THE FORMAL EXPRESSION OF MARKEDNESS

A Dissertation Presented

by

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DEDICATION

In memory of my brother.

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Although this is probably the first part of the dissertation you'll read, it was the last part I wrote. Now that everything's (almost) over, I feel like I finally have a moment to contemplate everything that's happened over the last five years. Looking back, I realize I owe a lot of people a lot of thanks.

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ABSTRACT

THE FORMAL EXPRESSION OF MARKEDNESS

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This dissertation presents a formal theory of markedness, set within Optimality Theory. Two of the leading ideas are (a) hierarchical markedness relations may be ignored, but never reversed and (b) the more marked an element is, the greater the pressure to preserve it.

An example of (a) is found in sonority-driven stress systems. In Gujarati, low vowels attract stress away from mid vowels, while Nganasan's stress system makes no distinction between the two categories. So, while stressed mid vowels are more marked than stressed low vowels (as shown by Gujarati), that distinction can be conflated (as in Nganasan). However, in no language is the markedness relation reversed: stressed mid vowels are never preferred over stressed low vowels.

An example of (b) is found in Yamphu. /t/ is eliminated through a process of debuccalization. In contrast, the more marked segments /k/ and /p/ remain intact; these segments avoid the debuccalization process because they are highly marked and thereby excite greater preservation.

Ideas (a) and (b) are formally expressed as a set of constraint-formation conditions. For constraints on output structures ('markedness' constraints), if a constraint assigns a violation to an element p in scale S, then the constraint also assigns a violation to every element that is more marked than p in S. An analogous proposal applies to faithfulness (i.e. preservation) constraints: if a faithfulness constraint bans an unfaithful mapping from element p in scale S, then the constraint also bans unfaithful mappings from all elements that are more marked than p in S. The result is that – regardless of the constraints' ranking – more marked elements are both subject to more stringent output conditions and preserved more faithfully than lesser-marked ones. The constraints are also shown to allow distinctions between scale categories to be collapsed.

A wide range of phonological phenomena provide evidence for the theoretical proposals, including analyses and typologies of sonority-driven stress (Nganasan, Gujarati, Kiriwina, and Harar Oromo), tone-driven stress, vowel and consonant epenthesis, vowel reduction (Dutch), coda neutralization (Malay and Yamphu), Place assimilation (Catalan, Ponapean, Korean, Swedish, and Sri Lankan Portuguese Creole), and coalescence (Attic Greek and Pāli).

TABLE OF CONTENTS

PART II: MARKEDNESS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

1.   Symbols in tableaux
☞   The winning form
💣☀   A incorrect/unattested winning form
☠   A form that never wins in any grammar

2.   Feature classes
K   dorsal (velar, uvular, pharyngeal)
P   labial (bilabial, labio-dental)
T   coronal (dental, alveolar, postalveolar, retroflex, (palatal))
?   glottal [? h ɦ N]
[vd]   The feature [voice]
[N]   The placeless (glottal) nasal (Trigo 1988, see ch.5§5.3)

3.   Prosodic Categories
μ   Mora
Ft   Foot
σ   Syllable
PrWd   Prosodic Word
MiP   Minor Phrase
MaP   Major Phrase
PPh   Phonological Phrase
IP   Intonational Phrase
UttP   Utterance

4.   Other symbols
| … | encloses a scale (e.g. | dorsal 〉 coronal |)
‖ … ‖   encloses a ranking (e.g. ‖ ONSET » MAX ‖)
x » y   constraint x outranks constraint y
x,y   the ranking of constraint x and y is indeterminate
≥x refers to all elements on a scale that are equally or more marked than x
≤x refers to all elements on a scale that are equally or less marked than x
{…}   in a constraint, encloses a set of scale elements (e.g. IDENT{KP})
/ /   Encloses an input form
[ ]   Encloses an output form
1   subscript numerals mark correspondence relations: /a_1/→[i_1] indicates that input /a/ corresponds to output [i].
M(x>y) a markedness constraint that favours x over y (i.e. assigns fewer marks to x than y). M(t>k) stands for a markedness constraint that favours [t] over [k]
F(x>y) a faithfulness constraint that preserves x without preserving y. F(t>k) preserves /t/ but not /k/.
M(x) a markedness constraint that assigns a violation to [x]
F(x) a faithfulness constraint that preserves the mapping /x/→[x].

Δ_α Designated Terminal Element of α. The terminal element that is associated to α by an unbroken path of prosodic heads.

$-\Delta_\alpha$ non-Designated Terminal Elements of α. All elements in α that are not α's DTE.

CHAPTER 1

INTRODUCTION

1.1   Introduction

This dissertation presents a formal theory of markedness, set within Optimality Theory. Two leading ideas behind the theoretical proposals are stated in (1).

(1)   <u>Leading Ideas</u>
(a) Markedness relations between categories may be ignored, but never reversed.
(b) The more marked an element is, the greater the pressure to preserve it.

The general issues that this dissertation addresses are outlined in §1.1.1. The leading ideas in (1) are discussed in §1.1.2.

Section 1.2 presents a synopsis of the theory, and §1.3 identifies its empirical implications. Section 1.4 contains an outline of this dissertation.

1.1.1   Markedness: Issues

A number of phonological phenomena treat certain classes of segments differently from others. For example, non-assimilated epenthetic consonants are always coronal [t s n l r] or glottal [ʔ h]; they are never labial [p m f] or dorsal [k ŋ x] (ch.5§5.3, Lombardi 1998).

Similarly, Place of Articulation is always neutralized to coronal or glottal (ch.6§6.6). For example, all plain stops in Kashaya are converted into [ʔ] in codas (Buckley 1994:99). In contrast, there is no language in which all stops are converted into the dorsal [k] or labial [p] in codas (ch.6§6.6).

In contrast, dorsals can trigger assimilation without coronals doing so. For example, stops and nasals in Korean must assimilate to a following [k] while they retain their underlying place of articulation before [t]. Moreover, there is no language where the opposite occurs: where coronals trigger assimilation but dorsals do not (ch.7§5).

As a final example, stress exhibits a rigid hierarchical preference for certain segment classes: stress will seek out high sonority segments, ignoring lower sonority ones. A relevant case is found in Gujarati, briefly outlined in (2). For further data, see ch.3§3.2.

(2)   <u>Gujarati stress in brief</u> (Cardona 1965, my own fieldwork)
  (a) Stress a low vowel [a]
      [tádʒetəɾ]   'recently'   [mánɪto]   'respected (masc.)'
      [sinemá]   'movie theatre' [betális]   '42'
  (b) Otherwise stress a non-final non-low peripheral vowel [ɛ ɔ e o i u]
      [kójəldi]   'little cuckoo'   [tʃʰokɾío]   'girls'
      [wísmərən]   'forgetfulness' [kʰəmíso]   'shirts'
  (c) Otherwise stress a penult central vowel [ə]
      [pə́təŋg]   'kite'   [pəɾə́bɖi]   'water-dispensing shed'
      [ɾəmə́ɖũ]   'toy'   [kə́ɾu]   'does, do'

Gujarati stress treats vowels in a **hierarchical manner**: stress relies on a vowel scale in which [a] is predominant, followed by mid and high peripheral vowels, and finally by [ə].

Gujarati stress also raises the issue of **universality**. Many other processes also refer to the same vowel scale used in Gujarati (i.e. the vocalic part of the sonority hierarchy – ch.3§3.2, Sievers 1881, Jespersen 1904). While some languages make fewer distinctions among the vowels for stress assignment and others make more, all follow the same hierarchy (ch.3§3.5). More importantly, the opposite 'anti-Gujarati' situation never occurs: there is no language in which stress ignores [a] and seeks out a non-low vowel instead.

Another issue relates to the **versatility and consistency** of the scale in different processes. The vowel scale described above is not only used for placing primary stress. Pichis Asheninca refers to it in locating secondary stress (J.Payne 1990), and syllabification in many languages refers to the same scale (e.g. Hooper 1976, Harris 1983, Selkirk 1984, Dell & Elmedlaoui 1985, 1988, Prince & Smolensky 1993:ch.1, Blevins 1995). It is also relevant to processes such as neutralization (ch.6, Crosswhite 1998, 1999, 2000) and coalescence (ch.8).

Even the few examples given above indicate that there is a cross-process and cross-linguistic consistency in terms of the classes of elements that are set in opposition to each other. For Place of Articulation distinctions, dorsals and labials are treated distinctly from coronals and glottal; for vowels, sonority determines hierarchical relations. The recognition of the cross-linguistic consistency of hierarchies has led to theories of 'markedness' – attempts to provide a unified explanation of the phenomena discussed above (classically: Jakobson 1941 et seq., Trubetzkoy 1931, 1939, Greenberg 1966; general discussion: Moravcsik & Wirth 1983, Eckman et al. 1983; for work in generative frameworks: Chomsky & Halle 1968:ch.9, Stampe 1972, Cairns & Feinstein 1982, Prince & Smolensky 1993, Causley 1999b).

The aim of this dissertation is to provide a formal theory of markedness relations. In other words, the aim is to provide a formal account of why certain phenomena treat certain segment classes as distinct from others and why there is both cross-phenomena and cross-linguistic consistency in this treatment.

There are a number of challenges to any such theory. Processes can collapse certain markedness distinctions (§1.1.1.1), and even ignore markedness entirely (§1.1.1.2).

In addition, the most marked elements can be retained while less marked ones are eliminated (§1.1.1.3).

1.1.1.1 Conflating markedness distinctions

A complicating factor for markedness is that – on the surface – markedness distinctions are only partially uniform cross-linguistically. Markedness categories that are distinct in some languages may be fused – or 'conflated' – in others.

An example of conflation is found in the Gujarati case presented in the preceding section. This system had 'sonority-driven' stress – where stress placement is sensitive to vowel quality. Notably, Gujarati treats mid and high peripheral vowels in the same way for stress purposes. Stress does not avoid high vowels for mid peripheral vowels – [tʃʰokɾío] 'girls', *[tʃʰókɾio], nor does stress avoid mid vowels for high vowels: e.g. [tʃumːóteɾ] '74', *[tʃúmːoteɾ]. In other words, the distinction between stressed high and mid peripheral vowels is ignored in this system. This will be called 'category conflation' (or just 'conflation' for short). The theoretical significance of conflation has been previously recognized in Kenstowicz (1996), Prince (1997a,b,c, 1998, 1999), and in my own work (de Lacy 1997a, 1999a, 2000a, 2002b).[1]

Languages differ as to which categories they conflate. For example, chapter 3§3.3 discusses stress in the Uralic language Nganasan; this language conflates schwa with high vowels in stress placement, and mid peripheral vowels with low vowels (Helimski 1998). The result is a vowel scale | ɨ,ə,i,u 〉 e,o,a | for Nganasan stress, compared with Gujarati's | ə 〉 i,u,e,o,ɛ,ɔ 〉 a |. Chapter 3 shows that conflation can apply to any contiguous part of the sonority scale, and conflate any number of categories. Conflation also applies to other scales, with a variety of effects. Examples of conflation of the Place of Articulation scale are given in ch.5§5.3.

In short, an adequate theory must not only be able to make category distinctions (e.g. high vs mid peripheral vowels in Nganasan), but collapse them as well (as in Gujarati). While allowing conflation, though, it is crucial to prevent reversals of the hierarchy: in no language does stress avoid mid peripheral vowels for high peripheral ones. More concretely, an adequate theory must explain why (i) mid vowels are more desirable for stress than high peripheral vowels in Nganasan, (ii) stressed mid and high vowels are equally desirable in Gujarati, and (iii) high vowels are never more desirable than mid vowels in the stress system of any language.

In summary, the present theory aims to explain why hierarchical markedness relations can be ignored, but never reversed. In slightly different terms, the observation arrived at here is that no statement of the form "*x* is universally more marked than *y*" is true. Rather, the form of such markedness statements should be "*y* is never more marked than *x*", so allowing for situations where *y* and *x* are treated as being equally marked.

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[1] Category conflation is different from 'tier conflation' (Halle & Vergnaud 1987), which is the elimination of a line of marks in a metrical grid.

1.1.1.2 Processes that ignore markedness entirely

A significant difficulty in providing a comprehensive account of markedness is that many processes do not treat categories in an asymmetrical way – they are seemingly not constrained by markedness considerations at all.

For example, there are almost no asymmetries in vowel epenthesis (cf consonant epenthesis – ch.5§5.3.3.3). Epenthetic vowels may be any of the set [ɨ ə i ɯ e ɛ a] (ch.4§4); there is no asymmetry based on height or peripherality. The only asymmetry relates to roundness: round vowels cannot be epenthetic (putting aside incidental processes like roundness harmony).

Similarly, there are almost no typological asymmetries in segmental inventories (ch.6). The term 'inventory' is used here to refer to the surface segments found in a language; it may be further modified by a prosodic position such as 'coda inventory', being those segments that can appear in syllable codas in a language.

For example, Hawaiian and Yellowknife Chipewyan have the highly marked stops [k p ʔ], but no less marked coronal [t] (Pukui & Elbert 1979, Haas 1968 resp.). In contrast, Tahitian lacks a [k], having the stop inventory [p t ʔ] in onsets (Coppenrath & Prevost 1974), Ayutla Mixtec lacks a [p], having only [k t ʔ] in native words (Pankratz & Pike 1967), and Maori lacks [ʔ] (having [k p t] – Bauer 1993).

Similarly, there are no implicational universals relating to the undergoers of assimilation (ch.7§7.2.2). For example, only coronals undergo assimilation in Catalan; labials and dorsals do not (Mascaró 1976). In contrast, only labials and dorsals undergo assimilation in Sri Lankan Portuguese Creole; coronals do not (Smith 1978, Hume & Tserdanelis 1999).

There are no asymmetries relating the output of segment coalescence (ch.8). If two segments are fused into one, the resulting segment may retain either the marked or the unmarked value of the input segments. For example, coalescence of /b^h/ and /t/ in Pāli yields [d^h] – an output that preserves the unmarked coronal PoA of the /t/. In contrast, coalescence of /p/ and /t/ in Gnanadesikan's (1995) child language data results in the more marked PoA – labial.

As a side note, all of the processes just cited have been argued to exhibit markedness asymmetries in previous work. The chapters cited provide evidence that this is not so.

In short, an adequate theory must also account for why the processes cited above are insensitive to markedness distinctions.

1.1.1.3 Processes that preserve marked elements

A major issue for a theory of markedness is that less marked elements can be eliminated while more marked elements are retained. Such a situation is contrary to expectations: the traditional notion behind markedness is that grammars seek to eliminate highly marked structures ('markedness reduction'). Processes that retain marked structures do exactly the opposite.

The Major Place of Articulation scale is provided in (3) for convenience; 'dorsal' is the most marked element and 'glottal' is least marked (ch.5§5.3, Lombardi 1998).

(3)   Major Place of Articulation Scale
        | dorsal 〉 labial 〉 coronal 〉 glottal |

The Nepalese language Yamphu provides a relevant example of preservation of marked Place of Articulation. In this language, coda coronal stops (i.e. /t/ and /tː/) debuccalize to [ʔ] while the more marked /k/ and /p/ remain unchanged. As a note on the data in (4), voiceless stops voice intervocalically in Yamphu (thus /hæːt-u-ŋ/ surfaces as [hæːduŋ]). The first two forms in (4a) have an underlying /t/, the second two have an underlying geminate /tː/. The data is from Rutgers (1998); further data is provided in chapter 6§6.3.

(4)   Yamphu /t(ː)/-debuccalization (ch.6, Rutgers 1998)
        (a) /t/ → [ʔ], /tː/ → [ʔ]
            [namːiʔ]   'daughter-in-law'   cf [namːid-æʔ] {instrumental/ergative}
            [hæːʔ-ma]   'to bite'   cf [hæːd-u-ŋ] 'I nibbled at'
            [triʔ-ma]   'contrary'   cf [kap-trid-u] 'he has (unexpectedly)'
            [kʰiʔ-ma]   'to bring'   cf [jaŋ-gʰitː-u-ŋ] 'I brought it for him'
            [siʔ-ma]   'to hit'   cf [sitː-a] 'hit+past', [sitː-iŋ] 'hit+exp.'
        (b) /p/→[p]
            [kʰap]   'language'
            [kep-ma]   'stick + infinitive'
        (c) /k/→[k]
            [æʔlik]   'bendy'
            [kʰaːk-pa]   'scrape one's throat + perform act'
            [aktok]   'like that'

The issue raised by Yamphu is why the more marked dorsals and labials should be exempt from debuccalization while the less marked coronals are not.

Similar situations are found in assimilation and coalescence. Chapter 7§7.2 describes several cases where dorsals and labials are prevented from assimilating while coronals are not. A famous case is Catalan, in which the coronal /n/ assimilates while the labial /m/ and dorsal /ŋ/ do not (Mascaró 1979).

Chapter 8 presents several cases of segment coalescence where the most marked feature value is retained. For example, when Attic Greek vowels coalesce, the resulting output vowel keeps the marked [+round] feature: /mistʰo+εːte/ → [mistʰɔːte] 'you may hire out', *[mistʰεːte] (ch.8§8.2, de Haas 1988).

On the other hand, the processes just cited also allow the most marked element to be eliminated while the least marked element is retained. For example, the highly marked /k/ is eliminated in Standard Malay codas, while the less marked /p/ and /t/ are retained (ch6§6.1). There is also an exact opposite to Catalan for assimilation: in Sri Lankan Portuguese Creole, labials [m] and dorsals [ŋ] assimilate while coronals [n] do not (ch.7§7.4.2). Finally, the unmarked value can emerge in coalescence: in Pāli, coalescence

of a labial and a coronal produces a coronal (e.g. /la<u>b</u>ʰ-<u>t</u>um/ → [la<u>d</u>ːʰum] 'take {infinitive}') (ch.8§8.4).

The claim that there are no asymmetries in assimilation and coalescence is controversial (cf Mohanan 1993, Jun 1995, de Haas 1988), so extensive evidence for the empirical claims made above is provided in chapters 6-8.

In summary, unmarked elements may be eliminated, while marked elements are retained (as in Yamphu, Catalan, Attic Greek). However, the opposite situation may also occur: marked elements may be eliminated while unmarked ones remain (as in Malay, Sri Lankan Portuguese Creole, Pāli).

1.1.2 Leading Ideas

This dissertation explores two leading ideas, repeated from (1) for convenience.

(5)   (a) Markedness relations between categories may be ignored, but never reversed.
        (b) The more marked an element is, the greater the pressure to preserve it.

Of course, (1)/(5) contain informal statements; a formal implementation is outlined in §1.3, set in Optimality Theory. The import of the leading ideas will be discussed informally here, not only for the sake of cross-theoretic applicability, but because it may help clarify the aims and reasons for the theoretical implementation in the next section.

The leading ideas in (5) can be used to account for all of the markedness-related phenomena identified in §1.2.1. (5a) and (b) will be discussed in turn.

- *Leading Idea I: "x is never less marked than y"*

Statement (5a) expresses the notion that categories may be conflated. In previous conceptions of markedness, markedness hierarchies are rigidly hierarchical (e.g. Jakobson 1941, Prince & Smolensky 1993). In the present theory, markedness relations may be collapsed. So, if x is more marked than y in some grammar, x is never less marked than y in any grammar. This collapse allows for grammars in which x and y are conflated in terms of markedness for some process.

This idea aims to account for cases where markedness distinctions can be ignored, as in Gujarati stress placement (§1.1).

- *Leading Idea II: the more marked, the more preserved*

Statement (5b) can be used to account for those processes that exhibit no markedness asymmetries at all, and for those which prevent highly marked elements from undergoing some process.

Phenomena that exhibit no markedness asymmetries follow from both the nature of markedness constraints and from the action of marked-element preservation. As a simple example, §1.1.1.2 observed that there are no asymmetries relating to the output form of segmental inventories. In other words, any segment may be missing from an inventory.

Inventories that lack a highly marked element exhibit a standard case of markedness reduction: the more marked elements are eliminated while the less marked

ones are retained. In contrast, inventories which lack less marked elements but retain highly marked ones (e.g. [k p ʔ]) come about through the action of marked-preservation: highly marked elements are preserved while less marked ones are eliminated.

The net surface result of markedness reduction and marked-preservation is that certain phenomena seem to be insensitive to markedness concerns altogether.

The same account can be used to explain why there are no markedness asymmetries for the output of coalescence, and the undergoers of assimilation.

Cases where the least marked element emerges in coalescence (e.g. /p+d/ → [t]) are due to markedness reduction, while cases where the most marked emerges (eg. /p+d/ → [b]) are due to retention of the marked element.

For assimilation, cases like Catalan where only coronals undergo assimilation follow from marked-preservation: dorsals and labials are exempt from an otherwise general assimilation process. In contrast, assimilation systems like Sri Lankan Portuguese Creole's – where only marked elements undergo assimilation – are due to markedness reduction. Assimilation is a means of reducing overall markedness, so dorsals and labials assimilate. Coronals do not assimilate because they are already adequately unmarked.

In short, markedness reduction produces systems in which highly marked elements are eliminated, while marked-preservation produces systems in which only the least marked elements are eliminated. The net result is that certain phenomena are apparently insensitive to markedness relations.

This proposal also explains why certain phenomena always exhibit markedness asymmetries. For example, dorsals and labials can never be produced by consonant epenthesis (putting aside incidental processes like assimilation). This follows from (i) markedness reduction: the least marked element will always be inserted (i.e. coronals and glottals), and (ii) marked-preservation: since there is no input element, there is nothing to preserve, so preservation is irrelevant for epenthesis. In short, consonant epenthesis is a 'pure' expression of markedness reduction; marked-preservation is irrelevant.

1.1.3 Summary

To summarize, the aim of this dissertation is to present a formal theory of markedness, set within Optimality Theory. Importantly, this dissertation does not aim to deal with issues such as the phonetic basis for sonority and Place of Articulation scale. The scales presented in the following chapters (and above) are constructed from phonological evidence only (see ch.3, ch.5).

Apart from the Sonority Hierarchy, many other scales have been proposed, including scales for place of articulation (ch.5, Jakobson 1941), vowel height (Clements 1991), consonantal stricture (Steriade 1993), inherent voicing (Gnanadesikan 1997), and tone (Ping 1996, 1999, de Lacy 1999a, 2002b).

Scales are by no means a peculiarly phonological phenomenon. McCarthy & Prince's (1994, 1995) morphological hierarchy of | *Root* ⟩ *Affix* | has been shown to have significant consequences for phonological processes. Scales relevant to syntax include the thematic hierarchy (Grimshaw 1990 and others), and scales of person and animacy (Silverstein 1976, Dixon 1979, Aissen 1999).

The influence of scales is pervasive. Apart from syllabification and stress assignment, the sonority scale influences foot structure and segmental cooccurence (see chapters 3, 4). The tonal scale can affect prosodification (de Lacy 1999a, 2002b), while the Place of Articulation and other subsegmental scales cause many subsegmental changes (see ch.6-8).

The influence of scales is also significant in syntax. The thematic hierarchy determines the initial/base position of arguments, while animacy has a significant role in syntax (Silverstein 1976, Dixon 1979, Aissen 1999, Woolford 1999). Syntactic and morphological scales will not be examined in this dissertation, though the general principles of scale composition proposed here could be extended to them. For relevant comments, see ch.9.

- *Where do scales come from?*

Before moving on to discuss the theory proposed herein, a comment must be made about the substantive basis of scales. The issues and proposals in this dissertation naturally raise the question "Where do scales come from?" In other words, is there a substantive basis for scales like the sonority hierarchy and Place of Articulation scale? If so, how does a scale come about?

While these questions are significant, they are not addressed in this dissertation. In fact, this dissertation begins where this question ends: the proposals herein are about how scales relate to the formal apparatus of OT, not about the origins of scales. The theory presented below does not assume anything – and does not *need* to assume anything – about scales except that constraints refer to them. The proposals about the relation of scales to the formal apparatus will hold regardless of where scales come from.

1.2   Theory

This section outlines a formal theory of markedness scale-reference, set within Optimality Theory (Prince & Smolensky 1993). For details, see chapter 2.[2] Optimality Theory is admirably suited to formally express the leading ideas in (1). In particular, violability of constraints will play a central role in the following theory – in many cases, the winning form will necessarily violate some markedness- or faithfulness-related constraint.

Underlying the following proposals is the claim that for every scale there is a set of markedness constraints and a set of faithfulness constraints. Both scale-referring markedness and faithfulness constraints have three properties in common, given in (6).

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[2]   From here on it is assumed that the reader is familiar with Prince & Smolensky (1993), as well as the proposals of McCarthy & Prince (1993a,b, 1995).

(6)   Core Properties of Scale-Referring Constraints
        For every set of constraints C that refers to a scale S
        (a) Every constraint in C refers to a contiguous range of S, and
        (b) Every constraint in C refers to the most marked element of S, and
        (c) The constraints in C can be ranked freely; there are no fixed rankings.

The meaning of the term 'refers' differs depending on whether the constraint is a markedness or faithfulness one. Scale-referring markedness constraints are discussed in §1.2.1, and faithfulness constraints in §1.2.2.
A final property adopted here is 'completeness': for every distinct set of constraints C that refers to a scale S, there are as many constraints in C as there are elements in S (after Green 1993). Therefore, the markedness constraints that refer to the scale $| \alpha \rangle \beta \rangle \gamma |$ are three in number, as are the number of faithfulness constraints.[3]

1.2.1   Markedness

The issue that underlies this section is how to account for category conflation. The proposal that constraints refer to a range of a scale (6a) and that there are no fixed rankings (6c) are significant in this regard.
The idea that scale-referring markedness constraints refer to a range of a scale has been discussed most extensively by Prince (1997 et seq.) (also de Lacy 1997a, 2000a; see ch.2§2.2.3 for further discussion of precursors). In Prince's terminology, constraints like those in (7) are in a 'stringency' relation to each other; accordingly this term will be adopted here.
For purposes of illustration, the Place of Articulation (PoA) scale given in (3) will be used here (i.e. | dorsal 〉 labial 〉 coronal 〉 glottal |). The set of constraints that conforms to the properties listed in (6) is given in (7).

(7)   PoA markedness constraints
        *{dorsal}   For every dorsal segment, assign a
                                            violation.
        *{dorsal,labial}   For every segment that is either dorsal or
                                            labial, assign a violation.
        *{dorsal,labial,coronal}   For every segment that is dorsal, labial, or
                                            coronal, assign a violation.
        *{dorsal,labial,coronal,glottal}   For every segment that is dorsal, labial,
                                            coronal, or glottal, assign a violation.

As an example, the constraint *{dors, lab} assigns a violation for every segment that has either dorsal or labial Place of Articulation: [kapa] therefore incurs two violations of *{dors, lab}.

---

[3] It is impossible to know whether Completeness is valid at this point. It can only be tested in the context of a full theory of scales (as opposed to the present theory, which is about scale-referring constraints not the form of scales).

The constraints in (7) conform to the properties in (6). They all assign violations to a contiguous range of the scale; for example, no constraint assigns a violation to coronals and dorsals without also assigning it to labials (6a). All the constraints militate against the marked endpoint of the scale – i.e. dorsals (6b). After (6c), the constraints' ranking is freely permutable. Finally, the constraint set is complete – there are as many constraints as there are scale distinctions.

There is a close relation between the free ranking of the constraints and the properties in (6a) and (6b). In order for the constraints to be freely rankable yet still express the PoA scale's hierarchical relations, it is necessary for the constraints to refer to contiguous parts of the scale. The quasi-tableau (8) illustrates this point.

(8)   Stringent markedness

	*{dors}	*{dors,lab}	*{dors,lab,cor}	*{dors,lab,cor,glottal}
ʔ				*
t			*	*
p		*	*	*
k	*	*	*	*

Tableau (8) shows that [ʔ] is the most harmonic consonant in terms of the PoA-referring markedness constraints. The constraints' ranking makes no difference to this result: if *{dors,lab,cor,glottal} outranked all the other constraints, [ʔ] would still be more harmonic than [t], [p], and [k]. Constraint ranking is irrelevant in effecting a hierarchy because glottals incur a proper subset of the violations of all other PoAs. So, after mark cancellation glottals will have no violations of any PoA-markedness constraint while all other PoAs will violate at least one constraint. The same point is true for [t] vs [p] and [k]: no ranking of the constraints will favour [p] or [k] over [t]. A similar situation emerges for [p] and [k]: no ranking will favour dorsals over labials. In this way, the constraints express the hierarchical relations of the PoA scale.

It is important to point out that although ranking between the scale-referring markedness constraints is irrelevant in establishing a hierarchy, the constraints are ranked with respect to each other in individual grammars (just as all OT grammars are total orderings of constraints). Moreover, rankings between scale-referring constraints are crucial in accounting for differences in category conflation, as illustrated in §1.3.1.1 and chapter 3.

If the markedness constraints did not refer to a contiguous range of the scale they could not be freely rankable. For example, if a constraint *{coronal} existed in CON, it could not be ranked just anywhere: if *{coronal} outranked all other PoA markedness constraints, it would reverse the hierarchy | dorsal, labial 〉 coronal |, favouring dorsals and labials over coronals.

The approach to scale-referring markedness constraints just outlined differs from theories that employ a fixed ranking of scale-referring constraints (Prince & Smolensky 1993). Section 1.3 contains a synopsis of the empirical differences between the two approaches.

There is a good deal more to say about the form of markedness constraints. Section 1.2.3 discusses cases where scales combine with structural elements to form constraints.

1.2.2 Faithfulness

Scale-based faithfulness constraints also refer to ranges of scales. Like scale-referring markedness constraints, scale-referring faithfulness constraints can be ranked freely with respect to each other.

For purposes of illustration, the set of Input→Output PoA-referring faithfulness constraints is provided in (9). For similar proposals for Place of Articulation, see Kiparsky (1994) and Jun (1995).

(9) Place of Articulation Faithfulness constraints
     IDENT{dors}   If input x is dorsal, then x has the same place of articulation
                        as its output correspondent x'.
     IDENT{dors,lab}   If input x is dorsal or labial, then x has the same place of
                        articulation as its correspondent x'.
     IDENT{dors,lab,cor} If input x is dorsal, labial, or coronal, then x has the same
                        place of articulation as its output correspondent x'.
     IDENT{dors,lab,cor,gl} If input x is dorsal, labial, coronal, or glottal, then x has the
                        same place of articulation as its output correspondent x'.

As an example, IDENT{dors,lab} requires input dorsals and labials to remain dorsals and labials respectively in the output. From input /paka/, the outputs [pata] and [taka] both incur one violation of IDENT{dors,lab}, while [tata] incurs two. Like the markedness constraints, the faithfulness constraints all preserve a contiguous range of the scale, and all preserve the most marked category – dorsal.

Note that the constraints are 'asymmetric' in the sense of Pater (1996, 1999): while IO-IDENT{dors} bans the mapping /k/→[p], it does not ban /p/→[k] (cf McCarthy & Prince 1995). This point is discussed further in ch.7§7.7.4.

The constraints in (9) conform to the properties in (6). They all assign violations to a contiguous range of the scale; for example, no constraint assigns a violation to unfaithful mappings from coronals and dorsals without also assigning it to labials (6a). All the constraints militate against the marked endpoint of the scale – i.e. unfaithful mappings from dorsals (6b). Finally, the constraints' ranking is freely permutable (6c).

The form of the faithfulness constraints effects a hierarchical relation between different PoAs in terms of preservation. Since every faithfulness constraint mentions dorsals, dorsals will be subject to the most preservation. Quasi-tableau (10) underscores this point.

(10)   Stringent faithfulness

	IDENT{dors}	IDENT {dors,lab}	IDENT {dors,lab,cor}
/k/→[p] or [t] or [ʔ]	*	*	*
/p/→[k] or [t] or [ʔ]		*	*
/t/→[k] or [p] or [ʔ]			*
/ʔ/→[k] or [p] or [t]			

As shown by the quasi-tableau, glottals are 'least preserved' in the sense that all other PoAs may be preserved while glottals are not. Similarly, coronals are 'less preserved' than dorsals and labials, and so on up through the scale. The empirical consequence of this property is that marked elements may be exempt from processes that less marked PoAs may undergo, such as assimilation and neutralization. The empirical consequences of this point are discussed in §1.3.

1.2.3 Structure

The final major component of the theory deals with the relation between scales and prosodic positions. For example, the Gujarati case discussed in §1.1 refers to the relation between sonority and the main stressed syllable. In contrast, certain other scales seem to bear quite a different relation to prosodic structure; for example, Place of Articulation never influences stress placement. I propose that these differences reduce to the fact that certain scales combine with prosodic elements to form constraints, while others do not. To be more precise, there is a difference between prosodic and non-prosodic scales in this matter, stated in (11).

(11)   The Scale-Structure Combination Restriction
          (a) Scales that refer to prosodic properties (e.g. tone, sonority) always combine with prosodic elements in constraints.
          (b) Scales that refer to subsegmental properties (e.g. voice, Place of Articulation) never combine with prosodic elements in constraints.

A subsegmental property is any feature that is a dependent of the root node. Thus, [voice], [coronal], and [nasal] are all subsegmental properties. Prosodic properties are all non-subsegmental features – elements that are part of prosodic nodes, or attach to prosodic nodes. For example, tone attaches to syllables or moras, so is a prosodic property; stress (or headedness) is a property of syllables, so is a prosodic property. Sonority is also a prosodic property (ch.3§3.1). Apart from sonority, the term 'prosodic property' follows usage established in Trubetzkoy (1939) and Firth (1948).

In short, if a constraint mentions the sonority scale, it must relate the sonority categories to a structural element. For example, there is a constraint *ɔ́/{ə}, militating against schwas in the prosodic position 'stressed syllable'. However, there is no constraint *{ə}, militating against segments with the sonority of a schwa without mentioning its relation to structure.

In contrast, if a constraint refers to a subsegmental feature scale (a 'featural' scale for short) – e.g. the Place of Articulation scale – it cannot refer to prosodic structure. For example, there can be no constraint *σ́/{dorsal}, militating against dorsal segments (i.e. velar consonants, back vowels) in stressed syllables.

The restriction in (11) prevents a number of phenomena from being sensitive to certain scales. For example, chapter 3 shows that stress placement is sensitive to sonority but never to subsegmental features like Place of Articulation. The existence of constraints that relate stressed syllables to sonority levels accounts for the sonority-sensitive aspect of stress, while the lack of constraints that combine Place of Articulation with stressed syllables means that stress placement is insensitive to Place of Articulation.

Importantly, (11) does not entirely preclude (apparent) reference to structural elements for phenomena that refer to featural scales. For example, neutralization of Place of Articulation can apply in codas alone; for discussion and relevant analyses of how (11) is consistent with this fact, see chapter 6.

The Scale-Structure Combination Restriction is treated as axiomatic in the present theory; I leave its reduction to more general principles for future work.

1.2.3.1 Structural elements

Prosodic scales are argued to combine with either of two structural elements – the 'Designated Terminal Element' (DTE, or Δ) and non-DTE (-Δ). The notion of DTE is based on Liberman's (1975) and Liberman & Prince's (1977) proposals, but is extended in a number of ways. Related proposals are found in Selkirk (1998, 2000), which served as the starting point for my own work (de Lacy 1999a, 2002b); Zec (2000) contains an analogous proposal. A detailed discussion of DTEs is presented in chapter 2 and exemplified in chapter 4; a synopsis of the core ideas is presented here.

A DTE of a prosodic category α is the terminal element on the prosodic plane that is (i) a head and (ii) associated to α via an unbroken chain of prosodic heads. Since the notion 'DTE' crucially relies on the notion 'prosodic head' it inherits the main property of heads: for every prosodic node α there is only one DTE of α. The structure in Figure 1.1 aims to clarify this definition by identifying the DTEs in a Prosodic Word (PrWd) structure. The symbol + marks heads and – non-heads; Δ stands for 'DTE' and -Δ for 'non-DTE'.

Figure 1.1: DTEs in the Prosodic Word
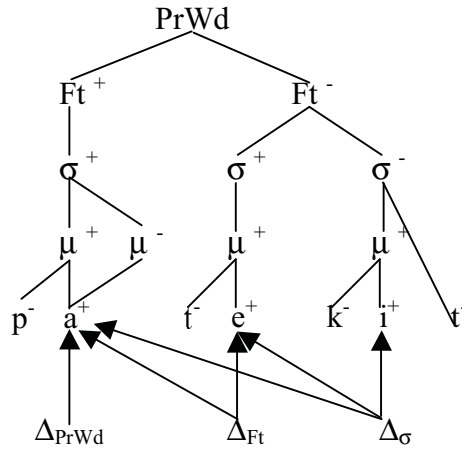
As indicated, there is only one Δ_{PrWd} in this structure – the head of the leftmost syllable [a]; this root node is the DTE of the PrWd since it is a head and is associated to the PrWd node by an unbroken chain of prosodic heads (i.e. the leftmost μ, σ and Ft nodes). In contrast, there are two Δ_{Ft}. The leftmost moraic segment [a] is a Δ_{Ft} since it is a head and is associated to a Ft node by a path of prosodic heads, as is [e]. In this structure the DTEs of moras are the same as the DTEs of syllables.

Selkirk (1998) has argued for tone that constraints may refer to DTEs of any prosodic category; this proposal is adopted here.

A non-DTE of α ($-\Delta_\alpha$) is every terminal node in α that is not the DTE of α. For example, every root node except [a] in is a $-\Delta_{PrWd}$. Similarly, every segment except [a] and [e] are foot non-DTES ($-\Delta_{Ft}$). Non-DTEs (especially of feet) are discussed in detail in ch.4.

Terminal nodes may be both the DTE of a constituent and the non-DTE of a higher constituent. For example, [e] in is the DTE of a syllable and the DTE of a foot, but is also a non-DTE of the PrWd. Similarly, [i] is a DTE of a syllable and a non-DTE of a foot and the PrWd.

In a sense, the notions DTE and non-DTE generalize Prince & Smolensky's proposal that there are separate sets of sonority constraints for the peak and margin of a syllable. DTEs and non-DTEs form the structural prominence scale $\mid \Delta_\alpha \rangle -\Delta_\alpha \mid$. More precisely, there are several DTE scales, one for each possible value of α: i.e. $\mid \Delta_\sigma \rangle -\Delta_\sigma \mid$, $\mid \Delta_{Ft} \rangle -\Delta_{Ft} \mid$, and so on. Every DTE scale combines with every prosodic scale to form a set of scales, one for each DTE specification.

As an example, the DTE of the foot (Δ_{Ft}) combines with the vocalic part of the sonority scale; a rather cut-down version is provided in (12) (see ch.3§3.2 for details). The label "i,u" refers to <u>all</u> high peripheral vowels: [i y ɰ u]; analogously, "ə" refers to all mid central vowels, "e,o" to all mid peripheral vowels, and "a" to all low vowels.

(12)   The vowel sonority scale (in brief)
        $\mid$ ə $\rangle$ i,u $\rangle$ e,o $\rangle$ a $\mid$

Constraints that combine the foot DTE and the sonority scale are given in (13).

(13)   <u>DTE-sonority constraints</u>
    $*\Delta_{Ft}/\{\partial\}$ "Assign a violation for every instance of a stressed vowel with the sonority of schwa"

    $*\Delta_{Ft}/\{\partial,i/u\}$ "Assign a violation for every instance of a stressed vowel with the sonority of schwa or a high peripheral vowel"

    $*\Delta_{Ft}/\{\partial,i/u,e/o\}$ "Assign a violation for every instance of a stressed vowel with the sonority of schwa, a high vowel, or a mid vowel"

    $*\Delta_{Ft}/\{\partial,i/u,e/o,a\}$ "Assign a violation for every instance of a stressed vowel with the sonority of schwa, a high vowel, a mid vowel, or a low vowel (i.e. all vowels)."

Evidence for the constraints in (13) is provided in ch.3 (also Kenstowicz 1996). As an example, $*\Delta_{Ft}/\{\partial,i/u\}$ assigns a violation to [pə́t] and one to [pít], but none to [pét] and [pát]. The constraints are freely permutable with respect to each other; more concretely, some grammar may contain the ranking ‖ $*\Delta_{Ft}/\{\partial\}$ » $*\Delta_{Ft}/\{\partial,i/u\}$ ‖ while another grammar may have the exact opposite ranking.

Following Prince & Smolensky's proposal for syllable peaks and margins, prosodic scales are **reversed** in combination with non-DTEs:

(14)   <u>Reversal in non-DTEs</u>
    $*\text{-}\Delta_{Ft}/\{a\}$, $*\text{-}\Delta_{Ft}/\{a,e/o\}$, $*\text{-}\Delta_{Ft}/\{a,e/o,i/u\}$, $*\text{-}\Delta_{Ft}/\{a,e/o,i/u,\partial\}$

Scale reversal in combination with non-DTEs underscores the fact that markedness is relative to position for prosodic scales. This does not contradict the generalization that the most marked scale element is always mentioned in constraints: the most marked sonority category for non-DTEs is "a", so it is always mentioned in non-DTE constraints.

The theory of structural scales presented above has broad empirical implications; in combination with the sonority scale it predicts that sonority can affect many different constituents, not just the peaks and margins of syllables (see ch.4).

This proposal addresses the issues of versatility and consistency: the fact that the same scale can engage in several different phenomena. With several series of constraints that differ only in the DTE or non-DTE they mention, analogous types of phenomena will occur at every prosodic level. For example, since foot DTEs (stressed syllables) attract high sonority elements, the constraints predict that the same should happen at every other level: there should be languages in which syllable DTEs and PrWd DTEs effect the same sort of attraction. Similarly, since syllable DTEs and non-DTEs can place thresholds on sonority the same should be true for higher level constituents: foot DTEs and non-DTEs should also be able to place thresholds on the sonority of their segments, and so on for all higher levels.

1.2.4 Summary

The theory presented in the previous subsections employs constraints that refer to ranges of scales and have freely permutable ranking. The constraints have been shown to formally implement the hierarchical relations expressed by scales, while allowing categories to be conflated. The theory is universal in that all the constraints exist in all grammars – a basic tenet of Optimality Theory.

The following section provides an overview of the evidence for the major properties of the theory; it summarizes arguments made in details in later chapters.

1.3 Empirical implications

The aim of this section is to provide an overview of how the theoretical proposals in §1.2 account for markedness-referring phenomena. This section is divided into two parts.

Section 1.3.1 discusses the effect of the markedness constraints. This section focuses on providing a formal account of two major markedness issues: (1) category conflation and (2) consistency of scale-reference at different prosodic levels. Issue (1) is discussed with reference to Gujarati's sonority-driven stress system, introduced in §1.1. The stringent form of the markedness constraints is argued to be crucial in providing an adequate account of this case. Issue (2) focuses on a case where stress is determined by reference to the post-tonic vowel, found in the Trobriand language Kiriwina.

Section 1.3.2 discusses the effect of the faithfulness constraints. This section focuses on providing a formal account of phenomena in which more marked elements are preserved while less marked ones are eliminated. This section mentions neutralization, assimilation, and coalescence.

1.3.1 Markedness

The theoretical proposals outlined in §1.2 aim to account for (1) markedness hierarchies, (2) category conflation, and (3) consistency of scales at various prosodic levels. Section 1.3.1.1 discusses the first two of these issues. It focuses on the stress system of Gujarati, introduced in §1.1. Section 1.3.1.2 deals with the third issue, showing that the same scale can influence elements at the syllable, foot, Prosodic Word, and higher levels.

1.3.1.1 Hierarchies and conflation

One of the leading ideas behind the present theory is that scale distinctions may be collapsed, or conflated. As Prince (1997 et seq.) has shown, constraints that refer to a range of a scale allow conflation. To illustrate this point, an analysis of Gujarati stress will be sketched here; a full analysis is given in chapter 3§3.4.

Gujarati stress refers to the vowel sonority scale given in (12). The markedness constraints that refer to the vowel sonority scale were provided in (13).

In words with identical vowels, stress falls on the penult in Gujarati: e.g. [awwána] 'coming', [pátəŋg] 'kite'. This can be ascribed to a trochaic foot that appears at the right edge of the PrWd: e.g. [aw(wána)]. The details of the footing constraints are presented in chapter 3§3.4; the constraint ALIGNFTR, which requires feet to be rightmost, will be used here.

- *Attraction to* [a]

As shown in (2a), stress seeks out the low vowel [a], even when it is not in the penult: e.g. [(tádʒe)təɾ] 'recently'. The constraint relevant at this juncture is *Δ_{Ft}/{ə,i/u,e/o} – it assigns a violation to all main-stressed vowels that are less sonorous than [a]. The candidate *[tadʒétəɾ] loses because it violates *Δ_{Ft}/{ə,i/u,e/o}, as shown in tableau (15).

(15)

	/tadʒetəɾ/	*Δ_{Ft}/{ə,i/u,e/o}	ALIGNFTR
	(a) ta(dʒétəɾ)	*!	
☞	(b) (tádʒe)təɾ		*

Candidate (a) contains mid vowel in the DTE position of a foot – i.e. a stressed syllable, so violating *Δ_{Ft}/{ə,i/u,e/o}. In contrast, candidate (a) has a low vowel in Δ_{Ft} position, crucially avoiding violations of the Δ_{Ft} constraint.

- *Avoidance of stressed schwa*

When there are no low vowels, stress generally falls on the penult, as expected: e.g. [kʰe(ɖío)] 'inkstand'. The exception is when the penult contains schwa – if the initial syllable contains some peripheral vowel, stress falls on it. In the present approach, avoidance of schwa comes about when *Δ_{Ft}/{ə} outranks the stress-placement constraint ALIGNFTR.

(16)

	/pustəkne/	*Δ_{Ft}/{ə}	*Δ_{Ft}/{ə,i/u,e/o}	ALIGNFTR
☞	(a) (pústək)ne		*	*
	(b) pus(tə́kne)	*!	*	

Tableau (16) shows that *Δ_{Ft}/{ə} is crucial in determining stress placement. The constraint *Δ_{Ft}/{ə,i/u,e/o} is indecisive since it assigns the same violations to both candidates.

- *Conflation*

The aspect of Gujarati stress that is of present significance is that it makes no distinction between mid and high vowels for stress – i.e. it conflates the two categories.

Stress does not avoid a penult high vowel to fall on a mid vowel: e.g. [tʃʰok(ɾío)] 'girls', *[(tʃʰókɾi)o], or vice-versa: e.g. [ju(ɾópni)] 'europe', *[(júɾop)ni]. For stress purposes, then, mid and high peripheral vowels are conflated.

To ensure that Gujarati stress is insensitive to the distinction between high and mid peripheral vowels, all constraints that favour one over the other must be ranked below ALIGNFTR. In the present theory, the relevant constraint is *Δ_Ft/{ə,i/u} – this constraint favours stressed mid vowels over stressed high vowels. It must be ranked below ALIGNFTR, as shown in (17).

(17)

/tʃʰokɾio/	*Δ_Ft/{ə}	*Δ_Ft/{ə,i/u,e/o}	ALIGNFTR	*Δ_Ft/{ə,i/u}
(a) (tʃʰókɾi)o		*	*!	
☞ (b) tʃʰo(kɾío)		*		*

Tableau (17) shows that reference to a range of the sonority hierarchy is essential. Gujarati requires an active constraint that distinguishes [a] from other vowels, but it is essential that no active constraint distinguishes stressed high vowels from stressed mid vowels. The constraint *Δ_Ft/{ə,i/u,e/o} performs both these tasks: (i) it favours [á] over all other stressed vowels and (ii) it assigns the same violations to stressed mid and high vowels. Both properties of the constraints are crucial – if it lacked one or the other, the incorrect candidate (a) would win or the distinction between [a] and other vowels would be lost.

The point that stringently formulated constraints can produce conflation was established by Prince (1997 et seq.); for conflation in sonority-driven stress in particular, see Prince (1997b, 1999). Chapter 3§3.6 discusses the types of conflation that stringent theories can do in more detail.

- *Fixed ranking and conflation*

Freely rankable stringent constraints differ from those in a fixed ranking in their ability to produce conflation; theories that impose a fixed ranking on constraints prevent certain types of conflation from happening.

For example, suppose there were a set of constraints || *Δ_Ft/{ə} » *Δ_Ft/{i,u} » *Δ_Ft/{e,o} ||; each constraint refers to a point on the scale rather than a range. All would have to outrank ALIGNFTR in order to ensure that [á] was more harmonic than all other stressed vowels:

(18)   Fixed Ranking Theory I

/ɔpʰisma/	*Δ_Ft/{i,u}	*Δ_Ft/{e,o}	ALIGNFTR
(a) (ópʰis)ma		*!	*
(b) ɔ(pʰísma)	*!		
☞ (c) ɔ(pʰismá)			*

The problem with such a constraint system is that it prevents the conflation of stressed mid and high vowels. The constraints $*\Delta_{Ft}/\{i,u\}$ and $*\Delta_{Ft}/\{e,o\}$ both distinguish between the two categories, necessitating that one category will attract stress away from the other:

(19) Fixed Ranking Theory II

/tʃʰokɾio/	$*\Delta_{Ft}/\{i,u\}$	$*\Delta_{Ft}/\{e,o\}$	ALIGNFTR
💣※ (a) (tʃʰókɾi)o		*	*
(b) tʃʰo(kɾío)	*!		

No ranking of constraints can produce the right result: if $*\Delta_{Ft}/\{i,u\}$ were ranked below ALIGNFTR, stress would not avoid high vowels at all. The problem is with the constraints themselves: they incorrectly predict that if a system avoids stressed mid vowels at all (i.e. if $*\Delta_{Ft}/\{e,o\}$ outranks stress-locating constraints), they cannot be conflated with any other category.

In summary, category conflation necessitates constraints that refer to a range of a scale, starting with the most marked element. This argument is presented in detail in chapter 3§3.6 and is extended by identifying the exact conditions under which fixed ranking theories and stringent constraints differ in terms of conflation.

1.3.1.2 Structure and scales

Chapter 4 contains arguments for the theory of structure-scale constraints proposed here. Arguments for two distinct aspects of the theory are presented: (1) there are constraints that refer to non-DTEs and (2) there are constraints that refer to (non-)DTEs of every prosodic category. The arguments are summarized below.

- *Non-DTEs*

Evidence for non-DTE-referring constraints comes from languages in which the position of stress is not determined by the sonority of the stressed syllable but from the sonority of unstressed syllables. To illustrate, a case where properties of the non-head syllable of the foot is relevant to stress is outlined below (see ch.4 for details).

There is usually a trochaic foot at the right edge of every Prosodic Word in Kiriwina (20a) (Lawton 1993, Senft 1986). However, the foot retracts if doing so will allow it to end up with a non-head vowel of low sonority (i.e. [i u]) (20b):

(20)   Kiriwina stress in brief
    (a)   Stress the penult

[ka(wála)]	'canoe pole'	[dumda(bógi)]	'early dawn'
[ba(kám)]	'I will eat'	[msi(mwési)]	*grass type*
[i(dói)]	'(a boat) brings sth.'	[i(dója)]	'it drifts'

    (b)   Unless antepenult stress will result in a low sonority foot non-head

[(kúli)a]	'cooking pot'	[(lámi)la]	'outrigger log'
[(mégu)va]	'white magic'	[(páku)la]	'blame'

Importantly, the sonority of the stressed syllable is irrelevant in this language – the foot retracts regardless of the resulting sonority of the stressed syllable: [(kúli)a] vs [(mégu)la] vs [(páku)la]. If the stress system was driven by the need to avoid stressed high vowels, there would be no reason to have antepenult stress in [(kúli)a] since it has a stressed high vowel. In other words, its competitor *[ku(lía)] is no improvement over [(kúli)a] in terms of the stressed syllable's sonority alone; all that matters is the sonority of the foot non-head.

The forms in (20b) show that the aim of foot retraction is to end up with a low sonority non-head – all the non-heads of feet have a high vowel. In contrast, all the feet in (20a) either already have a high vowel foot non-head (e.g. [msi(mwési)]) or foot retraction would not result in a high-vowel non-head (e.g. *[(ído)ja], *[dum(dábo)gi]), so such retraction would be gratuitous.

This system requires a constraint that refers specifically to the non-DTEs of feet (-Δ_{Ft}). Foot non-DTEs are all those elements that are not heads of the nucleus of stressed syllables. By avoiding all such segments with more sonority than a high vowel – i.e. *-Δ_{Ft}\{e,o,a\} – stress will only retract onto a high vowel. Tableau (21) illustrates this point.

(21)

	/meguva/	*-Δ_{Ft}\{e/o,a\}	ALIGNFTR
	(a) me(gúva)	*!	
☞	(b) (mégu)va		*

Candidate (21a) is ruled out because it has a highly sonorous foot non-DTE – i.e. [a]. In contrast, the foot non-DTE in candidate (21b) is the relatively low sonority vowel [u].

Kiriwina also shows that non-DTEs reverse the scale in comparison with DTEs. While DTE constraints promote high sonority, the grammar aims to avoid high sonority non-DTEs.

- *DTEs of other categories*
Constraints may refer to DTEs of any prosodic category. Consequently, there are constraints for DTEs of every member of the prosodic hierarchy: e.g. *Δ_μ/x, *Δ_σ/x, *Δ_{Ft}/x, *Δ_{PrWd}/x, *Δ_{PPh}/x, and so on. Consequently, the theory predicts that DTEs of every level

should show the same predilections for scale elements. For example, since foot DTEs prefer high sonority elements, PrWd DTEs should too, and so on through the prosodic hierarchy. Chapter 4 discusses cases that support this prediction.

- *The notion 'markedness'*

Proposing that scales combine with DTEs and non-DTEs in different ways means that the tradiational notion of 'markedness' does not apply directly to certain scales. For example, there is no real sense in which the sonority category 'low vowel' is unmarked. Instead, markedness of prosodic scales depends on the structural element with which they combine. So 'low vowel' is the least marked category in terms of DTEs, but the most marked for non-DTEs.

In contrast, markedness is easily applied to featural scales: since featural scales do not combine with DTEs, the least marked element remains consistent across contexts. So, 'glottal' is always the least marked PoA element.

1.3.2 Faithfulness

Chapters 6 to 8 deal with scale-referring faithfulness constraints. Scale-referring faithfulness constraints are argued to have two primary properties: (1) they collectively favour preservation of more marked elements over less marked ones and (2) they preserve ranges of a scale. These two proposals are relatively independent. It is possible to have a theory which subscribes to (1) and not (2) (e.g. the fixed ranking || IDENT{*marked*} » IDENT{*unmarked*} || – Jun 1995). It is also possible to have faithfulness constraints that refer to ranges of a scale (i.e. property 2) without subscribing to (1) (e.g. IDENT{Place} – Prince 1998, 1999). Accordingly, the two properties are discussed separately below: (1) in §1.3.2.1 and (2) in §1.3.2.2.

1.3.2.1 Preservation of the marked

Chapters 6 and 7 present evidence that faithfulness constraints must refer to the most marked element of a scale. Chapter 6 discusses neutralization, while chapter 7 deals with processes that avoid heterorganic consonant clusters – primarily assimilation. A brief overview of one of the arguments is presented here, using Place assimilation in Catalan.

If there are faithfulness constraints that specifically preserve marked scale elements, it is expected that they could prevent marked elements from taking part in various processes. In Catalan, for example, only coronals undergo assimilation; the more marked labials and dorsals are exempt from this process (Mascaró 1976, and analyses in Kiparsky 1994, Jun 1995).

(22)   Catalan coronal-only assimilation in brief
        (a) Coronal + *x* (/son/ 'they are')
                [son əmiks]   'they are friends'
                [som bɛus]   'they are voices'
                [soŋ kuzins]   'they are cousins'

(b) Labial + *x* (/som/ 'we are')

      [som əmiks]   'we are friends'
      [som pɔks]   'we are few'
      [som dos]   'we are two

(c) Dorsal + *x*

      [tiŋpa]   'I have bread'

To produce coronal assimilation, a markedness constraint that bans heterorganic consonant clusters must outrank all faithfulness constraints to coronals. This markedness constraint is called ASSIM here for convenience; a full theory of the constraints that trigger assimilation is presented in ch.7§7.4.

(23)

/son bɛus/	ASSIM	IDENT{dors,lab,cor}
(a) son bɛus	*!	
☞ (b) som bɛus		*

In contrast, it is more harmonic to preserve non-coronals faithfully than to lose their features through assimilation. To exempt non-coronals from undergoing assimilation, a constraint that specifically targets them must outrank ASSIM: i.e. IDENT{dors,lab}.

(24)

/som dos/	IDENT{dors,lab}	ASSIM
☞ (a) som dos		*
(b) son dos	*!	

In short, without a constraint that preserves only the most marked members of the PoA scale, the Catalan system could not be produced.

This general approach to PoA faithfulness has also been proposed by Kiparsky (1994) and Jun (1995). In this dissertation, the proposal is extended to all scales, and the present constraints are shown to produce a variety of blocking effects. Full analyses of the Catalan system and a number of other related cases are given in chapter 7§7.2.

Chapter 6 discusses the effect of marked-faithfulness constraints for neutralization. As with assimilation, faithfulness constraints can prevent marked elements from neutralizing, producing segmental inventories that contain highly marked and highly unmarked elements, but no segments of intermediate markedness. This was discussed briefly for the Yamphu coda [k p ʔ] inventory in §1.1.1.3, in which only /t/ debuccalizes. The same general analysis applies here: a faithfulness constraint that preserves the marked dorsals and labials blocks a markedness constraint from debuccalizing /t/.

1.3.2.2 Faithfulness conflation

This section discusses the empirical implications of the proposal that faithfulness constraints refer to ranges of a scale. The empirical effect of this property in markedness constraints is category conflation; there is an analogous effect for faithfulness. Two Input→Output mappings are conflated if they incur the same violations of faithfulness constraints. In chapter 8, this point is illustrated in several case studies involving coalescence. A brief example is provided here, involving Place of Articulation.

In Pāli, heterorganic clusters are banned, so underlying consonant clusters are coalesced into a geminate. The manner of articulation of the surface geminate depends on principles discussed in ch.8§; here the output's Place of Articulation will be the focus.

In combinations of underlying labials and coronals, the coronal PoA always survives.

(25)　　Pāli coalescence I: /Labial + Coronal/ → [Coronal]
　　　　/k^{h}ip-ta/　　　→ [k^{h}it:a]　　'throw {participle}'
　　　　/lab^h-tab:a/　→ [lad:^{h}ab:a] 'take {gerund}'
　　　　/lab^h-tum/　　→ [lad:^{h}um]　'take {infinitive}'
　　　　/lub^h-ta/　　　→ [lud:^{h}a]　　'long for {participle}'
　　　　/lab^h-ta/　　　→ [lad:^{h}a]　　'take {participle}'
　　　　/lab^h-tva:/　　→ [lad:^{h}a:]　'take {absolutive}'

Since labials are more marked than coronals, faithfulness cannot be responsible for the preservation of coronal PoA. More precisely, no faithfulness constraint preserves coronals without also preserving labials, and some faithfulness constraint preserves labials without preserving coronals (i.e. IDENT{dors,lab}). Thus, by faithfulness alone, the marked feature will always be favoured.

However, markedness constraints favour coronals over labials. Thus, the fact that [lud:^{h}a] and not *[lub:^{h}a] is output from /lub^h-ta/ is the result of some markedness constraint – i.e. *{dors,lab} – favouring *[lud:^{h}a] over *[lub:^{h}a]. Tableau (26) shows the ranking necessary for this result.

(26)

/lub$^h_1$-t$_2$a/	*{dors,lab}	IDENT{dors,lab}
(a) lub:$^h_{1,2}$a	*!	
☞　(b) lud:$^h_{1,2}$a		*

The input segments /b^h/ and /t/ coalesce in the output candidates (a) and (b). This means that both /b^h/ and /t/ correspond to a single output segment – [b:^{h}] in (a) and [d:] in (b). The markedness constraint *{dors,lab} favours the candidate with the least marked output: i.e. the one with the coronal [d:^{h}]. Crucially, all faithfulness constraints that favour the preservation of labials over coronals – IDENT{dors,lab} – must be outranked by *{dors,lab}; as the tableau shows, the opposite ranking would incorrectly result in (a) as the winner.

However, the ranking || *{dors,lab} » IDENT{dors,lab} || is not the whole story. This ranking would eliminate all labials: /lab^h-tabːa/ would surface as *[lad^{h}tadːa]. So, to block wholesale elimination of labials, some labial-preserving faithfulness constraint must outrank *{dors,lab}. However, there is a restriction on this constraint: it must also preserve coronals. If it were otherwise, /lub^h-ta/ would surface as *[lubː^{h}a]. The only solution is to have a faithfulness constraint that preserves labial and coronal PoA equally: i.e. IDENT{dors,lab,cor}. Tableau (27) illustrates this point.

(27)

/lub$^h_1$-t$_2$abːa/	IDENT{dors,lab,cor}	*{dors,lab}	IDENT{dors,lab}
(a) ludː$^h_{1,2}$adːa	* *!		* *
(b) lubː$^h_{1,2}$abːa	*	* *!	
☞ (c) ludː$^h_{1,2}$abːa	*	*	*

Candidate (a) has eliminated all labials. By doing so, it violates IDENT{dors,lab,cor} twice: once for the fact that /b^h/ has a non-labial correspondent, and once for the fact that /bː/ has correspondent [dː]. In contrast, candidates (b) and (c) only violate the faithfulness constraint once. Candidate (b) violates IDENT{dors,lab,cor} because /t/ has a labial output correspondent, and (c) violates it because /b^h/ has a coronal correspondent.

It is crucial that (b) and (c) incur equal violations of IDENT{dors,lab,cor}. If (c) incurred more violations, (b) would incorrectly win. The fact that (b) and (c) incur equal violations allows the markedness constraint *{dors,lab} to emerge, favouring the least marked candidate (c).

In short, Pāli shows that a constraint that equally favours preservation of labials and dorsals is necessary.

- *Preservation of dorsals*
  Interestingly, underlying /dorsal+coronal/ clusters surface as dorsals, not coronals.

(28)   <u>Pāli coalescence II</u>: /Dorsal + Coronal/ → [Dorsal]
  /sak-ʃːa-ti/   → [sakː^{h}ati]   'be able to {future + 3p.sg.}'
  /sak-ʃ-ti/   → [sakː^{h}i]   'be able to {aorist+3p.sg.}'
  /lik^h-ʃ-ti/   → [likː^{h}i]   'write {aorist+3p.sg.}'
  /lag-ʃ-ti/   → [lagːi]   'bore through {aorist+3p.sg}'
  /lag-na/   → [lagːa]   'bore through {participle}'

The examples show that the output geminate is a fusion of the output elements – the aspiration in [sakː^{h}i] is due to the input /ʃ/ (see ch.8 for details).

The proposal that there are faithfulness constraints to marked elements accounts for this result. Since more marked elements are subject to greater preservation, IDENT{dorsal} will favour retaining the dorsal feature rather than the coronal one. In short, the fact that

dorsals win over coronals can be ascribed to the fact that IDENT{dors} outranks all markedness constraints that favour coronals over dorsals.

(29)

/sak$_1$-ʃ$_2$-t$_3$i/	IDENT{dors}	*{dors,lab}
☞ (a) sak:$^h_{1,2,3}$i		*
(b) sat:$^h_{1,2,3}$i	*!	

For a full development of this analysis, see chapter 8§8.4.

1.4 Dissertation outline

The remainder of this dissertation is organized much as in sections 1.2 and 1.3. The theoretical proposals are presented in chapter 2, followed by a discussion of the markedness-related proposals (particularly conflation) in chapters 3 and 4, concluding with an examination of the faithfulness-related proposals (chs.5-9).

- Part I: Theory
- *Chapter 2* presents a theory of scale-referring constraints. At the core of this theory is a proposal about feature values and about how constraints refer to those values. The theory consists of three related but relatively independent parts: (1) proposals about scale-referring markedness constraints, (2) proposals about scale-referring faithfulness constraints, and (3) proposals about the relation between structural elements and scales. The following chapters provide evidence for each of these parts of the theory.

- Part II: Markedness
- *Chapter 3* contains evidence that scale-referring constraints must refer to ranges of scales and be freely permutable in their ranking. Cases of conflation in sonority-driven stress are examined, focusing on the stress systems of Nganasan and Gujarati.

- *Chapter 4* presents evidence that reference to both DTEs and non-DTEs is necessary. This point is illustrated by providing analyses of sonority-driven stress in Kiriwina and Harar Oromo, vowel reduction in Dutch, and in the typology of epenthetic vowels.

- Part III: Faithfulness
- *Chapter 5* discusses the main faithfulness-related theoretical proposals in detail. It also contains a discussion of the Place of Articulation scale, which is used extensively in chs.6-8.

- *Chapter 6* contains analyses of neutralization and segmental inventories. This chapter shows that 'gapped' inventories exist – inventories that contain highly marked and highly unmarked segments but no segments of intermediate markedness. Faithfulness constraints that specifically preserve marked categories are argued to be necessary for such cases. Languages discussed include Malay and Yamphu.

- *Chapter 7* also presents arguments that that there are faithfulness constraints that specifically preserve the most marked scale elements. Processes that avoid heterorganic consonant clusters – assimilation, deletion, and epenthesis – are discussed. Languages analyzed include Catalan, Ponapean, Harar Oromo, Attic Greek, and Korean.

- *Chapter 8* presents evidence that the ranking of faithfulness constraints must be freely permutable. The empirical focus is cases of coalescence and bidirectional assimilation. Languages analyzed include Attic Greek, Chipewyan, Harar Oromo, Swedish, and Pāli.

- *Chapter 9* contains a summary and conclusions.

PART I

THEORY

CHAPTER 2

THEORY

2.1   Introduction

This chapter presents a theory of scale-referring markedness and faithfulness constraints and discusses its relation to previous proposals. Three relatively independent issues provide the organization for the presentation for this theory.

(1)   <u>Issues</u>
    (a) Markedness
        (i) In what way do scale-referring markedness constraints assign violations?
        (ii) What are the structural descriptions of scale-referring markedness constraints?
    (b) Faithfulness
        (i) In what way do scale-referring faithfulness constraints assign violations?
        (ii) What are the structural descriptions of scale-referring faithfulness constraints?
    (c) Structure
        (i) Which scales can/cannot combine with structural elements?
        (ii) With which structural elements may scales combine?

Section 2.2 deals with the way in which scale-referring constraints assign violations – their 'violation profiles' (1ai, 1bi).

Section 2.3 deals with the structural description of scale-referring constraints – i.e. their symbolic form (1aii, 1bii). This section deals with the representation of scales as multi-valued features.

Section 2.4 deals with constraints that combine scales and structural elements. This section claims that only 'prosodic' scales – ones that refer to non-subsegmental properties like tone – may combine with structural elements to form constraints (1ci). A precise characterization of the structural elements with which scales combine is also provided (1cii).

Section 2.5 summarizes the theoretical proposals and outlines how the rest of this dissertation provides evidence for them.

2.2   Violation profiles

The following discussion assumes that for every scale S, there is a set of markedness and a set of faithfulness constraints that refer to S.[4] The aim of this section is to provide a precise characterization of such scale-referring constraints.

The present theory has two goals. One is to correctly translate the hierarchical relations expressed by scales into constraint-violation terms. As discussed in ch.1, this means not only accounting for hierarchical relations, but for category conflation as well. More concretely, the theory aims to explain why for the partial Place of Articulation (PoA) scale | dorsal 〉 coronal |: (i) dorsals can be treated as more marked than coronals, (ii) dorsals can be treated as equally marked as coronals (i.e. dorsals and coronals can be conflated), and (iii) dorsals are never treated as less marked than coronals.

The other goal is to have a theory with faithfulness and markedness constraints that can be ranked freely; no constraints are in a universally fixed ranking. As in Prince (1997a,b,c, 1998, 1999), chapter 3 shows that free ranking of markedness constraints is essential in producing certain types of conflation. Chapter 8 shows that free ranking of faithfulness constraints is essential for certain types of coalescence.

The following two sections present a theory that both expresses the hierarchical relations in scales and has fully permutable constraint ranking. Section 2.2.1 is devoted to markedness constraints, and §2.2.2 to faithfulness constraints.

2.2.1   Featural scale-referring markedness constraints

Prince (1997 et seq.) has shown that in order to allow the ranking of scale-referring markedness constraints to be freely permutable while still respecting markedness relations the constraints must refer to ranges of scales in a particular way. To be precise, each constraint must assign a violation to a contiguous range of a scale, always including the most marked element. Prince dubs the relation amongst such scale-referring constraints 'stringency'; this term will be adopted here.

- *Informal schema*

There are a number of ways to formally implement stringency. The particular way chosen here is expressed in the schema in (2). Schema (2) applies to 'featural' scales – scales that refer to subsegmental features such as Place of Articulation and [voice]; non-featural scales (e.g. sonority, tone) are discussed in §2.4.

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[4] While it is imaginable that there may be some scale or scale elements for which there are no corresponding constraints, this possibility is currently untestable, so it is put aside here. I have found no scale for which it could be proven that there is only a set of markedness constraints and no faithfulness constraints, or vice-versa.

(2)   Featural scale-referring markedness constraints
        (a) For every element *p* in every scale S, there is a markedness constraint *m*.
        (b) *m* assigns a violation for each segment that either
                (i) contains *p*
            or (ii) contains anything more marked than *p* in scale S.

        (2a) requires that (i) there is a set of markedness constraints for every scale and (ii) there are as many markedness constraints for a scale S as there are elements in S. For example, for a scale Z=| *x* ⟩ *y* ⟩ *z* | there are three markedness constraints that refer to Z.
        By (2b), if a markedness constraint *m* refers to the element *y* in scale Z, it will assign a violation to *y* and all elements that are more marked than *y* in Z (i.e. *x*) (2bi); in familiar notation, *m* can be written as *{*x,y*}. Therefore, *m* will assign a violation for every segment that is/contains *y* or *x*. However, *m* will not assign violations to any element lower on the scale – *z* in this case. The ultimate result is a set of markedness constraints with the form *{x}, *{x,y}, *{x,y,z}. In short, if *p* violates a markedness constraint C, then everything more marked than *p* will also violate C.

- *Formal schema*
        Schema (2) is expressed in more precise terms in (3). The definition assumes that a constraint is a function from a candidate to a set of violation marks (after Prince & Smolensky 1993).[5] Thus, "m(CAND) → V" is the constraint function *m* from a candidate CAND to a set of violation marks V. The schema expresses that the number of violation marks in the set V is the same as the number of distinct *x*'s in the candidate, where *x* is any element that is equally or more marked than the scale element in question. Conditions (c) and (d) restrict the definition.

(3)   Featural Scale-Referring Markedness Constraints (formal)
        (a) For every scale S, there is a set of markedness constraints M.
        (b) For every element *p* in S, there is some m∈ M such that
            for all *x* in S such that *x* is equally or more marked than *p*,
                m(CAND) → V
                    - CAND is a candidate
                    - V is a set of violation marks.
                    - the cardinality of V is the same as the number of distinct *x*'s in CAND.
        (c) There are no other members of M.
        (d) There are no other sets of markedness constraints for S apart from M.

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[5] One may point out that a set of *n* violation marks has the same cardinality as a set of *n+1* violation marks (if *n*≠0). To avoid this problem, take a 'violation mark' to be any element from a denumerably infinite set of discrete elements (e.g. the natural numbers). Thus, a set of three violation marks is {1,2,3}, with a cardinality of 3. For an alternative way of conceiving of constraints, see Samek-Lodovici & Prince (1999) and Prince (2002).

Condition (d) prevents several different sets of markedness constraints from referring to the same scale; it bans another set of markedness constraints apart from M from referring to S in a way that is inconsistent with (3).

On the other hand, (d) does not prevent S from being mentioned in combination with some other scale. For example, chapter 7 presents a set of constraints that combine the Place of Articulation scale with itself; these constraints are distinct from the set that refers only to the PoA elements and to nothing else. Similarly, §2.4 discusses prosodic scales, where a single scale combines with many different structural elements.

The schemas in (2) and (3) encapsulate the proposal that scale-referring markedness constraints are stringently formulated. This point can be illustrated using the Major Place of Articulation scale | dorsal 〉 labial 〉 coronal 〉 glottal| (ch.5§5.3.3).

By (2)/(3), there are four PoA-referring markedness constraints because the scale has four elements. One assigns violations to dorsals alone; this constraint will be named *{dorsal} here, but – importantly – nothing is implied about its structural description (see §2.2.3). Of the other three constraints: (i) *{dorsal,labial} assigns a violation to a candidate for every instance of a dorsal or labial, (ii) *{dorsal,labial,coronal} assigns a violation to all segments that are have either dorsal, labial, or coronal Place of Articulation, and (iii) *{dorsal,labial,coronal,glottal} assigns a violation to effectively all segments.

- *Harmonic Bounding*
  Quasi-tableau (4) shows the constraints in action.[6]

(4)

	*{dors}	*{dors, lab}	*{dors, lab, cor}	*{dors, lab, cor, gl}
k	*	*	*	*
p		*	*	*
t			*	*
ʔ				*

The quasi-tableau shows how the markedness constraints impose a harmonic ordering on segments that differ in PoA without recourse to ranking (also see Prince 1997 et seq.). No matter what the ranking of the constraints, dorsals always incur more significant violations than all other segments; thus dorsals are disfavoured by these constraints. Similarly, regardless of the ranking, labials are never favoured above coronals – every constraint that coronals violate is also violated by labials, and there is one constraint that labials violate and coronals do not.

The reason that ranking is irrelevant relates to the relationship between constraint violations: in terms of the PoA-referring markedness constraints, coronals incur a proper subset of the violations of every other PoA. So, after the mark-cancellation procedure – whereby violation marks common to both candidates in a pairwise competition are

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[6] The term 'quasi-tableau' refers to tableaux that compare harmonic bounding relations between forms rather than demonstrate winners under some particular ranking.

eliminated (Prince & Smolensky 1993) – coronals will not have any violations of the markedness constraints above, unlike the other PoAs.

The situation presented above is a type of harmonic bounding. A candidate α is a harmonic bound for β if α incurs a proper subset of β's violations (Samek-Lodovici 1992, Prince & Smolensky 1993:ch.9, McCarthy 2001b§1.3.1).[7] In such a situation, no grammar will ever output β since α will always be more harmonic than it. Prince & Smolensky (1993:ch.9) show that harmonic bounding reduces to properties of the mark-cancellation procedure. If α has a subset of β's marks, then after mark cancellation β will still have violations while α does not, therefore dooming β to 'loser' status. Adopting terminology from Samek-Lodovici & Prince (1999), α is a harmonic bound for β if no constraint 'favours' β over α and some constraint favours α over β. A constraint C favours α over β if α incurs fewer violations of C than β does.

The constraints presented above impose a type of harmonic bounding, but localized to just the markedness constraints for the PoA scale. Thus, [p] may win in some grammar, but only through the action of some non-'PoA markedness' constraint (e.g. a faithfulness constraint like IDENT{dorsal,labial}). In terms of the PoA-markedness constraints alone, [t] is a harmonic bound for [p]. Such a relation between a set of constraints is called 'local harmonic bounding' here.

The local harmonic bounding relation is essential in allowing the constraints' ranking to be permutable. If the PoA-markedness constraints were not in such a relation, their ranking could not be fully permutable and maintain the scale's hierarchical relations. For example, suppose CON contained a constraint that favoured dorsals and labials over coronals – e.g. *CORONAL. No longer is [t] a local harmonic bound for [p] and [k]: with *CORONAL ranked above the other constraints, the harmonic relations are reversed so that [t] is less harmonic than [p] and [k]. A similar story holds for *LABIAL – again, this constraint favours dorsals over labials, potentially reversing the ranking between the two.

In short, local harmonic bounding is essential for having freely ranked scale-referring markedness constraints that maintain the hierarchy encoded in the scale.

2.2.2   Featural scale-referring faithfulness constraints

I propose that (i) faithfulness constraints refer to ranges of a scale, just like markedness constraints and (ii) that faithfulness constraints all preserve the most marked member of scales. This proposal allows a generalization over both markedness and faithfulness constraints, encapsulated in the following hypothesis:

(5)   The Marked Reference Hypothesis (MRH)
        If a constraint C refers to scale S, C refers to the most marked member of S.

The formal import of the term 'refer' differs depending on the type of constraint. (5) requires *markedness* constraints to assign a violation to the most marked member. In

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[7]   Samek-Lodovici & Prince (1999) identify another type of harmonic bounding – 'collective' harmonic bounding – in which a candidate always incurs a subset of the combined violations of two or more other candidates. This type of harmonic bounding is not relevant here.

contrast, (5) requires *faithfulness* constraints to always preserve the most marked scale member. The MRH is encapsulated in the following informal schema for scale-based faithfulness constraints:[8]

(6)   Featural scale-referring faithfulness constraints (informal)
       (a) For every element *p* in every scale S, there is a faithfulness constraint *f*.
       (b) *f* preserves *p* and all elements in S that are more marked than *p*
              i.e. *f* assigns a violation for every element *x* that
                     (i) is equally or more marked than *p* in S
              and (ii) has a correspondent that is unfaithful to *x*.

As with the markedness constraints, the schema in (6) requires one faithfulness constraint per scale element. If a faithfulness constraint preserves an element *p* in the scale, it also preserves every more marked element. For example, take a scale Z=| *x* ⟩ *y* ⟩ *z* |. If a faithfulness constraint preserves the mapping from /y/ to its correspondent – i.e. it assigns violations to the mappings /y/→[x] and /y/→[z] – it also preserves the mapping from all more marked elements – i.e. /x/. The notion 'mapping' is expressed in terms of Correspondence Theory (McCarthy & Prince 1995); examples are provided below.
       The schema in (6) does not place any restrictions on the dimension of faithfulness: there are separate sets of scale-referring faithfulness constraints for all dimensions (Input→Output, Base→Reduplicant, Output→Output, and so on).

