with nasal assimilation is ruled out due to its violation of the faithfulness constraint.

(204) Nunggubuyu /man-payama/ → *manpayama* **mampayama* ‘(group) to keep going’

/man-payama/ / \ [Cor][Lab]	MAX(PL[α])	*PL[COR]/__C
a.  <i>manpayama</i> / \ [Cor][Lab]		*
b. <i>mampayama</i> V [Lab]	*!	

When a dorsal nasal is followed by another *nasal* consonant, segmental deletion, rather than place assimilation, applies. The reason that the entire segment deletes, rather than simply assimilating in place to the following nasal, is a ban against a geminate consonant. According to Heath (1984), geminate sequences are not allowed underlyingly and a sequence of identical consonants across a word-boundary is actively eliminated (/ama-yi:mit-tuc/ → *amay:i:mituc* ‘on the apple tree’, /ŋanu-mun-naŋ/ → *ŋanumunaŋ* ‘I saw his foot’.) Thus, I assume that the constraint against geminates (*GEMINATE) is never violated in the language. In (205), the dorsal nasal is followed by a labial nasal across a morpheme boundary. The faithful candidate a. violates a high-ranking markedness constraint against a noncoronal consonant in preconsonantal position. If place assimilation applies to this nasal plus nasal sequence, the sequence would become a geminate and fatally violate *GEMINATE (candidate b.). As a result, the dorsal nasal deletes (candidate c.) even though it violates a faithfulness constraint against segmental deletion that candidate b. satisfies.

(205) Nunggubuyu /wulaŋ-miri/ → *wulamiri* **wulaŋmiri*, **wulammiri* ‘by means of blood’

	/wulaŋ-miri/ / \ [Dor][Lab]	*PL[PER]/__C	*GEMINATE	MAX-C	MAX(PL[α])
a.	wulaŋmiri / \ [Dor][Lab]	*!			
b.	wulammiri \/ [Lab]		*!		*
c.	wulamiri [Lab]			*	*

Again, this contrasts with a coronal stop-initial cluster, which does not undergo any change. This is due to the relatively low ranking of the markedness constraint against coronal consonants in this position. In (206), a coronal (retroflex) nasal is followed by a labial nasal and no change occurs. The markedness constraint against a coronal in this position is dominated by both faithfulness constraints, MAX-C and MAX(PL[α]), and no change occurs.

(206) Nunggubuyu /narun̥-miri/ → *narun̥miri* ‘by means of a basket’

	/narun̥-miri/ / \ [Cor][Lab]	MAX-C	MAX(PL[α])	*PL[COR]/__C
a.	narun̥miri / \ [Cor][Lab]			*
b.	narummiri \/ [Lab]		*!	
c.	narumiri [Lab]	*!	*	

When a dorsal oral stop is followed by another oral stop, the result is also deletion, not assimilation. This is also due to the ban on geminates. Segmental deletion applies,

avoiding a violation of *GEMINATE and the constraint against a noncoronal consonant in preconsonantal position.

(207) Nunggubuyu /amawuluk-cijun/ → *amawulucijun* ‘honey-eating material, LOC.’

	/amawuluk-cijun/ / \ [Dor][Cor]	*PL[PER]/__C	*GEMINATE	MAX-C	MAX(PL[α])
a.	amawulukcijun / \ [Dor][Cor]	*!			
b.	amawuluccijun \\ [Cor]		*!		*
c.	amawulucijun [Cor]			*	*

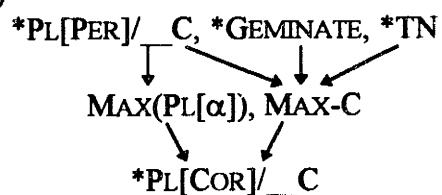
When a dorsal oral stop is followed by a nasal stop, the result is also deletion rather than assimilation. There is an independent process of nasal assimilation in the language that turns a sequence of oral stop plus nasal stop into a nasal stop cluster (/mic-ŋaŋanci/ → *miŋŋaŋanci* ‘girls’, /wu-ŋac-miri/ → *wuŋaŋmiri* ‘by means of firewood’). To conform to this pattern, a dorsal stop followed by a nasal stop would have to turn into a nasal. If assimilation applied on top of this nasalization, a geminate would be created. Thus, segmental deletion rather than place assimilation applies. In (208), the constraint that drives nasal assimilation is *TN. First, the faithful candidate a. is ruled out due to its violation of a constraint against a noncoronal in preconsonantal position. Candidate b. satisfies this constraint by place assimilation but the sequence of oral stop plus nasal stop still violates *TN. Candidate c., with both place assimilation and nasal assimilation, satisfies both the constraint against noncoronal place and *TN, but it creates a geminate. Thus, candidate d., with segmental deletion, is optimal.

(208) Nunggubuyu /mantak-maɽakaric/ → *mantamaɽagaric* ‘dangerous group’

	/mantak-maɽakaric/ / \ [Dor][Lab]	*PL[PER]/__C	*TN	*GEMINATE	MAX-C	MAX(PL[α])
a.	mantakmaɽakaric / \ [Dor][Lab]	*!	*			
b.	mantapmaɽakaric V [Lab]		*!			*
c.	mantammaɽakaric V [Lab]			*!		*
d.	mantamaɽakaric [Lab]				*	*

To summarize, in Nunggubuyu, the constraint against preconsonantal noncoronal stops ranks above faithfulness constraints against segmental deletion or place assimilation. This forces various changes in noncoronal stops that are followed by another consonant. On the other hand, no corresponding changes are found for coronal stops in preconsonantal position. This was derived by ranking the markedness constraint against preconsonantal coronal stops below faithfulness constraints.

(209)



4.2.2.3 Syncope

Old Telugu

Dravidian languages also tend to have rich coronal inventories and we find coronal unmarkedness patterns in some of these languages. In Old Telugu, vowel syncope is sensitive to an output constraint such that it applies only when the resulting consonant cluster is coronal-initial. Thus, coronal stop-initial consonant clusters but no noncoronal stop-initial clusters arise as a result of vowel syncope.

According to Krishnamurti (1961), Old Telugu has the following stop inventory.

Both oral and nasal stop consonants have sub-coronal place contrasts.

(210) Old Telugu stop inventory (Krishnamurti 1961)

Labial	Dental	Alveolar	Retroflexed	Palatal	Velar
p b	t d		ʈ ɖ	c ɟ	k
m		n	ɳ		ŋ

In native words, *u* is optionally deleted after certain coronal consonants (*n, l, d, r*) in medial syllables. This optional syncope in Old Telugu creates coronal-initial clusters but not noncoronal-initial clusters. For example, certain verbal roots take *-du* as intransitive suffix and *-cu* as transitive suffix; among those roots, the root-final *u* may be deleted if the preceding consonant is *n* but not if the preceding consonant is *g*, as shown in (211). Additional examples of vowel syncope are given in (212), all of which occur after a coronal consonant. The numbers beside each example represent the page numbers in Krishnamurti (1961).

(211)		INTRANS.		TRANS.	
a.	/unu-/	un- <i>ḍu</i> ⁶²	'to be, to occur'	un(u)-cu	'to keep, let stay' (197, 303)
	/ninu-/	niṇ- <i>ḍu</i>	'to be filled, full'	nin(u)-cu	'to fill' (197, 414)
b.	/magu-/	magu- <i>ḍu</i>	'to return, turn back'	magu-cu	'to cause to turn back' (197)
	/mogu-/	mogu- <i>ḍu</i>	'to close, contract'	mogu-cu	'to fold, close (hands, eyes, etc.)' (197)
(212)	a.	<i>ciluka</i>	~	<i>cilka</i>	(126)
		<i>ka:luva</i>	~	<i>ka:lva</i>	(126)
		<i>aḍugu</i>	~	<i>aḍgu</i>	(126)
		<i>arugu</i>	~	<i>argu</i>	(126)
		<i>pu:ḍu-cu</i>	~	<i>pu:ḍcu</i>	'to bury' (196)
		<i>vir-ugu</i>	~	<i>virgu</i>	'to break' (138)
	b.	<i>kinuka</i>	~	<i>kinka</i>	* <i>kiṇka</i> 'anger' (2)
		<i>ka:nuka</i>	~	<i>ka:nka</i>	* <i>ka:ṇka</i> 'gift' (2)
		<i>co-nupu</i>	~	<i>co-npu</i>	* <i>compu</i> 'to insert' (199)
	c.	<i>pu:nu-cu</i>	~	<i>pu:ncu</i>	~ <i>pu:ñcu</i> 'to yoke' (126)
		<i>anu-cu</i>	~	<i>ancu</i>	~ <i>añcu</i> 'to send' (126)
		<i>manu-cu</i>	~	<i>mancu</i>	~ <i>mañcu</i> 'to nourish' (126)

A similar asymmetry in vowel syncope is found in changes from Old to Modern Telugu, as shown in (213), although a subsequent assimilation eliminated coronal-initial clusters.

(213)	Old Telugu	Modern Telugu	
a.	<i>saḍ-alu</i>	<i>saḷḷu</i>	'to slacken' (140)
	<i>oḍ-alu</i>	<i>oḷḷu</i>	'body' (140)
	<i>maṛ-alu</i>	<i>maḷḷu</i>	'turn' (140)
b.	<i>pag-alu</i>	<i>pag-alu</i>	'day' (140)
	<i>tag-ulu</i>	<i>tag-ulu</i>	'to touch' (140)



In Old Telugu, a sequence of a nasal stop plus an oral stop or affricate is homorganic except for the sequences created by this syncope process. Since syncope applies only when the preceding consonant is coronal, the only nonhomorganic nasal plus

⁶² For intransitive forms, an option of no syncope is not listed and the /n/ assimilates to the following retroflex in place of articulation.

stop clusters possible in the language are coronal-initial. When the coronal nasal is followed by a velar or a labial stop, as shown in (212)b., /n/ remains stable. Thus, the coronal nasal in *kinka* ‘anger’ contrasts with [ŋ] in *koŋku* ‘to hesitate’, where the nasal is homorganic to the velar stop. On the other hand, when the following consonant is a palatal affricate as in c., /n/ optionally assimilates to the palatal place. Also, when /n/ is followed by a retroflex stop after syncope, assimilation occurs, as can be seen from the examples in (212)a.

In Old Telugu, vowel syncope is constrained by an output constraint that prohibits noncoronal stop-initial clusters. Thus, syncope occurs only when the vowel is followed by a coronal stop and not by a noncoronal stop. This also follows from the markedness constraint hierarchy that treats the coronal stop as the most unmarked of oral places. Let me posit a cover constraint SYNCOPE that bans a high back vowel *u* in a medial open syllable. The ranking of this constraint relative to the faithfulness constraint against vowel deletion (MAX-V) is undetermined and, depending on the choice of ranking, syncope occurs or not, as shown in (214).