- *Formal schema*
       A more precise version of (6) is provided in (7). The 'dimension' variable D refers to Input→Output, Base→Reduplicant, Output→Output, and so on. The aim of (a) is to require a separate set of constraints for every different dimension, but restrict constraints to only one set per dimension.

(7)   Featural scale-referring markedness constraints
       (a) For every scale S, for every dimension D there is a set of faithfulness constraints F.
       (b) For every element *p* in S, there is some f∈ F such that
              for all elements *x* in S such that *x* is equally or more marked than *p*,
                     D-f(CAND) → V
                            • CAND is a candidate
                            • V is a set of violation marks.
                            • the cardinality of V is the number of distinct /x/→[y] mappings along dimension D such that *x*≠*y*.
       (c) There are no other members of F.
       (d) There are no sets of faithfulness constraints for S on dimension D apart from F.

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[8] See Howe & Pulleyblank (to appear) for a somewhat different approach to scale-referring faithfulness (see ch. 7 for discussion).

- *Example*

To illustrate, for every faithfulness dimension there are four faithfulness constraints for the PoA scale | dorsal 〉 labial 〉 coronal 〉 glottal |. One constraint per dimension preserves dorsals alone; it will be informally called IDENT{dorsal} here (see §2.3 for a precise formulation of its structural description). Another preserves both dorsals and labials – IDENT{dorsal, labial}; this constraint is violated for every input dorsal or labial that does not retain its featural specifications in the output. For example, /kapa/ → [tata] incurs two violations of IDENT{dorsal, labial}. It is important to point out that the constraint requires identity between input and output element: the mappings /k/→[p] and /p/→[k] also incur a violation of IDENT{dorsal,labial}. The other two faithfulness constraints are IDENT{dorsal,labial,coronal} and IDENT{dorsal,labial,coronal,glottal}.

The effect of the form of these constraints can be seen in quasi-tableau (8). The 'candidates' are Input→Output mappings from different underlying PoAs. Each mapping is unfaithful; exactly how it is unfaithful is irrelevant, so the outputs are designated [~x] for all /x/, where [~x] is some segment that differs solely from /x/ in terms of PoA.

(8)

	IO-IDENT {dors}	IO-IDENT {dors,lab}	IO-IDENT {dors,lab,cor}	IO-IDENT {dors,lab,cor,gl}
/k/→[~*k*]	*	*	*	*
/p/→[~*p*]		*	*	*
/t/→[~*t*]			*	*
/ʔ/→[~*ʔ*]				*

Quasi-tableau (8) shows the mappings to be in a local harmonic bounding relation. In informal terms, the constraints ensure that unfaithfulness to dorsals incurs more serious violations than unfaithfulness to every other PoA. Consequently, unfaithfulness to the least marked elements – glottals – is least significant. In effect, with these constraints it is impossible to impose a stricter faithfulness requirement on coronals without imposing the same requirements on the more marked labials and dorsals. The same is true for the relation between labials and dorsals.

The empirical relevance of local harmonic bounding for faithfulness is discussed in chapter 8. For the moment, it is worth noting the symmetry between the form of markedness and faithfulness constraints: for each markedness constraint there is a faithfulness constraint that refers to the same set of scale elements. The net result is that the elements that violate the most markedness constraints are also those that are most preserved. The effects of this implication are discussed in chapters 6 and 7.

As with the markedness constraints, in order for faithfulness constraints to be in a local harmonic bounding relation there can be no faithfulness constraint that preserves a lesser marked scale element without also preserving all more marked ones. A constraint such as IDENT[coronal], for example, will preserve mappings from /t/ but not from /k/ or /p/. This predicts that there could be a system in which /t/s excite greater faithfulness than

/p/ and /k/, potentially preventing them from undergoing processes that other PoAs undergo. Chapter 7 shows that such a constraint has undesirable empirical consequences.

2.2.3 Previous theories

A leading idea in the present theory is that scale-referring constraints are freely rankable. As shown above, this requirement necessitates sets of constraints that impose local harmonic bounding relations between candidates. There are a number of precursors to this idea. A few are briefly identified here; more detailed discussion of the proposals is provided in later chapters, when appropriate (see esp.ch.3).

Precursors to the stringent idea can be seen in pre-OT work. For example, Clements (1990) argues that the sonority of a segment is calculated by reference to the features [sonorant], [approximant], [vocalic], and [syllabic]. The features are in subset-superset relation with each other: if a segment is [+vocoid], it is also [+approximant] and [+sonorant], and so on for each feature value. To clarify, Clement's (1990:292) table is reproduced here (O=obstruent, N=nasal, L=liquid, G=glide).

Figure 2.1: Clements (1990) sonority calculation

O	< N	< L	< G	
–	–	–	–	"syllabic"
–	–	–	+	vocoid
–	–	+	+	approximant
–	+	+	+	sonorant
0	1	2	3	rank (relative sonority)

In Clement's theory there is no need to refer to a hierarchy of features to determine a segment's sonority – no particular feature has primacy over the others precisely because the features' values are related to each other in a subset-superset manner. The present approach is loosely related to this idea – there is no fixed ranking because constraints are in a local harmonic bounding relation.

The local harmonic bounding idea can also be found in early OT work, in the context of specific analyses. For example, Kiparsky (1994) uses faithfulness constraints similar to the ones outlined above to deal with PoA assimilation in Catalan (an approach discussed in detail in chapter 7§7.2), while Green (1993) uses sonority constraints analogous to the ones discussed above to deal with syllabification. Finally, Beckman's (1998) theory of positional faithfulness employs faithfulness constraints that refer to morpheme classes in a special-general relation, rather than in a fixed ranking (cf ch.6). [9]

As mentioned above, the most extensive discussion of stringent constraints in previous OT work is in a series of lectures by Alan Prince (Prince 1997a,b,c, 1998, 1999). Prince shows that stringent constraints can express scale hierarchies, just like constraints in

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[9]   Beckman (1998) proposes that there are faithfulness constraints to roots and non-specific faithfulness constraints ‖ FAITH-Root, FAITH ‖. Beckman's constraints achieve the same result as McCarthy & Prince's (1995) fixed ranking ‖ FAITH-root » FAITH-affix ‖ by means of their stringency relation.

a fixed ranking. I have also argued the same point for scales, primarily in the context of prominence-driven stress (de Lacy 1997a, 2000a).

Prince also identifies the crucial empirical difference between the stringent constraints and Fixed Ranking theories – they differ in their ability to produce conflation (also de Lacy 1997a, 2000a). This point is discussed in more detail in chapter 3. In the present work, the aim is to precisely characterize these differences, expanding on Prince's work and my own.

To summarize, the requirements that scale-referring constraints be freely permutable and effect hierarchical relations can be achieved by invoking harmonic bounding. Harmonic bounding in turn necessitates that scale-referring constraints have particular properties: they must assign violations to a contiguous part of the scale, and always to the same endpoint. In short, the violation profile of scale-based constraints must be such that they produce local harmonic bounding in the way described above. The requirements provide a guide to determining the structural description of constraints, a matter to which we can now turn.

2.3   Structural descriptions

This section contains a proposal about the 'structural description' of scale-referring constraints: i.e. how constraints refer to scales, rather than how violations are calculated for each constraint. Section 2.3.1 proposes that the structural description of scale-referring constraints is most easily stated using a multi-valued feature, generalizing proposals by Selkirk (1984), Green (1993), Gnanadesikan (1997), and others. Section 2.3.2 discusses the form of the scale-referring constraints.

To make the aims of this section clearer, the 'structural description' of a constraint is distinct from its 'violation profile'. For example, there is general agreement regarding the violation profile of the well-known constraint ONSET (Prince & Smolensky 1993, McCarthy & Prince 1993): ONSET assigns a violation for each vowel-initial syllable. However, there is controversy regarding the structural description of ONSET: it has been formulated negatively (*$_\sigma$[V – McCarthy & Prince 1993a), with the ALIGN schema (i.e. ALIGN-L(σ,C) – McCarthy & Prince's 1993b), and in other ways as well. However, the controversy over the structural description does not in any way affect the standard view that there is need for a constraint that has the particular violation profile as given above. In other words, the violation profile of a constraint and its structural description may be examined separately. Accordingly, as with ONSET the proposals about scale-referring constraints' structural descriptions in this section are separate from those about their violation profiles (presented in the preceding section); the validity of the proposals in this section do not depend on the validity of the proposals about violation profiles in the preceding section, and vice-versa.

2.3.1   Multi-valued features

I adopt an approach to feature values that is closely related to Prince's (1983) grid theory in that feature values are considered to be a string of elements – *x*'s and *o*'s (also see

Green 1993). This approach allows for a formally definable notion of relative similarity; this point will prove to be important in providing a formal definition of the structural description of scale-referring constraints (§2.3.2).

I propose that a feature's value is a string that has the form x_0o_0, where $_0$ stands for '0 to any number'. For example, valid feature values are *x*, *o*, *xo*, *xxooo*, but not *xox* or *ox*. This approach will be called the "*xo* theory".

In effect, every value shows the extent of a scale – a scale of *n* distinctions has values of length *n*-1. For example, the feature [nasal] has two values, traditionally [+nasal] and [–nasal], so the present approach represents the distinction as [*x*nasal] and [*o*nasal]. For ternary features, such as Gnanadesikan's (1997) consonantal stricture, a string of length 2 is used, distinguishing *xx*, *xo*, and *oo* values.

The *xo*-theory offers a way to formally express scales. In this respect, the same formal object expresses scales and features: a scale is simply a multi-valued feature. The Place of Articulation scale will serve as an example.

(9)   <u>Major Place of Articulation (PoA) Scale</u>
        | dorsal ⟩ labial ⟩ coronal ⟩ glottal |

The PoA scale is expressed by the feature [Place]. It makes four distinctions, so has a feature value string of length 3. The feature values in (10) match the points on the scale.

(10)   <u>Multi-valued Place of Articulation features</u>
        [*xxx*Place]   dorsal
        [*xxo*Place]   labial
        [*xoo*Place]   coronal
        [*ooo*Place]   glottal

In Prince & Smolensky's (1993) theory, scales are converted into constraints, while in the present theory scales are expressed as features. The marked value of the scale is assigned a string value consisting entirely of *x*'s, with the length of that string depending on the number of distinctions made in the scale. Every less marked value differs from the most marked value in terms of its *x* content, as seen in the PoA features above.

To recap, a grid theory for feature values is employed here, with some slight changes: (i) a feature string has the form x_0o_0, not just x_0 and (ii) all features employ this formalism, not just stress or multi-valued features.[10] Scales are therefore expressed as multi-valued features.

Of course, this approach is by no means a theory of scales. The core of the theory of scales is in its constraints. However, a *xo* approach to feature values does provide a formal mechanism for a theory of the structural description of scale-referring constraints.

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[10] One important difference between grid theory and the present approach is that grid marks for stress encode relative similarity rather than absolute values. In contrast, the *xo* values encode absolute values: [*xxo*Place] refers to labials, and so forth.

This point is discussed in §2.3.2; the following section discusses the notion of multi-valued features in comparison to binary ones.

2.3.1.1 Multi-valued and binary features[11]

The proposal that there are multi-valued features is somewhat nonstandard, given the predilection for binary (2-valued) and privative (1-valued) features in previous work (Jakobson, Fant, & Halle 1952, Jakobson & Halle 1956, Chomsky & Halle 1968, Creider 1986, Steriade 1995b:147-157).

However, the proposal that there are multi-valued feature is by no means novel. Chomsky & Halle (1968) employ a multi-valued feature for stress, and a number of researchers have effectively proposed a multi-valued [Sonority] feature (Steriade 1982, Selkirk 1984, van der Hulst 1984, Durand 1990, Green 1993). Ladefoged (1975) and Williamson (1977) propose multi-valued laryngeal features, and Stahlke (1975) and many others have proposed a multi-valued feature for tone (cf Odden 1995). Recently, Gnanadesikan (1997) has argued that several features are ternary-valued and Clements' (1991) [open] feature can be 'stacked', effectively producing multiple distinctions in vowel height (also see Clements & Hume 1995, Lindau 1978). In other words, these theories have expanded the set of feature values to include many more distinct elements (usually represented by the natural numbers {0,1,2,…}, for convenience).

The 'natural number' approach is only one way to allow multi-valued features. Prince's (1983) grid theory provides another method (also precursors in Kiparsky 1979, Selkirk 1984). Instead of an *n*-valued [stress] feature, a string of *x*'s specifies relative stress among syllables or moras. The grid theory approach to multi-valued features has frequently been extended to other features: for example, it has been used for sonority with gridmarks standing for different sonority levels (van der Hulst 1984, Milliken 1988, Zec 1988, Parker 1989, Clements 1990, 1992, Green 1993).[12]

In the present work, the grid-theory approach to features is adopted, and extended as detailed in the previous section.

- *Binary vs Multi-valued features*

Surprisingly few works explicitly compare the virtues of binary and multi-valued features. All of the ones that do – Sommerstein (1977), Creider (1986), and McCarthy (1988) – agree with Creider's statement that "there are surprisingly few phonological arguments [against multi-valued features] in the literature". In the most recent and detailed account, McCarthy (1988:94) states the following, comparing binary- with multi-valued features:

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[11] My thanks to the audience at Haskins Laboratories for their comments on a talk closely related to this section.

[12] Grid theory is unlike multi-valued features in that gridmarks (and even some multi-valued features) are construed as representing *relative* values for the feature (stress, sonority) (see esp. Selkirk 1984:112, 121). This conception sets it apart from Gnanadesikan's feature value theory, in which features can be ternary-valued with each value expressing an absolute, not relative, value (although Gnanadesikan's *constraints* have the effect of relative values).

(11)   "Are there any differences, then, between these two very different theories of essentially the same problem? Explicit discussion of this question is rare, and the arguments raised are unpersuasive, tending to emphasize methodological rather than empirical differences." (McCarthy 1988:94)

McCarthy observes that arguments presented for one or the other approach are not based on empirically testable issues, but instead rely on appeals to theory-internal simplicity or ease of implementation (e.g. SPE's evaluation metric). McCarthy points out that objections to multi-valued features often rest on the assumption that multi-valued features automatically introduce the full power of arithmetic to the grammar, allowing features to be incremented or decremented by any number. Of course, the algorithms that manipulate feature values are somewhat independent from the form of the features themselves. The same goes for the objection that there is no obvious limit to the number of distinctions allowed per feature; again the issue of the maximum number of distinctions per feature is entirely separate from the form of the features themselves. In other words, the *xo* proposal does not introduce the full power of arithmetic operations commonly associated with integers.

More concretely, McCarthy compares a theory such as the one presented in the previous section – where there is a single multi-valued [Place] feature – and one that has a non-terminal Place node which dominates several independent features ([coronal], [labial], [dorsal], etc.). McCarthy concludes that "all arguments in favour of the class node Place apply with equal force to the *n*-ary feature [Place]" (p.94); the reader is referred to this work for further discussion.

However, McCarthy does raise one argument in favour of the privative Place feature approach. Labial cooccurrence restrictions in Arabic apply across intervening segments; thus a stem /btf/ is blocked from appearing faithfully. McCarthy argues that these follows straightforwardly if [labial] and [coronal] are on different tiers, illustrated in Figure 2.2 from McCarthy (1988).

Figure 2.2: Tiers and multi-valued features (McCarthy 1988)
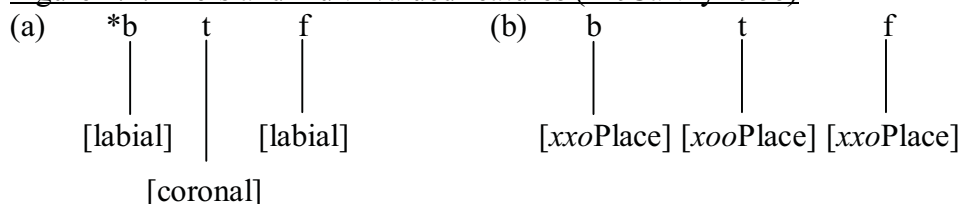
If [labial] and [coronal] are on different autosegmental tiers, it is a straightforward matter to explain why labials cannot appear in the output even when non-adjacent: their [labial] features are adjacent on a tier, and thus are subject to the OCP. In contrast, a theory with a single [Place] feature (Figure 2.2:b) clearly cannot appeal to tier-adjacency.

Within Autosegmental theory, this is clearly a strong argument. However, recent solutions to similar problems have been resolved in non-representational ways (Alderete

1997, Suzuki 1998, Fukuzawa 1999). Constraints that ban multiple instances of the same feature value within a certain domain have been employed to deal with such cases: e.g. Alderete's (1997) locally self-conjoined constraint *{labial}^{2}. These constraints do not appeal to tier-adjacency, so they can employ either multi-valued or privative Place features.

In short, there is no compelling phonological reason to reject multi-valued features in favour of binary/privative ones, or indeed to reject binary/privative features in favour of multi-valued ones.[13] In the present theory, multi-valued features will be assumed to be possible.

As a final note, the proposal that there are multi-valued features by no means precludes the existence of binary or privative ones. In fact, as shown in ch.3§3.5.3, the cumulative effect of binary features can be indistinguishable from multi-valued ones for scale purposes in certain situations. However, it is **not** the case that all multi-valued features can be decomposed into several independent binary features. Two arguments for this – (i) natural class behaviour and (ii) conflation – are discussed in ch.3§3.5.3; I leave discussion until that point because it refers to examples discussed in that chapter.

2.3.2   Constraint form

This section incorporates the *xo* theory of feature values into a theory of constraint form. The expression of this theory for markedness constraints is the schema in (12). F is a feature, and *v* is its value (i.e. a string of *x* and *o*'s).

(12)   <u>Featural markedness constraint definition</u>
*[*v*F]   Assign a violation for every segment that is [v_2F]
                      where *v* is a substring of v_2

In a constraint like *[*x*Place], *x* is the value of [Place]. Therefore, *[*x*Place] is violated by every segment whose [Place] value contains *x*: i.e. [*xoo*Place], [*xxo*Place], and [*xxx*Place].

There is a restriction on the schema in (12): *v* may only contain *x*'s. Certainly, constraints may refer to the *o* values, but not in context-free markedness constraints (see §2.4). Following Green (1993), constraint instantiation is assumed to be complete; in other words, there is a constraint *[*v*F] for every possible length of *v*, implying that there are also *[Place], *[*xx*Place] and *[*xxx*Place] constraints. Completeness is built into the schemas (3b) and (7b).

Together, the *[*v*Place] constraints – with the restrictions stated above – have the desired harmonic bounding effect. Quasi-tableau (13) illustrates this result.

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[13]   Chain shifts have been argued to provide evidence for multi-valued features (e.g. Gnanadesikan 1997 and works cited therein), though Creider (1986) argues to the contrary.

(13)   Harmonic Bounding for PoA Constraints

	*[Place]	*[*x*Place]	*[*xx*Place]	*[*xxx*Place]
ʔ	*			
t	*	*		
p	*	*	*	
k	*	*	*	*

As the quasi-tableau shows, the constraints are in a local harmonic bounding relation with each other. *[*x*Place] is violated by all segments except [ʔ], while *[*xx*Place] is violated by only the marked segments [p] and [k]. Every constraint assigns violations to a contiguous part of the scale, and every element is a harmonic bound for elements higher on the scale in terms of the PoA constraints.

The *xo* theory of feature values plays an important role in providing a structural description that produces harmonic bounding. To produce harmonic bounding, the structural description of the scale-referring constraints needs to refer to a relation of inclusion between the members of the scale. So, any structural description that includes [p] must also include [k], and so on. The *xo* theory allows reference to inclusion in a straightforward way via the substring relation.

- *No covert disjunction*

In contrast, theories without the *xo* representation offer no easy formal way to refer to sets of features. For example, a theory with a set of privative PoA features – [glottal], [coronal], [labial], and [dorsal] – offers no straightforward method of referring to the set {[labial], [dorsal]}. A constraint such as *{[labial], [dorsal]} "Assign a violation to a segment that is either [labial] or [dorsal]" introduces a great deal of formal apparatus to the theory of constraint form. More precisely, a disjunction operation is introduced: a violation is assigned if the segment is [labial] *or* [dorsal]. Certainly, theories have proposed constraint conjunction operations, as in Local Conjunction (Smolensky 1993); a conjoined constraint such as *[labial]&*[dorsal] is violated only if both *[labial] and *[dorsal] are violated within some domain. However, the constraint *{[labial], [dorsal]} is *disjunctive*, violated if either *[labial] or *[dorsal] are violated within the domain of a single segment: i.e. *[labial]∨*[dorsal]. The addition of a disjunction to structural descriptions greatly expands the possible space of constraints and goes no way toward explaining why it is that *[labial] and *[dorsal] form a disjunctive constraint while, for example, *[coronal] and *[dorsal] do not.[14]

The proposal presented above does not covertly implement a disjunction operator in constraint form. Certainly, the interpretation of the constraints does allow for a disjunctive evaluation: *[*xx*Place] effectively assigns violations to segments that are [*xxo*Place] *or* [*xxx*Place]. However, this formalism has nothing of the power of a disjunction operator. For example, the present proposal does not allow different features to be disjoined. A constraint that assigns a violation to all segments with either feature f_1 or

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[14]   This contrasts with Crowhurst & Hewitt's (1997) constraint disjunction, with which constraints – not the elements of their structural descriptions – may be disjoined. See ch.3 for discussion.

feature f_2 is not possible in the present approach – constraints only refer to different values of the same feature. Moreover, the present approach does not allow any arbitrary pair of feature values to be disjoined: only adjacent values are effectively disjoined. For example, there is no constraint that assigns a violation to a segment only if it is [*xoo*Place] or [*xxx*Place], since [*xoo*] and [*xxx*] are not contiguous feature values.

In short, while the effect of the present approach has the flavour of disjunction, it has very little of the power of a disjunctive operator. The disjunction approach and its empirical consequences are discussed further in chapter 3§3.4.2.

- *Faithfulness*
  Schema (14) is for scale-referring faithfulness constraints; again F is a feature and *v* is its value.

(14) Schema for faithfulness to featural scales
       IDENT[*v*F]   If segment α is [v_2F] and *v* is a substring of v_2,
                         then α' (the correspondent of α) is [v_2F].

For example, IDENT[*x*Place] requires every input segment with a Place value that includes *x* to retain its input specification in the output. More concretely, IDENT[*x*Place] requires coronals to surface as coronals, labials as labials, and dorsals as dorsals, but is not violated if glottals do not surface faithfully. Similarly, IDENT[*xx*Place] is violated only if input labial and dorsal segments do not have output correspondents with the same PoA; it is not violated if glottal or coronal PoA is not preserved. The form of this constraint schema and its empirical effects are discussed in detail in chs.5-8.

- *Summary*
  To summarize, 'scale-referring constraints' are standard markedness constraints, with the structural description given in (12) above. In this way, the theory of scale-referring constraints is integrated into a general theory of markedness and features.

The proposal that scales are expressed as multi-valued features (almost) reduces the theory of scale-referring constraints to a simple generalization: there is a separate markedness and faithfulness constraint for every value of every feature. For example, the Place of Articulation scale is expressed by a set of constraints that refers to all four values of the [Place] feature. The restriction is that constraints may only refer to *x* values (except for special circumstances discussed in §2.4), and do so in the 'substring' manner encoded in the constraint schemas in (12) and (14). Thus, the theory of scales presented here almost reduces to the theory of multi-valued features and how they in turn express scales.

2.4   Scales and structure
Scale-referring constraints often mention a structural position. For example, Prince & Smolensky (1993) propose that the positions 'syllable peak' and 'syllable margin' are combined with the sonority scale to produce sets of constraints that influence syllabification. Similarly, Kenstowicz (1996) has proposed that the sonority scale can

combine with the structural position 'foot head' (i.e. the stressed syllable of a foot) and 'foot margin', and I have proposed the same for tone (de Lacy 1999a, 2002b). This section presents proposals about constraints that combine scales with structural elements.

Structure-reference in scale constraints raises two questions: (i) what are the structural elements with which scales may combine? and (ii) which scales may combine with structural elements, and which ones cannot?

Section 2.4.1 presents proposals that the structural elements found in scale-referring constraints are always one of two elements: the Designated Terminal Element (DTE) and non-DTE, adapted from Liberman & Prince (1977).

Section 2.4.2 claims that there are general restrictions on which constraints may combine with structural positions in constraints: prosodic scales must combine with structural elements while featural scales must not.

2.4.1   DTEs and non-DTEs

I propose that scales can only combine with one of two structural elements: the Designated Terminal Element (DTE) and non-DTE, defined in (15) and (16) respectively. The notion of 'DTE' is taken from Liberman (1975) and Liberman & Prince (1977), but is extended in having 'non-DTEs' and reference to two elements in the definition. Related proposals are found in Selkirk (1998, 2000), Zec (2000), and my own work (de Lacy 1999a). Works that specifically discuss the phonological relevance of non-DTEs (especially non-heads of feet) are Kenstowicz (1996), Ping (1999), and de Lacy (2002b).

(15)   Definition of DTE
$DTE_{(\alpha,\beta)} =_{def}$ A node n of type β is the DTE of prosodic category α iff the path from n to α consists of an unbroken chain of prosodic heads.

A 'path' from n to α starts with node n and goes through all nodes that (i) dominate n and (ii) are dominated by α.

(16)   Definition of non-DTE
$non\text{-}DTE_{(\alpha,\beta)} =_{def}$ a node n of type β is a non-DTE of α iff
    (i) n is (transitively) associated to α
and   (ii) n is not a $DTE_{(\alpha,\beta)}$

The definitions presented above differ from Liberman's (1975) and Liberman & Prince's (1977) original conception in two ways. One is the notion 'non-DTE'. The other is that DTEs are 2-place elements: $DTE_{(\alpha,\beta)}$ refers to the node that is of type β and dominated by an unbroken chain of prosodic heads to α. For example, $DTE_{(Ft,\mu)}$ (read as "the mora-DTE of a foot") refers to all those head *moras* that are dominated by head syllables that are dominated by *feet*; in comparison, $DTE_{(Ft,Rt)}$ refers to the head *root node* dominated by the head mora dominated by the head syllable of a foot. For discussion of why the β argument is necessary, see §2.4.1.1.

Every node on the prosodic plane is taken to be marked as a head or non-head; moras, syllables, and feet are marked for headedness, as are root nodes. Since the definition of the DTE crucially relies on the notion 'prosodic head' it inherits the main property of heads: for every prosodic node α there is only one DTE of α.[15]

The arguments α and β can be any member of the prosodic hierarchy, from the root node to the Utterance Phrase node. Selkirk (1998) has argued that there are DTEs for every prosodic category for tone (also see de Lacy 1999a); Zec (2000) has explored a similar idea for sonority. Further evidence for this claim is provided in chapter 4.

- *Exemplification I: inside the syllable*
The structures in Figures 2.3 and 2.4 aim to clarify the definition of DTE. Figure 2.3 is the syllable [kæt]. A superscript + marks a node as a head and a superscript - as a non-head; the symbols [k], [æ], [t] are root nodes. The σ node is not marked as either a head or non-head since its head status is irrelevant in determining its DTEs in this structure.

Figure 2.3: DTEs below the syllable
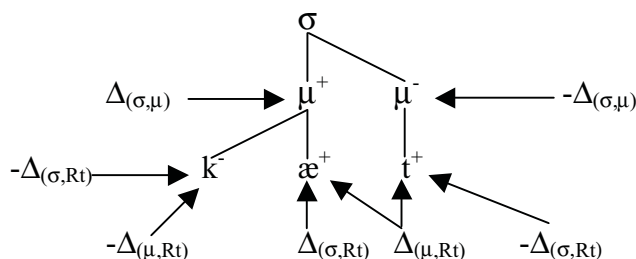
The root-node DTE of the syllable $\Delta_{(\sigma,Rt)}$ is the head root node dominated by a chain of heads to the σ node. Only the root node [æ] in Figure 2.3 meets this description – it is a head and it is dominated by a head mora which in turn is dominated by the σ.

In contrast, [t] is a non-DTE of the syllable: $-\Delta_{(\sigma,Rt)}$; [t] is not associated to the σ node by an unbroken chain of heads – it is dominated by a non-head mora. [k] is a $-\Delta_{(\sigma,Rt)}$ as well, but because it is not a head.

The leftmost mora in Figure 2.3 is a mora-DTE of the syllable: it is a head mora dominated by an unbroken chain of prosodic heads (of length 0 in this case) to a syllable node.

Part of the usefulness of DTEs is that a node may be a DTE of some category but a non-DTE of another (necessarily higher) category. For example, [t] in Figure 2.3 is a non-DTE of the syllable, but it is a mora DTE: [t] is a head that is dominated by an unbroken chain of heads – in this case a 1-length chain – to the μ node. This dual nature proves to have significant empirical consequences, as discussed in later chapters (esp. ch.4§4.4). In any case, it is important to recognize that the majority of elements are both DTEs and non-DTEs of some category. The DTE of the Utterance Phrase (i.e. the highest prosodic unit)

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[15] The idea that every constituent contains one and only one head has persisted in work on the Prosodic Hierarchy and has been embodied in the (probably inviolable) OT constraint HEADEDNESS of Selkirk (1995) and Ito & Mester (1992) (cf Crowhurst 1996).

is the only element that is not a non-DTE of any category. Some elements are perpetual non-DTEs, though. For example, [k] in Figure 2.3 (i.e. an onset) is not a DTE of any category, since it is a non-head of the lowest prosodic level (i.e. μ).

- *Exemplification II: inside the PrWd*

The dual DTE-nature of terminal elements is more evident in larger structures, as in the PrWd in Figure 2.4. The figure below identifies the root-node DTEs and non-DTEs; DTEs are shaded.

Figure 2.4: DTEs and non-DTEs in the PrWd

	p	a	t	e	u	k	i	s
PrWd	-Δ	Δ	-Δ	-Δ	-Δ	-Δ	-Δ	-Δ
Ft	-Δ	Δ	-Δ	Δ	-Δ	-Δ	-Δ	-Δ
σ	-Δ	Δ	-Δ	Δ	-Δ	-Δ	Δ	-Δ
μ	-Δ	Δ	-Δ	Δ	Δ	-Δ	Δ	
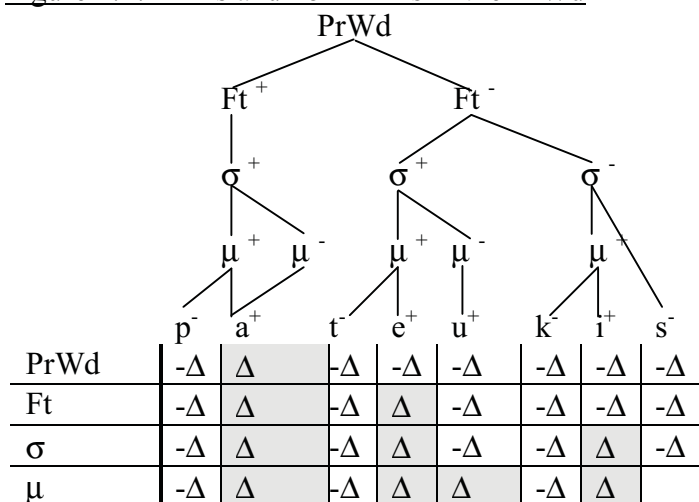
[a] is the DTE of the Prosodic Word in Figure 2.4, while every other element is a -Δ_{PrWd}. Similarly, [a] and the schwas are DTEs of a foot, while all other root nodes are foot non-DTEs. This table makes it clear that an element may be a DTE for one constituent but not for another.

Another point that emerges in Figure 2.4 is that it is possible for a root node to have no DTE status with respect to some constituent. The word-final [s] in is neither a Δ_{μ} nor a -Δ_{μ} since it is not dominated by a mora.[16] In effect, then, no constraint of the form *$\Delta_{\mu} \leq x$ or *-$\Delta_{\mu} \geq x$ will apply to it. This situation is only possible when strict layering is violated. The empirical effects of this fact are discussed in chapter 4§4.4.

Traditional notions such as 'syllable peak' and 'margin' can be expressed as DTEs and non-DTEs. For example, the peak (i.e. nucleus) of a syllable is $\Delta_{(\sigma,Rt)}$, while the margin (onset and coda) is -$\Delta_{(\sigma,Rt)}$. Further constituents such as onset, rime, and coda can also be expressed in this system.

As a final note, the present theory is not a theory of prosodic structure (cf Selkirk 1984), but rather is a theory of reference to prosodic structure. Thus, the DTE proposal has

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[16] The attachment of [s] directly to the σ node is meant to show the DTE status of an element that does not obey Strict Layering (Selkirk 1984). Depending on the theory of syllable structure adopted, non-strict layering may be banned (cf Selkirk 1995).

no bearing on whether elements may be extraprosodic, or whether feet may be ternary, and the like.

2.4.1.1 Constraint form

DTEs and non-DTEs form the structural prominence scale $|\ \Delta_{(\alpha,\beta)} \rangle$ -$\Delta_{(\alpha,\beta)}\ |$, generalizing P&S's peak-margin structural scale. More precisely, there are several DTE scales, one for each possible specification of α: i.e. $|\ \Delta_{(\sigma,\beta)} \rangle$ -$\Delta_{(\sigma,\beta)}\ |$, $|\ \Delta_{(Ft,\beta)} \rangle$ -$\Delta_{(Ft,\beta)}\ |$, and so on for each prosodic category. Every DTE scale combines with every prosodic scale to form a set of scales, one for each distinct α,β specification.

At this point, it is important to emphasize the role of the β part of the DTE definition. As an example, $\Delta_{(Ft,\sigma)}$ refers to the head syllable of a foot, while $\Delta_{(Ft,\mu)}$ refers to the head mora of the foot. In principle every value of α,β for DTEs can be combined with scales to form constraints. However, most of these constraints will be vacuously satisfied depending on the scale. For example, on the assumption that tone associates to moras, the only relevant DTEs and non-DTEs for the tonal scale will be those that are moras: i.e. $\Delta_{(\alpha,\mu)}$ and -$\Delta_{(\alpha,\mu)}$. In contrast, sonority is considered a property of root nodes here, so the only relevant DTEs and non-DTE combinations are $\Delta_{(\alpha,Rt)}$ and -$\Delta_{(\alpha,Rt)}$.[17] Since it will be self-evident which type of DTE is relevant depending on the scale discussed below, the β part of the DTE definition will not be supplied from now on unless it is directly relevant.

As an example, the constraints that refer to the tonal scale will be discussed here (Ping 1996, 1999; de Lacy 1999a, 2002b). The tonal scale used here has three distinctions: $|\ L \rangle M \rangle H\ |$.[18] The feature [Tone] represents this scale, with the values in (17).

(17)   <u>Multi-valued tone features</u>
         [*oo*Tone]   High
         [*xo*Tone]   Mid
         [*xx*Tone]   Low

Constraints that refer to the tonal scale also mention DTEs. Schematically, the DTE-tone constraints are as in (18). Recall that the scale reverses in combination with non-DTEs.

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[17] This fact limits the number of constraints that can be active in a grammar in a practical sense. However, this in no way inhibits generation of the constraints. Given a prosodic hierarchy with 9 elements, and two structural elements (Δ, -Δ), there are $162n$ markedness constraints for each prosodic scale with n elements. As pointed out above, effectively only $36n$ constraints are any use in practice for any scale. Of course, this means that CON contains a large number of scale-referring constraints. The sheer number of constraints is of no concern though: what is important is that (a) the constraints are empirically adequate and (b) the constraints have a common well-defined source – i.e. the schemas identified in this chapter (cf McCarthy & Prince's 1993a ALIGN, and McCarthy & Prince's 1995 IDENT, which also describe large numbers of constraints).

[18] It is quite possible that the Tonal Prominence Scale is a total order of all possible heights, which may number as many as six (Odden 1995:453ff). The examples I have collected only offer evidence for three tone height distinctions in relation to stress, so this conservative form of the hierarchy is presented here (de Lacy 1999a, 2002b).

(18)   DTE-Tone constraints
       (a) DTE constraints: $*\Delta_\alpha/xx$Tone, $*\Delta_\alpha/x$Tone
       (b) Non-DTE constraints: $*\text{-}\Delta_\alpha/o$Tone, $*\text{-}\Delta_\alpha/oo$Tone

The constraints in (18) follow the general schema for prosodic markedness constraints, given in (19).

(19)   Prosodic markedness constraints with DTEs – definition
       $*\Delta_{(\alpha,\beta)}/[v\text{F}]$ "Incur a violation for every segment that
                               (1) is a β-DTE of α
                   and   (2) is $[v_2\text{F}]$, where v is a substring of v_2."
                   • v consists solely of x elements.

For example, the constraint $*\Delta_\omega/[x\text{Tone}]$ is violated by every PrWd DTE that has a [Tone] specification that contains an x: i.e. [xxTone], [xTone]. In other words, the constraint is violated by mid- and low-toned primary stressed syllables.

The constraints can be expressed in somewhat more transparent notation using the symbols ≥ and ≤. For example, $*\Delta_\alpha/x$Tone can be expressed as $*\Delta_\alpha \leq$M, meaning "Assign a violation to a DTE that is associated to a mid tone or a tone lower (i.e. more marked) on the scale (i.e. L)". Similarly, $*\text{-}\Delta_\alpha \geq$M means "Assign a violation to a non-DTE that is associated to a mid tone or a tone higher (i.e. less marked) on the scale (i.e. H)". This notation will be used from now on for the sake of brevity.

As P&S observe, the relation of scales to structural combinations is reversed in non-DTE constraints. In their example, voiceless stops are the most marked syllable peaks, but least marked margins (see Dell & Elmedlaoui 1988). In the case above, low tone is the most marked element for DTEs, while it is the least marked for non-DTEs. In the present theory the scale reversal is formally expressed by a difference in the feature value used: for DTEs it is x while for non-DTEs it is o.[19]

(20)   Prosodic markedness constraints with non-DTEs – definition
       $*\text{-}\Delta_{(\alpha,\beta)}/[v\text{F}]$ "Incur a violation for every segment that
                               (1) is a β-non-DTE of α
                   and   (2) is $[v_2\text{F}]$, where v is a substring of v_2."
                   • v consists solely of o elements.

For example, the tonal non-DTE constraints for PrWd non-DTEs are $*\text{-}\Delta_{\text{PrWd}}/[oo\text{Tone}]$ (a ban on high-toned non-DTEs), $*\text{-}\Delta_{\text{PrWd}}/[o\text{Tone}]$ (banning high- and mid-toned PrWd non-DTEs), and $*\text{-}\Delta_{\text{PrWd}}/[\text{Tone}]$ (which bans all tones on PrWd non-DTEs).

It is worth noting that the difference between DTE and non-DTE constraints does not follow from any part of the theory – it must be stipulated that scales reverse.

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[19] It could be that -Δ constraints have the form "Incur a violation if v is *not* a substring of v_2.", eliminating the need to refer to o values. However, this formulation introduces negation – a potentially undesirable operation in constraint form.

- *The sonority constraints*

As a more extended example, the sonority scale presented in chapter 1, and repeated below, distinguishes 12 steps:

Figure 2.5: The Sonority Hierarchy
(a) Consonant sonority

voiceless ⟩ voiced ⟩ voiceless ⟩ voiced ⟩ nasals ⟩ liquids ⟩ glides ⟩ …
stops   stops   fricatives   fricatives

(b) Vowel sonority

          high   mid   high   mid   low
… central ⟩ central ⟩ peripheral ⟩ peripheral ⟩ peripheral
   vowels   vowels   vowels   vowels   vowels

Since the scale distinguishes 12 steps, there is a feature [Sonority] with a feature value string of length 11.[20] Voiceless stops are [*xxxxxxxxxx*Sonority], while [a] is [*oooooooooooo*Sonority]. Since this notation is difficult to read, the ≥ and ≤ notation introduced above will be used from now on. Using this notation, the DTE equivalent of P&S's peak and margin constraints are given below. A capitalized coronal member stands for the entire manner of articulation (e.g. T stands for voiceless stops, from [t]).

(21)   DTE+sonority Constraints
        (a)   *Δ_σ≤T, *Δ_σ≤D, *Δ_σ≤S, *Δ_σ≤Z, *Δ_σ≤N, *Δ_σ≤L,
                 *Δ_σ≤ɨ, *Δ_σ≤ə, *Δ_σ≤{i,u}, *Δ_σ≤{e,o}, *Δ_σ≤a
        (b)   *-Δ_σ≥a, *-Δ_σ≥{e,o}, *-Δ_σ≥{i,u}, *-Δ_σ≥ə, *-Δ_σ≥ɨ
                 *-Δ_σ≥L, *-Δ_σ≥N, *-Δ_σ≥Z, *-Δ_σ≥S, *-Δ_σ≥D, *-Δ_σ≥T

As an example, *Δ_σ≤{ə} assigns violations to root-DTEs of σ nodes (i.e. syllable nuclei) with sonority of less than or equal to mid central vowels.

The DTE of a syllable (Δ_σ) is the element that is the head of the syllable and associated to a σ node by an unbroken chain of heads (see (15)). This concept of Δ_σ correlates with the syllable 'peak', while -Δ_σ relates to the syllable margin. As with the Tone constraints, the sonority scale is reversed in combination with non-DTEs: the best peak is the worst margin, and vice-versa.

Of course, the sonority scale does not only combine with syllable DTEs, but with DTEs of every other level. These constraints will be discussed in the following chapters, when they become relevant.

This introduction to DTEs and non-DTEs concludes with the note that all DTE-referring constraints are freely permutable. There is no fixed ranking between constraints based on the type of DTE element; evidence that constraints that refer to *$\Delta_{(\alpha,\beta)}$ do not universally outrank *-$\Delta_{(\alpha,\beta)}$ constraints or vice-versa is presented in chapter 4. Similarly,

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[20] See Parker (2002) for the same conclusion – that sonority is a single unified multi-valued feature. Chapter 3§3.5.3 discusses proposals in which sonority is constructed from smaller scales.

there is no need to impose a fixed ranking between constraints that differ in their value for α or β: $*\Delta_{(\alpha,\beta)}$ constraints do not universally outrank constraints that refer to $*\Delta_{(\alpha+1,\beta)}$, or vice-versa.

      To repeat a point made in ch.1, the proposal that scales combine with DTEs and non-DTEs in different ways means that the traditional notion of 'markedness' does not apply directly to certain scales. For example, there is no real sense in which the sonority category 'low vowel' is unmarked. Instead, markedness of prosodic scales depends on the structural element with which they combine. So 'low vowel' is the least marked category in terms of DTEs, but the most marked for non-DTEs.

      In contrast, markedness is easily applied to featural scales: since featural scales do not combine with DTEs, the least marked element remains consistent across contexts. So, 'glottal' is always the least marked PoA element.

2.4.2 Featural and prosodic scales

      While DTEs combine with some scales (e.g. Tone, Sonority), they do not combine with others. For example, chapter 3§3.5 shows that the PoA scale cannot combine with structural elements. If it could, a constraint such as $*\acute{\sigma}/[\text{dorsal}]$ would exist in CON, predicting an unattested type of stress system: one where stress is sensitive to Place of Articulation. In contrast, some scales only appear in constraints with DTEs. For example, the sonority scale cannot form a set of context-free constraints of the form $*[v\text{Sonority}]$, where v is some value, since these constraints also produce unattested systems (see chapter 3§3.5.2). Accordingly, a theory of scales must identify the scales that must appear with DTEs and the scales that must not.

      I propose the restriction in (22).

(22)   <u>The Scale-Structure Combination Restriction</u>
      (a) Scales that refer to prosodic properties (e.g. tone, sonority) always combine with prosodic elements in constraints.
      (b) Scales that refer to subsegmental properties (e.g. voice, Place of Articulation) never combine with prosodic elements in constraints.

      A 'Prosodic' scale refers to non-segmental features like tone, sonority, and prosodic structure, while featural scales include those features commonly regarded as dependents of the root node (e.g. [voice], Place, [nasal], and so on). So, there are no constraints of the form $*\Delta \leq [v\text{Place}]$, or $*\text{-}\Delta \geq [v\text{Nasal}]$, and so on. Similarly, all constraints on sonority or tone must mention a (non-)DTE. This proposal is discussed further in chapters 3 and 4.

      As stated above, the 'prosodic' scales include the Tonal scale and Sonority scale. Tone has not been considered a subsegmental feature since Leben (1973) and Goldsmith (1976). Sonority is standardly considered a property of entire segments (or root nodes), unlike subsegmental features like place of articulation. This follows the spirit of McCarthy's (1988) proposals that major class features reside in the root node, and that major class features are essential in defining sonority (Clements 1990, Rice 1992). Thus,

sonority is a property of the root node rather than being a dependent feature, unlike [voice] or [nasal]. These scales are dubbed 'prosodic' here, with the further claim that only these sorts of scales can combine with structural scales while featural scales cannot.

The generalization made above has broad consequences. It prevents positional markedness constraints to subsegmental features: there are no constraints like $*\Delta_{PrWd}\leq$[labial], or $*\Delta_{\mu}/[-voice]$. Chapter 3 shows that such a restriction is necessary in relation to subsegmental features and Δ_{Ft} and Δ_{PrWd}. To summarize the argument, if there were constraints such as $*\Delta_{PrWd}\leq$[labial], stress placement would be potentially sensitive to Place of Articulation – a situation that never happens.

Inside the syllable, a number of researchers have argued that markedness constraints that refer to the relation between constituents and subsegmental features are necessary (e.g. Ito 1986, Zoll 1998).

As a note on Beckman's (1998) Positional Faithfulness theory, it may seem that (22a) precludes positional faithfulness constraints such as onset-IDENT[voice] since this faithfulness constraint refers to a prosodic position and a subsegmental feature. However, this is outside the scope of (22). (22) prevents the general algorithm that generates constraints from (or relates constraints to) scales from producing full sets of (non-)DTE-referring scale constraints. This explains why there are no faithfulness constraints such as $-\Delta_{PrWd}$IDENT$\{i,u\}$, for example (see ch.9). However, the proposal does not prevent an entirely different algorithm from producing DTE-referring constraints. Beckman's Positional Faithfulness theory is just such another algorithm – it combines a small set of prosodic positions with scales in a totally independent way from the scale-combination processes proposed here. Note that the set of prosodic elements that Positional Faithfulness allows to combine with scales is a small subset of those of the DTE theory (i.e. onsets, stressed syllables), and even elements that are not definable using DTEs and non-DTEs (e.g. root-initial syllables). In short, the present theory and Positional Faithfulness can potentially coexist.

Of course, empirical restrictiveness will ultimately determine which theories can coexist with the present proposals. The present work aims to argue that all the constraints proposed here are necessary; in some cases it requires that certain types of constraint must not exist – as for combinations of DTEs with featural scales.

For the purposes of this dissertation (22) is taken to be axiomatic; its reduction to other principles is left for future work.

2.5 Summary

The contents of the preceding sections can be summarized as a series of proposals about scale-referring constraints:

- *Proposal*: The ranking of scale-referring constraints is freely permutable (§2.3). Leads to:

    Local Harmonic Bounding: Both markedness and faithfulness constraints must refer to a range of a scale.

- *Proposal*: Prosodic scales must combine with structural elements in constraints; Featural scales cannot do so (§2.4).
  Related Proposal:
  Scale-referring constraints may only refer to the structural elements 'DTE' and 'non-DTE'.

- Proposal: Scale-reference is consistent across constraint types. (§2.5)
  Leads to:
  Faithfulness to the Marked: If a faithfulness constraint preserves a scale element, then it also preserves every more marked scale element.

The following chapters examine the empirical consequences of the proposals presented above.

- Chapter 3 is devoted to showing that the ranking of scale-referring markedness constraints is freely permutable. This result necessitates that they be in a local harmonic bounding relation.

- Chapter 4 aims to show that reference to both DTEs and non-DTEs is necessary.

- Chapter 5 provides an extended discussion of scale-referring faithfulness constraints.

- Chapters 6 and 7 present evidence for the Marked Reference hypothesis, showing that all scale-referring faithfulness constraints preserve the most marked element.

- Chapter 8 provides evidence that faithfulness constraints must be freely rankable.

- Chapter 9 presents a summary of the proposals and their empirical consequences.

PART II

MARKEDNESS

CHAPTER 3

MARKEDNESS AND CONFLATION

3.1   Introduction

The aim of this chapter is to show that scale-referring markedness constraints must be freely rankable. The proposal that scale-referring markedness constraints are stringently formulated – i.e. that they refer to ranges of scales (ch.2§2.2.1) – follows from free ranking; without free ranking the constraints would be unable to express hierarchical relations, as established in chapter 2.

As Prince (1997 et seq.) shows, evidence that scale-referring markedness constraints are freely rankable comes from category conflation – the elimination of category distinctions for a particular process. To introduce conflation, the complementary notion 'categorization' will be discussed first (from de Lacy 1999a).

'Categorization' refers to the distinctions that languages can potentially make between different categories for some process. For example, the Papua New Guinea language Kobon distinguishes amongst peripheral low, mid, high, and central mid and high vowels in stress placement, with stress falling on the most sonorous vowel available (Davies 1981, Kenstowicz 1996). The Kobon system shows that each of the mentioned types is a different category for stress purposes.

However, not every language makes the full range of possible category distinctions. Some collapse – or 'conflate' – categories, treating them in the same way for stress purposes. Kenstowicz (1996) was the first to recognize the significance of conflation for a theory of scales.

As an example, stress in Gujarati is sensitive to sonority but makes no distinction between high and mid vowels. Like Kobon, stress seeks out low vowels (1b), and avoids stressed schwa (1c), but it does not avoid high vowels for mid vowels or vice-versa (1d), showing that the two categories are effectively treated as one.

(1)   Gujarati stress in brief
          (a) Default stress on penult
                [awːána]   'coming'   [bólo]   'speak (imperf.)'
                [pə́təŋg]   'kite'   [júrop]   'Europe'
                [sáɖa]   'plus ½'   [kʰəmíso]   'shirts'

(b) Avoidance of stressed non-low vowels

[hɛɾán]	'distressed'	[ʃikáɾ]	'a hunt'
[bolátʃ]	'is/are spoken'	[nuksán]	'damage'

(c) Avoidance of stressed schwa

[kójəldi]	'little cuckoo'	[wísməɾən]	'forgetfulness'
[búkəɽo]	'a mouthful'	[pústəkne]	'book'

(d) No avoidance of stressed high vowels

[tʃʰokɾío]	'girls'	[kʰeɖío]	'inkstand'

Categorization and conflation are relevant for phenomena apart from stress. The same issues arise in syllabification and every other sonority-related prosodification process. For example, tonal distinctions can also be conflated for stress purposes (ch.4, de Lacy 1999a), and distinctions between different types of prosodic structure are often collapsed in stress assignment (de Lacy 1997a). In short, not only must scale-referring constraints capture the hierarchical relations implicit in scales, they must also allow for elements of a scale to be treated identically in some grammars.

Conflation is key evidence for the stringent approach (Prince 1997 et seq., de Lacy 1997a, 2000a). In fact, conflation casts a different light on what a scale informally expresses. A scale such as | *x* 〉 *y* | does not imply that "*x* is always more harmonic than *y*". Instead, it expresses the idea that "*y* is never more harmonic than *x*", allowing for the possibility that *x* and *y* can be equally harmonic in some grammar. More concretely, the partial sonority scale | *e,o* 〉 *a* | does not imply that stressed [a] will always be treated as more harmonic than stressed mid vowels, since in some languages (e.g. Nganasan – §3.3) they are treated in the same way. Instead, it implies that stressed mid vowels will never be more harmonic than stressed [a]: stress will never actively avoid [a] in favour of mid vowels.

This chapter explores the significance of conflation and characterizes the general differences between the stringent approach and one with constraints in a fixed ranking (cf Prince & Smolensky 1993 – sonority-driven syllabification, Kenstowicz 1996 – sonority-driven stress, de Lacy 2002b – tone-driven stress).

The aims of this chapter are:

(1) To show the need for freely rankable constraints. This is achieved through an analysis of sonority-driven stress in the Uralic language Nganasan in §3.3. A brief synopsis of why constraints in fixed rankings cannot produce all attested conflations is discussed in §3.3 and expanded in §3.6.

(2) To show that the particular constraints proposed here are needed, as opposed to some other theory with stringent constraints. Section 3.4 is devoted to this point; it contains an analysis of 'environment-specific' conflation in Gujarati stress. This type of conflation excludes systems that are only partially stringent, and certain approaches that generate stringent constraints through constraint operations (e.g. constraint encapsulation – Prince & Smolensky 1993, disjunction – Crowhurst & Hewitt 1997).

(3) To identify the typology of conflations possible with the present theory's constraints. Section 3.5 shows that some conflations are required, others optional, and yet others impossible.

(4) To identify precisely which conflations Fixed Ranking theories cannot produce – discussed in §3.6.

Section 3.7 contains a summary.

To start, §3.2 discusses the sonority scale, the markedness constraints that refer to it, and which of these are relevant for sonority-driven stress.

3.2   The sonority scale and constraints

The vocalic part of the sonority scale is relevant in this chapter, so this section presents proposals about sonority distinctions between vowels and how they relate to the present theory's constraints.

In broad terms, there is a good deal of consensus about the ranking of elements in the sonority hierarchy (see discussion in Parker 2002). In contrast, there is a great deal of disagreement over how many sonority distinctions there are (Sievers 1881, de Saussure 1915, Hooper 1972, Kiparsky 1979, Steriade 1982, Selkirk 1984, Venneman 1988, Clements 1990, Rice 1992, Gnanadesikan 1997, Parker 2002). This dissertation takes the view that the sonority hierarchy encodes a relatively large number of distinctions. The basis for the ones made in Figure 3.1 is processes that are commonly considered to be sensitive to sonority: i.e. syllabification and sonority-driven stress (see Crosswhite 1999 for vowel neutralization).

Among the vowels the categories in Figure 3.1 are distinguished here, analogous to Kenstowicz (1996:9).[21] Scale (Figure 3.1a) gives the category labels, and (Figure 3.1b) lists the members of the categories.

Figure 3.1: Vowel sonority scale

(a) | high central vowels ⟩ mid central vowels ⟩ high peripheral vowels ⟩ mid-high peripheral vowels ⟩ mid-low peripheral vowels ⟩ low peripheral vowels |

(b) | ɨ ʉ ⟩ ə ɵ ɘ ɚ ⟩ i y ɯ u ⟩ e ø ɤ o ⟩ ɛ œ ʌ ɔ ⟩ æ a ɶ ɑ ɒ |

The sonority distinctions among vowels relate to two dimensions: height and peripherality. The primary distinction is peripherality, which separates the central vowels from the others. Within the classes of 'peripheral' and 'central', vowels are distinguished by height: lower vowels are more sonorous than higher vowels. So, [a] is more sonorous than [e] and [o], which are in turn more sonorous than [i] and [u]; similarly, mid [ə] is more sonorous than the high central vowel [ɨ].

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[21]   See Parker (2002) and references cited therein for discussion of possible substantive bases for the sonority scale, or lack thereof (Clements 1990, Dogil & Luschützky 1989, Kawasaki 1982, Ohala 1974, 1990). This issue is not of concern here; the aim of the present theory is to provide an account of the formal expression of scales, not whether and how they are substantively grounded.

Voiceless vowels and the tense-lax distinction are not mentioned above, primarily because the cases in the following chapters contain no evidence for their sonority ranking. I have found no evidence that nasalisation or glottalisation affect the sonority of vowels, nor have I found compelling evidence for sonority distinctions in terms of frontness and backness.[22]

Phonological evidence for the sonority distinctions made above will be presented in the following sections.

3.2.1   The constraints

As discussed in chapter 2, the sonority hierarchy is considered to be a multi-valued feature [Sonority]. With the vowel and consonant hierarchies combined, the sonority scale above distinguishes thirteen categories. Accordingly, the value returned by the [Sonority] feature is a string of length 12. So, the low vowel [a] is [*xxxxxxxxxxxx*Sonority], while [p] is [*ooooooooooooo*Sonority] and [ŋ] is [*xxxxxooooooo*] Sonority.

For expository convenience, the fully articulated form of the [Sonority] feature will not be used here. Instead, a more transparent terminology will be employed: [≥X] means "equally or more sonorous than a category of type X", where X is one of the sonority categories. For example, [≥Nasal] refers to all segments that are either nasal or more sonorous than nasals. Conversely, [≤Nasal] refers to all segments that are either nasal or *less* sonorous than nasals.

The conditions on scale-referring constraints laid out in chapter 2 and the sonority distinctions made above allow several sets of sonority-based constraints to be identified. All DTE-referring constraints have the form $*\Delta_\alpha \leq [X]$ "Incur a violation for every DTE of α which is less or equally as sonorous as X". All non-DTE constraints have the form $*-\Delta_\alpha \geq [X]$ "Incur a violation for every non-DTE of α which is more or equally as sonorous as X".

There are series of constraints for every possible value of α. For example, there is a series of sonority-referring constraints for DTEs of syllables: e.g. $*\Delta_\sigma \leq \mathrm{\partial}$ is violated when any segment that is equally or less sonorous than schwa appears inside a syllable DTE (i.e. is the head of a syllable). Similarly, $*\Delta_{PrWd} \leq \{e,o\}$ is violated when the head of the main-stressed syllable is a mid vowel or is some less sonorous segment. The result is a series of such stringent constraints.

In the following sections, the primary focus will be on the set of constraints that relate to DTEs and non-DTEs of Prosodic Words (PrWd) and Feet (Ft) since these constraints relate directly to prominence-driven stress and stress-conditioned neutralization. As a reminder, the DTE of a PrWd (Δ_{PrWd}) is the nucleus of the syllable with primary (i.e. word-level) stress. In contrast, the DTE of a foot (Δ_{Ft}) is the nucleus of the stressed syllable within a foot – i.e. both secondary and primary stressed nuclei.

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[22] Some researchers consider front vowels less sonorous than back vowels (Jones 1918, Pike 1943, Hooper 1976, Foley 1977, Howe & Pulleyblank 2001). Reasons for this sonority distinction often appeal to epenthesis facts; chapters 4 and 5 argue that there is no need for such a distinction to be encoded in sonority terms. Sonority-driven stress offers evidence that there is no front back distinction: if there were such a distinction, we could expect a language where stress avoided front vowels for back vowels of the same height. To my knowledge, no such language exists.

The analysis of Gujarati does not require reference to any other types of DTE constraints. Evidence for the necessity of reference to non-DTEs is provided in chapter 4.

3.3 End-conflation: Nganasan

The aim of this section is to illustrate the ability of the present theory's constraints to conflate categories. This is done through an analysis of the stress system of the Uralic language Nganasan ([ŋanásan]). This language is particularly interesting because it has conflation at both ends of the sonority scale – the more sonorous categories 'low vowel' and 'mid vowel' are conflated for stress purposes, as are high vowels with central vowels.

Section 3.3.1 presents relevant data, followed by an analysis in §3.3.2. Section 3.3.3 discusses what it means for two categories to be conflated in Optimality Theoretic terms. Section 3.3.4 considers representational approaches to sonority-driven stress. Since the aim of this section is to show the need for freely rankable constraints, constraints in a fixed ranking are discussed at appropriate junctures; a full discussion of fixed ranking theories can be found in §3.6.

3.3.1 Nganasan[23]

This section presents an analysis of the Avam dialect of the Uralic language Nganasan, also known as Tawgi or Tawgi-Samoyed. The description of stress presented here is from Helimski (1998, p.c.) and fieldwork by Olga Vaysman (p.c.), with data supplemented by Castrén (1854), Haydú (1964), and Tere⬤⬤enko (1979).

Nganasan has the vowels listed in Table 3.1.[24]

Table 3.1: Nganasan vowels

i	y	ɨ		u
e		ə		o
		a		

Syllables have the shape CV(V)(C). Rimes may contain a diphthong or a long vowel.

Helimski (1998:486) describes stress as falling on a final CV: syllable, else the penult, as shown in (2). Each root and its affixes form a separate stress domain; compounds form two domains, one for each root.

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[23] I am indebted to Eugene Helimski and Olga Vaysman for discussing Nganasan's stress system with me and providing additional facts and data from their fieldwork. The most recent work on Nganasan phonology is found in Helimski (1998) and Vaysman (2002, in prep.).

[24] There are some restrictions on vowels. For example, the front vowels do not appear in the first syllable after dentals. The mid vowel [o] only appears in non-initial syllables when flanked by labial sounds [b m], and non-initial [e] only occurs after palatals. Neither of these restrictions is significant for stress, so they will not be discussed further here. Helimski (1998) and Vaysman (2002, p.c.) differ as to whether Nganasan has palatalized coronals [tʲ dʲ sʲ nʲ lʲ] (Helimski) or true palatals [c ɟ ʃ ɲ ʎ] (Vaysman); the latter approach is adopted here.

(2)   Nganasan Default Penult Stress
        [kʲymáː]   'knife'
        [kóruʔ]   'house'
        [kə́ndəʔ]   'sledge'
        [kuhúmi]   'our (dual) skin'
        [báːrbə]   'master, chief'
        [bə.lóu.kə]   'a kind of moveable dwelling on runners'

However, stress can optionally fall on the antepenult if it contains a non-high vowel and the penult contains a high or central vowel in a mono-vocalic syllable.

(3)   Nganasan Antepenult Stress

        (a) Antepenult [e o], Penult [i y u ə ɨ]
                [ɟémbiʔʃi]   'dressing'   [cétəmtɨ]   'four'
                [ŋónɟiʔə]   'going out'   [hóðyʔə]   'writing'
                [kóntuɟa]   'carries'   [hótəɟa]   'writes'

        (b) Retraction to [a], Penult [i y u ə ɨ]
                [nánunə]   {1p.sg.locative}   [tánduɟə]   'wider (attrib)'
                [báruʃi]   'devil'   [kánəmtu]   'which (in order)'
                [ŋaɟágəjcy]   '2 younger sisters'   [ɟákəgəj]   'two twins'
                [hʲásɨrə]   'fishing rod'

Importantly, central and high peripheral vowels are not 'unstressable': e.g. [kə́ndəʔ] 'sledge', [ɲintɨ́ðɨ] 'aux.neg.3dual', [kuhúmi] 'our (dual) skin'.
The Nganasan pattern shows that there is a distinction between [a e o] on the one hand and [i y u ə ɨ] on the other. Importantly, there are no distinctions within these sets. Stress does not retract from a penult [e o] onto a low vowel: e.g. [ʃajbómtɨ] '7ᵗʰ', *[ʃájbomtɨ]. Similarly, stress does not retract from a central vowel onto a high vowel, as in (4).

(4)   No retraction from central to high vowels
        [ŋiʎə́nɨ] 'below'   [ŋuʔə́ðuʔ] 'once'
        [ŋɨtə́nə] 'I still'   [kuhuðə́mə] 'skin for me'
        [hytə́ðə] 'trunk'   [kubutə́ndi] 'skin {3dual lative}'
        [hursə́ɟi] 'returning'   [kubutə́tə] 'skin {2sg lative}'
        [ɲintɨ́ðɨ] 'aux.neg.3dual' cf [ɲíntɨ]   [kuhugə́jcə] 'skin {2sg nom.}'

Stress does not retract from a high vowel to a central vowel either: e.g. [nənsúʔə] 'stands up', *[nə́nsuʔə], [nəðúʔə] 'scours', [təɲíni] 'there {locative}'.

In other words, Nganasan has two conflations: it conflates mid with low vowels for stress purposes, and high with central vowels.[25]

3.3.2 Analysis

This section provides an analysis of sonority-driven stress, set within Optimality Theory. For other analyses of sonority-driven stress – though (obviously) not using the constraints proposed here – see Cohn & McCarthy (1994), Kenstowicz (1996), de Lacy (1997a), Gordon (1999), Broselow (1999), Zec (2000), and Crowhurst & Michael (2002).

While stress retraction to the antepenultimate syllable – and sensitivity to sonority – is optional, Eugene Helimski (p.c.) reports that it is the prevalent pattern. Accordingly, the grammar in which stress shift takes place is the focus of this section.

Words with vowels of the same sonority show that the default position for stress is the penult: e.g. [kuhúmi] 'skin, hide'. To deal with default stress placement, the constraints in (5) will be used.

(5)   ALIGNFTR   "The right edge of every foot must be aligned with the right edge of a PrWd." (McCarthy & Prince 1993a)

   FTBIN   "Every foot is binary at the syllabic or moraic level." (McCarthy & Prince 1986)

   TROCHEE   "Every foot is left-headed" [i.e. ALIGN-L(ɕ,Ft)] (McCarthy & Prince 1993a)

The constraint FTBIN deserves some brief discussion. Feet are assumed to be maximally disyllabic – trisyllabic and unbounded feet do not exist (Hayes 1995).[26] So, the role of FTBIN is to ban monomoraic – i.e. 'degenerate' – feet. As shown in tableau (6), FTBIN, ALIGNFTR, and TROCHEE produce penult stress.

(6)   Nganasan default stress

/kuhumi/	FTBIN	ALIGNFTR	TROCHEE
☞ (a) ku(húmi)			
(b) ku(humí)			*!
(c) (kúhu)mi		*!	
(d) kuhu(mí)	*!		

---

[25] The Uralic language Moksha Mordvin has been reported as having the same conflation of vowel qualities as Nganasan (Paasonen 1938:114-119, Kenstowicz 1996). However, Kenstowicz notes that crucial data is missing from published sources (i.e. words that show conflation of high vowels and schwa – [CəC{i,u}]). Jack Reuter and Aleksandr Feokstitov (p.c.) report that words with such a shape do not exist in the standard dialect, but appear in south-east dialects. There is some evidence that high vowels are not conflated with schwa: stress moves off the default initial position if there is a high vowel in the second syllable in Feokstitov's dialect: [pətí] 'put {3sg}'. Thus, at least one dialect of Moksha has the scale | ə ⟩ i,u ⟩ e,o,a |, without conflation of the schwa and high vowels.

[26] In OT the statement that an output structure "does not exist" means one of two things: (i) GEN never creates it, or (ii) it is harmonically bounded by some other structure (i.e. binary feet). For a discussion about which one is more appropriate for foot size, see Hyde (2001).

The dotted line indicates that the ranking of the constraints cannot be determined at this point. In order for a ranking argument to be established, constraint conflict must occur: the winner and a competitor must incur violations of distinct constraints. In the situation above, the winner does not incur any violations of the relevant constraints, so – just as with local harmonic bounding – ranking between them is indeterminate. This situation will change once the interaction of the sonority-stress constraints is considered.

3.3.2.1 Avoidance of stressed high and central vowels

Stress does not fall on a monomoraic penult when two conditions are met: (i) the penult contains a high or central vowel and (ii) the antepenult contains a non-high non-central vowel. The avoidance of high and central vowels in stressed syllables is expressed by the constraint $*\Delta_{PrWd}\leq\{i,u\}$. This constraint is violated when a PrWd DTE – i.e. a main-stressed syllable nucleus – contains a high vowel or anything less sonorous (i.e. [ə ɨ]). As a reminder, the notation "$\leq\{i,u\}$" refers to all segments with the same sonority or less than peripheral high vowels; this includes the Nganasan vowels [i y u ə ɨ].

The avoidance of stressed high and central vowels forces the foot to retract from the right edge of the PrWd: i.e. [(hótə)ɟa] 'writes', [(kóntu)ɟa] 'carries'. Such a footing violates ALIGNFTR, indicating that $*\Delta_{PrWd}\leq\{i,u\}$ must outrank this constraint.

(7)

	/kontuɟa/	$*\Delta_{PrWd}\leq\{i,u\}$	ALIGNFTR
	(a) kon(túɟa)	*!	
☞	(b) (kóntu)ɟa		*

The constraint $*\Delta_{PrWd}\leq\{i,u\}$ is violated by candidate (7a) because it contains a primary-stressed high vowel. In contrast, (7b) avoids violating this constraint by stressing a mid peripheral vowel. It is important to emphasize that "{i,u}" is an abbreviation for "peripheral high vowels", including [i y ɯ u]. This ranking therefore accounts for antepenult stress in words like [(náky)ryʔ] as well.

The ranking in (7) accounts for the fact that stress avoids [ə] for mid and low vowels, as shown in tableau (8).

(8)

	/hotəɟa/	$*\Delta_{PrWd}\leq\{i,u\}$	ALIGNFTR
☞	(a) (hótə)ɟa		*
	(b) ho(tə́ɟa)	*!	

Analogous to the situation in tableau (7), candidate (b) violates $*\Delta_{PrWd}\leq\{i,u\}$ because it contains a stressed schwa.

The ranking arguments supplied above indicate a general schema for sonority-driven stress. As shown in tableau (8), the ranking of the DTE-sonority constraint

$*\Delta_{PrWd}\leq\{i,u\}$ over the foot-parsing constraints is a necessary component of sonority-driven stress. Without such a ranking, no sonority influence on stress would be visible.

In general terms, then, sonority-driven stress arises when some (non-)DTE-sonority constraint outranks some active stress-placement constraint. Of course, the extent of the constraints' influence depends on the details of the ranking. In Nganasan, the constraint $*\Delta_{PrWd}\leq\{i,u\}$ is so highly ranked that its influence is transparently obvious. However, other sonority-stress constraints have less influence.

At the other extreme is a language that has no sonority-sensitivity at all. The ranking necessary for sonority-driven stress is discussed further in §3.5.1 (see de Lacy 2002b for analogous rankings for tone-driven stress).

3.3.2.2 Low-end and high-end conflation

The ranking presented above accounts for the fact that stress avoids a penult or central high only when the antepenult contains a mid or low vowel. If the antepenult contained a high or central vowel, there would be no reason to stress it since doing so would not improve on violations of $*\Delta_{PrWd}\leq\{i,u\}$.

(9)

	/ɨɣusa/	$*\Delta_{PrWd}\leq\{i,u\}$	ALIGNFTR
	(a) (ɨ́ɣu)sa	*	*!
☞	(b) ɨɣ(gúsa)	*	

The tableau above shows that ALIGNFTR can be decisive in choosing the winner when more than one candidate incurs equal violations of the sonority-stress constraints. Since $*\Delta_{PrWd}\leq\{i,u\}$ assigns the same violations to candidates (a) and (b), the vowels [ɨ́] and [ú] are conflated for stress purposes – they are treated in exactly the same way.

High and central vowels are similarly conflated in Nganasan. In words with an initial high or central vowel in the penult, for example, stress falls on the penult as usual: e.g. [hursə́ɟi] 'returns'. The present ranking accounts for this pattern, as illustrated in tableau (10).

(10)

	/hursəɟi/	$*\Delta_{PrWd}\leq\{i,u\}$	ALIGNFTR
	(a) (húrsə)ɟi	*	*!
☞	(b) hur(sə́ɟi)	*	

Crucially, both candidates (a) and (b) incur the same violations of $*\Delta_{PrWd}\leq\{i,u\}$. Since $*\Delta_{PrWd}\leq\{i,u\}$ is not decisive, the violations of ALIGNFTR become relevant, favouring the penult-stressed (b).

By assigning the same violations to stressed central and high vowels, $*\Delta_{PrWd}\leq\{i,u\}$ effectively conflates the two categories. Since neither is preferred over the other, the footing constraints take over, preferring the default stress position.

So, for stressed high and central vowels to be treated the same, it is crucial that no constraint that favours one over the other outranks ALIGNFTR. More concretely, the constraint $*\Delta_{PrWd}{\leq}\vartheta$ must be ranked below the footing constraints. Since $*\Delta_{PrWd}{\leq}\vartheta$ favours stressed high vowels over stressed schwa, any other ranking would make an unwanted distinction between the two categories. This point is made in tableau (11).

(11)

/hursəɟi/	ALIGNFTR	$*\Delta_{PrWd}{\leq}\vartheta$
(a) (húrsə)ɟi	*!	
☞ (b) hur(sə́ɟi)		*

As the tableau shows, the constraint $*\Delta_{PrWd}{\leq}\vartheta$ is crucially 'inactive' – it does not assign a violation that is relevant in determining the winner for stress purposes. At this point, it is possible to make a general statement about conflation: if two categories are conflated, there is no 'active' constraint that favours one over the other.

- *'Active'*

   The term 'active' is used in a very limited sense here. A more general sense of the term 'active' is found in Prince & Smolensky (1993), in which a constraint is active if it bifurcates the candidate set into winners and a non-empty set of losers for some competition. For example, ALIGNFTR is active in Nganasan because it relegates candidate (b) in (11) to loser status in the competition between candidate forms from the input /hursəɟi/.

   The term 'active' is used in a much more local sense here, applying solely to competitions relating to stress placement. For example, $*\Delta_{PrWd}{\leq}\vartheta$ is inactive for stress purposes: it never distinguishes winners from losers that differ just in terms of stress position. As tableau (11) shows, by the time candidate evaluation reaches $*\Delta_{PrWd}{\leq}\vartheta$, the position of stress has been determined (i.e. all remaining forms have stress in the same position). Thus, $*\Delta_{PrWd}{\leq}\vartheta$ is inactive in a very local sense, relating to stress position. However, it is possible that $*\Delta_{PrWd}{\leq}\vartheta$ is active in the general sense: $*\Delta_{PrWd}{\leq}\vartheta$ may make a crucial bifurcation in determining the quality of epenthetic vowels, for example (i.e. a TETU effect – McCarthy & Prince 1994).

   In contrast, $*\Delta_{PrWd}{\leq}\{i,u\}$ is active for stress placement. As shown in tableau (8), this constraint makes a crucial determination between candidates that differ in stress position. The term 'active' will be used in the local sense from now on; its scope of reference in this chapter will be to stress position: so, constraint C is active in relation to stress if it eliminates candidates (i.e. assigns them 'loser' status) that differ from winning forms in terms of stress position.

- *Summary*

   As an interim summary, the ranking needed to deal with conflation of the low-sonority categories in Nganasan is $\|\ *\Delta_{PrWd}{\leq}\{i,u\}\ »\ $ALIGNFTR$\ »\ *\Delta_{PrWd}{\leq}\vartheta\ \|$. This sort of ranking involves a general constraint outranking a more specific one, dubbed 'anti-

Paninian' in Prince (1997 et seq.). A constraint C_1 is more general than C_2 if C_1 incurs a superset of C_2's violations.

This is not the only ranking needed, though. Although stress avoids the less sonorous high and central vowels for the more sonorous mid and low vowels, it makes no distinction between mid and low vowels. Specifically, stress does not avoid a mid-vowel penult for a low vowel: e.g. [ʃajbómtɨ] 'seventh', *[ʃájbomtɨ]; of course, stress does not avoid a low vowel penult for a mid vowel: e.g. [konáʔa] 'going'. This type of conflation is 'high-end conflation' – conflation of categories at the unmarked end of the scale.

As discussed above, two categories are distinct when no active constraint assigns them different violations. Since the constraint *$\Delta_{PrWd}\leq$\{e,o\} favours [á] over [é] and [ó], it must be inactive. In the present case, this means that it is ranked below ALIGNFtR.

(12)

	/ʃajbomtɨ/	ALIGNFTR	*$\Delta_{PrWd}\leq$\{e,o\}
☞	(a) ʃaj(bómtɨ)		*
	(b) (ʃájbom)tɨ	*!	

This is 'high-end conflation' – conflation of categories at the unmarked end of the scale. As shown in tableau (12), high-end conflation has the same character in ranking terms as conflation of the low-end categories. So, *$\Delta_{PrWd}\leq$\{e,o\} occupies the same position as *$\Delta_{PrWd}\leq$ə in the ranking established so far: || *$\Delta_{PrWd}\leq$\{i,u\} » ALIGNFTR » *$\Delta_{PrWd}\leq$ə, *$\Delta_{PrWd}\leq$\{e,o\} ||.

Before moving on to consider why the present theory can successfully conflate categories, some other interactions of footing constraints with the sonority-stress constraints will be identified.

3.3.2.3 The interaction of sonority and prosodic conditions

There are two situations in which sonority conditions fail to force stress retraction. One relates to long vowels in penultimate and final position, and the other relates to pre-antepenult position.

- *Long Vowels*

Sonority does not take precedence over stress on a long vowel. For example, stress does not fall on the antepenult in [ŋonáːðə] 'once again', even though doing so would result in a more sonorous stressed vowel (e.g. *[ŋónəːðə]). In [kýːʔæʔ] 'they died', stress does not fall on the ultima, though doing so would also improve sonority-stress markedness (e.g.*[kyːʔǽʔ]).

This follows from foot form considerations. If stress appeared on the ultima in *kyːʔæʔ* the foot would either be degenerate *[kyː(ʔǽʔ)] or trimoraic *[(kyːʔǽʔ)]; both candidates violate FTBIN.[27]

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[27] The constraint NONFINALITY could also be used to block final stress (Prince & Smolensky 1993). Since FTBIN is independently necessary and appears in subsequent analyses, it will be used here.

The same reason accounts for the lack of retraction to the antepenult in *ŋónəːðə*. If stress fell on the antepenult, the result would be a degenerate or trimoraic foot: *[(ŋó)nəːðə], *[(ŋónəː)ðə].

Thus, FTBIN outranks *Δ_PrWd≤{i,u}, as shown in tableau (13).

(13)

/ŋonəːðə/	FTBIN	*Δ_PrWd≤{i,u}
(a) (ŋó)nəːðə	*!	
(b) (ŋónəː)ðə	*!	
☞ (c) ŋo(nə́ː)ðə		*

This still leaves such words with the form [CaːCə́ː] to be accounted for, since stress on the [aː] would form an acceptable foot (i.e. *[(Cáː)Cəː]). The lack of such forms will fall out from consideration of the lack of pre-antepenult stress.

As a typological note, one may wonder if stress ever avoids long vowels for shorter vowels purely for sonority reasons. It can: sonority takes precedence over length in Kara, where stress seeks out a low vowel [a] even if the default position has a long vowel (Schlie & Schlie 1993). For a description and analysis, see de Lacy (1997a).

- *Limits on stress retraction*

While main stress appears on the antepenult under the right sonority conditions in Nganasan, it never appears on other positions. For example, the ultima never bears main stress, even when it contains a more sonorous vowel: e.g. [ɟygúsa] 'get lost', *[ɟugusá]. Similarly, main stress never retracts to the pre-antepenult: e.g. [nagətə́nə] 'stands up {elative}', *[nágətənə]. Eugene Helimski (p.c.) reports a more complex effect: stress retraction to the antepenult is the norm in three syllable words (e.g. [nákyryʔ] 'three'), but is less common in four-syllable words: e.g. [ŋamʲacýmə]~[ŋamʲácymə] 'nine'. The limits on stress placement will be argued to follow from the interaction of footing constraints and the sonority-stress constraints.

As with heavy syllables, the constraints FTBIN and TROCHEE provide the reason why stress cannot appear on the final syllable. For stress to fall on a final light syllable, either the foot would have to be iambic – e.g. *[ɟu(gusá)] – or degenerate – e.g. *[ɟugu(sá)]. With both FTBIN and TROCHEE outranking *Δ_PrWd≤{i,u}, final stress will be blocked even when it contains a more sonorous vowel.

(14)

/ɟugusa/	TROCHEE	FTBIN	*Δ_PrWd≤{i,u}
☞ (a) ɟu(gúsa)			*
(b) ɟugu(sá)		*!	
(c) ɟu(gusá)	*!		

A similar fact accounts for the lack of retraction to pre-antepenult position. Again, footing constraints override the avoidance of high and central stressed vowels. Two constraints are relevant in preventing pre-antepenult stress.

(15)　PARSE-σ　　　 "Every syllable is associated to a foot" (Prince & Smolensky 1993)
　　　 HDFTR　　　　 "The rightmost foot is the head." (Tesar 1996)

The constraint PARSE-σ requires exhaustive footing. It outranks ALIGNFTR in Nganasan, as evinced by the presence of secondary stress in longer words: [kìntələ̀btɨkútiŋ] 'you are smoking'.

(16)

	/kintələbtɨkutiŋ/	PARSE-σ	ALIGNFTR
☞	(a) (kìntə)(lə̀btɨ)(kútiŋ)		* *
	(b) kintələbtɨ(kútiŋ)	* * * *!	

The constraint HDFTR requires the rightmost foot to be the head. Together, PARSE-σ and HDFTR ensure that main stress does not retract to the pre-antepenult. This is illustrated with the word /nagətənə/ in tableau (17).

(17)

	/nagətənə/	HDFTR	PARSE-σ	*Δ_{PrWd}≤{i,u}	ALIGNFTR
☞	(a) (nàgə)(tə́nə)			*	* *
	(b) (nágə)tənə		* *!		* *
	(c) (nágə)(tə̀nə)	*!			* *

The ranking shows the difficulties that arise with pre-antepenult stress. If main stress falls on the pre-antepenult as in (b) and (c), either PARSE-σ or HDFTR are violated. In (b), PARSE-σ is violated because there are unfooted syllables; in (c), HDFTR is violated because the head foot is not the rightmost one. With these constraints outranking *Δ_{PrWd}≤{i,u}, it is more harmonic to stress a low sonority vowel, as in (a).

The ranking given above has one interesting effect: it accounts for Helimski's observation that stress retraction does not take place in four-syllable words (e.g. [ŋamʲacýmə], *[ŋamʲácymə]). If stress did appear on the antepenult, the output form would have two unfooted syllables: *[ŋa(mʲácy)mə]. In comparison, the penult-stressed form has no unfooted syllables: [(ŋàmʲa)(cýmə)]. This result is illustrated in tableau (18).

(18)

	/ŋamʲacymə/	PARSE-σ	*Δ_{PrWd}≤{i,u}
☞	(a) (ŋàmʲa)(cýmə)		*
	(b) ŋa(mʲácy)mə	* *!	

Importantly, the ranking does not affect trisyllabic words. In trisyllabic forms, either antepenult or penult stress will incur the same violations of PARSE-σ, allowing the influence of $*\Delta_{PrWd}\leq\{i,u\}$ to emerge. This situation is illustrated in tableau (19).

(19)

	/nakyryʔ/	PARSE-σ	$*\Delta_{PrWd}\leq\{i,u\}$
☞	(a) (náky)ryʔ	*	
	(b) na(kýryʔ)	*	*!

In short, the limitations on stress retraction in Nganasan follow from the interaction of footing and the sonority-stress constraints. The resulting ranking is summarized in Figure 3.2.

Figure 3.2: Nganasan sonority-driven stress ranking summary

FTBIN
|
PARSE-σ HDFTR
|
$*\Delta_{PrWd}\leq\{i,u\}$
|
ALIGNFTR
|
$*\Delta_{PrWd}\leq\partial$ $*\Delta_{PrWd}\leq\{e,o\}$
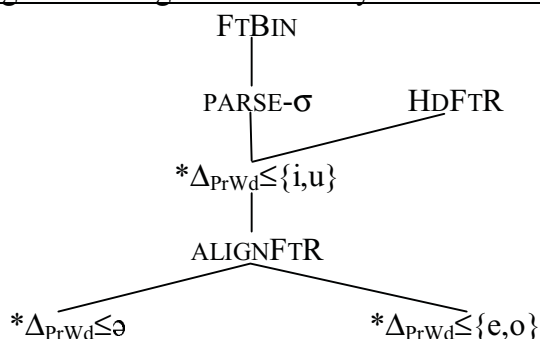
With the ranking details aside, the properties of the present theory that allow it to produce conflation in Nganasan will be discussed.

Before moving on to consider the details of conflation, a brief discussion of the ranking needed for non-retraction will be given. The ranking in Figure 3.2 deals with the system in which stress retracts to the antepenult. However, retraction is optional in Nganasan: stress may remain on the default penult position. This sonority-insensitive pattern comes about by having ALIGNFTR dominate $*\Delta_{PrWd}\leq\{i,u\}$ as well as $*\Delta_{PrWd}\leq\{e,o\}$ and $*\Delta_{PrWd}\leq\{\partial\}$. For approaches to optionality involving 'tied' constraints, ALIGNFTR and $*\Delta_{PrWd}\leq\{i,u\}$ would be unranked with respect to each other (Anttila 1997, and references cited in McCarthy (2001b:233).

3.3.3   The essentials of conflation

This section is devoted to showing that unfettered ranking permutation is essential in allowing conflation, building on Prince (1997 et seq.). To do this, an argument that constraints in a fixed ranking cannot produce conflation is presented, regardless of whether the constraints are stringently or non-stringently formulated.

Categorization and conflation are antagonistic requirements on a theory of scale-referring constraints. The former requires the theory to make distinctions between

categories, while the latter requires them to be conflated. The discussion above showed that two categories are conflated when they are assigned the same violations by active constraints (see §3.3.2.2 for discussion of 'active'). For example, stressed central and high vowels are conflated in Nganasan because the only relevant active constraint is *$\Delta_{PrWd}\leq\{i,u\}$ and it assigns the same violations to both types. The relevant tableau is repeated in (20).

(20)

	/hursəɟi/	*$\Delta_{PrWd}\leq\{i,u\}$	ALIGNFTR
	(a) (húrsə)ɟi	*	*!
☞	(b) hur(sə́ɟi)	*	

The observation that conflation comes about when two categories incur the same violations of active constraints necessitates that a theory of scales have constraints that refer to ranges of elements on a scale. To prove this point, consider a theory with constraints that refer to points on a scale (Prince & Smolensky 1993, Kenstowicz 1996).

(21) || *Δ_{PrWd}/ə » *Δ_{PrWd}/{i,u} » *Δ_{PrWd}/{e,o} » *Δ_{PrWd}/a ||

No constraint assigns the same violations to both [ə́] and [í ú]. Therefore, the two categories cannot be conflated with just these constraints. This point is illustrated in the following tableau. Since [í ú] is favoured over [ə́], the ranking incorrectly predicts that stress should always avoid [ə] for high vowels.

(22)

	/hursəɟi/	*Δ_{PrWd}/ə	*Δ_{PrWd}/{i,u}	ALIGNFTR
●※	(a) (húrsə)ɟI		*	*
	(b) hur(sə́ɟi)	*!		

There is no ranking of the Fixed Ranking constraints that can produce the result attested in Nganasan and is consistent with the ranking in (21). The only other option is to rank both *Δ_{PrWd}/ə and *Δ_{PrWd}/{i,u} below ALIGNFTR. However, such a ranking eliminates all sensitivity to sonority; stress is incorrectly predicted to always fall on the penult:[28]

(23)

	/kanəmtu/	ALIGNFTR	*Δ_{PrWd}/ə	*Δ_{PrWd}/{i,u}
	(a) (kánəm)tu	*!		
●※	(b) ka(nə́mtu)		*	

There is no way to fix the problem identified above by introducing other constraints. It is crucial in Nganasan that some active constraint (or constraints) favour [é

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[28] Fixed Ranking theories can effect some conflation. For detailed discussion, see §3.5.

ó á] over [ə́ í ú] while no active constraint favours [í ú] over [ə́]. While the Fixed Ranking theory has constraints that do the former, those same constraints do not satisfy the latter condition.

It is not enough that a theory have constraints that refer to ranges of a scale. In order for conflation to take place, the ranking of the constraints must be freely permutable. Nganasan illustrates this point well. In Nganasan *$\Delta_{PrWd} \leq \{i,u\}$ outranks both *$\Delta_{PrWd} \leq \{e,o\}$ and *$\Delta_{PrWd} \leq ə$. This ranking allows central and high vowels to be conflated, and mid and low vowels to be conflated (see tableaux (11) and (12)). If either *$\Delta_{PrWd} \leq \{e,o\}$ or *$\Delta_{PrWd} \leq ə$ had to always outrank *$\Delta_{PrWd} \leq \{i,u\}$, the Nganasan conflations would be impossible.

In fact, §3.4 shows that Gujarati employs the exact opposite to the Nganasan ranking: both *$\Delta_{PrWd} \leq \{ə\}$ and *$\Delta_{PrWd} \leq \{e,o\}$ outrank *$\Delta_{PrWd} \leq \{i,u\}$. This ranking allows conflation of high and mid peripheral vowels (since *$\Delta_{PrWd} \leq \{i,u\}$ is inactive). The activity of *$\Delta_{PrWd} \leq \{ə\}$ ensures that central vowels are treated distinctly from peripheral vowels, and *$\Delta_{PrWd} \leq \{e,o\}$ prevents conflation of [a] with other vowels. For a full analysis, see §3.4.

To put the observation above in slightly different terms, the problem with constraints in a fixed ranking is that they impose implicational relations between conflations. For example, if the ranking ‖ *$\Delta_{PrWd} \leq ə$ » *$\Delta_{PrWd} \leq \{i,u\}$ ‖ were universal, no language could both avoid stressed high vowels and conflate them with [ə́]. If schwa is conflated with high vowels, then no constraint that favours the latter over the former can be active. Therefore *$\Delta_{PrWd} \leq ə$ must be inactive. However, if *$\Delta_{PrWd} \leq ə$ is inactive, then every lower-ranked constraint is also inactive, including *$\Delta_{PrWd} \leq \{i,u\}$. The effect is that stress is not sonority sensitive. In other words, this theory predicts that if category *x* is actively penalized by some constraint, *x* is not conflated with any other category.

The opposite fixed ranking ‖ *$\Delta_{PrWd} \leq \{i,u\}$ » *$\Delta_{PrWd} \leq ə$ ‖ incorrectly predicts that if [ə́] is avoided and not conflated with [í ú], then [í ú] will also be avoided. If [ə́] is not conflated with [í ú], then some constraint that distinguishes the two categories must be active – i.e. *$\Delta_{PrWd} \leq ə$. If *$\Delta_{PrWd} \leq ə$ is active, though, then every higher ranked constraint is also active. So, *$\Delta_{PrWd} \leq \{i,u\}$ must be active, so predicting a distinction between stressed high vowels and other types. In short, such a fixed ranking rules out languages in which stress avoids schwa but is conflated for the other categories.

Section 3.6 provides a more detailed characterization of the limitations on conflation in the Fixed Ranking theory.

3.3.4 Representational theories

Up to this point, Nganasan stress has been assumed to be sensitive to sonority rather than some other property. The alternative is a 'representational' theory in which stress cannot refer to sonority, but only to structural distinctions. In one version of such a theory, stress's avoidance of [ə i y u ɨ] for [e o æ a] in Nganasan would reduce to the claim that the vowels in the former set have fewer moras than the latter. Stress preference for syllables with greater moraic content would produce the observed stress system.

There are problems with the implementation of the representational approach, not just in Nganasan but in most other cases of sonority-driven stress. One relates to

proliferation of structure. Nganasan has both long and short vowels: e.g. [ti] 'we (dual)' cf [hiː] 'night'. Therefore, if the difference between high vowels and schwa on the one hand and non-high vowels on the other were moraic, one would be forced to posit a ternary moraic distinction in Nganasan. Not only does such a proposal have unattested effects on phonetic realization, but it opens the door for many more moraic contrasts than are attested. In effect, such an approach reduces moras to serving as little more than a diacritic device that is effectively synonymous with sonority.

Representational theories also make strong predictions about other processes in the grammar. Proposing that [ə] and high vowels have fewer moras than other vowels predicts that they can – and perhaps must – be treated differently for other mora-referring processes. For example, there is a minimal word restriction in Nganasan – every content word is minimally CVC or CV(C)V: e.g. [tuː] 'fire', [bɨʔ] 'water', [nəsa] 'scours'. For word minima all moras count as the same: [nəsa] is not monomoraic. This point is discussed at length by Gordon (1999).

- *'Schwa is special' theories*
  Another popular representational theory relates specifically to the opposition between schwa and peripheral vowels. Oostendorp (1995) and many others have claimed that schwa is phonologically distinct from all other vowels in that it lacks features. With additional theoretical devices, this fact makes schwas 'weak', and consequently unable to bear to stress. This theory is one of a class that considers schwa to be fundamentally different from all other vowels, in a phonological sense.

  The present work denies that schwa is significantly different from other vowels in phonological terms – the only difference is that schwa is lower on the sonority scale than (most) other vowels. The fact that Nganasan treats high vowels and schwa in the same way supports this proposal: Nganasan clearly does not make a division between schwa and peripheral high vowels.

  Problems for the 'featureless schwa' approach also arise when considering the high central vowel [ɨ]. In Nganasan (and Pichis Asheninca too – Payne 1990), [ɨ] acts like schwa – it repels stress at every opportunity. If lack of features accounts for repulsion of stress, [ɨ] must also be featureless, rendering [ɨ] and [ə] phonologically indistinct; this is a significant problem for languages that contrast the two vowels (e.g. Nganasan, Maga Rukai – Hsin 2000:32ff).

  In short, stress does not show that schwa is fundamentally different from other vowels, phonologically speaking. Schwa is simply low on the sonority hierarchy; its behaviour in phonological processes follows from this fact.

- *Generalizing the critique*
  The same type of criticism not only applies to representational approaches to sonority-driven stress, but to representational approaches to scales in general. For example, a representational approach to the PoA scale has it that non-coronals have Place features while coronals are featureless. Such an approach has been criticized for the implications it has elsewhere in the grammar – this approach predicts that coronals should be transparent to place assimilation and fail to condition any process (assuming that default

rules are the last ones to apply). As McCarthy & Taub (1992) point out, though, this prediction is not borne out (also see ch.7 in Prince & Smolensky 1993: ch.9, Steriade 1995b). Similar arguments have been made for the tonal scale; these again are inadequate, as discussed in ch.6§6.5.2.3.

3.3.5   Summary

To summarize, the full range of attested conflations can only be produced by constraints whose ranking is freely permutable. Nganasan's conflation of stressed central and high peripheral vowels necessitates a constraint that assigns the two categories the same violations while favouring mid- and low vowels – i.e. $*\Delta_{PrWd}\leq\{i,u\}$. It also requires all constraints that distinguish between the categories – i.e. $*\Delta_{PrWd}\leq\partial$ – to be inactive, and therefore lower ranked than $*\Delta_{PrWd}\leq\{i,u\}$. Since other languages require the opposite ranking (e.g. Gujarati – §3.4), it is clear that ranking of scale-referring constraints must be freely permutable.

Constraints in fixed rankings cannot produce all possible conflations. By having a fixed ranking between constraints, implicational relations are set up between categories: the conflation of one set of categories comes to depend on the conflation of others.

Many of the results in this section depend on the claim that any group of contiguous categories can be conflated. To demonstrate the validity of this claim, the stress system of Gujarati is analyzed in the next section; unlike Nganasan, Gujarati conflates the 'middle' vowel sonority categories i/u and e/o. A full typology of attested conflations is presented in §3.5. Section 3.6 explores the consequences of fixed rankings for conflation in more detail.

3.4   Medial conflation: Gujarati[29]

As mentioned in the introduction, Gujarati [gʊ(d)ʒɾáti] stress is sensitive to sonority distinctions. In terms of conflation, Gujarati complements Nganasan: instead of conflating categories at the ends of the vowel sonority scale, the medial categories 'mid vowels' and 'high vowels' are conflated instead.

Gujarati has eight vowels, given in Table 3.2.

Table 3.2: Gujarati vowels

Front	Central	Back
i		u
e	ə	o
ɛ		ɔ
	a	

Table 3.3: Gujarati consonants

	labial	dental	alveolar	(alveo-) palatal	retroflex	velar	glottal
-vd stops	p	t̪		tʃ	ʈ	k	
+vd stops	b	d̪		dʒ	ɖ	g	
fricatives		s̪ (z̪)		ʃ			
nasals	m	n̪		(ɲ)	ɳ	(ŋ)	N[30]
laterals			l		ɭ		
flap			ɾ				
glides	w~v			j			h

- Symbols in brackets are marginal.
- For [N], see ch.5§5.3.3.1.

Gujarati syllables can be described by the template $(C_1)(C_2)V((C_3)C_4)$. Onsets are optional, as shown by [a.po] 'give', and [pi.e] 'he drinks'. C_2 must be one of [j h], while C_3 must be a nasal homorganic with a following stop (e.g. [hiɲc], [təŋg]).[31] Geminate consonants are allowed: e.g. [chəpːən] '56', [gusːo] 'anger'.

The following description of stress placement is based on my own fieldwork and Cardona (1965).

For stress purposes, distinctions between syllable types prove to be of little relevance. The primary determinant of stress is sonority. Cardona (1965) describes some variation that my consultant did not exhibit. The following description is therefore based on my results; Cardona's work is discussed in §3.4.1.4. Only stress in di- and tri-syllabic words is described because there are few Prosodic Words of more than three syllables in length.[32]

Stress is realized as raised pitch and amplitude. Phonological evidence that stress is located as described below comes from intonation and allophony. For intonation, stressed syllables are the locus for the pitch accents of intonational melodies. Allophonic alternations between high peripheral and non-peripheral vowels [i u]~[ɪ ʊ] are also conditioned by stress (Cardona 1965:20-1). The non-peripheral allophones appear in non-final open syllables, except when they are stressed.

(24)   Gujarati vowel allophony

Stressed [í ú]		Unstressed [ɪ ʊ]	
[bíɖi]	type of cigar	[nɪʃál]	'school'
[súdʰi]	'until'	[ʊtáwəl]	'rush, hurry'

---

[30] [N] is a nasal glide. See chapter 5 for discussion.
[31] Cardona (1965:31) also mentions that C_2 may be [ɾ] or [ɖ], though this varies depending on the dialect.
[32] Words with more than three syllables are typically morphologically complex, with PrWd divisions coinciding with morpheme boundaries. Other long forms contain prefixes or enclitics, neither of which counts in stress placement. To account for this latter fact, I take it that the PrWd in Gujarati encloses only the root and suffixes, excluding prefixes and clitics (a common pattern – see Nespor & Vogel 1986).

The following table describes the position of primary stress; there is no secondary stress. This data expands on (1).

(25) Gujarati Stress
    (a) Stress a syllable with [a]
        (i) in the penult

[awːánã]	'coming'	[utáru]	'passenger'
[mubárak]	'New Year'	[sáme]	'in front'
[azádi]	'freedom'	[tʃálo]	'go (imperf.)'
[sáɖa]	'plus ½'	[tʃálɪs]	'40'
[dʒája]	'let's go'	[sáɖu]	'plain'
[betálɪs]	'42'	[ápũ]	'I give'
[pətʃásmũ]	'50th'	[gádʒər]	'carrot'

        (ii) else in the initial syllable

[tádʒetər]	'recently'	[pákɪstan]	'Pakistan'
[lájbrɛɾi]	'library'	[máŋəki]	'swift mare'
[mánɪto]	'I want'	[ákrəmən]	'invasion'

        (iii) else in the final syllable

[sinemá]	'movie theatre'	[hɛɾán]	'distressed'
[pəhɛlán]	'year'	[bolátʃ]	'is (are) spoken'
[ɔpʰɪsmá]	'office'	[ʃikáɾ]	'a hunt'
[tʃɔpərá]	'girls'	[nuksán]	'damage'
[dekʰátʃ]	'can be seen'	[pəgáɾ]	'wages, salary'

    (b) Else stress a non-final syllable with one of [ɛ ɔ e o i u]
        (i) in the penult

[tʃʰokɾío]	'girls'	[kʰeɖío]	'inkstand'
[tʃumːóteɾ]	'74'	[kʰəmíso]	'shirts'
[pəhɛ́lũ]	'first'	[bése]	'sit(s) down'
[ópʰɪs]	'office'	[júrop]	'Europe'

        (ii) else in the initial syllable

[pústəkne]	'book'	[wísmərən]	'forgetfulness'
[óʈkʰəwũ]	'know'	[kójəldi]	'little cuckoo'
[búkəʈo]	'a mouthful'		

    (c) Else stress penult [ə]

[kə́ɾe]	'does, do'	[nə́vo]	'new (masc.)'
[dʒə́min]	'land'	[ʃə́ɾu]	'beginning'
[pə́təŋg]	'kite'	[pəɾə́bɖi]	'water-dispensing shed'
[pəɾə́ntu]	'but'	[rəmə́kɖũ]	'toy'

The description can be informally cast in terms of two interacting preference scales, one relating to sonority, and one relating to position.

With regard to sonority, stress is attracted to the highly sonorous vowel [a] over every other type. So, if a word contains an [a], it always ends up stressed, while the other vowels miss out: e.g. [tádʒetəɾ] 'recently', [sinemá] 'cinema, movie theatre'. Similarly, stress tends to avoid schwa for higher sonority vowels: e.g. [ólkʰəwũ] 'to know', [kójəldi] 'little cuckoo'. However, stress does not avoid [ə] entirely: when the only other syllable is final, stress will rather stay on the schwa: e.g. [ʃə́ɾu] 'beginning', [pəɾə́ntu] 'but'.

Of present interest is the fact that stress does not prefer mid peripheral vowels over high peripheral vowels. For example, stress falls on the penult in [tʃʰokɾío] 'girls', and not on the more sonorous mid vowel: *[tʃʰókɾio]. In other words, the open mid, close mid, and high vowels are conflated for stress purposes in Gujarati.

The other preference scale relates to position. The penult is clearly the most unmarked stress position: in words where all vowels are identical, the penult receives the stress: [awːána] 'coming', [wəkʰə́tsəɾ] 'on time'. The next most favoured position is the antepenult.[33] This is evident from words with both an initial and final [a]: e.g. [pákɪstan] 'Pakistan'; since stress must fall on an [a] but the penult is not available, it can fall on either the antepenult or ultima here, but chooses the antepenult.

The final position is clearly the least desirable position. Stress only falls on an ultima [a] if there are no other [a]'s present: e.g. [sinemá] 'cinema, movie theatre'. This is the only situation where stress falls on the ultima. Stressing a final syllable is deemed less desirable than stressing a schwa: e.g. [kə́ɾe] 'does, do', [pəɾə́bɖi] 'water-dispensing shed'. This fact will be shown to follow from the interleaving of a constraint banning degenerate feet – McCarthy & Prince's (1986) FTBIN – with the DTE-sonority constraints. Specifically, FTBIN will dominate all constraints that seek to avoid stressed schwa alone (i.e. *Δ$_{PrWd}$≤{ə}), so preventing stressed schwa from forcing final stress; in contrast, *Δ$_{PrWd}$≤{e,o} will outrank NONFINALITY, meaning that the desire to avoid non-low stressed vowels will disregard the final stress prohibition.

So, Gujarati stress can be described informally as resulting from two interacting preference hierarchies: the sonority preference ranking of | *a* ⟩ *ε,ɔ,e,o,i,u* ⟩ *ə* | and the position hierarchy of | *penult* ⟩ *antepenult* ⟩ *ultima* |. The following section casts these hierarchies, and their interaction, in terms of the present theory.

3.4.1 Analysis

The unmarked position of stress is the penult, as shown by words where all syllables have vowels of the same sonority: e.g. [awːánã] 'coming', [ekóteɾ] '71', [wəkʰə́tsəɾ] 'on time'. This fact follows if Gujarati has a trochaic (left-headed) foot aligned with the right edge of the PrWd: i.e. [e(kóter)]. This is the same pattern as found in Nganasan, so the same constraints and analysis are employed here:

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[33] Or the initial syllable – it is impossible to tell given the restrictions on PrWd-length noted above.

(26)   Gujarati I: Final Trochee

/ekoteɾ/	ALIGNFTR	FTBIN	TROCHEE
(a) (éko)teɾ	*!		
☞ (b) e(kóteɾ)			
(c) eko(téɾ)		*!	
(d) e(kotéɾ)			*!

As in Nganasan, the footing constraints are violated in some situations, namely when there is a non-penult [a] or when the penult contains a [ə]. The following two sections deal with both of these situations in turn.

As in Nganasan, a constraint requiring left-headed feet (i.e. TROCHEE) outranks all sonority-stress constraints. Importantly, this constraint does not ban monosyllabic (i.e. degenerate) feet – this is FTBIN's job, as illustrated in (26). As we will see, FTBIN is crucially violated in certain words with final [a] (e.g. [sine(má)]).

3.4.1.1 Avoidance of stressed non-[a]

Stress does not always appear on the penult in Gujarati: it is attracted to an initial [a] when the penult contains a mid vowel (e.g. [tádʒetəɾ] 'recently'), high vowel (e.g. [mánito] 'respected (masc.)'), or schwa (e.g. [mánəki] 'swift mare'). Of course, [a] is the most sonorous vowel, so this departure from the default stress position indicates that sonority has an overriding influence on stress in this language.

For stress to avoid the penult in favour of stressing an [a], two conditions must hold: (i) some constraint must favour stressed [a] over all other stressed vowels, and (ii) that constraint must outrank ALIGNFTR. The latter ranking is crucial since initial stress means that the foot cannot be right aligned: i.e. [(tádʒe)təɾ].

The present approach provides such a constraint: $*\Delta_{PrWd}\leq\{\varepsilon,\mathfrak{o}\}$ "Assign a violation to the DTE of a PrWd if it contains a vowel with less sonority than a low vowel." Only [á] does not violate this constraint. Tableau (27) shows the necessary ranking.

(27)   Gujarati II: $*\Delta_{PrWd}\leq\{\varepsilon,\mathfrak{o}\}$ » ALIGNFTR

/lajbrɛri/	$*\Delta_{PrWd}\leq\{\varepsilon,\mathfrak{o}\}$	ALIGNFTR
☞ (a) (lájbrɛ)ri		*
(b) laj(brέri)	*!	

A further ranking can also be determined. Final [a] also attracts the stress if no other vowel is as sonorous: [ʃikáɾ] 'a hunt', [sinemá] 'cinema', [ɔpʰismã́] 'office'. In these words, the foot is right-aligned so ALIGNFTR is not violated. Instead, it is FTBIN that is violated since the foot is necessarily monosyllabic: [ʃi(káɾ)], [sine(má)].[34] So, $*\Delta_{PrWd}\leq\{\varepsilon,\mathfrak{o}\}$ must outrank FTBIN.

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[34] I assume that TROCHEE is undominated, eliminating candidates with iambic feet (e.g. [(ʃikáɾ)]).

(28)   Gujarati III: $*\Delta_{PrWd}\leq\{\varepsilon,\mathfrak{o}\}$ » FTBIN

	/ʃikaɾ/	$*\Delta_{PrWd}\leq\{\varepsilon,\mathfrak{o}\}$	FTBIN
	(a) (ʃíkaɾ)	*!	
☞	(b) ʃi(káɾ)		*

Even though the stress-sonority constraint $*\Delta_{PrWd}\leq\{\varepsilon,\mathfrak{o}\}$ outranks ALIGNFTR and FTBIN, this does not mean that the two foot-locating constraints are irrelevant to stress placement. They can have an emergent effect, determining the hierarchy of positional preference identified in the preceding section. For example, when all vowels in a word are [a], the constraint $*\Delta_{PrWd}\leq\{\varepsilon,\mathfrak{o}\}$ will not determine the winning form. In this situation, the foot-locating constraints play a decisive role:

(29)   Gujarati IV: Emergence of ALIGNFTR and FTBIN

	/awwanã/	$*\Delta_{PrWd}\leq\{\varepsilon,\mathfrak{o}\}$	ALIGNFTR	FTBIN
	(a) (áwwa)nã		*!	
☞	(b aw(wánã)			
	(c) awwa(nã́)			*!

In this way, the foot-locating constraints establish a hierarchy of positional preference: when sonority is not at issue, stress prefers to fall on the penult. The next most favoured position is the initial syllable; when only the initial and final syllables contain [a], the initial wins: [(pákɪs)tan] 'Pakistan', *[pakɪs(tán)]. This fact allows us to establish a further ranking: since the final-stressed form violates FTBIN while the initial-stressed form violates ALIGNFTR, the former must outrank the latter:

(30)   Gujarati V: FTBIN » ALIGNFTR

	/pakɪstan/	$*\Delta_{PrWd}\leq\{\varepsilon,\mathfrak{o}\}$	FTBIN	ALIGNFTR
☞	(a) (pákɪs)tan			*
	(b) pakɪs(tán)		*!	
	(c) pa(kístan)	*!		

To summarize, the ranking || $*\Delta_{PrWd}\leq\{\varepsilon,\mathfrak{o}\}$ » FTBIN » ALIGNFTR || not only accounts for the fact that stress avoids syllables without [a], but accounts for the hierarchy of preference in position: the constraints determine that the most harmonic position is the penult, then the antepenult, then finally the ultima.

3.4.1.2 Avoidance of stressed schwa

Attraction of stress to [a] is not the only visible effect of sonority-stress interaction in Gujarati. Stress also avoids the lowest sonority vowel [ə]: e.g. [pústəkne] "book", [wísməɾən] 'forgetfulness', [kójəldi] 'little cuckoo'.

Schwa is not 'unstressable'. Stress falls on [ə] in two situations: (i) when there are no other non-[ə] vowels (e.g. [pə́təŋg] 'kite', [wəkʰə́tsəɾ] 'on time'), and (ii) when the

only other option is final stress on a non-low vowel (e.g. [kə́ɾe] 'do', [nə̃́wo] 'new', [ʃə́ɾu] 'beginning', [pəɾə́bɖi] 'water-dispensing shed'). This latter situation contrasts with the influence of [a] on stress: Gujarati prefers a final stressed [a] over a penult of lower sonority, while it does not prefer a final higher sonority stressed vowel to a low sonority penult [ə́]. This restriction will prove significant in evaluating the adequacy of scale theories below. For the moment, the focus will be on presenting an account that employs the constraints proposed so far.

Stressed [ə] in Gujarati is clearly less harmonic than other stressed vowels. The relevant constraint is $*\Delta_{PrWd} \leq ə$, a constraint that assigns stressed schwa a violation, but no other stressed vowels.

The word [(kójəl)di] provides a clue to the ranking of $*\Delta_{PrWd} \leq ə$ with respect to the foot-locating constraints. Since the foot is not right-aligned in this word due to the desire to avoid a stressed schwa, $*\Delta_{PrWd} \leq ə$ must outrank ALIGNFTR:

(31)   Gujarati VI: ‖ $*\Delta_{PrWd} \leq ə$ » ALIGNFTR ‖

	/kojəldi/	$*\Delta_{PrWd} \leq ə$	ALIGNFTR
☞	(a) (kójəl)di		*
	(b) ko(jə́ldi)	*!	

This leaves the ranking of $*\Delta_{PrWd} \leq ə$ and FTBIN to be determined. In this respect, the form [(kə́re)] is illuminating. Its competitor is *[kə(ré)], with a higher sonority Δ_{PrWd}, but a FTBIN violation. Clearly, the FTBIN violation is not worth avoiding a stressed schwa in Gujarati. Therefore, FTBIN must outrank $*\Delta_{PrWd} \leq ə$.

(32)   ‖ FTBIN » $*\Delta_{PrWd} \leq ə$ ‖

	/kəɾe/	FTBIN	$*\Delta_{PrWd} \leq ə$
☞	(a) (kə́ɾe)		*
	(b) kə(ɾé)	*!	

As in Nganasan, the competitor [(kəɾé)], with an iambic foot, is eliminated through the undominated constraint TROCHEE; this constraint bans right-headed feet.

In summary, the ranking for avoidance of stressed schwa is ‖ TROCHEE, FTBIN » $*\Delta_{PrWd} \leq ə$ » ALIGNFTR ‖. This ranking is interesting because it shows how the influence of sonority on a stress system may be restricted to specific environments. Unlike $*\Delta_{PrWd} \leq \{ε, ɔ\}$, $*\Delta_{PrWd} \leq ə$ does not outrank every relevant foot-locating constraint; its domination by FTBIN precludes sonority-sensitivity in every environment.[35]

In other words, the ranking interaction of the sonority-stress constraints and foot-locating constraints not only determines whether stress will be influenced by sonority, but the extent of that influence. One other point is that the ranking ‖ FTBIN » ALIGNFTR ‖ has been proven both directly (in (30)) and by transitivity.

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[35] Gujarati contrasts with Chukchi in this regard: Kenstowicz shows that avoidance of stressed schwa can motivate final stress in Chukchi, while avoidance of stressed high vowels cannot. See Kenstowicz (1996) for an analysis, which can be straightforwardly converted into the present constraints.

The remaining relevant constraint is *Δ_PrWd≤{i,u} – this constraint is violated when the Δ_PrWd contains a segment with the sonority of a high vowel or less. Since every grammar contains the same constraints, it is not possible to say that this constraint is irrelevant in Gujarati – it must be ranked somewhere. This ranking is the subject of the next section.

3.4.1.3 Conflation of medial categories

There are three sonority distinctions in Gujarati stress: [a] vs [ɛ ɔ e o i u] vs [ə]. Of present interest is the fact that mid and high peripheral vowels are treated in the same way. Mid and high vowels both lose stress to [a]: e.g. [mánito] 'I want', [nuksán] 'damage', [boláj] 'is spoken', [tádʒetər] 'recently'. Similarly, they both attract stress away from [ə]: [pústəkne] 'book', [wísmərən] 'forgetfulness', [kójəldi] 'little cuckoo'. However, mid and high vowels do not attract stress away from each other. Stress does not avoid high vowels for the more sonorous mid vowels: e.g. [tʃʰokríne] 'boys', [kʰedío] 'inkstand'. Nor does stress avoid mid vowels for high vowels: e.g. [tʃumːóter] '74'. In short, mid and high vowels form a single unified category for stress purposes.

As discussed in §3, categories are distinct if they incur distinct violations of active constraints (see §3.3.2.2 for discussion of 'active'). Therefore, for [í ú] to be distinct from [é ó], some constraint that favours one over the other must be active. The relevant constraint is *Δ_PrWd≤{i,u}; this constraint is violated by stressed high vowels (and everything of lesser sonority), but not stressed mid vowels. So, in any grammar that distinguishes the two – e.g. Nganasan – *Δ_PrWd≤{i,u} must be active. Conversely, if [í ú] and [é ó] are conflated, it follows that *Δ_PrWd≤{i,u} must be inactive. In Gujarati, then, *Δ_PrWd≤{i,u} must be sufficiently low-ranked so as not to be crucial in choosing the winner.

As the analysis in the preceding section shows, the sonority-stress constraints conflict with constraints on stress placement and footing. So, to render *Δ_PrWd≤{i,u} inactive, it must be outranked by such conflicting constraints: i.e. ALIGNFTR and FTBIN in Gujarati. With such a ranking, no distinction is made between mid vowels and high vowels. This is demonstrated in tableau (33): if mid vowels were favoured over high vowels, stress should appear on the initial syllable in [tʃʰokríne].

(33)   Ranking of *Δ_PrWd≤{i,u}

/tʃʰokrine/	ALIGNFTR	*Δ_PrWd≤{i,u}
(a) (tʃʰókri)ne	*!	
☞ (b) tʃʰok(ríne)		*

Importantly, there is no active constraint that distinguishes between [í ú] and [é ó]. Specifically, no sonority-stress constraint that outranks the foot-form constraints favours stressed mid vowels over stressed high vowels: they both incur the same violations of *Δ_PrWd≤{ɛ,ɔ} and *Δ_PrWd≤ə. Tableau (34) aims to clarify this point by showing the full ranking of constraints.

(34)

	/tʃʰokɾine/	*Δ$_{PrWd}$≤{ɛ,ɔ}	FTBIN	*Δ$_{PrWd}$≤ə	ALIGNFTR	*Δ$_{PrWd}$≤{i,u}
	(a) (tʃʰókɾi)ne	*			*!	
☞	(b) tʃʰok(ɾíne)	*				*

Stressed mid and high vowels incur a violation of *Δ$_{PrWd}$≤{ɛ,ɔ} because they both have the sonority of mid vowels or less, while both avoid violating *Δ$_{PrWd}$≤ə because they are both more sonorous than [ə]. The only constraint that does make a distinction is inactive – it never makes the crucial determination of winner status for stress placement.

In contrast to Gujarati, Nganasan does not conflate high and mid vowels with regard to stress. The resulting ranking for Gujarati is summarized in Figure 3.3.

Figure 3.3: Gujarati sonority-driven stress ranking summary

$$*Δ_{PrWd}≤\{ɛ,ɔ\} \qquad \text{TROCHEE}$$
$$|$$
$$\text{FTBIN}$$
$$*Δ_{PrWd}≤ə$$
$$|$$
$$\text{ALIGNFTR}$$
$$*Δ_{PrWd}≤\{i,u\}$$
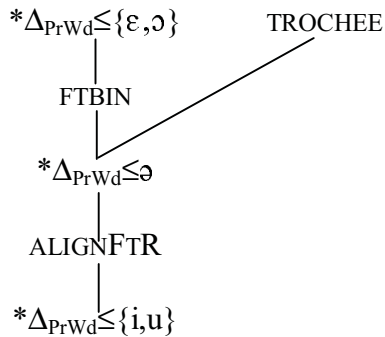
The contrast between Gujarati and Nganasan's ranking is striking. Whereas Nganasan has *Δ$_{PrWd}$≤{i,u} outranking all other sonority-stress constraints, the opposite is the case in Gujarati. The Gujarati system further underscores the point that the sonority-stress constraints must be freely permutable. With ‖ *Δ$_{PrWd}$≤{ɛ,ɔ} » *Δ$_{PrWd}$≤ə » *Δ$_{PrWd}$≤{i,u} ‖ it is clear that there is no fixed ranking of sonority-stress constraints, at least.

3.4.1.4 Variation

Cardona (1965) reports a few instances of free variation in his description of Gujarati stress. The most major variation is in avoidance of stressed penult [ə]. Like the dialect described in this section, stress can fall on the penult if it contains a schwa and the ultima a non-low vowel: e.g. [kə́ɾe] 'does, do'. However, Cardona reports that if the penult [ə] is in an open syllable, stress may fall on the ultima:

(35)   Free Variation: Cə.CV^{-LOW} (Cardona 1965:33)
    [jə́min]~[jəmín]   'land'
    [ʃə́ɾu] ~[ʃəɾú]   'beginning'
    [kə́ɾe] ~[kəɾé]   'does, do'
    [nə́wo]~[nəwó]   'new'

However, stress will not fall on the final syllable if the penult is closed:

(36)   Penult stress: CV́C.CV
    [gə́w.ɾi]   'a name of Parvati',   *[gəw.ɾí]
    [wə́s.tu]   'matter',   *[wəs.tú]
    [pə́ɳ.ɖe]   'personally',   *[pəɳ.ɖé]
    [sə́N.tʃo]   'a machine',   *[səN.tʃó]

There are two differences between the grammars. One is in the ranking of the constraint TROCHEE. In the dialect without final stress, TROCHEE is undominated. It therefore rules out forms like *[(kəɾé)], with an iamb; FTBIN – as usual – rules out *[kə(ɾé)], so resulting in [(kə́ɾe)]. It still will not rule out words like [ʃi(káɾ)] and [sine(má)] – these forms do not violate TROCHEE, having left-headed feet, and *Δ_{PrWd}≤{ɛ,ɔ} outranks FTBIN.
    In the grammar with final stress in [jəmín], TROCHEE is outranked by *Δ_{PrWd}≤ə. With this ranking, stress can fall on a final syllable to avoid a penult ə, producing an iamb. This is illustrated in tableau (37).

(37)

/kəɾe/	FTBIN	*Δ_{PrWd}≤ə	TROCHEE
(a) (kə́ɾe)		*!	
☞ (b) (kəɾé)			*
(c) kə(ɾé)	*!		

The second difference between the grammars is in weight-by-position (Hayes 1989). Codas count as moraic in the grammar with [kəɾé] but not the grammar with [gəwrí]. It is significant that FTBIN still outranks *Δ_{PrWd}≤{ə}; this ranking explains why stress will not leave a penult closed syllable with ə. In /gəwɾi/, for example, candidates with final stress are either *[(gəw.ɾí)] or *[gəw(ɾí)]. Both violate FTBIN – the former because it has an uneven (σ_{μμ}σ_μ) foot and the latter because it has a degenerate foot. So, final stress is ruled out by FTBIN, producing penult stress. This situation is illustrated in tableau (38).

(38)

/gəwɾi/	FTBIN	*Δ$_{PrWd}$≤ə	TROCHEE
☞ (a) (gə́w)ɾi		*	
(b) (gəwɾí)	*!		*
(c) gəw(ɾí)	*!		

In short, the difference between the grammars is in the ranking of TROCHEE. In the dialect described here, TROCHEE is undominated; in contrast, the dialect that avoids penult [ə] in open syllables has TROCHEE crucially outranked by *Δ$_{PrWd}$≤ə.

3.4.2 Environment-specific conflation

Gujarati is not only interesting in terms of the categories it conflates, but also in that conflation varies depending on the environment. In non-final syllables, [ə́] is less harmonic than any of [í ú é ó ɛ́ ɔ́], which in turn are less harmonic than [á]. However, in final position, [ə́] is conflated with non-low vowels for stress: they are all equally avoided. For example, [kə́ɾe] shows that final [é] is not more harmonic than penult [ə́]. This is 'environment-specific' conflation, where the conflation of categories varies depending on their position.

Environment-specific conflation is important in distinguishing the stringency approach from theories that combine constraints. These include Crowhurst & Hewitt's (1997) constraint disjunction and Kenstowicz' (1996) proposal that scale categories may be conflated before producing constraints. I also include Prince & Smolensky's (1993) 'constraint encapsulation' with the caveat that this was intended as a purely abbreviatory device (Alan Prince p.c.), and not as a theory of constraint combination.

The first step is to show how environment-specific conflation is done in the present theory. A discussion of how it differs from the 'encapsulation' approaches just mentioned is then provided.

In the present theory, environment-specific conflation comes about when a constraint C renders an otherwise active sonority-stress constraint inactive in a specific competition. In Gujarati, C is FTBIN. It renders *Δ$_{PrWd}$≤ə inactive when one candidate has final stress and the other does not. Such a situation happens for [kə́ɾe], for example. The winner is not *[kə(ɾé)] because FTBIN rules out the degenerate foot, rendering *Δ$_{PrWd}$≤ə inactive.

(39)

/kəɾe/	FTBIN	*Δ$_{PrWd}$≤ə
☞ (a) (kə́ɾe)		*
(b) kə(ɾé)	*!	

FTBIN only renders *Δ$_{PrWd}$≤ə inactive in this specific competition. FTBIN is irrelevant in other competitions that do not involve final stress (e.g. [kójəldi]). *Δ$_{PrWd}$≤ə makes the crucial choice in such situations, as shown in tableau (40).

(40)

	/kojəldi/	FTBIN	*Δ$_{PrWd}$≤ə
☞	(a) (kójəl)di		
	(b) ko(jə́ldi)		*!

Environment-specific conflation provides evidence that the ranking of the sonority-stress constraints must be freely permutable. The evidence is best explained with reference to a fixed ranking theory, such as the one in (41), adapted from Kenstowicz (1996) and Prince & Smolensky (1993).

(41)   Fixed Ranking stress-sonority constraints
|| *Δ$_{PrWd}$/ə » *Δ$_{PrWd}$/{i,u} » *Δ$_{PrWd}$/{ɛ,ɔ} » *Δ$_{PrWd}$/a ||

In Gujarati, FTBIN renders *Δ$_{PrWd}$/ə inactive in final syllables: FTBIN outranks *Δ$_{PrWd}$/ə to prevent final stress in words like [kə́ɾe]. This ranking means that FTBIN also outranks *Δ$_{PrWd}$/{i,u}, and by transitivity all the other sonority-stress constraints in (41). However, if FTBIN outranks all sonority-stress constraints, stress will not fall on a final [a] as in [ʃi(káɾ)], *[(ʃíkaɾ)], as shown in tableau (42).

(42)

	/ʃikaɾ/	FTBIN	*Δ$_{PrWd}$/ə	*Δ$_{PrWd}$/i,u
☀	(a) (ʃíkaɾ)			*
	(b) ʃi(káɾ)	*!		

The problem illustrated in (42) follows from transitivity of ranking. FTBIN effectively renders *Δ$_{PrWd}$/ə inactive in situations of final stress; in other words, in the competition [(kə́re)] vs *[kə(ré)], FTBIN alone determines the winner, rendering *Δ$_{PrWd}$/ə's violations irrelevant. Since *Δ$_{PrWd}$/ə – and by transitivity FTBIN – outranks *Δ$_{PrWd}$/{i,u}, FTBIN also renders *Δ$_{PrWd}$/{i,u} inactive in final stress competitions, as illustrated in tableau (42). Thus, FTBIN's predominant position in the ranking incorrectly prevents sonority from being a factor in any competition involving final stress – i.e. in the *[(ʃíkaɾ)]~[ʃi(káɾ)] competition.

Because the ranking of the present theory's constraints is freely permutable, the same implication does not hold. If || FTBIN » *Δ$_{PrWd}$≤ə ||, it is not necessarily the case that || FTBIN » *Δ$_{PrWd}$≤{ɛ,ɔ} ||. As established above, it is necessary that *Δ$_{PrWd}$≤{ɛ,ɔ} outranks FTBIN in this language; the relevant tableau is repeated in (43).

(43)

	/ʃikaɾ/	*Δ$_{PrWd}$≤{ɛ,ɔ}	FTBIN
	(a) (ʃíkaɾ)	*!	
☞	(b) ʃi(káɾ)		*

This point about environment-specific conflation not only rules out theories with constraints in a fixed ranking, but also theories in which such constraints can be combined through some operation. For example, a theory in which constraints can be combined to form a single constraint through a disjunction operator would amalgamate $*\Delta_{PrWd}/\{i,u\}$ and $*\Delta_{PrWd}/\{\varepsilon,\mathfrak{o}\}$ to form a single constraint that assigned a violation to a stressed syllable with either a high vowel or a mid vowel (see e.g. Crowhurst & Hewitt 1997).[36] Such a constraint will be called $*\Delta_{PrWd}/\{i,u\}\vee*\Delta_{PrWd}/\{\varepsilon,\mathfrak{o}\}$ here, and the general type of constraint as 'encapsulated'.

Certainly, encapsulated constraints can produce conflation. For Gujarati, for example, the ranking would be $\|\ *\Delta_{PrWd}/\mathfrak{o}\ \gg\ *\Delta_{PrWd}/\{i,u\}\vee*\Delta_{PrWd}/\{\varepsilon,\mathfrak{o}\}\ \gg\ *\Delta_{PrWd}/a\ \|$, with the high- and mid-vowel constraints encapsulated. The problem is that the encapsulation approach cannot produce the type of environment-specific conflation seen in Gujarati. Since FTBIN outranks $*\Delta_{PrWd}\leq\mathfrak{o}$, it also outranks $*\Delta_{PrWd}/\{i,u\}\vee*\Delta_{PrWd}/\{\varepsilon,\mathfrak{o}\}$; the result is that FTBIN renders the latter inactive in the same environments as the former. /ʃikaɾ/ is incorrectly predicted to surface as *[ʃíkaɾ].

(44)

/ʃikaɾ/		FTBIN	$*\Delta_{PrWd}/\mathfrak{o}$	$*\Delta_{PrWd}/\{i,u\}\vee*\Delta_{PrWd}/\{\varepsilon,\mathfrak{o}\}$
☞✳	(a) (ʃíkaɾ)			*
	(b) ʃi(káɾ)	*!		

Again, there is no ranking that will produce the attested [ʃikár]. For this to happen, FTBIN would have to rank below the encapsulated constraint, producing a ranking contradiction.

To summarize, fixed ranking theories make strong predictions about the environments in which constraints will be inactive. In a fixed ranking theory, if scale-constraint C is rendered inactive in environment E, then all scale-constraints ranked lower than C will also be rendered inactive in that environment. This prediction makes a system with environment-specific conflation like Gujarati's impossible to produce. In contrast, the freely permutable constraints proposed here do not have any such implications. The properties of Fixed Ranking theories are discussed in more detail in §3.6.

This section has shown that the present theory can account for stress systems in which medial categories are conflated. It also showed that the theory can account for environment-specific conflation, where different conflations apply in different environments.

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[36] Prince & Smolensky (1993:ch.9) combine constraints in this way; their term 'encapsulation' is used here. Kenstowicz (1996) suggests a similar approach, proposing that "grammars may differ in the granularity with which sonority distinctions are recognized". Kenstowicz (1996) also suggests an approach with unranked constraints; this proposal will not be discussed here. Crowhurst & Hewitt (1997) propose that constraints can be combined in a disjunctive relation, as here. Prince & Smolensky's (1993) PKPROM has a similar effect, and similar problems – see de Lacy (1997a) for discussion of this constraint in particular.

3.5 Typology

This section addresses two issues relating to empirical coverage. One is whether the stringent constraints can produce every attested conflation. The other is whether they are restrictive – are they unable to produce impossible conflations?

While this section explores these two issues within the context of sonority-driven stress, it is worth noting that the constraints that motivate sonority-driven stress are only a small part of the present theory. In fact, the constraints discussed here are only those that refer to sonority combined with PrWd and foot DTEs. Remaining are all those constraints that refer to other categories – the syllable, mora, phonological phrase, and so on – and other scales, such as tone, Place of Articulation, and so forth. In addition, constraints on non-DTEs have yet to be discussed, even though these do have an effect on sonority-driven stress (discussed in detail in ch.4§4.3).

Even so, the typology of conflation for sonority-driven stress will be the focus of this section because it is a self-contained microcosm of the present theory: the issues that arise in sonority-driven stress – hierarchy and conflation – also arise in every other scale-related empirical phenomenon. The same issues arise for tone-driven stress (de Lacy 1999a, 2002b) and for syllabification (Prince & Smolensky 1993); the effects of hierarchies and conflation are even evident in neutralization, as discussed extensively in chapters 6 and 9.

In short, sonority-driven stress is useful for examining the predictions of the present theory since its effects are largely duplicated in other domains. So, what the present theory predicts for hierarchies and conflation in sonority-driven stress also holds for every other related phenomenon.

- Section 3.5.1 examines the ranking needed for a grammar to exhibit sonority-driven stress.
- Section 3.5.2 discusses factors that never play any role in stress assignment, such as Place of Articulation.
- Section 3.5.3 asks whether a set of binary scales can produce the same result as a single multi-valued scale.
- Section 3.5.4 deals with the typology of conflation. It identifies two different types of conflation and discusses their empirical effects.
- Section 3.5.5 discusses the relation between conflation and hierarchical implications.

3.5.1 Ranking for sonority-driven stress

Two independent rankings are necessary to produce sonority-driven stress. Both rankings involve constraints on stress placement, such as ALLFTL. One involves the sonority-stress constraints, and the other faithfulness constraints. Both rankings will be discussed in turn.

For stress to be sensitive to sonority, some sonority-stress constraint must outrank some stress-locating constraint. In the hypothetical example below, $*\Delta_{PrWd}{\leq}\vartheta$ outranks ALIGN-$\acute{\sigma}$-L to produce avoidance of stressed schwa; the opposite ranking would render $*\Delta_{PrWd}{\leq}\vartheta$ inactive, and therefore stress would ignore sonority.

(45)

/pəti/	$*\Delta_{PrWd}{\leq}ə$	ALIGN-$\acute{\sigma}$-L
(a) pəti	*!	
☞ (b) pətí		*

It is necessary for some sonority-stress markedness constraint to outrank some active stress-locating constraint for sonority-driven stress to work, but this ranking is not sufficient. The ranking of faithfulness constraints is also relevant.

A candidate not considered in tableau (45) is [páti], where the /ə/ has changed to [a]; this change effectively avoids violating $*\Delta_{PrWd}{\leq}ə$, and so offers an alternative response to sonority-driven stress. To eliminate such a candidate, faithfulness constraints must at least outrank the stress-locating constraints. The relevant constraint is IDENTV, which preserves input vowel feature specifications (after McCarthy & Prince 1995).

(46)

/pəti/	$*\Delta_{PrWd}{\leq}ə$	IDENTV	ALIGN-$\acute{\sigma}$-L
(a) pə́ti	*!		
☞ (b) pətí			*
(c) páti		*!	

The tableau shows that the ranking between IDENTV and the sonority-stress constraint is irrelevant: sonority-driven stress comes about when IDENTV and some sonority-stress constraint both outrank stress-locating constraints.

The ranking between IDENTV and the sonority-stress constraint does have some effect. If the latter outranks the former, neutralization will take place in words where stress must inevitably fall on a vowel banned by the sonority-stress constraint. An example is the word [pətə] – stress cannot help but fall on a schwa. With $*\Delta_{PrWd}{\leq}ə$ outranking IDENTV, though, whichever vowel receives stress changes.

(47)

/pətə/	$*\Delta_{PrWd}{\leq}ə$	IDENTV	ALIGN-$\acute{\sigma}$-L
(a) pə́tə	*!		
(b) pətə́	*!		*
☞ (c) pátə		*	

If IDENTV outranks the sonority-stress constraint, neutralization does not take place. This is the situation in Nganasan, for example.

If the stress-locating constraints dominate either IDENTV or the sonority-stress constraints, sonority-driven stress does not take place. If both the stress-locating constraints and the sonority-stress constraints outrank IDENTV, neutralization takes place:

(48)

/pəti/	*$\Delta_{\text{PrWd}}{\leq}$ə	ALIGN-ó-L	IDENTV
(a) pə́ti	*!		
(b) pətí		*!	
☞ (c) páti			*

If the stress-locating constraints and IDENTV both outrank the sonority-stress constraints, neither neutralization nor sonority-driven stress happens:

(49)

/pəti/	IDENTV	ALIGN-ó-L	*$\Delta_{\text{PrWd}}{\leq}$ə
☞ (a) pə́ti			*
(b) pətí		*!	
(c) páti	*!		

The rankings are summarized in Table 3.4. Σ stands for 'some sonority-stress constraint', while 'stress' stands for some stress-locating constraint.

Table 3.4: Ranking Typology

Ranking			Type		
Σ	IDENT	stress	sonority-driven	with neutralization	(47)
IDENT	Σ	stress	stress	without neutralization	
Σ	stress	IDENT	Neutralization		(48)
stress	Σ	IDENT			
IDENT	stress	Σ	no stress-sonority		(49)
stress	IDENT	Σ	interaction		

The ranking schema can be generalized for all prominence-driven stress cases by replacing Σ with some constraint that relates $\Delta_{\text{PrWd/Ft}}$ to some property. For further discussion, see de Lacy (1999a, 2002b).

3.5.1.1 Positional markedness vs positional faithfulness: Telling the two apart

One of the crucial properties of the rankings identified in Table 3.4 is that the constraints that motivate sonority are of the 'positional markedness' sort – they refer to a combination of a prosodic position and a property. Since there has been some controversy over whether positional markedness constraints are necessary – i.e. whether they can be entirely supplanted by positional faithfulness constraints (Beckman 1998 cf Zoll 1998). This section aims to identify the general properties where positional markedness and positional faithfulness differ.

Positional markedness constraints that are relevant mention at least two distinct elements, having the general form *x/y; this constraint assigns a violation for candidates that have a position x and property y in combination. For example, violations of the

constraint *-Δ$_{PrWd}$≥{i,u} can be eliminated by either moving the DTE or altering the quality of the vowel, as shown in tableau (50); the exact outcome is determined by the relative ranking of faithfulness and stress constraints and the properties of the candidate under evaluation.

(50)

	/pəta/	*-Δ$_{PrWd}$≥{i,u}	IDENTV	ALIGN-ǿ-L
	(a) pǽta	*!		
☞	(b) pətá			*
☞	(c) pǽtə		*	

The faithful candidate (a) has a high-sonority unstressed vowel [a], so fatally violates *-Δ$_{PrWd}$≥{i,u}. This leaves candidates (b) and (c). Candidate (b) avoids violating *-Δ$_{PrWd}$≥{i,u} by shifting stress onto the [a]. Candidate (c) also avoids *-Δ$_{PrWd}$≥{i,u}, but instead by reducing /a/ to [ə].

Both of these responses are attested. Candidate (b) wins in the Papuan language Kara: stress avoids [ə] for higher sonority vowels (Schlie & Schlie 1993, p.c., de Lacy 1997a). Candidate (c) wins in New Zealand English (my native dialect): all unstressed vowels reduce to [ə], and [ə] can be stressed (e.g. [bǽɾə] 'bitter').

This 'symmetrical effect' of positional markedness constraints is explicitly discussed in de Lacy (1999a, 2000a, 2002b) and Smith (2002).

The symmetrical effect property can be used to determine whether a positional markedness or positional faithfulness constraint is appropriate. Since both vowel centralization and stress shift are possible ways to avoid stressed schwa, the constraint(s) that ban(s) stressed schwa must be of the positional markedness variety.

- *Positional faithfulness*

Beckman's (1998) positional faithfulness constraints have quite a different effect from positional markedness ones. Positional faithfulness constraints do not promote unfaithfulness, but can only block certain unfaithful mappings; in contrast, a positional markedness constraint can favour unfaithful candidates over faithful ones. However, as shown by Beckman (1998), a positional faithfulness constraint in combination with a context-free markedness constraint can produce much the same result as a positional markedness constraint (also see Zoll 1998). For example, the ranking || ǿ-IDENTV » *≥{i,u} || (where *≥{i,u} bans all vowels with equal or more sonority than high vowels) can produce vowel reduction in unstressed syllables, after Beckman (1998).

(51)

	/pitaki/	ǿ-IDENTV	*≥{i,u}	IDENTV
	(a) pítaki		* * *!	
☞	(b) pítəkə		*	* *
	(c) pǽtəkə	*!		* * *

Unlike positional markedness constraints, though, positional faithfulness constraints cannot interact with context-free constraints to trigger changes in prosodic structure. The reason for this difference relates to the fact that faithfulness is not an issue in the sonority-driven stress systems of the sort encountered above. In other words, the primary competing forms do not differ in terms of faithfulness, but only in stress position.

For example, in Gujarati the form /hɛɾan/ has output candidates *[hɛ́ɾan] and [hɛɾán]. These candidates do not differ in terms of faithfulness, so no faithfulness constraint can distinguish them – the entire responsibility falls on markedness constraints.[37] If all markedness constraints were context-free, there would be no way to distinguish the two candidates; stress will fall on the default position. Thus, a theory without positional markedness constraints – and only positional faithfulness and context-free constraints – incorrectly predicts that sonority-driven stress systems of the type discussed above cannot exist. Positional markedness constraints are therefore necessary.

In short, positional faithfulness constraints of the form *p*-IDENT[*f*], where *p* is a prosodic position and *f* is a feature, cannot interact with context-free markedness constraints to cause *p* to change. Thus, they cannot motivate sonority-driven stress, or any prosodic change without attendant unfaithfulness (see §3.5.2 for a rather indirect exception to this statement).

3.5.1.2 Hierarchy and form stringency

Prince (1997a,b,c, 1999) identifies a potential problem with freely rankable stringent constraints. Constraints that have a stringency relation on elements of structure may turn out to be in straightforward conflict when entire structures are compared. The problem is illustrated with respect to the sonority-stress constraints here.

The constraints considered here are $*\Delta_{Ft}\leq\{i,u\}$ and $*\Delta_{Ft}\leq\{\partial\}$. As shown in tableau (52), the constraints are in conflict in competition between two candidates from the input /pitəkitə/.

(52)

/pitəkitə/	$*\Delta_{Ft}\leq\{\partial\}$	$*\Delta_{Ft}\leq\{i,u\}$
(a) (pítə)(kìtə)		* *
(b) pi(tə́ki)tə	*	*

If $*\Delta_{Ft}\leq\{\partial\}$ outranked $*\Delta_{Ft}\leq\{i,u\}$, candidate (a) would win; in the opposite ranking, candidate (b) would win.

Of course, for this to be a real conflict, other candidates must be eliminated. Most notably, [(pítə)kitə] and [pitə(kítə)] must be dispensed with as both are local harmonic bounds for (a) and (b) in terms of the constraints above (they only incur one violation of $*\Delta_{Ft}\leq\{i,u\}$). A constraint like LAPSE will do the job (Prince 1983, Selkirk 1984, Green &

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[37] This statement disregards constraints that preserve stress. However, if such constraints were active, the system would be a lexical stress one, not prominence-driven.

Kenstowicz 1995); this constraint penalizes sequences of unstressed syllables. The following discussion will assume that LAPSE is high-ranked.

The concern is with the ranking in which candidate (b) wins: $\parallel$ *Δ_{Ft}≤{i,u} $\gg$ *Δ_{Ft}≤{ə} $\parallel$. Under this ranking, it seems that stress avoids high vowels (as in [(pítə)(kìtə)]) for schwa (as in [pi(tə́ki)tə]). In other words, this ranking seems to create a scale reversal.

Prince (1999) shows that this problem arises with freely rankable stringent constraints, as outlined above. In contrast, it does not happen with constraints in a particular fixed ranking – namely where constraints that ban marked elements outrank all those that ban more marked elements: e.g. $\parallel$ *Δ_{Ft}/{ə} $\gg$ *Δ_{Ft}/{i,u} $\gg$ *Δ_{Ft}/{e,o} $\gg$ *Δ_{Ft}/{a} $\parallel$. Because *Δ_{Ft}/{ə} always outranks *Δ_{Ft}/{i,u}, a candidate with stressed [ə] will always incur a more serious violation than any without stressed schwa, regardless of the number of stressed [í]'s it contains. To make one thing clear, it makes no difference whether the constraints in a fixed ranking are stringent or not. This is evident from tableau (52): if *Δ_{Ft}≤ə universally outranked *Δ_{Ft}≤{i,u}, the candidate [pi(tə́ki)tə] would never win.

- *Potential solutions and conflation*

Prince (1999) identifies four potential solutions to this problem, one of which will be discussed here.[38] This solution retains the stringent form of constraints, but keeps a fixed ranking between them. If *Δ_{Ft}≤{ə} universally outranks *Δ_{Ft}≤{i,u}, then [pi(tə́ki)tə] will never beat [(pítə)(kìtə)] for sonority reasons alone.

However, a fixed ranking – even of stringent constraints – eliminates the ability to conflate freely (see §3.6). More concretely, the ranking $\parallel$ *Δ_{Ft}≤{i,u} $\gg$ *Δ_{Ft}≤{ə} $\parallel$ is needed in Nganasan to conflate high vowels and schwa. If *Δ_{Ft}≤{ə} universally outranks *Δ_{Ft}≤{i/u}, schwa cannot be conflated with high vowels.

Generalizing, in order to get conflation of central and high vowels there *must* be some markedness constraint that assigns the same violations to stressed schwa and stressed high vowels. This fact makes the potential for [pi(tə́ki)tə] to be favoured over [(pítə)(kìtə)] inevitable if the theory is to deal with conflation.

- *Reconsidering the effect*

The particular problem of [pi(tə́ki)tə] vs [(pítə)(kìtə)] will be the focus here since the sonority scale is the focus of this dissertation. To recap, the fear is that *Δ_{Ft}≤{i,u} causes a reversal of the sonority hierarchy: stress seemingly avoids high vowels for schwa. However, this is only superficially so.

*Δ_{Ft}≤{i,u} has two effects: (i) it favours mid and low peripheral vowels over high vowels and schwa and (ii) it promotes minimization of structure (specifically, minimization of the number of stressed syllables). In its second property, it is like every other negatively formulated markedness constraint: *f favours candidates with fewer instances of f over those that contain more f's.

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[38] The critique below also applies to the other three solutions in Prince (1999), some of which are too complex to discuss briefly here – see Prince (1999:4ff) for discussion.

To illustrate $*\Delta_{Ft}\leq\{i,u\}$'s structure-minimizing effects, compare two candidates from input /pitikiti/: (a) [(píti)(kìti)] vs (b) [pi(tíki)ti]. Candidate (a) violates $*\Delta_{Ft}\leq\{i,u\}$ twice, while (b) violates it only once. Sonority clearly plays no crucial role here; the winner is solely determined because $*\Delta_{Ft}\leq\{i,u\}$ – like all negative markedness constraints – prefers a minimum of structure (i.e. stressed syllables, in this case).

Returning to the central case, it is clear that $*\Delta_{Ft}\leq\{i,u\}$ prefers [pi(tə́ki)tə] over [(pítə)(kìtə)] for two reasons: (i) [pi(tə́ki)tə] has less structure than [(pítə)(kìtə)] and (ii) $*\Delta_{Ft}\leq\{i,u\}$ conflates schwa and high vowels. Point (ii) is the source of the apparent problem: because high vowels and schwa are conflated, the structure-minimization aspect of the constraint can show through. So, the effect of $*\Delta_{Ft}\leq\{i,u\}$ can be informally described as "In a word with only high vowels and schwa, minimize feet." The fact that a less sonorous vowel ends up stressed is an entirely incidental side effect of the structure-minimization aspect of $*\Delta_{Ft}\leq\{i,u\}$.

So, $*\Delta_{Ft}\leq\{i,u\}$ plays much the same role in this case as FTBIN does in Gujarati. As shown for Gujarati, FTBIN bans final stress. In a competition like [(kə́ɾe)] vs *[kə(ɾé)], the surface effect is as if the scale has been reversed: stress seems to prefer [ə] for the mid peripheral vowel [e]. However, this apparent reversal is only incidental – it is a side effect of the pressure for binary left-headed feet.

In short, a language in which $*\Delta_{Ft}\leq\{i,u\}$ alone is active in the particular way described above will produce an effect such that (i) stress will avoid high vowels and schwa for mid and low peripheral vowels (as in Nganasan) and (ii) in words with only high vowels and schwa the candidate with the minimum number of stressed syllables will win.

To sum up, the potential problem identified by Prince (1999) does not apply in the narrow confines of the sonority-driven case applied here. The apparent problem is simply analogous to cases attested in natural language: constraints may eliminate sonority-sensitivity in particular environments. $*\Delta_{Ft}\leq\{i,u\}$ inherently eliminates sensitivity to the distinction between schwa and high vowels, allowing its structure-minimization aspect can show through in this particular case.

As a concluding note, Prince's (1999) problem is more generally applied to stringent constraints, as he shows with a 'structural' scale of the type $|\,CC]_\sigma \rangle C]_\sigma\,|$. Since such structural scales are not considered in this dissertation, the implications of this fact will not be considered here.

3.5.1.3 Positive and negative constraints

At this point it is timely to consider positively formulated constraints, since they have properties that seem to deal with the issue raised in the preceding section. However, positive constraints raise other problems, identified for non-stringent constraints in de Lacy (1999a, 2000a), and extended to stringently formulated constraints here.[39]

The constraints proposed in this work are negatively formulated: they ban structures rather than require them. In other words, the constraints assign a violation to a

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[39] My thanks to Moira Yip and the audience at the Tone Workshop in Tromsø for their comments on a paper that closely relates to the points in this section. For further critical discussion of positive constraints of the type discussed here and their properties, see Yip (2000).

candidate if it contains some structure Σ. In contrast, positive constraints *require* certain structures: they assign violations to a candidate if it does not contain some structure Σ. For example, the constraint $\Delta_{Ft}\rightarrow$[a] requires all stressed syllables to contain the vowel [a].

To put the negative-positive distinction in more formal terms, negative constraints have the form *Σ, where Σ is some structure. Negative constraints are evaluated by taking the 'power structure' of a candidate (i.e. the set of all possible substructures of a candidate's prosodic and featural structure); the number of violations incurred is the same as the number of distinct structures in the power structure that are identical to Σ. In contrast, positive constraints with the form $x\rightarrow y$ require that every *x* be related to *y* (usually through the association relation); every *x* that is not so related incurs a violation.

For sonority-driven stress, positively formulated non-stringent constraints have been proposed by Crosswhite (1999); positively formulated stringent constraints are employed in de Lacy (1997a).

- *The pile-up problem*

A difference between positive and negative constraints is the 'pile-up' effect: where greater complexity in relation to a property *p* (usually more instances of *p*) is preferred over less complexity.

Negative constraints favour less structure over more – this property was at the core of the issue discussed in the preceding section. In contrast, positive constraints favour more structure over less. The tone-DTE constraints in (53) illustrate this point well; H stands for 'high tone', M for 'mid tone', and L for 'low tone'. The constraints in (53) are non-stringent since positive non-stringent constraints exhibit the pile-up problem in a far more transparent manner; the result will be extended to positive stringent constraints below.

(53)   (a) $*\Delta_\sigma$/L » $*\Delta_\sigma$/M » $*\Delta_\sigma$/H
        (b) $\Delta_\sigma\rightarrow$H » $\Delta_\sigma\rightarrow$M » $\Delta_\sigma\rightarrow$L

As an example, the constraint $\Delta_\sigma\rightarrow$H requires syllable DTEs to be associated to a high tone. The problem with these constraints is that they do not simply favour higher tone over lower tone, but *contour* tones over *simplex* tones. This is because a contour tone as in [pâ] satifies both $\Delta_\sigma\rightarrow$H and $\Delta_\sigma\rightarrow$L (i.e. it violates $\Delta_\sigma\rightarrow$M only), while [pá] violates both $\Delta_\sigma\rightarrow$M and $\Delta_\sigma\rightarrow$L.

The following tableau illustrates this point. In this grammar, an underlyingly toneless syllable is required to have tone on the surface. The ban on contour tones is ranked below $\Delta_\sigma\rightarrow$L, with the consequences seen in (54).

(54)

/pa/	$\Delta_\sigma{\to}$H	$\Delta_\sigma{\to}$M	$\Delta_\sigma{\to}$L	*CONTOUR
(a) pá		*!	*	
(b) pā	*!		*	
(c) pà	*!	*		
(d) pâ		*!		*
☞ (e) pa^{HLM}				*

In short, positive constraints predict a language where the epenthetic tone is a contour tone, not a singleton. Moreover, if the positive constraints are ranked above DEP-T – a constraint prohibiting tone epenthesis (Myers 1997) – they will produce a language in which *all* syllables bear contour tones, and none have singletons.

This result is clearly undesirable. No language is reported to have contour tones on all syllables (Cheng 1973, Pike 1948, Ping 1999).

The same problem arises in many other situations as well. For example, Prince & Smolensky's (1993) sonority-margin constraints are formulated negatively (*MAR/glide » *MAR/liquid » *MAR/nasal » *MAR/fricative » *MAR/stop). The constraints' positive counterparts would cause a pile-up problem for margins. The best onset and coda would be [tsfnlj], as it satisfies all the constraints MAR→glide, MAR→liquid, MAR→nasal, MAR→fricative, MAR→stop. More generally, positive margin-sonority constraints favour complex margins over simplex ones. This also raises a significant typological problem: there is no language that requires complex margins but bans single-segment ones.

In contrast, negative constraints do not produce the pile-up result. Since negative constraints favour less structure over more, they universally prefer singletons to contour tones, as shown in tableau (55).

(55)

/pa/	*Δ_σ/L	*Δ_σ/M	*Δ_σ/H	*CONTOUR
☞ (a) pá			*	
(b) pā		*!		
(c) pà	*!			
(d) pâ	*!		*	*
(e) pa^{HLM}	*!	*	*	*

The same argument holds for sonority. Positive constraints prefer DTEs that contain rising diphthongs to those with singletons. For example, the structure in (56a) satisfies both $\Delta_\sigma{\to}$[a] and $\Delta_\sigma{\to}$[i,u], while (56b) does not (the structural assumptions for rising diphthongs follow McCarthy 1995). This predicts – among other things – that rising diphthongs could be epenthetic.

(56)   <u>Diphthong Pile-Up</u>

(a) μ   (b) μ

                  i   a   a

The same can be argued for positive constraints for Place of Articulation: the coarticulated [kp] satisfies both [Place]→[labial] and [Place]→[dorsal], so being more harmonic than just [k], [p], or even [t].

- *Stringency and the pile-up problem*

The problem identified above also arises for positive stringent constraints. Negative and positive stringent tonal constraints are provided in (57).

(57)   Stringent DTE-tone constraints
        (a)   *Δ$_\sigma${L}, *Δ$_\sigma${L,M}, *Δ$_\sigma${L,M,H}
        (b)   Δ$_\sigma$→{H}, Δ$_\sigma$→{H,M}, Δ$_\sigma$→{H,M,L}

As an example, the constraint Δ$_\sigma$→{H,M} requires syllable DTEs to be either high- or mid-toned.

The pile-up problem does not arise as directly with the positive stringent constraints. For example, the competitors [pá] and [pâ] both do equally well on the constraints in (57).

However, the pile-up problem re-emerges when both DTE and non-DTE constraints are considered. As discussed at length in chapter 4, and mentioned in chapter 2, a segment can be both a DTE and a non-DTE. For example, in [('pati)], [i] is a DTE of a syllable, but a non-DTE of a foot. The problem arises when the conflicting conditions on DTEs and non-DTEs are both active. For example, Δ$_\sigma$→H requires [i] to bear a high tone, but the non-DTE constraint -Δ$_{Ft}$→L requires [i] to bear a low tone. Thus, the most harmonic form for [i] to take is again the contour tone [î]. With positive constraints, the tonally optimal form of /pati/ is therefore [('pátî)].

So, positive DTE and non-DTE constraints can work together to create the unattested situation whereby all unstressed syllables bear a contour tone while all stressed ones bear a simplex one (tableau (58)).

(58)

/pati/	Δ$_\sigma$→{H}	-Δ$_{PrWd}$→{L}	*contour
(a) ('pátí)		*!	
☞ (b) ('pátî)			*
(c) ('pâtî)			* *!

In contrast, negative constraints cannot produce such a pattern. Consider the constraints *Δ$_\sigma$/{L} and *-Δ$_{PrWd}$/{H}. These constraints cannot both be satisfied by having

a contour tone on a PrWd non-DTE. It is most harmonic to minimize tones in this situation, inevitably violating one or the other constraint.[40]

In short, positive constraints encounter the 'pile-up' problem: they favour more structure over less, either individually or through their interaction. In contrast, negative constraints favour less structure over more.

3.5.2   Factors that never play a role in stress assignment

The present theory makes restrictive predictions about possible hierarchical relations between vowel categories in sonority-driven stress. Specifically, the constraints cannot produce a system in which stress avoids higher sonority vowels for lower sonority ones – in other words, where the sonority hierarchy is reversed, unless some incidental factor intervenes (e.g. a ban on final stress).

The reason for this restriction relates to how the present theory assigns violations. Every $*\Delta_\alpha/x$ constraint favours higher sonority DTEs over lower sonority ones, so there is no ranking of these constraints that will force stress to avoid high sonority vowels.   While [a] attracts stress in several languages (e.g. Abelam, Gujarati, Kara, Kobon, Yimas)[41], there is no language in which it repels stress. The same can be said for mid vowels over high vowels (e.g. Abelam, Asheninca, Chukchi, Kobon, Komi, Mordwin), for high vowels over schwa (e.g. Chukchi, Gujarati, Lushootseed, Malay, and many others), and for high vowels over [ɨ] (e.g. Pichis Asheninca).

One issue this typology raises is not why stress is sensitive to sonority, but rather why it is not sensitive to so many other properties. There are no stress systems in which subsegmental features such as Place of Articulation or backness in vowels plays a role in assigning stress. The same goes for features such as [round], [nasal], and secondary articulation. An example of such an unattested system is one in which stress falls on the leftmost round vowel, otherwise on the initial syllable: e.g. [páta], [póto], [póta], [pató].[42]

The present theory provides a response to this issue by drawing a fundamental distinction between prosodic and featural scales: the former combine with structural elements to form constraints, while the latter do not. The empirical effect of this division is that only prosodic features (i.e. sonority, tone, structure) may play a role in affecting stress placement.