(214) Old Telugu /aɖugu/ → aɖugu ~ aɖgu

/aɖugu/ / \\ [Cor][Dor]	SYNCOPE	MAX-V	*PL[Cor]/__C
a.  aɖugu / \\ [Cor][Dor]	*		
b.  aɖgu / \\ [Cor][Dor]		*	*

What is of interest for the current discussion is that the option of syncope is available only for coronal-initial clusters. This is because the markedness constraint against

a preconsonantal coronal consonant is dominated by the constraint that promotes syncope. In contrast, when the consonant preceding *u* is not a coronal, syncope is impossible. This is because the markedness constraint against a noncoronal stop in preconsonantal position outranks the markedness constraint motivating the syncope, as shown in (215).

(215) Old Telugu /magu-ɖu/ → *maguɖu* **magɖu* ‘to return, turn back’

	/magu-ɖu/ / \ [Dor][Cor]	*PL[PER]/__C	SYNCOPE	MAX-V
a. 	maguɖu / \ [Dor][Cor]		*	
b.	magɖu / \ [Dor][Cor]	*!		*

4.2.2.4 Morpheme Structure Constraints

Tamil

Coronal unmarkedness in preconsonantal position is also found as a form of morpheme structure constraint in some dialects of Tamil, another Dravidian language. The stop consonant inventory of Kanniyakumari Tamil is given in (216). The language contrasts oral stops at six places and nasal stops at four places and has phonemic contrasts among different coronal places: dental, alveolar and retroflex. In Kanniyakumari Tamil, consonant clusters are restricted such that the consonants in clusters are in general homorganic. But, if a coronal nasal belongs to the initial syllable of the word, it can be the

first consonant of a cluster, without being homorganic to a following consonant, as shown in (217) (Christdas 1988; Bosch and Wiltshire 1992; Beckman 1998).⁶³

(216) Tamil stop inventory (Christadas 1988)

Labial	Dental	Alveolar	Retroflexed	Palatal	Velar
p	t̪	t	ʈ	c j	k
m		n	ɳ	ɲ	(ŋ)

- (217) /munʃiy/ *munʃi* ‘teacher’
 /tunpam/ *tunbā* ‘sorrow’
 /inpam/ *inbā* ‘delight’
 /naŋpan/ *naŋbā* ‘friend’
 /anp/ *anbu* ‘love’

Vasanthakumari (1989), based on a different dialect, also lists *ɳn*, *tm* and *ʈn* as the only possible stop plus nasal sequences and *ɳm* as the only possible nasal plus stop sequence. Some examples are given in (218). Note that again, the first (i.e., the preconsonantal) position of these clusters is occupied by a coronal stop or nasal.

- (218) *reɳnam* ‘jewel’
atmisan ‘admission’
caɳni ‘chutney’
uɳmay ‘truth’

Assuming Richness of the Base (Smolensky 1996), the same technique that derived the coronal unmarkedness pattern in previous cases will derive the coronal unmarkedness found in morpheme structure constraints. The constraint against noncoronal consonants in preconsonantal position ranks above the relevant faithfulness constraint and a hypothetical input with a preconsonantal labial nasal will be ruled out, as (219) demonstrates. On the other hand, the constraint against a coronal stop in the corresponding position will rank

⁶³ For discussion and analysis of the restriction to initial syllable, see Beckman (1998).

below faithfulness constraints. So the coronal stop will surface faithfully. This is demonstrated in (220).

(219) Tamil Hypothetical /amta/ → *anta* or *āta* **amta*

	/amta/ / \ [Lab][Cor]	*PL[PER]/__C	MAX(PL[α])
a.	amta / \ [Lab][Cor]	*!	
b.	anta V [Cor]		*

(220) Tamil /tunbam/ → *tunbā* ‘sorrow’

	/tunbam/ / \ [Cor][Lab]	MAX(PL[α])	*PL[COR]/__C
a.	tunbā / \ [Cor][Lab]		*
b.	tumbā \/ [Lab]	*!	

In this section, we saw that the coronal unmarkedness pattern is found in nonprevocalic position in languages with sub-coronal contrasts for stops. This contrasts with the reverse markedness pattern, which is found only in languages without a sub-coronal contrast. Now, I will turn to the cases of coronal unmarkedness found in languages without a sub-coronal place contrast for stops.

4.2.3 No sub-place contrast and coronal unmarkedness

In this section, I will show that the coronal unmarkedness pattern is attested also in languages without sub-coronal contrasts. This serves to demonstrate that the coronal unmarkedness pattern is truly a general pattern and is attested even in contexts where the

place cues for coronal stops are particularly weak. This follows from the existence of the context-free markedness constraint hierarchy (*PL[PER] » *PL[COR]) that is applicable to any context that may restrict place of articulation in a given position through constraint conjunction. Specifically, a context-sensitive version of the default markedness hierarchy specific to nonprevocalic position given in (221) is generated through constraint conjunction.

(221) *PL[PER]/__~V » *PL[COR]/__~V

There is a perceptually grounded hierarchy that makes conflicting demands on the output in nonprevocalic positions in single coronal languages, given in (222). The ranking between the two hierarchies is not fixed: languages that show markedness reversal, (222) dominates (221), while in languages that show the coronal unmarkedness pattern, (221) dominates (222). It is to this latter type of language that we now turn.

(222) *PL[COR]/__~V » *PL[PER]/__~V
 |
 ∅

4.2.3.1 Place Assimilation

Sri Lanka Portuguese Creole

According to Smith (1978), in Sri Lanka Portuguese Creole (SLPC), spoken in the Batticaloa region, nasal plus stop sequences are all homorganic within a morpheme, as shown in (223). When a morpheme-final nasal is followed by a heterorganic consonant, nasal place assimilation applies only when the nasal is labial or velar but not when it is

[illegible]

Labial	Dentoalveolar	Palatal	Velar
p b	t d	c j	k g
m	n	ɲ	ŋ ⁶⁶

⁶⁵ However, it is worth mentioning that all speakers of this Creole are bilingual and speak Tamil and that even though the Batticaloa Creole itself does not contrast sub-coronal places for nasal consonants, Batticaloa Tamil contrasts dental/alveolar stops with retroflex stops, as shown below.

Labial	Dental	Alveolar	Retroflex	Palatal	Velar
p	t		ʈ	c	k
m		n	ɳ	ɲ	


⁶⁶ Smith (1978) assumes that the velar nasal is derived from a nasal plus velar stop cluster but points out the need for underlying /n/ (p.103).

The place assimilation in SLPC is derived by the now familiar technique of ranking the faithfulness constraint violated by place assimilation between two markedness constraints, as shown in (226).


(226) *PL[PER]/__C » MAX(PL[α]) » *PL[COR]/__C

In (227), the markedness constraint against noncoronal consonants in preconsonantal position ranks above the faithfulness constraint and candidate b., with place assimilation, is chosen as optimal. On the other hand, in (228), the markedness constraint against coronal place in prevocalic position ranks below the faithfulness constraint and no change is forced.

(227) SLPC /pikini:m ka:zə/ → *pikini:ŋ ka:zə* ‘small house’

	/pikini:m ka:zə/ / \ [Lab][Dor]	*PL[PER]/__C	MAX(PL[α])
a.	pikini:m ka:zə / \ [Lab][Dor]	*!	
b. 	pikini:ŋ ka:zə ∨ [Dor]		*

(228) SLPC /kəlku:n pə/ → *kəlku:n pə* ‘for the turkey’


	/kəlku:n pə/ / \ [Cor][Lab]	MAX(PL[α])	*PL[COR]/__C
a. 	kəlku:n pə / \ [Cor][Lab]		*
b.	kəlku:m pə \ / [Lab]	*!	

4.2.3.2 Deletion (Place neutralization)

Spanish

In the standard dialect of Spanish, whose nasal inventory consists of /n/, /m/ and /ɲ/,⁶⁷ the coronal nasal /n/ is the only nasal allowed in the word-final position, except for /m/ in a few loan words and proper names (Harris 1998 among others). Even for those exceptional words such as *álbum*, *memorandum*, *Islam* and *Menem* (the last name of the president of Argentina), the word-final /m/ is variably realized as [m] or [n]. This is another instance of coronal unmarkedness. This is the case despite the fact that Spanish does not contrast sub-coronal places. The place neutralization in Spanish follows from the constraint against word-final noncoronal stops dominating the place faithfulness constraint, as shown in (229).

(229) Spanish /album/ → *albun*

	/album/ [Lab]	*PL[PER]/__#	MAX(PL[α])	*PL[COR]/__#
a.	album [Lab]	*!		
b. 	albun [Cor]		*	*

Attic Greek

A similar neutralization of word-final nasals to coronal place in languages without sub-coronal place contrasts is found in Ancient Greek. In Ancient Greek, where /m/ and

/n/ are the only nasal phonemes, word-final consonants are restricted to coronal place (*r*, *s*, *n*) and the change of word-final *m* to *n* is attested in following forms: Lat. *Lupum* → Gk. *Lukon*; Skt. *Abharam* → Gk. *Epheron* (Chen 1973, Joseph 1990). A similar neutralization of nasal consonant to /n/ is reported for Fante (Kiparsky 1995 based on Welmers 1973), Croatian dialects Avar and Lakk (Kiparsky 1995) and cooking terms of Patzun Cakchiquel (Campbell 1974a). Attic Greek is especially interesting since in a single language, preconsonantal position and word-final position exhibit different place markedness patterns.

Recall from above (p.59, 105) that in a sequence of oral stops or nasal stops in Attic Greek, C_1C_2 , C_1 is always restricted to noncoronal place (*p^ht^heymai* ‘voice’ and *mnē:mō:n* ‘mindful’ but **nm* or **nŋ*; *pemptos* ‘sent’, *t^helktron* ‘charm’, *bdeluros* ‘disgusting’, *kte:nō* ‘to kill’ etc. but **tk*, **tp* etc.). Thus, stop consonants in preconsonantal position follow the coronal marked pattern. This contrasts with the restriction found in word-final position. Here, the only stop consonant is the coronal nasal /n/ (*skē:ptron* ‘sceptre’, *ant^hrō:pon* ‘man, ACC.’, *t^helktron* ‘charm’). This shows that we need to separate out place markedness constraints specific to preconsonantal position from the ones specific to word-final position. The constraints for the two positions are separately rankable and thus the disparity in place markedness patterns between preconsonantal and word-final positions is predicted to occur.

⁶⁷ Palatal consonants in Spanish /ɲ/ and /ʎ/ come primarily from multisegmental Latin sources (Green 1990, Harris 1999) and Carreira (1988) argues that even in synchronic grammar, [ɲ] is not a phoneme in Spanish but is derived from [n] and [j]

(230) Separate constraints for preconsonantal and word-final position

	Preconsonantal position	Word-final position
Coronal unmarkedness	*PL[PER]/__C » *PL[COR]/__C	*PL[PER]/__# » *PL[COR]/__#
Coronal markedness	*PL[COR]/__C » *PL[PER]/__C ∅	*PL[COR]/__# » *PL[PER]/__# ∅
Ranking in Greek	*PL[COR]/__C » *PL[PER]/__C ∅	*PL[PER]/__# » *PL[COR]/__#

4.2.3.3 Metathesis

Hamer

Hamer is a South Omotic language spoken in Southwestern Ethiopia. Hamer restricts preconsonantal position to a coronal consonant (*t, s, l, r, n, ʃ*) or a nasal homorganic to a following consonant. When a morpheme ending in a noncoronal consonant is followed by a consonant-initial suffix, various processes apply to avoid a non-alveolar-initial heterorganic cluster (Lydall 1976, Zoll 1998). When either of the consonants in a cluster is nasal, place assimilation applies, as in (231)a. But, when neither of the consonants is nasal, metathesis applies, as in (231)b. Note that Hamer does not contrast sub-coronal places for coronal stops, as shown in (232).

- (231) a. /kum-sa/ [kunsə] 'cause to eat'
 /om-na/ [omma] 'bows'
 b. /uk-sa/ [uskʌ] 'cause to spear'
 /ep-sa/ [espa] 'cause to cry'
 /wob-sa/ [wospa] 'make bent'

(232) Hamer Stop consonant inventory (Lydall 1976)⁶⁸

Labial	Alveolar	Palatal	Velar	Uvular
p b	t d	c j	k g	k'
ɓ	ɗ		ɠ	
m	n	ɲ	ŋ	

The following analysis is from Zoll (1998).⁶⁹ Assimilation and metathesis are motivated by a constraint against labial place in preconsonantal position. In other words, the markedness constraint against noncoronal place ranks above relevant faithfulness constraints, forcing various changes. In (233), a labial nasal is followed by a coronal nasal by morpheme concatenation and progressive place assimilation applies to eliminate the preconsonantal labial place feature. The faithful candidate a. is ruled out by the constraint against noncoronal place in preconsonantal position. Assimilation (candidate c.) rather than metathesis (candidate b.) applies because the faithfulness constraint against metathesis ranks above the place feature faithfulness constraint for nasal consonants.

(233) Hamer /om-na/ → *omma* 'bows'⁷⁰

/om-na/ / \ [Lab] [Cor]	*PL[PER]/__#	LINEARITY	MAX(PL[α])/[+NAS]
a. omna / \ [Lab] [Cor]	*!		
b. onma / \ [Cor] [Lab]		*!	
c. omma \/ [Lab]			*


⁶⁸ /k'/ denotes a uvular ejective and /ɓ, ɗ, ɠ/ denote implosives.

⁶⁹ I reformulated Zoll's (1998) constraints to bring them in line with the other constraints I am using.

⁷⁰ When both consonants in clusters are nasals, the direction of assimilation is from root to affix. This follows from the positional faithfulness constraint IDENT (ROOT) (cf. Beckman 1998, Zoll 1998).

When neither consonants in sequences of coronal plus noncoronal consonants are nasal, however, metathesis rather than place assimilation applies. This is because the place featural faithfulness constraint for nonnasal consonants, MAX(PL[α])/[-NAS], is ranked higher than the faithfulness constraint against metathesis, LINEARITY, unlike the corresponding faithfulness constraint for nasal consonants, MAX(PL[α])/[-NAS]. This is illustrated in (234). A noncoronal stop, *k*, is followed by a consonant-initial suffix. The faithful candidate a., fatally violates the constraint against a preconsonantal noncoronal consonant. Although the candidate with metathesis (b.) violates LINEARITY, the alternative candidate with place assimilation (c.) violates a higher-ranking constraint against a place feature deletion in nonnasal consonant. Thus, the candidate with metathesis is chosen as optimal.

(234) Hamar /ʊk-sʌ/ → *uskʌ* ‘cause to spear’

	/ʊk-sʌ/ / \ [Dor] [Cor]	MAX(PL[α])/[-NAS]	*PL[PER]/__C	LINEARITY	MAX(PL[α])/[+NAS]
a.	ʊksʌ / \ [Dor] [Cor]		*!		
b. 	uskʌ / \ [Cor] [Dor]			*	
c.	ʊtsʌ ∨ [Cor]	*!			

Thus, Hamar is a language that shows the default markedness pattern in preconsonantal position. The restriction against noncoronal place in this position is satisfied through metathesis as well as assimilation.

4.2.3.4 Morpheme Structure Constraints

Hindi

Hindi shows the default markedness pattern in preconsonantal position through a morpheme structure constraint. Hindi contrasts a dental/alveolar oral stop and a retroflex oral stop, but no corresponding phonemic contrast is found for nasal stops, as shown in (235). According to Ohala (1983), in native morphemes a sequence of nasal stop plus oral stop is homorganic, as shown in (236)a. But some exceptions to this restriction are found, and all of them involving coronal nasal-initial sequences, as shown in (236)b.⁷¹

(235) Hindi stop inventory (Misra 1967, Kachru 1990)

Labial	Dental	Retroflexed	Palatal	Velar	Uvular
p p ^h b b ^h	t t ^h d d ^h	ʈ ʈ ^h ɖ ɖ ^h	c c ^h j j ^h	k k ^h g g ^h	q ⁷²
m	n			ŋ	

- (236) a. *p^həŋki* ‘handful’
tamba ‘copper’
ʃ^həŋɖa ‘flag’
ɡuŋʃ ‘sounded, echoed’
kəndʰa ‘shoulder’
 b. *tinka* ‘bit of dry grass’
mənka ‘bead’
kənba ‘s[i]deways glance’
čingari ‘spark’
kunba ‘family’
inkar ‘denial’

⁷¹ There are other exceptions at the “phonetic level” that are not coronal-initial but these are either loan-words (*nəmda* ‘a rug’, *mumkin* ‘possible’) or are brought about by a schwa-deletion rule (*/čiməʈ/* → *čimʈa* ‘tongs’, */səməʃ^h/* → *səməʃ^ha* ‘to threaten’)

⁷² Kachru (1990) includes the uvular stop in the Hindi stop inventory unlike Misra (1967) and Ohala (1983) but notes that it is found only in the highly Sanskritised or highly Persianised varieties.

Again, by the assumption of Richness of the Base (Smolensky 1996), the Morpheme Structure Constraint of heterorganic preconsonantal nasal stops to coronal place follows from the constraint ranking that derived the default markedness pattern in assimilation, metathesis and place neutralization. The constraint against noncoronal consonants in preconsonantal position ranks above the relevant faithfulness constraint and a hypothetical input with a preconsonantal labial nasal will be ruled out, as (237) demonstrates. On the other hand, the constraint against a coronal stop in the corresponding position will rank below the faithfulness constraints. So a coronal stop will surface faithfully. This is demonstrated in (238).

(237) Hindi Hypothetical /amta/ → *anta* **amta*

	/amta/ / \ [Lab][Cor]	*PL[PER]/__C	MAX(PL[α])
a.	amta / \ [Lab][Cor]	*!	
b.	anta V [Cor]		*

(238) Hindi /tinka/ → *tinka*, **tiŋka* 'bit of dry grass'

	/tinka/ / \ [Cor][Dor]	MAX(PL[α])	*PL[COR]/__C
a.	tinka / \ [Cor][Dor]		*
b.	tiŋka \ / [Dor]	*!	

In this section (4.2.3), we saw that the coronal unmarkedness pattern is found in nonprevocalic position not only in languages with a sub-coronal contrast for stops but also

in languages without a sub-coronal place contrast for stops. This is despite the fact that in these languages, the coronal stops in nonprevocalic positions are expected to be perceptually weaker than corresponding noncoronal stops. The default markedness hierarchy is context-free and does not make reference to the sub-coronal contrasts of a language. Thus, it is expected to be active in any language and in any position including nonprevocalic positions in single coronal languages. This completes the list of evidence that shows that the coronal unmarkedness pattern is truly a default pattern that arises from a context-free markedness constraint hierarchy and is not confined to any specific context.

In the next section, we will discuss the place restriction patterns in nonprevocalic positions in Finnish. Finnish is interesting since a variety of repair strategies—debuccalization, assimilation, deletion—are at work to satisfy the place restrictions. Also, Finnish presents additional evidence that the place restriction tends to be more severe when the stop is nasal than when it is oral. This supports the place markedness hierarchy regarding nasality of stops I proposed in the previous chapter.

4.2.4 Nasality and coronal unmarkedness: the case of Finnish

In Finnish, the distribution of stop consonants is restricted such that in word-final position and in certain preconsonantal positions, the only stops allowed other than stops homorganic to a following consonant are the coronal stops, *t* and *n*. Word-final and preconsonantal stops occupy the coda position prosodically. However, the generalization regarding place restriction in stops cannot be stated as a straightforward prosodic restriction on codas (Yip 1991). Not all codas in Finnish follow the same restriction; rather, depending on the segmental make-up of the contexts, different degrees of place

feature restrictions are attested. Thus, generalizations are better stated in terms of the quality of place cues available in different contexts. This provides strong new evidence for the Licensing by Cue approach (cf. Steriade 1997).

The table in (239) summarizes the patterns of place restrictions in nonprevocalic position depending on the nasality of the stop itself and the neighboring segmental contexts. A striking generalization emerges that, given the same external context, nasal stops tend to allow an equal number or fewer place contrasts than corresponding oral stops.

(239) Place licensing by segmental contexts

(V: vowel, C: consonant, T: nasal or oral stop, F: fricative, L: sonorant)

Segmental Contexts	Place restrictions	
	Nasal stops	Oral stops
V F	HOMORGANIC OR COR	HOMORGANIC, COR, LAB OR DOR
V #	HOMORGANIC OR COR	HOMORGANIC OR COR
V T	HOMORGANIC	HOMORGANIC OR COR
L C	NA	HOMORGANIC

Among nonprevocalic positions, the position before a fricative (V_F) shows the least restricted pattern of place licensing. All three oral stops occur before a fricative, as shown in (240)a. Among nasal stops, only the coronal nasal is found in this position, as shown in (240)b.⁷³

- (240) a. *lapsi* 'child' *katso* 'look' *laakso* 'valley'
b. *kansa* 'folk' *vanha* 'old'

In word-final position (V_#), both nasal and oral stops are restricted to coronal place only.⁷⁴ Historically, stem-final /k/ was lost, leaving its trace in the so-called

⁷³ An *-ms-* sequence is found only in *Jämsä* (place name) (Karttunen 1970).