For stress to be sensitive to a property *p*, there must be some markedness constraint that distinguishes between a stressed syllable with *p* and one without *p*. Therefore, main

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[40] As a matter of fact, the most harmonic response to the two constraints is to have mid tone on non-DTEs, as attested in a number of languages (e.g. Ayutla Mixtec has epenthetic mid tones – Pankratz & Pike 1969).
[41] Abelam – Laycock (1965); Pichis Asheninca – J.Payne (1990); Chukchi – Krause (1980), Kenstowicz (1996); Gujarati – §3.3, Cardona (1965); Kara – Schlie & Schlie (1993), de Lacy (1997a) ; Kobon – Davies (1981), Kenstowicz (1996); Komi – Itkonen (1955), Lytkin (1961) ; Lushootseed – Urbanczyk (1996); Malay – Lapoliwa (1981); Mordwin – Kenstowicz (1996), Zaicz (1998), Jack Reuter p.c.; Yimas – Foley (1991).
[42] Stress in the Australian language Madimadi has been claimed to exhibit sensitivity to place of articulation of onset consonants (Hercus 1969, Davis 1985). However, Gahl (1996) has proposed an alternative analysis, where stress is only sensitive to morphological structure. Similarly, Crowhurst & Michael (2002) show that syllables with nuclei of [ɯi] attract stress over those with [i] nuclei in Nanti. It is clear that sonority is not the only relevant factor in this system: it is probably the case that [ɯi] attracts stress because of its greater moraic content.

stress can be sensitive to the presence of [ə] because there is a constraint $*\Delta_{PrWd}\leq\{ə\}$. However, main stress cannot be sensitive to vowel roundness because there is no constraint $*\Delta_{PrWd}\leq[+round]$.

Similarly, constraints such as $*\Delta_\alpha/midV$ also cannot exist for empirical reasons. This constraint rules out mid vowels in DTEs, predicting a language in which DTEs avoid mid vowels for less sonorous vowels. Tableau (59) illustrates this point for sonority-driven stress. With $*\Delta_{PrWd}/midV$ ranked above all other PrWd-DTE markedness constraints and stress locating constraints, stress will avoid a mid vowel for a high vowel – an unattested system.

(59)

/petito/	$*\Delta_{PrWd}/midV$	ALLFTL
(a) (péti)to	*!	
☞ (b) pe(títo)		*

The ban on constraints like $*\Delta_\alpha/midV$ also follows from the scale combination restriction: 'mid vowel' is not the most marked category of any prosodic scale, so it cannot combine with prosodic elements.

- *Reduction and Faithfulness*

An opaque type of stress sensitivity to subsegmental features can be caused by constraints that mention prosodic positions. This section discusses the effect of positional markedness constraints; they can be used to force deviation from the default prosodic structure if doing so will preserve some feature value that would otherwise be lost.

For example, suppose there is a language in which all unstressed syllables reduce to [ə]. Suppose also that faithfulness to vowel roundness – IDENT[+round] – is ranked above all stress-placement constraints (i.e. ALLFTL, for argument's sake). Stress will move to a non-initial position if doing so will prevent a round vowel from reducing. Tableau (60) illustrates this point.

(60)

/pato/	$*-\Delta_{PrWd}\geq\{i,u\}$	IDENT[+round]	ALLFTL
(a) (páto)	*!		
(b) (pátə)		*!	
☞ (c) pə(tó)			*

Candidate (a) is ruled out because the unstressed vowel is not [ə] – $*-\Delta_{PrWd}\geq\{i,u\}$ assigns a violation to all unstressed (and secondary stressed) syllables that contain a peripheral vowel. Candidate (b) has stress on the leftmost syllable, so satisfying ALLFTL. However, by doing so, /o/ is forced to reduce to [ə], losing its roundness. This unfaithfulness to [round] fatally violates IDENT[+round], dooming candidate (b). The only remaining candidate is (c), with stress on the round vowel.

The net result is effectively a system in which stress falls on the leftmost round vowel, and unstressed vowels reduce. Under this ranking, stress seems to be sensitive to subsegmental features, albeit in an opaque way.

On the other hand, the surface form does not violate the generalization that stress falls on the most sonorous element: stress falls on [o], which is more sonorous than [ə]. The question now is whether a system could be set up in which stress is sensitive to a subsegmental feature and the *output* has a stressed vowel that is less sonorous than unstressed ones, due to sensitivity to some subsegmental feature.

- *The Wilsonian problem*

The type of concern just outlined comes to the fore in considering observations by Wilson (1999, 2000). Wilson observes that positional faithfulness constraints can be used to force a change in prosodic structure if doing so will help eliminate marked structures.

Imagine a system in which a change in sonority does not take place in unstressed syllables, but rather roundness is neutralized (any other vowel feature – e.g. nasality – could also be used). In other words, round vowels are only contrastive in stressed syllables, and eliminated elsewhere: /poto/ → [póte]. Can the desire to eliminate [+round] force a change in stress with the result that the stressed vowel is less sonorous than the unstressed one? In such a case, /poti/ would emerge as [petí], not as *[póti] with stress on the (default) initial syllable.

The answer is "yes", but in a rather opaque sense.

To explain, in the present theory [round] is not a prosodic property, so it cannot combine with a (non-)DTE position to form a constraint. To eliminate the [round] contrast in unstressed syllables, then, the only option is a positional faithfulness analysis (Beckman 1998; also see this chapter, §3.5.1.1). Thus, || б́-IDENT[round] » *+round » IDENT[+round] ||. As shown above, ALLFTL must be ranked below IDENT[+round].

The form /poti/ is at issue here.

(61)

/poti/	б́-IDENT[round]	*+round	IDENT[+round]	ALLFTL
(a) póti		* !		
(b) potí		* !		*
(c) péti	* !		*	
☞ (d) petí			*	*

The tableau shows that stress does end up on the less sonorous vowel [i] from input /poti/; stress does not fall on the default leftmost position. This is due to the effect of *+round. This constraint aims to minimize the number of round vowels in a form, but is blocked in its work by б́-IDENT[round]. The solution is to move stress onto an unround vowel, as in (d), and so neutralize all round vowels in unstressed syllables.

In short, this is a system where stress falls on the leftmost unround vowel, then all unstressed round vowels neutralize.

However, it is not a system in which – on the surface – less sonorous vowels always beat more sonorous vowels. Although /poti/ is realized as [petí], it contrasts with input /peti/, which is realized as [péti] under the ranking above. In /peti/→[péti], stress clearly does not avoid the more sonorous [e] for [i]. The result is that the system – on the surface – has lexical stress: there are surface forms that contrast only in the position of stress: [péti] (from /peti/) vs [petí] (from /poti/). Roundness, then, acts as little more than a diacritic for stress avoidance in this system. Crucially, it does not create a system where – on the surface – stress always avoids high sonority vowels for lower sonority ones. Similarly, on the surface stress does not avoid round vowels for unround vowels; there certainly is stress-sensitivity to roundness, but in a rather indirect fashion.

- *Summary*

To summarize, stress is never sensitive to subsegmental features. This observation partly follows from the proposal that DTEs may not combine with subsegmental features in constraints.

However, stress sensitivity to subsegmental features can follow as a byproduct of a sonority-based contrast neutralization (i.e. vowel reduction and roundness neutralization), whether by means of positional faithfulness or positional markedness constraints. In other words, stress sensitivity to subsegmental features is possible, but only in an opaque way: stress can avoid vowels based on their roundness, but only if their roundness is neutralized on the surface. The result is a system that – on the surface – apparently has lexical stress, not sonority-sensitive stress. In short, it is always true that in no language stress avoids a high sonority stressed vowel for a lower sonority one in all environments (i.e. putting aside interfering factors like foot form).[43]

3.5.3   Hierarchical form: Subhierarchies and *n*-ary scales

Part of the present theory's hierarchy effects derives from the form of the sonority scale.[44] The idea that there is a single sonority hierarchy to which scale-constraints refer was adopted in chapter 2. There is a possible alternative though: the sonority hierarchy may in fact be several subhierarchies, each covering part of the sonority scale (e.g. Gnanadesikan 1997). For example, the vowel sonority scale may be considered to be made up of two scales: one for peripherality | *central 〉 peripheral* |, and one or two for height | *high 〉 mid 〉 low* | (or even | *–low 〉 +low* | and | *+high 〉 –high* |).

- *Scale reversals*

In many cases it is difficult to distinguish the empirical effects of subscales from having a single scale. However, there is a disambiguating phenomenon: when the

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[43] One way around this is if *only* round vowels reduce to [ə]: i.e. /patota/ → [pátəta]. The ranking ‖ IDENT[+round] » ALLFTL ‖ could then prevent round vowels from neutralizing, producing [patóta], where stress falls on [o], avoiding the more sonorous [a]. However, vowel reduction never targets round vowels without also targeting unround vowels (Crosswhite 1998), so this situation will never arise for independent reasons.

[44] I am grateful to the audience at Haskins Laboratories for comments on a talk that closely relates to this section.

hierarchical relation between two categories can be either way in particular grammars. As an example, the vowel peripherality scale and the vowel height scale mentioned above encode many of the same hierarchical relations between categories as the single sonority scale employed in this chapter. However, schwa outranks high vowels on the Height scale, but the opposite ranking holds on the Peripheral scale. Therefore, languages with both rankings are predicted to appear.

The problem for this particular example is that the vowel sonority scale is remarkably rigid in its hierarchical relations. Sonority-driven stress, for example, always treats [ə́] as worse than stressed high vowels. The same is true for the relations between low, mid, and high vowels. For consonant sonority, syllabification shows that the | *vowel* ⟩ *liquid* ⟩ *nasal* ⟩ *obstruent* | hierarchy is also inviolate, suggesting that the Sonority hierarchy consists of a single scale rather than several interacting subscales (see Parker 2002 for a similar conclusion for different reasons).

It is important to note, though, that the present theory does not predict that the Sonority hierarchy must be a single unified scale. As with any scale, such a determination must come about through evidence. Situations of indeterminate ranking are simply a way to determine whether a hierarchy is derived from several subscales or a single scale.

In that regard, an example of a place where subhierarchies may be relevant is with respect to obstruent voicing. In some versions of the sonority hierarchy, voiced obstruents are universally more sonorous than voiceless obstruents: | *voiced fricatives* ⟩ *voiced stops* ⟩ *voiceless fricatives* ⟩ *voiceless stops* | (e.g. Jespersen 1904, Bolinger 1962, Alderete 1995). Others make the cut between fricatives and stops: | *voiced fricatives* ⟩ *voiceless fricatives* ⟩ *voiced stops* ⟩ *voiceless stops* | (e.g. Selkirk 1984, Dell & Elmedlaoui 1985, 1988, Ladefoged 1993, Blevins 1995, and many others). Suppose for argument's sake that there is evidence that both rankings are valid for particular grammars. Such a situation indicates an indeterminate ranking: | voiced stop ⟩ voiceless fricative | holds in one grammar, while | voiceless fricative ⟩ voiced stop | in another. Such a situation would indicate that there are two subscales, such as an Obstruent Voicing scale | voiced ⟩ voiceless | and an Obstruent Continuancy scale | fricative ⟩ stop |. Since voiced stops are higher on the scale than voiceless fricatives in the former but the opposite relation holds in the latter, such scales would predict variable ranking.

In short, there are reasons of theoretical implementation that some scales cannot be decomposed into several smaller subscales. The reasons relate to natural class behaviour and the formal expression of hierarchy; both of these issues are discussed in turn below.

- *Natural classes*
Suppose that the vowel sonority scale | ə ⟩ i,u ⟩ e,o ⟩ a | can be decomposed into a series of binary scales: (a) | ə ⟩ i,u,e,o,a |, (b) | ə,i,u ⟩ e,o,a | and (c) | ə,i,u,e,o ⟩ a |. Since these scales are consistent in terms of their hierarchy, they will have an effect similar to that of a single unified scale, as discussed in the preceding section.

However, the present theory draws a direct relation between scales and features. Thus, decomposing a scale in the way just outlined implies that there are three binary features, called f_a, f_b, and f_c, each expressing the scales in (a), (b), and (c) above. For argument's sake, from scale (a), [ə] is [$-f_a$] and [i u e o a] are all [$+f_a$]; from scale (b), [ə i

u] are all [$-f_b$] while [e o a] are all [+f_b]. Similarly, from (c), [ə i u e o] are all [$-f_c$] while [a] is [+f_c].

Some of the features have analogues in current feature theories. For example, [f_c] classes sounds in the same way as [low] does, and [f_a] distinguishes between peripheral and central vowels.

However, proposing such features raises the question of their behaviour in other phonological processes. After all, proposing a new feature is no trivial matter. The feature can be expected to participate in dissimilation, assimilation, harmony, coalescence, and a multiplicity of other phonological processes. For example, [low] is a reasonable feature because it participates in assimilation and dissimilation (e.g. Kera – Suzuki 1998), and in vowel harmony (van der Hulst & van der Weijer 1995:519ff).

But what of a feature such as [f_b]? There is no vowel harmony whereby every vowel must be either one of [ə i u] or one of [e o a]. However, with a feature like [f_b] it would be a simple matter to construct such a case. There is similarly no evidence for assimilation and dissimilation of [f_b].

In general, proposing that multi-valued scales can be decomposed into smaller scales raises the issue of natural classes: if there is a scale | ə,i,u ⟩ e,o,a | and a corresponding binary feature, why do [ə] and [i u] not act as a natural class for a variety of other phonological processes?

The same question can be asked for the Place of Articulation scale, which is | dorsal ⟩ labial ⟩ coronal ⟩ glottal | (ch.5§5.3). If this scale is decomposed into a series of binary scales (a) | dorsal ⟩ labial, coronal, glottal |, (b) | dorsal, labial ⟩ coronal, glottal | and (c) | dorsal, labial, coronal ⟩ glottal | – with corresponding features to boot – this predicts that dorsal and labial will act as a class (after scale (b)) for processes like assimilation and dissimilation. Scale (b) implies that there is a feature *f* and dorsals and labials are [$-f$] while coronals and glottals are [+*f*] (or vice-versa – the choice of value is immaterial). Thus, one could rightly expect a process in which dorsals dissimilate in the presence of labials and vice versa: e.g. /kapa/ → [tapa], cf /tapa/ → [tapa]. I know of no such dissimilation process.

The same is true of assimilation: consonants should be expected to assimilate in [*f*] value. So, one would expect to find a situation where /anka/ → [amka]. In this case, the [+*f*] /n/ assimilates to the [–*f*] value of /k/. Since both labials and dorsals are [–*f*], the /n/ has a choice of surfacing as [m] or [ŋ]. In this particular grammar, because [ŋ] is more marked than [m], /n/ becomes [m]. Tableau (62) illustrates this situation.

(62)

/anka/	*ŋ	AGREE[*f*]	IDENT[*f*]
(a) anka		*!	
☞ (b) amka			*
(c) aŋka	*!		*

AGREE[*f*] requires adjacent consonants to agree in *f*-value (Lombardi 1996, 1999). So, because [n] is [+*f*] and [k] is [–*f*], candidate (a) falls afoul of AGREE[*f*]. The two

remaining options are for /n/ to surface as [m] or [ŋ] – both are [–*f*]. The constraint *ŋ decides the matter – it bans dorsal nasals, so ruling out (b) (see chs.6,7 for more on this constraint).

The net result is that /n/ turns into [m] before [k]. This type of assimilation does not take place (see ch.7).

The multi-valued feature approach avoids the issue just described. The processes identified above – assimilation, dissimilation, and harmony – all require agreement in terms of a certain feature value. With a multi-valued feature like [Sonority] or [Place], there is a distinct value for every category. For example, dorsals are [*xxx*Place] and labials are [*xxo*Place]. In terms of processes that refer to feature value identity – like assimilation and dissimilation – labials and dorsals will not act as a class because their feature values for [Place] are different. This rests on the assumption that all constraints that require identity are like the IDENT ones proposed here (for discussion see ch.5).

In short, multi-valued features allow classes to be defined without appealing to some aspect of identity between elements. So, there is no feature value that schwa and high vowels share that mid and low vowels do not share, yet they can be referred to as a class for sonority due to the nature of the scale-referring constraints proposed here.

- *Maintenance of hierarchies*

Suppose there is a single 3-element scale $| \gamma \rangle \beta \rangle \alpha |$. This would have three constraints: *{γ}, *{γ,β}, and *{γ,β,α}. As demonstrated in ch.2 and this chapter, these constraints formally implement the hierarchy expressed by the scale.

Now suppose that this scale was really three separate scales: (a) $| \gamma \rangle \alpha |$, (b) $| \beta \rangle \alpha |$, and (c) $| \gamma \rangle \beta |$. The present theory would generate six constraints: (a) *{γ}, *{γ,α}; (b) *{β}, *{β,α}, and (c) *{γ}, *{γ,β}.

With free ranking of these constraints, all hierarchical relations in the subscales are lost. For example, *{β} can outrank *{γ}, so eliminating the hierarchy in the scale $| \gamma \rangle \beta |$. Similarly, *{γ,α} can outrank *{β}, so reversing the hierarchy $| \beta \rangle \alpha |$; the same is true for the ranking $|| *\{β,α\} \gg *\{γ\} ||$, which reverses the scale $| \gamma \rangle \alpha |$.

In short, the mechanisms proposed here effectively eliminate the hierarchies encoded in the subscales given above. The only way to produce the hierarchy $| \gamma \rangle \beta \rangle \alpha |$ is to have a single unified scale, and consequently three constraints *{γ}, *{γ,β}, and *{γ,β,α}.

Of course, one may object to the point made above on the grounds that either (a) some other constraint-creation algorithm could be used or (b) some meta-condition prevents certain constraints from being produced. Without a concrete proposal for (a), it is pointless to pursue this issue further. As for (b), one obvious meta-condition that could be proposed is that if $| x \rangle y |$ on any scale, then there can be no constraint that favours *y* over *x*. However, such a condition is much too strong. Different scales can reverse favouring relations between different types of elements: a segment's markedness is not an absolute notion, but only relative to a particular scale. More concretely, chapter 6 argues that coronals are more marked than glottals on the PoA scale, but the opposite is true in another scale.

- *Summary*

In summary, it is not a trivial matter to decompose a single multi-member scale into several smaller scales. Doing so has the potential to eliminate hierarchical relations in scales. It also may predict unattested class behaviour.

As a concluding comment, whether sonority or any other property is a single unified scale or is composed of several smaller scales is not a question that can be easily answered outside a particular theory of the formal implementation of scales. The theory presented in this dissertation makes clear predictions about the consequences of having single scales or a multiplicity of smaller scales, as identified above.

3.5.4 Typology of conflation

This section identifies the present theory's predictions for conflation. The theory requires some categories to conflate, allows others to optionally conflate, and prevents other conflations from ever happening. Section 3.5.4.1 deals with required conflations, while §3.5.4.2 examines the other two types.

3.5.4.1 Conflation by constraint form

The present theory requires some 'universal' conflations: where two categories are always treated alike. Since two categories *x* and *y* are distinct iff some constraint favours one over the other, it follows that two categories are never distinct if there is no such constraint.

An example of a universal conflation is the distinction between [í] and [ú]. No constraint proposed here favours one over the other; therefore, it is trivially true that for every possible ranking, all constraints that distinguish [í] from [ú] are inactive; therefore, [í] and [ú] are conflated. This particular prediction is borne out by the fact that no stress system treats these two categories differently. There is no language, for example, where stress seeks out the leftmost [i], avoiding a [u] closer to the default stress position (or vice versa). Similarly, no language treats [e] as distinct from [o] for stress purposes, so the same explanation holds: there is no constraint that favours [é] over [ó], or vice versa.

3.5.4.2 Contiguous conflation

As shown in sections 3.3 and 3.4, conflation is not only effected by constraint form, but by ranking as well. Section 3.3 showed that schwa and high vowels could conflate for stress purposes, as could mid and low vowels; §3.4 showed that high and mid vowels could conflate. However, not all imaginable conflations are possible. (63) is an empirical generalization about the conflations observed in sonority-driven stress systems.

(63)   The Conflation Generalization
  • *x,y,z* are members of some scale S
  If *x* and *y* are conflated into a single category C,
  and *z* is between *x* and *y* in S (i.e. | *x* 〉 *z* 〉 *y* | or | *y* 〉 *z* 〉 *x* |)
  then *z* is conflated into category C.

In other words, a set of categories can only conflate if they form a contiguous part of the scale. Prince (1997 et seq.) shows that fully permutable stringent constraints place no other restrictions on conflation, predicting that any conflation of contiguous categories can happen. Support for this generalization is given in the table below. Building on Prince (1999) and my own work (de Lacy 1997a, 2000a), almost every possible contiguous conflation in stress-sonority interaction is attested.[45]

Table 3.5: Stress conflation typology[46]

Categories				Languages	Active Constraints
ə	i/u	e/o	a	Kobon (Davies 1981)	all *Δ/*x*
ə	i/u	e/o	a	Gujarati (§3.4)	*Δ≤ə, *Δ≤{e,o}
ə	i/u	e/o	a	Asheninca (Payne 1990)	*Δ≤ə, *Δ≤{i,u}
ə	i/u	e/o	a	Yil (Martens & Tuominen 1977)	*Δ≤ə
ə	i/u	e/o	a	-	*Δ≤{i,u}, *Δ≤{e,o}
ə	i/u	e/o	a	Nganasan (§3.3, Helimski 1998)	*Δ≤{i,u}
ə	i/u	e/o	a	Kara (Schlie & Schlie 1993)	*Δ≤{e,o}
ə	i/u	e/o	a	all vowels are treated the same	

  (i) 'ə' stands for any central vowel [ə ɨ ʉ]

The only gap is a language that conflates [ə́] and [í ú] but distinguishes mid from low vowels. In such a grammar, stress would be much as in Nganasan, except that it would retract from a mid vowel penult to a low vowel. I assume that this gap is accidental.

•   *Non-contiguous conflation*
  Missing in the table above – and in the data collected – is a language that conflates non-contiguous categories. For example, there is no language that treats high vowels and low vowels in the same way and distinguishes both types from mid vowels for stress placement. More concretely, there is no language like the one described in (64).

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[45] Categories are marked as conflated if they are grouped inside the same box. For example, the mid and low vowels are conflated in Asheninca, but the central and high vowels are not. Note that 'ə' stands for any central vowel (e.g. Asheninca has [ɨ], not schwa).
[46] The table does not list every sonority distinction. For example, the distinction between tense and lax vowels is not discussed, nor is the distinction between types of central vowels. These omissions are due to lack of data, so I will not comment further on this issue.

(64)   Non-Contiguous Conflation
        (a) Stress falls on the leftmost high or low vowel [i u a]
                [píta], [píte], [píti]
                [páta], [páte], [páti]
        (b) otherwise it falls on a mid vowel:
                [péte]

In this language, stress avoids a mid vowel without also avoiding a low vowel. In effect, [a] and high vowels have been conflated into a single category.

The reason why the present theory prevents such conflation relates to hierarchies and the fact that non-contiguous conflation requires a reversal in hierarchical relations. If stress avoids mid vowels for high vowels, there must be some constraint that favours stressed high vowels over stressed mid vowels. The present theory has no such constraint; the only constraint that bans stressed mid vowels also bans stressed high vowels: i.e. $*\Delta_{PrWd} \leq \{e,o\}$. In short, such a language would require a reversal in the relative ranking of mid and high vowels.

From a conflation perspective, for [a] and high vowels to be conflated no active constraint can assign them violations. However, for mid vowels to be distinct from both [á] and [í ú], some set of constraints must assign mid vowels unique violations. In the present theory, both $*\Delta_{PrWd} \leq e,o$ and $*\Delta_{PrWd} \leq i,u$ would have to be active to distinguish mid vowels from the others. However, these constraints also distinguish high vowels from [a], meaning that they cannot be conflated. In other words, the present theory constraints necessitate that for a scale $| x > y > z |$, if x is distinct from y and z is distinct from y, then x is not conflated with z.

It is important to note that the predictions of the present theory not only rest on its constraints, but on the idea that CON contains no antagonistic constraints – i.e. constraints that impose the opposite harmonic relations between categories. For example, the constraint $*\acute{\sigma}/midV$ cannot exist; this constraint assigns violations to mid vowels in stressed syllables, thereby favouring stressed high and low vowels over stressed mid vowels. Such a constraint allows for a non-contiguous conflation, thereby subverting the present theory's effects. The fact that such a conflation does not happen indicates that CON does not contain such a constraint.

In summary, the present theory allows for contiguous conflations only, but places no restrictions on which categories conflate or how many separate conflations there may be in a single system.

While this chapter has focused on vowel sonority, there are constraints for every subset of the sonority hierarchy: e.g. $*\Delta_{PrWd} \leq liquid$, $*\Delta_{PrWd} \leq nasal$, etc. With these constraints, the present theory predicts that stressed liquids and nasals should be even less desirable than schwa. This prediction is borne out in the New Zealand dialect of English (my own). Schwa can be stressed: e.g. [bə́t] 'bit', [prə́ti] 'pretty'.[47] However, stress never falls on a liquid or nasal, as in many other English dialects. In words like 'illness', schwa takes the stress: [ə́lnəs], *[l̩nəs].

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[47] The high front lax vowel [ɪ] in other English dialects corresponds to [ə] in New Zealand English.

3.5.5 The conflation-hierarchy implication

The preceding sections have identified the present theory's predictions for hierarchical relations and possible conflations. This section examines dependencies between the two. The present theory predicts (65).

(65) The Conflation-Hierarchy Implication
- *x,y,z* are members of some scale S
  if *x* and *y* are conflated
  and *x* is more harmonic than *z*,
  then *y* is more harmonic than *z*.

For example, the categories 'mid vowel' and 'high vowel' are conflated in Gujarati: neither attracts stress over the other (e.g. [juɾópni], [kʰeɖío]). Mid vowels attract stress away from schwa ([kójəldi], *[kojə́ldi]), so the present theory predicts that high vowels will attract stress away from [ə] too (as indeed they do: e.g. [wísmərən], *[wismə́rən]).

A system that is predicted to not exist is one that is similar to Gujarati, with high and mid stressed vowels conflated and where (i) mid vowels attract stress away from schwa but (ii) stress does not avoid schwa for high vowels, producing [wismə́rən] instead of [wísmərən]. In effect, this situation is one of "Avoid [ə́] only if the alternative is *significantly* better (i.e. a mid vowel)."

I have found no systems like quasi-Gujarati; more generally, there is no language in which the Conflation-Hierarchy Implication does not hold. The reason that the prediction identified above follows from the present proposals is outlined in (66). *x, y,* and *z* refer to scale categories.

(66) Conflation-Hierarchy Implication: reasoning
- *x,y,z* are members of the same scale
  (i) If *x* is more harmonic than *z* then there is some active constraint C_1 which favours *x* over *z*.
  (ii) If *x* is conflated with *y* then no active constraint favours *x* over *y* or *y* over *x*.
  (iii) If no active constraint distinguishes *x* over *y*,
    then C_1 must assign the same violations to *x* as it does to *y*.
  (iv) If C_1 assigns the same violations to *x* and to *y*,
    then C_1 favours *y* over *z* (because C_1 favours *x* over *z* – from (i).)
  (v) Therefore, *y* is more harmonic than *z*.

This outline will now be discussed step-by-step.

If *x* is more harmonic than *y* in a grammar, then some active constraint assigns more violations to *y* than to *x*. For example, [é] is more harmonic than [ə́] in Gujarati because [ə́] violates some active constraint while [é] does not. At this point, it doesn't matter what the constraint is: the present theory offers both $*\Delta_{PrWd} \leq \{i,u\}$ and $*\Delta_{PrWd} \leq \partial$ – either will give the right result. Now, when we say that [é] is conflated with [í] (and [ú]),

we mean that there is no active constraint that distinguishes the two. The constraint *Δ$_\text{PrWd}$≤{i,u} does distinguish [é] from [í], so it cannot be active. This leaves *Δ$_\text{PrWd}$≤ə as the only possible active constraint. But now [í] must be distinct from [ə́]: the latter violates the active constraint *Δ$_\text{PrWd}$≤ə while the former element does not. In this way, it follows purely by the logic of ranking and the form of the constraints that if high and mid vowels are conflated, and mid vowels are actively favoured over schwa, then high vowels are also favoured over schwa.

In a sense, this result reduces to a general property of classical OT: constraints eliminate losers; they do not pick which of the remaining candidates is the winner (McCarthy 2001b:106-7). In other words, if a candidate violates a constraint C, C cannot pick out which of the remaining candidates must be the winner. That job is up to the remaining constraints. For example, if a candidate [apa] violates ONSET, ONSET cannot then designate that [pa] must win; whether [pa] or [ʔapa] wins is determined by other constraints (i.e. MAX and DEP). The same is true of the present situation: if a candidate violates *Δ$_\text{PrWd}$≤ə, it cannot designate that the winning candidate must contain a stressed [a]. Which non-ə́ candidate wins is entirely up to the remaining constraints.

In summary, the present theory places a number of restrictions on conflation. Conflation of non-contiguous categories is not possible, and conflation necessitates certain hierarchical relations.

3.6 Conflation and fixed ranking

The aim of this section is to precisely characterize the types of conflation that fixed ranking scale-theories are able and unable to produce, building on work by de Lacy (1999a, 2000a) and Prince (1999).

In §3.6.1, an individual set of constraints in a fixed ranking is shown to allow only 'high-end conflation' – conflation with the most unmarked scale categories. Section 3.6.2 considers the conflations produced when several sets of constraints in fixed rankings are intermingled. This section shows that although several sets of constraints with a particular complementarity of form allow for a larger number of conflations, they are still unable to produce systems with two or more separate conflated sets of categories (as in Nganasan). Section 3.6.3 summarizes the results.

3.6.1 High-end and low-end conflation

By way of example, the fixed-ranking constraints in (67) will be employed here:

(67) Fixed Ranking Sonority-Stress Constraints (after Kenstowicz 1996)
|| *ə́/ə » *ə́/{i,u} » *ə́/{e,o} » ə́/a ||

As established in previous sections, two categories *x* and *y* are conflated when there is no active constraint that distinguishes between them (see §3.3.2.2 for discussion of 'active'). An active constraint is one that is crucial in picking a winner from some relevant

candidate competition.[48]   For example, since the categories 'stressed high vowel' and 'stressed mid vowel' are conflated in Gujarati, there can be no constraint that assigns different violations to them, and is active – i.e. outranks AᴌɪɢɴFᴛR in this situation.

In contrast, two categories *x,y* are distinct when some constraint that distinguishes *x* from *y* is active. In Gujarati, the categories 'stressed schwa' and 'stressed high vowel' are distinct, so some active constraint must favour one over the other – i.e. *σ́/{ə}.

In Fixed Ranking theories, there are implicational relations between constraint activity: if a constraint *x* is active then all constraints that universally outrank it are also active. For example, if the constraint *σ́/{e,o} is active, then so are *σ́/{i,u}, and *σ́/ə. The forced activity of these constraints prevents conflation of the categories to which they refer. For example, since *σ́/ə is active, the category 'stressed schwa' cannot be conflated with any other category. The same goes for *σ́/{i,u}. An implication of this point is that if a category conflates in a fixed ranking theory, it can only conflate with the unmarked category. For stress, the diagram in (68) graphically illustrates the possible conflations: each oval represents a conflated set. In short, if a category *c* is conflated at all, it is conflated with the most unmarked scale category – [a] in this case.

(68)   Possible conflations under Fixed Ranking
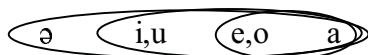
To clarify, the Nganasan low-end conflation case will be reviewed here.

As pointed out above, Fixed Ranking theories can successfully conflate any category with the most unmarked scale element. For example, the categories 'stressed mid vowel' and 'stressed low vowel' can be conflated, in the Nganasan analysis, and repeated here.

(69)

	/ʃajbomtɨ/	AᴌɪɢɴFᴛR	*σ́/{e,o}	*σ́/a
	(a) (ʃájbom)tɨ	*!		*
☞	(b) ʃaj(bómtɨ)		*	

Since all constraints that distinguish the two categories are inactive, the distinction between mid- and low-vowels is successfully eliminated in the ranking in (69).

In this same way, high vowels can be conflated with mid and low vowels for stress – achieved by rendering *σ́/{i,u}, *σ́/{e,o}, and *σ́/{a} inactive through ranking. Finally, stressed schwa can be conflated with high, mid, and low vowels if all sonority-stress constraints are inactive. In all these conflations, though, the conflated categories form a contiguous range of the scale starting with the least marked [á]. This type of conflation is called 'high-end conflation' here.

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[48] For stress, a "relevant candidate competition" involves candidates that differ in stress placement. Properly speaking, the activity of a constraint is relative to specific processes. For example, a constraint may be inactive for stress purposes, yet active in determining the quality of epenthetic material. The meaning of the term 'active' will be self-evident in the following discussion.

However, the Fixed Ranking theory cannot produce 'low-end' conflations, illustrated in (70). Each oval represents a low-end conflation – one that cannot be achieved with a single set of constraints in a fixed ranking.

(70)   Low-end conflations
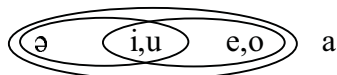
To illustrate, it is impossible for stressed high vowels and mid vowels to be conflated with the Fixed Ranking constraints unless they are conflated with low vowels. To explain, if central and high peripheral vowels are not conflated with low vowels, then constraints that distinguish between high peripheral and central vowels must be active: i.e. *ó/{i,u}, *ó/{ə}. However, if these constraints are active, they have the unfortunate side effect of producing a distinction between high and central-vowels, therefore preventing them from conflating. The relevant tableau from the Nganasan analysis is repeated in (71).

(71)

/hursəɟi/	*ó/{ə}	*ó/{i,u}	ALIGNFTR
(a) hur(sə́ɟi)	*!		
●※ (b) (húrsə)ɟi		*	*

A summary of the results identified above is given below.

(72)   Fixed Ranking and High-End Conflation
   • For all sets of constraints C with constraints of the form *Σ/*x*,
         where *x* ∈ S, S is a scale,
         Σ is some structural element,
         and the members of C are in a fixed ranking
   If *x* is conflated with *y*,
   then *x* is also conflated with *u*.
      • *x,y,u* are members of S.
      • *u* is the unmarked category in S, relative to the structural element Σ.

In other words, a set of constraints in a fixed ranking can only produce 'high-end' conflation – it cannot conflate unmarked categories without also conflating them with marked ones.

3.6.2   Complementary constraints and multiple conflation
If the Fixed Ranking theory can only produce high-end conflation, it follows that the Fixed Ranking theory can only produce one set of conflated categories per system. In other words, a system like Nganasan's is impossible to produce: this language has two

different conflations – of central and high peripheral vowels, and of mid peripheral and low vowels.

To illustrate, a constraint type relevant for conflation here in sonority-driven stress is one that mentions the unstressed syllable (closely equivalent to the non-DTE of the PrWd, in the present theory). Unstressed syllable (ŏ) constraints are provided in (73).[49]

(73) <u>Fixed Ranking unstressed syllable-sonority constraints</u>
      || *ŏ/a » *ŏ/{e,o} » *ŏ/{i,u} » *ŏ/ə ||

Following Prince & Smolensky (1993), Kenstowicz (1996), and the present proposals, the constraints reverse the scale hierarchy, with unstressed low vowels the least favoured type. These constraints are the fixed ranking equivalent of the present theory's *-Δ_{PrWd}/sonority constraints (cf de Lacy 1999a for non-heads and the tonal scale, Prince & Smolensky 1993 for syllable margins).

The constraints have an effect that is very close to that of the *ó/*x* constraints: they favour candidates with stressed low vowels over all others, and so on through the hierarchy. This point is illustrated in tableau (74).

(74)

/pətiketa/	*ŏ/a	*ŏ/{e,o}	*ŏ/{i,u}	ALIGN-ó-L
(a) pə́tiketa	*!	*	*	
(b) pətíketa	*!	*		*
(c) pətikéta	*!		*	* *
☞ (d) pətiketá		*	*	* * *

The tableau shows that the winning form is the one with the stressed low vowel. In a form without low vowels, candidate (c) – with a stressed mid-vowel – would win, and so on through the hierarchy.

As observed in Prince (1999) and my previous work (de Lacy 1999a), the *ŏ/*x* constraints have the same hierarchical effect as the *ó/*x* constraints, they differ in conflation. While the *ó/*x* constraints cannot conflate [ə́] and [í ú], for example, the *ŏ/*x* constraints can do so.

(75)

/pəti/	*ŏ/a	*ŏ/{e,o}	ALIGN-ó-L	*ŏ/{i,u}
☞ (a) pə́ti				*
(b) pətí			*!	

In the tableau above, stress does not avoid schwa for the high vowel, showing that the two categories are conflated. Even so, the activity of *ŏ/a and *ŏ/{e,o} shows that high vowels and schwa are not conflated with any other category.

The reason that the *ŏ/*x* constraints can conflate stressed schwa with stressed high vowels again reduces to the fact that Fixed Ranking theories can produce high-end conflation. Since the sonority scale is reversed in combination with ŏ, schwa is the high end of the scale for this particular set of constraints. So, any conflation with schwa is admissible, effectively producing the conflations diagrammed in (76).

(76)   (((ə   i,u) e,o) a)

The net result is that almost any conflation may take place in the Fixed Ranking theory if both *ó/sonority and *ŏ/sonority constraints exist. To illustrate the empirical effect of this point, a table of conflation types is presented in Table 3.6, with active constraints indicated for each conflation type.

Table 3.6: Conflation typology: Fixed Ranking theory

Categories				Active Constraints
ə	i/u	e/o	a	*ó/ə » *ó/{i,u} » *ó/{e,o}
ə	i/u	e/o	a	*ó/ə, *ŏ/a
ə	i/u	e/o	a	*ó/ə » *ó/{i,u}
ə	i/u	e/o	a	*ó/ə
ə	i/u	e/o	a	*ŏ/a » *ŏ/{e,o}
ə	i/u	e/o	a	*Predicted to be impossible*
ə	i/u	e/o	a	*ŏ/a
ə	i/u	e/o	a	*None*

As indicated, almost every conflation can be done with the Fixed Ranking constraints. However, there is one type that is still predicted to be impossible: the Nganasan system.

The property that sets the Nganasan system apart from the others is that it has two conflations: [ə́]~[í ú] and [é ó]~[á]; all others have just one (or none). This property points to a general result: even with both the *ó/*x* and *ŏ/*x* constraints, the Fixed Ranking theory cannot produce systems with two or more conflations.

To illustrate this point, in order to conflate [ə́] with high vowels, there can be no active constraint that distinguishes the two. This requires *ó/ə to be inactive, and hence all the *ó/*x* constraints to be inactive. Therefore, all the conflations must be due to the *ŏ/*x* constraints.

The *ŏ/*x* constraint that distinguishes [ə́] from [í ú] is *ŏ/{i,u}, as shown in tableau (75) above. Hence, it must be inactive. However, *ŏ/{e,o} must be active in order to distinguish high vowels and schwa from mid vowels. This point is made in tableau (77).

(77)

	/kontuɹa/	*ŏ́/a	*ŏ́/e,o	ALIGNFTR
	(a) kon(túɹa)	*	*!	
☞	(b) (kóntu)ɹa	*		*

However, a problem arises: since *ŏ́/{e,o} is active, *ŏ́/{a} must also be active. Since these two constraints distinguish stressed mid vowels from low vowels, the ranking requires the categories 'mid vowel' and 'low vowel' to be distinct. Thus, mid vowels and low vowels cannot be conflated if high vowels and schwa are also conflated, as shown below.

(78)

	/ʃajbomtɨ/	*ŏ́/a	*ŏ́/e,o	ALIGNFTR
	(a) ʃaj(bómtɨ)	*!		
☀	(b) (ʃájbom)tɨ		*	*

The problem just described results from the general property of constraint activation described above. If a constraint C is active, then all constraints that are in a fixed ranking above it are also active. If a constraint is active and distinguishes x from all other categories, then x cannot be conflated with any other category. Since *ŏ́/{e,o} must be active in Nganasan, *ŏ́/a must also be active. If *ŏ́/a is active, then [á] cannot be conflated with any other category. To generalize: relative to a set of constraints that mention scale S, if category c is not conflated with category d and d is more marked than c on S, then x is not conflated with any category in S. The net result is that there can only be one conflation per system.

Although only the *ó́/*sonority* and *ŏ́/*sonority* constraints have been discussed here, the result generalizes to all sets of structurally complementary scale-referring markedness constraints. So, for any set of fixed-ranking constraints with the form *Σ/x (Σ is a constituent and x is some scale category), if there is a corresponding set of constraints *Σ'/x (Σ' is every relevant structural position except for Σ) then the combined effect of the two constraints allows for every system with a single set of conflated categories. However, it still does not allow for systems with two or more separate conflations. This point is summarized in (79).

(79)   Structurally Complementary Scale Constraints in a Fixed Ranking: Conflation
For a scale S
and two sets of constraints C_1, C_2 on S,
(a) C_1's members have the form $*\Sigma/x$,
            Σ is a structural position, $x \in$ S.
(b) C_2's members have the form $*\Sigma'/x$,
        Σ' is every relevant structural position except for Σ
(c) for all $x,y \in$ S, if $\| *\Sigma/x \gg *\Sigma/y \|$ then $\| *\Sigma'/y \gg *\Sigma'/x \|$
Then the only restriction in conflation on scale S with respect to Σ is that:
        (i) if x is conflated with y and
        (ii) if z is conflated with some category,
        then z is conflated with x and y.

In other words, no two-conflation systems are allowed. By generalizing the result this way, it applies not only to sonority-driven stress, but to all sonority-influenced prosodification, including – for example – syllabification. In addition, the generalization extends beyond the sonority scale to tone (de Lacy 1999a).

3.6.3 Summary

To summarize, a set of scale-referring markedness constraints K in a fixed ranking cannot produce low-end conflation: if c is conflated, it must be conflated with the most unmarked category. If there is a set of constraints that is structurally complementary to K in the way described in §3.6.2, then almost all systems with a single conflation can be produced. However, no systems with two or more conflations can be generated with fixed-ranking constraints, regardless of the number of constraints in CON.

These results are summarized in (80).

(80)   Fixed Ranking Conflation Implication
For all sets of constraints with the form $*\Sigma/s$,
        where s is a point on scale S,
        and Σ is some structural element [optional]
(i) If $*\Sigma/p$ is active, then
for all $x \in$ S s.t. $| x \rangle p |$, $*\Sigma/x$ is active.
(ii) For all y, if $*\Sigma/y$ is active then y is not conflated with any category.
(iii) Therefore, if p is not conflated with any category, then
for all $z \in$ S s.t. $| z \rangle p |$, z is not conflated with any category.

In other words, if x and y are distinct categories and $| x \rangle y |$, then x is distinct from all categories (i.e. x is not conflated with any category), relative to a particular set of constraints.

Importantly, the result above does not apply to sets of constraints $*\Sigma/x$ where there is no corresponding set $*\Sigma'/x$. With such constraints, it is only possible to produce high-end conflation, as established in §3.6.1. Such a system is provided in chapter 4§4.3

(Kiriwina). This system is shown to require constraints that refer to the structural category $-\Delta_{Ft}$ and that there is no set of constraints that refers to the exact complement – i.e. a combination of foot DTEs and unfooted syllables. Since this system has low-end conflation too, it provides crucial evidence for the stringent formulation of scale-referring markedness constraints, like Nganasan.

This section concludes with the point that the property of the Fixed Ranking theory that prevents low-end conflation is its invariant ranking; the fact that its constraints are not stringently formulated is irrelevant. In other words, a theory with stringent constraints in a fixed ranking would also fail to produce adequate conflation. The reason relates to activation – in any fixed ranking theory, if a constraint C is active, it implies that all other constraints that outrank it are also always active. Since constraint activation implies lack of conflation, any fixed ranking theory will have implicational relations between conflations. The fact that any contiguous conflation is possible – and therefore that there are no implicational relations between conflations – shows that scale-referring markedness constraints are freely rankable, and therefore stringently formulated.

Finally, it should be noted that conflation in prosodification is not the only phonological phenomenon that shows the need for stringent constraints. Other relevant phenomena – neutralization and assimilation – are presented in chapters 5 and 7. Nevertheless, conflation in prosodification provides the most transparent evidence for stringent constraint form.

3.7 Summary

This chapter has shown that the ranking of scale-referring constraints must be freely permutable. This property of the present theory enables it to deal with conflation, while fixed ranking places unattested restrictions on possible conflations. In effect, fixed ranking of scale-based constraints makes certain conflations dependent on others: *x* and *y* can only conflate if *y* and *z* have already been conflated.

The dependency relation can be illustrated with the fixed ranking $\parallel$ $*\Delta_{PrWd}\leq\{i,u\}$ » $*\Delta_{PrWd}\leq\{e,o\}$ $\parallel$. If stressed mid vowels are distinct from stressed low vowels, as in Gujarati, then $*\Delta_{PrWd}\leq\{e,o\}$ must be active. But if it is active, then $*\Delta_{PrWd}\leq\{i,u\}$ is also active. If $*\Delta_{PrWd}\leq\{i,u\}$ is active, then high vowels and mid vowels cannot be conflated, as shown by [tʃokɾine] below:

(81)

	/tʃokɾine/	$*\Delta_{PrWd}\leq\{i,u\}$	$*\Delta_{PrWd}\leq\{e,o\}$	ALIGNFTR
☞	(a) (tʃókɾi)ne		*	*
	(b) tʃok(ɾíne)	*!	*	

There is no ranking of the constraints above that can produce conflation of high and mid vowels here. Since the two categories can only be conflated if $*\Delta_{PrWd}\leq\{i,u\}$ is inactive, ALIGNFTR would have to outrank $*\Delta_{PrWd}\leq\{i,u\}$. Such a situation would also render $*\Delta_{PrWd}\leq\{e,o\}$ inactive, though, meaning that mid and low vowels should be

conflated too. In short, fixed ranking sets up implicational restrictions between possible conflations, but freely rankable constraints impose no such restrictions.

As demonstrated in §3.6, identifying exactly which conflations are impossible with fixed ranking constraints depends largely on the existence of other related constraints. A valid generalization, though, is that no fixed ranking theory can produce systems with two or more conflations. In addition, on its own, no set of constraints in a fixed ranking can produce low-end conflation – conflation of marked categories alone. However, if there are two sets of constraints that differ only in that they refer to complementary structural elements, any system with a single conflation can be produced.

As discussed in chapter 2, unfettered ranking permutation and the need to effect hierarchical relations between categories necessitates local harmonic bounding. In turn, local harmonic bounding necessitates scales that refer to contiguous parts of a scale. So, the argument presented in this chapter not only advocates free ranking, but that constraints refer to a range of a scale rather than individual points.

The results of this chapter have broad implications for theories of constraints.
• Constraints cannot be in fixed rankings as they would be unable to adequately produce all attested conflations.
• Constraints cannot refer to points on a scale – to do so would prevent hierarchical relations and allow non-contiguous conflations.
• CON cannot contain any constraint that is antagonistic to the constraints of the present theory: if a constraint favours x over y, there can be no constraint that favours y over x; such a situation would eliminate hierarchical relations and produce unattested conflations. This restriction clearly places severe restrictions on CON, so not only does the present theory propose a set of constraints, but significantly limits the space of possible additional constraints in CON.

CHAPTER 4

NON-DTES

4.1   Introduction

The aim of this chapter is to show the need for markedness constraints that refer to non-DTEs. In particular, evidence for the foot non-DTE ($-\Delta_{Ft}$) is presented.[50] Foot non-DTEs are all those root nodes that are (i) inside a foot and (ii) not the foot's DTE; they are circled in Figure 4.1.

Figure 4.1: Foot non-DTEs
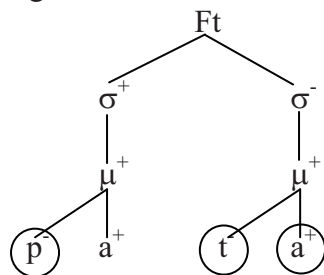
A point that will prove to be important in the following discussion is that the term 'foot non-DTE' is not synonymous with 'unstressed syllable'. Unstressed syllables that are not parsed into feet are not foot non-DTEs – they have no DTE status at all with respect to feet. This follows from the definition of non-DTE: to be a non-DTE of a foot, a segment must be dominated by a Ft node. For example, in [(páte)ki], [e] is a foot non-DTE, but [i] is not because it is not contained inside a foot. However, both [e] and [i] are non-DTEs of the PrWd; this difference will prove crucial in that following case studies.

Foot non-DTEs are the focus of this chapter because constraints that refer to them have fairly transparent empirical effects. In this chapter, constraints on foot-DTEs will be shown to influence stress, motivate vowel neutralization, and figure in vowel epenthesis.

A secondary aim is to show that DTEs can refer to any prosodic category. Thus, there are constraints that refer to DTEs of feet, as well as those that mention DTEs of syllables, Prosodic Words, Intonational Phrases and so on. Selkirk (1998) and de Lacy (1999a) have argued this point for tone, and Zec (2000) has a similar approach to sonority. This chapter provides further evidence for this point.

Section 4.2 shows that constraints on the sonority of foot non-DTEs can influence the position of feet, and therefore of stress. For example, in the Oceanic language Kiriwina a trochaic foot usually appears at the right edge of the PrWd (1a). However, the foot will appear further towards the left edge if doing so will result in a low-sonority foot non-DTE

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[50] To be precise, the focus is on $-\Delta_{\{Ft,Rt\}}$ – i.e. the Root node non-DTEs of a foot.

(1b). For example, stress falls on the antepenult in [(mígi)la] because penult stress would result in a foot with a high sonority non-head: *[mi(gíla)].

(1)   Kiriwina stress in brief

　(a) Default penultimate stress

[am(bái)sa]	'where?'	[bo(nára)]	'shelf (in house)'
[ikoi(súvi)]	'he puts in'	[imom(kóli)]	'he tasted (it)'
[ka(wála)]	'canoe pole'	[tau(áu)]	'hey, men!'

　(b) Stress retraction

[(kúli)a]	'cooking pot'	[(lámi)la]	'outrigger log'
[la(ódi)la]	'jungle'	[(lúgu)ta]	'yam type'
[(mígi)la]	'the face'	[(páku)la]	'blame'

A markedness constraint that bans high sonority foot non-DTEs – specifically *-$\Delta_{Ft} \geq \{e,o\}$ – is shown to provide an account for this system. Kiriwina also exhibits conflation that crucially requires stringent constraints, analogous to Nganasan in ch.3§3.3.

A similar argument is made for stress placement in the Ethiopic language Harar Oromo in §4.2.2. Harar Oromo differs from Kiriwina in its response to *-$\Delta_{Ft} \geq \{e,o\}$: rather than deviating from the default stress position, feet are reduced in size.

Section 4.3 shows that constraints on foot-DTEs can produce certain patterns of vowel neutralization. To be precise, vowel reduction in the informal register of Dutch only takes place in the foot non-DTE: e.g. [(fònə)loγ(í)] 'phonology', *[(fònə)ləγ(í)]. This case is argued to require a markedness constraint that refers specifically to foot non-DTEs.

Section 4.4 shows that non-DTE markedness constraints affect the typology of epenthetic vowels. This section shows that any unround vowel can be epenthetic [ɨ ə i ɛ a]. This fact is argued to follow from the tension between DTE and non-DTE markedness constraints. Further evidence for non-DTE constraints comes from Shipibo, a language in which the epenthetic vowel is [a] in foot heads and [i] in non-heads.

Section 4.5 summarizes the findings of this chapter.

4.2   Stress and non-DTEs

Some non-DTE constraints have already been discussed in the context of scales. For example, Prince & Smolensky (1993) have a set of constraints that relate sonority and the syllable margin (i.e. -Δ_σ). Similarly, Kenstowicz (1996) proposes that there are constraints on sonority in the 'foot margin' – the foot's non-head syllable nucleus. I have proposed constraints on tone in foot non-DTEs (de Lacy 1999a, 2002b); also see Zec (1999). In a related vein, Crosswhite (1999) proposes constraints on the sonority of unstressed syllables.

Constraints that mention non-DTEs reverse the scale to which they refer. So, while the DTE constraints militate against low sonority elements, the non-DTE constraints militate against high sonority. This reversal is indicated in the abbreviated constraint form by *-$\Delta_\alpha \geq s$, where *s* is some sonority level. The full constraint form refers to the *o* element

of feature values: i.e. $*-\Delta_\alpha/[oooo\text{Sonority}]$; $*-\Delta_\alpha\geq\{i,u\}$ is violated by any non-DTE of category α that is more sonorous than a schwa (i.e. [i u e o ɛ ɔ a]). This point is discussed in ch.2§2.4.1.1.

So, the least harmonic non-DTE is a low vowel, then mid peripheral vowels, then high peripheral vowels, and so on through the sonority hierarchy to the least sonorous categories. In terms of foot non-DTE constraints, then, a foot with the form (CV́Ci) is more harmonic than (CV́Ca) since the latter contains a high sonority foot non-DTE [a], while the former contains the less sonorous [i]. In constraint terms, the latter foot violates $*-\Delta_{Ft}\geq a$, while the former does not.

This section discusses two languages that provide evidence for foot non-DTE constraints. §4.2.1 analyses the stress system of Kiriwina, spoken in the Trobriand Islands, and §4.2.2 deals with Harar Oromo, an Ethiopic language. Both languages seek to form a foot with low sonority non-DTEs, but achieve their aims by somewhat different means: the former retracts stress from the default position, while the latter alters foot size.

4.2.1 Kiriwina

Kiriwina – also called Kilivila – is spoken in the Trobriand Islands and the Milne Bay province of Papua New Guinea. The description and data presented here come from Lawton's (1993) and Senft's (1986) grammars (hereafter L and S respectively).

Kiriwina has five vowels [i e a o u], and a syllable structure of (C)V(V)(m).[51] Bivocalic nuclei are the diphthongs [ai au ei eu oi ou]; bivocalic nuclei never consist of two identical vowels (i.e. a long vowel – S12, 20). Mid vowels almost never occur word-finally (Senft p.24).[52]

Stress usually falls on a final bimoraic syllable (i.e. CVV(C), CVC), otherwise on the penult. Increased amplitude and duration are the primary correlates of stress (L43). L also notes some allophonic variation conditioned by stress (p.18).

(2)   Default stress in Kiriwina

(a) Final Heavy Syllable (CVV(C), CVC)

[ivabodaním]	'he came last walking'
[bakám]	'I will eat'
[ikiúm]	'he did secretly'
[tauáu]	'hey, men!'
[lakatupói]	'I have asked'
[idói]	'(a boat) brings something'

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[51]   Coda [m] can only appear with monomoraic nuclei and the diphthongs [ai ei] (S 21); no examples of CVVm syllables were provided with stress indicated in the sources. [m] can also appear as the sole nucleus in a word-initial syllable: e.g. [mtona] 'he 3p.sg', [msa] 'afterbirth', [mdauvali] 'fly'. In these cases, stress can fall on [m]: e.g. [ḿ.wo] {island name}, [ḿ.na] {particle} (L23).
[52]   Senft (p.24) states that mid vowels "are rarely found in word-final position, except when used in poetic and emphatic forms." I found no tokens in his data with final mid vowels and stress marked.

(b) Else penult

[idója]	'it drifts'	[imomkóli]	'he tasted (it)'
[dumdabógi]	'early dawn'	[am.bái.sa]	'where?'
[péu.la]	'strong'	[náu.ʔu]	'nose plug'

However, stress falls on the antepenultimate syllable in one situation: when the penult contains a high vowel and the ultima contains [a] (L45, S25).

(3)   [CV́C{i,u}Ca] in Kiriwina
      (a) [CV́CiCa]

[mígila]	'the face'	[luko-sísiga]	{clan name}
[tom:éikita]	'selfish person'		
[lámila]	'outrigger log'	[katusawásila]	'clear throat'
[vigim-kóvila]	'to complete'	[laódila]	'jungle'
[kúlia]	'cooking pot'		

      (b) CV́CuCa

[lasíkula]	'pull canoe'		
[méguva]	'white magic'		
[pákula]	'blame'	[mlomʷáluva]	'a red soil'
[lúguta]	'yam type'	[búluva]	'thong tying door'

In contrast, stress does not retract when the penult contains a non-high vowel (4a), or when the ultima contains a high vowel (4b).

(4)   Kiriwina sonority-driven stress
      (a) CVC{é,ó,á}Ca[53]

[tomtomóta]	'dumb'
[idója]	'it drifts'
[kawála]	'canoe pole'
[bonára]	'shelf (in house)'

      (b) CVCV́C{i,u}

[igibulúi]	'he is angry at'	[msimʷési]	*grass type*
[mtumʷátu]	'shaggy'	[imomkóli]	'he tasted (it)'
[mdowáli]	'housefly'	[dumdabógi]	'early dawn'
[ivági]	'he did (it)'		
[ikoisúvi]	'he puts in'	[mlópu]	'cave'
[gugulombʷailígu] 'the meeting I love'			

No forms of the shape [CVCVC{e,o}] are cited because word-final mid vowels are very rare word-finally, and no relevant examples are provided by L and S.[54] Even so, there

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[53] I was unable to find any […CeCa] words with stress indicated. There are very few such words in L, although they do exist: e.g. *beba* 'butterfly' (303), *dodoleta* 'band of carved decoration'.

is evidence that mid vowels are as undesirable as low vowels in foot non-head position, shown in §4.2.1.3.

Alternations support the description of stress above. L99 observes that focus is marked by replacing the final vowel of verbs with a high vowel: e.g. [lumkola] 'feel', [lumkoli] 'feel {with focus}'. In words with otherwise antepenultimate stress, L reports that the vowel change causes stress to appear on the penult, though he does not give any transcriptions of examples.

4.2.1.1 Default footing

The default stress position can be ascribed to a quantity-sensitive trochaic foot, aligned as close to the right PrWd boundary as possible: i.e. [ba(kám)], [tau(áu)], [i(dója)], [imom(kóli)], [am(bái)sa]. Forms like [ba(kám)] show that Kiriwina is quantity-sensitive (i.e. *[(bákam)]), so feet have the form (CVX) (e.g. [ba(kám)], [tau(áu)]), or (CVCV) (e.g. [i(dója)]). There is no evidence that feet are ever iambic or degenerate. Therefore, the constraints TROCHEE and FTBIN are undominated in this language (see ch.3§3.3.2 for definitions).[55]

Right-edge foot alignment is promoted by the constraint ALIGNFTR. Violations of ALIGNFTR can be forced by FTBIN. This is the case for [(náu)ʔu]: for this candidate to have a right-aligned foot, the foot would either be degenerate (e.g. *[nau(ʔú)]) or trimoraic (e.g. *[(náuʔu)]).[56] To avoid this situation and allow for the more harmonic non-right-aligned binary foot, FTBIN must outrank ALIGNFTR.

(5)

/nauʔu	FTBIN	ALIGNFTR
(a) (náuʔu)	*!	
(b) nau(ʔú)	*!	
☞ (c) (náu)ʔu		*

The only candidate to satisfy both FTBIN and ALIGNFTR is *[na(úʔu)], a candidate that fatally violates constraints on syllabification.[57]

The following section shows that the *$\Delta_{Ft}\geq x$ constraints account for the cases of antepenultimate stress.

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[54] It is not uncommon for word-final position to be a particular locus of neutralization. The constraints that produce neutralization of final /e o/ will not be discussed here since this is tangential to the main point (see Crosswhite 1999 for relevant discussion). The present analysis predicts that words of the shape [CVC{i,u}C{e,o}] would have antepenult stress.

[55] Minimal word restrictions show that FTBIN outranks either DEP or MAX: words must be minimally bimoraic (i.e. a foot – McCarthy & Prince 1986, 1993b).

[56] Trimoraic trochees of the form ($\sigma_{\mu\mu}\sigma_{\mu}$) are permitted in other languages (Hayes 1995, Kager 1993). However, Hayes argues that they are marginal, so I will assume that they are not permitted in Kiriwina. This ranking also bans trimoraic feet in antepenult-stress words like [(mígi)la], *[(mígila)].

[57] Specifically ONSET, which favours [(náu)ʔu] over [na.(ú.ʔu)]; see Prince & Smolensky's (1993:§3.2) analysis of Tongan stress for discussion.

4.2.1.2 Non-DTEs

Constraints on foot non-DTEs are the primary motivation for antepenultimate stress in Kiriwina. Kiriwina aims to avoid a high sonority foot non-DTE, where 'high sonority' refers to both mid and low vowels. In /lamila/, for example, the incorrect output form *[la(míla)] has a foot with a very high sonority non-DTE: [a]. In contrast, the foot non-DTE [i] in the attested form [(lámi)la] has relatively low sonority. The relevant foot non-DTE constraints are listed in (6).

(6)   Foot non-DTE sonority constraints
         $*\text{-}\Delta_{Ft} \geq \{i,u\}$ "Assign a violation for every foot non-DTE that is equally or more sonorous than high vowels ([i u e o a])."
         $*\text{-}\Delta_{Ft} \geq \{e,o\}$ "Assign a violation for every foot non-DTE that is equally or more sonorous than mid vowels ([e o a])."
         $*\text{-}\Delta_{Ft} \geq a$ "Assign a violation for every foot non-DTE that is equally or more sonorous than high vowels ([a])."

The constraint $*\text{-}\Delta_{Ft} \geq \{e,o\}$ is active in Kiriwina: this constraint assigns a violation to a candidate if a foot non-DTE has more sonority than a high vowel. To deal with a form like [mígila], $*\text{-}\Delta_{Ft} \geq \{e,o\}$ must outrank ALIGNFTR:

(7)

/migila/	$*\text{-}\Delta_{Ft} \geq \{e,o\}$	ALIGNFTR
☞ (a) (mígi)la		*
(b) mi(gíla)	*!	

An element is a non-DTE of a foot if (i) it is dominated by a foot node and (ii) it is not the foot's DTE. In candidate (a), only [m], [g], and [i] satisfy these two requirements – [í] is a foot DTE, and [l] and [a] are not dominated by a foot node. Since [m], [g], and [i] are all less sonorous than mid vowels, the constraint $*\text{-}\Delta_{Ft} \geq \{e,o\}$ is not violated.

In contrast, candidate (b) has the high sonority [a] as a foot non-DTE, fatally violating $*\text{-}\Delta_{Ft} \geq \{e,o\}$.

Note that $\text{-}\Delta_{Ft}$ refers not only to the vowel in the unstressed syllable of a foot, but to all segments that are not the foot's DTE. For candidate (b), this includes the onset of the stressed syllable [g], the onset of the unstressed syllable [l], and the nucleus of the unstressed syllable [a]. In effect, then, the $*\text{-}\Delta_{Ft}$ constraint is not only sensitive to the sonority of the non-head syllable's nucleus, but to the onsets as well. In practice, though, only the non-head syllable's nucleus will ever be relevant; for the onsets to ever affect the outcome, they would have to be more sonorous than the non-head's nucleus. This situation only ever comes about in syllables with low sonority syllabic consonants and relatively high sonority onsets (e.g. [ln̩], [wl̩]). This situation is not relevant in Kiriwina.

The constraint $*\text{-}\Delta_{Ft} \geq \{e,o\}$ must refer specifically to the non-DTE of a foot. The only other potentially viable option is for it to refer to PrWd non-DTEs: $*\text{-}\Delta_{PrWd} \geq \{e,o\}$. However, this will not produce the right result. A non-DTE of a PrWd is effectively every

element except the primary-stressed vowel. So, the $-\Delta_{PrWd}$ elements in (a) are [m g i l a], and in (b) they are [m i g l a]. Therefore, a constraint like $*-\Delta_{PrWd}\geq\{e,o\}$ will be equally violated by both candidates since both have [a] as a $-\Delta_{PrWd}$. Since $*-\Delta_{PrWd}\geq\{e,o\}$ is equally violated, ALIGNFTR would make the crucial decision, incorrectly favouring (b) over (a).

4.2.1.3 Conflation and mid vowels

It is crucial that the constraint $*-\Delta_{Ft}\geq\{e,o\}$ be active in Kiriwina rather than $*-\Delta_{Ft}\geq\{a\}$. $*-\Delta_{Ft}\geq\{e,o\}$ is violated by both (CVC{e,o}) and (CV́Ca) feet equally, explaining why words like [i(dója)] have penultimate stress rather than antepenultimate *[(ído)ja]. In the present approach, this is because antepenultimate stress will not improve the non-DTE's sonority significantly enough: *[(ído)ja] still has a high sonority foot non-DTE, as illustrated in tableau (8).

(8)

/idoja/	$*-\Delta_{Ft}\geq\{e,o\}$	ALIGNFTR
(a) (ído)ja	*	*!
☞ (b) i(dója)	*	

[idója] also provides evidence for the ranking of $*-\Delta_{Ft}\geq\{a\}$, a constraint that penalizes feet with [a] non-DTEs. The word *idója* shows that $*-\Delta_{Ft}\geq\{a\}$ cannot be active. If it were, [i(dója)] should be less harmonic than *[(ído)ja].

(9)

/idoja/	$*-\Delta_{Ft}\geq\{e,o\}$	$*-\Delta_{Ft}\geq\{a\}$	ALIGNFTR
💣 (a) (ído)ja	*		*
(b) i(dója)	*	*!	

The point made above is that both (CVC{e,o}) and (CVCa) feet are conflated in Kiriwina: they are equally disharmonic. So, any constraint that distinguishes them – such as $*-\Delta_{Ft}\geq a$ – must be ranked below ALIGNFTR, which effectively renders it irrelevant in determining the winner between candidates that differ only in stress placement.

The ranking of the other vowel-non-DTE constraint $*-\Delta_{Ft}\geq\{i,u\}$ is indeterminable. Since it assigns the same violations to all feet, its ranking cannot be determined by stress placement.

The ranking || $*-\Delta_{Ft}\geq\{e,o\}$ » ALIGNFTR || also predicts that words ending in mid vowels will undergo stress retraction; however, no words allow final mid vowels, so there is no way to test this prediction.

4.2.1.4 Non-retraction

The ranking above accounts for all the other facts of Kiriwina stress. As noted above, stress does not retract to the antepenult when the final vowel is high: e.g.

[igibu(lú.i)], [mdo(wáli)], [m(lópu)]. The reason for the lack of retraction is that the feet in these words do not have any non-DTEs with unacceptably high sonority – none violate *-$\Delta_{Ft}\geq$\{e,o\}. Therefore, retraction would be gratuitous, as shown in tableau (10).

(10)

	/igibului/	*-$\Delta_{Ft}\geq$\{e,o\}	ALIGNFTR
☞	(a) igibu(lúi)		
	(b) igi(búlu)i		*!

The ranking also accounts for the fact that stress does not retract when the penult contains a non-high vowel and the ultima a low vowel. Both *[(bóna)ra] and [bo(nára)] incur the same violations of *-$\Delta_{Ft}\geq$\{e,o\}, so retraction would achieve nothing.

(11)

	/bonara/	*-$\Delta_{Ft}\geq$\{e,o\}	ALIGNFTR
	(a) (bóna)ra	*	*!
☞	(b) bo(nára)	*	

The same ranking accounts for the lack of retraction in [tomto(móta)]: the retracted form *[tom(tómo)ta] does not improve DTE sonority; other relevant examples are given in (4a).

- *DTE constraints in Kiriwina*
  The words cited above also show why an approach that entirely relies on DTE constraints will not work. DTE constraints are only useful when competing candidates differ in DTE sonority. However, there are many cases in Kiriwina where candidates do not differ in DTE sonority yet the antepenultimate-stressed form wins.
  For example, the two prime competitors from /migila/ are [(mígi)la] and *[mi(gíla)]. Both candidates incur exactly the same DTE violations since both have stressed high vowels. Therefore, since the DTE constraints do not favour one candidate over the other, the choice of winner should fall to ALIGNFTR, incorrectly predicting that the penultimate-stressed candidate should win. Of course, the difference between [(mígi)la] and *[mi(gíla)] is not in their DTEs, but in the sonority of the foot non-DTE.
  Since DTE sonority does not matter in Kiriwina, all DTE constraints that distinguish [i u e o a] must be inactive. For example, *$\Delta_{Ft/PrWd}\leq$\{i,u\} would incorrectly favour *[(pʷá.jú)ju] 'sour' over [pʷa(jú.ju)] if active, and *$\Delta_{Ft}\leq$\{e,o\} would incorrectly favour *[(mámo)va] over [ma(móva)] 'be alive'.
  The tableau below illustrates the undesirable effect of DTE constraints in Kiriwina.

(12)

	/mamova/	*-$\Delta_{Ft}\geq$\{e,o\}	ALIGNFTR	*$\Delta_{Ft}\leq$\{e,o\}
☞	(a) ma(móva)	*		*
	(b) (mámo)va	*	*!	

If $*\Delta_{Ft}\leq\{e,o\}$ (or $*\Delta_{PrWd}\leq\{e,o\}$) outranked ALIGNFTR, (b) would win.

- FTBIN

Finally, it is possible to establish a ranking between FTBIN and $*\text{-}\Delta_{Ft}\geq\{e,o\}$. One way to avoid violations of the non-DTE constraint is to reduce the size of the foot. For example, [migi(lá)] does not have a highly sonorous foot non-DTE since its only foot non-DTE is [l]. Since this strategy is not employed in Kiriwina, FTBIN must outrank $*\text{-}\Delta_{Ft}\geq\{e,o\}$.

(13)

	/migila/	FTBIN	$*\text{-}\Delta_{Ft}\geq\{e,o\}$
☞	(a) (mígi)la		*
	(b) migi(lá)	*!	

This ranking will turn out to be of more than passing interest: §4.2.2 shows that Harar Oromo employs the opposite ranking.

As a final note, the constraint TROCHEE must also outrank $*\text{-}\Delta_{Ft}\geq\{e,o\}$, otherwise the iambic footed *[mi(gilá)] would win.

4.2.1.5 Morpheme boundaries

Retraction only takes place in Kiriwina when there is no morpheme boundary within the last three syllables of the word (L43). When morpheme boundaries intervene, stress falls on the penult regardless of sonority.

The words in the left column of (14) contrast with those in the right column solely in terms of morpheme boundaries. As shown, the presence of a morpheme boundary immediately before either the penult or ultima results in penultimate stress. The bold face morpheme in the right column is the root.[58]

(14)   Kiriwina Stress and Morpheme Boundaries (Lawton, p.45)

[lámila]	'outrigger log'	[la-**míla**]	'I have become sth'
[méguva]	'white magic'	[me-**gúla**]	'it originated (there)'
[lúguta]	'yam type'	[lu-**gú**-ta]	'my sister (male speaking)'
[latu-sawásila]	'clear throat'	[**wasí**-la]	its obligation
[mígila]	'the face'	[**migí**-la]	'his face'
[to-m-méikita]	'selfish person'	[**bobʷailí**-la]	'gift'

Morpheme boundaries before the antepenult are irrelevant: e.g. [i-**(búku)la**] 'it bore in clusters', *[i-**bu(kúla)**], [luku-**(sísi)ga**] 'clan name'.

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[58] Neither S nor L give examples with multiple suffixes.

- *PrWd-Root alignment*

The lack of retraction in morphologically complex forms can be ascribed to two separate restrictions. One is that the left edge of the PrWd must coincide with the left edge of the root by action of the constraint ALIGN-L(Root, PrWd) (McCarthy & Prince 1993a). This will prevent stress from falling on the prefix in words like [me-gúla] 'it originated (there)' since it must be prosodified as
[me{(gúla)}], where {} mark PrWd boundaries. The word cannot be prosodified as *[{(mé-gu)la}] because this prevents the root's and PrWd's left edges from coinciding.

(15)

	/me-gula/	ALIGN-L(Root,PrWd)	*-$\Delta_{Ft} \geq \{e,o\}$
☞	(a) me-{(gúla)}		*
	(b) {(mé-gu)la}	*!	

- *PrWd-Suffix alignment*

Alignment of the root's and PrWd's left edges will not account for penult stress in [migí-la], though. In this form, the PrWd boundaries will appear as [{mi(gí-la)}]; so there is no apparent reason why the foot cannot appear at the left edge: i.e. *[{(mígi)-la}].

One cannot ascribe penult stress in these forms to a peculiarity of the suffix *-la*, either: the suffixes *-ta*, *-na*, and *-gwa* also cause stress to fall on the penult (L46). Moreover, it is not the shape of suffixes that is relevant – bimoraic suffixes can take the stress: e.g. [i-bukula-váu] 'it bore in clusters again' (cf [i-búkula] 'it bore in clusters').

I have not been able to devise an OT solution to this issue that I consider entirely satisfactory. One approach is to invoke a constraint that requires the right edge of a foot to align with the right edge of a suffix: ALIGN-R(Ft, suffix). This will favour the morphologically complex [mi(gí-la)] over *[(mígi)-la]. Tableau (16a) shows that ALIGN-R(Ft, suffix) ranked above *-$\Delta_{Ft} \geq \{e,o\}$ will produce the attested result. Tableau (16a) shows the contrasting case with the monomorphemic [(mígi)la] – since there is no suffix in this form, ALIGN-R(Stem,Ft) is vacuously satisfied, so allowing the effect of the DTE-sonority constraint to emerge.

(16)

(a)	/migi-la/	ALIGN-R(Ft,suffix)	*-$\Delta_{Ft} \geq \{e,o\}$	ALIGNFTR
	(a) (mígi)-la	*!		*
☞	(b) mi(gí-la)		*	

(b)	/migila/	ALIGN-R(Ft,suffix)	*-$\Delta_{Ft} \geq \{e,o\}$	ALIGNFTR
☞	(a) (mígi)la			*
	(b) mi(gíla)		*!	

The reason that this account is not entirely satisfactory is because it appeals to alignment of a prosodic constituent with an affix and not a root; contradicting Selkirk's (1995) and McCarthy & Prince's (1993a) proposals. Nevertheless, the Kiriwina facts are reminiscent of other stress systems. For example, Latin famously stresses a heavy penult,

else the antepenult. Steriade (1988a) observes that Latin has several clitics, like *que* 'and', which force stress to fall on the penult even if it is light (also see Halle 1990:158ff). Analogous to Kiriwina, addition of an enclitic in Latin forces metrical structure to diverge from the default pattern. I leave the discussion of this issue in Kiriwina at this point.

- *Stress Window*

The final property of interest is the issue of the stress window. Lawton says that stress retracts to the antepenultimate syllable, but does not mention that it ever retracts to the pre-antepenult. In the present analysis, a word of the shape [CVCiC{e,o,a}Ca] would be best output with initial stress. I was unable to find any words that would decide this one way or the other and were marked for stress, although such words may exist (e.g. [tolibwala] 'house owner' and [toliwaga] 'name of a chiefly subclan', although these seem to be morphologically complex). Unfortunately, morphemes that are long enough for a window effect to be seen are rare; it may be the case that the data relevant for determining the presence of a window effect is not available for independent reasons.

4.2.1.6 Summary

Kiriwina shows that the sonority of foot non-DTEs can be decisive in determining stress placement. The rankings established in the preceding sections are summarized in Figure 4.2.

Figure 4.2: Kiriwina sonority-driven stress ranking summary

FTBIN   TROCHEE   ALIGN-L(Root,PrWd)

$*$-$\Delta_{Ft}\geq\{i,u\}$ $*$-$\Delta_{Ft}\geq\{e,o\}$

ALIGNFTR

$*$-$\Delta_{Ft}\geq\{a\}$ $*\Delta_{Ft/PrWd}\leq\{i,u\}$ $*\Delta_{Ft/PrWd}\leq\{e,o\}$
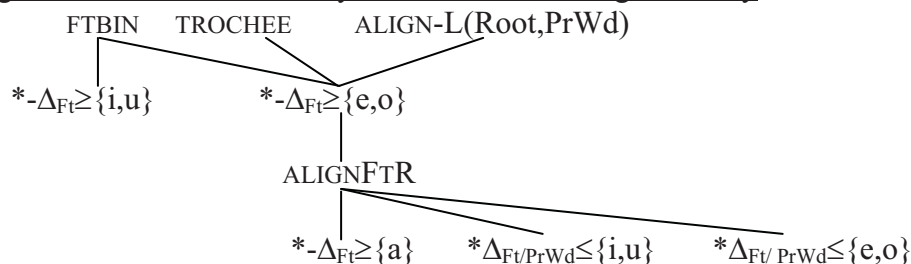
The ranking expresses the fact that foot-form is invariant – since FTBIN and TROCHEE outrank all other constraints, no sonority consideration will force feet to be other than well-formed bimoraic trochees.

The crucial ranking is between $*$-$\Delta_{Ft}\geq\{e,o\}$ and ALIGNFTR. It is this ranking that forces feet to retract if doing so will result in a foot with a low sonority non-head.

It is equally important that ALIGNFTR outrank $*$-$\Delta_{Ft}\geq\{a\}$, though. The inactivity of $*$-$\Delta_{Ft}\geq\{a\}$ is crucial to the conflation of mid and low vowels as equally disharmonic foot non-DTEs. The reverse ranking will be illustrated in the analysis of Harar Oromo. The same is true of DTE constraints – since Kiriwina ignores the sonority of stressed syllables, all relevant foot- and PrWd-DTE constraints must be inactive.