⁷⁴ Across a word boundary in casual speech, the coronal nasal is partially assimilated to the following consonant.

aspiration phenomenon (Itkonen 1964; Campbell 1976); after stems which were k-final historically, a word-initial consonant is geminated as in (241). Before a vowel-initial word, a geminate glottal stop occurs. In absolute final position, no remnant of /k/ is found. In contrast, word-final /t/ remains intact except in southwestern dialects, where a similar gemination/deletion phenomenon developed (Campbell 1976, p.39). Synchronically, the coronal oral stop is saliently released word-finally and tends to resist assimilation: *tulet ko* → **tulekko* ‘do you come?’.⁷⁵ /p/ is not found word-finally either historically or synchronically (Karttunen 1970, p.31). Stem-final *m* turns into *n* word-finally, resulting in alternations between *m* and *n* in certain nouns, as shown in (242).

- (241) *ota* ‘take (it)’ ← *otak*
otap pois ‘take (it) away’
otat tämä ‘take this’
otak kaikki ‘take all of (it)’
otal lasi ‘take the glass’
ota? ?itse ‘take (it) yourself’ (Campbell 1976 pp.34-35)

- (242) *puhelin* ‘telephone’ NOM. SG. *puhelimet* ‘telephone’ NOM. PL.
eläin ‘animal’ NOM. SG. *eläimet* ‘animal’ NOM. PL.
avain ‘key’ NOM. SG. *avaimet* ‘key’ NOM. PL.
sydän ‘heart’ NOM. SG. *sydämet* ‘heart’ NOM. PL.

Before a stop consonant (V_T), nasal stops are always homorganic to the following stop, as shown in (243). Place assimilation applies if a nasal is followed by a heterorganic stop consonant, as shown in (244).

-
- kahden kesken* → *kahde~~n~~kesken* ‘between the two’
talon poika → *talo~~n~~poika* ‘farmer’
talon mies → *talo~~n~~mies* ‘janitor’
talon väki → *talo~~n~~väki* ‘people of the house’ (Harms 1964; Branch 1990).

⁷⁵ But certain lexical items undergo assimilation in casual speech : *nyt se menee* → *nys se menee* ‘now it goes’ (A. Iivonen, p.c.). The specific conditions of assimilation remain to be investigated.

- (243) a. Nasal Stop + Oral Stop
hintä 'price' *kampa* 'comb' *hanhi* 'snow crust'
 b. Nasal Stop + Nasal Stop
pannu 'pan' *tumma* 'dark' *hännen* 'snow crust'
- (244) *lum + ta* → *lunta* 'snow, part. sg.'
liem + tä → *lientä* 'broth, part. sg.'
tuom + ta → *tuonta* 'dog-cherry, part. sg. (dial. and poet.)'
 cf. Standard Finnish : *tuomea*
on + ks → *onks* 'is [it]?'
on + pa + s → *ompas* '[it] really is'

(Karttunen 1970; Keyser and Kiparsky 1984; Branch 1990)

Oral stops before another stop are either homorganic or coronal, as shown in (245). Historically, **pt* and **kt* clusters were lost through debuccalization (**pt*, **kt* → *ht*) while **tk* clusters remained intact (Posti 1953; Hakulinen 1961; Musselman 1997).⁷⁶ The synchronic remnants of the *k~h*, *p~h* alternation are present in synchronic alternations or dialectal variations, as shown in (246). Also, early loan-words with original /kt/ or /pt/ clusters are adapted in Finnish as /ht/, as shown in (247).⁷⁷ The /ht/ clusters of Finnish words in (248) are reconstructed as **kt* through comparisons with related languages.

- (245) Oral Stop + Oral Stop⁷⁸
aatto 'evening' *oppi* 'learn' *lakki* 'cop'
matka 'trip'

⁷⁶ When the **kt* or **pt* cluster occurred in non-initial syllables, assimilation took place rather than debuccalization:

<i>annatte</i>	'you give(PL.)'	← <i>*andakts</i>
<i>kastetta</i>	'dew, PRT. SG.'	← <i>*kastekta</i>
<i>kuolettaa</i>	'to kill'	← <i>*-pt-</i> (This could be from <i>*kt</i> (Posti 1953))
<i>kalatta</i>	'without fish'	← <i>*-pt-</i> (This could be from <i>*kt</i> (Posti 1953))

⁷⁷ However, there are loan-words with /pt/ or /kt/ clusters: *apteekki* 'pharmacy', *kapteeni* 'captain', *adjektiiv* 'adjective'. I assume that these words are more recent loans that entered Finnish lexicon after the words in (247). However, unlike clear loan-words such as *adjektiiv* 'adjective', *apteekki* 'pharmacy' and *kapteeni* 'captain' are not perceived as particularly nonnative (L. Pylkkanen, p.c.) although it is true that *pt* clusters are quite rare.

⁷⁸ **tp* is ruled out by an independent filter, **[-son]p* (Prince 1984), and I assume that Oral Stop + Nasal Stop clusters are ruled out as Sonority Sequencing violations.

- (246) *k~h*
*kaksi*⁷⁹ ~ *kahta* 'two' NOM. ~ PRT.
yksi ~ *yhtä* 'one' NOM. ~ PRT.
näke- ~ *nähty*, *nähtiin*, *nähtävä* 'see' stem ~ PST. PRT. ACT., PSS. PST, PRS. PRT. PSS.
vaaksi ~ *vahti* 'foam' dialectal ~ standard
p~h
viipsinpuut ~ *vyyhti* 'reel ~ skein'
- (247) *k→h*
lehtari 'lectern' ← *lektari* SW. OBS.
sihteeri 'secretary' ← *sikter* SW. OBS.
mahti 'power, might' ← *makt* Early SW.
vahti 'guard'
lyhti 'lantern'
p→h
luhti 'loft' ← *lopt*, *lupt*, *lofft* Old Swedish
tuhto 'bench in a boat, thwart' ← *of(s)ton* Proto-Germanic
cf. *opta* Old Norse
- (248) *ahtaa* 'crowd together'
ehtoo 'evening'
huhta 'ground-clearing'
kohtu 'womb'
ohito 'bear'

The last context where stop consonants are found is in C_2 position of three-consonant sequences (L_C). In three-consonant clusters C_1 is limited to a sonorant *l*, *r*, or a nasal homorganic to the following consonant. C_2 is either an oral stop or /s/ and when C_2 is an oral stop, it must be the first part of a geminate.⁸⁰ In other words, only homorganic place is licensed in this position, as shown in (249).

- (249) *helppo* 'easy' *polttä* 'burn' *silkki* 'silk'
torppa 'cottage' *kartta* 'map' *serkku* 'cousin'
limppu 'rye bread' *tonttu* 'elf' *kinkku* 'ham'

To recapitulate the generalization, given the same external context, nasal stops allow fewer place contrasts than corresponding oral stops. This also supports the proposal

⁷⁹ The earlier change of *ti* → *si* bleeds *kt* → *ht*.

that the place contrasts are conditioned by the quality of the perceptual cues of place features. As we saw in the previous chapter, given the same external context, the place cues for nasal stops tend to be inferior to those for oral stops. This perceptual scale is projected into a markedness constraint hierarchy, repeated in (250).

(250) *PL[α]/[+NAS] » *PL[α]/[-NAS]

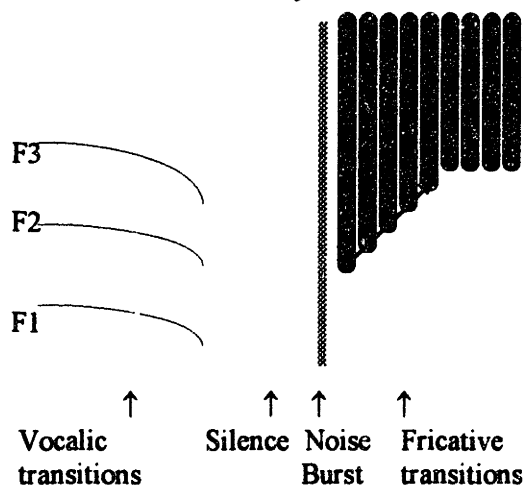
In Finnish, the degree of place restriction on nonprevocalic stops also differs depending on the external context. I propose that this also follows from the perceptibility of place cues in different contexts. First of all, vocalic transitions are better place cues than consonantal (fricative or liquid) transitions because the change from a stop to a vowel with an open vocal tract generates more drastic transitions than the change from a stop to another consonant. Also the periodic noise of a vowel is a more robust cue perceptually than the frication noise of a fricative (Wright 1996). Thus, interconsonantal position fares the worst since it has no vocalic transition cues.

Among contexts with VC transition cues but without CV transition cues (V_F, V_#, V_T), the position before a fricative (V_F) is better than word-final (V_#) or pre-stop position (V_T). Engstrand and Ericsson (1999) showed that when the /s/ next to an oral stop was cut off and played in isolation to subjects, they could identify the preceding or following stop reliably. Unlike a stop consonant, during the production of fricative sounds there is a continuation of oral airflow. Thus, when a stop is followed by a fricative, the stop is bound to have an audible release, unlike when it is followed by a stop

⁸⁰ Karttunen (1970) also lists *-mps-* but says that it is so rare that it can be treated as exceptional.

consonant. Moreover, a following fricative provides transition cues especially for labial stops. This is schematically illustrated in (251).

(251) Schematic illustration of acoustic events surrounding a labial oral stop preceded by a vowel and followed by a fricative /s/



As for the relative perceptibility of place cues in the other two contexts (V_#, V_T), I assume that the V_# position provides better place cues than the V_T position since the VC transitions in a V_# context are free from the articulatory and auditory interference of a following consonant that the V_T context may suffer from. The VC transitions for stops in pre-stop position may be somewhat influenced by the consonantal gesture of the following consonant, especially when the consonantal gestures are overlapped. Even when the overlap is minimal, one can expect perceptual interference of the following consonants for the perception of place features in this position (cf. Byrd 1992).

Thus, we can set up the following perceptibility scale of place features, given in (252). This scale is again projected into the grammatical component as a markedness constraint hierarchy, as shown in (253).

(252) $PL[\alpha]/V_F \succ PL[\alpha]/V_ \# \succ PL[\alpha]/V_T \succ PL[\alpha]/L_C$

(253) $*PL[\alpha]/L_C \gg *PL[\alpha]/V_T \gg *PL[\alpha]/V_ \# \gg *PL[\alpha]/V_F$

Local conjunction of these constraints with the constraints in (250) yields the expanded hierarchy of constraints in (254). By further conjoining these constraints with the default markedness constraints ($*PL[PER] \gg *PL[COR]$), we get the further expanded hierarchy in (255).