Kiriwina shows that there is no fixed ranking between DTE and non-DTE constraints. If the DTE counterpart of $*$-$\Delta_{Ft}\geq\{e,o\}$ had to outrank it in every grammar, for example, there should be wholesale avoidance of stressed high vowels, even when the foot

non-DTE's sonority was not at stake. More concretely, $*\Delta_{Ft}\leq\{e,o\}$ would require stress to fall on a low vowel even when the foot non-DTE was not at issue: e.g. [ta(búsi)] 'paddle' would be *[(tábu)si].

Conversely, if the non-DTE constraint $*\text{-}\Delta_{Ft}\geq\{e,o\}$ had to outrank its DTE counterpart $*\Delta_{Ft}\geq\{e,o\}$ in every grammar, every language with sonority-driven stress would have to be sensitive to the sonority of the foot non-DTE. This is clearly not the case, as shown by the many languages cited in chapter 3 in which only the sonority of the head is significant.

The final point that deserves comment is the position of $*\text{-}\Delta_{Ft}\geq\{i,u\}$, a constraint that militates against all Kiriwina vowels in foot non-heads. Since all candidates would violate this constraint equally, its ranking with respect to ALIGNFTR is largely irrelevant; it must be dominated by FTBIN, though, otherwise feet would be degenerate – this point is illustrated in Harar Oromo in the next section.

4.2.2   Harar Oromo

The stress system of the Ethiopic language Harar Oromo is also influenced by the sonority of the foot non-DTE. Harar Oromo's stress system is similar to Kiriwina's in many ways: it too aims to have a right-aligned trochaic foot and to avoid feet with highly sonorous non-DTEs. However, Harar Oromo differs from Kiriwina in two ways. One is that only forms with [a] as a foot non-DTE are avoided – mid vowel foot non-DTEs are permitted. The other difference is that Harar Oromo reduces the size of the foot, rather than moving it from the right edge.

The data presented here come from Owens (1985). Harar Oromo has five vowels [i e a o u] and their long counterparts [iː eː aː oː uː]. In nouns and adjectives, vowel length is contrastive medially (e.g. [boːruː] 'dirty' *cf* [boruː] 'tomorrow'), but of the short vowels only [a] is found finally (e.g. [nama] 'person'). In other words, vowel length in word-final position is only contrastive for the low vowel (see (18)). This restriction accounts for the lack of forms with short non-low final vowels in the data presented below.[59] Syllable structure is (C)V(ː)(C) (e.g. [bimˌbeː] 'mosquito', [moːrˌma] 'neck'); an extra consonant is allowed word-finally (e.g. [moːrm] 'neck', [sogidː] 'salt').

In nominals, stress can only fall on the ultima or penult.[60] The default position for stress is the penult, as shown in the following words (Owens 1985: 29):

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[59]   The ban on word-final short non-low vowels can be seen as a type of apocope: non-low short vowels are deleted. This can be ascribed to the ranking || CONTIG » $*\Delta_{\mu}\leq\{e,o\}$ » MAX ||. The ranking of $*\Delta_{\mu}\leq\{e,o\}$ over MAX results in deletion of non-low vowels in syllable rimes. However, CONTIG prevents medial deletion. From input /nami/, the output would therefore be [nam]. Restriction of apocope to short vowels is common, and can be formally implemented by having a faithfulness constraint that preserves long vowels outrank $*\Delta_{\mu}\leq\{e,o\}$ (see Beckman 1998).

[60]   Tone placement on verbs, an important indicator of stress, is affected by a number of verbal suffixes that obscure the overall pattern. I refer the reader to Owens (1985:28ff), and focus solely on nominal stress here.

(17)   Harar Oromo default nominal stress
      [ábleː]   'knife'   [kítliː]   'kettle'
      [hantʃ'ábːiː] 'ice, sleet'   [kúrsi]   'chair'
      [háːreː]   'donkey'   [okːóteː]   'pan'
      [huláleː]   'door even'   [xáleː]   'liver'

        Stress is realized by increased duration and amplitude (Owens, p.37). In addition, high tone obligatorily associates to the stressed syllable and spreads rightward (tone is therefore entirely predictable in these words). So, words with penult stress have high tone on the penult and ultima, but low tone on preceding syllables (e.g. [hànˈtʃ'ábːíː] 'ice, sleet') while words with final stress have high tone on the ultima only (e.g. [màkìːˈnáː] 'car').

        The words in (17) show that stress in Harar Oromo is quantity-insensitive: it makes no distinction between bimoraic and monomoraic syllables (e.g. [kítliː] 'kettle').

        Significantly, stress does not always fall on the penult: it appears on the final syllable if it contains a low vowel ([a] or [aː]).[61]

(18)   Harar Oromo: Final [a(ː)] attracts stress
      [adːá]   'forehead'   [lolá]   'battle'
      [dumːeːsá]   'cloud'   [magaláː] 'market'
      [gurbáː]   'boy'   [makiːnáː] 'car'
      [huláː]   'door'   [maná]   'house'
      [ibidːá]   'fire'   [mutʃ'áː]   'child'
      [intalá]   'girl'   [namá]   'person'

        The words [makiːnáː] 'car' (18) and [kúrsiː] 'chair' (17) are both loanwords, showing that the stress placement rule is productive.

        Harar Oromo stress is very similar in kind to Gujarati stress (ch.3§3.4). In both languages, the default position for stress is the penult, and in both languages [a] influences stress. However, there is one important difference between Gujarati and Harar Oromo: when *both* the penult and ultima contain [a], stress falls on the penult in Gujarati but on the ultima in Harar Oromo. For example, Harar Oromo has [namá], while Gujarati has [sáɖa]. This difference will provide evidence for foot non-DTE constraints in Harar Oromo.

4.2.2.1 Default stress and DTEs

        The default position for stress in Harar Oromo is the penultimate syllable: e.g. [kúrsiː] 'chair', [k'urtúmiː] 'fish'. To account for this fact, a quantity-insensitive trochaic foot at the right edge of the PrWd is employed here: e.g. [k'ur(túmiː)]. The foot must be

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[61] Owens observes that there are some exceptions to the generalizations made above. In the main these are morphologically conditioned. For example, stress falls on the final syllable in the class of 'invariable adjectives' (e.g. [adíː] 'white', *[ádiː] – p.29), and a number of suffixes are pre-stressing, producing penult stress and overriding the sonority conditions on stress: e.g. [gúdː-aː] 'big+masc.', *[gúdːaː]. There also seem to be a few lexical exceptions: e.g. [málːaː] 'cheek' (p.29), [sagalé] 'sound', [horíː] 'wealth', [eːrúː] 'field, farm', [angáfa] 'eldest sibling'. Since Owens asserts that the exceptions are clearly in the minority, I put them aside and focus on the general pattern.

quantity insensitive because the length of the rime clearly does not affect stress placement, as shown by the examples just given.

As in Gujarati, the constraint TROCHEE requires the head of the foot to be leftmost, while FTBIN-σ requires the foot to be disyllabic. The constraint ALIGNFTR requires all feet to be rightmost.

(19)   Default Stress in Harar Oromo

/k'urtumiː/	FTBIN	TROCHEE	ALIGNFTR
☞ (a) k'ur(túmiː)			
(b) k'urtu(míː)	*!		
(c) k'ur(tumíː)		*!	
(d) (k'úrtu)miː			*!

However, words whose ultima contains an [a(ː)] have final stress (e.g. [dumːeːsá] 'cloud', [namá] 'person'), indicating that there is some high-ranking constraint that favours candidates with a final [á(ː)]. This is the subject of the following section.

4.2.2.2 Non-DTEs

The non-DTE constraints provide an account for final stress in words like [namá]. In all words with penult stress, the non-head syllable of the foot contains a low sonority vowel [iː eː oː uː], but never the highest sonority [a] or [aː]. For example, in [(ábleː)] 'knife', the non-DTE of the foot contains the nucleus [eː]; the same position in [(kúrsiː)] 'chair' has a low-sonority high vowel. In contrast, penult stress in words with a final [a] would create a foot with a very high sonority non-DTE: e.g. *[(náma̲)], *[(gúrbaː)].

Final stress in these words is a solution to this problem: [na(má)], [gur(báː)]. By employing a degenerate foot, highly sonorous foot non-DTEs are avoided. For example, the only foot non-DTE in [gur(báː)] is [b]; the segments [gur] are not inside a foot, and so are not foot non-DTEs.

Avoidance of a high-sonority non-DTE is motivated by the constraint *-$\Delta_{Ft}{\geq}a$ "Assign a violation for a non-DTE with [a]". With this constraint outranking FTBIN, stress seeks out a final [a]:

(20)

/nama/	ALIGNFTR	*-$\Delta_{Ft}{\geq}a$	FTBIN
(a) (náma)		*!	
☞ (b) na(má)			*
(c) (ná)ma	*!		*

Candidate (a) violates *-Δ_{Ft}/a because one of its foot non-DTEs is [a]. As shown by candidates (b) and (c), the only sort of foot that avoids violating *-Δ_{Ft}/a is a degenerate

one. By having a degenerate foot, foot non-DTEs are eliminated: there is no vocalic -Δ_{Ft} in [na(má)] or *[(ná)ma].[62]

Of the candidates with degenerate feet, candidate (c) loses to (b) because it does not have a right-aligned foot.

The same ranking produces the correct stress for [a]-final words without penult [a], as illustrated in (21).

(21)

/gurbaː/	ALIGNFTR	*-$\Delta_{Ft} \geq a$	FTBIN
(a) (gúrbaː)		*!	
☞ (b) gur(báː)			*
(c) (gúr)baː	*!		*

In short, Harar Oromo and Kiriwina present different responses to the same problem – i.e. high sonority foot non-DTEs. While Kiriwina retracts stress from the right edge to avoid high sonority non-DTEs, Harar Oromo opts to reduce foot size.

A further ranking that can be established for Harar Oromo is that the non-DTE constraint *-$\Delta_{Ft} \geq \{a\}$ is active in its system while *-$\Delta_{Ft} \geq \{e,o\}$ is not. This latter point is shown by words like [(ábleː)] 'knife', *[ab(léː)]. In contrast, *-$\Delta_{Ft} \geq \{e,o\}$ is active in Kiriwina while *-$\Delta_{Ft} \geq \{a\}$ is not, again illustrating the point that scale-referring constraints' ranking must be freely permutable.

- *The inadequacy of DTE constraints in Harar Oromo*

Non-DTE constraints must be used to account for Harar Oromo. DTE-referring ones cannot produce the right results, especially with regard to words like [namá] 'person'. In such words, stress falls on an ultima [a] even when the penult contains an [a]. The problem is that there is no motivation to deviate from the default stress position (i.e. penult). In constraint terms, ranking any DTE constraint above FTBIN will not cause final stress in this situation. This is illustrated in tableau (22).

(22)

/nama/	*$\Delta_{Ft} \leq \{e,o\}$	FTBIN
💣 (a) (náma)		
(b) na(má)		*!

The problem illustrated above is that there is no motivation for stress to avoid penult [a]: the constraint *$\Delta_{Ft} \leq \{e,o\}$ treats a penultimate [á] the same as a final [á], allowing FTBIN to emerge as the crucial constraint. The same result will happen no matter which DTE constraint is used. This follows from the fact that all viable candidates will have a stressed [a], so all will incur equal violations of all DTE constraints.

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[62] The candidate [(namá)], with an iambic foot, is ruled out by *-$\Delta_{Ft} \geq a$, due to the initial syllable's [a]. This form shows that FTBIN, and not TROCHEE, is the crucially dominated constraint here.

Analogous to Kiriwina's stress pattern, the point that the [na(má)]~*[(náma)] competition raises is that the sonority of the foot DTE is not at issue; the only difference between the two candidates is in the content of their foot non-DTEs.

In short, the DTE-sonority constraints cannot provide a solution to the Harar Oromo system. As in Kiriwina, it is the sonority of the foot's non-head syllable that matters.

4.2.2.3 Summary

The ranking established for Harar Oromo is summarized in Figure 4.3.

Figure 4.3: Harar Oromo ranking summary

$$\text{*-}\Delta_{Ft}\geq\{a\} \qquad\qquad \text{ALIGNFTR}$$
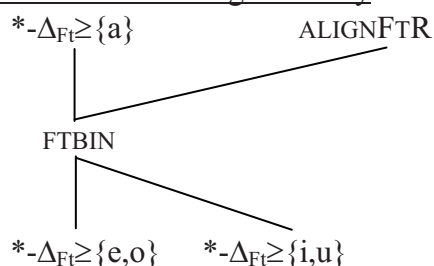
$$\text{FTBIN}$$

$$\text{*-}\Delta_{Ft}\geq\{e,o\} \qquad \text{*-}\Delta_{Ft}\geq\{i,u\}$$

The ranking ‖ *-$\Delta_{Ft}\geq\{a\}$ » FTBIN ‖ is responsible for sonority-driven stress. ALIGNFTR prevents feet from responding to *-$\Delta_{Ft}\geq\{a\}$ by movement as in Kiriwina, so they respond by reducing the size of the foot.

The constraints *-$\Delta_{Ft}\geq\{e,o\}$ and *-$\Delta_{Ft}\geq\{i,u\}$ do not force feet to reduce in size, so must be inactive in this ranking.

Together, Harar Oromo and Kiriwina illustrate a property of Optimality Theory: "heterogeneity of process and homogeneity of target" (see McCarthy 2001b for discussion). Violations of similar markedness constraints are avoided by different means. Harar Oromo responds to restrictions on the foot non-DTE by reducing foot size; in contrast, feet retract from the right edge in Kiriwina. In constraint terms, the difference is due to the ranking of ALIGNFTR and FTBIN – the former dominates the latter in Harar Oromo while the opposite holds in Kiriwina. Section 4.3 presents yet another option for satisfying non-DTE constraints: vowel reduction.

4.2.3 Alternatives: Sequential theories

The aim in the analyses of Kiriwina and Harar Oromo was to show that constraints must refer to non-DTEs. In the confines of the present theory, there is certainly no other way to produce the Kiriwina system; the DTE constraints are of no use because the sonority of DTEs is often the same in competing candidates (i.e. Kiriwina [mígila] vs *[migíla]).

But what of entirely different constraints? This section examines ‘sequential’ constraints. Such constraints refer to the relation between nearby elements; in this

instance, they would weigh the sonority difference between elements in nearby stressed syllables. The aim is to show that 'non-sequential' constraints of the sort proposed here are necessary in any case, and that sequential constraints have undesirable typological consequences.

4.2.3.1 Sonority-cline/distance theories

I know of no analysis of sonority-driven stress that has employed a sequential theory. However, one type of sequential theory that may seem like an obvious alternative will be discussed here: that there are sets of constraints that promote a falling sonority cline – or sonority distance – from DTEs to non-DTEs. Such constraints are similar to those proposed for sonority-distance effects (Selkirk 1984, Clements 1990, Baertsch 1998, Gouskova 2002, Parker 2002). The question of interest here is whether a theory with sonority-cline/distance constraints could supplant the present approach. The unifying factor in all such theories is that 'the steeper the cline (or greater the distance), the better'.

The problem such a theory encounters with Kiriwina is that sonority distance will not distinguish feet of the form (CíCi) and (CáCa) since both nuclei have the same distance between them – i.e. '0'. However, the two foot types are treated differently. (CíCi) is highly desirable, motivating stress to retract from the right edge (e.g. [(mígi)la], *[mi(gíla)]). In contrast, (CáCa) is avoided (e.g. [sa(máni]) 'admit', *[(sáma)ni]). The same is true for Harar Oromo: (CáCaː) is avoided (e.g. [maga(láː)] 'market', *[ma(gálaː)]), whereas (CíCiː) is not (e.g. [(kítliː)] 'kettle', *[kit(líː)]).

In short, sonority distance or cline is not all that matters in Kiriwina and Harar Oromo. Crucially, low sonority foot non-DTEs are favoured more than high sonority ones, regardless of the sonority of foot DTEs.[63]

Since conditions on non-DTE sonority play an independent role in Kiriwina and Harar Oromo, one may ask whether there is any need for sonority-distance constraints related to footing at all. Constraints that refer to sonority-distance are at least not necessary to account for the cases discussed in this section and chapter 3. Constraints that state independent restrictions on DTEs and non-DTEs adequately account for these patterns of sonority-driven stress, as well as all the others I have examined (see ch.3§2.5.3 for a list). I have argued a similar point for tone-driven stress elsewhere (de Lacy 1999a, 2002b): constraints on the difference between tone levels within a foot are not necessary in tone-driven stress.

Again, the success of the present theory in accounting for Kiriwina and Harar Oromo is that its constraints focus solely on the sonority of a single element; they do not take into account the sonority of adjacent elements.

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[63] A similar problem arises with the OCP, which is another type of sequential constraint. Suzuki (1998§2.4.3.2) uses the constraint OCP(a)$_{Ft}$ to ban two instances of [a] within a foot. This constraint – and others like it – cannot be used to deal with Kiriwina stress: OCP(a)$_{Ft}$ incorrectly favours *[(bóna)ra] over [bo(nára)]. Moreover, OCP(a)$_{Ft}$ can be rejected on typological grounds: it favours the foot (CíCa) over (CáCa) even though the latter has a higher sonority stressed syllable, so producing a situation of markedness reversal.

In summary, a theory that has sonority-distance constraints alone will face a difficult challenge in Kiriwina and Harar Oromo. The two languages treat (CíCi) and (CáCa) feet differently, even though they do not differ in sonority cline/distance.

This is not to say that sonority-distance constraints do not exist in CON. For example, cooccurrence restrictions on onset segments are often cast in terms of sonority-distance restrictions (Selkirk 1984, Baertsch 1998, Morelli 1998). The same is true for syllable contact effects (Murray and Vennemann 1983, Vennemann 1988, Davis 1998, Gouskova 2002), and for restrictions on possible diphthongs. However, in all these cases, sonority distance is calculated between adjacent elements. In no language are two non-adjacent segments banned because their sonority is too similar. The cases discussed here have an entirely different nature: the sonority of adjacent elements is not at issue; in fact, the sonority of non-adjacent syllable nuclei is evidently never significant either.

In short, there is no evidence that the extra power of a sequential theory is needed. The localistic nature of the (non-)DTE constraints provides an adequate account of the attested languages. On the other hand, it is important to point out that the DTE and non-DTE theory does not *preclude* sequential constraints. It is possible that sequential constraints coexist with the DTE constraints. However, if they do, the DTE theory places strong restrictions on their form. If sequential constraints exist, none of them may contradict a DTE constraint, favouring a low sonority DTE over a high sonority one, or vice versa for a non-DTE.

4.2.4   Summary

This section has shown that markedness constraints that refer specifically to foot non-DTEs are necessary. If markedness constraints could only refer to DTEs, it would be impossible to produce either the Kiriwina or Harar Oromo systems since stress ignores the sonority of DTEs entirely, relying on the sonority of the foot non-head to determine its position.

This section also showed that it is necessary to refer to the *foot*'s non-DTE, as opposed to some other category. Reference to the sonority of 'unstressed syllables' (or -Δ_{PrWd}) is inadequate, failing to distinguish forms such as Kiriwina's [(mígi)la] from [mi(gíla)].

- *Tone and non-DTEs*

While the sonority scale has been the focus of this section, it is important to point out that the same effects can be seen with other prosodic scales, such as tone. In the present theory, foot non-DTEs can combine with the tonal scale, producing a set of constraints that favour lower-toned foot non-DTEs over higher-toned ones: i.e. *-$\Delta_{Ft}\geq$L, *-$\Delta_{Ft}\geq$M, *-$\Delta_{Ft}\geq$H.

In de Lacy (1999a, 2002b), I showed that such constraints were instrumental in determining foot placement in several Mixtec languages (for a full analysis, see the cited works). For example, the default position for stress in Ayutla Mixtec is on the initial syllable: e.g. [ˈʃínúrá] 'his pineapple'. (Pankratz & Pike 1969). However, stress will seek out the leftmost high-toned syllable that is immediately followed by a low-toned syllable:

e.g. [lú(ˈlúrà)], *[(ˈlúlú)rà] 'he is small'. The works cited argued that this pattern comes about through the action of a constraint against non-low toned non-DTEs that outranks ALIGNFTL. This is illustrated in tableau (23).

(23)

	/lulura/	*-$\Delta_{Ft}{\geq}M$	ALIGNFTL
☞	(a) lú(ˈlúrà)		*
	(b) (ˈlúlú)rà	*!	

- *Typology and non-DTEs*

This section concludes by discussing the relevance of non-DTE constraints to the typology of sonority-driven stress systems. As established in chapter 3, stress never seeks out a lower sonority vowel, ignoring a higher sonority one in the default stress position. The non-DTE constraints do not subvert this result. In fact, non-DTE constraints have much the same effect as DTE constraints. Non-DTE constraints will also promote stress on sonorous vowels, as shown in tableau (24).

(24)

	/tika/	*-$\Delta_{Ft}{\geq}\{a\}$	ALIGN-ő-R
	(a) (tíka)	*!	
☞	(b) (tiká)		*

In short, the non-DTE constraints do not adversely affect the implicational relations for sonority-driven stress, or more generally for prosodification. The hierarchical relations imposed by scales still hold: stress will only ever be attracted to sonorous vowels.

Of course, non-DTE constraints do present a variety of additional predictions for sonority-driven stress. As argued in the previous sections, the sonority of the stressed syllable may not be at issue in a particular language, but rather the sonority of the foot non-DTE (or some other relevant non-DTE). Since the non-DTE constraints only favour low sonority elements, no language will ever seek to make a high sonority element a non-DTE, avoiding lower sonority elements. For example, there is no language that avoids having the non-DTE of a foot contain a high vowel, preferring a low vowel instead. In such a language, stress would retract from a penult low vowel onto the antepenult if the ultima contained a high vowel (e.g. /pakali/ → [(páka)li], *[pa(káli)]; this is the exact opposite situation to Kiriwina (§4.2.1). Again, this sort of system cannot occur because no constraint favours the scenario just sketched out.

In short, the present theory predicts that – when active – the DTE and non-DTE constraints will motivate stressed syllables to seek out highly sonorous vowels, while non-heads will aim to have low sonority elements. These implicational relations ensure that the typological generalizations identified for conflation in chapter 3§3.5 still hold: non-contiguous conflations are not allowed, and the Conflation-Hierarchy Implication still holds. In other words, the non-DTE constraints have no adverse effects on sonority-sensitive prosodification.

To conclude, this section has identified two languages that require constraints that refer to the properties of the non-DTE of a foot.

4.3 Faithfulness and non-DTEs

The previous sections showed that non-DTE constraints could motivate deviation from the default stress position. However, there are a number of other ways to respond to a prohibition on high sonority non-DTEs. One way is to change high sonority non-DTEs into low sonority ones. This is what happens in Dutch: high sonority vowels reduce to [ə] in certain unstressed positions (Kager 1989, Oostendorp 1995).

Exactly which unstressed position can undergo reduction depends on the speech register. Oostendorp (1995) provides forms for the word /fonoloɣi/ 'phonology', given in (25).[64]

(25)   Vowel Reduction in Dutch Registers
        Formal register   [fònoloɣí]
        Semi-formal register [fònəloɣí]
        Very Informal   [fònələɣí]
        No register   *[fònoləɣí]

The Semi-formal register form [fònəloɣí] is of particular interest since reduction only takes place in one of the unstressed syllables, not both. Kager (1989:312) shows that the difference in reduction in [fònəloɣí] relates to foot structure. In the Semi-formal register, /o/ only reduces in the non-head position of a foot; in other unstressed syllables it remains faithful: i.e. [(fònə)lo(ɣí)].

The primary aim of this section is to show that reduction in the semi-formal register requires markedness constraints that ban high-sonority vowels in foot non-DTEs. In fact, further complexities of reduction in the Semi-formal register show the need for several non-DTE constraints, including constraints on foot non-DTEs ($*\text{-}\Delta_{Ft} \geq \{i,u\}$) and on non-DTEs of the ProsodicWord ($*\text{-}\Delta_{PrWd} \geq \{e,o\}$).

Section 4.3.1 discusses the details of reduction in the Semi-formal register. An analysis is presented in §4.3.2.

Reduction in the other registers and the unattested reduction pattern (*[fònoləɣí]) is the focus of §4.3.3.

§4.3.4 contains a summary.

4.3.1 Dutch Semi-formal reduction: Description

There is a large literature on vowel reduction in Dutch (Martin 1968, Booij 1977, 1981, van der Hulst 1984, Zonneveld 1985, Kager 1989, Kager, Visch, and Zonneveld

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[64] John McCarthy points out that the same pattern is seen in flapping in English. For example, *repetitive* is acceptable as [rə(pétə)təv] (formal), [rə(pérə)təv] (standard), and [rə(pérə)rəv] (very casual), but never *[rə(pétə)rəv]. This pattern can be explained by an account similar to the one below if markedness constraints that promote flapping in non-DTEs are employed. This issue is left for future work.

1987, Oostendorp 1995). Within this literature, there is a great deal of agreement about the details of reduction and its relation to register.

Reduction in the semi-formal register is complex. Certain unstressed vowels reduce to schwa, but whether they do so in every unstressed position depends on the type of vowel. While /a/ and /e/ reduce to [ə] in all unstressed positions, /o/ and /i/ only reduce in the weak position of a foot (Kager 1989:312, Booij 1981, Oostendorp 1995). For example, /lokomotif/ is realized as [(lòkə)mo(tíf)], not *[(lòkə)mə(tíf)]. The category 'weak position of a foot' is effectively equivalent to 'foot non-DTE' (-Δ_{Ft}), as will be shown below. The round high vowels /y/ and /u/ do not reduce at all.

Figure 4.4 summarizes the generalizations in graphical form.

Figure 4.4: Dutch Semi-Formal reduction summary

⟶ indicates reduction in all unstressed positions

----▶ indicates reduction in -Δ_{Ft} only.
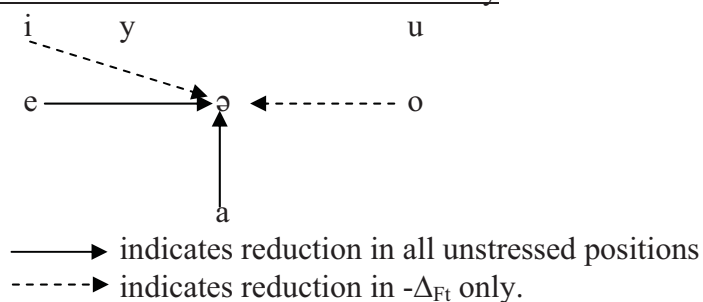
Semi-formal reduction presents several analytical challenges. The one that is of central interest here is the difference between the non-DTE of foot and other unstressed positions for /o/ and /i/. The following sections will argue that this pattern follows from the constraint *-$\Delta_{Ft} \geq \{i,u\}$, which bans high sonority elements in foot non-DTEs alone.

As implied above, neither primary nor secondary stressed vowels ever undergo reduction: e.g. [(gálə)], *[(gə́lə)]; [(ˌparə)(ˈdis)], *[(pə̀rə)(dís)] (Kager 1989:297, Booij 1981).

- *Non-metrically conditioned influences*

The focus of this section will be on the patterns of vowel reduction influenced by metrical structure. A number of non-metrically based conditions also trigger and restrict vowel reduction, though.

Vowels in onsetless syllables also do not undergo reduction, nor do prevocalic vowels. Finally, word-final vowels in open syllables do not reduce (e.g. [kɔ́la], *[kɔ́lə] 'cola' – K304). These restrictions will be discussed in §4.3.3 since they are unrelated to the aspect of vowel reduction that is of immediate interest: i.e. its metrical conditioning.

In short, all post-consonantal non-pre-vocalic vowels in non-final unstressed syllables with onsets are subject to reduction.

- *Data*

The words listed below are taken from Kager (1989) (Hereafter K). Footing is my own, based on Kager's proposals; stress in Dutch is left-to-right trochaic and quantity-sensitive – tense vowels count as bimoraic (Kager 1989:313, Oostendorp 1995§4.2). The

transcriptions are from *Cassell's Dutch Dictionary* (van Wely 1977), with vowel reduction marked following K's indications. Glosses are given where the English translation is not immediately apparent.

(26)   /a/ reduces in footed and stray unstressed syllables[65]

[(kàrə)(mél)]	*karamel*	[(sìɣə)(rét)]	*sigaret*
[(kɔ̀lə)(bòrə)(tǿr)]	*collaborateur*	[(jèry)zə(lém)]	*Jerusalem*
[rə(déis)]	*radijs* 'radish'	[(àpə)kə(líps)]	*apocalyps*
[(pànə)rə(mík)]	*panoramiek*		

(27)   /e/ reduces in footed and stray unstressed syllables

[(pròsə)(dé)]	*procédé* 'process'	[(lìtə)rə(týr)]	*literatuur*
[(èkə)(nòmə)(trí)]	*econometrie*	[sə(nát)]	*senaat*
[(àntə)sə(dént)]	*antecedent*	[(èpi)də(mí)]	*epidemie*

(28)   /o/ reduces in footed unstressed syllables only

[(ʃòkə)(lá)]	*chocola* 'chocolate'	[(lìmə)(nádə)]	*limonade*
[(pèlə)(tón)]	*peloton* 'platoon'	[(lòkə)mo(tíf)]	*lokomotief*
[(èko)nə(mí)]	*economie*	[(ònə)(màtə)(pé)]	*onomatopee*
[to(mát)]	*tomaat* 'tomato'	[(kàtə)go(rí)]	*categorie*

(29)   /i/ reduces in footed unstressed syllables only

[(rèlə)(kwí)]	*relikwie* 'relic'	[(dìsə)(plínə)]	*discipline*
[(kàrə)kə(týr)]	*karikatuur*	[(spèsə)(fìsə)(téit)]	*specificiteit*
[mi(nút)]	*minuut*	[(ìndə)vi(dú)]	*individu*
[(sèrtə)fi(kát)]	*certificaat*		

(30)   Dutch /y/ and /u/ reduction
(a) /y/ does not reduce

[(màny)fɑk(týr)]	*manufaktuur* 'drapery'	[(prímy)lə]	*primula*
[(stìmy)ləs]	*stimulus*	[(kòmy)(níst)]	*communist*

(b) /u/ does not reduce

[(ʒàlu)(zí)]	*jaloezie*	[(kàmu)(fláʒə)]	*camouflage*

The following section presents an analysis of this reduction pattern.

4.3.2   Semi-formal reduction: Analysis

Crosswhite (1999) proposes that certain cases of vowel reduction are a response to a ban on high sonority elements in unstressed syllables. The following analysis adopts the spirit of this approach. The formalism relies on the non-DTE constraints.[66] Semi-formal

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[65] Evidence that the underlying forms contain the vowels indicated comes from the Formal register, in which no reduction takes place.

[66] Crosswhite's (1999§2.1) constraints refer to the category 'unstressed syllable'. The present theory differs in referring to non-DTEs of prosodic units, effectively distinguishing between different types of unstressed

reduction in Dutch is of particular interest to the present theory because it requires the action of constraints that refer to non-DTEs of different prosodic categories (i.e. -Δ_{Ft} and -Δ_{PrWd}), in some cases crucially ranked with respect to each other.

This analysis starts with reduction of /a/ and /e/ in all unstressed syllables (§4.3.2.1). Section 4.3.2.2 deals with the less general /o/ and /i/ reduction, and §4.3.2.3 concludes by accounting for the lack of reduction of /y/ and /u/.

4.3.2.1 /a/ and /e/ reduction: PrWd non-DTEs

/a/ and /e/ both reduce in unstressed syllables, regardless of whether the syllable is in a foot or not: e.g. /literatyr/ → [(lìtə)rə(týr)] *literatuur*. In the present theory, there is no category 'unstressed syllable' (cf Crosswhite 1999). Instead, 'unstressed syllable' is every PrWd non-DTE that is not a foot DTE.

The non-DTE of a PrWd is every element that is not the primary stressed segment of a PrWd. So, the constraint *-$\Delta_{PrWd}\geq\{e,o\}$ bans all segments with sonority of more than high vowels that do not bear primary stress. This constraint outranks all faithfulness constraints that preserve the peripherality of /a/ and /e/ – i.e. lowness for /a/ (IDENT[+low]) and frontness for /e/ (IDENT[−back]); these constraints will collectively be called IDENTV here. With the ranking || *-$\Delta_{PrWd}\geq\{e,o\}$ » IDENTV ||, reduction of /a/ and /e/ will take place in all unstressed positions, as shown in tableau (31).

(31)

/literatyr/	*-$\Delta_{PrWd}\geq\{e,o\}$	IDENTV
(a) (lìte)ra(týr)	* *!	
(b) (lìtə)ra(týr)	*!	*
☞ (c) (lìtə)rə(týr)		* *

It is essential to invoke a constraint that refers to the non-DTEs of *PrWds* rather than non-DTEs of feet here. -Δ_{PrWd} refers not only to unstressed syllables within feet, but also 'stray' (i.e. unfooted) syllables. In [(lìtə)rə(týr)], only the first schwa is a -Δ_{Ft}; the second is not a foot non-DTE because it is not dominated by a Ft node. If only *-$\Delta_{Ft}\geq\{e,o\}$ were active, the output would be *[(lìtə)ra(týr)] without reduction in the stray syllable.

- *Blocking reduction in stressed syllables*

The constraint *-$\Delta_{PrWd}\geq\{e,o\}$ promotes reduction in both secondary stressed and unstressed positions. It therefore favours *[(ə̀ntə)sə(dént)] 'antecedent', with reduction in the secondary stressed syllable, over the actual winner [(à̀ntə)sə(dént)]. This example underscores the point that PrWd non-DTEs are not the same as 'unstressed syllables': unstressed syllables are all those PrWd non-DTEs that are not foot DTEs while -Δ_{PrWd} refers to all syllables that do not bear main stress (i.e. secondary stressed and unstressed syllables).

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syllable; in fact, there is no direct non-DTE equivalent to the category 'unstressed syllable', as discussed below.

The DTE constraint $*\Delta_{Ft}\leq\{\ni\}$ blocks reduction in stressed syllables by banning schwa in precisely that position. The constraint also has the incidentally desirable effect of explaining why [ə] is never permitted in stressed position: with this ranking, underlying /ə/ will be forced to peripheralize if it ends up with stress: i.e. /pət/ → [pét] (or some other peripheral vowel), *[pə́t].

$*\Delta_{Ft}\leq\{\ni\}$ must outrank $*\text{-}\Delta_{PrWd}\geq\{e,o\}$, as shown in (32).

(32)

	/antesedɛnt/	$*\Delta_{Ft}\leq\{\ni\}$	$*\text{-}\Delta_{PrWd}\geq\{e,o\}$	IDENTV
☞	(a) (àntə)sə(dɛ́nt)		*	* *
	(b) (ə̀ntə)sə(dɛ́nt)	*!		* * *

One further ranking is needed to account for lack of reduction in secondary stressed syllables. The ranking given in (32) would not prevent /e/ or /a/ from raising to [i], so satisfying $*\text{-}\Delta_{PrWd}\geq\{e,o\}$. The constraint IDENT[−high] can be used to avoid this result. If IDENT[−high] outranks $*\text{-}\Delta_{PrWd}\geq\{e,o\}$, the [−high] /a/ and /e/ will not be able to raise to [+high] /i/; however, they will be able to reduce to the [−high] [ə].

(33)

	/antesedɛnt/	IDENT[−high]	$*\text{-}\Delta_{PrWd}\geq\{e,o\}$
☞	(a) (àntə)sə(dɛ́nt)		*
	(b) (ìntə)sə(dɛ́nt)	*!	

The constraint IDENT[−high] will be used as stated here. This constraint is not an *ad hoc* solution – it turns out that it plays an important role in other reduction patterns, discussed in the context of /o/-reduction below.

The final point of this section is that it is significant the constraint $*\text{-}\Delta_{PrWd}\geq\{e,o\}$ is used here rather than $*\text{-}\Delta_{PrWd}\geq\{i,u\}$. This difference accounts for the fact that /i/ does not reduce in unfooted unstressed positions: e.g. [mi(nút)] *minuut*, *[mə(nút)] (cf [rə(dɛ́is)], *[ra(dɛis)] 'radish'). To prevent reduction of /i/ in stray syllables, IDENTV must outrank $*\text{-}\Delta_{PrWd}\geq\{i,u\}$, as shown in tableau (34).

(34)

	/mi(nút)/	$*\text{-}\Delta_{PrWd}\geq\{e,o\}$	IDENTV	$*\text{-}\Delta_{PrWd}\geq\{i,u\}$
☞	(a) mi(nút)			*
	(b) mə(nút)		*!	

Diagram (35) summarizes the rankings established in this section.

(35)   Interim ranking summary I: /a/ and /e/ reduction

$$*\Delta_{Ft}\leq\{\text{ə}\}\qquad \text{IDENT}[-\text{high}]$$

$$*\text{-}\Delta_{PrWd}\geq\{e,o\}$$

$$\text{IDENT}V$$

$$*\text{-}\Delta_{PrWd}\geq\{i,u\}$$
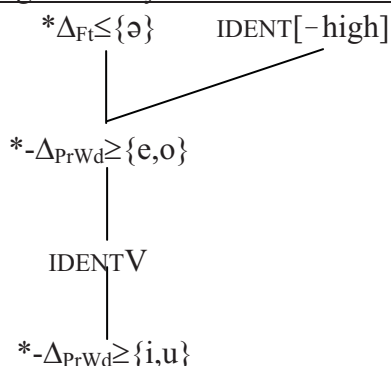
As a concluding comment, one of the significant points of this section is that there is no term that corresponds directly to 'unstressed syllable' in the (non-)DTE theory. Instead, 'unstressed syllables' are those $-\Delta_{PrWd}$ that are not Δ_{Ft}. This may seem surprising given that processes like vowel reduction generally seem to target 'unstressed syllables' as a group (for relevant proposals, see Crosswhite 1999). However, as demonstrated in this section, the fact that there is no 1:1 relation between 'unstressed syllables' and non-DTEs does not prevent processes from being limited to unstressed syllables alone. Moreover, the non-DTE theory predicts that there are different types of unstressed syllables – specifically that unstressed syllables in foot non-DTEs are distinct from unfooted syllables; this point is discussed in the following section.

4.3.2.2 /o/ and /i/ reduction: Foot non-DTEs

In contrast to /e/ and /a/, /o/ and /i/ do not reduce in every unstressed syllable. /o/ and /i/ only reduce when they are in the non-DTE position of a foot: e.g. [(lòkə)mo(tíf)], *[(lòkə)mə(tíf)] 'locomotive'; [(ìndə)vi(dú)] *individu*, *[(ìndə)və(dú)]. /i/ reduction will be discussed first, followed by /o/ reduction.

- /i/ *reduction*

Since /i/ only reduces in the non-DTE position of a foot, the PrWd non-DTE constraint $*\text{-}\Delta_{PrWd}\geq\{i,u\}$ cannot be responsible for /i/-reduction (as established in the preceding section). Instead, the relevant constraint is the foot non-DTE constraint $*\text{-}\Delta_{Ft}\geq\{i,u\}$, which bans peripheral vowels only in the weak member of a foot. Tableau (36) shows that this constraint outranks IDENTV.

(36)

	/individu/	$*\text{-}\Delta_{Ft}\geq\{i,u\}$	IDENTV	$*\text{-}\Delta_{PrWd}\geq\{i,u\}$
	(a) (ìndi)vi(dú)	*!		* * *
☞	(b) (ìndə)vi(dú)		*	* *
	(c) (ìndə)və(dú)		* *!	*

- /o/ *reduction*

Reduction of /o/ is a slightly more complex matter than /i/-reduction, but shows the interaction of different types of non-DTE constraint in a rather striking way. The constraint *-$\Delta_{PrWd}\geq$\{e,o\} – used in the preceding section – promotes reduction of /o/ in every PrWd non-DTE. However, /o/ is prevented from neutralizing in all such positions because doing so would make it lose its 'colour' features – i.e. roundness. In more formal terms, the constraint IDENT[round] prevents /o/ from neutralizing, as shown in tableau (37) with the word [to(mát)] *tomaat*, *[tə(mát)].

(37)

	/tomat/	IDENT[round]	*-$\Delta_{PrWd}\geq$\{e,o\}
☞	(a) to(mát)		*
	(b) tə(mát)	*!	

IDENT[round] will not block reduction of /a/, /e/, and /i/ because these vowels' [‒round] specification is preserved in [ə].

However, /o/ does reduce to [ə] in foot non-DTE position. As with /i/, there is a stronger pressure to reduce in foot non-DTEs than in unfooted 'stray' positions. As with /i/, a foot non-DTE constraint *-$\Delta_{Ft}\geq$\{e,o\} can be used to motivate this change. With *-$\Delta_{Ft}\geq$\{e,o\} outranking IDENT[round], /o/ will reduce to [ə].

(38)

	/lokomotif/	*-$\Delta_{Ft}\geq$\{e,o\}	IDENT[round]	*-$\Delta_{PrWd}\geq$\{e,o\}
	(a) (lòko)mo(tíf)	*!		* * *
☞	(b) (lòkə)mo(tíf)		*	* *
	(c) (lòkə)mə(tíf)		* *!	*

Again, something must be said about why /o/ does not reduce to [u] – *[(lòku)mə(tíf)] – since this would preserve its [+round] specification. The constraint IDENT[‒high] provides the answer: IDENT[‒high] outranks IDENT[round]; this ranking prevents /o/ from raising to the [+high] [u], but allows /o/ to reduce to the [‒high] mid vowel [ə].

Diagram (39) summarizes the rankings established in this section, and amalgamates them with the ones from the previous section. The rankings on the left side are those from the previous section, and those on the right are from this section.

(39)   Interim ranking summary II: /o/ and /i/ reduction + /a/ and /e/ reduction

$$*\text{-}\Delta_{Ft}\geq\{e,o\} \qquad \text{IDENT}[-\text{high}]$$

$$*\Delta_{Ft}\geq\text{ə}$$

$$\text{IDENT}[\overline{\text{round}}]$$

$$*\text{-}\Delta_{PrWd}\geq\{e,o\} \qquad *\text{-}\Delta_{Ft}\geq\{i,u\}$$

$$\text{IDENT}\overline{\text{V}}$$

$$*\text{-}\Delta_{PrWd}\geq\{i,u\}$$
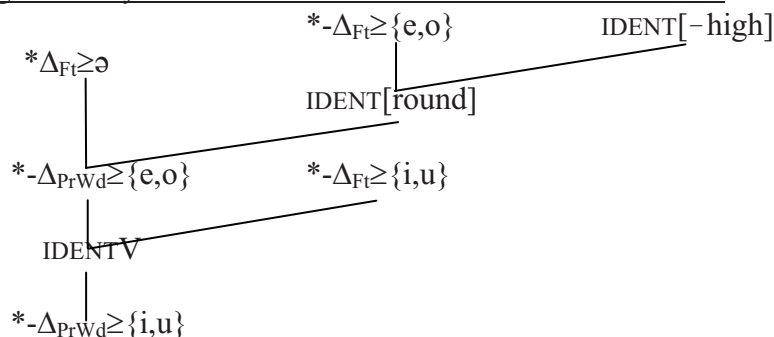
The discussion has passed by an important aspect of the analysis without comment: /i/ reduction is motivated by the constraint $*\text{-}\Delta_{Ft}\geq\{i,u\}$, while /o/ reduction is motivated by $*\text{-}\Delta_{Ft}\geq\{e,o\}$. The next section shows why this must be the case, and therefore why /o/ reduction cannot be forced by $*\text{-}\Delta_{Ft}\geq\{i,u\}$.

4.3.2.3 /y/ and /u/ preservation

Unlike /o/, the round high vowels /y/ and /u/ do not reduce in any position: e.g. [(kòmy)(níst)] *communist,* *[(kòmə)(níst)]; [(ʒàlu)(zí)] *jaloezie,* *[(ʒàlə)(zí)]. As with the lack of /o/ reduction in stray syllables, this effect can be ascribed to the constraint IDENT[round]. If IDENT[round] outranks $*\text{-}\Delta_{Ft}\geq\{i,u\}$, neither /y/ nor /u/ will reduce, as shown in tableau (40).

(40)

/komynist/	IDENT[round]	$*\text{-}\Delta_{Ft}\geq\{i,u\}$
☞ (a) (kòmy)(níst)		*
(b) (kòmə)(níst)	*!	

/y/ cannot reduce to any other vowel here: reducing to [u] or [o] will still incur violations of $*\text{-}\Delta_{Ft}\geq\{i,u\}$.

This ranking shows that there is a crucial difference between the foot-level $*\text{-}\Delta_{Ft}\geq\{e,o\}$ and $*\text{-}\Delta_{Ft}\geq\{i,u\}$ in Dutch. The former outranks IDENT[round] while the latter does not: || $*\text{-}\Delta_{Ft}\geq\{e,o\}$ » IDENT[round] » $*\text{-}\Delta_{Ft}\geq\{i,u\}$ ||. $*\text{-}\Delta_{Ft}\geq\{e,o\}$ must outrank IDENT[round] to allow /o/ to reduce in foot non-DTEs, while IDENT[round] must outrank $*\text{-}\Delta_{Ft}\geq\{i,u\}$ in order to block reduction of high round vowels. This ranking concludes the analysis of Semi-formal vowel reduction in Dutch.

The complete ranking is presented in Figure 4.5.

Figure 4.5: Dutch Semi-Formal register vowel reduction ranking

$$*\text{-}\Delta_{Ft}\geq\{e,o\} \qquad \text{IDENT}[-\text{high}]$$
$$*\Delta_{Ft}\leq\partial$$
$$\text{IDENT}[\text{round}]$$
$$*\text{-}\Delta_{PrWd}\geq\{e,o\} \qquad *\text{-}\Delta_{Ft}\geq\{i,u\}$$
$$\text{IDENTV}$$
$$*\text{-}\Delta_{PrWd}\geq\{i,u\}$$
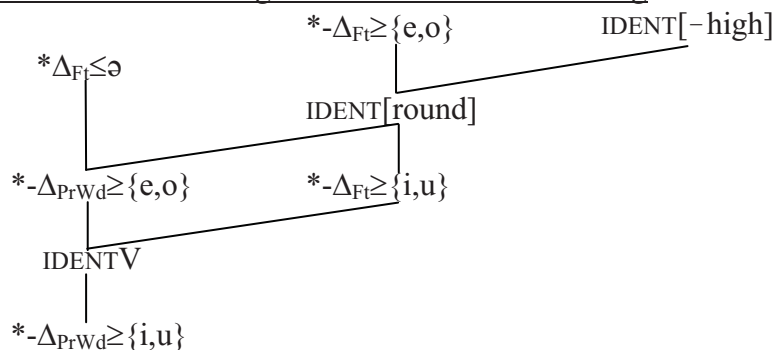
The fact that the PrWd-level constraint *-$\Delta_{PrWd}\geq\{i,u\}$ is inactive (i.e. ranked below IDENTV) is crucial in preventing /i/ from reducing in all positions. The fact that /i/ (and /o/) only reduce in foot non-DTE positions is evidence that a markedness constraint must promote reduction in this specific position.

4.3.3 Informal and unattested reduction

Reduction in the Formal and Informal registers is much less complex than in the Semi-formal register. No reduction takes place in the Formal register, a situation that can be produced by ranking IDENTV above all non-DTE constraints.

Almost every vowel reduces in every unstressed position in the Informal Register. The exceptions are /y/ and /u/, which only reduce in the non-DTEs of feet. The ranking needed for this register differs from the Semi-formal one only in that the non-DTE markedness constraints are higher in the ranking, by precisely two strata.

To force neutralization of /o/ in stray syllables, *-$\Delta_{PrWd}\geq\{e,o\}$ must outrank the faithfulness constraints IDENT[round]. Similarly, to force neutralization of /i/ in all unstressed syllables, *-$\Delta_{PrWd}\geq\{i,u\}$ must outrank IDENTV. However, since reduction of /y/ and /u/ is blocked in stray syllables, IDENT[round] must outrank *-$\Delta_{PrWd}\geq\{i,u\}$. The example in (41) is /lokomotif/, which is realized as [(lòkə)mə(tíf)] in the informal register, compared with [(lòkə)mo(tíf)] in the Semi-formal register.

(41)   Informal reduction of /o/

/lokomotif/	*-$\Delta_{PrWd}\geq\{e,o\}$	IDENT[round]
☞ (a) (lòkə)mə(tíf)	*	* *
(b) (lòkə)mo(tíf)	* *!	*

Reduction of /y/ and /u/ in foot non-DTEs requires the ranking || *-$\Delta_{Ft}\geq\{i,u\}$ » IDENT[round] ||.

(42)   Informal reduction of /u/

/ʒɑluzi/	*-Δ_{Ft}≥{i,u}	IDENT[round]
(a) (ʒɑ̀lu)(zí)	*!	
☞ (b) (ʒɑ̀lə)(zí)		*

To prevent reduction of /y/ and /u/ in stray syllables, IDENT[round] still must outrank *-Δ_{PrWd}≥{i,u}; of course, this ranking will not prevent reduction of /i/ to [ə] in unstressed syllables.

The full ranking is summarized in Figure 4.6. In essence, it differs from the Semi-formal register's ranking only in that the markedness constraints have been moved up two strata in the ranking. The constraints *Δ_{Ft}≤{ə} and IDENT[−high] are omitted here; they occupy a similar position as in the Semi-Formal register – outranking all -Δ_{PrWd} constraints.

Figure 4.6: Dutch Informal register vowel reduction ranking

$$\text{*-}\Delta_{PrWd}≥\{e,o\} \qquad \text{*-}\Delta_{Ft}≥\{i,u\}$$

$$\text{IDENT[round]}$$

$$\text{*-}\Delta_{PrWd}≥\{i,u\}$$

$$\text{IDENT}V$$
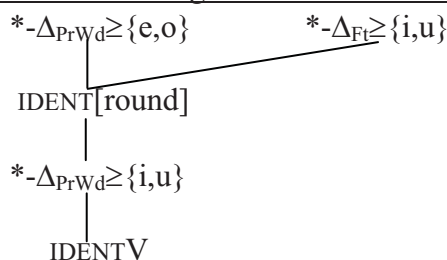
- *Impossible reduction*

The constraints used here not only account for vowel reduction in the non-formal registers, but also for the unattested reduction pattern ☠[(fòno)lə(ɣí)].[67] I adopt Kager's proposal in (43) that reduction in stray syllables implies reduction in foot non-DTEs.

(43)   Kager's Generalization
"For vowels whose reducibility depends on position, reduction is generally easier in adjunct [i.e. foot non-DTE] positions than in stray positions." (K313)

Kager's Generalization falls out from the present theory: from input /fonoloɣi/, ☠[(fòno)lə(ɣí)] is harmonically bounded by the candidate with reduction in the foot non-DTE alone [(fònə)lo(ɣí)].

The relevant constraints here are (i) those that promote reduction in unstressed syllables – i.e. the foot and PrWd non-DTE constraints and (ii) faithfulness constraints.

The major competing candidate is [(fònə)lo(ɣí)], with reduction in the foot non-DTE only. This candidate fares equally well in terms of faithfulness as ☠[(fòno)lə(ɣí)] – both are unfaithful to an input /o/.[68]

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[67]   The symbol ☠ indicates a form that is not only unattested in a particular grammar, but also universally impossible.

In terms of markedness constraints, ☠[(fòno)lə(ɣí)] fares no better on any markedness constraint than [(fònə)lo(ɣí)]. Specifically, for all *-Δ_PrWd/*x* constraints, ☠[(fòno)lə(ɣí)] and [(fònə)lo(ɣí)] incur the same number of violations. However, [(fònə)lo(ɣí)] incurs fewer violations than ☠[(fòno)lə(ɣí)] for several constraints (e.g. *-Δ_Ft≥{i,u}).

In short, [(fònə)lo(ɣí)] is a harmonic bound for ☠[(fòno)lə(ɣí)]: the latter incurs a subset of the former's violations. Tableau (44) illustrates this point.

(44)

	/fonoloɣi/	*-Δ_Ft≥{i,u}	*-Δ_PrWd≥{i,u}	IDENTV
☞	(a) (fònə)lo(ɣí)		*	*
☠	(b) (fòno)lə(ɣí)	*	*	*

For ☠[(fòno)lə(ɣí)] to win in some grammar, there would have to be a markedness constraint that promoted reduction in unfooted syllables, thus dooming [(fònə)lo(ɣí)]. Since 'stray syllable' is not definable in non-DTE (or DTE) terms, there is no such markedness constraint in the present theory.

A faithfulness alternative would be to invoke a faithfulness constraint that refers to the foot non-DTE but not to unfooted PrWd non-DTEs. Thus, [(fònə)lo(ɣí)] is less faithful than ☠[(fòno)lə(ɣí)] because the former does not retain the underlying /o/'s features in the foot non-DTE position. Such a constraint is not available in the present theory, so the pattern is predicted to be impossible (cf Alderete 1995, Yip 1995).[69]

In short, Kager's Generalization follows from the fact that candidates with reduction in stray syllables only are harmonically bounded by those with reduction only in foot non-DTEs. This follows from the fact that there is no way to refer to stray syllables without also referring to foot non-DTEs in the present theory.

- *Non-metrical restrictions on neutralization*

As noted in the description of vowel reduction, vowels in onsetless unstressed syllables in Dutch do not reduce: e.g. *elíte, *əlíte; idóol, *ədóol*. K298 notes that lack of reduction is particularly pervasive in word-initial syllables. This statement might be recast as 'vowels in syllables with [h] and [ʔ] onsets cannot reduce', since there is an epenthetic [ʔ] at the beginning of all vowel-initial lexical words, and [ʔ] is epenthesized in V-initial medial syllables after [a]: e.g. [báʔobab], [máʔoist]. Oostendorp (1995) suggests that reduction in these cases is blocked by a constraint that requires syllables to have a specification for Place of Articulation, assuming that [h] and [ʔ] are placeless (cf chs.5, 6, 7). The issue is somewhat complex, though: see Kager (1989:298-9) for a detailed discussion.

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[68] I assume that there is no position-specific faithfulness constraint that favours preservation of /o/ in a stray syllable over preservation of /o/ in a foot non-DTE. This seems reasonable, given theories of positional faithfulness (Beckman 1998, Casali 1997).

[69] This does not prevent *different* reductions from taking place in the foot non-DTE and stray syllables. See Crosswhite (1999) for extensive discussion.

Similarly, prevocalic vowels reduce with difficulty, especially in the initial syllable: e.g. [kaíro], *[kəíro] (K299). Similarly, final open syllables are irreducible (Kager 1989: 303-4): e.g. *cóla, táugee, kóffie, Málmö, híndoe*.

It is clear that these restrictions on reduction are not related to DTE or non-DTE status, so – strictly speaking – they are beyond the scope of the present theory. However, they certainly deserve a detailed explanation as similar restrictions occur in other languages (Crosswhite 1999:ch.6). Crosswhite provides reasons for the lack of reduction in all such cases, making use of positional faithfulness constraints and constraints on admissible vowel-vowel sequences. This section will not explore an analysis of these additional restrictions along these lines here; see Crosswhite (1999:ch.6) for a general solution.[70]

4.3.4 Summary

This section has shown that vowel reduction in Dutch registers is produced by constraints on non-DTEs, both of the Foot and the PrWd.

Dutch vowel reduction is striking in that it provides evidence for the activity of several non-DTE constraints in the same grammar: $*\text{-}\Delta_{Ft}\leq\{i,u\}$, $*\text{-}\Delta_{Ft}\leq\{e,o\}$, $*\text{-}\Delta_{PrWd}\leq\{i,u\}$, and $*\text{-}\Delta_{PrWd}\leq\{e,o\}$. These constraints are demonstrably distinct in Dutch, as they interleave with faithfulness constraints. For example, $*\text{-}\Delta_{Ft}\leq\{e,o\}$ outranks IDENT[round] in the Semi-formal register, while $*\text{-}\Delta_{Ft}\leq\{i,u\}$ does not.

The Dutch system shows both the expressiveness and restrictiveness of the (non-)DTE approach. The DTE and non-DTE constraints can be used to refer to a variety of categories of syllables. For example, constraints that refer to DTEs of the PrWd apply only to main-stressed syllables, while those that refer to DTEs of feet apply to both main and secondary stressed syllables. In contrast, there is no DTE category that applies solely to secondary stressed syllables; thus, any constraint that influences secondary stressed syllables also influences main stressed ones (unless it is blocked by some constraint that refers specifically to main-stressed syllables, as in positional faithfulness).

More relevant to Dutch is the distinction between footed unstressed syllables and unfooted (stray) unstressed syllables. The category $\text{-}\Delta_{Ft}$ allows constraints to refer to only those unstressed syllables that are in feet. In contrast, there is no definable non-DTE category that refers solely to stray syllables. The effect is that no markedness constraint can influence the content of stray syllables without also influencing footed unstressed syllables as well.

In short, the DTE/non-DTE approach to constraint form provides adequate expressiveness, but is not unrestricted.

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[70] One final restriction on vowel reduction deserves some comment in the context of the present theory. Some final vowels in CVC syllables can undergo reduction: *mótər, proféssər, rádər*. However, reduction is easiest when the final vowel is immediately post-tonic; final reduction in words stressed on the antepenult is more difficult: *lúcifer, Júpiter, rábies, Aristóteles*. The difference in ease of reduction in CVC syllables again seems to refer to a difference between foot non-DTEs and PrWd non-DTEs: vowels in foot non-DTEs – i.e. immediately post-tonically *(mótər)* cf *(lúci)fer* – reduce more easily, showing that foot non-DTE constraints have a greater effect, as they do generally in the language.

As a closing comment, the Dutch system is not unique. Nagy (1998) reports that post-tonic syllables in Faetar obligatorily reduce to [ə], while reduction is optional for pre-tonic syllables (also see Nagy & Renolds 1997). Russian also exhibits differences between immediately pre-tonic (i.e. arguably footed) and other syllables in terms of vowel reduction (see Crosswhite 1999 and references cited therein for discussion and analysis). Similar patterns are found in Saami (Bye 2001) and Lushootseed (Urbanczyk 1996).

4.4 The interaction of DTEs and non-DTEs: Vowel epenthesis

Evidence that markedness constraints refer to non-DTEs is also found in phenomena that are sensitive to the interaction between DTE and non-DTE scale preferences. The existence of both DTE and non-DTE constraints means that the markedness of a vowel depends on its position. In the present theory, high sonority segments are the least marked type in DTEs, but most marked in non-DTEs. In contrast, low sonority segments are least marked in non-DTEs, but most marked in DTEs.

There is a further property of the DTE theory: a segment can be both a DTE and a non-DTE. For example, the [i] in [pá.ti] is the DTE of the syllable and mora, but a non-DTE of the foot and PrWd. Therefore, both DTE and non-DTE constraints can apply to it. The net result can be a tug-of-war between DTE constraints and non-DTE constraints, with the result that the least marked segment is neither high sonority nor low sonority, but has a quality that is a compromise between the two extremes – e.g. [ɛ].

This section shows how the antagonism between DTE and non-DTE constraints accounts for all the different types of epenthetic vowels, and for the fact that epenthetic vowel features may differ depending on the environment in the same language.

Section 4.4.1 presents a typology of epenthetic elements. It also provides rankings for epenthesis of various types of vowel systems.

Section 4.4.2 discusses Shipibo, a language that has epenthetic [a] in foot heads and epenthetic [i] in foot non-heads (Lauriault 1948, Elías 2000, p.c.). This situation is shown to come about through the action of DTE and non-DTE constraints.

Section 4.4.3 discusses universals of epenthesis. While a vowel of any sonority can be epenthetic, there are restrictions on languages with more than one epenthetic vowel quality, like Shipibo.

4.4.1 The spectrum of epenthesis

Table 4.1 shows that any non-round vowel [ɨ ə i ɯ e ɛ a] can be epenthetic.

The table lists cases of 'default' epenthesis, where the epenthetic segment is not influenced by the featural content of adjacent elements. 'Copy' epenthesis (where the epenthetic element duplicates part or all of a nearby vowel) is discussed only in passing (§4.4.1.2); see Kitto & de Lacy (1999) and references cited therein for discussion of copy vowels. More generally, the cases below do not include those where epenthetic vowel content is influenced by processes such as vowel harmony and assimilation.

The aim in the table is genetic diversity, but for practical (i.e. visual) reasons examples of each type have been limited to a maximum of 10 languages. To give a sense

of the relative frequency of the types, of a total of 105 languages (randomly selected), 22 have [i], 19 [ə], 13 [a], 10 [e], 7 [ɯ], 5 [ɨ], 3 [o], and 26 had copy vowels (see Kitto & de Lacy 1999).

Table 4.1: Typology of epenthetic vowels

Vowel	Language		Family	Reference
ɨ	Amharic		Semitic	Hayward (1986)
	Karao		N.Phillipine	Brainard (1994)
	Washo		Hokan	Kenstowicz & Kisseberth (1971)
ə	Chukchi	Chukotko-Kamchatkan		Krause (1980)
	Hindi		Indo-Aryan	Steriade (1995b:138)
	Itelman	Chukotko-Kamchatkan		Bobaljik (1997)
	Karo Batak		Sundic	Woolams (1996)
	Ladahki		Tibetan	Koshal (1979)
	Malay		Sundic	Ahmad (1994)
	Mongolian		Altaic	Svantesson (1995)
	Palestinian Arabic	Semitic		Abu-Salim (1982:10)
	Sekani		Athapaskan	Hargus (1988)
	Wolof		Senegambian	Ka (1985)
i	Alabama		Muskogean	Montler & Hardy (1991)
	Harari		Ethiopian	Rose (1997)
	Maltese		Semitic	Hume (1992)
	Manam		Oceanic	Lichtenberk (1983:32)
	Māori		Polynesian	de Lacy (2002a)
	Moañés Galician	Romance		Martinez-Gil (1997)
	Ojibwa		Algonquian	Piggott (1992)
	Pāli		Indo-European	Fahs (1985)
	Pipil		Aztecan	Campbell (1985)
ɯ	Japanese (loans)	Isolate		Ito & Mester (1995)
	Kannada		Dravidian	Sridhar (1990)
	Koḍava		Dravidian	Ebert (1996)
	Tamil		Dravidian	Vasanthakumari (1989)

	Basque	Indo-Eurpoean	Hualde (1991)
	Chipewyan	Athapaskan	Li (1946)
	Czech	Slavic	Ketner (2003)
	Galician	Romance	Colina (1997)
	Gengbe (Mina)	Niger-Congo	Abaglo & Archangeli (1989)
e/ɛ	Mohawk	Iroquoian	Hopkins (1987)
	Spanish	Romance	Steriade (1995b)
	Slave	Athapaskan	Rice (1989:133)
	Temiar	Mon-Khmer	(closed σs) McCarthy (1980)
	Tiberian Hebrew	Semitic	(word-final closed σs) Rappaport (1984)
	Axininca Campa	Arawakan	Payne (1990), McCarthy & Prince (1993b)
	Coos	Penutian	Frachtenberg (1922)
	Dakota	Siouan	Shaw (1980:120)
	Klamath	Penutian	Kenstowicz & Kisseberth (1971)
a	Lardil	Pama-Nyungan	Piggott (1993)
	Mabalay Atayal	Formosan	Lambert (1999§3.2.1)
	Marathi	Indo-Aryan	Pandharipande (1997)
	Mesola Italian	Romance	Repetti (1996)
	Sudanese Arabic	Semitic	Haddad (1983)
	Wapishana	Arawakan	Tracy (1972)

The table omits languages with more than one epenthetic vowel. See §4.4.2 for discussion.

The epenthetic vowels listed above are inserted to satisfy a variety of requirements, including minimal word restrictions, metrical conditions, and segmental phonotactic restrictions (see Broselow 1982).

The following subsections identify the rankings of the DTE and non-DTE constraints that produce the attested vowel qualities. Section 4.4.1.1 shows how the dominance of DTE over non-DTE constraints can result in the high sonority [a] as the epenthetic vowel, focusing on epenthesis in Coos (Frachtenberg 1922).

Section 4.4.1.2 shows how the dominance of the non-DTE constraints can produce low sonority [ɨ], [ə], and (to some extent) [i], with special attention paid to epenthesis in Maga Rukai (Hsin 2000).

Section 4.4.1.3 shows how a mingling of the DTE and non-DTE constraints produces vowels with intermediate sonority – [e], [ɛ], and (to some extent) [i]; [ɛ]-epenthesis in Chipewyan is the main case discussed in this section.

Section 4.4.1.4 discusses vowels that are never, or only ever marginally, epenthetic (e.g. [u o ɔ ɵ]).

4.4.1.1 Epenthetic [a]

McCarthy & Prince (1994) have shown that the quality of epenthetic elements is due to the emergent effect of markedness constraints. This follows from the fact that epenthetic elements have no underlying correspondents, so faithfulness constraints cannot influence their form. Since faithfulness constraints are irrelevant, the featural content of an epenthetic vowel is the pure expression of markedness constraints. Therefore, default epenthesis provides insight into the DTE and non-DTE constraints.

In terms of the DTE constraints alone, high sonority vowels – i.e. [a] – are the least marked type. The influence of the DTE constraints on epenthetic quality can be seen in a variety of languages. One language of this type that has received a great deal of recent discussion is Axininca Campa (Payne 1990, McCarthy & Prince 1993b), but a number of other languages also have epenthetic [a]. For example, Frachtenberg (1922:309ff) describes [a]-epenthesis in the Penutian language Coos.

Coos has the short vowels [i e a o u] and [ə], and the long vowels [iː eː æː aː oː uː]. Syllable structure is (C)(C)V(X)(C), where X is a sonorant (nasal, liquid, glide, or vowel). Codas are restricted to certain [nasal+obstruent] and [liquid+stop] clusters (i.e. [mt ms mx nt nk nl lt lm ɬt ɬts]). Nuclei may contain a short vowel, long vowel, or diphthong. Examples of syllables can be seen in [dəms.tets] 'through a prairie' and [ha.taː.jims] *no gloss*, [tkem] *no gloss* (p.307-8).

The restrictions on syllable structure motivate epenthesis in a variety of situations. As Frachtenberg explains, all inadmissible word-final and medial clusters are avoided through the insertion of a vowel (p.309). (45) provides relevant examples.

(45)   [a]-epenthesis in Coos
    (a) Epenthesis in word-final clusters

[míɬax]	cf [miɬx-ánəm]	'lunch make me' (315)
[lhinap]	cf [lhinp-íːje]	'they two came through' (315)
[álqas]	cf [alqs-áːja]	'they two are afraid of it' (315)
[tsilats]	cf [tsíl-tsəxəm]	'he was astonished' (315)
[kwaːxal]	cf [n-kwáːxl-a]	'they two have bows' (315)
/winq-s/	→ [wínqas]	'mat, spider' (309)
/helq/	→ [hélaq]	'he arrived' (309)

    (b) Epenthesis in word-medial clusters (p.309)[71]

/winq-xəm/	→ [winάqaxəm]	'it is spread out' (309)
/helq-xəm/	→ [helάqaxəm]	'it is the end' (309)
/ɬnq-a/	→ [ɬnάq-a]	'they two went down' (309)

As an example, /alqs/ cannot be faithfully output with an acceptable coda *[alqs], so [a] is epenthesized to resolve the problem [al.qas]. In ranking terms, a constraint (or constraints) against inadmissible coda clusters must outrank DEP-IO. A detailed account

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[71]   It is not clear why /winq-xəm/ cannot be repaired by a single epenthetic vowel *[wi.naq.xəm], *[win.qa.xəm]. Frachtenberg (1922) provides no relevant comments, so I leave the issue aside here.

of the constraints against inadmissible codas in Coos will not be given here as this would take the discussion too far from the point here; the constraint – or set of constraints – will simply be called *CODA_CLUSTER here. To prevent deletion, MAX-IO must also outrank DEP. The rankings are illustrated in tableau (46).

(46)

/alqs/	*CODA_CLUSTER	MAX	DEP-IO
(a) alqs	*!		
☞ (b) al.qas			*
(c) als		*!	

The issue of present interest is not what motivates epenthesis, but rather what determines the quality of the epenthetic vowel. In this regard, there must be some markedness constraint that favours [a] over all other vowels – i.e. [e o i u ə].

A contender for this role is the syllable-level DTE constraint $*\Delta_\sigma \leq \{e,o\}$. This constraint militates against all nucleus segments with less sonority than a low vowel. Thus, it will favour [álqas] over all other candidates, including *[álqes], *[álqis], and *[álqəs].

The constraint $*\Delta_\sigma \leq \{e,o\}$ must outrank all markedness constraints that would favour any of the non-low vowels over [a]. This includes all non-DTE constraints that refer to the positions 'foot non-DTE' and 'PrWd non-DTE'. For example, the constraint $*-\Delta_{PrWd} \geq \{i,u\}$ favours [ə] over [a] in unstressed syllables, so incorrectly favouring *[(álqəs)] over [(álqas)]. Since [a] is the worst type of non-DTE (as it is the most sonorous element), $*\Delta_\sigma \leq \{e,o\}$ must outrank all relevant non-DTE constraints (i.e. all those that refer to non-DTEs of feet and all higher categories. The following tableau illustrates this ranking.

(47)

/alqs/	$*\Delta_\sigma \leq \{e,o\}$	$*-\Delta_{PrWd} \geq \{i,u\}$	$*-\Delta_{Ft} \geq \{i,u\}$
☞ (a) (álqas)		*	*
(b) (ál.qəs)	*!		

To generalize, [a] is epenthesized in the DTE of α when some DTE constraint with the form $*\Delta_\alpha \leq \{e,o\}$ outranks all non-DTE constraints of the form $*-\Delta_\beta \geq x$, where β is a higher prosodic category than α. In Coos, for example, $*\Delta_\sigma \leq \{e,o\}$ outranks all $*-\Delta_{Ft} \geq \{i,u\}$, $*-\Delta_{PrWd} \geq \{i,u\}$, and so on.

- *a > i > e*
  To conclude with an interesting complexity of the Coos system, it seems that [a] is not epenthesized in all environments: after [s], the epenthetic vowel is [i] (e.g. [də́msit] cf [dəmst-éts lhínap] 'to the prairie he came', [hǽtsit:] cf [hǽtsteni:jeqəm] 'a story is being told'). This is due to a constraint requiring agreement in place of articulation between [s] and a following vowel, which will be referred to as AGREE[coronal] here (after Hume

1992, Clements & Hume 1995). AGREE[coronal] is not otherwise active in Coos, but emerges in epenthesis, just as $*\Delta_\sigma \leq \{e,o\}$ emerges. AGREE[coronal] must outrank $*\Delta_\sigma \leq \{e,o\}$ to block epenthesis of the low (non-front) vowel [a].

However, this process raises the question of why [i] is epenthesized rather than [e] since both could satisfy AGREE[coronal]. An answer is provided by lower-ranked DTE markedness constraints. Since the constraint $*\Delta_\sigma \leq \{e,o\}$ assigns the same violations to [i] and [e], lower-ranked constraints are free to determine which of the two vowels is most harmonic. Since [e] is more sonorous than [i], a non-DTE constraint like $*\text{-}\Delta_{PrWd} \geq \{e,o\}$ will favour the latter over the former. The result is illustrated in tableau (48).

(48)

/dəmst/	AGREE[coronal]	$*\Delta_\sigma \leq \{e,o\}$	$*\text{-}\Delta_{PrWd} \geq \{e,o\}$
☞ (a) dems<u>i</u>t		*	
(b) dems<u>e</u>t		*	*!
(c) dems<u>a</u>t	*!		*

To be more complete, [e] can be prevented from winning by having $*\text{-}\Delta_{PrWd} \geq \{e,o\}$ outrank all DTE constraints that favour [e] over [i] – i.e. $*\Delta_\sigma \leq \{i,u\}$.

Thus, although the non-DTE constraints are dominated, they can have an emergent effect, even in a system where DTE constraints predominate.

4.4.1.2 Epenthetic [ɨ ə]

As shown in the preceding section, the dominance of syllable-level DTE constraints over higher-level non-DTE ones results in a high sonority epenthetic vowel. Unsurprisingly, the opposite ranking produces a low sonority epenthetic vowel. Complete dominance of the non-DTE over the DTE constraints will result in a grammar epenthesizing the lowest sonority vowel allowed in its inventory.

Maga Rukai offers an interesting example of low-sonority epenthesis that shows the effect of non-DTE constraints in a rather striking way. Hsin (2000) reports that Maga Rukai has seven contrastive vowels: the peripheral vowels [i e a o u] and the central vowels [ɨ ə]. Every word in Maga Rukai must end in a vowel, so epenthesis is used to eliminate consonant-final words. This is a common process in Tsou languages (Tsuchida 1976).

At first, Maga Rukai vowel epenthesis may seem irrelevant to present concerns because the final vowel is generally a copy of the preceding vowel (49a) (cf Selayarese – Basri et al. 1977). However, a key piece of data is that copying does not take place after [a] – [ɨ] is inserted instead (49b).

(49)   Maga Rukai epenthesis
    (a)   [ikiv<u>i</u>] 'tail'   [kpiŋi] 'clothing'
             [θvek<u>e</u>] 'betel nut'   [rvel<u>e</u>] 'arrow'
             [tesbok<u>o</u>] 'egret (black)'   [svoŋvoŋ<u>o</u>] 'butterfly'
             [uŋul<u>u</u>] 'drink'   [tkaslud<u>u</u>] 'shrimp'
             [krɨm<u>ɨ</u>] 'palate'   [aḍmɨm<u>ɨ</u>] 'iron'
             [ḍkəs<u>ə</u>] 'camphor laurel' [lcəŋ<u>ə</u>] 'vegetable'
    (b)   [cacŋal<u>ɨ</u>] 'start'   [tkorpaŋ<u>ɨ</u>] 'frog'

Hsin (2000) provides evidence that the underlying forms listed above lack a final vowel underlyingly. The evidence is rather complex since a number of processes interact to change the underlying form substantially on the surface (including iambic vowel deletion, deletion, and coalescence). The reader is referred to Hsin (2000:95ff) for discussion of the input status of these vowels.[72]

- *Vowel Copy*

The most striking aspect of Maga Rukai epenthesis is the fact that the epenthetic vowel – for the most part – is a copy of the preceding one. Since copy epenthesis is not the focus of this section, the constraint that promotes copying is referred to as AGREEV here, requiring harmony between adjacent vowels.

AGREEV outranks markedness constraints that favour a particular vowel over all others, like the DTE constraint $*-\Delta_{PrWd}\geq\{ə\}$, which favours [ɨ] over all other vowels. Tableau (50) illustrates this ranking. NOCODA, a constraint that bans coda consonants (Prince & Smolensky 1993), outranks DEP in Maga Rukai, so motivating epenthesis.[73]

(50)

/rvel/	AGREEV	$*\Delta_{PrWd}\geq\{ə\}$
☞ (a) rvél<u>e</u>		*
(b) rvél<u>ɨ</u>	*!	

However, $*-\Delta_{PrWd}\geq\{ə\}$ is not inactive. Its effect emerges in epenthesis after [a], as in [tkorpaŋɨ] 'frog'. Epenthesis of [ɨ] in this situation raises two questions: (i) why is the epenthetic vowel not [a]? and (ii) why is the epenthetic vowel [ɨ]? Non-DTE constraints provide an answer to both these questions.

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[72] To summarize, Hsin (2000) shows that [dmel<u>e</u>] derives from a form with underlying /a/ and /i/, which I take to be /damil/ here. Vowels in the weak member of a foot are prohibited, so *[(damíl)] is banned. Instead of deleting, [a] coalesces with the following vowel, forming [(dmél)]. Finally, epenthesis takes place, producing [(dmé)l<u>e</u>]. This proposal explains why the negative form is [(dàm)(líː)]: the negative consists of a mora, which forces the underlying [i] to metathesize. The result is that neither vowel is deleted, so showing the true quality of the input vowels. If the input was /damile/ – i.e. the copy vowel was underlying – the negative would be *[damleː].

[73] NOCODA does not cause word-medial epenthesis (e.g. [tkasluḍu], *[tkas<u>a</u>luḍu]). There are two possible reasons for this: (1) CONTIGUITY blocks medial epenthesis (McCarthy & Prince 1995, Kenstowicz 1994b), or (2) medial consonant clusters are all complex onsets (cf Kager's 1997 account of Macushi).

Since [a] is the most marked non-DTE, [a]-copying can be blocked by a constraint such as $*\text{-}\Delta_{PrWd} \geq \{a\}$. This situation is illustrated in tableau (51).

(51)

/tkorpaŋ/	$*\text{-}\Delta_{PrWd} \geq \{a\}$	AGREEV	$*\text{-}\Delta_{PrWd} \geq \{ə\}$
(a) tkòrpáŋa	*!		
(b) tkòrpáŋə		*	*!
☞ (c) tkòrpáŋɨ		*	

The constraint $*\text{-}\Delta_{PrWd} \geq \{a\}$ bans high sonority non-DTEs, so eliminating the candidate with epenthetic [a]. This leaves the candidates without copy vowels – (b) and (c).

The tableau also goes some way to accounting for the emergence of [ɨ] in this situation. Since both (b) and (c) do not have copy vowels, they violate AGREEV equally. This allows the lower-ranked constraint $*\text{-}\Delta_{PrWd} \geq \{ə\}$ to emerge, favouring the lowest sonority vowel available – i.e. [ɨ]. In other words, [ɨ] wins in this situation because it is the most desirable non-DTE.