(254)

$*NASAL PL[\alpha]/C_C \gg *ORAL PL[\alpha]/C_C$
 $\downarrow \qquad \qquad \downarrow$
 $*NASAL PL[\alpha]/V_T \gg *ORAL PL[\alpha]/V_T$
 $\downarrow \qquad \qquad \downarrow$
 $*NASAL PL[\alpha]/V_ \# \gg *ORAL PL[\alpha]/V_ \#$
 $\downarrow \qquad \qquad \downarrow$
 $*NASAL PL[\alpha]/V_F \gg *ORAL PL[\alpha]/V_F$

(255)

$*NASAL PL[PER]/C_C \gg *NASAL PL[COR]/C_C$	$*ORAL PL[PER]/C_C \gg *ORAL PL[COR]/C_C$
$\downarrow \qquad \qquad \downarrow$		$\downarrow \qquad \qquad \downarrow$
$*NASAL PL[PER]/V_T \gg *NASAL PL[COR]/V_T$	$*ORAL PL[PER]/V_T \gg *ORAL PL[COR]/V_T$
$\downarrow \qquad \qquad \downarrow$		$\downarrow \qquad \qquad \downarrow$
$*NASAL PL[PER]/V_ \# \gg *NASAL PL[COR]/V_ \#$	$*ORAL PL[PER]/V_ \# \gg *ORAL PL[COR]/V_ \#$
$\downarrow \qquad \qquad \downarrow$		$\downarrow \qquad \qquad \downarrow$
$*NASAL PL[PER]/V_F \gg *NASAL PL[COR]/V_F$	$*ORAL PL[PER]/V_F \gg *ORAL PL[COR]/V_F$
		$\downarrow \qquad \qquad \downarrow$

In (255), double arrows (\gg), straight arrows (\rightarrow) and dotted lines (---) all represent strict ranking. The rankings represented by double arrows indicate the default markedness hierarchy between coronal and noncoronal places. The straight arrows represent the generalization that a particular place feature is the least likely to appear in an interconsonantal context (C_C) while it is the most likely to appear in prevocalic position (_V), with three post-vocalic contexts (V_T, V_# and V_F) ranking in between. The rankings represented by dotted lines reflect the generalization that given the same

segmental context, an oral stop with a particular place is more likely to surface faithfully in than a nasal stop of the same place. Interleaving these markedness constraints with faithfulness constraints will account for the place restriction patterns of Finnish stops summarized in (256), repeated from above.

(256) Place licensing by segmental contexts

(V: vowel, C: consonant, T: nasal or oral stop, F: fricative, L: sonorant)

Segmental Contexts	Place restrictions	
	Nasal stops	Oral stops
V F	HOMORGANIC OR COR	HOMORGANIC, COR, LAB OR DOR
V #	HOMORGANIC OR COR	HOMORGANIC OR COR
V T	HOMORGANIC	HOMORGANIC OR COR
L C	NA	HOMORGANIC

Interconsonantal position (C_C)

First, in interconsonantal position (C_C), no independent place feature is licensed and only stops that are homorganic to the following stop are allowed. I assume that homorganic stops share the place feature of the following consonant and, if the following consonant is prevocalic, the place feature itself does not violate any of the markedness constraints against a place feature in nonprevocalic position. Thus, for C_C position, the faithfulness constraint is dominated by all relevant markedness constraints, as shown in (257), and no independent place features are found.

(257)

*NASAL PL[PER]/C_C
 »
 *NASAL PL[COR]/C_C, *ORAL PL[PER]/C_C
 »
 *ORAL PL[COR]/C_C
 »
 MAX (PL[α])


Before a stop (V_T)

In post-vocalic position before a stop, nasal stops are always homorganic to following stops, and never bear an independent place feature. All markedness constraints against nasal stop place in this position dominate the faithfulness constraints as in (258).

(258) *NASAL PL[PER]/V_T » *NASAL PL[COR]/V_T » MAX (PL[α])

Thus, an input with heterorganic sequences as in *lum* + *ta* 'snow, PART. SG.' assimilates, as shown in (259). The faithful candidate **lumta* violates the markedness constraint against labial place for nasals before a stop consonant. The candidate with assimilation (*lunta*), which violates the lower ranking constraint MAX(PLACE), is optimal. Assimilation also applies to a coronal-initial cluster (ex. *on* + *pa* + *s* → *ompas* '[it] really is') since the markedness constraint against coronal place in this position also outranks the faithfulness constraint, as shown in (260).

(259) Finnish /lum + ta/ → *lunta* 'snow, PART. SG.'

	/lum + ta/ [Lab] [Cor]	*NASAL PL[PER]/V_T	*NASAL PL[COR]/V_T	MAX (PL[α])
a.	lumta / \ [Lab] [Cor]	*!		
b. 	lunta V [Cor]			*

(260) Finnish /on + pa + s/ → *ompas* '[it] really is.'

	/on + pas/ [Cor] [Lab]	*NASAL PL[PER]/V_T	*NASAL PL[COR]/V_T	MAX (PL[α])
a.	onpas / \ [Cor] [Lab]		*!	
b. on	ompas V [Lab]			*

On the other hand, in the same position (V_T) oral stops can be either coronal or homorganic to the following stop. Labial or dorsal places cannot appear independently in this position. Thus, the faithfulness constraint ranks above the markedness constraint against coronal oral stops in this position but below the one against dorsal or labial stops, as shown in (261).


(261) *ORAL PL[PER]/V_T » MAX (PL[α]) » *ORAL PL[COR]/V_T

Since the markedness constraint against dorsal or labial stops ranks above faithfulness, these consonants do not surface faithfully in the output but rather undergo debuccalization.⁸¹ The dorsal and labial stops in /kt/ and /pt/ clusters in (262) and (263),

⁸¹ The question arises: why are the clusters repaired through debuccalization rather than assimilation? The correct candidate with [ht] in the output incurs a violation of *GLOTTAL (albeit low-ranked) while a candidate with assimilation [tt] does not. I assume that the answer lies in the perceptual similarity between the input and the output (Steriade 1999c). In Section 5, I argue that Finnish stop consonants in preconsonantal position are audibly released with a clear burst with some frication. If the same gestural organization applies to /kt/ and /pt/ clusters, they would be pronounced with certain frication noise after the /k/ and the /p/. These sounds would be more similar to [ht] than [tt] acoustically. Thus, a faithfulness constraint against mapping between [k^ot]/[p^ot] and [tt] (DON'T CHANGE KT, PT → TT) outranks *GLOTTAL (^o meaning audible release).


lose their place features since they violate the markedness constraints against dorsal or labial stops in this position; the output with [ht] is chosen since it only violates the lower-ranking faithfulness constraint. On the other hand, the /tk/ cluster in (264) remains intact since the markedness constraint against coronal stops in this position ranks below the faithfulness constraint.

Finnish /kak + ta/ → *kahta* 'two' PRT. (cf. *kaksi* 'two' NOM.)


	/kak + ta/ [Dor] [Cor]	*ORAL PL[PER]/V_T	MAX (PL[α])	DON'T CHANGE K ^o T, P ^o T → TT	*[GLOTTAL]
a.	kakta / \ [Dor] [Cor]	*!			
b. 	kahta / \ [Glott] [Cor]		*		*
c.	katta V [Cor]		*	*!	

On the other hand, as has been mentioned in footnote 76, when these clusters occurred in non-initial syllables historically, they underwent assimilation (**pt*, **kt* → *tt*) rather than debuccalization. This correlates with the generalization that vowel epenthesis applies only to stressed (i.e., usually initial) syllables. In non-initial syllables, the consonantal gestures are relatively closer together in timing and the pronunciation of [kt] in this context may sound more like [tt] than [ht].


Finnish *annatte* 'you give(pl.)' ← **andakte*

	andakte / \ [Dor] [Cor]	*ORAL PL[PER]/V_T	MAX (PL[α])	DON'T CHANGE K ^o T, P ^o T → TT	*[GLOTTAL]
a.	annakte / \ [Dor] [Cor]	*!			
b.	annahte / \ [Glott] [Cor]		*		*!
c. 	annatte V [Cor]		*		


(262) Finnish /kak + ta/ → *kahta* ‘two’ PRT. (cf. *kaksi* ‘two’ NOM.)

	/kak + ta/ [Dor] [Cor]	*ORAL PL[PER]/V_T	MAX (PL[α])	*ORAL PL[COR]/V_T
a.	kakta /\ [Dor] [Cor]	*!		
b. 	kahta /\ [Glot] [Cor]		*	

(263) Finnish *tuhto* ‘bench in a boat, thwart’ ← *-pt-

	/tupto/ /\ [Lab] [Cor]	*ORAL PL[PER]/V_T	MAX (PL[α])	*ORAL PL[COR]/V_T
a.	tupto /\ [Lab] [Cor]	*!		
b. 	tuhto [Cor]		*	

(264) Finnish *matka* ‘trip’

	/matka/ /\ [Cor] [Dor]	*ORAL PL[PER]/V_T	MAX (PL[α])	*ORAL PL[COR]/V_T
a. 	matka /\ [Cor] [Dor]			*
b.	mahka [Dor]		*!	

Word-final position (V_#)

Next, in word-final position the only stops allowed are coronal stops whether they are nasal or oral stops. Here, MAX(PL[α]) ranks above the markedness constraint against coronal stops in this position and below the markedness constraint against noncoronal stops in this position, as shown in (265).

(265)

*NASAL PL[PER]/V_#
 »
 *ORAL PL[PER]/ V_#
 »
 MAX (PL[α])
 »
 *NASAL PL[COR]/ V_#
 »
 *ORAL PL[COR]/ V_#

Thus, stems that end in a labial nasal change the nasal to coronal place when it appears in word-final position, as shown in (266). The faithful candidate **puhelim* violates the high-ranking faithfulness constraint against a labial nasal in this position while the correct candidate *puhelin* does not.

(266) Finnish /puhelim/ → *puhelin* ‘telephone’ NOM. SG. (cf. *puhelimet* ‘telephone’ NOM. PL.)


	/puhelim/ [Lab]	*NASAL PL[PER]/V_#	MAX(PL[α])	*NASAL PL[COR]/ V_#
a.	puhelim [Lab]	*!		
b.	puhelin [Cor]		*	*

Before a fricative (V_F)

Next, in postvocalic position before a fricative (V_F), the only nasal stop allowed is a coronal. Thus, the faithfulness constraint is again interleaved between the markedness constraints, as shown in (267). An input with /nh/ clusters surfaces faithfully, as shown in (268). The candidate with a placeless glide (**vaNha*) is ruled out since it violates the faithfulness constraint against MAX(P[α]), which ranks above the markedness constraints against coronal places in this position.