To ensure that [ɨ] appears in this situation rather than some other vowel, further rankings are crucial. Importantly, $*\text{-}\Delta_{PrWd} \geq \{ə\}$ must outrank all DTE constraints that promote [ə] and more sonorous elements above [ɨ]: i.e. $*\Delta_\sigma \leq \{ɨ\}$ and $*\Delta_\mu \leq \{ɨ\}$.

To generalize, [ɨ] is epenthesized in the non-DTE of α when some non-DTE constraint of the form $*\text{-}\Delta_\alpha \geq \{ə\}$ outranks all DTE constraints of the form $*\Delta_\beta \leq x$, where β is a lower category than α. In Maga Rukai, $*\text{-}\Delta_{PrWd} \geq \{ə\}$ outranks $*\Delta_\sigma \leq \{ɨ\}$, $*\text{-}\Delta_\mu \geq \{ɨ\}$, and so on. In other words, Maga Rukai epenthesis is emergence of the unmarked – the unmarked vowel in terms of the non-DTE constraints emerges when other options – i.e. copying – are blocked.

An analogous ranking can be used to produce [ə] and [i] as epenthetic vowels for languages in which they are the least sonorous vowels available.

4.4.1.3 Epenthetic [e ɛ]
The cases discussed so far have all relevant DTE constraints outranking all non-DTE ones or vice-versa. However, the DTE and non-DTE constraints can interleave with each other. The net result can be that neither the most nor the least sonorous vowel is ideal for a particular position. In such a case, the epenthetic vowel emerges with 'medium' sonority relative to the other vowels – i.e. [e ɛ] or [i], depending on the other vowels in the language's inventory.

[ɛ]-epenthesis is found in the Athapaskan language Chipewyan (Li 1946). Chipewyan has the vowels [i e ɛ a o u] (p.399). Syllables have the shape CVC, where coda consonants must be (i) coronal or glottal and (ii) fricatives or sonorants (i.e. [θ ð s z ʒ h n ɬ l r]) or (iii) [ɣ].

Words are minimally disyllabic in Chipewyan. As in its relative Slave (Rice 1989:133), if a stem is monosyllabic and is not accompanied by a prefix, [ɛ] is

epenthesized before the stem. Because of a ban on onsetless syllables, [h] accompanies [ɛ]-epenthesis, as shown in (52).

(52)   Minimal Word epenthesis in Chipewyan
        /tsaɣ/   →   [h̲ɛtsaɣ]   'he sg. was crying'
        cf /ɣwa-tsaɣ/   →   [ɣwatsaɣ]   'he will cry'
          /uh-tsaɣ/   →   [h̲uhtsaɣ]   'you pl. were crying'
          /ʃuh-t-tĩ/   →   [ʃuhtĩ]   'you (dual) were eating'

[ɛ]-epenthesis appears in a multiplicity of other situations in Chipewyan, illustrated in (53). In all the cases, the epenthetic vowel is inserted to satisfy phonotactic requirements.

(53)   [ɛ]-epenthesis elsewhere in Chipewyan
        /n-tsʰaɣ/   → [nɛtsʰaɣ]   'you sg. were crying'
                        cf /i-t-tsʰaɣ/→[h̲itsʰaɣ] 'we pl. were crying'
        /ʃ-n-tʰĩ/   → [ʃɛnɛtʰĩ]   'you sg. were eating'
        /ʃ-n-ɣ-tĩ/   → [ʃɛnɛɣɛ-tʰĩ] 'they (dual) ate'
                        cf [ʃ-uh-tʰĩ] 'you (dual) were eating'
        /n-θ-i-tʰɛs/   → [nɛθitʰɛz]   'we lay down'
        /h-n-θ-tʰɛs/   → [h̲ɛnɛðtʰɛz] 'they lay down'
                        cf [n-i-tʰɛs] 'you sg were lying down'
        /tu-n-tĩ/   → [tunɛtĩ]   'he was drowning'
                        cf [tu-n-i-tĩ] 'you were drowning'

        The issue of present interest is why the epenthetic vowel is [ɛ], as opposed to the more sonorous [a] or less sonorous [e] or [i]. The combined effect of the DTE and non-DTE constraints provides an answer.

        The DTE constraint *Δ_σ≤{e,o} bans all syllable nuclei with less sonority than low-mid vowels. If this constraint outranks all non-DTE constraints that favour high vowels over mid vowels (e.g. *-Δ_{PrWd}≥{e,o}), the epenthetic vowel will not be [i], as shown in §4.4.1.1.

        The non-DTE constraint *-Δ_{PrWd}≥{a} bans all high sonority PrWd non-DTEs. [ɛ] is only epenthesized in non-main stressed positions, so the epenthetic vowel will always be subject to this constraint.[74]

        The net result is that the DTE constraint *Δ_σ≤{e,o} rules out high and high-mid vowels and the non-DTE constraint *-Δ_{PrWd}≥{a} rules out [a]. This leaves [ɛ] as the only viable epenthetic vowel, as illustrated in tableau (54). As in the preceding sections, epenthesis is motivated by a ban on consonant clusters outranking DEP-IO.

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[74] I assume that the head syllable is always in the stem (following Rice 1987 for Slave). Since alternations only show epenthetic elements outside stems, the effect is that there is only evidence for the quality of non-head epenthetic elements.

(54)

/n-tsʰay/	*Δ_σ≤{e,o}	*-Δ_PrWd≥{a}	*Δ_σ≤{ε,ɔ}	*-Δ_PrWd≥{ε,ɔ}
(a) nitsʰáy	*!		*	
(b) netsʰáy	*!		*	
(c) natsʰáy		*!		*
☞ (d) nɛtsʰáy			*	*

The tableau shows how antagonistic conditions on DTE and non-DTE sonority can result in a vowel of medium sonority.

As a final note, [ε] is selected over the round vowel [ɔ] because of another scale: round vowels are more marked than unround ones. This point is developed in the next section.

- *Mid vowel epenthesis elsewhere*

Chipewyan is not unique in having an epenthetic mid vowel. Mohawk's epenthetic [e] has been the subject of much discussion (Michelson 1988, Hagstrom 1997 and references cited therein). As mentioned above, Slave also has an epenthetic [ε], as does Czech (Ketner 2003), several Romance languages have an epenthetic mid vowel, and Temiar and Tiberian Hebrew have [e]-epenthesis in closed syllables (McCarthy 1980, Rappaport 1981, resp.).

Moreover, the present ranking is not only needed for epenthetic mid vowels. It is necessary in all situations where neither the least nor the most sonorous vowel in a language is the epenthetic one. For example, a language that has a central vowel but epenthesizes [i] will have to employ a ranking analogous to Chipewyan's: a DTE constraint will have to ban central vowels and a non-DTE constraint will eliminate all non-high peripheral vowels; such a language is discussed in §4.4.2.

4.4.1.4 Universals of epenthetic quality

Despite the variation in sonority in epenthetic vowels, they all have features in common: putting aside interference from processes like vowel harmony and dissimilation, all epenthetic vowels are [−round] and almost all are [−back]. This section discusses cases of putative [+round] and/or [+back] epenthetic vowels, concluding that they are extremely marginal, and perhaps unattested. Reasons for their exclusion are also provided.

Convincing cases of round epenthetic vowels are hard to come by. In fact, while cases of [u] or [o] have been reported, it remains uncertain whether there are any round epenthetic vowels. Cases of epenthetic [o] will be discussed first (Hungarian, Pendau, and Seri), followed by cases of epenthetic [u], and finally a case of epenthetic [ɣ].

- [o] *epenthesis*

Quick (2000:30) shows that Pendau epenthesizes [o] between consonant-final roots and clitics: [dʒundʒuŋ]~[dʒundʒuŋoɲo] 'his/her house', cf [babi] 'pig'~[babi-ɲo] 'his/her pig'. However, there is an independent process of vowel harmony: affix vowels agree with

root vowels in [round] and [low] (e.g. [me-ide] 'small', [me-meɲoŋ] 'cold', [ma-paris] 'difficult', [mo-doda] 'red', [mo-buluŋ] 'green'). On top of that, all enclitics contain a round vowel: [ʔu] {1p.sg.gen.}, [mu] {2p.sg.gen}, [to] {1p.pl.incl.}, [ɲo] {3p.sg.gen.}, [mo] {completive aspect}, [po] {continuative aspect}. Therefore, the appearance of epenthetic [o] instead of [e] or [a] can be ascribed to the influence of nearby vowels. In short, the vowel's roundness is due to an incidental harmony process, and is not an indication of the form of context-free markedness constraints.

Marlett (1981:55) reports that Seri has epenthetic [o]. However, this vowel seems to appear only before an [m]: e.g. /tm-kap/ → [tomkap] *no gloss*, /i-t-k-m-piː/ → [itkompiː] 'didn't he taste it?'. It also appears in very restricted morphological environments (i.e. between certain prefixes). Moreover, elsewhere [i] is inserted: e.g. /ʔp-mi-panʃχ/ → [iʔp̲i̲mpanʃχ] '1sg-proximal-run' (p.54). It is possible that epenthetic [o] is not epenthetic at all, but part of the input.

As in Seri, Hungarian epenthetic [o] only appears in restricted morphological environments, and [a] acts as the epenthetic vowel in other environments (Fowler 1986); it is therefore possible that [o] is a morpheme while [a] is the true default.

- [u] *epenthesis*

Epenthetic [u] has been reported by various sources for a number of Dravidian languages (e.g. Sinhala – Keer 1996:10). However, other sources report that the vowel is actually a [ɯ] or [ɨ] (e.g. Koḍava – Ebert 1999, Bright 1975:13). Even so, Bright claims that the epenthetic vowel is [u] in dialects of Kannada and Telugu, contrasting with epenthetic [ɨ] in other Dravidian languages. In addition, Paradis (1992) reports that the epenthetic vowel is [u] in Fula (also see Causley 1999b:73).

Finally, E.Sapir (1965:17) reports that [u] or [ʊ] (the choice depends on ATR harmony) is used to separate consonants in Diola Fogny: e.g. /amaŋut+ja/ → [amaŋutuja] 'if you don't want'.[75] Again, it is not clear that [u] is truly epenthetic. Sapir also reports that deletion is used to eliminate underlying clusters: e.g. /lɛt+ku+jaw/ → [lɛkujaw], *[lɛt̲u̲kujaw] 'they won't go'. There is no immediately apparent reason why deletion should apply in one instance but epenthesis in the other; the morphological and phonological environments seem indistinguishable. It may be the case that deletion is the default case. In fact, this is borne out by the fact that input consonant clusters separated by [u]/[ʊ] undergo deletion in rapid speech: /ujuk+ja/ → *slow* [ujuk̲u̲ja], *fast* [ujuja] 'if you see'. In short, [u]-epenthesis does not behave like epenthesis in other languages – it applies for no apparent reason to separate clusters that are otherwise resolved by deletion.

Without in-depth examination of each case – something beyond the scope of the present section – no further comment on these cases will be made here. At the very least, [u]-epenthesis is highly marginal.

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[75] [ɔ] is used to separate consonants in the formation of distributives: /RED+fuleŋ/ → [fuleŋɔfuleŋ]; However, ∅ does not appear in other forms, with no apparent regularity.

- [ʏ] *epenthesis*

     The only other case of a round epenthetic vowel is the front lax round [ʏ] in Icelandic (Kiparsky 1984, Karvonen & Sherman 1997). [ʏ] is inserted between a stem-final consonant and an [r]. The only suffixes that produce this environment are the nominative masculine singular [r] and third person singular [r]: e.g. [daɣʏr] 'day {nom.sg}', [tekʏr] 'take {3sg.pres.}'. Icelandic [ʏ] stands out from the cases in Table 4.1 in terms of the restrictiveness of its environment: it is not epenthesized for word-minima reasons, or to break up any pair of illicit consonants, but only appears in the environment C+_r. This – along with its rare featural content – may suggest that [ʏ] is not truly epenthetic. Instead, it may be a morpheme, either inserted in just this environment, or as part of the underlying representation of the nom.sg. and 3sg.pres. morphemes. The fact that it does not appear in the environment V+_r may be due to a ban on [Vʏ] clusters. Of course, this issue deserves much more serious consideration; nevertheless, it is possible that Icelandic does not present a case of a round epenthetic vowel.

- *Theory*

     The lack of round epenthetic vowels is expected in the present theory. Vowel roundness is a marked value (see ch.8§8.2). Thus, there is no motivation for vowels to be round: to be so would be gratuitously marked. Of course, this leaves aside cases of assimilation and harmony that produce round vowels.

     In other words, epenthetic unround vowels are harmonic bounds for epenthetic round vowels in terms of context-free markedness constraints: i.e. *[round]. Faithfulness constraints cannot be invoked to preserve round vowels since epenthetic vowels have no underlying features (see ch.4§4.4 for discussion).

     The only way that an epenthetic vowel could be round is if roundness was an incidental property of some category on a prosodic scale, like sonority. However, there is no evidence that the sonority scale distinguishes round from unround vowels: no stress system is sensitive to roundness. Since no prosodic scale favours round and unround vowels of the same sonority equally, the emergent influence of *[+round] will always result in an epenthetic unround vowel.

     A similar reason accounts for the fact that almost all epenthetic vowels are non-back. As argued in ch.8§8.3.3, backness in vowels is marked. So, again, an epenthetic vowel with a [+back] specification would be gratuitously marked. As with roundness, there is no prosodically based (i.e. sonority) motivation to have a back vowel – back vowels are not more sonorous than front vowels of the same height and peripherality. So, sonority cannot subvert the featural influence of the constraint *[+back].

     The major exception to the [+back] generalization is the low vowel [a], which is often classed as [+back] in many languages, and can be epenthetic. This is an exception because it often has no front counterpart, so *[+back] is necessarily violated; as shown above epenthetic [a] comes about through imposition of sonority requirements.

     The one remaining issue is the set of languages with epenthetic [ɯ]. It is notable that – except for Japanese – all are Dravidian. Moreover, there seems to be some disagreement – or language-internal variation – as to whether the epenthetic vowel is back [ɯ] or central [ɨ]. For example, the epenthetic vowel is reported to vary in realization as

[ɯ] and [ɨ] in Koḍava (Ebert 1996:1). Similarly, Bright (1975:13) reports most Dravidian epenthetic vowels to be [ɨ]. Therefore, it may be that [ɯ] classes as a central vowel in these languages, thus being less sonorous than all other types. Again, this issue requires further investigation and careful phonetic measurement, and is unfortunately beyond the scope of this dissertation.

4.4.2 Contextual epenthesis in Shipibo

The claim that high sonority vowels are preferred in DTEs and low sonority ones are favoured in non-DTEs finds striking support in the Peruvian language Shipibo (Lauriault 1948, Elías 2000, p.c.).[76]

Shipibo has the surface vowels [ɨ i ʊ a]. Each syllable contains a single vowel and an optional onset consonant (i.e. (C)V). An epenthetic vowel is inserted to avoid coda consonants, as in the forms /karib-kɨ/ → [karibakɨ] 'went again', and /honɨrib-kɨ/ → [honɨribikɨ] 'hid again'. From these examples, it is evident that the epenthetic element has two realizations: [a] and [i]. Lauriault observes that the epenthetic vowel is [a] in odd numbered syllables, and [i] in even syllables. The following data illustrates this generalization with a consonant-final stem plus the suffix –[kɨ] {completed action}:[77]

(55) Shipibo epenthesis
(a) [a]-epenthesis in odd-numbered syllables

[karibakɨ]	'went again'	[bʊribakɨ]	'went away again'
[piribakɨ]	'ate again'	[jʊmɨtsʊribakɨ]	'stole again'
[aribakɨ]	'did it again'		

(b) [i]-epenthesis in even-numbered syllables

[ʊĩribikɨ]	'saw it again'	[rʊaribikɨ]	'it croaked again'
[ʊnãribikɨ]	'knew again'	[rakɨribikɨ]	'was afraid again'
[bʊʊribikɨ]	'healed again'	[tɨɨribikɨ]	'worked again'
[honɨribikɨ]	'hid again'	[tearibikɨ]	'bothered again'
[jʊnʊribikɨ]	'commanded again'		

Lauriault also shows that the quality of the epenthetic element changes when other affixes are added before the epenthetic element:

(56) /a-rib-kɨ/ → [aribakɨ] 'did it again'
    /a-ma-rib-kɨ/ → [amaribikɨ] 'made him do it again'
    /a-ma-rɨs-rib-kɨ/ → [amarɨsibakɨ] 'merely made him do it again'

In contrast, morphemes added after the epenthetic element have no effect on its form: [aribakɨ] 'did it again' *cf* [aribarɨskɨ] 'merely did it again'.

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[76] My thanks to José Elías for providing the underlying forms, narrow transcriptions of output forms, and the description of stress.

[77] The only data Lauriault provides consists of the morphemes *rib* 'repeated action' and *kɨ* 'completed action'. However, he asserts that other morpheme combinations exhibit the a/i alternation.

- *The foot in Shipibo*

The variation in epenthetic quality in Shipibo can be related to the foot. Shipibo has left-aligned trochaic feet: e.g. [(júnʊ)(rìbi)ki].[78] Whenever the epenthetic element appears in the head syllable of a foot, it is realized as the most sonorous vowel [a]. In contrast, whenever it appears in the non-head of a foot, it emerges as the low sonority vowel – [i].[79]

To account for this variation, the foot-referring constraints $*\Delta_{Ft}\leq\{i,u\}$ and $*\text{-}\Delta_{Ft}\geq\{a\}$ are invoked here. The latter constraint bans high sonority vowels in foot non-DTEs, while the former constraint militates against low sonority vowels in foot heads. With these constraints, the variation in epenthetic quality emerges. Epenthesis is motivated by a ban on coda consonants (NOCODA) outranking DEPIO.

(57) Epenthesis of [a] in Foot DTEs in Shipibo

/karib-kɨ/	$*\Delta_{Ft}\leq\{i,u\}$	$*\text{-}\Delta_{Ft}\geq\{a\}$
☞ (a) (kári)(bàkɨ)		
(b) (kári)(bikɨ)	*!	

(58) Epenthesis of [i] in Foot Non-DTEs in Shipibo

/jʊnʊ-rib-kɨ/	$*\Delta_{Ft}\leq\{i,u\}$	$*\text{-}\Delta_{Ft}\geq\{a\}$
(a) (júnʊ)(rìba)kɨ	* *	*!
☞ (b) (júnʊ)(rìbi)kɨ	* *	

In both the tableaux above, foot-form constraints dominate the sonority constraints. Higher ranked constraints require left-aligned trochaic feet, effected by PARSE-σ, TROCHEE, and ALIGNFTL (McCarthy & Prince 1993b). If this were not so, footing would be sensitive to sonority. In addition, faithfulness constraints outrank the sonority constraints above, so preventing neutralization.

There is one remaining issue, related to the discussion of Chipewyan [ɛ]. The non-DTE epenthetic vowel in Shipibo is not the least sonorous one available – i.e. [ɨ]. Instead, it is the 'medial' sonority [i]. With the non-DTE constraints alone, [ɨ] is more harmonic than [i] in non-DTE position since the latter violates $*\text{-}\Delta_{Ft}\geq\{i,u\}$ while the former does not.

As with Chipewyan, the emergence of [i] is due to the intermingling of DTE and non-DTE constraints. Although [i] fares worse than [ɨ] in terms of non-DTE constraints, it

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[78] For an in-depth discussion of Shipibo stress, see Elías (2000). Elías (p.c.) observes that the initial foot can appear as an iamb under special circumstances: e.g. [(karí)(bàkɨ)]. For discussion, see Elías (2000). There is little phonetic or phonological evidence for the secondary stresses postulated. It is possible that the foot structure has no phonetic realization, a situation found in other Peruvian languages (Huariapano – Parker 1998), and in languages such as Cairene Arabic (Hayes 1995).

[79] The data do not provide evidence for the quality of the epenthetic vowel in an unfooted syllable (in this case, the final syllable of an odd-parity word). If it were found to be [i], the appropriate constraint for Shipibo would be $*\text{-}\Delta_{PrWd}\geq\{e,o\}$, not $*\text{-}\Delta_{Ft}\geq\{e,o\}$. If it were found to be [a], this could be ascribed to the emergent effect of a constraint such as $*\Delta_{\sigma}\leq\{e,o\}$. In any case, the behaviour of stray syllable epenthesis does not alter the general point: that DTEs and non-DTEs place different conditions on vowel quality.

is favoured by DTE constraints. Thus, choice of [i] over [ɨ] can be ascribed to a constraint such as *$\Delta_\sigma \leq \{ɨ\}$, as shown in tableau

(59)

/onãrìb-kɨ/	*-$\Delta_{Ft} \geq \{e,o\}$	*$\Delta_\sigma \leq \{ɨ\}$
(a) (ónã)(rìb<u>a</u>)kɨ	*!	*
☞ (b) (ónã)(rìb<u>i</u>)kɨ		*
(c) (ónã)(rìb<u>ɨ</u>)kɨ		* *!

      As discussed in the previous section, the epenthetic vowel cannot be [ʊ] because of the emergent ban on round vowels (i.e. by *[+round], outranked by IDENT[+round] to preserve input roundness contrasts).

4.4.3   Universals of epenthesis
      To summarize the results of the preceding sections, the DTE and non-DTE constraints together predict that there are no straightforward absolute universals relating to epenthetic quality. A language may take an epenthetic vowel of any sonority in any position.

- *Implicational relations within a language*
      The DTE constraints do make a somewhat complex prediction, though. The prediction relates to languages like Shipibo, where the quality of the epenthetic vowel differs depending on position. When the quality of the vowel is determined by sonority requirements (as opposed to, e.g., assimilation), the present theory predicts that the more sonorous version of the vowel will appear in a more 'DTE-like' position. A position P_1 is more 'DTE-like' than position P_2 if P_1 is a DTE of category α while P_2 is not.
      For example, Shipibo has two epenthetic vowels – [a] and [i]. Epenthetic vowels end up in two places: Δ_{Ft} and -Δ_{Ft}. The Δ_{Ft} position is more DTE-like than -Δ_{Ft} because the former is a DTE of a Ft while the latter is not. Therefore [a] will appear in the Δ_{Ft} position.
      In contrast, the constraints predict that there is no 'anti-Shipibo' language where [i] is epenthesized into the Δ_{Ft} position while [a] appears as a -Δ_{Ft}. This involves the less sonorous [i] ending up in the more DTE-like position Δ_{Ft}.
      This prediction follows from the form of the constraints and the nature of the prosodic hierarchy. If a high-sonority vowel *x* is epenthesized into a DTE of category K, this could only have come about through the influence of a DTE-markedness constraint: *Δ_K/*x*. Significantly, this constraint not only puts a restriction on Δ's of category K, but on DTEs of all higher categories. For example, *$\Delta_\sigma \leq \{a\}$ not only requires [a] to appear in DTEs of syllables, but also puts the same restriction on DTEs of Ft, PrWds, and so on. This therefore rules out the possibility of epenthesizing a less sonorous vowel into a DTE of a higher category.
      To expand on the last point, the only way that [i] could be epenthesized into a foot DTE in Anti-Shipibo is for some markedness constraint M that favoured [i] over [a] to

outrank $*\Delta_\sigma \geq \{a\}$. M must not only favour [i] over [a], but must only favour it in foot DTE position, and nowhere else. Thus, M would have a form like $*\Delta_{Ft}/i$; the problem with such a constraint is clear – it reverses the scale relation between [a] and [i], and is not allowed in the present theory.

- *Perpetual DTEs and non-DTEs*

    Epenthesis of low sonority vowels depends on the influence of a non-DTE constraint. This raises the issue of positions that are DTEs of every category. If position *p* is not a non-DTE of any category, then anything epenthesized into *p* is subject only to DTE constraints. Since DTE constraints all favour high sonority elements, the epenthetic vowel in *p* must therefore be [a], and can never be anything less sonorous [ɛ e i ə ɨ].

    A number of languages provide no insight into this question since epenthetic vowels go out of their way to avoid DTE positions (i.e. most importantly, the main stressed syllables) in many languages (Alderete 1995, Beckman 1998, Broselow 2001). However, cases of epenthesis into Δ_{PrWd} position are attested.

    A problem is raised by a relevant case in Arabic: [i] is epenthesized into main-stressed position: e.g. [katabtílu], *[katabtálu] (McCarthy 1979). The problem is that [i] is a low-sonority vowel, yet the position it appears in is the DTE of the highest prosodic level (in some utterances). In short, the DTE-sonority constraints cannot deal with the Arabic system.

    While this presents a problem for the DTE-sonority constraints, it may merely be the case that epenthetic vowel quality is also influenced by other scales. If some other scale favours [i] over [a], [i] will appear in DTE position under an appropriate ranking. Exploration of this issue is left for future work.

    However, it is worth noting that a point similar to the one for DTEs can be made for certain non-DTE positions. Onset position is a non-DTE of all constituents. Since onsets are not DTEs of any category, only non-DTE constraints can apply to them. Therefore, epenthesis into onset position must always produce a low sonority element, as long as other factors do not intervene. Certainly, epenthesis of stops – the lowest sonority category – into onsets is common; a full discussion is provided in ch.5§5.3. Epenthetic onset elements can be highly sonorous, but only in response to their environment (e.g. [ɹ] in Boston English – McCarthy 1994, epenthetic glides – Rosenthall 1994).

4.5   Summary

    The aim of this chapter was to show the need for constraints that refer to non-DTEs. The primary focus was on the foot non-DTE. Evidence for non-DTE constraints was presented from systems with sonority-driven stress, vowel reduction, and epenthesis. Each of these cases is discussed in turn.

- *Sonority-driven stress*

    In Kiriwina and Harar Oromo, stress placement refers to the sonority of the vowel in the foot's non-head. For example, stress falls on the antepenult in Kiriwina's [(mígi)la] because the alternative – stress on the default penult position *[mi(gíla)] – results in a foot

with a high sonority non-head. Similarly, stress falls on the ultima in Harar Oromo's [na(má)] because stress on the penult *[(náma)] would create a foot with a high sonority non-head.

In these languages, DTE sonority is irrelevant. This is clearly shown by Kiriwina [(mígi)la] – the competing *[mi(gíla)] does not differ in DTE sonority at all. Since DTE sonority is irrelevant, reference to the foot's non-DTE is essential.

- *Vowel neutralization*

Dutch presents a case where the foot non-head places difference conditions on vowel neutralization than in other unstressed positions. While [o] and [i] reduce to [ə] in foot non-heads in the informal register, they do not reduce in unfooted syllables: e.g. /lokomotif/ → [(lòkə)mo(tíf)] 'locomotive', *[(lòkə)mə(tíf)] (Kager 1989 and many others). It is clear that vowel reduction does not simply refer to the category 'unstressed syllable' here (cf Crosswhite 1999). Instead, there is a crucial difference between foot non-DTE position and other unstressed syllables, so necessitating markedness constraints that refer to this position.

- *Epenthesis*

The DTE constraints promote high sonority elements, so a CON without antagonistic constraints would incorrectly predict the epenthetic vowel to be [a] in all languages. The non-DTE constraints provide this antagonism. They provide an account for why [a] is epenthesized into foot heads in Shipibo, while [i] appears in foot non-heads. The tension between DTE and non-DTE constraints was used to account for cases with 'medial sonority' elements, like Chipewyan's [ɛ].

- *Other categories*

While *foot* non-DTEs have been the focus of this chapter, the theory has non-DTE and DTE constraints that refer to all other elements of the prosodic hierarchy. This point has already been argued for tone by Selkirk (1998) and in my own work (de Lacy 1999a, 2002b). The following paragraphs sketch the evidence for this proposal.

Prince & Smolensky (1993) show that sonority constraints that refer to syllable DTEs (i.e. nuclei) and syllable non-DTEs (i.e. margins) are necessary in accounting for syllable structure restrictions (also see ch.6§6.5.2.2).

Evidence that constraints refer to foot DTEs and non-DTEs is provided in this chapter (also ch.1§1.4.1.2), by Kenstowicz (1996) for sonority, and for tone in de Lacy (1999a, 2002b).

Evidence that constraints refer to PrWd DTEs (as opposed to foot DTEs) is given for Nganasan stress in ch.3§3.2. Evidence for reference to PrWd non-DTEs (as opposed to foot non-DTEs) was provided in §4.3.

No evidence for reference to categories of higher levels is provided in this dissertation. This is because I know of no evidence that sonority is sensitive to such higher levels. However, this does not mean that constraints cannot refer to higher levels, such as DTEs of Prosodic Phrases, Intonational Phrases, and so on. It is clear that constraints on tone must refer to these levels, so accounting for the fact that heads of these phrases attract

high tone, while non-heads attract low tone. For example, Kim (1997) shows that every Major Phrase in Korean must contain at least one high tone, and that no other high tones are permitted. The constraints $*\Delta_{MaP}/L$ and $*-\Delta_{MaP}/H$ must outrank tone-faithfulness to achieve this result. Similarly, the phonologically assigned (i.e. default) intonational tune in the Polynesian language Maori is H*L⁻ on every Major Phrase (Bauer 1993).[80] This can be explained if $*\Delta_{MaP}/L$ and $*-\Delta_{MaP}/H$ are employed in this language. See de Lacy (1999a§5.2, 2003) for related discussion.

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[80] If declarative intonation is assumed to be the phonological default (phonologically assigned) tonal melody, the tone-prominence constraints explain why the most common pattern is H*L%, with a high tone on the head of a MajorP/IntonationalP.

PART III

FAITHFULNESS

CHAPTER 5

PRELIMINARIES TO FAITHFULNESS

5.1 Introduction

The aim of Part III, including chapters 5 to 8, is to present a theory of scale-referring faithfulness constraints and provide evidence for it.

There are two leading ideas behind the theory. One is that more marked elements excite greater preservation than less marked ones. The other is that categories can be conflated for faithfulness purposes.

To expand on the first of these proposals, degree of markedness will be argued to correlate with degree of preservation (also see Kiparsky 1994, Jun 1995, and chs.6,7). For example, in the Place of Articulation scale | dorsal ⟩ labial ⟩ coronal ⟩ glottal | (discussed in detail in §5.3), the most marked element is 'dorsal'. Therefore, pressure to preserve dorsals is paramount; no other element is subject to the same degree of preservation. Least of all are glottals – since they are least marked, they are also the (relatively) least preserved.

This is not to say that dorsals will always be preserved in preference to less marked categories. Categories can be conflated for faithfulness: labials can be accorded the same degree of preservation as dorsals in some grammars; in others dorsals, labials, and coronals can be conflated for faithfulness purposes.

- *Constraints*

The 'marked preservation' proposal – that marked elements excite greater preservation than less marked ones – is formally expressed by (i) having constraints that preserve marked elements but not less marked ones and (ii) not having any constraints that preserve unmarked elements but not marked ones.

The faithfulness conflation proposal is formally expressed in a way analogous to the proposal for markedness conflation (ch.3) – faithfulness constraints are formulated stringently.

To schematize the combined effect of these proposals, for a scale | γF ⟩ βF ⟩ αF |, where γ is the most marked value of feature F, there is a set of faithfulness constraints, listed in (1). Since all the constraints preserve the marked element, constraints of this type will be called 'marked-faithfulness' constraints.

(1)   Marked-faithfulness constraints

IDENT{γF}   If *x* is γF, then its correspondent *x*' has the same value for F
                        as *x* (i.e. *x*' is γF).

IDENT{γF,βF}   If *x* is γF or βF, then its correspondent *x*' has the same value
                        as *x* for feature F (i.e. γF or βF respectively).

IDENT{γF,βF,αF}   If *x* is γF or βF or αF, then its correspondent *x*' has the same
                        value as *x* for feature F.

The constraints in (1) are the 'skeleta' for scale-referring constraints. They may be elaborated by mentioning dimension of application (e.g. Input→Output, Output→Output, Base→Reduplicant), or certain prosodic positions (Casali 1997a,b, Beckman 1998); examples of each of these dimensions are provided in chapter 6. They may also be elaborated by restriction to a prominent position (Beckman 1998); examples will be provided when relevant.

The constraint IO-IDENT{γF,βF} demands that input segments specified as γF or βF remain faithful in the output. So, IO-IDENT{γF, βF} assigns a violation to (i) all mappings from /γF/ that result in [βF] or [αF] and (ii) all mappings from /βF/ that result in [γF] or [αF].

The constraints are 'asymmetric' in the sense of Pater (1996, 1999). For example, while IDENT{γF} bans /γF/ → [βF], it does not militate against /βF/→[γF]. For further discussion of this point, see ch.7§7.7.4.

Unless otherwise stated, all IDENT constraints will refer to the Input→Output dimension in this and the following chapters. For discussion of IDENT and its effect on dimension, see ch.7§7.7.4.

Finally, there are no MAX or DEP equivalents of the IDENT constraints. For discussion, see ch.6§6.4.2.

The form of stringent faithfulness constraints is discussed further in §5.2; an implementation of the Place of Articulation scale is provided in §5.3.

The constraints in (1) are stringent in that an unfaithful mapping from a less marked element incurs a proper subset of the violations of an unfaithful mapping from a more marked element. Quasi-tableau (2) illustrates this point: an unfaithful mapping from the most marked element [γF] incurs a superset of violations of all unfaithful mappings from less marked elements.

(2)   Stringent form of faithfulness constraints

	IDENT{γF}	IDENT{γF,βF}	IDENT{γF,βF,αF}
/γF/ → [βF] or [αF]	*	*	*
/βF/ → [γF] or [αF]		*	*
/αF/ → [γF] or [βF]			*

The tableau shows that the constraints have the cumulative effect that more marked elements are subject to more preservation than less marked ones. For example, since [γF]

is the most marked element, all faithfulness constraints preserve it. Since [βF] is more marked than [αF], more faithfulness constraints preserve [βF] than [αF].

The faithfulness constraints also allow conflation. As determined in ch.3, two categories are conflated when they incur the same violations of active constraints. Since [γF] and [βF] both violate IDENT{γF,βF} equally, the categories [γF] and [βF] will be conflated in a grammar where IDENT{γF,βF} is the only active faithfulness constraint. Similarly, all the categories will be conflated in a grammar in which IDENT{γF,βF,αF} is the only active faithfulness constraint.

- *Seperability of proposals*
    It is important to point out from the outset that the 'marked preservation' aspect of the faithfulness constraints in (1) is quite separate from the fact that they are stringently formulated. To underscore this point, there are many alternative theories with stringent constraints that do not have the 'marked preservation' property. For example, the 'unmarked-faithfulness' constraints IDENT{αF}, IDENT{αF,βF}, and IDENT{αF,βF,γF} – based on the scale | γF ⟩ βF ⟩ αF | – are stringently formulated but cannot preserve marked elements without also preserving unmarked ones.

    Moreover, there are non-stringent theories that effectively express the marked-preservation property. For example, the set of non-stringent constraints in a fixed ranking ‖ IDENT{γ} » IDENT{β} » IDENT{α} ‖ encodes the 'marked preservation' property by virtue of having faithfulness constraints to marked elements universally outrank all faithfulness constraints to less marked elements (Jun 1995, Kiparsky 1994).

    Chapter 6 and 7 argue solely for the point that faithfulness constraints must have the 'marked preservation' property; they do *not* present arguments that faithfulness constraints must be stringently formulated. Accordingly, the arguments presented in those chapters support all theories with the 'marked preservation' property, including the stringent approach in (1) and the fixed ranking theory outlined in the preceding paragraph.

    In contrast, chapter 8 argues solely for the point that faithfulness constraints must be stringently formulated. Evidence for this proposal comes from 'faithfulness conflation', where two competing candidates are equally unfaithful, so allowing a lower-ranked constraint to make the crucial decision. This chapter shows that Fixed Ranking theories of faithfulness cannot produce such cases.

    In short, the 'marked preservation' and stringency proposals are separable – neither depends on the validity of the other. Similarly, the empirical phenomena that support the proposals are also quite separate, as summarized briefly below.

5.1.1 Empirical implications

The proposed form of the scale-referring faithfulness constraints has a number of empirical effects.

Since marked elements can excite greater preservation than less marked ones, marked values may be exempt from processes that less marked values undergo. For example, with only the constraint IDENT{γF} outranking all markedness constraints, input segments specified as [γF] will surface faithfully, but the less marked values [βF], [αF]

will undergo changes triggered by the markedness constraints. Thus, only the marked value may escape processes such as neutralization (chs.6,9) and assimilation (ch.7).

The other major empirical effect has to do with 'faithfulness conflation'. As shown in ch.3§3.6, stringent markedness constraints allow category distinctions to be collapsed for certain processes; the same is true of stringent faithfulness constraints. Since an unfaithful /γF/ mapping and an unfaithful /βF/ mapping incur the same violation of IDENT{γF,βF}, if IDENT{γF,βF} is the only active faithfulness constraint for some competition, the two mappings would be effectively conflated in terms of unfaithfulness. Such conflation has visible effects in certain types of coalescence (ch.8).

Some concrete examples are given below to illustrate the points made above.

- *Neutralization: marked-faithfulness & Gapped Inventories*

Chapter 6 discusses the effect of the proposal that marked elements are more faithfully preserved than less marked elements. The phenomena discussed relate to neutralization of Major Place of Articulation distinctions: i.e. | dorsal 〉 labial 〉 coronal 〉 glottal |. Neutralization produces an 'inventory', a term that refers to the surface segments that can appear in a particular position.

Two kinds of inventories are identified, following Prince & Smolensky (1993) and Prince (1997c). One type produces a 'harmonically complete' inventory of segments, consisting of a contiguous set of the scale starting with the least marked element. For example, the Polynesian language Tahitian has the voiceless stops [p t ʔ] – in terms of PoA this is a contiguous set, starting with the least marked 'glottal', extending through to labial (Coppenrath & Prevost 1974). Tahitian's relative Tongan also has a harmonically contiguous system, having representatives of all major PoAs: [k p t ʔ] (Churchward 1953).

The other type of inventory is of more immediate interest. This is the 'harmonically gapped' type (a term from Prince 1997c): it consists of the least marked element and a highly marked element, but crucially lacks elements of intermediate markedness. The Polynesian language Hawaiian provides a relevant case: it has the stop inventory [k p ʔ] (Pukui & Elbert 1979). This inventory has the least marked glottal element and the highly marked labials and dorsals, but lacks the less marked coronal PoA (other examples of this inventory are given in ch.6§6.3).

Gapped segmental inventories require faithfulness constraints that exclusively refer to marked categories. To show this, relevant PoA-referring constraints are given in (3); further discussion of their form is given in §5.3.

(3)   Place of Articulation constraints
        (a) Markedness

*{dors}	For every dorsal segment, assign a violation.
*{dors,lab}	For every segment that is either dorsal or labial, assign a violation.
*{dors,lab,cor}	For every segment that is dorsal, labial, or coronal, assign a violation.
*{dors,lab,cor,glottal}	For every segment that is dorsal, labial, coronal, or glottal, assign a violation.

        (b) Faithfulness

IDENT{dors}	If x is dorsal, then x has the same place of articulation as its correspondent x'.
IDENT{dors,lab}	If x is dorsal or labial, then x has the same place of articulation as its correspondent x'.
IDENT{dors,lab,cor}	If x is dorsal, labial, or coronal, then x has the same place of articulation as its correspondent x'.
IDENT{dors,lab,cor,gl}	If x is dorsal, labial, coronal, or glottal, then x has the same place of articulation as its correspondent x'.

For coronals to be eliminated, some markedness constraint that bans coronals must outrank all faithfulness constraints that preserve it: i.e. ‖ *{dors,lab,cor} » IDENT{dors,lab,cor}, IDENT{dors,lab,cor,glottal} ‖.

(4)   Neutralization Ranking: ‖ ∃Mk(x) » ∀Faith(x) ‖

/t/	*{dors,lab,cor}	IDENT{dors,lab,cor}	IDENT{dors,lab,cor,glottal}
(a) t	*!		
☞ (b) ʔ		*	*

However, the more marked elements /p/ and /k/ surface faithfully. Prince (1997c, 1999) has shown that some faithfulness constraint that preserves dorsals and labials must outrank all markedness constraints that ban them in such a system. So IDENT{dors,lab} must outrank all markedness constraints, including *{dors,lab,cor}.

(5)   Preservation Ranking: ‖ ∃Faith(x) » ∀Mk(x) ‖

/kapa/	IDENT{dors,lab}	*{dors,lab,cor}
☞ (a) kapa		* *
(b) ʔaʔa	* *!	

It is crucial that the faithfulness constraint preserve only labials and dorsals. If it preserved coronals as well, coronals would not neutralize at all. In short, the ranking identified above allows only /k p ʔ/ to surface faithfully; /t/ is debuccalized to [ʔ].

Chapter 6 shows how the theory deals with both gapped and harmonically contiguous inventories. The theory is also shown to be restrictive: it cannot produce 'disharmonic' inventories, in which only marked elements exist (e.g. [k p], with no [t] or [ʔ]).

- *Assimilation: Marked Faithfulness & Blocking*

Further evidence that marked elements are subject to more faithfulness than less marked ones is presented in chapter 7. With Kiparsky (1994) and Jun (1995), this chapter will argue that systems in which only unmarked PoAs assimilate require faithfulness constraints that exclusively preserve marked categories.

For example, only coronals undergo assimilation in Catalan: /son bɛus/ → [som bɛus] 'they are voices', cf /som dos/ → [som dos], *[son dos] 'we are two'; /tiŋ presə/→[tiŋ presə], *[tim presə] 'I have bread' (Mascaró 1976, 1986, Hualde 1992). As proposed by Kiparsky (1994), this system can be produced by ranking a faithfulness constraint that preserves dorsals and labials only above all assimilation-triggering constraints (called ASSIM here).

Tableau (6) shows the ranking needed for coronal assimilation: ASSIM must outrank all constraints that preserve coronals – i.e. IDENT{dors,lab,cor}.

(6)   Coronals undergo assimilation

/son bɛus/	ASSIM	IDENT{dors,lab,cor}
(a) son bɛus	*!	
☞ (b) som bɛus		*

In contrast, since dorsals and labials do not undergo assimilation, some faithfulness constraint that preserves them – and only them – must outrank ASSIM.

(7)   Dorsals and labials do not undergo assimilation

/tiŋ presə/	IDENT{dors,lab}	ASSIM	IDENT{dors,lab,cor}
☞ (a) tiŋ presə		*	
(b) tim presə	*!		*

The ranking || IDENT{dors,lab} » ASSIM || does not effect the outcome of tableau (6): since IDENT{dors,lab} does not evaluate mappings from a coronal, all candidates in (6) will vacuously satisfy it.

This chapter shows that Catalan-type systems can be produced using the marked-faithfulness constraints, and that – under certain assumptions – that marked-faithfulness constraints are an indispensable part of any analysis of such systems.

The remainder of the chapter deals with further predictions of the marked faithfulness constraints and their interaction with markedness.

- *Coalescence: Stringent faithfulness*

Chapter 8 provides evidence that faithfulness constraints are formulated stringently. For Place of Articulation, this means that there are constraints IDENT{dors,lab} and IDENT{dors,lab,cor} which preserve several different PoA specifications equally, as opposed to a set of faithfulness constraints for each PoA individually: e.g. || IDENT{dors} » IDENT{lab} » IDENT{cor} ||.

Evidence for this proposal comes from a type of coalescence in which the output retains unmarked values. For example, adjacent consonants in Pali coalesce to satisfy certain syllable-based restrictions (ch.8§8.4). If the two input consonants differ in their PoA specification, the output retains the least marked value. For example, the /b^h-t/ in /lab^h-tab:a/ coalesce to form a [d:^{h}] (i.e [lad:^{h}ab:a] 'take {gerund}'). The coalesced output [d:^{h}] retains the less marked PoA – i.e. coronal.

The reason that coronals survive is due to markedness: *{KP} favours [d:^{h}] over *[b:^{h}]. Thus, *{dors,lab} outranks all faithfulness constraints that favour preservation of labials over coronals – i.e. IDENT{dors,lab}.

(8)

	/lab$^h_1$-t$_2$ab:a/	*{dors,lab}	IDENT{dors,lab}
	(a) lab:$^h_{1,2}$ab:a	* *!	
☞	(b) lad:$^h_{1,2}$ab:a	*	*

Candidate (a) incurs two violations of *{dors,lab} because it contains two labials: [b:^{h}] and [b:]. In contrast, (b) contains only a single labial – [b:], so winning over (a).

The evidence for stringent faithfulness constraints relates to a failed candidate: *[lad:$^h_{1,2}$ad:a]. In this form, the input /b:/ has neutralized to [d:]. A labial-preserving faithfulness constraint must prevent this neutralization from taking place. As tableau (9) shows, IDENT{dors,lab,cor} does this effectively.

(9)

	/lab$^h_1$-t$_2$ab:a/	IDENT{dors,lab,cor}	*{dors,lab}	IDENT{dors,lab}
☞	(a) lad:$^h_{1,2}$ab:a	*	*	*
	(b) lad:$^h_{1,2}$ad:a	* *!		* *

Candidate (a) violates IDENT{dors,lab,cor} once because the input /b^h/ has a coronal output correspondent: [d:^{h}]. In contrast, candidate (b) violates IDENT{dors,lab,cor} twice: one for the /b^h/→[d:^{h}] mapping and the other for the /b:/→[d:] mapping. In short, IDENT{dors,lab,cor} is crucial in preventing wholesale neutralization of labials.

IDENT{dors,lab,cor} also has one other essential property: it conflates two unfaithful mappings. Tableau (10) illustrates this situation.

(10)

/lab$^h_1$-t$_2$abːa/	IDENT{dors,lab,cor}	*{dors,lab}	IDENT{dors,lab}
☞ (a) ladːʰ$_{1,2}$abːa	*	*	*
(b) labːʰ$_{1,2}$abːa	*	* *!	
(c) ladːʰ$_{1,2}$adːa	* *!		* *

While IDENT{dors,lab,cor} eliminates candidate (c) (the candidate with across-the-board labial neutralization), it assigns equal violations to (a) and (b). These equal violations allow the markedness constraint *{dors,lab} to determine the outcome, favouring candidate (a). In other words, in order for *{dors,lab} to have an influence on the outcome, the unfaithful mappings /b^h-t/→[dː^h] and /b^h-t/→*[bː^h] must be treated as equally unfaithful.

In short, a faithfulness constraint that assigns equal violations to unfaithfulness of dorsals, labials, and coronals – i.e. IDENT{dors,lab,cor} – is essential in accounting for this type of coalescence, hence the need for stringent faithfulness constraints. The remainder of chapter 8 provides a survey of coalescence cases, and documents the implications of the theory in other related areas.

- *Structure of Part III in Brief*
  Table (11) summarizes the structure of Part III. Chapters 6 and 7 argue the point that all faithfulness constraints preserve the most marked element. Chapter 8 deals with the proposal that faithfulness constraints are stringently formulated.

(11)   Outline of Part III

Chapter	Theoretical issue	Phenomenon
6	Marked preservation	PoA Neutralization
7	Marked preservation	Assimilation (PoA and voice)
8	Faithfulness conflation – stringency	Coalescence

- *The rest of this chapter*
  There are two parts to the rest of this chapter. §5.2 discusses the formal implementation of the present theory in more detail. §5.3 is an extended discussion of the Place of Articulation faithfulness constraints and the Place of Articulation scale itself.
  The aim of these sections is to (i) clarify the preceding discussion and (ii) provide evidence for some basic assumptions made in the following chapters.

5.2   Scale-referring faithfulness constraints: Theory

The aim of this section is to provide a more formal discussion of the proposals summarized in §5.1.

The theory of scale-referring faithfulness constraints presented here derives from two separate hypotheses. One is that faithfulness constraints are stringently formulated.

The other is that more marked elements can be preserved while less marked elements are not.

These two leading ideas have obvious parallels to the form of markedness constraints: markedness constraints are also stringently formulated (ch.3), and they assign violations to more marked elements without assigning violations to less marked ones.

Since degree of markedness correlates with degree of faithfulness in such a direct way, markedness and faithfulness constraints have a very similar form. In effect, for every set of elements that markedness constraints refer to, there is a faithfulness constraint that refers to the same set. So, one can generalize over the form of both markedness and faithfulness scale-referring constraints as in (12).

(12)   Marked Reference Hypothesis (MRH)
          If a constraint C that refers to scale S mentions category c in S,
          then C also mentions all categories k
          where k is more marked than c in S.

The meaning of 'mentions' depends on whether the constraint is a markedness or faithfulness one. If the constraint is a markedness constraint M, M 'mentions' category c if it assigns a violation for every instance of c in a candidate. If the constraint is a faithfulness constraint F, F 'mentions' c if F assigns a violation for the mapping $/c/ \rightarrow [d]$, where $[d] \neq [c]$.

Section 5.2.1 shows how the hypothesis is formally implemented in the present theory. Section 5.2.2 discusses alternative formulations of the faithfulness constraints.

5.2.1   Scale faithfulness

The MRH in (12) provides a strong condition on scale-referring faithfulness constraints. The other condition adopted here is completeness: for every scale element s there is some faithfulness constraint that mentions s. Thus, there is no element in a scale that is neglected by faithfulness entirely.

To restate the example from the introduction, for a scale $| \gamma F \rangle \beta F \rangle \alpha F |$, there are three scale-referring faithfulness constraints. The faithfulness constraints can be informally defined as in (13).

(13)   Marked-faithfulness constraint skeleta
          IDENT{γF}   If x is γF, then its correspondent x' has the same value for F
                                            as x (i.e. x' is γF).
          IDENT{γF,βF}   If x is γF or βF, then its correspondent x' has the same value
                                            as x for feature F.
          IDENT{γF,βF,αF} If x is γF or βF or αF, then its correspondent x' has the same
                                            value as x for feature F.

For every scale element, there is some faithfulness constraint in (13) that preserves it. In addition, (13) lists the *only* faithfulness constraints that refer to $| \gamma F \rangle \beta F \rangle \alpha F |$. The

MRH rules out constraints that preserve only /β/ or /α/, or preserve /α/ and /γ/ without also preserving /β/.

It is important to point out that the structural descriptions of the constraints in (13) are described informally. As discussed in chapter 2, scales are implemented in the present theory through feature value strings. So, properly speaking the scale | γF 〉 βF 〉 αF | is a set of feature values [*xx*F], [*xo*F] and [*oo*F].

In other words, the faithfulness constraints preserve feature value strings rather than individual scale elements. More precisely, faithfulness constraints refer to substrings of the feature values, analogous to markedness constraints. Thus, there are three faithfulness constraints: IDENT[*xx*F], IDENT[*x*F], and IDENT[F]. As an example, IDENT[*x*F] applies to segments with *x* as a substring of the value of F: i.e. [*xx*F] and [*x*F]. From this, the stringent form of faithfulness constraints derives. In general, then, there is one schema for IDENT, given in (14).

(14)   Faithfulness Schema
       IDENT[*v*F]   • *v* is a feature value string.
                         • Val(α,F) is the value of feature F in segment α.
                         • α and α' are correspondents.
                         If *v* is a substring of Val(α,F)
                         then Val(α,F) = Val(α',F).

The schema states that IDENT constraints refer to substrings of feature values. So, IDENT[*x*F] refers to all values of F that contain the string *x* – i.e. [*xo*F], [*xx*F] for a feature F with a value string of length 2. If the input value contains *x*, then the output is required to faithfully preserve the input value. So, if the input is [*xx*F], IDENT[*x*F] demands that the output also be [*xx*F]; it cannot be [*xo*F] or [*oo*F].

To further exemplify (14), suppose that there is an input segment that has the value [*xo*F]. Then for IDENT[*x*F], *v* in (14) is *x* and Val(α,F) is *xo*. Since *x* is a substring of *xo*, then the correspondents must agree in feature value – i.e. they must both be *xo*.

The formulation in (14) differs minimally from McCarthy & Prince's (1995) IDENT schema. In effect, the only difference is that restrictions are placed on the domain of the constraint. For example, IDENT{dors,lab} requires identity in terms of PoA, but only applies to dorsals and labials.

5.2.2   Restrictions

There are several restrictions on the form of the faithfulness constraints in this theory. One relates to MAX and DEP constraints, and the other to the interpretation of IDENT.

The present theory does not employ scale-referring MAX[feature] and DEP[feature] constraints (cf Lombardi 1995, 1999, McCarthy 1995, 2000b, Causley 1997, Pulleyblank 1998, Howe & Pulleyblank 2001, and others). For example, there is no MAX{[*xxx*Place]}, which requires all input dorsal features to have an output dorsal feature correspondent. An

empirical argument against MAX-feature constraints is presented in ch.6§6.4.2.1. In other words, IDENT constraints are the only ones that can refer to scale elements.

Another point relates to the form of the IDENT constraints. The IDENT constraints require identity rather than inclusion in terms of the feature value *v*. For example, IDENT[*xx*Place] does not require every input segment with *xx* in its Place value to simply contain *xx* in its Place value in the output. Such a requirement would allow less marked elements to become more marked with impunity: for example, the mapping /m/→[ŋ] would be admissible since /m/ is [*xx*Place], [ŋ] is [*xxx*Place], and both values contain *xx*. While in most cases such a mapping would not take place because /m/→[m] incurs fewer markedness violations than /m/→[ŋ], it does become an issue in assimilation. If IDENT[*xx*Place] does not block the mapping /m/→[ŋ], then labials should always assimilate to dorsals. This incorrect version of IDENT is called '☠IDENT' in the tableau below:

(15) <u>Faithfulness constraints do not work this way</u>

/amka/	☠IDENT[*xx*Place]	ASSIM
(a) amka		*!
☞ (b) aŋka		

In short, IDENT constraints require feature values to be identical, not freely chosen from a set of possible values.

It is also important to point out that the elements mentioned in the antecedent are the same as those in the consequent. For example, IDENT{dors} can be cast as "If an input segment S is dorsal, then S's correspondent must be dorsal." The antecedent and consequent cannot refer to different elements: e.g. *"If an input segment S is dorsal, then S's output correspondent must be labial" (i.e. an 'unfaithfulness' constraint), or *"If an input segment is dorsal, then its output correspondent must be [+voice]" (cf Orgun 1994).

5.3   Major Place of Articulation: Form and constraints

Since the Major Place of Articulation (PoA) scale figures prominently in several of the following chapters, it will be used here to exemplify the structure of the marked faithfulness constraints.

The form of the PoA scale used here is given in (16), closely following Lombardi (1995, 1998b). The scale in (16) has precursors in a great deal of previous work, including Jakobson (1941), Paradis & Prunet (1991) and references cited therein, and within Optimality Theory Prince & Smolensky (1993:ch.9§1.2,§2), Smolensky (1993), Gnanadesikan (1995), Prince (1997c, 1999), and Pater & Werle (2001), to name but a few.

(16) <u>The Major Place of Articulation (PoA) Scale</u>
       | dorsal 〉 labial 〉 coronal 〉 glottal |

'Labial' refers to both bilabial and labiodental (e.g. [β], [v]). 'Coronal' covers interdental, dental, alveolar, and palato-alveolar places of articulation. 'Dorsal' is used

primarily to refer to velars; for discussion of the classification of uvulars and pharyngeals see McCarthy (1994). 'Glottal' refers solely to the glottals [ʔ h ɦ] and to *anusvara* [N], discussed in Trigo (1988) and §5.3.3. The scale does not deal with secondary place articulations (i.e. labialization, palatalization, velarization); these will be discussed where appropriate.

The PoA scale is well suited to illustrating the points in this section and the following chapters. Since it is a featural scale (cf sonority), it cannot combine with DTEs in markedness constraints; there are no constraints of the form *Δ_α/{dorsal}, for example (for strong typological reasons – see ch.3§3.5). Therefore, there is no ambiguity about the markedness of PoA in a particular position: dorsal segments are highly marked for PoA regardless of whether they are in an onset, coda, stressed syllable, or any other prosodic constituent. This consistency makes featural scales ideal for approaching questions about neutralization. In contrast, prosodic scales are ambiguous when it comes to neutralization and markedness. For example, [a] is unmarked as a DTE, but highly marked as a non-DTE; this markedness ambiguity has significant empirical effects (see ch.4§4.4), but is too complex to use as an exemplar of a theory of neutralization.

Moreover, the PoA scale already has a significant amount of theoretical support (see references above).

The primary aim of this section is to exemplify the form of scale-referring constraints. So, §5.3.1 discusses the form of the PoA-markedness constraints. This section also provides arguments that they must be stringently formulated.

Section 5.3.2 presents the PoA-faithfulness constraints.

The form of the PoA scale is discussed in §5.3.3. This section presents evidence for the distinctions and ranking in (16). It discusses the 'glottal' class, especially with regard to nasals and Trigo's (1988) proposals. Diagnostics for determining relative markedness are identified. Evidence from consonant epenthesis is presented to show that glottals and coronals are less marked than labials and dorsals. Finally, evidence for the relative markedness of labials and dorsals is discussed.

5.3.1 The PoA markedness constraints

There are four PoA markedness constraints in the present theory, given in (17) (also see Prince 1999). Their extended form is given in the left column. The right column gives their abbreviated form, used from now on.

(17)   PoA Markedness Constraints

Long Form	*Short Form*
*{dorsal}	*{K}
*{dorsal,labial}	*{KP}
*{dorsal,labial,coronal}	*{KPT}
*{dorsal,labial,coronal,glottal}	*{KPTʔ}

The constraint *{KPT} is violated by a segment that is either dorsal, labial, or coronal. For example, the form [kapataʔ] will incur three violations of *{KPT} – one for [k], one for [p], and one for [t]. In contrast, [ʔ] does not violate *{KPT}.

As dictated by the MRH in (12), every constraint bans the most marked element – dorsals. Just as with the sonority constraints, the markedness constraints are in a stringency relation, as shown in quasi-tableau (18).

(18)   Stringent PoA Markedness Constraints

	*{K}	*{KP}	*{KPT}	*{KPTʔ}
[k]	*	*	*	*
[p]		*	*	*
[t]			*	*
[ʔ]				*

As with the sonority constraints in chapter 3, there is no need to invoke a fixed ranking to ensure that glottal will always be the least marked PoA. Since no constraint favours non-glottals over glottals and some constraint favours glottals over every other PoA, glottals will always be most harmonic in terms of the markedness constraints. In short, glottals are a local harmonic bound for all other PoAs.

5.3.1.1 Manner and PoA

The constraints in (17) are intended to be the skeleta for all PoA-referring markedness constraints. In other words, there may be elaborations on the constraints in (17) as long as their favouring relationships – i.e. which PoAs are treated as more harmonic than others – are kept the same.

- *No implicational relations between different manners of articulation*

One elaboration relates to manner of articulation. A survey of inventories reported in Appendix A shows that there is no relation between different manners of articulation for PoA. To be precise, no implicational statements of the form "If there is a segment with PoA *x* in *MoA1* then there is a segment with PoA *x* for *MoA2 (MoA1≠MoA2)*", where MoA is 'Manner of Articulation', were found to hold.

The lack of implicational relations between PoAs of different manners can be seen in Polynesian languages. For example, Maori has the voiceless stops [p t k] and the voiceless fricatives [f h] (Bauer 1993); there clearly is no implicational relationship between the existence of dorsal and coronal voiceless stops and the existence of those same PoAs for voiceless fricatives. Colloquial Samoan shows that the opposite also does not hold: this language has [f s] and [k p ʔ], showing that the existence of a coronal voiceless fricative does not imply the presence of a coronal voiceless stop (Clark 1976, Mosel & Hovdhaugen 1992).

Similarly, Hawaiian has the voiceless stops [k p ʔ], nasals [m n], and fricative [h] – the existence of a coronal nasal does not imply the presence of a coronal voiceless stop or

voiceless fricative in any of the other manners of articulation (Pukui & Elbert 1979). Conversely, Colloquial Samoan has the voiceless fricatives [f s] and nasals [m ŋ] – again the presence of a coronal voiceless fricative does not imply the presence of a coronal nasal.

Table 5.1 underscores this point. It lists languages in which the PoA contrasts for a particular manner of articulation are a proper subset of those found in another manner of articulation. For example, PoA contrasts in Murut voiceless fricatives are a proper subset of the voiced stop contrasts: the former has just the coronal [s], while the latter has [b d g]. Conversely, voiced stop contrasts are a proper subset of voiceless fricative contrasts in Wintu. The gaps for voiced fricatives are probably accidental – due to the relative rarity of voiced fricatives cross-linguistically. The table below is based on the survey reported in Appendix B.

Table 5.1: PoA proper subset relations among different manners of articulation[81]

⊂	-vd stops	+vd stops	-vd fricatives	+vd fricatives	nasals
-vd stops		Nganasan [tk(ʔ)]~[bdg]	Ormuri [ptk]~[fsxχh]	-	Vanimo [pt]~[mnɲ]
+vd stops	Djapu [d]~[ptɟtʲʲtk]		Wintu [bd]~[fsxχh]	-	Central-Eastern Tundra Nenets [bd]~[mnŋ]
-vd fricatives	Tongan [fsh]~[ptkʔ]	Murut [s]~[bdg]		-	Kewa [s]~[mnɲ]
+vd fricatives	E.Mari [zʒ]~[ptk]	Boazi [vz]~[bdg]	W.Mari [sʒ]~[fsʃx]		Harar Oromo [z]~[mnɲ]
nasals	Mordvin [mnɲ]~[ptck]	Komi [mnɲ]~[bdɟg]	Hungarian [mnɲ]~[fsʃxh]	Mountain Slave [mn]~[vzʒɣ]	

As Table 5.1 shows, there are no implicational relations between different manners of articulation for PoA contrasts.[82]

- *Theoretical implications*

The theoretical implication of the observation just made is that there may well be manner-specific PoA constraints. Markedness constraints of this type could have the form *{KPT}/nasal (i.e. *{ŋmn}), *{KPT}/[−vd stop] (i.e. *{kpt}), and so on. For example, to account for the fact that there is a velar [k] in Mordva but no velar nasal [ŋ], *{K}/nasal

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[81] References: Boazi (Foley 1986:61), Central-Eastern Tundra Nenets (Salminen 1998), Djapu Yolngu (Morphy 1983), Harar Oromo (Owens 1985:10), Hungarian (Abondolo 1998b:433), Kewa (Foley 1986:60-1), Komi (Hausenberg 1998:309), Mari (Kangasmaa-Minn 1998:221), Mordva (Zaicz 1998:185-6), Mountain Slave Rice 1989:30), Murut (Prentice 1971:16), Nenets (Salminen 1998:522-3), Nganasan (Helimski 1998:483-4), Ormuri (Efimov 1986), Tongan (Churchward 1953), Vanimo (Ross 1980), Wintu (Broadbent & Pitkin 1964).

[82] Interestingly, there are also no implicational relations between series of segments differing only in glottal distinctions. For example, Haida has plain and aspirated labials [p pʰ], but no labial ejective [p'] (Sapir 1923). In contrast, Harar Oromo has the ejectives [p' t' tʃ' k'], but only the plain voiceless stops [t] and [tʃ] (Owens 1985). No account of these facts will be provided here.

would outrank all velar-preserving faithfulness constraints while *{K}/{-vd stop} would not.

A separate issue is whether there are manner-specific faithfulness constraints to complement the markedness constraints (e.g. IDENT{KPT}/nasal vs IDENT{KPT}/stop). As it turns out, the cases discussed in chs.6-8 do not provide much insight into this issue. If the constraints did exist, they would not affect the results of the following chapters. Since this is tangential to the main point of this Part, the issue is left for future research.[83]

For the sake of brevity, the PoA markedness constraints will be mentioned without manner specifications in the following chapters; the manner of articulation will be mentioned only when it is directly relevant.

5.3.1.2 Stringent form

Since chapter 3 showed in detail why markedness constraints must be stringently formulated, this section will briefly and schematically identify a phenomenon that provides evidence for stringent PoA-markedness constraints.

Take a hypothetical system where stops are neutralized to [ʔ] in codas: e.g. /ak/ → [aʔ], /atma/ → [aʔma]. As discussed in detail in ch.6, this type of neutralization involves the constraint *{KPT}, which outranks all faithfulness constraints that preserve dorsal, labial, and coronal PoA (i.e. all faithfulness constraints).

(19)

/ak/	*{KPT}	IDENT{KPT}
(a) ak	*!	
☞ (b) aʔ		*

However, suppose that [ʔ]'s are banned before other glottals, so that *[aʔha] is unacceptable.[84] This ban will prevent coda stops from debuccalizing in this environment too, so that /akha/ → [akha], *[aʔha]. Importantly, though, /akha/ is not realized as *[atha] – in other words, /k/ does not neutralize to the next least marked element [t] when it cannot neutralize to [ʔ]. So, unless /k/ can neutralize to [ʔ] in this language, it does not neutralize at all.

With stringent markedness constraints, this blocking effect is easy to achieve. The constraint against glottal+glottal clusters – OCP(glottal) – must outrank *{KPT}, as shown in tableau (20).

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[83] It is difficult to separate the effects of manner-specific markedness and faithfulness constraints. If there were manner-specific faithfulness constraints, one could expect them to block a process for a particular manner of articulation while allowing others to undergo it. For example, nasals assimilate in PoA in English while fricatives and stops do not. This may indicate that IDENT{KPT}/{stop,fricative} outranks all assimilation-triggering constraints while IDENT{KPT}/nasal is ranked lower. On the other hand, it may indicate that there are nasal-specific PoA constraints: *{KPT}{KPT}/nasal may outrank IDENT{KPT}, while assimilation-inducing constraints for stops and fricatives are ranked below the faithfulness constraint.

[84] For such a constraint, see the discussion of Yamphu in ch.7§7.5.4. Also see McCarthy (1994) for discussion of OCP constraints on glottals. In any case, any constraint that blocks the usual output of neutralization in a specific environment could be used here.

(20)

/akha/	OCP(glottal)	*{KPT}	IDENT{KPT}
(a) aʔha	*!		*
☞ (b) akha		*	
(c) atha		*	*!

Candidate (a) has neutralized /k/ to [ʔ], but in doing so fatally violates OCP(glottal). This leaves candidates (b) and (c). Candidate (c) is important: instead of neutralizing /k/ to [ʔ], it changes /k/ to the next least-marked element [t]. However, the next least marked element is not good enough in this system: unless /k/ can neutralize to [ʔ], it will not neutralize at all. This property is formally achieved by the stringent form of the constraint *{KPT}: *{KPT} assigns the same violations to both [k] and [t], so it does not favour (c) over (b). The crucial constraint is then IDENT{KPT}, which prefers the faithful (b) over (c). Crucially, no constraint that favours [t] over [k] (e.g. *{K}, *{KP}) can outrank IDENT{KPT} otherwise (c) would beat (b).

To show why the stringent *{KPT} is necessary for this case, consider a fixed ranking theory with || *K » *P » *T ||. To get neutralization of /k/ to [ʔ], *K would have to outrank all faithfulness constraints that preserved it (i.e. all faithfulness constraints in the present theory). The same is true for *P and all labial-preserving faithfulness constraints, and *T and all coronal-preserving faithfulness constraints.

To block neutralization to [ʔ] before other glottals, OCP(glottal) would have to outrank *K. That way from input /akha/, *[aʔha] would be eliminated. However, there is now no way to prevent /k/ from neutralizing to [t], producing *[atha] from /akha/. This is illustrated in tableau (21).

(21)

/akha/	OCP(glottal)	*K	*T	IDENT{KPT}
(a) aʔha	*!			*
(b) akha		*!		
💣 (c) atha			*	*

The tableau above shows that the form with debuccalization (a) is correctly eliminated, thanks to OCP(glottal). However, problems arise in the competition between (b) and (c). Because *K favours [t] over [k], it incorrectly eliminates the faithful form, with the result that the form with neutralization to [t] wins.

There is no way to avoid this problem. No markedness constraints can be invoked: such a constraint would have to favour [k] over [t] and outrank *K, incorrectly reversing the markedness relation between dorsal and coronal, thereby predicting unattested phenomena such as epenthetic dorsals (cf §5.3.3.3). No faithfulness constraint can be employed either: if a dorsal-preserving faithfulness constraint like IDENT{K} outranked *{K}, /k/ would never neutralize to [ʔ], even in environments where it should.

The problem is that the markedness constraint *K favours coronals over dorsals. So, if [ʔ] is not available, /k/ will inevitably seek out the next least marked element – coronals – in the Fixed Ranking theory.

As shown in (20), the solution to this problem is to conflate candidates (a) and (b) – if both incur the same violations of active markedness constraints, faithfulness will emerge to preserve the most faithful candidate.

To generalize from this case, stringent markedness constraints allow neutralization to be blocked when it will not yield the least marked element in a specific environment. In contrast, non-stringent constraints predict that "the next best is good enough" – that for a scale | z 〉 y 〉 x |, if z generally neutralizes to x but x is blocked in some z-neutralizing environment, z will always neutralize to the next least marked element y.

5.3.2   The PoA faithfulness constraints

The PoA faithfulness constraints are given in (22).

(22)   <u>PoA Faithfulness</u>
   IDENT{K}   If x is dorsal, then x' has the same PoA as x.
   IDENT{KP}   If x is dorsal or labial, then x' has the same PoA as x.
   IDENT{KPT}   If x is dorsal, labial, or coronal, then x' has the same PoA as x.
   IDENT{KPTʔ}   If x has any PoA, then x' has the same PoA as x.

As an example, IDENT{KP} requires input dorsals and labials to surface faithfully. So, IDENT{KP} is violated by any unfaithful mapping from /k/ or /p/: i.e. /k/ → [p] or [t] or [ʔ] and /p/ → [k] or [t] or [ʔ]. It is not violated by the mappings /k/→[k] and /p/→[p], nor by any unfaithful mapping from a coronal or glottal (i.e. /t/→{k,p,ʔ}, /ʔ/→{k,p,t}).

Table (23) shows the effect of the faithfulness constraints.

(23)   <u>Violations</u>

	IDENT{K}	IDENT{KP}	IDENT{KPT}	IDENT{KPTʔ}
/K/ → [P] or [T] or [ʔ]	*	*	*	*
/P/ → [K] or [T] or [ʔ]		*	*	*
/T/ → [K] or [P] or [ʔ]			*	*
/ʔ/ → [K] or [P] or [T]				*

Chapter 6§6.4.2 will argue that IDENT constraints are the only type of faithfulness constraint that refers to scales; there are no MAX or DEP constraints that refer to features: i.e. no MAX{K}.

To provide a more formal statement of the PoA-faithfulness constraints, Place of Articulation is taken to be the feature [Place], with the possible values of this feature as in (24).

(24)   [Place] values
        [xxx Place]   = dorsal
        [xxo Place]   = labial
        [xoo Place]   = coronal
        [ooo Place]   = glottal

The Marked Reference Hypothesis is implemented in the present theory as the requirement that every constraint must refer to the same value element – i.e. x, in this case. For the Place of Articulation scale, this requirement allows the following markedness and faithfulness constraints:

(25)   (i)   PoA Markedness Constraints
        *[*xxx*Place], *[*xx*Place], *[*x*Place], *[Place]
    (ii)   PoA Faithfulness Constraints
        IDENT[*xxx*Place], IDENT[*xx*Place], IDENT[*x*Place], IDENT[Place][85]

As discussed in chapter 2 and illustrated in chapter 3, the markedness constraints are evaluated as such: *[*x*Place] is violated for every instance of a Place feature f if f's value contains x. So, *[*x*Place] is violated by [*xxx*Place], [*xxo*Place], and [*xoo*Place] features.

Faithfulness constraints require identity between correspondents. A constraint like IDENT[*xxx*Place], for example, requires an input segment that is [*xxx*Place] to be [*xxx*Place] in the output. The constraint IDENT[*xx*Place], on the other hand, requires input dorsals to be dorsals in the output, and input labials to be labials in the output. Extensive support for the form of the faithfulness constraints will be provided in later chapters.

5.3.3   The form of the PoA scale

The aim of this section is to justify the distinctions and ranking given in the PoA scale proposed here, repeated in (26).

(26)   The Major Place of Articulation (PoA) Scale
    | dorsal ⟩ labial ⟩ coronal ⟩ glottal |

The form of the scale most closely agrees with Lombardi's (1998) proposals.[86] Other precursors (of which there are many) were mentioned in the introduction to §5.3.

The idea that there is a markedness hierarchy involving different places of articulation has had much support. However, there is a great deal of disagreement over the details.

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[85]   The value of [Place] in IDENT[Place] is e (the empty string), which all values of [Place] contain. Therefore, IDENT[Place] preserves all PoA values.
[86]   Lombardi (1995) groups pharyngeals [ʕ ħ] with glottals as the least marked PoA. No evidence relevant to the markedness status of pharyngeals is presented in the following chapters, so determination of its status will be left for future research.

Section 5.3.3.1 discusses the category distinctions made in (26), focusing especially on the 'glottal' class. This class includes [ʔ], [h], and Trigo's (1988) [N] – a nasal glide. Recognition of a nasal equivalent to [ʔ] and [h] will prove to be important in explaining patterns of nasal neutralization and epenthesis.

Evidence for the rankings of the PoA scale is discussed in sections 5.3.3.2-5.3.3.4. Section 5.3.3.2 identifies diagnostics used to determine relative markedness.

The proposal that glottals and coronals are the least marked PoAs is discussed in §5.3.3.3. This section presents evidence from consonant epenthesis and neutralization to support this proposal. The proposal that velars can be the least marked PoA is also considered (Trigo 1988, Rice & Causley 1998, Rice 2000a,b).

Section 5.3.3.4 deals with the ranking between labials and dorsals.

5.3.3.1 Glottals

The PoA scale in (26) distinguishes four main classes of PoA. As the coronal, labial, and dorsal classes are generally accepted in a great deal of previous work, the 'glottal', or 'laryngeal', class is the focus of this section. The class of glottals includes the glottal stop [ʔ], the fricatives/approximants [h ɦ], and Trigo's (1988) [N]. The least well known of these – [N] – will be discussed first, followed by a discussion of glottals as a class.

The following discussion builds on Trigo's (1988) proposal that there are nasal counterparts of [ʔ] and [h]. I will argue that there are two separate nasal glottals. One is a nasalized approximant [ɦ̃]. The other is a nasal stop, symbolized as [N] (not to be confused with uvular [ɴ]). Although [N] is phonologically glottal, I propose it is phonetically realized with an oral constriction in the velar-uvular region.

- *The Nasal Glide (Anusvara)* [ɦ̃]

[ɦ̃] is the Sanskrit *anusvara*, also found in Japanese word-final codas (McCawley 1968, Trigo 1988). Trigo describes it as a 'glide-like transitional element'. In Gujarati it is said without (complete) occlusion in the oral cavity, thus sounding like a nasalized [h] (or – rather – a nasalized [ɦ] since it is voiced).

[ɦ̃] is reported to occur in a number of Peruvian languages. For example, Rich (1963) reports its existence in Arabela onsets, which also can contain [m] and [n]. The Arabela [ɦ̃] is clearly nasal: it motivates nasal harmony, just as [m] and [n] do (e.g. [ɦ̃ãnũʔ] 'to fly', cf [nũwãʔ] 'partridge', [mõnũʔ] 'kill').

[ɦ̃] is also reported to alternate with [ŋ] in some languages. Payne (1990:162) reports that it appears in Aguaruna onsets, but is realized as [ŋ] in codas: [suŋkuŋ] 'influenza' cf [suŋkũɦ̃-ãn] 'influenza+accusative' (p.162).

Just like [h], [ɦ̃] continues the articulations of preceding vowels. For example, McCawley (1968:84) describes the Japanese [ɦ̃] as "a nasalized prolongation of the preceding vowel".

- *The glottal nasal* [N]

In phonological terms, [N] contrasts with [ɦ] solely in terms of the feature [continuant]. What makes [N] an elusive phonological element to identify is its phonetic realization: it is realized with an occlusion in the velar or uvular region, therefore making it phonetically identical to [ŋ]. Nevertheless, [N] and [ŋ] are phonologically distinct.

Clearly, any proposal that two phonologically distinct elements have the same phonetic realization requires careful scrutiny. The first aim is to explain why a nasal stop specified as [glottal] would require a velar constriction. Evidence that there is a nasal stop that is phonologically a glottal will then be presented.

The reason that a glottal nasal is realized with velar constriction arises from a proposal by Ohala & Lorentz (1977). They argue that the main feature that distinguishes PoA in nasals should be seen as difference in the size of the oral cavity (p.585). A bilabial [m] has the largest oral cavity, then [n]; [ŋ] has the smallest.

Figure 5.1: Vocal Tract shape for [m], [n], [ŋ] (from Ohala & Lorentz 1977:586)
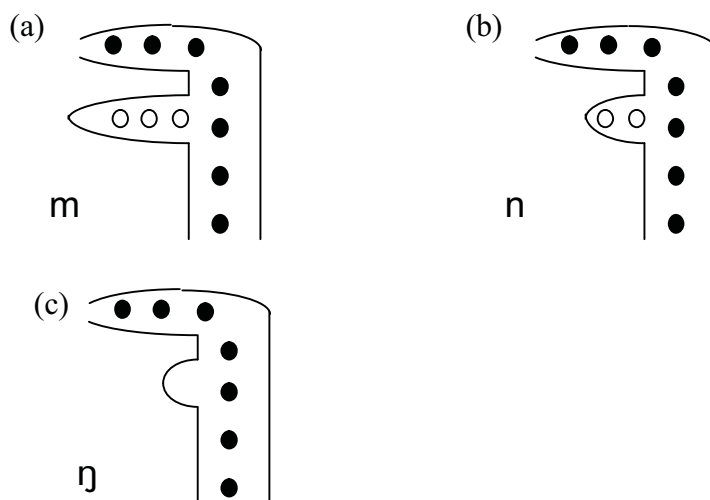
I suggest that the implementation of the 'placeless' [N] effectively calls for the most direct route from the glottis to the nostrils (via the pharyngeal and nasal airways). Any oral cavity would subvert this aim; therefore the size of oral cavity must be restricted. As shown in the diagrams above, a constriction in the velar region is the best that can be done in this regard.