(267) *NASAL PL[PER]/ V_F » MAX(PL[α]) » *NASAL PL[COR]/ V_F

(268) Finnish *vanha* ‘old’

	/vanha/ [Cor]	*NASAL PL[PER]/ V_F	MAX(PL[α])	*NASAL PL[COR]/ V_F
a. 	vanha [Cor]			*
b.	vaNha		*!	

There are no examples of synchronic or diachronic alternations of /mh/ or /nh/ clusters but by the assumption of Richness of the Base (Smolensky 1996), the hypothetical input of /mh/ cannot surface as such in Finnish due to the constraint ranking in (267), as shown in (269). The expected output changes the underlying /m/ into [n] since coronal is the least marked place in this position. We see this change word-finally, where *m~n* alternate.

(269) Finnish Hypothetical /amha/ → *anha*


	/amha/ [Lab]	NASAL PL[PER]/ V_F	MAX(PL[α])	NASAL PL[COR]/ V_F
a.	amha [Lab]	*!		
b. 	anha [Cor]		*	*

As for the oral stops, stops of all three places are allowed in this position (V_F). The faithfulness constraint ranks over all markedness constraints in this context, as shown in (270), and thus, all heterorganic clusters surface faithfully in the output. For example, *laakso* ‘valley’ surfaces faithfully in (271) since the candidate with place assimilation


(**laatso*) violates the high-ranking faithfulness constraint. Similarly *lapsi* ‘child’ surfaces without assimilation in (272).

(270) MAX(PL[α]) » *ORAL PL[PER]/ V_F » *ORAL PL[COR]/ V_F

(271) *laakso* ‘valley’

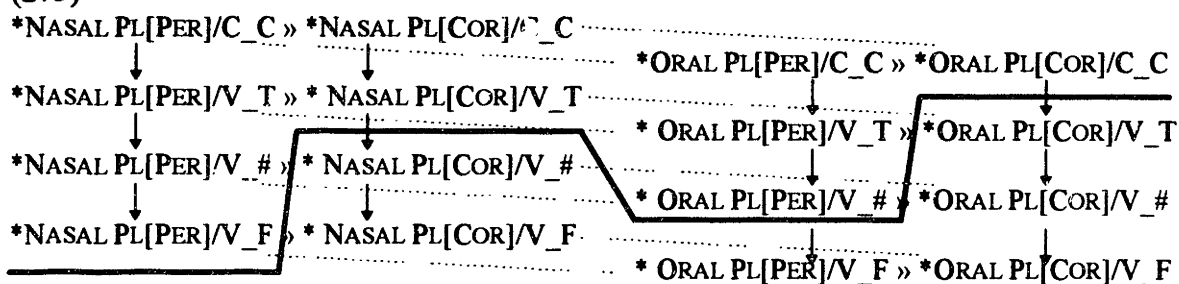
	/laakso/ /\ [Dor] [Cor]	MAX(PL[α])	*ORAL PL[PER]/ V_F	*ORAL PL[COR]/ V_F
a. 	laakso /\ [Dor] [Cor]		*	
b.	laatso V [Cor]	*!		

(272) *lapsi* ‘child’

	/lapsi/ /\ [Lab] [Cor]	MAX(PL[α])	*ORAL PL[PER]/ V_F	*ORAL PL[COR]/ V_F
a. 	lapsi /\ [Lab] [Cor]		*	
b.	latsi V [Cor]	*!		

The constraint rankings argued for can be summarized as follows. The faithfulness constraint, MAX(PL[α]), is ranked relative to the markedness constraints such that the markedness constraints above the dark line in (273) dominate the faithfulness constraint while the markedness constraints below the dark line are dominated by the faithfulness constraint.

(273)



To summarize, in certain nonprevocalic positions in Finnish, stops consonants exhibit the default place markedness pattern. However, depending on the nasality of the stop consonants and also the neighboring segmental context, different degrees of place restrictions are attested. I proposed that these variations in place restriction also follow from the differences in perceptibility of place cues in these positions. By conjoining the contextual markedness constraints projected from the perceptibility scale with Prince and Smolensky's default markedness constraints, we derived the place restriction patterns of nonprevocalic stops in Finnish.

Chapter 5 Previous approaches

In this chapter, I will review three previous approaches to coronal versus noncoronal asymmetry—*Coronal Underspecification* (Kiparsky 1985, Avery and Rice 1989b, Paradis and Prunet 1991ab among others), *Underspecification by constraints* (Kiparsky 1994) and *Perceptually grounded faithfulness constraints* (Jun 1995). I will evaluate how these approaches can account for the generalizations that have been discussed in this thesis. (274) summarizes the generalizations discovered through my survey, which a theory of place markedness must account for.

(274) Coronal unmarkedness and coronal markedness

	Coronal unmarkedness	Coronal markedness
Segmental contexts	No restriction	restricted to nonprevocalic position
Inventory structure	No restriction	restricted to languages without contrast
Processes involved	deletion, assimilation, debuccalization, place neutralization, metathesis, MSC, syncope, epenthesis, vocalic spreading ⁸²	deletion, assimilation, debuccalization, place neutralization, metathesis, MSC

The coronal unmarkedness pattern is ubiquitous and it is not restricted to specific segmental contexts (such as preconsonantal or word-final position) or to languages with a particular inventory structure. Coronal unmarkedness is manifested through diverse phenomena such as deletion, assimilation, debuccalization, place neutralization, vowel syncope and Morpheme Structure Constraints. On the other hand, the coronal markedness

⁸² One may notice that not all processes that exhibit the default markedness pattern also attest the coronal markedness pattern. This asymmetry is partly due to the fact some processes are only applicable to consonants in prevocalic position, such as vocalic spreading in Bedouin Arabic. Yet other processes such as vowel syncope in Old Telugu are not found with the coronal markedness pattern. This may be simply an accidental gap or there may be some phonetic grounds for restrictions on repair strategies (cf. Steriade 1999c). I leave this question for future research. Here, I simply note that a variety of processes show coronal markedness as well as coronal unmarkedness.

pattern is strictly restricted in its contexts; it is found only in nonprevocalic positions and only in languages without a sub-coronal place contrast. The coronal markedness pattern is also attested through diverse phenomena such as deletion, assimilation, debuccalization, place neutralization, metathesis and Morpheme Structure Constraints. To account for these generalizations, I have proposed that there are two separate place markedness constraint hierarchies. The default markedness hierarchy of Prince and Smolensky (1993) that generates the coronal unmarkedness pattern is context-free. Through constraint conjunction, this hierarchy is applicable to any context where a place restriction is found. On the other hand, a perceptually grounded markedness hierarchy that generates the coronal markedness pattern is context-specific such that it is applicable only in nonprevocalic positions in languages that lack sub-coronal place contrasts. I will review how previous approaches to coronal versus noncoronal asymmetry may deal with different aspects of the place asymmetry. It will be demonstrated that none of the previous approaches can account for all aspects of the place asymmetry. (275) provides an overview of the chapter summarizing the analytical devices that different approaches propose for aspects of the coronal versus noncoronal asymmetry.

(275) Sources of coronal versus noncoronal asymmetry in different approaches

	Coronal unmarkedness	Coronal markedness
Current proposal	Context-free markedness constraint hierarchy: *PL[PER] » *PL[COR]	Perceptually grounded markedness constraint hierarchy : *PL[COR]/__~V » *PL[PER]__~V Ø
Coronal Underspecification	Underspecification of [Coronal] & Restriction against place specifications	Underspecification of [Coronal] & Assimilation as a feature filling process
Underspecification by Constraints	Inclusion hierarchy of place markedness and faithfulness constraints: *PL[PER], *PL[α], DEP[PER], DEP[α]	Inclusion hierarchy of place faithfulness constraints: MAX[PER], MAX[α]
Perceptual faithfulness constraints	???	Perceptually grounded faithfulness constraints: MAX[PER]/__' » MAX[COR]/__'

5.1 The Coronal Underspecification approach

It has been proposed that the coronal versus noncoronal asymmetry can be derived from a representational difference between coronal and noncoronal consonants: coronal consonants are not specified for either the [Coronal] feature or the Place node itself as shown in (276); and all asymmetries between coronal and noncoronal places are claimed to follow from this representational difference (Kiparsky 1985, Sohn 1987, Avery and Rice 1989ab, Rice and Avery 1993, Paradis and Prunet 1989, 1991b, Rice 1992, Yip 1991 among others).

(276)

/t/		/p/		/k/
Root	Root	Root	Root	Root
Place	or	Place		Place
		[Labial]		[Dorsal]

The idea behind the Coronal Underspecification approach is that coronal consonants are inert in phonological processes because they are literally unmarked and

therefore invisible. The underspecified [Coronal] feature is filled in by a default rule later on in the derivation. Despite its appeal as a simple and elegant solution to the coronal syndrome, Coronal Underspecification has serious conceptual and empirical problems (Mohan 1991, McCarthy and Taub 1992, Steriade 1995 among others). In this section, I will demonstrate in addition that the theory fails to provide an adequate analysis of the data we discuss here.

In the Coronal Underspecification approach, any asymmetry between coronal place and noncoronal places is claimed to follow from their representational difference, that is, no place specification for coronal versus specification for noncoronal. Thus, for phenomena where coronal consonants have fewer distributional restrictions than do the corresponding noncoronal consonants (i.e., the coronal unmarkedness pattern), Coronal Underspecification holds that the positions showing the coronal unmarkedness pattern are restricted to segments with no place specification. That is why only coronal consonants are allowed there.

For example, the preference for coronal consonants over labial or dorsal consonants as an epenthetic element may follow from the assumption that an epenthetic element is required to have the minimum amount of structure possible (cf. Archangeli 1984). A segment without a place feature will therefore be chosen as an epenthetic element over one with place features. The placeless segment is filled in with a default place feature, [Coronal], through a universal default rule.

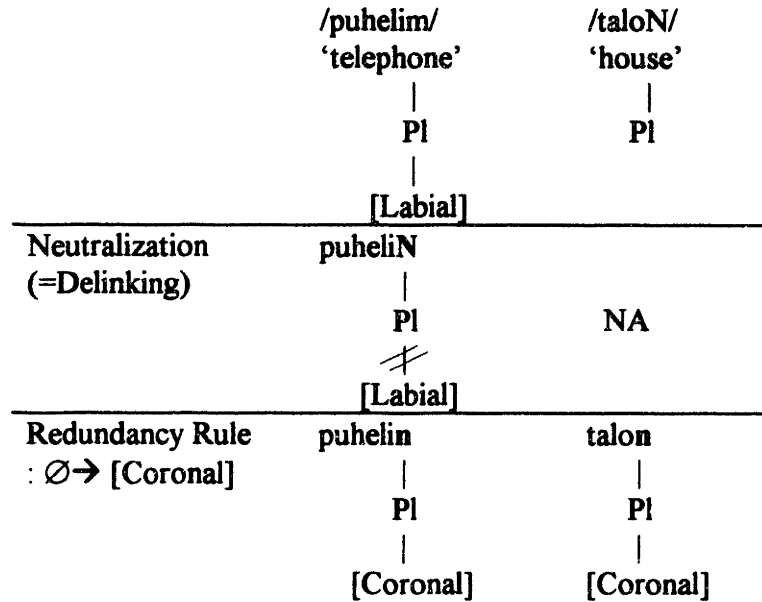
The inventory generalizations also find a similar explanation in the Underspecification approach. Assuming that “inventories are built up monotonically, with a step-by-step addition of structure” (Rice 1992, p.64), it is expected that, other things

being equal, languages will add coronal consonants to the inventory before labial or dorsal consonants since coronal consonants have less place structure. Thus, the generalization that if an inventory includes a dorsal or a labial consonant, it also has a corresponding coronal consonant, is derived.

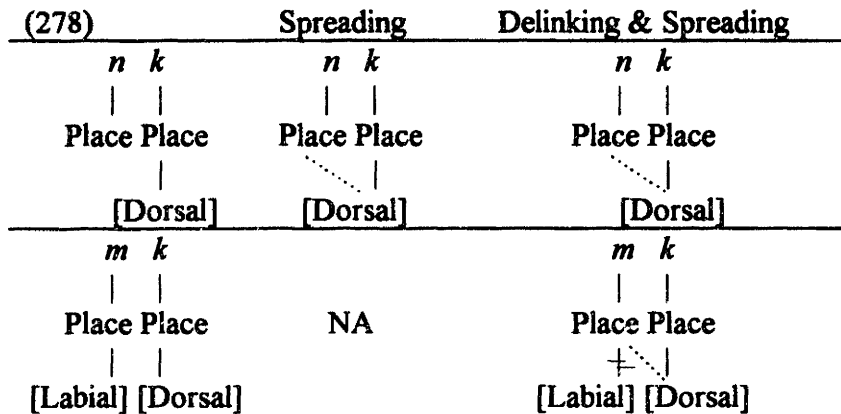
In several languages, the OCP is inert for coronal place but active for labial place. This asymmetry also follows from the assumption of Coronal Underspecification. [Coronal] is not specified at the point where the OCP applies and coronal consonants are in effect invisible to the OCP (Yip 1989).

Along the same reasoning, neutralization of place contrasts to coronal place is analyzed as neutralization to no place specification. Neutralization is assumed to be the result of a delinking operation that deletes an existing place feature (Kiparsky 1985). In Finnish, for example, a word-final labial nasal neutralizes to coronal nasal. The coronal nasal is not specified as [Coronal] underlyingly (*talon*) while the labial nasal is specified as [Labial] (*puhelim*) in (277). The delinking operation applies to the word-final labial nasal, making it identical to the underlyingly placeless nasal. Later on, the empty place node is filled in as [Coronal] through the redundancy rule and neutralization results in a coronal consonant.

(277)



On the other hand, Coronal Underspecification predicts that coronal consonants should be the preferred target of place assimilation, if there is any asymmetry between coronal and noncoronal places at all. According to Kiparsky (1985), assimilation can be either a simple feature spreading process or a combination of feature delinking and spreading processes. Kiparsky (1985) assumes that simple feature spreading is the more unmarked of the two processes. While the delinking and spreading type of assimilation will apply to all potential targets, the simple feature filling type will apply only when the target position is unspecified for the feature that spreads. Thus, the preferential assimilation of coronal consonants follows from the assumption that coronal consonants are underspecified for place. This is demonstrated in (278).



The Coronal Underspecification approach, however, cannot account for the coronal unmarkedness pattern found in Sri Lanka Portuguese, where only noncoronal consonants undergo assimilation but coronal consonants remain stable. Coronal Underspecification also fails to explain the fact that the coronal unmarkedness pattern is also found in languages that contrast sub-coronal places such as Lardil, Nunggubuyu, Tamil and Old Telugu. In languages with sub-coronal place contrasts, by the standard assumption, sub-coronal place contrasts are represented by features that are dependent on [Coronal]; in order to represent the contrast among coronal consonants, the [Coronal] feature must be specified in the underlying representation, as shown in (279).

(279)

Alveolar	Labial
/t/	/p/
Place	Place
[Coronal]	[Labial]
/ \	
[-Dist][+Ant]	

Here, coronal consonants must be specified for place features. So, there is no representational asymmetry that can distinguish coronal place from noncoronal places. This is a problem for the Coronal Underspecification approach, which derives the asymmetry between coronal and noncoronal places from their representational difference.

In languages with sub-coronal place contrasts, no asymmetry between coronal and noncoronal places—coronal unmarkedness as well as coronal markedness—is expected. This is incorrect.

The Coronal Underspecification approach also fails to account for cases where the reversed markedness pattern is enforced by processes other than coronal assimilation. The appearance of coronal consonants is selectively avoided in certain languages, not only by place assimilation but also by segmental and featural deletion, metathesis and Morpheme Structure Constraints. Rice (1996) claims that underlying coronal consonants may not appear as coronal in certain positions in certain languages because the default fill-in rule for a coronal place feature may fail to apply in those positions. However, allowing default rules to refer to specific contexts and to differ from language to language undermines the explanatory power of the Coronal Underspecification approach itself, since the Coronal Underspecification approach claims that feature specifications in the underlying representation reflect universal markedness relations and the default rules that fill in unmarked feature values are supposed to also be universal. Thus, the concept of a language- and context-specific default rule is undesirable.

5.2 *The Underspecification by Constraint approach*

Kiparsky (1994) proposes to do without Prince and Smolensky's context-free markedness constraint hierarchy.⁸³ Rather, he proposes a principle regarding possible types of constraints: "for every constraint that refers to a phonological category, there is

⁸³ Alderete et al. (1996) point out that Kiparsky (1994)'s approach, without context-free place markedness constraints, cannot produce the emergence of the unmarked effect in reduplication.

an otherwise identical constraint that refers specifically to the marked member of that category.” This is how the markedness relation is reflected in the constraint system. As a result, constraints form an inclusion hierarchy and preserve the effect of a scale without imposing a fixed constraint ranking (Prince 1997).⁸⁴

I will refer to this approach as *Underspecification by constraint*. Kiparsky’s (1994) approach inherits from the Coronal Underspecification approach the idea that coronal consonants are special because they are invisible. The difference is that in Kiparsky (1994), coronal place is invisible not in terms of representation but in the constraint system. In this approach, a global assumption regarding the markedness relation between coronal and noncoronal places is made and from this, inclusion hierarchies are formed for any type of constraints that refers to place features. They include not only markedness constraints but also faithfulness constraints (both MAX type constraints and DEP-type constraints) as shown in (280). In this section, I will show that the Underspecification by Constraint approach makes predictions that markedness reversal may occur (a) in any processes involving place or segmental deletion and (b) only in these processes, but that neither of these predictions is borne out.

⁸⁴ Prince (1997) points out that the inclusion hierarchy is richer than the fixed ranking hierarchy and increases the number of predicted systems.

(280) **Markedness Relation :** Marked : Labial, Dorsal Unmarked: Coronal



Constraint System :	<ul style="list-style-type: none"> • Markedness constraints <ul style="list-style-type: none"> *CODA/PL[PER], *CODA/PL[α] OCP(PL[PER]), OCP(PL[α]) • Faithfulness constraints <ul style="list-style-type: none"> <u>DEP constraints</u> <ul style="list-style-type: none"> DEP(PL[PER]), DEP(PL[α]) <u>MAX constraints</u> <ul style="list-style-type: none"> MAX(PL[PER]), MAX(PL[α])
----------------------------	--

In this approach, markedness constraints such as *CODA/PL, OCP, etc. can refer specifically only to noncoronal place but not to coronal place. For example, there are two kinds of constraints against coda place specification: one against all places (281a) and another against labial or dorsal places (281b). But, there is no constraint specifically against coronal place. Thus, other things being equal, a noncoronal consonant in coda position is bound to incur an additional constraint violation compared to a corresponding coronal consonant. Thus noncoronal consonants are less likely to surface in this position. These place markedness constraints therefore promote the coronal unmarkedness pattern.⁸⁵

- (281) a. *PL[α]/CODA
b. *PL[PER]/CODA

For example in Finnish, the coda constraint against noncoronal place (281b) dominates the faithfulness constraint and a dorsal or labial stop in word-medial coda position debuccalizes, as shown in (282). But the general coda constraint (281a) is dominated by faithfulness constraints and a coronal stop does not debuccalize, as shown in (283).

(282) Finnish /kak + ta/ → *kahta* ‘two’ PRT. (cf. *kaksi* ‘two’ NOM.)⁸⁵

	/kak + ta/ [Dor][Cor]	*PL[PER]/CODA	MAX(PL[α])	*PL[α]/CODA
a.	kakta /\ [Dor][Cor]	*!		*
b.	kahta /\ [Glot][Cor]		*	

(283) Finnish /matka/ → *matka* ‘trip’

	/matka/ /\ [Cor][Dor]	*PL[PER]/CODA	MAX(PL[α])	*PL[α]/CODA
a.	matka /\ [Cor][Dor]			*
b.	mahka /\ [Glot][Dor]		*!	

Similarly, DEP faithfulness constraints as a whole promote the coronal unmarkedness pattern. There are DEP(PL[PER]) and DEP(PL[α]) but there is no DEP(PL[COR]). Thus, other things being equal, a candidate with coronal epenthesis will incur a subset of constraint violations that candidates with labial or dorsal epenthesis incur. An example from Axininca Campa is given in (284).

⁸⁵ This constraint corresponds to Kiparsky (1994)’s CODA-NEUTRALIZATION constraint.



⁸⁶ I assume that *CODA/PL[α] penalizes oral place features only and glottal consonants do not violate the constraint.