This implementation can be compared with another 'placeless' consonant [h]: like the proposal for [N], [h] is produced by creating the most direct route from the glottis to the sound radiation point (the mouth); the nasal cavity is closed off in this case.

The net result is that two different phonological segments – /ŋ/ and /N/ – have the same phonetic realization, but for quite different reasons. The phonological specifications of /ŋ/ issue a directive for velar constriction; in contrast, the phonological specifications of /N/ merely require a direct route from source to radiation point, and velar constriction happens to be necessary to achieve this goal.

- *Phonological Evidence for [N]*

    The reason so much time has been spent in discussing [N] is that it appears prominently in the analysis of neutralization in chapter 6. For example, a number of languages neutralize all nasal PoA contrasts to [N] in coda position (e.g. Hullaga Quechua, Seri[87], Yamphu (Rutgers 1998), Makassarese (Aronoff et al. 1987), and Misantla Totonac (San Marcos dialect) (Mackay 1994:380); others are provided in ch.6§6.6.1. Since [N] is realized with velar constriction, the result is a coda nasal inventory of just [ŋ], or [m ŋ] if only coronals neutralize.

    One may wonder why this velar nasal should be considered to be [N] at all. A variety of evidence is presented in ch.6§6, so I will only summarize it here.

    One reason relates to parallelism of neutralization. Most of the languages with neutralization to [N] also have neutralization of oral stops to [ʔ] and/or fricatives to [h]. In contrast, no language has neutralization of oral stops to [k] and fricatives to [x] (see ch.6§6.6.3.1).

    Another reason relates to epenthesis. The oral stops [ʔ] and [t] are commonly produced by epenthesis, as is the glottal [h]; in contrast, [k] and [x] are never epenthetic. As shown in §5.3.3.2, Uradhi provides an example of epenthesis that produces 'ŋ', supporting the proposal that this is phonologically [N].

    Another reason relates to the behaviour of nasals in assimilation to glottals. For example, the coronal nasal /n/ assimilates to a following glottal's PoA in Yamphu (Rutgers 1988): /pen-ʔi/ → [peŋʔi] 'he's sitting'; /hen-heː-nd-u-æn-de/ → [heŋheːndwende] 'can you open it?' (p.44) (for further discussion see ch.6§6.6). This is easily explained if the nasal realized here is [N]: i.e. [peNʔi], [heNheːndwende]. Otherwise, it is difficult to see why a glottal would cause a preceding nasal to turn into a velar. Certainly, assimilation of stops to glottals results in a glottal, not a velar: e.g. /mo-dok-ha/ → [modoʔha] 'like those' (p.48).

    Further evidence for the phonological status of [N] will be presented in ch.6§6.6.

- *Comparison with Trigo (1988)*

    In summary, I have proposed that there are two nasal glottals: the approximant [ɦ̃] and the stop [N]. The latter is realized with constriction in the velar~uvular region, making it indistinguishable from [ŋ].

    Although this proposal is based on Trigo's (1988) work, it is important to point out that it differs from Trigo's (1988:45ff) proposals. For Trigo, there is no glottal nasal stop; there is only a nasal glide, equivalent to [ɦ̃] here. To account for the fact that this sound is realized with velar constriction in some languages, Trigo proposes that "the dorsal articulation of place-less consonants is acquired to implement the [+consonantal] feature" (p.49). In other words, glottal nasals always start off as /ɦ̃/ and are converted to velar nasal stops at some point in the derivation (p.55).

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[87] To be precise, /m/→[ŋ] before pause (e.g. /koːtpam/→ [kóːtpaŋ] 'sardine'), but not in an unstressed syllable (e.g. [sáːòm] 'he will beg' – Marlett 1981:20). Faithfulness to the stressed syllable blocks neutralization in this case (Beckman 1998).

I do not adopt Trigo's view for two reasons. One is theory-internal: /N/→[ŋ] conversion is necessarily opaque. /N/ must first trigger all processes that rely on its glottal PoA, then at the last it is converted into a velar. Since the output is phonologically velar [ŋ], this is necessarily a two-step process in Trigo's theory: first /n/-assimilation produces [N], which is then followed by velarization to [ŋ]. In the present view, the assimilated nasal is the glottal [N] in the output: i.e. [peNʔi]. There is no 'velarization' step – realization of the stop with velar constriction is not due to a phonological process, but a matter of phonetic implementation. I reject the opaque approach because it does not sit well with classic Optimality Theory as presented by Prince & Smolensky (1993). Certainly, opacity does exist, and theories for dealing with it have been proposed (McCarthy 1999, 2002a, Goldrick & Smolensky 1999, Goldrick 2000, Bye 2001). However, /N/-velarization is quite a different type of opaque process: it is obligatory, occurring every time /N/ appears.

The other reason is more concrete, relating to the markedness of velars. Trigo (1988:ch.2) argues that the phonological rule that inserts dorsals applies to placeless consonants generally, not just /N/. With an opaque derivation, this implies that placeless oral stops and oral fricatives could also be given a [dorsal] feature. As Trigo shows, the result of this prediction is that [k] can be epenthetic and a target of neutralization. For epenthesis, a placeless consonant is inserted, then assigned a [dorsal] feature to produce [k]. For neutralization, stop consonants first debuccalize, then the output is assigned a dorsal feature, predicting that [k] and [x] can be the output of place neutralization.

Although Trigo argues that cases supporting these predictions exist, I will argue that none withstand scrutiny – there is never epenthesis of [k] or [x], and these segments are never the output of neutralization (see also Paradis & Prunet 1990a,b, 1994). Since the arguments are best set in a theory of neutralization, I leave discussion of this point until ch.6§6.6. For a discussion of epenthesis, see 5.3.3.3.

• *Glottals are not placeless*

The final issue to be discussed here is the phonological representation of the class of glottals [ʔ h ɦ N]. I will argue that these elements bear a PoA feature, following McCarthy (1994) (cf Clements 1985, Sagey 1986, Hayes 1986, Avery & Rice 1989, Rice & Avery 1993). McCarthy (1994) presents evidence that the place feature of glottals is phonologically active in a number of phonological processes (also see Rose 1996). Ch.6§6.5.2.1 adds to this evidence.

McCarthy's (1994) proposal that these elements have the feature [+glottal] will be adopted. Following a suggestion by John Kingston, the [+glottal] feature can be interpreted as requiring an absence of consonantal constriction downstream from the sound source that divides the oral cavity into separate resonating chambers.[88] This is the case for [N]: the nasal passage provides the only resonating chamber; there is no oral resonating chamber due to velar constriction.

For phonological interests, the crucial point is that glottals have a PoA feature.

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[88] The ban on a *consonantal* constriction – a constriction related to the production of a consonant – allows for coarticulation of glottals with vowels (as typically happens). My thanks to John Kingston for discussion of this point.

5.3.3.2 Markedness diagnostics

The rankings proposed in the scale | dorsal ⟩ labial ⟩ coronal ⟩ glottal | are motivated by a particular conception of markedness diagnostics – phenomena that show asymmetries in the treatment of different PoAs. The aim of this section is to first identify the diagnostics considered valid in this work. The section concludes by identifying other previously proposed diagnostics, and outlining why they are not considered relevant.

Many diagnostics for determining markedness relations have been proposed (Greenberg 1966, Brown & Witkowski 1980, Moravcsik & Wirth 1983:6, Paradis & Prunet 1991, Causley 1999b§2.3, Rice 2000a,b). Of these, the ones in Table 5.2 are argued to be valid.

Table 5.2: Markedness diagnostics considered valid
  (a) Neutralization: outputs
      If /x/ and /y/ neutralize to produce [x], then *y* is more marked than *x*.
      (Jakobson 1941, Trubetzkoy 1939; ch.6§6, Cairns 1969)
  (b) Deletion
      If *y* undergoes structurally conditioned deletion and *x* does not, then *y* is more marked than *x*.[89]
      (Rice 2000a,b, ch.6§6.4.2)
  (c) Epenthesis (Consonant)
      If consonant *x* is epenthesized and *y* is not, then *y* is more marked than *x*.
      (Archangeli 1984, 1988, McCarthy & Prince 1994, §3.3.3)
  (d) Assimilation: triggers
      If *y* triggers assimilation and *x* does not, then *y* is more marked than *x*.
      (Mohanan 1993:75,76; Jun 1995:78; ch.7§7.7)
  (e) Prosodification: mutual influence
      If some prosodic constituent α is attracted to or attracts *x* and ignores *y*, then *y* is more marked than *x* in terms of α.[90]
      (tone & stress: Goldsmith 1987, de Lacy 1999a, 2002b; sonority & stress: chs.3,4, Kenstowicz 1996; sonority and syllable structure: Prince & Smolensky 1993 and references cited therein).
  (f) Inventory structure (to a very limited extent)
      If the presence of *x* in a segmental surface inventory implies the presence of *y* but not vice versa, then *y* is more marked than *x*.
      (Jakobson 1941, Trubetzkoy 1939, Greenberg 1966; cf ch.6)

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[89] The term 'structurally-conditioned' is from Trubetzkoy (1939:235ff). A process is structurally conditioned if (i) it takes place in some prosodic position (e.g. coda, onset, stressed syllable) and (ii) no surrounding elements are involved in triggering the process. For example, [k] is deleted in Lardil codas (Hale 1973) – this is structurally conditioned deletion. In contrast, deletion of [k] before another dorsal is not structurally conditioned since a non-structural element – i.e. the other dorsal – is crucial to triggering the process.
[90] For example, [a] attracts stress over [i] in Gujarati, so [i] is more marked than [a] in terms of stress.

The diagnostics in Table 5.2 are argued to be valid in this work; of these six, (f) is only partially useful.

The output of neutralization (a) is discussed in ch.6§6.6. Evidence is adduced to show that neutralization of two elements always results in the less marked of the two. For example, if /p/ and /t/ neutralizes in coda position, the outcome will always be [t], and never [p].

Chapter 6§6.4.2 provides evidence that the undergoers of deletion – diagnostic (b) – also exhibit a markedness-based asymmetry. This section argues that if *x* deletes, then so do all more marked elements. For example, if /t/ deletes in codas, so do the more marked /p/ and /k/. In contrast, there is no language in which /t/ deletes while /k/ and /p/ do not in the same environment.

For diagnostic (c), §5.3.3.3 shows that the output of consonant epenthesis is always a glottal or coronal, and never a dorsal or labial. Note that this asymmetry does not apply to vowel epenthesis, discussed in ch.4§4.4.

Chapter 7§7.5 agrees with Jun (1995) and Mohanan (1993) that the triggers of assimilation always include more marked elements (diagnostic (d)). For example, if /t/ requires a preceding consonant to assimilate to it (e.g. /mt/ $\rightarrow$ [nt]), then so will /k/ (i.e. /mk/ $\rightarrow$ [ŋk]). In other words, there is no language in which /t/ triggers assimilation while /k/ does not; in contrast, there are languages in which /k/ triggers assimilation while /t/ does not (e.g. Korean). This asymmetry again provides evidence for relative PoA markedness.

Diagnostic (e) refers to the interaction of prosodic structure with scales. This was the topic of chapters 3 and 4. In chapter 3, for example, it was shown that there are languages in which a more sonorous element attracts stress away from a less sonorous one, but the opposite situation never occurs: there are no languages in which a less sonorous element can attract stress away from a more sonorous one. This typological asymmetry was argued to provide evidence for markedness.

Diagnostic (f) – inventory structure – is of only limited value in determining markedness relations, despite the fact that it is cited most often to support markedness claims. Chapter 6 (esp.§6.3,6.4) shows that almost no implicational relation holds between any pair of PoAs in a segmental inventory. For example, the existence of a labial in an inventory does not guarantee the existence of a coronal and vice-versa. Chapter 6 also argues that the least marked element cannot be eliminated in inventories, so inventories do offer a diagnostic for the least marked element in a scale.

The undergoers and/or output of dissimilation might also be included in Table 5.2, although its status is as yet controversial (Alderete 1997, Ito & Mester 1996a,b cf Suzuki 1998, Fukazawa 1999).

- *Invalid diagnostics*

Diagnostics that do not show markedness relations – at least on the surface – are listed in Table 5.3.

Table 5.3: Markedness diagnostics considered invalid
  (a) Inventory structure
     If *x* is in some segmental inventory and *y* is not, then *y* is more marked than *x*.
     (Jakobson 1941, Trubetzkoy 1939, Greenberg 1966; cf ch.6)
  (b) Neutralization: Undergoers
     If /y/ undergoes neutralization but /x/ does not, then *y* is more marked than *x*.
     (Jakobson 1941, Trubetzkoy 1939; ch.6§6, Cairns 1969)
  (c) Vowel Epenthesis
     If vowel *x* is epenthesized and *y* is not, then *y* is more marked than *x*.
     (Archangeli 1984, 1988, McCarthy & Prince 1994, §3.3.3)
  (d) Assimilation: Undergoers
     If *x* undergoes assimilation and *y* does not, then *y* is more marked than *x*.
     (Kiparsky 1985; Mohanan 1993:63,76; Jun 1995:33,70ff; cf ch.7§7.5)
  (e) Coalescence
     If *x* and *y* coalesce to form *y*, then *y* is more marked than *x*.
     (de Haas 1988, Causley 1999b:ch.5; ch.8§8.4)

As mentioned above, inventory structure (a) provides only a limited diagnostic for markedness. If neither of two elements is the least marked in a scale, either may appear in an inventory without the other. Related to this is the claim of chapter 6§6.3 that almost any PoA can undergo neutralization while other segments do not.

Chapter 4§4.4 has shown that vowel epenthesis – diagnostic (c) – also does not provide a completely valid markedness diagnostic. Any non-round vowel may be epenthetic [ɨ ə i e ɛ a], with the only asymmetry being that round epenthetic vowels are at least extremely rare, and perhaps unattested.

Chapter 7 discusses diagnostic (d). It shows that there are no implicational relations between undergoers of assimilation; if dorsals undergo assimilation, there is no guarantee that coronals and labials will too, and vice-versa (ch.7§7.2).

Diagnostic (e) is discussed in chapter 8§8.4, which shows that both marked and unmarked features can persist in the output of coalescence.

- *Other diagnostics*
  The diagnostics listed in both Table 5.2 and Table 5.3 all relate to synchronic processes. The reliability of diachronic change as providing unambiguous testimony of markedness relations is not clear to me. To give one example, chapter 6 shows that there are synchronic grammars where /k/ neutralizes to [t], but none where /t/ neutralizes to [k]; in contrast, Proto-Eastern-Polynesian *t has been realized as Hawaiian [k] (Clark 1976). It is likely that non-phonological influences reduce diachronic change's reliability as a markedness diagnostic.
  Other diagnostics include frequency (both within and across languages – Greenberg 1966, Schwartz 1979, Paradis & Prunet 1991:10-12), early acquisition (Menn 1983, Stoel-Gammon 1985, Vihman et al. 1986), speech errors (Stemberger & Stoel-Gammon 1991), and behaviour in aphasia (Béland & Favreau 1991). These latter diagnostics relate to

performance mechanisms, while those in the Tables above relate to competence. The following chapters focus on competence diagnostics only.

5.3.3.3 Coronals and glottals: Consonant epenthesis

The idea that coronals are less marked than both labials and dorsals is popular (see Paradis & Prunet 1991, McCarthy & Taub 1992 and references cited in these works for discussion). This section identifies some markedness diagnostics that support this claim. The relative ranking of coronals and glottals is also discussed, as is the proposal the velars are less marked than coronals.

- *Epenthesis: Data*

Epenthetic segments can be divided into two types for PoA. One is where the PoA is copied from a nearby segment. This is the case in glide epenthesis, for example, where the glide is palatal [j] if an adjacent vowel is front, but labial [w] if the vowel is back (e.g. Dakota – Shaw 1980:90). Such cases are treated as arising from PoA assimilation in ch.7.

The other type is where the PoA is not influenced by surrounding segments – 'default' epenthesis. Such cases show the emergence of context-free markedness constraints. For example, the epenthetic consonant in Hare and Bearlake Slave is [h], regardless of the environment (Rice 1989:133). /h/-epenthesis is used to eliminate onsetless syllables: e.g. /icẽ/ → [hicẽ] 'we sing' (cf /t-icẽ/ → [ticẽ] 'we start to sing'); /le-i-wee/ → [lehiwee] 'we cut in two'.

As Table 5.4 shows, epenthetic consonants may take on glottal [ʔ h N] or coronal [t s n l ɹ] PoA. The list builds on Lombardi (1998, p.c.), and on my previous work on epenthesis (Kitto & de Lacy 1999).[91]

Table 5.4: Typology of consonant epenthesis[92]

	Language	Reference
	Chadic	Frajzyngier & Kopo (1989)
	Cupeño	Crowhurst (1994)
ʔ	Larike	Laidig (1992)
	Mohawk	Hale & White Eagle (1980)
	Tigre	Raz (1983)
	Tsishaath Nootka	Stonham (1999)

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[91] I am grateful to Linda Lombardi for discussing PoA in consonant epenthesis with me. For discussion and theoretical proposals relating to PoA markedness and epenthesis, see Lombardi (1995, in prep.).

[92] Epenthetic [l] has been reported for Bristol English (Wells 1982, Gick 1999). However, Bermudez-Otero (2003) shows that this is not truly epenthetic.

t	Axininca Campa	Payne (1981)
	Korean	Kim-Renaud (1986:19)
	Maori	de Lacy (2002a) & references cited therein
	Odawa Ojibwa	Piggott (1993), Lombardi (1998)
h	Ayutla Mixtec	Pankratz & Pike (1967)
	Chipewyan	Li (1946)
	Fox	Bloomfield (1924:220)
	Huariapano	Parker (1994a:100-1, 1998)
	Slave (Bear Lake, Hare)	Rice (1989:133)
	Tigre	Rose (1996)
	Tucanoan (utterance-final C-epenthesis)	Welch & Welch (1967:18)
	Yagua	Payne & Payne (1986:438)
	Yucatec Mayan (utterance-final C-epenthesis)	Straight (1976:71)
N	Uradhi	Hale (1973), Crowley (1983), Trigo (1988:57ff), cf Paradis & Prunet (1990a)
	Kaingang	Yip (1992) [cit Lombardi 1998:14]
n	Fula language game	Bagemihl (1989), Lombardi (1998)
	Gokana	Hyman (1982, 1985), Lombardi (1998)
	Korean	Hong (1997)
	Murut	Prentice (1971:113)[93]
	Tunica	Haas (1946), Lombardi (1998)
ɹ	Anejom̃	Lynch (2000:29)
	Boston English	McCarthy (1993)
	Japanese	Mester & Ito (1989), Lombardi (1998)
	Southern Tati	Yar Shater (1969)

[ʔ] is the most common epenthetic element; only a few representative cases are listed above.

The most common site of epenthesis is in onsets. Fox provides an example of onset [h]-epenthesis: /mana icawiwa/ → [mana hichawiwa] (Bloomfield 1937:220); Slave presents a further case (Rice 1989:130ff).

Epenthetic consonants can also appear in codas. For example, Ayutla Mixtec requires the PrWd-initial syllable to be bimoraic (i.e. CVC) (Pankratz & Pike 1967). Usually this is achieved by geminating the following consonant: [tos.so] 'a floral arch', [tim.maʔ] 'candle', [cel.le] 'scissors', [naj.jaʔ] 'a dog'. However, coda stops are banned, so /h/ is inserted into stressed syllable codas instead of geminating them: [tuh.tʲa] 'atole', *[tut.tʲa], [ʃah.kuʔ] 'a few', [kah.tʃi] 'cotton'. Parker's (1994a, 1998) analysis of Huariapano provides an example of metrically conditioned [h] epenthesis in codas.

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[93] Only in a very restricted environment: mainly in the environment /a:+V/, but also at other V+V junctures.

Uradhi dialects provide a case of epenthetic [N] (Trigo 1988:57ff, Hale 1973, Crowley 1983). All Uradhi utterances end in a consonant (a condition implemented by a version of FINAL-C – McCarthy & Prince 1994§5). This condition is met by insertion of [N] after vowel-final words: e.g. [iwi-N] 'morning bird', [juku-N] 'tree'. Words can also end in a coronal nasal; in such a case, the coronal remains unchanged: [nani-mun] 'ground-ablative' (p.325). For further discussion, see Trigo (1988).[94]

Of the epenthetic consonants, [n N l] seem to be acceptable epenthetic codas. Epenthetic onsets are typically [ʔ t h] or a homorganic glide [j w] and perhaps [ɹ].

There are also languages that assign epenthetic consonants their PoA through assimilation in some environments, and a default PoA in others. For example, a number of languages epenthesize glides next to high vowels, but [ʔ] elsewhere: Dutch (Booij 1995:191), Tamil (Wiltshire 1988), Kalinya (Rosenthall 1994:180), Malay (Cohn 1989, Cohn & McCarthy 1994).

In contrast, no language inserts an epenthetic labial [p f m] or dorsal [k x ŋ] (for discussion, see ch.6§6.6) (unless some independent process – like assimilation – interferes).[95]

• *A note on glides*

Glides present a rather special case in relation to epenthesis. The 'commonly accepted' glides are [j w ɥ] and (probably) [h] (Chomsky & Halle 1968); [ɹ] might also be considered a glide, but more controversially. The interesting fact about the set [h j w ɥ] is that there is no 'pure' coronal glide; the closest is the palatal [j]. Chapters 7 and 8 will show that palatality is marked, with the effect that an epenthetic [j] may be ruled out by means of a ban on palatal segments. If the constraint against palatals is ranked high enough *and* the glottal [h] is also avoided, the most unmarked PoA for glides left is labial. In short, the present system predicts that there could be languages with an epenthetic [w], if that language avoids palatals and glottals. Parker (1989) shows that this is precisely the case for Chamicuro. However, it is important to emphasize that glides are a special case – they are special because they essential lack an dental/alveolar element; in essence, this means that the labial [w] can be 'promoted' in unmarkedness. The existence of dental/alveolars of all other manners of articulation means that the same thing cannot happen for other manners of articulation – [p], [f], and [m] can never be epenthetic.

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[94] Paradis & Prunet (1990a:12) propose that the epenthetic segment is simply a floating [+nasal] feature that acquires dorsality from the preceding vowel. More recent views of vowel features do not consider all vowels to be [dorsal], so this approach is put aside here. Having said this, Uradhi offers some interesting further complexities. Final nasals – both underlying and epenthetic – can be optionally denasalized if the preceding consonant is oral. The result is [ʔ] or [k], depending on the dialect. This complication is left for future research.

[95] Trigo (1988:57ff) argues that Uradhi has epenthetic [N], not [ŋ], though the phonetic realization is the same.

• *Epenthesis: theoretical implications*

This asymmetry in epenthesis shows that coronals and glottals are less marked than dorsals and labials. In more technical terms, this asymmetry shows that (i) there is a markedness constraint or constraints that favour coronals and glottals over dorsals and labials, and (ii) that there is no markedness constraint that favours dorsals and/or labials over glottals and/or coronals. If a constraint 'favours *x* over *y*', it assigns fewer violations to *x* than to *y*.

To explain this point, faithfulness constraints do not apply to epenthetic segments.[96] Therefore, the featural content of epenthetic segments is entirely determined by markedness constraints (Smolensky 1993:5). Since epenthetic elements emerge as coronals and glottals and not labials or dorsals, there must therefore be markedness constraints that favour the former pair over the latter pair (i.e. *{K} and *{KP} in the present theory). Moreover, since epenthetic elements are never labials or dorsals, it must be the case that no markedness constraint favours them over glottals and coronals. If there were a constraint *{Tʔ}, for example, and it outranked all anti-{KP} constraints, epenthetic elements could be dorsal or labial.

Lombardi (1998) observes that inventories without glottals show that there cannot be a markedness constraint that favours dorsals and labials above coronals (i.e. *{T}). In all such cases, the epenthetic consonant is coronal: e.g. Maori (Bauer 1993, de Lacy 2002a), Axininca Campa (Payne 1981). For example, Axininca Campa inserts [t] to eliminate onsetless syllables; it has the stops [k p t] (Payne 1981:59)

(27)   <u>Axininca Campa [t]-epenthesis</u> (Payne 1981:108ff)
/i+N+koma+i/ →   [iNkoma<u>t</u>i]   'he will paddle'
/i+N+koma+aa+i/→   [iNkoma<u>t</u>aa<u>t</u>i] 'he will paddle again'
/i+N+koma+ako+i/→ [iNkoma<u>t</u>ako<u>t</u>i] 'he will paddle for'
/i+N+koma+ako+aa+i+ro/ → [iNkoma<u>t</u>ako<u>t</u>aa<u>t</u>iro] 'he will paddle for it again'
cf /i+N+tʃik+i/   → [iNtʃiki] 'he will cut', *[iNtʃik<u>t</u>i]
   /no+na+ak+i+ro/   → [nona<u>t</u>akiro] 'I have carried it', *[nona<u>t</u>ak<u>t</u>iro]

If there were a constraint *{T}, a system could easily be constructed whereby labials or dorsals would be epenthetic. For example, if glottals were eliminated and *{T} outranked all other markedness constraints, a system with [k p t] would have epenthetic [p]:

(28)   <u>No *{T}</u>

/a/	*{T}	*{K}	*{KP}
(a) ta	*!		
☞ (b) pa			*
(c) ka		*!	*

In short, epenthesis shows that there can be no constraint that favours dorsals and labials over coronals.[97]

- *Coronals vs Glottals*

The epenthetic element can be (and usually is) glottal even when a coronal is available (Lombardi 1998). Therefore, some markedness constraint must favour glottals over coronals. On the other hand, the markedness constraint cannot favour dorsals and labials over coronals, as established above. The present theory's *{KPT} satisfies both these requirements. The existence of this constraint relies on the proposal that coronals are more marked than glottals.

Certainly, glottals may be banned from inventories, indicating that some markedness constraint favours coronals over glottals; ch.6§5.2 discusses this issue in detail.

- *Other diagnostics*

Other diagnostics apart from epenthesis support the proposal that glottals and coronals are less marked than dorsals and labials.

In ch.6§6.6, the output of neutralization is shown to always be glottals or coronals, never labials or dorsals. It is also shown that the featural content of the output of neutralization is determined (almost) solely by markedness constraints. Hence, direction of neutralization shows the structure of markedness constraints (just like epenthesis).

Ch.6§6.4.2 discusses asymmetries in deletion. Cases where only dorsals and labials are deleted (e.g. Lardil, Nunggubuyu) are argued to show the need for markedness constraints that favour coronals and glottals over the other PoAs. The lack of cases where coronals delete but labials and dorsals survive is argued to show that there are no constraints that ban coronals without also banning labials and dorsals.

As a final note, since subsegmental scales (i.e. not sonority or tone) do not affect prosodic structure (ch.3§3.5.2.2), prosodification provides no evidence for featural scales.

- *Velar unmarkedness*

This discussion concludes with a brief consideration of two counter-proposals for markedness, both involving velar as less marked than coronals.

Trigo (1988) proposes that coronals are least marked in onset position, but dorsals are least marked in coda position.

Rice & Causley (1998) and Rice (2000a,b) propose that – in effect – there are two scales relevant to PoA. One relates to structural complexity: on this scale, velars are less marked than coronals, labials, and other dorsals.[98] However, PoAs can also be evaluated

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[97] This discounts fixed rankings. If fixed ranking was allowed, *{T} would have to be universally outranked by constraints that favoured coronals over dorsals and glottals. Some languages epenthesize [ʔ] even when it is otherwise banned in the language (e.g. German, English). The present constraints provide no particular insight into these cases, so they will not be discussed further here.

[98] Rice & Causley (1998) propose that glottals consist of a bare root node while velars consist of a root node and a Place node, but no place features. In contrast, coronals, labials, and non-velar dorsals have more complex structure: root nodes, Place nodes, and place features.

in terms of structural completeness, in which case coronals, labials, and non-velar dorsals are less marked than both velars and glottals. In effect, then, there are two scales, one in which coronals are less marked than velars, and another in which velars are less marked than coronals.

Both proposals make predictions about the output of epenthesis and neutralization. For epenthesis, they predict that [k] could be an epenthetic consonant, as could [x]. Cases that seem to have epenthetic velars are discussed in ch.6§6.6.2; for all of these (very few) cases, the 'epenthetic' velar is argued to really be a morpheme.

Ch.6§6.6.1 shows that there are no cases where segments neutralize to velars. Thus, there is no case where stops neutralize to [k], or fricatives to [x]; languages with nasal neutralization to [ŋ] are argued to instead involve neutralization to [N]. In contrast, a number of languages neutralize stop PoA distinctions to coronals.

Other arguments for velar unmarkedness will be shown to rely on unreliable diagnostics. For example, Trigo (1988:84ff) argues that assimilation provides evidence for velar unmarkedness: in some languages, only velars undergo assimilation, while in others only velars trigger it. Chapter 7 shows that the typology of undergoers in assimilation provides no support for relative markedness.

Trigo (1988:90ff) also cites evidence from transparency to vowel feature spreading. In Chinook, only the velars [k k' g x], uvulars [q q' ɢ χ] and glottal [ʔ] are transparent to rounding harmony: e.g. /u-k'asks/ → [uk'usks] 'girl' (cf [i-k'asks] 'boy') , [u-qunakʃ] 'large boulder' (cf [i-qanakʃ] 'stone'); cf [t-pawilʔ-ma] 'bunches of grass', [u-lata-is] 'flounder'. Trigo proposes that the ability of dorsals to allow spreading indicates that they lack any place features. Paradis & Prunet (1994) provide an alternative account, based on the proposal that feature spreading is strictly local (also see Gafos 1996). Consequently, [+round] can only spread through consonants that can bear a [+round] feature. It just so happens that only velars and uvulars can bear such a secondary articulation: [pʷ tʷ] are not allowed in the language.

Paradis & Prunet provide an interesting array of cross-linguistic support for their proposal. They adduce a minimally contrasting case from Inor: this language allows labialized labials and velars, and consequently allows rounding harmony to spread through both types, but not coronals. Given the Inor facts, if transparency truly indicated lack of PoA features, one would have to argue that both labials and velars are featureless in Inor.

In short, there is no solid evidence that velars can be less marked than coronals in any grammar. Further discussion of this point is provided in ch.6§6.6.3.1.

5.3.3.4 Dorsals vs labials

This section discusses evidence for the relative markedness of dorsals and labials.

There is very little agreement over the relative markedness of dorsals and labials; some authors have labials as the more marked of the pair (e.g. Prince 1997, Hamilton 1997), others have dorsals as more marked than labials (Mohanan 1993, Lombardi 1998, Bernhardt & Stemberger 1998:172), and yet others have no ranking between the two (e.g. Jun 1995). Few of the authors offer diagnostics for the rankings (cf Hamilton 1997 – inventories in Australian languages; Mohanan 1993:75-6 – assimilation triggers).

Very few of the markedness diagnostics are applicable to the ranking between labials and dorsals. For example, since either a coronal or glottal is always available in an inventory, neutralization will never reduce PoA contrasts to labials or dorsals. Likewise, epenthesis will never produce a labial or dorsal since coronals and glottals are universally less marked.

Of all the diagnostics, only two remain: deletion and direction of neutralization. In Siuslawan codas, [k] deletes but [p] does not (Frachtenberg 1922; ch.6§4.2.2). This indicates that some markedness constraint that bans [k] but not [p] outranks MAX, the anti-deletion constraint (McCarthy & Prince 1995). Moreover, no markedness constraint that assigns a violation to [p] can outrank MAX in this grammar. The existence of a markedness constraint that targets dorsals alone – i.e. *{K} – indicates that dorsals and labials are distinct on some scale.

Siuslawan deletion does not show that dorsals are necessarily more marked than labials. It could be that dorsals and labials are not ranked with respect to each other (e.g. Smolensky 1993, Rice 2000a, Jun 1995, Cho 1999).

However, there is an absence of typological evidence that labials are ever deleted while dorsals remain.[99] Therefore, I have as yet found no need for a markedness constraint that bans labials without banning dorsals. If it is always true that labials cannot delete without dorsals also deleting, then all markedness constraints that assign a violation to labials must also assign one to dorsals, just as *{KP} does.

Evidence for the | dorsal 〉 labial | ranking also comes from triggers of assimilation. Chapter 7:§6 discusses this issue, showing that dorsals can trigger place assimilation while labials do not (also Mohanan 1993:75-6). For example, labials assimilate to a following dorsal in Korean, but dorsals do not assimilate to a following labial (see ch.7§6.2.2 for other examples). Chapter 7 provides arguments that this asymmetry follows from the greater markedness of dorsals: more marked elements may force assimilation while less marked elements do not. In contrast, I found no cases where labials forced assimilation while dorsals did not.[100] This indicates that labials are never more marked than dorsals under any ranking. This fact can only follow if there is no markedness constraint *{P}, banning labials but not dorsals.

The lack of *{P} can be explained if dorsals are universally more marked than labials. Since markedness constraints must mention the most marked member of a scale, any constraint that mentions labials must therefore also mention dorsals: i.e. *{KP}.

To conclude, although there is evidence that dorsals are more marked than labials, it is less robust than evidence that coronals and glottals are less marked than labials and dorsals. Accordingly, the theoretical proposals presented in the following chapters never rely on the relative markedness of dorsals and labials. In almost all cases, the argument would follow if labials were more marked than dorsals, or they had the same ranking on the PoA scale. The few cases where the ranking is relevant will be identified when they arise.

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[99] There are languages with dorsals but no labials. However, this does not indicate that input labials delete in such cases – they may neutralize, as shown in chapter 6.
[100] The case of Received Pronunciation English with assimilation of /n/ to labials but not dorsals is discussed in ch.7§7.5.4.

5.4   Summary

The aim of this chapter was to introduce the scale-referring faithfulness constraints used in the following chapters. The constraints have two important properties: (i) they preserve more marked elements over less marked ones, and (ii) they are stringently formulated. Arguments for the necessity of these two properties are presented in the following chapters.

A secondary aim of this chapter was to provide an implementation of the PoA scale in terms of constraints. Evidence for the form | dorsal 〉 labial 〉 coronal 〉 glottal | was provided; further evidence is supplied in the following chapters where relevant.

CHAPTER 6

FAITHFULNESS TO THE MARKED I:

NEUTRALIZATION

6.1   Introduction
        This chapter is the first of two to argue for the proposal that marked elements are subject to greater preservation than less marked ones. This informal statement is formally expressed for the Major Place of Articulation scale | dorsal (K) 〉 labial (P) 〉 coronal (T) 〉 glottal (ʔ) | by the marked-faithfulness constraints in (1).

(1)   <u>Major Place of Articulation marked-faithfulness constraints</u>
        • *x* corresponds to *x*'
        IDENT{K}   If *x* is dorsal, then *x*' has the same PoA as *x*.
        IDENT{KP}   If *x* is dorsal or labial, then *x*' has the same PoA as *x*.
        IDENT{KPT}   If *x* is dorsal, labial, or coronal, then *x*' has the same PoA as *x*.
        IDENT{KPTʔ} If *x* has any PoA, then *x*' has the same PoA as *x*.

        For the remainder of this chapter, all IDENT constraints will refer to the Input→Output dimension unless otherwise stated. So, IO-IDENT will be abbreviated to IDENT. For discussion of the relevance of dimension to IDENT constraints, see ch.7§7.7.4.
        As explained in chapter 5, the form of the constraints ensures that faithfulness to unmarked elements never overrides faithfulness of marked elements. For example, every faithfulness constraint that preserves coronals also preserves the more marked labial and dorsal elements (i.e. IDENT{KPT}, IDENT{KPTʔ}). The result is that there is no way to single out unmarked elements for special faithfulness; in contrast it is possible for marked elements to be preserved faithfully while less marked elements are not.
        As an example, IDENT{KP} requires both dorsals and labials to be faithfully preserved. So, any unfaithful mapping from /k/ will incur a violation, as will any unfaithful mapping from /p/. However, IDENT{KP} incurs no violations for unfaithful mappings from /t/ or /ʔ/.
        As a reminder, the 'marked preservation' aspect of the faithfulness constraints in (1) is quite separate from the fact that they are stringently formulated (i.e. refer to ranges of a scale). As discussed in ch.5§5.1, the 'unmarked-faithfulness' constraints IDENT{T}, IDENT{TP}, and IDENT{TPK} are also stringently formulated but cannot preserve marked elements without also preserving unmarked ones. In contrast, the set of non-stringent constraints in a fixed ranking || IDENT{K} » IDENT{P} » IDENT{T} » IDENT{ʔ} || encodes the 'marked preservation' property by having faithfulness constraints to marked elements

universally outrank all faithfulness constraints to less marked elements (Jun 1995, Kiparsky 1994).

This chapter and the next argue solely for the point that faithfulness constraints must have the 'marked preservation' property; they do *not* present arguments that faithfulness constraints must be stringently formulated. Accordingly, the arguments presented in this chapter support all theories with the 'marked preservation' property, including the stringent approach in (1) and the fixed ranking theory outlined in the preceding paragraph. The need for stringent form is discussed in chapter 8.

- *Neutralization*

The empirical focus of this chapter is neutralization. The term 'neutralization' is used here to refer only to structurally conditioned non-assimilative and non-dissimilative neutralization, to use Trubetzkoy's (1939:233ff) terminology. This includes processes that change the featural content of a segment in a certain structural position (or in all structural positions), but do not refer to adjacent segments. For example, in Slave all stops and fricatives are neutralized to [h] in coda position regardless of which segments precede or follow (Rice 1989) – this counts as neutralization here. In contrast, /ŋ/ changes to [m] in Chukchi codas, but only before a labial consonant (ch.7§7.4.3.1, Bogoras 1922, Krause 1980); although this is a type of neutralization, it is assimilative and therefore not the focus of this chapter (see ch.7). As a note on terminology, the phrase "/α/ neutralizes to /β/" will be used to mean that /α/ and /β/ neutralize, producing [β]. Thus, Slave's coda /k/ neutralizes to [h].

This chapter will discuss (i) neutralization of PoA distinctions in syllable codas and (ii) absolute PoA neutralization. The latter refers to the situation where certain segments are banned in all environments.

- *Gapped inventories*

Evidence for marked-faithfulness constraints comes from languages that have inventories that contain highly marked elements but lack less marked ones. The term 'inventory' is used here to refer to the surface segments found in a language; it may be further modified by a prosodic position, such as 'coda inventory', being those segments that can appear in syllable codas in a language. The particular type of inventory of interest here is exemplified by Yamphu (Rutgers 1998). This Nepalese language has the stops [k p t ʔ] in onset position. In codas, though, only [k p ʔ] appear; /t/ is neutralized to [ʔ].

A selection of relevant data is provided in (2); this case is discussed in more detail in §6.3. Yamphu has intervocalic voicing of singleton stops (e.g. [hæd-u-ŋ], *[hæt-u-ŋ]).

(2)   Yamphu coda PoA neutralization (in brief)
       (a) /t/→[ʔ]
              [namːiʔ]   'daughter-in-law' cf [namːid-æʔ] {instrumental, ergative}
              [tʰeʔ-nimːa]   'we lifted you'   cf [tʰed-u-ŋ] 'I lifted you'
              [siʔ-ma]   'to hit'   cf [sitː-a] 'hit+past', [sitː-iŋ] 'hit+exp.'
       (b) /p/→[p]
              [kʰap]   'language'
              [kep-ma]   'stick + infinitive'
       (c) /k/→[k]
              [æʔlik]   'bendy'
              [kʰaːk-pa]   'scrape one's throat + perform act'
              [kʰaːk-ma]   'scrape one's throat + infinitive'
       (d) /ʔ/→[ʔ]
              [asiʔ]   'previously' (cf [asi.ʔ-em-ba] 'before')
              [jiːw-æʔ-mu]   'river-possessive-down' (cf [kaniŋ-æʔæ] 'we-poss.')

       In the Prague School conception of markedness (Jakobson 1941, Trubetzkoy 1939),
Yamphu coda neutralization is surprising, to say the least. Yamphu eliminates a very
unmarked element in codas – the coronal /t/ – but leaves the highly marked elements /k/
and /p/ untouched. On the surface, this seems to be directly contrary to the spirit of
markedness theory.
       The proposal that marked elements may excite great preservation provides an
explanation for Yamphu. /k/ and /p/ escape the PoA neutralization process because they
are highly marked, and so are the subject of greater preservation than the less marked
element /t/.
       In formal terms, the key constraint is IDENT{KP}, which preserves input dorsals
and labials in the output but not coronals. IDENT{KP} outranks all constraints that promote
elimination of dorsals and labials: i.e. *{KP} and *{KPT}.

(3)

	/ap/	IDENT{KP}	*{KP}	*{KPT}
☞	(a) ap		*	*
	(b) aʔ	*!		

       Tableau (3) shows how IDENT{KP} blocks neutralization of /p/ to [ʔ]. In contrast,
IDENT{KP} does not prevent /t/ from neutralizing.
       If all faithfulness constraints that preserve coronals (IDENT{KPT}, IDENT{KPTʔ})
are ranked below the constraints that ban coronals (*{KPT}) the result will be that /t/ is
debuccalized, as shown in tableau (4).

(4)

/at/	*{KPT}	IDENT{KPT}	IDENT{KPT?}
(a) at	*!		
☞ (b) a?		*	*

Tableau (5) puts the two rankings together (ignoring IDENT{KPT?} and *{KP} for brevity). The input to tableau (5) is /sok+sæt/ 'squeeze+pull', producing [sok-sæ?].

(5)   Marked preservation and unmarked neutralization

/sok+sæt/	IDENT{KP}	*{KPT}	IDENT{KPT}
(a) soksæt		* *!	
☞ (b) soksæ?		*	*
(c) so?sæ?	*!		* *
(d) so?sæt	*!	*	*

As a side note, debuccalization is blocked in onsets by positional faithfulness constraints (Beckman 1998, Lombardi 1995, 1999).

The inventory of coda consonants in Yamphu is 'gapped', a term from Prince (1997c, 1998). While Yamphu has the marked elements [k p] and the highly unmarked [?] in codas, its inventory lacks the 'intermediately' marked [t]; in other words, [t] is a gap in an otherwise contiguous range of the PoA scale. This chapter shows that faithfulness constraints that preserve only marked elements are essential in accounting for gapped inventories.[100]   Prince (1998) has also shown that this type of constraint can produce gapped inventories.

This chapter also shows that – contrary to previous claims – every type of gapped inventory exists for every manner of articulation. As a brief example, Table 6.1 lists coda inventories of voiceless stops. As shown, every type of gapped inventory – one that lacks a less marked element but contains a more marked one – is attested. A ✓ indicates that the stop is present in the coda of the language cited, while a blank square means that the stop is banned.

Table 6.1: Gapped voiceless stop inventories

k	p	t	?	*Coda Inventory*
✓	✓		✓	Cockney English, Yamphu
✓		✓	✓	Nambiquara
	✓		✓	Nganasan
✓			✓	Fuzhou
✓		✓		Mordvin

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[100]   To underscore the point that gapped inventories support the 'marked preservation' proposal and not the proposal that faithfulness constraints are stringently formulated, the ranking ‖ IDENT{K} » IDENT{P} » *{KP}, *{KPT} » IDENT{T} ‖ with non-stringent faithfulness constraints can also produce the Yamphu system (also see Prince 1999).

The same point can be (and is) made for onset inventories. For example, Hawaiian only allows [k p ʔ] in onsets (Pukui & Elbert 1979, 1986). These languages are discussed in detail in §6.3.

- *Harmonically complete inventories*

    The marked-faithfulness constraints are not limited to producing gapped inventories: they can also produce 'harmonically complete' ones, a term from Prince & Smolensky (1993:ch.9). A harmonically complete inventory consists of a contiguous range of a scale, starting with the least marked element. For PoA, harmonically complete inventories of voiceless stops are [ʔ], [t ʔ], [p t ʔ], [k p t ʔ].

    Section 6.2 shows how the marked-faithfulness constraints produce harmonically complete inventories.

- *Disharmonic inventories*

    In contrast, the theory does not allow inventories that lack the least marked element, called 'disharmonic' here. For example, there is no inventory consisting of [k p] alone.

    The reason for the lack of this inventory is what Moreton (1999) dubs 'Harmonic Ascent'. In Optimality Theory, deviation from the faithful candidate can only occur if an alternative is less marked. So, /k/→[t] is a possible neutralization because some markedness constraint favours [t] over [k] (i.e. *{K}). However, /t/→[k] is impossible as a neutralization because there is no markedness constraint that favours [k] over [t]: every markedness constraint that assigns a violation [t] also assigns it to [k] (i.e. *{KPT}).

    Section 6.4 develops this proposal in detail. Importantly, it shows that it only holds true if IDENT constraints are the only type allowed for features. Constraints like MAX-F can produce disharmonic inventories.

    In short, the least marked element can never be eliminated from an inventory. The typological consequences of this claim are explored in §6.4, as well as the influence of other scales, accounting for the elimination of glottals in a number of languages.

- *Interaction with Other Scales & Processes*

    While the results outlined above are true of PoA neutralization alone, surface inventories can be influenced by other constraints. For example, Abau has a disharmonic voiceless stop inventory of [k p] in medial onsets. The lack of [t] is due to a lenition process that turns /t/ into the flap [ɾ]. In this case, the existence of a surface disharmonic inventory is not due to the PoA constraints, but to the influence of other intersecting constraints.

    Section 6.5 identifies a number of processes that have a usually transparent effect of producing disharmonic inventories. Moreover, the marked-faithfulness constraints will be shown to be crucial in explaining why segments with marked PoAs can be prevented from undergoing such processes.

    One important non-PoA influence that will be introduced from the beginning is the behavior of the glottals [ʔ h N]. Section 5 presents a variety of evidence to show that glottals are highly sonorous. This fact makes them undesirable syllable margins (see

ch.3,4). Thus, a ban on high-sonority margins may eliminate glottals without affecting other PoAs. As with Abau's flapping process, the result is a disharmonic inventory.

- *Neutralization Target*

The final issue discussed in this chapter relates to the marked-faithfulness constraints' influence on the output target of neutralization: e.g. whether /k/ neutralizes to [p], [t], or [ʔ]. This section shows that it is crucial that the faithfulness constraints have no influence on the output target. For example, no marked-faithfulness constraints favours neutralization to [p] over neutralization to [ʔ] and [t]; if it did the unattested /k/→[p] neutralization could take place. This result follows from the fact that the faithfulness constraints assign equal violations to all unfaithful mappings. Its empirical effect is that a segment will always neutralize to the least marked PoA available.

The form of the marked-faithfulness constraints means that markedness constraints are forced to make the crucial determination as to the target of neutralization: they force neutralization to the least marked PoA available. Neutralization targets are discussed in §6.6.

- *Implications for markedness*

This chapter has implications for the concept of 'markedness'. As observed by Prince (1998), previous theories of markedness have "programmatically assumed that something like harmonic completeness is true of every language." Given the existence of gapping, inventories can no longer be seen to provide clear evidence about markedness relations in scales. To be more concrete, the fact that [k] exists in Hawaiian but not [t] does not imply that [k] is less marked than [t] in any grammar. In short, this chapter all but eliminates inventory structure as a diagnostic for markedness.

The one exception relates to the least marked element. The present theory predicts that the least marked element of scale S can never be eliminated by S-referring constraints. This point is discussed in detail in §6.4.

In contrast, this chapter affirms direction of neutralization and epenthesis as reliable diagnostics for markedness (§6.6). Both direction of neutralization and epenthesis are free from the influence of faithfulness constraints, so they provide insight into the form of markedness constraints.

- *Organization*

The organization of the rest of this chapter is as follows.

Section 2 discusses harmonically complete inventories – those that contain a contiguous section of the PoA scale, starting with the least marked element. The ranking needed to produce such theories is identified, along with typological evidence for the existence of the full range of such inventories.

Section 3 deals with gapped inventories – those that contain highly marked elements and the least marked element, but lack segments of intermediate markedness. This section identifies a number of gapped inventories, and identifies the ranking responsible for producing them.

Section 4 discusses disharmonic inventories – those that lack the least marked element – and why they are banned in the present theory.

Section 5 also deals with disharmonic inventories, and shows how they can arise through the interaction of other scales and processes with the PoA constraints.

The topic of section 6 is direction of neutralization. This section discusses the fact that neutralization always results in the least marked scale element, and how the form of the faithfulness constraints contributes to this result.

Section 7 provides a summary.

Many of the results presented in this chapter refer to a typological survey of coda and onset inventories. The results of this survey are presented in Appendix A. Moreover, references for languages mentioned in passing will not be given in the text for the sake of brevity but in Appendix B.

6.2 Harmonically complete inventories

Gapped inventories are the focus of this chapter since they provide evidence that marked-faithfulness constraints are necessary. However, to be able to discuss gapping fruitfully, harmonically complete inventories must be examined first.

On the descriptive side, this section aims to establish typological facts about harmonically complete inventories. On the theoretical side, the aim is to identify the ranking responsible for harmonically complete inventories using the marked-faithfulness constraints. The general ranking needed to produce neutralization is also identified.

Harmonically complete inventories do not provide direct evidence for the form of the marked-faithfulness constraints; however, showing how the marked-faithfulness constraints produce them is a necessary step towards the analysis of Gapped inventories.

The term 'Harmonically Complete' comes from Prince & Smolensky (1993:187).

(6)   Harmonic completeness
        "Harmonic completeness means that when a language admits forms that are marked
        along some dimension, it will also admit all the forms that are less marked along
        that dimension." (Prince & Smolensky 1993:187)

A harmonically complete inventory in terms of PoA is one that contains a contiguous range of the scale starting with the least marked element. At one extreme, [ʔ] is a harmonically complete voiceless stop inventory; it is found as the result of coda PoA neutralization in many languages (e.g. Kalantan Malay, Kashaya). At the other extreme, [k p t ʔ] is the fullest harmonically complete inventory; the others are [p t ʔ] and [t ʔ]. Section 6.2.1 describes the range of attested harmonically complete inventories.

Section 6.2.2 identifies the ranking needed for harmonically complete inventories. Harmonic completeness is discussed in detail in Prince & Smolensky (1993:ch.9), Smolensky (1993), and Prince (1998). The proposals in this section owe much to this previous work, but differ in that marked-faithfulness constraints are employed here.

Section 6.2.3 summarizes the results of this section. It also identifies the general ranking needed to ensure neutralization of /α/ to [β].

6.2.1 Description

This section presents evidence that harmonically complete inventories exist for all places of articulation, for both coda inventories and onset inventories. Moreover, two types of harmonically complete inventory are identified. One type is purely the product of the PoA markedness constraints; the other type takes into account the influence of an independent process – Glottal Elimination.

- *Standard harmonically complete Inventories*

With the PoA scale | dorsal 〉 labial 〉 coronal 〉 glottal |, and no other interfering factors, there are four harmonically complete inventories. Table 6.2 lists examples of each type of harmonically complete voiceless stop inventory; table 6.3 does the same for voiceless fricatives. For the sake of brevity, only one language is cited for each system (see Appendix A for other manners of articulation and further examples).

The languages listed under 'coda inventory' have the contrasts indicated in codas; in onsets they have a fuller range of contrasts (see Appendix A for details). The languages listed under 'onset inventory' have the range of contrasts indicated in onsets in all positions. References for languages cited are given in Appendix B.

Table 6.2: Harmonically complete inventories I: Voiceless stops

k	p	t	ʔ	Coda Inventory	Onset Inventory
			✓	Kashaya	Nancowry and Tübatulabal reduplicants
		✓	✓	Chickasaw	Harar Oromo (plain stops)[101]
	✓	✓	✓	Standard Malay	Tahitian
✓	✓	✓	✓	Pendau	Tongan

Table 6.3: Harmonically complete inventories II: Voiceless fricatives

x	f	s	h	Coda Inventory	Onset Inventory
			✓	Fox	Rapanui
		✓	✓	Chipewyan	Sikaiana
	✓	✓	✓	Maltese	Yanomam
✓	✓	✓	✓	Egyptian Arabic	Harar Oromo

As an example, Kashaya has the inventory of plain voiceless stops [k p t ʔ] in onsets, but neutralizes this to just [ʔ] in codas (Buckley 1994:99). Almost at the other end

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[101] Harar Oromo has three series of stops: plain voiceless, voiced, and voiceless glottalized (Owens 1985:10). Of the plain voiceless stops, there are only the coronals [t] and [ʔ]. [k] only appears as a geminate. The other stop series have more PoAs: [b d dʒ g], [p' t' tʃ' k'].

of the harmonically complete inventory type, Tahitian has an onset inventory of [p t ʔ], lacking [k].

I have been unable to find a language that has [ʔ] as the only voiceless stop in onsets. I suggest this typological gap exists for functional reasons: voiceless stops tend to be used a great deal in lexical items, so several contrasts are called for; therefore the lack of an onset inventory with only a [ʔ] is not a concern from a competence point of view. However, onset inventories can be reduced to just [ʔ] in certain environments, such as in reduplicants (see §6.2.2.2, Alderete et al. 1999).

In contrast, there is no such restriction on voiceless fricatives: a number of Polynesian languages only allow [h] in onsets (e.g. Rapanui (Easter Island); see Clark 1976 for a survey).

- *Glottal Elimination*

The systems just mentioned do not exhaust the list of harmonically complete PoA inventories. Several independent processes can interfere with the output of neutralization, one of the most significant being 'Glottal Elimination': the fact that glottals [ʔ h] are banned from onset and/or coda inventories in some languages. For example, onsets in Maori can contain the voiceless stops [k p t], but no [ʔ] (Bauer 1993); for voiceless fricatives, Apatani codas allow [s] but no [h] (onsets allow [x s h]).

Section 6.5.2 argues that Glottal Elimination has nothing to do with place neutralization: it is driven by entirely different markedness constraints. In that section, glottals are argued to be more sonorous than segments with different PoA, so a ban on highly sonorous syllable margins (see ch.3) can effectively eliminate glottals from an inventory. For a discussion of the full typological effects of Glottal Elimination, see §6.5.2. For the moment, the notion of Glottal Elimination will be adopted without further comment.

The effect of Glottal Elimination is to promote coronals to least marked status: if there is no glottal, then there is no lesser-marked PoA than coronal. So, languages with Glottal Elimination provide a further three types of harmonically complete inventory, listed in tables 6.4 and 6.5. The tables again list voiceless stop and voiceless fricative inventories.

Table 6.4: Voiceless stop inventories with Glottal Elimination

K   P   T   ʔ

k	p	t	ʔ	Coda Inventory	Onset Inventory
		✓		Uradhi	-
	✓	✓		Formal Kiowa	Vanimo
✓	✓	✓		New Zealand English	Maori

Table 6.5: Voiceless fricative inventories with Glottal Elimination

				K	P	T	?		
x	f	s	h	*Coda Inventory*				*Onset Inventory*	
		✓		Apatani				Fore	
	✓	✓		English				East Futuna	
✓	✓	✓		Seri				Mordvin (Erzya)	

At this point, one may wonder whether 'glottal' is actually a highly marked PoA, and its high markedness accounts for Glottal Elimination. There are two pieces of evidence for glottal's low markedness. One is that epenthesis and direction of neutralization show that glottals are less marked than dorsals, labials, and coronals in terms of PoA. The other is that inventories are of almost no use in determining PoA markedness: for every PoA, there is some language that lacks that PoA (see §3). For discussion of the proposal that glottals lack (Place) features, see §6.5.2. Therefore, the following discussion proceeds on the idea that Glottal Elimination is independent of place neutralization.

- *Voiced Fricatives and Voiced Stops*
       Voiced Stops (and voiced fricatives) are distinct from voiceless stops, voiceless fricatives, and nasals in that they have no glottal counterpart.[102] Because of this, coronal is predicted to be the least marked PoA for voiced stops and fricatives. The harmonically complete inventory types for voiced stops and fricatives are therefore just three: (i) [d], [b d], [g b d] for voiced stops and (ii) [z], [v z], [ɣ v z] for voiced fricatives. Neutralizations involving voiced stops and voiced fricatives will not be discussed in any detail in the following sections because overt PoA neutralizations involving them (i.e. those with alternations) are so few: usually coda voiced stops and voiced fricatives are eliminated by voice neutralization. See Appendix A for typological generalizations.

6.2.2 Ranking
       The aim of this section is to identify the ranking needed to produce harmonically complete inventories. Prince & Smolensky (1993) and Prince (1998) have discussed harmonically complete systems in detail. The present work builds on their proposals, with the difference that the following discussion employs stringent marked-faithfulness constraints instead of non-stringent non-marked faithfulness ones (see §6.2.3 for discussion).
       This section focuses on the inventories found in Standard Malay (Lapoliwa 1981, Teoh 1988, Trigo 1988:41ff). Malay offers an excellent case study for such inventories: it has different harmonically complete voiceless stop inventories in different environments.

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[102] This is not entirely true since fricatives have a voiced glottal [ɦ]. However, [ɦ] never seems to contrast with [h], so it cannot be said that an inventory has an [ɦ] with the same status as other fricatives. Thus, [ɦ] is put aside here. Recall from ch.5 that nasals have a glottal member – [N].

The harmonically complete inventory [p t ʔ] is found in Malay codas. This inventory lacks only the most marked element [k]. Section 6.2.2.1 shows how this inventory is produced using the marked-faithfulness constraints.

A language related to Standard Malay – Ulu Muar Malay – has the smallest possible harmonically complete inventory – [ʔ]; this is found in the codas of reduplicants. The ranking responsible for this inventory is identified in §6.2.2.2.

Standard Malay onsets exhibit a harmonically complete inventory with Glottal Elimination: [k p t]. The ranking responsible for this inventory is provided in §6.2.2.3.

Section 6.2.2.4 generalizes over the results, giving a general characterization of the ranking needed for harmonically complete inventories.

6.2.2.1 Malay codas: [p t ʔ]

This section describes the coda inventory found in several Malay dialects, including Standard Malay (Lapoliwa 1981). As a general comment on the strategy taken for the examples in this language, coda inventories will be the focus because they most readily provide alternations (though cf §6.2.2.2, §6.3.4.2). To support the proposals in this chapter, it is important to show that the surface inventories come about through neutralization of PoA distinctions, rather than some incidental process (cf §6.5).

- *Description*

While Malay onsets allow the voiceless stops [k p t], codas permit only [p t ʔ]. There is clear evidence that input /k/ neutralizes to [ʔ]. The data in (7) is from Lapoliwa (1981:88-9) (see also Onn 1980:9, Teoh 1988:98ff).[103] The suffix –*an* expresses a result: e.g. [didik-an] is 'the result of educating', [-i] is a transitivizer.

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[103] Teoh (1988) differs from Lapoliwa in reporting that underlying /k+V/ sequences surface as [ʔkV]: e.g. /masak-an/ → [masaʔkan] 'dish' (103), cf /ikat+an/→[ikatan] 'ties'. Teoh notes that all underlying stem-final stops geminate before V-initial suffixes in slow speech: /lətup+an/→[lətoppan] 'explosion', /ikat+i/→[ikatti] 'to tie' (p.106-7). Teoh argues that gemination of input /k/ produces a coda [k] which is forced to neutralize, yielding /k+V/→[k.kV]→[ʔ.kV]. Thus, the underlying /k/ breaks into two segments: the one in coda neutralizes to [ʔ] as expected, and the one in the onset is realized faithfully – as [k]. This data will not be discussed here since it is tangental to the point of this section – that /k/→[ʔ]. For discussion of geminate alterability, see Keer (1999).

(7)   Malay codas [p t ʔ] (Lapoliwa 1981:88-9)[104]

(a) /k/→[ʔ]

Root	_#	_+C	_+V
/baik/	baiʔ 'good'	baiʔ-lah 'all right'	kə-baik-an
/didik/	didiʔ 'educate'		didik-an
/duduk/	duduʊʔ 'sit'	duduʔ-kan 'to seat'	duduk-i
/gərak/	gəraʔ 'move'	gəraʔ-lah 'move it'	gərak-an
/pendek/	pendɛʔ 'short'	pəndeʔ-ɲa 'in short'	kə-pəndek-an
/sorak/	soraʔ 'shout'	soraʔ-ɲa 'way he shouted'	sorak-i

(b) /p t/ stay faithful

[atap]	'roof'
[ikat]	'to tie'
[lətup]	'to explode'
[sakat]	'parasitic plant'
[suŋut]	'grumble'

In short, the result of /k/-debuccalization is the harmonically complete coda inventory [p t ʔ].

Malay is not unique in having this particular pattern: a case just like it is found in Arekuna Carib: [k p t] appear in onsets, but /k/ neutralizes to [ʔ] in codas: /nak-nai/ → [naʔnái] 'aunt', cf [makɔ́i] 'sin' (Edwards 1978). The same pattern is also found in Makassarese (Aronoff et al. 1987). An analogous case for onset inventories is found in Tahitian (Coppenrath & Prevost 1974); the Tahitian ranking is mentioned in the analysis below.

- *Neutralization*

To neutralize /α/ to [β] in Optimality Theory, a markedness constraint that favours [β] over [α] must outrank all faithfulness constraints that preserve /α/ (at the very least – see §6.2.2.4 for details). Therefore, to neutralize /k/ to [ʔ] some markedness constraint that assigns violations to [k] but not [ʔ] must outrank all faithfulness constraints that preserve /k/.

Since almost all PoA-markedness constraints favour [k] over [ʔ], any would do at this point. *{K} will be used here – the reason for this choice will become evident below. Since all faithfulness constraints preserve /k/, *{K} must outrank them all.

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[104] Lapoliwa also cites the free variants [gərak-lah], [sorak-ɲa], [baik-lah] (but not *[pəndek-ɲa]). The variable appearance of [k] rather than [ʔ] in these forms may relate to the development of onset clusters, so that /baik-lah/ can be syllabified as [bai.klah] or [baiʔ.lah]. Such clusters are found only in loans and as the result of certain syncope processes (Hendon 1966:32-3). In any case, the appearance of [ʔ] word-finally – unambiguously a coda – shows that /k/ neutralizes to [ʔ].

(8)　　　Neutralization of coda /k/, step 1

/baik/	*K	IDENT{K}	IDENT{KP}	IDENT{KPT}	IDENT{KPTʔ}
(a) baik	*!				
☞　(b) baiʔ		*	*	*	*

As the tableau shows, candidate (a) is eliminated because it contains a dorsal, so violating *{K}. All the dorsal-preserving faithfulness constraints are ranked lower, so the input dorsal cannot survive. As a reminder, a constraint like IDENT{KP} is violated by unfaithful mappings from either dorsals or labials. So, the fact that /k/→[ʔ] in candidate (b) results in a violation of IDENT{KP}.

A point that will turn out to be significant relates to the form of the markedness constraint that triggers neutralization. If /k/ neutralizes to [ʔ], /k/-neutralization must be motivated by a markedness constraint that favours [ʔ] over [k]. It is not simply enough that the markedness constraint assigns a violation to [k]. So, the constraint *{KPTʔ} cannot be used to force /k/-neutralization. This constraint assigns the same violations to all PoAs, so it does not favour any segment over [k]. Since all segments violate *{KPTʔ} equally, it will not assign any crucial violations. Since *{KPTʔ} is not decisive, the decision will be passed to lower ranked constraints. Tableau (9) underscores this point.

(9)

/baik/	*{KPTʔ}	IDENT{K}
☞☀　(a) baik	*	
(b) baiʔ	*	*!

Since [baik] and [baiʔ] violate *{KPTʔ} equally, the constraint is irrelevant in picking a winner. The lower-ranked constraint IDENT{K} then emerges to favour the faithful form.

The ranking identified above does not guarantee that /k/ will neutralize; it could also delete. To prevent deletion, McCarthy & Prince's (1995) anti-deletion constraint MAX must outrank all of the IDENT constraints. For further discussion of the role of deletion in inventory-formation, see §6.4.2.

- *No neutralization in onsets*

The proposal that neutralization in onsets is blocked by an onset-specific faithfulness constraint is adopted here (Lombardi 1995, 1999, Jun 1995, Padgett 1995, Beckman 1998). In this case, some /k/-preserving onset-IDENT constraint must outrank *{K}, so preventing /kepeh/ from neutralizing to *[ʔepeh] or *[tepeh].[105] The opposite ranking would produce a language that bans [k] in onsets as well as codas, as found in

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[105] The primary ranking arguments in this section stands regardless of whether positional markedness or positional faithfulness motivates coda place neutralization (Beckman 1998 cf Zoll 1996). If a set of coda-specific PoA constraints (e.g. *coda/{K}, etc.) were used to motivate neutralization, the ranking needed would be the same.

Tahitian (Coppenrath & Prevost 1974).[106] In tableau (10), the onset-faithfulness constraint onset-IDENT{K} is used, but it could well be any other onset-IDENT constraint.

(10)　Neutralization of coda /k/, step 2: Preserving the onset

	/ikat/	onset-IDENT{K}	*K	IDENT{K}
☞	(a) ikat		*	
	(c) itat	*!		*

- *Neutralization target*

The final important issue relates to why /k/ turns into [ʔ] rather than [t] or [p]. The reason follows from the form of both the faithfulness and markedness constraints. The outputs [p], [t], and [ʔ] are equally unfaithful to /k/ – they all incur the same violations of the PoA-faithfulness constraints (see §6.6 for further discussion). Therefore, the choice of output falls to the PoA-markedness constraints. Since [ʔ] is a local harmonic bound for all other segment types in terms of the PoA-markedness constraints, it will emerge triumphant regardless of ranking. This result is illustrated in tableau (11).

(11)　Neutralization of coda /k/, step 3: getting the right target

	/baik/	*{K}	*{KP}	*{KPT}	*{KPTʔ}
	(a) baik	*!	*	*	*
	(b) baip		*!	*	*
	(c) bait			*!	*
☞	(d) baiʔ				*

Note that [ʔ] is a harmonic bound for all the other PoAs in terms of the PoA-markedness constraints alone. Other constraints may interfere with this result, producing neutralization to coronals instead. Section 6.6 provides a detailed discussion of this point.

- *Preservation*

All stops apart from /k/ are faithfully preserved in Malay codas. So, the type of ranking used to eliminate /k/ in (8) must be reversed for all other PoAs. For example, since /p/ is preserved, some faithfulness constraint that preserves /p/ (IDENT{KP}, IDENT{KPT}, or IDENT{KPTʔ}) must outrank all markedness constraints that favour some other segment over [p] (i.e. *{KP} and *{KPT}, but not necessarily *{KPTʔ} as explained above). The same is true for the coronal /t/: at least one of IDENT{KPT} and IDENT{KPTʔ} must outrank *{KPT}.

Tableau (12) illustrates preservation of coda /p/; it employs IDENT{KPT} for the sake of exposition, but – as observed above – IDENT{KP} and IDENT{KPTʔ} would serve equally well.

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[106] As a matter of interest, all words that have a cognate form with [k] in other languages have [ʔ] in Tahitian: e.g. Maori [kai] 'food, eat' cf Tahitan [ʔai].

(12)

	/atap/	IDENT{KPT}	*{KP}	*{KPT}
☞	(a) atap		*	* *
	(b) ata?	*!		

The only other segment not discussed here is /ʔ/. Underlying /ʔ/ will clearly stay faithful in Malay codas, appearing as [ʔ]. Interestingly enough, nothing has to be said about the ranking of the PoA constraints to ensure that /ʔ/ survives faithfully. The reason relates to the ranking needed to neutralize a segment: /ʔ/ can only be eliminated through the action of a markedness constraint that favours some other segment over [ʔ]. However, none of the PoA-markedness constraints have this property; *{KPTʔ} is the only one that assigns a violation to [ʔ], and it also assigns a violation to every other PoA. Thus, /ʔ/ can never be eliminated in terms of the PoA constraints. For further discussion, see §6.2.2.3 and §6.4.

- *Ranking summary*
  The resulting ranking for Malay codas is summarized in Figure 6.1. The solid lines indicate that the higher constraint outranks the lower one. The dotted lines indicate that at least one of the rankings must hold: so either IDENT{KPT} or IDENT{KPTʔ} (or both) must outrank *{KPT}; either IDENT{KP}, IDENT{KPT}, or IDENT{KPTʔ} must outrank *{KP}.

Figure 6.1: Malay coda neutralization ranking
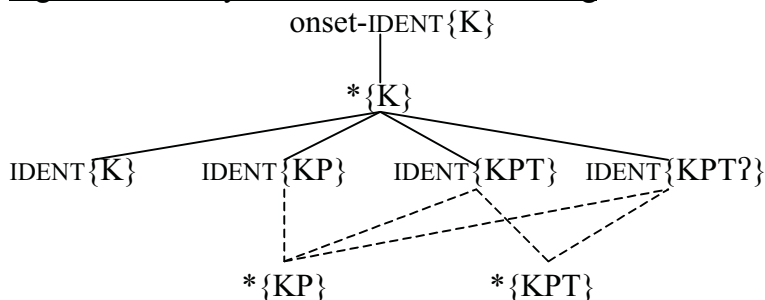
As discussed above, the position of the markedness constraint *{KPTʔ} is irrelevant because it does not favour any segment over any other type.[107] The topmost faithfulness constraint could be any onset-IDENT constraint, since all preserve /k/.
The diagram gives a sense of the ranking needed to neutralize and preserve. To neutralize /k/ to [ʔ], some constraint that favours [ʔ] over [k] must outrank over all /k/-preserving faithfulness constraints: this is shown in the diagram, where *{K} outranks all the faithfulness constraints above. The diagram shows that the other PoAs survive because some relevant faithfulness constraint outranking all relevant markedness constraints. A precise version of the ranking needed for neutralization will be provided in §6.2.2.4.

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[107] This does not mean that *{KPTʔ} (or its faithfulness counterpart IDENT{KPTʔ}) is always inconsequential – see ch.7 for discussion.

The diagram also gives a sense of the ranking needed for a harmonically complete inventory. A harmonically complete inventory is one in which the more marked elements are banned. In ranking terms, this involves a markedness constraint that bans marked values alone (*{*m*f}) outranking all faithfulness constraints that preserve those values (IDENT{*m*f}, IDENT{*m*f,*u*f}). It also may involve some faithfulness constraint that preserves unmarked values (IDENT{*m*f,*u*f}) outranking all markedness constraints that ban those values (i.e. *{*m*f, *u*f}) (for discussion on whether this ranking is necessary, see §6.4). The result is the ranking || *{*m*f} » IDENT{*m*f}, IDENT{*m*f, *u*f} » *{*u*f, *m*f} ||, with certain assumptions about the ranking of other constraints (see §6.2.2.4). In the ranking above, the marked value of the [Place] feature is 'dorsal', and the relatively unmarked values are 'labial' and 'coronal', hence the ranking || *{K} » IDENT{KPT} » *{KP}, *{KPT} ||. A precise account of the ranking needed for harmonically complete inventories will be provided in §6.2.2.4.

- *Other manners of articulation*
  The ranking for Malay can also be used to account for the same type of neutralization in other manners of articulation. For example, an interesting case is found in Florentine Italian spirantization (Giannelli & Savoia 1979, Kirchner 1998). Between a vowel and sonorant, labial and coronal stops spirantize to fricatives. In the speech of younger speakers, /p/ spirantizes to [ɸ], and /t/ to [θ], but velar /k/ debuccalizes to [h] (/k/ spirantizes to [x] in the formal speech of older speakers). The net result is a spirantized harmonically complete inventory of [ɸ θ h], lacking [x]. Again, the dorsal PoA is neutralized while the others are preserved.

6.2.2.2 [ʔ] in Ulu Muar Malay reduplicant codas

The Ulu Muar Malay language shares the restriction on [k] in codas with Standard Malay, but also exhibits another harmonically complete coda inventory – only [ʔ] is allowed in reduplicant codas (Hendon 1966).

Hendon (1966:58-9) reports that the coda stops [k p t] in two reduplicants neutralize to [ʔ] in Ulu Muar Malay. The full reduplicant (13a) reduplicates the entire stem and replaces stem-final stops with [ʔ]. The partial reduplicant (13b) reduplicates the first CV of the stem and the stem-final consonant. If the stem-final consonant is a stop, it reduplicates it as a [ʔ].

(13)   Ulu Muar Malay reduplicant coda debuccalization [ʔ] (Hendon 1966:58,59)
        (a) Full reduplicant
                [m-<u>rataʔ</u>-ratap]   'wails and wails'
                [<u>lakiʔ</u>-lakit]   'sticks in various places'
                [di-<u>aliʔ</u>-alit-kan]   'is transferred by repeated scrapings'
                [di-<u>pijaʔ</u>-pijaʔ]   'is repeatedly trampled on'

(b) Partial (CVC) reduplicant

[tʃaʔ-tʃakap]	'talks in a low tone'
[gaʔ-galap]	'is repeatedly dark'
[siʔ-sikit]	'various small quantities'
[laʔ-laŋit]	'ceiling cloth'
[taʔ-tariʔ]	'accordion'
[goʔ-goleʔ]	'takes a cat-nap'

If the stem-final consonant is not a stop or there is no stem-final consonant, [ʔ] does not appear in the full reduplicant: [matʃa-matʃam] 'various kinds', [laja-lajaŋ] 'kite', [putu-putus] 'are severed', [jaŋke-jaŋkeh] 'feels stiff all over', [ija-ijaw] 'are green'; [api-api] 'fire', [mato-mato] 'policeman' (p.59).[108]

The CVC reduplicant is only found with stems that end in a stop, /h/, or a nasal. If the stem ends in a nasal, the reduplicant's final consonant is a nasal homorganic with the following stop: [kaŋ-kawan] 'friend', [sin-siaŋ] 'during the daytime on various days' (p.59). If the stem ends in /h/, the reduplicant's consonant is [h]: [sopʊh-pueh] 'to their complete satisfaction'.

Debuccalization of stops is clearly an emergent process because stop-C clusters are permitted in non-reduplicative morpheme-juncture environments: e.g. [niãt-kan] 'is prayed for' (64), [idʊp-kan] 'is kept alive'(65), [atap-rumãh] 'thatch of a house' (9), [sakit-mato] 'have eye trouble' (9).

What makes reduplicant codas interesting is that they go further in debuccalization than non-reduplicant codas: while only /k/ debuccalizes in base codas, all stops debuccalize in reduplicant codas. The result is that the stop inventory of coda reduplicants is the minimal harmonically complete inventory: [ʔ].

- *Eliminating all but [ʔ]*

The issue of immediate interest is the neutralization of reduplicant coda stops to [ʔ]. The account given here parallels the account given by Alderete et al. (1999) for Tübatulabal and Nancowry in some respects – in these languages, all reduplicant onsets are neutralized to [ʔ].

As discussed in the previous section, neutralization of /α/ to [β] only comes about when some markedness constraint that favours [β] over [α] outranks all faithfulness constraints that preserve /α/. In the case of Malay reduplicants, since /t/ neutralizes to [ʔ], some markedness constraint that favours [ʔ] over [t] (i.e. *{KPT}) must outrank all faithfulness constraints that preserve /t/ in reduplicants. In the latter case, the relevant PoA faithfulness constraint refers to the Base-Reduplicant dimension, as given in (14).

---

[108] This reduplication pattern is reminiscent of the one found in Makassarese (Aronoff et al. 1987, McCarthy & Prince 1994:sec.5). In Makassarese a [ʔ] also appears in reduplication: [balaʔbalao] 'toy rat'. However, McCarthy & Prince argue that the glottal stop is epenthetic, forced by a constraint requiring PrWd-final consonants. Alderete et al. (1999) use the same solution to account for the fact that all reduplicant onsets are [ʔ] in Nancowry and Tübatulabal reduplicants. The epenthesis solution is not available for the present data: [ʔ] only appears when the stem has a final stop (putuputus, *[putuʔputus], cf [dipijaʔpijaʔ]). If [ʔ] were an epenthetic consonant, its appearance would be driven by purely prosodic factors, and not contingent on the presence of a stem-final stop.

(14)   BR-IDENT{KPT}   If *x* is K or P or T, then *x'* has the same PoA as *x*.
- *x* is in the base
- *x'* is in the reduplicant
- *x* and *x'* are correspondents

The relevant ranking is provided in tableau (15). As for faithfulness in bases, IO-IDENT{KPT} – the input-output version of IDENT{KPT} – outranks *{KPT} to prevent neutralization of coda /t/. Only violations by stops of the constraint *{KPT} are shown below.

(15)

/RED-lakit/	*{KPT}	BR-IDENT{KPT}	BR-IDENT{KPTʔ}
(a) lakitlakit	* * * *!		
☞ (b) lakiʔlakit	* * *	*	*

A similar ranking must hold for /p/: some markedness constraint that favours [ʔ] over [p] (i.e. *{KP}, *{KPT}) must outrank all BR-IDENT constraints that preserve it (i.e. BR-IDENT{KP}, BR-IDENT{KPT}, BR-IDENT{KPTʔ}). This type of ranking has been invoked for similar PoA neutralizations in reduplication by Alderete et al. (1999).

Importantly, IO-IDENT{KPT} outranks *{KPT}. This prevents coda neutralization in every environment, eliminating the candidate *[lakiʔlakiʔ] from /RED-lakit/.

As pointed out in the preceding section, no special ranking needs to be invoked for base [ʔ]. Since no PoA-markedness constraint favours any other segment over [ʔ], base [ʔ] will be faithfully copied regardless of the ranking.