(284) Axininca Campa /i-N-koma-i/ → *in̩komati* ‘he will paddle’



	/i-n̩-koma-i/	ONSET	DEP(PL/[PER])	DEP(PL[α])
a.	in̩.ko.ma.i	*!		
b. ☞	in̩.ko.ma.ti [Cor]			*t
c.	in̩.ko.ma.pi [Lab]		*!	*p
d.	in̩.ko.ma.ki [Dor]		*!	*k

On the other hand, the inclusion hierarchy of MAX constraints promotes the coronal *markedness* pattern. There are MAX(PL[α]) and MAX(PL[PER]) but no MAX(PL[COR]). Thus, other things being equal, it is predicted that coronal place is more likely to be lost than noncoronal places in assimilation or deletion processes. For example in Yakut, MAX(PL[PER]) dominates the place markedness constraint, *PL[α]/_C, which motivates assimilation, and labial and dorsal consonants do not undergo assimilation, as shown in (285). On the other hand, there is no faithfulness constraint specific to coronal place that can dominate *PL[α]/_C and sustain coronal place; therefore when *PL[α]/_C dominates a general faithfulness constraint MAX(PL[α]), coronal consonants undergo assimilation, as shown in (286).

(285) Yakut /sep-kA/ → *sepke* **sekke* 'tool'

	/sep-kA/ / \ [Lab][Dor]	MAX(PL[PER])	*PL[α]/_C	MAX(PL[α])
a. 	sepke / \ [Lab][Dor]		*	
b. 	sekke \/ [Dor]	*!		*

(286) Yakut /sot-popun/ → *soppopun* 'we do clean'

	/sot-popun/ / \ [Cor][Lab]	MAX(PL[PER])	*PL[α]/_C	MAX(PL[α])
a. 	sotpopun / \ [Cor][Lab]		*!	
b. 	soppopun \/ [Lab]			*

In Kiparsky's (1994) system, the MAX constraints are the source of markedness reversal (i.e., coronal markedness) and they are in conflict with markedness constraints that demand coronal unmarkedness in the output. Since constraints are freely rerankable, depending on the ranking of the markedness constraints and the faithfulness constraints (MAX) relative to one another, coronal unmarkedness or coronal markedness may appear. For example, in Yakut, assimilation targets only coronal consonants. In the output, only noncoronal consonants surface in preconsonantal position. On the other hand, in Sri Lanka Portuguese Creole, assimilation targets only noncoronal consonants. The difference between the two languages comes from different ranking of markedness constraints and faithfulness constraints relative to each other, as the table in (287) summarizes. Thus, Kiparsky (1994) can capture cases of markedness variability that are found in processes

involving MAX(PL[α]) violations, processes such as place assimilation, debuccalization, segmental deletion, etc.

(287)

	Constraint ranking	What surfaces?
a.	*PL[PER]/_C » MAX(PL[PER]), MAX(PL[α]) » *PL[α]/_C	Coronal consonants only → Coronal Unmarked
b.	MAX(PL[PER]) » *PL[PER]/_C, *PL[α]/_C » MAX(PL[α])	Noncoronal consonants only → Coronal Marked

However, since the MAX(PL[α]) hierarchy is the sole source of the reversed markedness pattern, the reversed markedness pattern is predicted to be found only in processes that involve MAX(PL[α]) violations but not in any other processes. However, we saw that in Leti and Moa, the coronal markedness pattern is also enforced through metathesis. Also, in Tagalog and Cebuano Bisayan, coronal consonants in preconsonantal position are actively avoided, but coronal assimilation is only one of the strategies employed. Rather, a combination of place assimilation (regressive and progressive) and metathesis *conspire* to achieve the goal of eliminating preconsonantal coronal stops. The Underspecification by Constraint approach fails to account for these cases.

Another implication of Underspecification by Constraints is that variations in markedness (i.e., markedness reversal) are predicted to be attested regardless of the inventory structure of a language. Since all constraints are freely rerankable, nothing in the system prevents a language with sub-coronal place contrasts from having the ranking in (287)b. Thus, the prediction is made that there is a language with sub-coronal place contrasts that shows the coronal markedness pattern. However, this prediction is not borne out by my survey.

5.3 The perceptually motivated faithfulness constraint approach

Based on a survey of place assimilation patterns, Jun (1995) proposes that assimilation preferentially targets coronal consonants over noncoronal consonants universally and proposes a hierarchy of perceptually motivated faithfulness constraints to account for the generalization.⁸⁷ According to this hierarchy, a coronal place feature in an unreleased position is more likely to be deleted than a noncoronal place feature in an unreleased position.

(288) MAX(PL[PER]/__') » MAX(PL[COR]/__')

Jun (1995) also proposes that the asymmetry between coronal and noncoronal consonants in place assimilation is due to the difference in perceptual salience between coronal and noncoronal consonants in unreleased position. The difference between Jun's (1995) approach and the proposal made in this thesis is that Jun (1995) proposes that a perceptibility scale is projected into the grammatical component as a faithfulness constraint hierarchy, not as a markedness constraint hierarchy as this thesis proposes.

This hierarchy is proposed to account for generalizations regarding place assimilation phenomena. Although it is not clear how this hierarchy should be interpreted in view of other place asymmetry phenomena, Jun suggests that this approach can be extended to account for generalizations regarding phonotactics in general. This is not

⁸⁷ Again, these constraints are reformulated from original versions to make the comparison with other constraints easier. Jun's hierarchy distinguishes not only coronal from noncoronal but also distinguishes dorsal and labial places MAX(PL[DOR]/__') » MAX(PL[LAB]/__') » MAX(PL[COR]/__') I will not be concerned with the contrast between dorsal and labial places here

correct, however. Although the perceptually grounded faithfulness constraints are necessary to account for some place asymmetry phenomena (cf. Hume 1998, Kang 1998, Steriade 1999c), the grammar must contain perceptually grounded markedness constraints to account for the whole range of place asymmetry phenomena. The criticism against Jun (1995) is three-fold.

First, as we have seen, although it is true that coronal consonants are in general a preferred target of assimilation over noncoronal consonants, this is not always the case; in Sri Lanka Portuguese and Nunggubuyu, it is the noncoronal but not coronal consonants that undergo assimilation. The faithfulness hierarchy in (288) cannot derive the right result for these cases of coronal unmarkedness. This is illustrated below with place assimilation in Nunggubuyu as an example, in (192). In order to get assimilation to apply to noncoronal consonants, the constraint that forces deletion—let us assume that this constraint is a general markedness constraint against a place feature, $*PL[\alpha]$ —should outrank the faithfulness constraint for noncoronal place.

(289) Nunggubuyu /ama-kulmuŋ-tuc/ → *amakulmumpac* **amakulmuŋpac* ‘belly, PROG’

	/ama-kulmuŋ-pac/ / \ [Dor][Lab]	$*PL[\alpha]$	MAX(PL[PER]/__)
a.	amakulmuŋpac / \ [Dor][Lab]	**!	
b. ✓	amakulmumpac ∨ [Lab]	*	*

If the constraint that forces assimilation of noncoronal consonants, $*PL[\alpha]$, outranks the faithfulness constraint against deletion of noncoronal place, by transitivity, $*PL[\alpha]$ should also outrank the faithfulness constraint against deletion of coronal place.

Thus, it is incorrectly predicted that if noncoronal consonants are assimilated, corresponding coronal consonants will also be assimilated in the language. This is illustrated in (291).

(290) Nunggubuyu /man-payama/ → *manpayama* **mampayama* '(group) to keep going'

/man-payama/ / \ [Cor][Lab]	*PL[α]	MAX(PL[PER]/__')	MAX(PL[COR]/__')
a. <i>manpayama</i> / \ [Cor][Lab]	**		
b. ➡ <i>mampayama</i> V [Lab]	*		*

Second, just as in the Underspecification by Constraint approach, if the MAX hierarchy is the only source of markedness reversal, we cannot account for the coronal markedness phenomena found in Tagalog, Cebuano Bisayan, Leti and Moa. In these languages, markedness reversal manifests itself through metathesis rather than featural or segmental deletion.

Third, Jun does not take into account the role of tongue body articulation in the production and perception of coronal consonants. His constraints do not make reference to sub-coronal place contrasts and it is expected that the coronal markedness pattern should be found in languages *with* sub-coronal place contrasts as well as ones *without*. This prediction is not borne out by the results of my survey: the coronal markedness pattern is found only in languages without sub-coronal place contrasts but not in languages with sub-coronal place contrasts.

Chapter 6 Conclusion

It is a well-established generalization that coronal consonants behave differently from noncoronal consonants (Paradis and Prunet 1991a among others). Until now, however, a proper understanding of the coronal versus noncoronal asymmetry and adequate analytical formalism have been lacking. In this thesis, I investigated the coronal versus noncoronal asymmetry, especially focusing on stop consonants. The research was guided by two new perspectives—Optimality Theory (Prince and Smolensky 1993) and Phonetically Grounded OT (Steriade 1997).

With the advent of Optimality Theory (Prince and Smolensky 1993), focus has shifted away from input representations or rules (or processes), since the theory holds that grammar consists of a set of constraints on well-formed outputs. A change from input to output occurs not because there is *a rule* but because the change best satisfies *output constraints*. Phonetically Grounded OT pursues the hypothesis that phonological phenomena are grounded in physical properties of speech production and perception and formalizes the idea with OT constraints (Jun 1995, Silverman 1995, Flemming 1995, Kirchner 1998, Steriade 1997, 1999abc, 2000 etc.).

I categorized data into two groups—coronal unmarkedness and coronal markedness—by the phonotactic patterns in the output rather than by the rules or processes that are involved. This strategy revealed that neither coronal markedness nor coronal unmarkedness is restricted to particular phonological processes, but both types of place restriction patterns are found in various processes, such as metathesis, deletion, assimilation, debuccalization, place neutralization and Morpheme Structure Constraints.

The survey also reveals that unlike default markedness, coronal markedness is found only in very restricted contexts—in nonprevocalic positions in languages that lack sub-coronal place contrasts. I proposed that coronal markedness has this contextual restriction because it is perceptually grounded: coronal stops in nonprevocalic positions in languages with a single coronal series are perceptually weaker than corresponding noncoronal stops. The perceptibility scale is projected into the grammatical component in the form of a markedness constraint hierarchy. These constraints are inherently context-specific and this accounts for the restriction of coronal markedness to particular contexts.

On the other hand, coronal unmarkedness is not restricted to any particular context. It is attested not only in nonprevocalic positions but also in phenomena that are not restricted to particular segmental contexts such as inventory generalizations and OCP phenomena. This follows from the context-free markedness constraints proposed by Prince and Smolensky (1993). Since these constraints are context-free, they can apply without any restrictions on segmental contexts or can be specialized for particular contexts through local conjunction with context-specific markedness constraints.

I also showed that the place restriction pattern is not uniform for stops consonants in all nonprevocalic positions in a language. Rather, the degree of place restrictions differ depending on the nasality of the stops consonants themselves or the external segmental contexts. Finally, I demonstrated that previous approaches to the coronal versus noncoronal asymmetry are inadequate

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