To prevent reduplicant onsets from neutralizing to [ʔ], an onset-specific version of BR-IDENT{KPT} must outrank *{K}, *{KP}, and *{KPT}. The opposite ranking would produce a system in which all onsets neutralize to [ʔ]. This is found in Nancowry and Tübatulabal reduplicants (see Alderete et al. 1999 for references and an analysis).

Figure 6.2 summarizes the ranking needed for coda neutralization.

Figure 6.2: Ulu Muar Malay reduplicant neutralization
ONSET-BR-IDENT{KPT}

*{KP}   *{KPT}

IDENT{KP}   IDENT{KPT}   IDENT{KPTʔ}
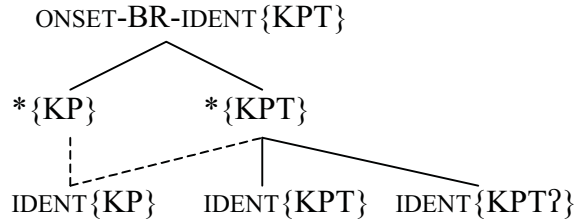
The dotted lines indicate a choice in a crucial ranking: at least one of *{KP} and *{KPT} must outrank IDENT{KP}. There is no need to mention constraints that pertain to the neutralization of [k] in reduplicants: since coda /k/ never appears in bases, it will not appear in reduplicants regardless of the ranking.

• *The form of the reduplicant*

This discussion of Malay reduplication will conclude with an account of the reduplicant's form. This approach is based on McCarthy & Prince's (1994, 1995) Generalized Template Theory, whereby reduplicant form is the result of emergent conditions on prosodic structure.

McCarthy & Prince (1994, 1995) show that reduplicant size can be related to morphological category: large (foot-size) reduplicants are roots, while smaller (syllable-size) ones are affixes. Because of independent conditions that require roots to have their own Prosodic Word (e.g. Selkirk 1995), root reduplicants are forced to be at least a foot in size to satisfy minimal word requirements. This idea is adopted here; the reader is referred to McCarthy & Prince (1994) for a detailed analysis along these lines (also see Urbanczyk 1996).

The reduplicants both aim to copy the rightmost stem consonant. This is most evident with the partial reduplicant in the form [kaŋkawan]: the reduplicant copies the stem-final [n] (subsequently assimilating it). Alderete et al. (1999), in their analysis of similar patterns in Nancowry, ascribe this behaviour to the constraint BR-ANCHOR-R (McCarthy & Prince 1995). BR-ANCHOR-R requires the rightmost base element to have a correspondent in the reduplicant. It must outrank requirements on contiguity in the base (BR-CONTIGUITY), otherwise the reduplicated form of [kawan] would be *[kawkawan]. BR-ANCHOR-R must also outrank the markedness constraint NOCODA, which would favour *[kakawan] over [kaŋkawan].

(16)

/RED+kawan/	BR-ANCHOR-R	BR-CONTIG	NOCODA
(a) kawkawan	*!		* *
(b) kakawan	*!		*
☞ (c) kaŋkawan		*	* *

However, reduplication of the stem-final consonant – consequently violating BR-ANCHOR-R – is blocked when the coda is not a nasal or a stop. This can be ascribed to an emergent ban on continuancy in codas, called *CODA/+CONT here (also see Zec 1988).[109] With *CODA/+CONT outranking BR-MAX, the reduplicant will copy only part of the base rather than having a continuant coda. Both BR-IDENT[cont] and *CODA/+CONT must outrank BR-ANCHOR-R, otherwise the full reduplicant would reduplicate all consonants, regardless of their manner of articulation.

This ranking only does part of the job, though: *putuʔputus satisfies both *CODA/+CONT and BR-MAX. To ban this candidate, the constraint BR-IDENT[cont] – requiring corresponding segments to agree in continuancy – must outrank BR-MAX.

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[109]   *CODA/+CONT can be reduced to the ranking || onset-IDENT[±continuant] » *+continuant » IDENT[±continuant] ||, given in §6.5.1.

(17)

/RED-putus/	*CODA/+CONT	BR-IDENT[cont]	BR-MAX
(a) putusputus	*!		
(b) putuʔputus		*!	
☞ (c) putuputus			*

Importantly, BR-MAX outranks all the PoA-markedness constraints. The opposite ranking would result in deletion of non-glottal codas, not neutralization.

- *Glottals elsewhere*
  As a final comment, while neutralization to glottals in codas only occurs in reduplicants in Malay, the present theory predicts that it could occur in any position – i.e. (i) codas of bases and (ii) in both onsets and codas.
  Neutralization of all PoA distinctions to [ʔ] in codas is extremely common – perhaps even the commonest type of PoA neutralization. Kashaya (Buckley 1994) presents an example: all plain stops debuccalize in coda position. Debuccalization does not apply to stops with a secondary articulation (i.e. glottalization, aspiration). The debuccalization examples are from Buckley (1994:99); page numbers for the contrasting non-debuccalized cases are given in brackets.

(18)   Kashaya stop debuccalization (Buckley 1994)
(a) /ṭ/ → [ʔ]
   /qahmaṭ/   →   [qahmaʔ] 'angry'   cf [qamat̠-ʔ] he's angry' (68)
   /ʃeʔeṭ/   →   [ʃeʔeʔ] 'basket'   cf [ʃeʔet̠-ʔemu] 'that's a basket' (72)
   /mahsiṭ/   →   [masiʔ] 'embers'   cf [masit-ʔ] 'it's embers' (68)
(b) /t/ → [ʔ]
   /qʰam'ot/ →   [qʰaboʔ] 'garter snake [qʰabot-ʔ] 'it's a garter snake' (68)
   /sulemat/ →   [sulemaʔ] 'rope'   cf [sulemat-ʔ] 'it's a rope' (68)
(c) /tʃ/ → [ʔ]
   /watatʃ/   →   [wataʔ] 'frog'   cf [watatʃ-ʔiq] 'it must be a frog' (73)
   /maːtʃatʃ/ →   [macaʔ] 'they'   cf [maːtʃatʃ-ʔeːmu] 'that's them' (72)
(d) /q/ → [ʔ]
   /mihjoq/   →   [mihjoʔ] 'woodrat'   cf [mihjoq-ʔ] 'it's a woodrat' (69)
   /mitʃʰaːq/ →   [micʰaːʔ] 'sweat'   cf [mitʃʰaq-ʔ] 'it's sweat' (69)

In contrast to Malay, *{KPT} outranks both IO-IDENT{KPT} and IO-IDENT{KPTʔ} in Kashaya, rather than BR-IDENT constraints. As in Malay, though, onset-specific IDENT constraints must outrank *{KPT}.
  Even more extreme than Kashaya is a language in which allows only glottals in onsets – i.e. neutralizes PoAs in all positions. As mentioned above, none of the languages in the survey (Appendix B) does this for voiceless stops in all environments (no doubt for functional reasons). However, it is attested with fricatives: a number of languages have

only [h] in onset position and no other fricatives (e.g. Rapanui (Easter Island), Kapingamarangi, Bororó Macro-Je). Moreover, neutralization of all stops to [ʔ] is found in restricted morphological environments: reduplicant onsets are neutralized to [ʔ] in Tübatulabal and Nancowry (Alderete et al. 1999, and references cited therein).

6.2.2.3 Glottal Elimination in Malay onsets
     Malay onsets contain yet another type of voiceless stop inventory: [k p t]. Notably, Malay onsets cannot contain [ʔ] (Hendon 1966:31, Lapoliwa 1981:85ff). In the present theory, such a situation cannot come about through the action of PoA constraints (see §6.4). Instead, this section shows that an independent process – 'Glottal Elimination' – is responsible for the lack of [ʔ].
     In §6.5, glottals are argued to be more sonorous than segments with other PoAs. Accordingly, the constraint *-$\Delta_\mu \geq$\{glottal\} bans glottals onsets, leaving [k p t]. To recall from ch.2-4, -Δ_μ refers to the non-DTE of a mora – i.e. onset consonants. As in ch.2§2.4.1, moraic non-DTEs are onset consonants, assuming that onset consonants are the dependent of a μ node while coda consonants are either moraic or dependents of the σ node (Hyman 1985, Zec 1988:7).

(19)   <u>DTEs below the syllable</u>
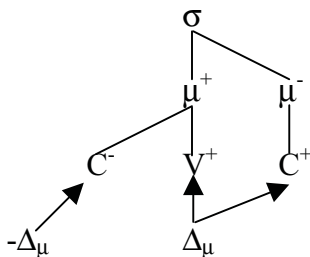
-    *Ranking*
     The ranking needed for Glottal Elimination depends on the means used to eliminate the glottals. This section starts by identifying the neutralization ranking.
     At least two rankings must hold for glottals to be eliminated. One involves a markedness constraint that favours some other segment over glottals – i.e. *-$\Delta_\mu \geq$\{glottal\} – outranking all glottal-preserving faithfulness constraints (i.e. IDENT\{KPTʔ\}).
     The other crucial ranking is that *-$\Delta_\mu \geq$\{glottal\} must outrank *\{KPT\}. Since *\{KPT\} favours glottals over all other segments, it would render *-$\Delta_\mu \geq$\{glottal\} inactive in any other ranking. This ranking will prove to have significant consequences for the typology of epenthesis and direction of neutralization (§6.6).
     Tableau (20) illustrates the two rankings needed for Glottal Elimination.

(20)   Glottal Elimination

/ʔa/	*-$\Delta_\mu \geq$glottal	IDENT{KPTʔ}	*{KPT}
(a) ʔa	*!		
☞ (b) ta		*	*

The tableau shows that both the rankings identified above are crucial. If IDENT{KPTʔ} outranked *-$\Delta_\mu \geq$glottal, [ta] would be blocked for its unfaithfulness. If *{KPT} dominated *-$\Delta_\mu \geq$glottal, [ta] would also be eliminated because it contains a coronal (as would [pa] and [ka]).

If glottals were eliminated through deletion rather than neutralization, *-$\Delta_\mu \geq$glottal would outrank MAX. Again, *-$\Delta_\mu \geq$glottal will outrank *{KPT}, but by transitivity in this ranking: if *{KPT} outranked MAX all PoAs would be banned in the inventory.[110]

- *Promotion of coronal*

Glottal Elimination effectively gives coronals 'least marked' status. This means that the glottal-less inventories [k p t], [p t], and [t] are – in effect – harmonically complete.

For example, Vanimo's [p t] inventory and Tahitian's [p t ʔ] inventory differ only in that the former has no glottal stop. In terms of the PoA constraints, then, Vanimo and Tahitian are not significantly different; the difference relates solely to the ranking of *-$\Delta_\mu \geq${glottal}. Apart from that, the languages' rankings are almost identical.

Since glottals are eliminated in Vanimo, coronals graduate to 'least marked' status in terms of PoA. This follows because *x* is less marked than *y* in a grammar if all markedness constraints that favour *y* over *x* are inactive. Since *-$\Delta \geq$glottal favours coronals over glottals, no active markedness constraint favours anything over coronals. Since coronals are the least marked remaining element, it makes no difference how coronal-referring faithfulness and markedness constraints are ranked; any ranking will produce the same result (see §3.3). The fact that coronals become least marked is attested by the fact that languages without glottals neutralize to coronal. Examples are provided in §6.

In short, the only difference between inventories with glottals and those without them is that constraints from another scale interfere with the workings of the PoA scale in the latter type.

Further discussion of the rankings needed to account for the typology of Glottal Elimination is given in §6.5.2.2.

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[110]   It is not clear whether [ʔ] is eliminated through deletion or neutralization in Malay. One strategem suggests that it is neutralized. Suppose there were an underlying stem-final /ʔ/ – it would emerge faithfully as [ʔ]: /baʔ/→[baʔ]; it could not delete because there is no ban on coda [ʔ]. Addition of a vowel-initial affix would make the /ʔ/ appear in an onset: [baʔ-i]. If glottals deleted in this position (i.e. [ba-i]), one would expect to find sets of words that have a stem-final [ʔ] in citation form but no consonant before vowels. Neither Lapoliwa nor Hendon report such words; the only ones with surface final-[ʔ] appear with a [k] preceding a vowel. Therefore, it is possible that /ʔ/ neutralizes to [k]. For an analysis, see §6.6.

6.2.2.4 Harmonic completeness

This section identifies the ranking needed to produce harmonically complete inventories. As a first step, the ranking needed to neutralize /α/ to [β] is discussed.

- *Neutralizing /α/ to [β]*

It is not a simple matter to ensure neutralization of /α/ to [β]. The following paragraphs step through the necessary and sufficient conditions, summarized (26) (also see McCarthy 2001b:67ff).

To neutralize /α/ to [β], some markedness constraint *M* that favours [β] over [α] must outrank all faithfulness constraints that ban the /α/→[β] mapping. Importantly, *M* must *favour* [β] over [α] – it cannot assign equal violations to both elements (like the constraint *{α,β}).

(21)   Neutralization, step 1

/α/	*{α}	IDENT{α}
α	*!	
☞ β		*

The part that makes the neutralization ranking complex is ensuring that no higher-ranked constraints prevent /α/ from neutralizing or being realized as [β]. For a start, no markedness constraint that favours [α] over [β] (e.g. *{β}) can outrank the neutralization-triggering constraint (*{α} here). Otherwise, [β] would be eliminated.

(22)   Neutralization, step 2

/α/	*{α}	*{β}	IDENT{α}
α	*!		
☞ β		*	*

Ensuring that /α/ neutralizes to [β] rather than some other segment requires a similar ranking. For every markedness constraint *m* that favours some other segment [γ] over [β], *m* must outrank all constraints that favour [β] over that [γ]. For example, the constraint *{β} bans [β] but not some other segment [γ], so a constraint that favours [β] over [γ] – i.e. *{γ} – must outrank *{β}.

(23)   Neutralization, step 3

/α/	*{α}	*{δ}	*{β}	IDENT{α}
α	*!			
δ		*!		*
☞ β			*	*

The final step is to ensure that faithfulness constraints do not prevent /α/ from neutralizing to [β]. For example, suppose [α] and [δ] shared some feature value [+*f*] that [β] does not have. If IDENT[+*f*] outranked *{δ}, /α/ would map to [δ], not [β], because

doing so would be more faithful. Thus, *{δ} must outrank IDENT[+*f*]. More generally for every segment γ, some markedness constraint that favours [β] over [γ] must outrank every faithfulness constraint that prefers the /α/→[γ] mapping over the /α/→[β] map.

(24)   Neutralization, step 4a

	/α/	*{α}	*{δ}	IDENT[+*f*]	*{β}	IDENT{α}
	α	*!				
	δ		*!			*
☞	β			*	*	*

There is an alternative to the ranking || *{δ} » IDENT[+*f*] ||. Suppose [α] and [β] shared some feature value [+*g*] that [α] and [δ] do not share. Then IDENT[+*g*] would favour the mapping /α/→[β] over /α/→[δ]. So, if IDENT[+*g*] (i) outranked all markedness constraint that favoured [δ] over [β] (i.e. *{β}) *and* (ii) outranked all faithfulness constraints that favoured the mapping /α/→[δ] over /α/→[β] (i.e. IDENT[+*f*]), then the same result would follow.

(25)   Neutralization, step 4b

	/α/	*{α}	IDENT[+*g*]	IDENT[+*f*]	*{β}	IDENT{α}
	α	*!				
	δ		*!			*
☞	β			*	*	*

In short, it is no easy matter to ensure that /α/ neutralizes to [β]. Apart from the basic || markedness » faithfulness || ranking to ensure neutralization in the first place (26a), the influence of other markedness constraints (26b,ci) and faithfulness constraints (26cii) must also be blocked. The rankings laid out above are summarized in (26).

(26)   Neutralization of /α/ to [β] Ranking
          (a) || ∃M(β>α) » ∀F(α) ||
                    • M(β>α) is a markedness constraint that favours segment β over α
                    • F(α) is a faithfulness constraint that bans the /α/→[β] mapping
          (b) There is no M(α>β) that outranks M(β>α)
          (c) For all segments γ (γ≠α,γ≠β),
          either   (i) some M(β>γ) outranks all F(α→γ, *α→β) and all M(γ>β)
          or   (ii)some F(α→β, *α→γ) outranks all M(β>γ) and all F(α→γ, *α→β)

- *Harmonically complete inventories: ranking*
          A harmonically complete inventory is one that contains some segment α and all less marked segments, but eliminates all segments that are more marked than α. For example, the inventory [p t ʔ] contains [p] and all less marked segments (i.e. [t ʔ]), but no more marked ones (i.e. [k]).

Characterizing a harmonically complete inventory in ranking terms is simply a matter of applying the neutralization ranking in (26) in certain way.

Suppose there is an inventory I that is harmonically complete in terms of a scale S. The most marked element of S in I will be called χ. Everything that is more marked than χ on scale S is neutralized, so the ranking in (26) must hold for each of these S-elements. In contrast, everything less marked than χ and χ itself is preserved, so one of the rankings in (26) cannot hold for each of these elements.

Applying the ranking in (26) in the way just described will produce a harmonically complete inventory. A slightly simpler characterization of harmonically complete inventories (and therefore easier to apply) is offered in (27). This focuses on the 'primary' neutralization ranking, identified in (26a). Importantly, (27) does not replace the full set of conditions needed to ensure neutralization; it is only presented here to simplify exposition of the core rankings.

(27)   <u>Ranking schema for harmonically complete inventories</u>
         For a scale S, an inventory I is harmonically complete in terms of S if
                  (a) there is some $x \in$ S in I, such that
                           for all z, $\| \exists F(x) \gg \forall M(z > x) \|$ (i.e. x is not neutralized)
         and   (b) for all $y \in$ S that are less marked than x in S,
                           for all z, $\| \exists F(y) \gg \forall M(z > y) \|$
         and   (c) for all $w \in$ S that are *more* marked than x in S,
                           for some z, $\| \exists M(z > w) \gg \forall F(w) \|$

In essence, (27) applies the preservation-ranking schema iteratively: if some segment x is preserved, then all less marked segments are also preserved. Since preservation of x comes about through having some faithfulness constraint that preserves x outrank all markedness constraints that favour some other segment over x, then the same ranking must hold for all less marked elements.

As a final note, (27) does not take into account the difference between MAX and IDENT. For discussion of how MAX relates to inventories, see §6.4.2.

6.2.3   Summary

The aim of this section was to show how the present theory deals with harmonically complete inventories.

To summarize, to preserve any particular PoA α, some faithfulness constraint that preserves α must outrank all markedness constraints that favour some other PoA over α (i.e. $\| \exists F(\alpha) \gg \forall M(\beta > \alpha) \|$). For example, to preserve /t/, IDENT{KPT} or IDENT{KPTʔ} must outrank *{KPT}; the faithfulness constraints do not have to outrank *{KPTʔ} since *{KPTʔ} does not favour any other PoA over coronals.

In a harmonically complete inventory, if any PoA α is preserved, then all PoAs less marked than α are also preserved. So the $\| \exists F(\alpha) \gg \forall M(\beta > \alpha) \|$ ranking applies for all segments less marked than α as well. The exception is the least marked element, which survives no matter what the ranking (see §6.5).

- *Theoretical essentials for harmonic completeness*

While the present theory can produce harmonically complete inventories, this does not set it apart from many alternative theories. In order to produce harmonically complete inventories, the only requirement on a faithfulness theory is that for every PoA there is some faithfulness constraint that preserves it, given certain standard assumptions about markedness constraints (i.e. that they favour unmarked segments over marked ones).

For example, Prince (1998) shows that a theory with a single faithfulness constraint – IDENT[Place] – can produce harmonically complete inventories. Similarly, a theory with 'unmarked' faithfulness constraints (e.g. IDENT{ʔ}, IDENT{Tʔ}, IDENT{PTʔ}, IDENT{KPTʔ}) can do the same job.

Similarly, a theory with constraints in a fixed ranking ‖ IDENT{K} » IDENT{P} » IDENT{T} ‖ will achieve the same result. For example, for Malay [p t ʔ] coda, the ranking ‖ *K » IDENT{K} » IDENT{P} » IDENT{T}, *P » *T ‖ will produce the right results: /k/ will be eliminated by virtue of the ranking ‖ *K » IDENT{K} ‖, while /p/ and /t/ will be preserved by having IDENT{P} outrank *P and IDENT{T} outrank *T.

Thus harmonically complete inventories do not provide any evidence for the marked faithfulness theory. However, showing how the marked-faithfulness constraints produce harmonically complete inventories is a necessary step towards explaining how Gapped inventories work.

On the other hand, some theories can *only* produce harmonically complete inventories. The next section shows that such theories – unlike the marked-faithfulness theory – are empirically inadequate.

6.3 Gapped inventories

A 'gapped' inventory is one that contains the least marked scale member and highly marked elements, but not those of intermediate markedness (the term 'gapped' is from Prince 1999). For example, the inventory of voiceless stops found in the Polynesian language Hawaiian has [k p ʔ], but no [t] (Pukui & Elbert 1979). Here, the least marked [ʔ] and highly marked [p] and [k] are present, but the intermediately marked [t] is missing.

Prince (1998) showed that a theory with marked-faithfulness constraints can produce gapped inventories. This section extends this observation, showing that analysis of gapped inventories requires marked-faithfulness constraints: no other constraint types can produce gapped inventories, given current theories of CON and EVAL. Thus, the existence of gapped inventories provides support for the present theory.

A number of theories of inventory structure have claimed that gapped inventories do not exist (e.g. Jakobson 1941, Prince & Smolensky 1993, Prince 1998). Counter to this claim, §6.3.1 identifies cases of gapped inventories and introduces the main example used in this section: the coda inventory [k p ʔ] found in Yamphu (Rutgers 1998).

Section 6.3.2 identifies the ranking needed for gapped inventories. Marked-faithfulness constraints are shown to play a crucial role in this ranking.

Section 6.3.3 discusses other gapped inventories focusing on [k t ʔ], found in the Uralic language Nganasan's codas (Helimski 1998).

Section 6.3.4 shows why the marked-faithfulness approach works, and why alternatives cannot produce gapped inventories.

Section 6.3.5 summarizes the findings in this section.

6.3.1   Description

Gapped PoA inventories are one of [K P ʔ], [K T ʔ], [K ʔ], [P ʔ], or [K T]. All of these inventories lack an element of intermediate markedness (T and/or P), but have a highly marked element (K and/or P), and the least marked element (ʔ, or T by virtue of Glottal Elimination).

Table 6.6 identifies gapped inventories for voiceless stops. For further examples and for other manners of articulation, see Appendix A. The languages listed under 'Coda Inventory' have the missing element(s) in onset position (e.g. Nambiquara has a [p] in onset position, and Fuzhou has [k p t] in onsets).

Table 6.6: Gapped voiceless stop inventories

k	p	t	ʔ	Coda Inventory	Onset Inventory
✓	✓		✓	Cockney English	Hawaiian
✓		✓	✓	Nambiquara	Ayutla Mixtec, Arabic
	✓		✓	Nganasan	-
✓			✓	Fuzhou	-
✓		✓		Mordvin	Japanese (Yamato & Sino-Japanese strata)

I was unable to find languages with the onset inventories [k ʔ] and [p ʔ]. However, coda inventories with the form [k ʔ] and [p ʔ] exist. I consider these to be accidental gaps.

The primary empirical focus in this section will be on the gapped [k p ʔ] inventory. There are several reasons for choosing this inventory. One is that the gap – [t] – is unambiguously less marked than [k] and [p] (see §6 and ch.5 for discussion). Thus, [k p ʔ] is clearly an inventory that has highly marked elements but no intermediate-marked element. In other words, the only crucial part of the PoA scale assumed here is that labials and dorsals are both more marked than coronals; the ranking between labials and dorsals is irrelevant.

- *Attestation*

The gapped [k p ʔ] inventory is found in onsets in the Polynesian languages Hawaiian, Luangiua, and colloquial Samoan (Pukui & Elbert 1979; Salmond 1974; Marsack 1962, Mosel & Hovdhaugen 1992 resp.).[111]   Outside Polynesia, the same inventory is found in two dialects of the Athapaskan language Chipewyan – Yellowknife (Haas 1968) and Fort Resolution (Rice 1978) (cf Fort Chipewyan Chipewyan – Li 1946,

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[111] The lack of [t] in Samoan and Luangiua is an independent development from Hawaiian; the languages are in entirely different subgroups (Clark 1976). The lack of [t] cannot be ascribed to physiological impairment (as was the lack of labials in Tlingit by Jakobson (1941:357-8)): this would not be able to explain why [t] exists in Formal Samoan and that speakers can switch between the two registers.

ch8§8.4), and the Southern Athapaskan languages Kiowa-Apache, Jicarilla, and Lipan (Haas 1968).

The [k p ʔ] inventory is found in codas in Yamphu (Rutgers 1998), Refugee Tibetan (Meredith 1990), and Chaoyang (Yip 1994).[112] Several English dialects also have this inventory, with Cockney English being particularly well documented (Sivertson 1960).

As an example, Cockney English has neutralization of PoA distinctions in codas. Specifically, /t/ neutralizes to [ʔ] in this position, as shown in (28). The column on the left shows the underlying form, the second column shows that /t/ neutralizes to [ʔ] in codas, and the third column gives evidence that /t/ is the underlying consonant.

(28)   Cockney Coda neutralization (Sivertsen 1960)

/nɔt/	[nɔʔ] 'not'	cf [nɔ.tɪʔ] 'not it'	(p.111)
/kʌt/	[kʌʔ] 'cut'	cf [kʌ.tɪʔ] 'cut it'	(p.110)
/stæɪt/	[stǽɪʔ] 'state'	cf [ðə.stæɪ.tjʊ.r̃ĩ] 'the state you're in'	(p.126)

In contrast, the highly marked /p/ and /k/ do not neutralize: [brɪk] 'brick', *[brɪʔ]; [ʌp] 'up', *[ʌʔ]. The output of Cockney neutralization is therefore a gapped coda inventory [k p ʔ]: it contains the least marked element [ʔ] and the highly marked [k] and [p], but lacks an element with intermediate markedness: [t].

Gapped coda inventories are especially important. It is crucial to show that gapped inventories come about through place neutralization rather than some other incidental process (e.g. lenition – see §5). Onset inventories are often uninformative in this regard since they typically do not show alternations. However, both Cockney English and Yamphu codas provide alternations: PoA neutralization clearly drives the elimination of [t], as it debuccalizes to [ʔ], just like Malay /k/.

6.3.1.1 Yamphu

The Nepalese language Yamphu provides a particularly clear case of a gapped [k p ʔ] inventory (Rutgers 1998). Yamphu onsets can contain any of the consonants in Table 6.7.

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[112] Yip (1994) argues that coda [ʔ] "is not a segment, but a feature of the entire morpheme". [ʔ] behaves distinctly from other stop codas: it does not contribute to weight, so [CVGʔ] (G is a glide) syllables are permissible, while *[CVG{p,k}] syllables are not. Even if [ʔ] is a feature, it is still possible that /t/ neutralizes to it, thus accounting for the gap in Chaoyang codas.

Table 6.7: Yamphu onset consonants

	labial	coronal		velar	glottal
stops	p	t	ts	k	ʔ
	pʰ	tʰ	tsʰ	kʰ	
	(b)				
fricatives		s			h
nasals	m	n		ŋ	
liquids		r ɭ			
glides	w		j		

The stops are voiced intervocalically and post-nasally, and are voiceless elsewhere.[113] Syllables have the form $(C_1)(C_2)V(ː)(C)$. Simple onsets can contain any of the consonants in Table 6.7 (except /ŋ/ is marginal). In complex onsets, C_1 can be a stop, fricative, or nasal; C_2 may be the trill [r], flap [ɭ], or glide [w].

- *Elimination of coronals*

Of the stops, only [k p ʔ] appear in codas. The coronal [t] can only appear in medial codas when it is part of a geminate: i.e. [tː], [tːʰ], [tːs], [tːsʰ]; this point will be discussed below. The ban on coronals runs throughout all manners of articulation: [n] is banned except before a homorganic consonant, and final [s] and [r] are also prohibited. The stops will be the focus of this section since they provide the most PoA contrasts (see §6.6.1).

There is abundant evidence that /t/ is eliminated in coda position through neutralization to [ʔ] (i.e. debuccalization). The evidence for /t/→[ʔ] is laid out in (29). The leftmost column shows the debuccalized form; debuccalization is found before all consonant-initial suffixes and word-finally, although only the infinitive suffix [ma] is given here for consistency's sake.

The final column provides evidence for the underlying form, consisting of the root plus a vowel-initial suffix (the root is underlined). Stops voice intervocalically, so /t/ surfaces as [d] in vowel-initial position (cf [tʰep-ma] 'to hit the top', [tʰeb-u-ŋ]; [sak] 'hunger' cf [sæg-æ]). Some verbs have a final geminate /tː/ underlyingly; the geminate still debuccalizes before a consonant, but emerges faithfully before a vowel (e.g. /kʰitː-ma/ → [kʰiʔma], cf [jaŋ-gʰitː-uŋ]). All data comes from Rutgers (1998:524-598).[114]

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[113] The only exception is /b/, which appears word-initially in a small number of words (p.18).
[114] For many more final-/t/ roots, see Rutgers (1998) – Rutgers helpfully provides underlying forms for all roots.

(29)   Yamphu coda PoA neutralization
(a) /t/→[ʔ]
[hæ:ʔ-ma]   'to bite'   [hæd-u-ŋ] 'I nibbled at'
[kʰæʔ-ma]   'to recede'   [he:-gʰad-a] 'the dryness receded'
[triʔ-ma]   'contrary'   [kap-trid-u] 'he has (unexpectedly)'
[leʔ-ma]   'to be brief'   [kʰæʔ-led-e] 'go briefly'
[kʰiʔ-ma]   'to bring'   [jaŋ-gʰit:-u-ŋ] 'I brought it for him'
[meʔ-ma]   'to allow'   [ram-met:-a-mi] 'they made me walk'
[peʔ-ma]   'important'   [ri:-ʔ-æm-bet:-e] 'spread it (important)'
[pʰæ:ʔ-ma]   'recessive'   [la:-bʰæt:-e] 'take it away'
[siʔ-ma]   'to hit'   [sit:-a] 'hit+past', [sit:-iŋ] 'hit+exp.'
(b) /p/→[p]
        [kʰap]   'language'
        [tsop]   'everybody, all'
        [optaŋ]   'head scarf'
        [kep-kʰad-i]   'Let's go sticking'
        [wapsa]   'chick'
        [kep-ma]   'stick + infinitive'
        [reploŋ]   'peeling of the skin'
(c) /k/→[k]
        [æʔlik]   'bendy'
        [kʰa:k-pa]   'scrape one's throat + perform act'
        [aktok]   'like that'
        [tsiktsiʔ]   'nasty, repugnant'
        [tsuksum]   'six days ago'
        [kʰa:k-ma]   'scrape one's throat + infinitive'
        [imakna]   'what-do-you-call-it?'
        [akjaʔwa]   'buttocks'
(d) /ʔ/→[ʔ]
        [ʔok-ma]   'find+infin.' (cf [tok-ma] 'open+infin.')
        [ji:w-æʔ-mu]   'river-possessive-down' (cf [kaniŋ-æʔæ] 'we-poss.')[115]
        [asiʔ]   'previously' (cf [asi.ʔ-em-ba] 'before')
        [ædæʔ-wa]   'a little' (cf variant [ædæʔ-a])
        [egeʔ-jæræŋ]   'on this side' (cf variant [egeʔ-æræŋ])
        [loʔ-wæ]   'leech' (cf [loʔ-æ] variant)

There is also evidence from nouns that /t/ debuccalizes to [ʔ] word-finally: [nam:iʔ] 'daughter-in-law' cf [nam:id-æʔ] {instrumental/ergative}.
Although only the infinitive *–ma* is used in the data in (a) above, [ʔ] appears before all sonorant-initial suffixes, as shown in (30).

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[115] The possessive has a number of phonologically conditioned allomorphs. Its basic form is /æʔæ/, but the final vowel is lost before consonants. For other alternations, see Rutgers (1998:65ff).

(30) Debuccalization of /t/ before other suffixes
    [tʰeʔ-na] 'I lifted you'
    [tʰeʔ-nimːa] 'we lifted you'
    [tʰeʔ-mini] 'I did not lift them'
    [tʰeʔ-ŋani] 'you did not lift me'
    cf   [tʰed-uŋ] 'I (dual) lifted you',
          [tʰed-adzuŋ] 'I (dual) lifted him'
          [tʰed-a] 'you lifted me'
          [tʰed-u] 'you lifted him'
          [tʰed-ami] 'they lifted me'

To complete the description, /t/ does not debuccalize before obstruents; it assimilates instead: /pit-kʰad-a/ → [pikːʰada] 'it started boiling' (p.42), /læːt-pe-ma/ → [læːpːema] 'to do' (p.43). Underlying glottals also geminate: /ham-beʔ-te/ → [hambetːe] 'where?', /hago-noʔ-so/ → [hagonosːo] 'even only now' (p.43). Geminate glottals are banned, so codas delete before glottals rather than debuccalize: /tʰet-ʔenːa/ → [tʰeʔenːa], *[tʰeʔːenːa] 'I lift' (p.605). An account of pre-glottal deletion will be provided below.

6.3.2 Ranking

A gapped inventory comes about through the action of faithfulness constraints that preserve marked features without preserving less marked elements.

In the Yamphu case, the labial [p] and dorsal [k] are preserved by ranking some constraint that preserves both over all markedness constraints that ban them in favour of another segment. Anticipating further developments, the ranking needed has IDENT{KP} over *{K}, *{KP}, and *{KPT}. The example in tableau (31) is [tsiptsok] 'marshy, soggy'.

(31) Preservation of the marked

/tsiptsok/	IDENT{KP}	*{K}	*{KP}	*{KPT}
☞ (a) tsiptsok		*	* *	* * * *
(b) tsiʔtsok	*!	*	*	* * *
(c) tsiptsoʔ	*!		*	* * *
(d) tsiʔtsoʔ	* *!			* *

- *Neutralizing /t/*
  As shown in §6.2, to neutralize /t/ to [ʔ] some markedness constraint against [t] must outrank all faithfulness constraints that preserve it: i.e. || *{KPT} » IDENT{KPT}, IDENT{KPTʔ} ||. The example used below is /namːit/ 'daughter-in-law', which surfaces as [namːiʔ] (cf [namːid-æʔ] {instrumental, ergative}).

(32)   Neutralization of the unmarked

/namːiʔ/	*{KPT}	IDENT{KPT}	IDENT{KPTʔ}
(a) namːit	*!		
☞ (b) namːiʔ		*	*

As with Malay, /t/ is blocked from neutralizing in onsets by an onset-specific IDENT constraint: either onset-IDENT{KPT} or onset-IDENT{KPTʔ} outranks *{KPT}. The opposite ranking would produce neutralization in all environments, as in Hawaiian and Yellowknife Chipewyan.

Importantly, the two sets of rankings just identified are compatible – they contain no contradictions. Figure 6.3 graphically illustrates this point.

Figure 6.3: Yamphu's gapped [k p ʔ] coda inventory ranking
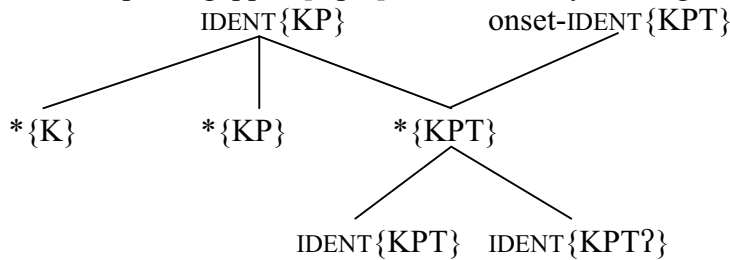
Tableau (33) illustrates Figure 6.3 with the word [sok-sæʔ] 'squeeze+pull', from /sok+sæt/.

(33)   Marked preservation with unmarked neutralization

/sok+sæt/	IDENT{KP}	*{KPT}	IDENT{KPT}
(a) soksæt		* *!	
☞ (b) soksæʔ		*	*
(c) soʔsæʔ	*!		* *
(d) soʔsæt	*!	*	*

Candidates (c) and (d) go too far in neutralizing [k], thereby fatally violating IDENT{KP}. Of the /k/-preserving candidates, (b) minimizes violations of *{KPT} by neutralizing /t/ to [ʔ]. The result is a coda inventory with [k p] and [ʔ], but no [t].

One final ranking is crucial in ensuring that /t/ neutralizes to [ʔ]: all constraints that favour coronals over glottals must be dominated by *{KPT}. Most importantly, this includes the sonority-based Glottal Elimination constraint *-Δ≥{glottal}. The opposite ranking will prevent /t/ from neutralizing to [ʔ], as shown in tableau (34) (also see §6.4, §6.6.3).

(34)

/namːit/	*{KPT}	*-Δ≥{glottal}
(a) namːit	*!	
☞ (b) namːiʔ		*

- *Medial assimilation*

To complete the account of Yamphu neutralization, something must be said about the behavior of coda [t] before stops and its appearance in geminates. As pointed out above, underlying /t/ does not turn into a [ʔ] before stops, it assimilates instead: /pit-kʰat-a/ → [pikːʰada] 'it started boiling', *[piʔkʰada] (p.42), /læːt-pe-ma/ → [læːpːema] 'to do' (p.43). Similarly, underlying geminates remain faithful: e.g. [sitː-a] 'hit+past', *[siʔta].

This pattern is common in cases of neutralization: assimilation pre-empts neutralization medially, so that it is only seen in word-final codas or in environments where assimilation is blocked (e.g. before sonorants). An account of this particular case of gemination is provided in ch.7:§3.2. I will briefly summarize the account here.

Assimilation beats neutralization in medial codas because a constraint banning heterorganic stop clusters – called ASSIM here (see ch.7 for discussion) – outranks the markedness constraint *{KPT}.

(35)   Assimilation beats neutralization in Yamphu

/læːt-pe-ma/	ASSIM	*{KPT}	IDENT{KPT}
(a) læːtpema	*!	* *	
☞ (b) læːpːema		*	*
(c) læːʔpema	*!	*	*

The constraint ASSIM bans all stop clusters that disagree in PoA: this includes both [tp] in (a) and [ʔp] in (c). At this point, the only remaining candidate is (b), even though it has a labial in coda position. Candidate (b) incurs one violation of *{KPT} as the geminate contains a single root node; nothing hinges on this point.

Crucially, ASSIM does not require stop+sonorant clusters to agree in PoA, so /læːt-ma/ will be realized as [læːʔma] since it does not violate ASSIM. In addition, ASSIM obviously cannot affect word-final consonants: /namːit/→[namːiʔ].

The ranking in (35) predicts that [ʔ]+stop clusters will be avoided generally in Yamphu: since ASSIM bans [ʔ+stop] clusters and it outranks IDENT{KPTʔ}, glottal stops cannot be retained before stops. This is the correct prediction: underlying glottals also geminate (e.g. /ham-beʔ-te/ → [hambetːe] 'where?'.

The final issue relates to the lack of assimilation of dorsals and labials: [kep-kʰad-i] 'let's go sticking', *[kekːʰadi]; [aktok], *[atːok]. Chapter 7 shows that this is unremarkable behavior: labials and dorsals can be prevented from assimilating by IDENT{KP}; thus, IDENT{KP} outranks ASSIM.

(36)

/ak$_1$t$_2$ok/	IDENT{KP}	ASSIM
☞　(a) ak$_1$t$_2$ok		*
(b) at:$_{1,2}$ok	*!	

Before moving on to generalize the result presented for Yamphu (§6.3.3), the ranking needed for gapped inventories with Glottal Elimination will be identified.

6.3.2.1 Glottal Elimination and gapped inventories

A gapped inventory with glottal elimination is one that lacks a labial and a glottal: i.e. [k t], [x s], [ŋ n].[116] For example, Gilbertese has only [k t in onsets (cf Ayutla Mixtec, with [k t ʔ] in onsets). Mordvin only allows [k t] in codas, but has [p] in onsets. Nunggubuyu also presents a good case of the [k t] type in codas: while onsets have dorsals, labials, and coronals [k p c ʈ t̪ t], codas can only contain dorsals and coronals: e.g. [ninik] 'soft', [wuʈpa] 'cocky-apple', [watpar] 'grevillea', [pacpara] 'mat' (Heath 1984:23); unfortunately, there are no alternations to show what happens to underlying /p/. The same is true of Hixkaryana (Derbyshire 1985:177, 179).[117]

For voiceless fricatives, there are a number of languages that ban [f] but have [x] and [s] (Yuma, Mansi, Atayal, Mataco-Noctenes). For nasals, Cayapa has [ŋ m n ɲ] in onsets, but only allows [ŋ n] in codas.

- *A gapped Cantonese secret language*

An interesting case that illustrates a gapped glottal-less inventory for both stops and nasals is found in reduplicant codas in a Cantonese secret language (Chao 1931, Yip 1982:656, Trigo 1988:54).

Cantonese has the stops [p t tʃ k kʷ] and nasals [m n ŋ], of which all but [tʃ] and [kʷ] can appear in coda position.[118] The secret language involves reduplication of the base with a number of attendant changes, exemplified by /kat/→[lat-kit]. The reduplicant's vowel is neutralized to [i] and the base's initial consonant is replaced with [l]. Of present interest is the fact that the reduplicant's coda undergoes neutralization: /p/ is realized as [t] and /m/ as [n]. Notably, [k] and [ŋ] do not undergo neutralization, resulting in a gapped reduplicant coda inventory of [k t] and [ŋ n].[119] The data is from Yip (1982:656); no glosses were given.[120]

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[116]　These particular examples are based on the proposal that dorsals are more marked than labials. Nevertheless, the argument stands even if the opposite holds since there are languages with [p t (ʔ)] and no [k], as shown in §6.2 (i.e. Malay).

[117]　Some dialects of Hixkaryana are reported to debuccalize [k t] codas to [ʔ].

[118]　Onset consonants are [p t tʃ k kʷ m n ŋ f s h l j w] and coda consonants are [p t k m n ŋ j w] (Kao 1971:59).

[119]　A minimally contrasting case is found in a Taiwanese secret language (Trigo 1988:54): both labials and dorsals undergo neutralization in reduplicants: [lapt̲s̲i̲t̲] 'ten', [liamt̲i̲n̲] 'tired', [lakp̲i̲t̲] 'north', [hɔŋh̲i̲n̲] 'wind'.

[120]　Yip does not cite any cases of a vowel-final root. This is important to show that the reduplicant's coda is not a prespecified coronal consonant. However, an almost identical Taiwanese language game shows the same pattern: vowel-final roots end up without a coda in the reduplicant: /a/ → [la i̲], *[la i̲t̲].

(37) <u>Cantonese Secret Language: Coda [k t], [ŋ n]</u>
　　(a) /t, n/ → [t, n]
　　　　/kat/　　→　　[lat-<u>kit</u>]
　　　　/tɕan/　→　　[lan-<u>tɕin</u>]
　　(b) /p, m/ → [t, n]
　　　　/ɕap/　　→　　[lap-<u>ɕit</u>]
　　　　/t'im/　→　　[lim-<u>t'in</u>]
　　(c) /k, ŋ/ → [k, ŋ]
　　　　/tɕœk/ →　　[lœk-<u>tɕik</u>]
　　　　/fuŋ/　→　　[luŋ-<u>fiŋ</u>]

The focus here is coda neutralization, so this will be the primary focus of the following discussion.

To force neutralization of labials, a markedness constraint that bans them (*{KP}) must outrank all relevant faithfulness constraints. As with Malay reduplication, the faithfulness constraints refer to the reduplicant: i.e. BR-IDENT{KP} and BR-IDENT{KPT}. For prior analyses that employ BR-IDENT constraints along the same lines, see Alderete et al. (1999)'s analyses of Tübatulabal and Nancowry.

The fact that labials are kept in onsets and the base indicates that *{KP} is dominated by relevant IO and onset faithfulness constraints: e.g. IO-IDENT{KP}.

(38)　<u>Reduplicant coda neutralization in Cantonese</u>

/tsap-RED/	IO-IDENT{KP}	*{KP}	BR-IDENT{KP}	BR-IDENT{KPT}
(a) lap <u>tsip</u>		* *!		
☞　(b) lap <u>tsit</u>		*	*	*
(c) lat <u>tsit</u>	*!			

Since dorsals are blocked from assimilating, some dorsal-preserving constraint must outrank all markedness constraints that ban dorsals. The only dorsal-faithfulness constraint available is IDENT{K} – this must outrank all markedness constraints, since all mention dorsals.

(39)　<u>Gapping in Cantonese reduplicants</u>

/pak-RED/	BR-IDENT{K}	*{KP}	BR-IDENT{KPT}
☞　(a) lak <u>pik</u>		* * *!	
(b) lak <u>pit</u>	*!	* *	*

The final aspect of this part of the analysis is the ranking needed to eliminate glottals. Since [ʔ] and [h] are banned in codas, *-Δ_σ≥glottal must outrank all glottal-preserving constraints IDENT{KPTʔ} and *{KPT}, as established above.

In short, the [k t] gapped inventory is produced by the rankings in Figure 6.4.

Figure 6.4: Cantonese gapped [k t] coda ranking

BR-IDENT{K}

*{K}   *{KP}   *-Δ_σ≥glottal

BR-IDENT{KP}   BR-IDENT{KPT}   BR-IDENT{KPTʔ}   *{KPT}
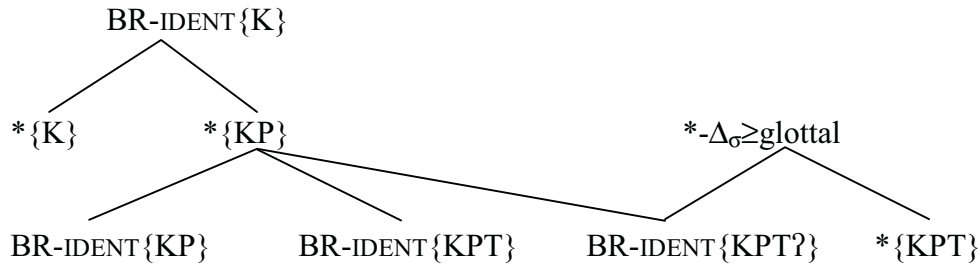
Several issues remain for this pattern. One major one is fixed segmentism: the reduplicant's vowel is always [i] and the initial consonant of the base is [l]. For recent analyses of fixed segmentism, see Alderete et al. (1999); Yip (2000) provides an analysis of a closely related dialect. Since this issue is tangential to the main point, it will not be discussed further here.

6.3.2.2 Ranking schema

To generalize the result of the preceding two sections, a gapped inventory is one in which a less marked element is neutralized but a more marked element is not.

Suppose there is an inventory I that is gapped in terms of a scale S. Therefore, there must be some S-element α that is neutralized – i.e. the rankings in (26) hold for /α/. There must also be some S-element β which is more marked than /α/, but is preserved. Therefore, some ranking in (26) does not hold for /β/.

A slightly simpler characterization of gapped inventories is offered in (40). This focuses on the 'primary' neutralization ranking, identified in (26a). Importantly, (40) does not replace the full set of conditions needed to ensure neutralization; it is only presented here tosimplify exposition of the core rankings.

The constraint form $M(\alpha>\beta)$ is a markedness constraint that favours α over β; $F(\alpha)$ is a faithfulness constraint that preserves α.

(40)   Gapped inventory ranking schema
         For some scale S,
         inventory I is gapped in terms of S if
                 (a) there is some $x \in S$ such that
                         for some $z \parallel \exists M(z>x) \gg \forall F(x) \parallel$
         and   (b) some $y \in S$ s.t.
                         (i) $\parallel \exists F(y) \gg \forall M(w>y) \parallel$
                 and   (ii) y is more marked than x in S.

Condition (40a) produces neutralization of scale element /x/: some markedness constraint that disfavours [x] outranks all /x/-preserving faithfulness constraints. In

contrast, there is some more marked element /y/ for which the opposite holds: some faithfulness constraint F(*y*) prevents /y/ from neutralizing.

For example, Yamphu /t/ satisfies condition (40a): || *{KPT} » IDENT{KPT}, IDENT{KPTʔ} ||. The more marked /p/ satisfies condition (40b): || IDENT{KP} » *{KP}, *{KPT} ||.

6.3.3   Other gapped inventories

This section aims to show how the general result identified in the previous section can be extended to other gapped inventories.

The primary case discussed is Nganasan's coda inventory of [p ʔ]. This inventory is gapped like Yamphu's in that it lacks /t/, but it is similar to Malay's in lacking a [k].

6.3.3.1 Nganasan

Nganasan has the consonants listed in Table 6.8, from Helimski (1998) and Olga Vaysman (p.c.).

Table 6.8: Nganasan Consonants

	labial	coronal	palatal	dorsal	glottal
stops	p	t	c	k	ʔ
	b	d	ɟ	g	
fricatives		s	ʃ		h
		ð	ʒ		
nasals	m	n	ɲ	ŋ	
liquids		l r	ʎ		

Syllables have the shape CV(V)(C). Rimes may contain a diphthong or a long vowel.

Codas can only contain a proper subset of the consonants in Table 6.8 (Helimski 1998:484). Of the sonorants, codas can contain nasals homorganic to the following consonant and the coronal liquids. Of present interest is the obstruent coda inventory: only [p] and [ʔ] are permitted. Helimski (1998) reports that the obstruents /t k s/ all demonstrably neutralize to [ʔ]; there are no clear alternations for the other obstruents (Helimski 1998:489). Examples for neutralization of coronals are provided in (41a), and for non-neutralization of labials in (41b).

(41)   Nganasan coda neutralization

(a) /t, d/ → [ʔ]

     /mat/   → [maʔ] 'house', cf [mað-ə] {genitive}

     /koðaʔa-t/ → [koðaʔa-ʔ] 'kill {3p}', cf [koðaʔa-ð-uŋ] {3pl+object}

     /kubu-t/   → [kubu-ʔ] 'skin + {predic.}', cf [kubu-t-uŋ] {3pl + indic.}'

     /kotu-t/   → [koðuʔ] 'kill+imper.pres.2sg', cf [kotu-ð-ə]

     /ɲintɨ-t/   → [ɲindɨ-ʔ] 'aux. negative + 3pl.', [ɲintɨ-ð-ɨŋ]

(b) /p, b/ → [p]

     [ɲerəptəː]   'first'

     [tapkətə]   'from there'

     [koðupsuðəm]   'kill {debitive, 1sg.}'

     [kuəɟymu nɨptia] 'man or woman'

     [koturuptuguɟ-]   base for 'continuously cause someone to kill'

- *Analysis*

The interesting aspect of Nganasan is that it not only eliminates [t] in codas, but [k] as well. Thus, it is a cross between Yamphu and Malay.

As in Yamphu, coda /t/ can be neutralized to [ʔ] through the ranking ‖ *{KPT} » IDENT{KPT}, IDENT{KPTʔ} ‖, shown in tableau (42). As in Yamphu, onset neutralization is blocked by a constraint on onset preservation: onset-IDENT{KPT}.

(42)   Elimination of /t/

/kotu-t/	*{KPT}	IDENT{KPT}	IDENT{KPTʔ}
(a) koðut	* * *!		
☞ (b) koðuʔ	* *	*	*

Again, /p/ can be preserved through the action of the faithfulness constraint IDENT{KP}; this must outrank all constraints that ban [p] – i.e. *{KP} and *{KPT}.

(43)   Preservation of /p/

/tapkətə/	IDENT{KP}	*{KPT}	*{KP}
☞ (a) tapkətə		* * * *	* *
(b) taʔkətə	*!	* * *	*

So far, nothing is different from the Yamphu ranking. However, the final analytic step is to neutralize /k/, setting Nganasan apart from Yamphu.

There is only one markedness constraint left that can be used to eliminate dorsals – *{K}. *{K} must outrank all faithfulness constraints that preserve dorsals – i.e. all faithfulness constraints. Since the other dorsal-eliminating constraints *{KP} and *{KPT} are already outranked by some faithfulness constraint, they cannot be used here.

(44)   Neutralization of /k/

	/piktə/	*{K}	IDENT{K}	IDENT{KP}
	(a) piktə	*!		
☞	(b) piʔtə		*	*

Figure 6.5 summarizes the Nganasan ranking.

Figure 6.5: Nganasan's gapped [p ʔ] coda inventory ranking

onset-IDENT{KPT}
|
*{K}
╱   ╲
IDENT{K}   IDENT{KP}
╱   ╲
*{KP}   *{KPT}
╱   ╲
IDENT{KPT}   IDENT{KPTʔ}
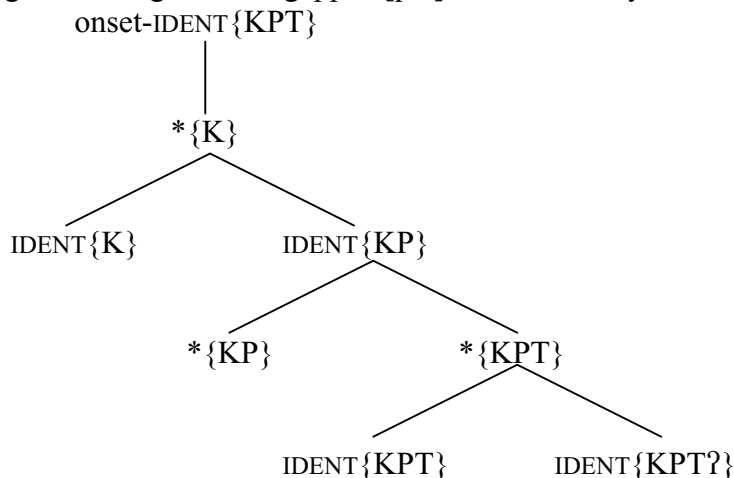
In short, Nganasan shows that the rankings used to produce gapped inventories and to eliminate highly marked elements are compatible.

6.3.4   The essentials of gapping

The preceding sections have shown how gapping works under the present theory. This section is devoted to showing that the present theory is successful because it has marked-faithfulness constraints. In other words, the aim of this section is to show why marked-faithfulness constraints offer the only possible account of gapped inventories.

Although §6.3.2 showed that the present theory can produce gapped inventories, it did not explicitly demonstrate that the reason for this was the marked faithfulness constraints. This section considers alternative faithfulness theories; it shows that there must be constraints that exclusively preserve marked elements.

- IDENT[Place]

The need for marked-faithfulness constraints can be illustrated by a theory without them. For example, Prince (1998) entertains the hypothesis that only one PoA-faithfulness constraint exists.[121] The faithfulness constraint IDENT[Place] preserves all PoAs equally.

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[121]   Prince & Smolensky (1993:ch.9§2) arrive at the same conclusion, though in terms of the Parse-Fill theory, not correspondence.

Prince (1997c, 1998) shows that the IDENT[Place] theory cannot produce gapped inventories (also see Prince & Smolensky 1993:ch.9). I will expand on this point here.

To produce an inventory like Hawaiian's [k p ʔ], the fact that /k/ and /p/ are retained can only be accounted for by ranking IDENT[Place] above all markedness constraints that ban [k] and [p] (i.e. *{K}, *{KP}, *{KPT}).

However, all markedness constraints that ban [t] also ban [k] and [p], and no faithfulness constraint preserves [k] and [p] without also preserving [t]. Therefore, there is no way to neutralize /t/.

(45)   The need for marked faithfulness

/taka/	IDENT[Place]	*{K}	*{KP}	*{KPT}
☞ (a) taka		*	*	* *
(b) ʔaka	*!		*	*
(c) ʔaʔa	* *!			

For /t/ to be eliminated, *{KPT} would have to outrank IDENT[Place]. However, this would also incorrectly eliminate /p/ and /k/.

This result does not depend on the markedness theory assumed. Even with a fixed ranking theory || *K » *P » *T » *ʔ ||, the result is the same. To ban /t/, IDENT[Place] must be outranked by *T, but this then implies that /k/ will also neutralize.

The same problem arises with faithfulness theories that have several different faithfulness constraints where none specifically preserve marked PoAs. For example, a theory with 'unmarked' faithfulness constraints (IDENT{ʔ}, IDENT{Tʔ}, IDENT{ʔTP}, IDENT{ʔTPK}) comes up against the same problem. For /t/ to neutralize, *{KPT} must outrank IDENT{Tʔ}, IDENT{ʔTP}, IDENT{ʔTPK}; this ranking will also force neutralization of /k/, though.

Thus, IDENT{KP} is essential in producing a [k p ʔ] inventory; analogously, IDENT{K} is necessary to produce [k t (ʔ)] inventories.

- *The Markedness Alternative*
  To show that the reasoning above is correct, it is also necessary to eliminate markedness-based alternatives.   Without marked-faithfulness constraints, the only alternative is to rely on a markedness constraint to produce the right results. To eliminate [t] using a markedness constraint without eliminating any more marked element would require a markedness constraint that assigns a violation to [t] but not to [k p] – i.e. *{T}. With the ranking, || *{T} » IDENT[Place] » M(k,p) ||, where M(k,p) is the set of markedness constraints that ban {KP}, only /t/ would be neutralized.[122]

Such an approach has obvious flaws.   The constraint *{T} eliminates the markedness relations between PoA: under the ranking || *{T} » *{KP} ||, coronals are more marked than labials and dorsals. This raises significant problems for direction of neutralization: the ranking || *{T} » *{KP}, *{K} || predicts a language in which all

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[122]   As shown by the ranking, *{T} is not in a fixed ranking with other PoA constraints. So, this type of theory is only one in which *{T} may dominate *{K} and *{P}.

coronals neutralize to labials in codas. Such languages do not exist: neutralization always proceeds towards the unmarked end of the scale, meaning that coronals cannot neutralize to the more marked labial PoA (§6). Tableau (46) shows that *{T} produces such a situation. This language also has Glottal Elimination.

(46)   No M(k∨p > t)

	/at/	*{T}	IDENT[Place]	*{K}
	(a) at	*!		
☞	(b) ap		*	
	(c) ak		*	*!

In short, a markedness-based approach to gapped inventories is doomed to failure – it requires markedness constraints that invert the markedness relations between scale elements. Since there is no markedness account of gapped inventories, faithfulness constraints bear the entire burden of accounting for their properties. A marked-faithfulness analysis therefore offers the only possible explanation of gapped inventories.

To summarize the reasoning presented above:

(a) As shown in (26), in order to preserve a PoA x, some faithfulness constraint that preserves x outranks all markedness constraints that disfavour x: $\| \exists F(x) » \forall M(y>x) \|$.

(b) The PoA-markedness constraints have the property that if y is less marked than x, then all markedness constraints that ban x also ban y.[123] So, $\| \exists F(x) » \forall M(x), \forall M(y) \|$.

(c) Now, suppose there were no marked faithfulness constraints. This means that there are no faithfulness constraints that exclusively preserve more marked elements. So, for all F(x), F(x) must also preserve all less marked elements y. Therefore, the final ranking is $\| \exists F(x,y) » \forall M(x), \forall M(y) \|$.

(d) From this ranking, since some faithfulness constraint that preserves y (i.e. F(x,y)) outranks all markedness constraints against y (i.e. M(y)), then [y] cannot be eliminated. Thus, preservation of x implies preservation of all less marked elements y in a theory without marked faithfulness constraints.

• *Surviving Theories*

Successful analysis of gapped inventories requires marked-faithfulness constraints. This leaves two general types of theory. One has faithfulness constraints that exclusively preserve marked elements. The marked-faithfulness theory presented here is of this type; as discussed in §6.1 the fixed ranking theory $\|$ IDENT{K} » IDENT{P} » IDENT{T} $\|$ also has this property. For example, the fixed ranking theory can produce elimination of /t/ and preservation of /k/ (i.e. part of the Yamphu system) through the ranking in (47).

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[123]   Or, in a fixed ranking theory, all markedness constraints that ban x outrank all markedness constraints that ban y. The result is the same.

(47)

/sok+sæt/	IDENT{K}	*{KPT}	IDENT{T}
(a) soʔsæt	*!	*	
(b) soʔsæʔ	*!		*
(c) soksæt		* *!	
☞ (d) soksæʔ		*	*

The other type of theory that can produce gapped inventories is a superset of the marked-faithfulness theories: it has both marked and unmarked faithfulness constraints; this type is discussed in chapter 7.

6.3.5 Summary

To summarize the findings of this section, marked-faithfulness constraints are essential in providing an account of gapped inventories. Without faithfulness constraints that preserve marked PoAs alone, only harmonically complete inventories can be produced (§3.3, Prince & Smolensky 1993:ch.9, Prince 1998).

In the present theory, a gapped inventory comes about when some PoA α is neutralized by the ranking $\| \exists M(\gamma > \alpha) \gg \forall F(\alpha) \|$ while a more marked element β is preserved by the ranking $\| \exists F(\beta) \gg \forall M(\delta > \beta) \|$ (M$(\gamma > \alpha)$ refers to a markedness constraint that favours γ over α). The reason that these two rankings are compatible follows from the fact that the faithfulness constraint that preserves the more marked element β need not also preserve the lesser-marked element α. For the [k p ʔ] inventory, this translates into the ranking $\| \text{IDENT}\{KP\} \gg *\{KPT\} \gg \text{IDENT}\{KPT\} \|$, as shown in tableau (48), reproduced from §6.3.2.

(48)

/sok+sæt/	IDENT{KP}	*{KPT}	IDENT{KPT}
(a) soksæt		* *!	
☞ (b) soksæʔ		*	*
(c) soʔsæʔ	*!		* *

As a concluding comment, although gapped voiceless stop inventories have been the focus of this section, they are found with other manners of articulation as well. An interesting case is found in Caribbean Spanish, described by Trigo (1988:72ff) and mentioned in c.5§5.1.3.2. For voiceless fricatives, [s] debuccalizes to [h] in codas: e.g. /tos/ → [toh] 'cough' (cf [tos-eh] 'coughs') (Trigo 1988:72ff). However, /f/ only optionally debuccalizes: [difteria]~[dihteria] 'diphtheria'. The effect is a gapped coda voiceless fricative inventory [f h], lacking [s]. The same fact holds for nasals. Trigo argues that /n/ debuccalizes to [N]: /tren/ → [treN] 'train' (cf [tren-eh] 'trains'). Again, /m/ only optionally neutralizes: [album]~[albuN] 'album', [adam]~[adaN] 'Adam'. However, nasal neutralization can be blocked by assimilation to the PoA of a following

stop: e.g. [tren ke], *[treŋ ke] 'train that' (cf [iN-seguro] 'insecure', [iN-finito] 'infinite' – there is no assimilation to fricatives). This is analogous to stop assimilation in Yamphu: an assimilation constraint blocks neutralization.

The next step is to show that while marked-faithfulness constraints can produce gapped inventories, they cannot produce unattested inventories – i.e. the 'disharmonic' type.

6.4   Disharmonic inventories

The remaining type of inventory is neither harmonically complete nor gapped: 'disharmonic' inventories differ from the other types in that they lack a least marked element: i.e. [K P], [K], and [P]. As a note, strictly speaking, inventories consisting of [K P T] are disharmonic in terms of the PoA constraints. Glottal Elimination promotes coronal to least marked status, though, so [KPT] inventories will be called harmonically complete.

The present theory predicts that disharmonic inventories never come about through PoA neutralization. They may come about through other incidental processes, such as lenition (§6.5), but no process motivated by the PoA markedness constraints will ever produce a disharmonic inventory.

This section is based on the claim that disharmonic inventories do not exist. Section 6.5 discusses inventories that are apparently disharmonic.

Section 6.4.1 shows why the present theory cannot produce disharmonic inventories.

Section 6.4.2 discusses the relation of deletion to disharmonic inventories. This section shows that a theory with MAX-feature constraints can produce disharmonic inventories while a theory with feature-specific IDENT constraints cannot. Furthermore, segment deletion is shown to create only harmonically complete inventories in the present theory, therefore setting deletion apart from neutralization.

6.4.1   Ranking

Barring incidental processes (see sec.3.4), the least marked element cannot be eliminated by neutralization in the present theory. This prediction follows from a property of Optimality Theory dubbed 'Harmonic Ascent' by Moreton (1999) (for discussion see McCarthy 2001b:101ff).

For a candidate to win, it must fare better than all others on both faithfulness and markedness constraints: i.e. it must be more harmonic on some dimension (hence 'harmonic ascent'). In the competition between an unfaithful candidate and the fully faithful form, the unfaithful candidate obviously cannot win on faithfulness. Therefore, if an unfaithful candidate wins, some markedness constraint must favour it over the fully faithful candidate. As an example, from input /k/ the unfaithful candidate [ʔ] could win over the faithful [k] because the markedness constraint *{K} favours the former over the latter. In contrast, from input /t/, the unfaithful candidate [p] can never win over [t] because no markedness constraint favours [p] over [t].

More generally, suppose that there is some segment α and no markedness constraint favours anything over α. There is then no way that any candidate but $[\alpha]$ can win given input $/\alpha/$: no other candidate will be less marked, and all others will be less faithful.

In terms of the PoA constraints alone, this is the case for $/ʔ/$. There is no PoA-markedness constraint that favours any other PoA over $[ʔ]$. Therefore, from input $/ʔ/$, the candidate $[ʔ]$ cannot lose to any other candidate on a markedness constraint, and it beats all others in faithfulness. Therefore, regardless of the ranking, $/ʔ/$ will always emerge as $[ʔ]$.

To illustrate this point, tableau (49) shows the competition between $[ʔ]$ and the next least marked segment $[t]$, from input $/ʔ/$. The constraints IDENT{KPTʔ} and *{KPTʔ} are the only ones that mention glottals, so only they are relevant to the competition.

(49)   No way to get rid of glottals

/ʔ/	*{KPTʔ}	IDENT{KPTʔ}
☞ (a) ʔ	*	
(b) t	*	*!

Tableau (49) shows that the ranking of IDENT{KPTʔ} and *{KPTʔ} is irrelevant; under either ranking $/ʔ/$ will be faithfully realized. The fact that both (a) and (b) violate *{KPTʔ} illustrates a general point about markedness constraints: the only way for $[t]$ to beat $[ʔ]$ is if a markedness constraint *favoured* $[t]$ over $[ʔ]$ – i.e. assigned a violation to $[ʔ]$ but not to $[t]$. Since no markedness constraint does this, $[t]$ can at best be equally as marked as $[ʔ]$. Therefore, faithfulness inevitably proves decisive.

In short, in terms of the PoA constraints $/ʔ/$ cannot be realized as anything but $[ʔ]$.[124]

6.4.1.1 The glottal/coronal universal

The result that glottals cannot be neutralized is artificial in the sense that it holds only of the PoA markedness constraints. This result is thwarted somewhat by the Glottal Elimination constraint *-$\Delta_\sigma \geq$\{glottal\}, which favours non-glottals over glottals. As shown in previous sections, if *-$\Delta_\sigma \geq$\{glottal\} outranks either (i) MAX or (ii) *{KPT} and IDENT{KPTʔ}, glottals can be eliminated from an inventory.

In this case, though, coronals graduate to 'least marked' status in terms of PoA. Having the least marked PoA, coronals therefore cannot be eliminated under any ranking. Tableau (50) illustrates this point. The ranking || *-$\Delta_\sigma \geq$glottal » IDENT{KPTʔ}, *{KPT} || ensures that glottals are banned from the inventory. With this ranking, the PoA constraints cannot force neutralization of $/t/$.

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[124]   One may ask "What if there is never any $/ʔ/$ in the input?" This question is irrelevant in OT given Richness of the Base.

(50)   Promoting coronals

/ti/	*-$\Delta_\sigma \geq$glottal	*{KPT}	IDENT{KPT?}
☞ (a) ti		*	
(b) ?i	*!		*
(c) pi		*	*!
(d) ki		*	*!

The coronal [t] wins in (50) because it graduates to least marked status: since glottals are eliminated for incidental reasons, there is no less marked available PoA than coronal: the candidates [pi] and [ki] cannot win because no markedness constraint favours [p] or [k] over [t]; furthermore, both are less faithful than [ti].

In short, the ranking of the PoA constraints in the marked-faithfulness theory is irrelevant to preservation of /t/ in neutralization.[125] As long as the ranking in (50) holds – producing (emergent) glottal elimination – any ranking of the PoA-faithfulness constraints will allow /t/ to emerge as [t].[126]

- *The Universal*

While coronals can be promoted to 'least marked' status by Glottal Elimination, no similar process can promote dorsals or labials above coronals. Evidence from epenthesis and targets of neutralization shows that dorsals or labials are never favoured over coronals by any markedness constraint (§6.6). Since there is no markedness constraint in CON that favours dorsals and/or labials over coronals, coronals and glottals cannot both be eliminated, leaving a [K P] inventory.

The result is the prediction for inventories in (51).

(51)   Universal for PoA Inventories
         For all inventories I,
                 for all manners *m* in I,
                       m contains
                               (i) a glottal,
                       and/or (ii) a coronal

Section 6.5 will introduce further caveats to (51), namely that incidental processes may change the manner of articulation of coronals, leaving only dorsals and labials. For example, /t/ may be lenited to [ɾ], leaving just [k p] as voiceless stops. Even in these cases, though, the input coronal PoA cannot be changed to a more marked PoA.[127]

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[125] Of course, /t/ may be eliminated due to other processes, like assimilation.
[126] The only caveat relates to deletion. If both *{KPT} and *-$\Delta_\sigma \geq$glottal outrank MAX (and other deletion-blocking constraints, like ONSET) then /t/ will emerge as ∅ (i.e. delete). However, in this case all other consonants will delete as well, regardless of their PoA. Of course, this does not create a system that lacks a [t] and [?] while retaining the more marked [p] and/or [k].
[127] An interesting prediction relates to PoA for geminates. Geminate glottals [?ː hː] seem to be remarkably rare, and clearly avoided in a number of languages. Thus, in all cases of geminates, coronals present the least marked PoA. Therefore – putting aside other interfering processes – coronal geminate voiceless stops should

- *Implications for Binary Scales*

The result just outlined can be generalized to all scales. For binary scales, its implication is that there can be no inventory consisting of just the most marked element.

For example, a two-valued (i.e. binary) scale on vowel nasality $| V^{nasal} \rangle V^{oral} |$ can be realized as two constraints: $*\{V^{nasal}, V^{oral}\}$ and $*\{V^{nasal}\}$. If $*\{V^{nasal}\}$ outranks all faithfulness constraints that preserve vowel nasality, the result will be an inventory without nasal vowels. However, no ranking can eliminate oral vowels: if $*\{V^{nasal}, V^{oral}\}$ outranks all faithfulness constraints, oral vowels will still surface as oral. The only other option – a nasal vowel – fares no better on markedness and worse on faithfulness, so oral vowels can never be neutralized to nasal ones.

Quasi-tableau (52) illustrates this point. The ☞ symbols indicate potential winners under some ranking. In contrast, the form (c) in which the oral vowel /o/ has been neutralized to the nasal [õ] will always lose because it is 'cumulatively' harmonically bounded by (a) and (b). In other words, every ranking will produce either (a) or (b) as a winner, but no ranking will let (c) win.

(52)

	/potã/	$*\{V^{nas}\}$	$*\{V^{nas}, V^{oral}\}$	IDENT$\{V^{nas}\}$	IDENT$\{V^{nas}, V^{oral}\}$
☞	(a) potã	*	* *		
☞	(b) pota		* *	*	*
	(c) põtã	* *	* *		*

The same result holds of all binary scales.

6.4.2   Deletion and MAX(Feature)

An aspect of the present theory that is crucial in banning disharmonic inventories is that neutralization is not allowed to compete with deletion.

To explain this point, the preceding sections have shown that a disharmonic inventory [k p] cannot come about through neutralization. However, inventories can also be formed by deletion. So, it is reasonable to be concerned that a disharmonic [k p] inventory could conceivably come about through deletion: i.e. /k p/ survive while /t/ and /ʔ/ delete. Since disharmonic inventories are never observed, they cannot be allowed to come about through deletion. Thus, a comprehensive theory of inventories must explain why deletion does not produce disharmonic inventories.

In the present theory, the reason that deletion (symbolized as ∅) cannot produce disharmonic inventories relates to the relative harmony of [T] and ∅. The form of the present theory's constraints ensures that if ∅ is more harmonic than [T] in a grammar, then ∅ is more harmonic than all other PoAs as well. Thus, if /T/ deletes, then so do [K] and

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always surface faithfully. Taylor's (197?) survey of geminates confirms this generalization: all of the 26 languages have coronal geminates, though not all have geminate dorsals.

[P] because ∅ avoids all PoA-markedness violations, and MAX is not sensitive to PoA distinctions, unlike IDENT.

More concretely, for /t/ to delete, some markedness constraint against [t] must outrank MAX – the constraint that bans deletion (McCarthy & Prince 1995). However, all markedness constraints that ban [t] in the present theory (i.e. *{KPT}, *{KPTʔ}) also ban all more marked elements – [p] and [k]. Therefore, if /t/ deletes, so do /p/ and /k/. This point is illustrated in tableau (53). The candidate with /t/-deletion only – (b) – loses to the candidate with deletion of all PoAs – i.e. (c).

(53)

	/kapito/	*{KPT}	MAX
	(a) kapito	* * *!	
	(b) kapio	* *!	*
☞	(c) aio		* * *

The next step is to show that no constraint can subvert the result in (53). In other words, there can be no constraint that bans (c) but not (b), while also eliminating (a).

For any constraint – markedness or faithfulness – to prevent deletion of K and P while letting T delete, the constraint would have to favour K and P over both T and ∅. This way, both [kapio] and [aio] would satisfy the constraint, but [kapio] would win on MAX.

No markedness constraint can be used to subvert the result in (53). To do so, there would have to be a PoA-markedness constraint that favoured K or P over T. There is no such constraint in the present theory, nor could there be in any theory; if there were such a constraint, it would incorrectly predict that T could neutralize to K and P (see §6.6).[128]

No faithfulness constraint can be invoked either. Such a faithfulness constraint would have to prevent /k/ and /p/ from deleting, without doing so for /t/. No faithfulness constraint in the marked-faithfulness theory can do this. For example, while IDENT{KP} prevents neutralization of /k/ and /p/ to a segment with a different PoA, it does not stop /k/ and /p/ from deleting. IDENT{KP} only requires corresponding segments to agree in PoA – it does not require every input segment to *have* an output correspondent. In effect, then, the marked-faithfulness constraints favour faithfulness and deletion equally: either staying faithful to the input or deleting will avoid violating IDENT. More concretely, candidates (a), (b), and (c) in (53) all violate IDENT{K}, IDENT{KP}, and IDENT{KPT} equally (i.e. not at all). Therefore, IDENT constraints cannot be used to favour (b) over (c).

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[128] The only way that a constraint like *{T} could exist in CON is if it were universally outranked by constraints against K and P.

6.4.2.1 MAX(Feature) and disharmonic inventories

The result identified above relies on there being no faithfulness constraint that favours K and/or P over T and ∅. If there were such a constraint, disharmonic inventories could come about through deletion.

Theories with MAX(feature) constraints have the potential for such faithfulness constraints (e.g. McCarthy & Prince 1994:fn.9, Lombardi 1995, 1999, Lamontagne & Rice 1995, McCarthy 1995, 2000b, Pater 1996, 1999, Zoll 1998, Causley 1997, 1998, 1999, Fukazawa 1999, Kingston 1999, Walker 2000).[129]   A fairly standard definition of a MAX(feature) constraint is provided in (54).

(54)   MAX(F)   "Every input feature F has a corresponding feature F' in the output and the values of F and F' are identical."

If there were PoA-specific versions of MAX(feature) such as MAX{KP}, then disharmonic inventories could occur. MAX{KP} requires an input dorsal or labial feature to be present in the output, and to retain the same value. Coupled with a ban on floating features, MAX{KP} can effectively prevent deletion of segments that contain an input dorsal or labial. Thus, /ka/ → [a] violates MAX{KP} while /ta/→[a] does not.

In effect, MAX{KP} favours K and P over both T and ∅. The result is that input /k/ and /p/ can survive while both /t/ and /ʔ/ delete.

(55)

/pitaʔe/	MAX{KP}	*{KPTʔ}	MAX
(a) pitaʔe		* * *!	
☞ (b) piae		*	* *
(c) iae	*!		* * *

In short, a theory with marked-MAX(feature) constraints predicts the existence of disharmonic inventories while a marked-IDENT theory does not. For other arguments against MAX-F (for completely different reasons), see Keer (1999:38ff) and Struijke (2001).

6.4.2.2 Limits on deletion

The present theory does not prohibit deletion entirely as an inventory-forming process. However, there are strong limits on deletion. To be precise, the theory makes the prediction in (56).

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[129]   These works have employed MAX-Feature constraints to account for a variety of processes. The processes most often discussed are cases of coalescence and floating features. For coalescence with IDENT constraints, see chapter 8 and Pater (1996) (cf Causley 1997, 1998); for floating features with IDENT constraints, see Struijke (2001).

(56) Inventory-forming deletion prediction
      Deletion can only form harmonically complete inventories

- *Harmonically Complete deletion in Lardil*

An example of how the theory can produce a harmonically complete inventory through deletion is found in Lardil (Hale 1973, Ito 1986, Wilkinson 1988, Prince & Smolensky 1993:ch.7).

Lardil has the consonants in Table 6.9, after Hale (1973). Hale's diacritics have been converted into IPA diacritics.

Table 6.9: Lardil consonants (Hale 1973, adapted)

	labial	lamino-dental	apico-alveolar	apico-domal	lamino-alveolar	dorsal
stops	p	t̪	**t**	ʈ	t̠	k
nasals	m	n̪	**n**	**ɳ**	n̠	ŋ
lateral			**l**			
flap			ɾ			
approximant	w			ɻ	j	

Only the apicals in bold and homorganic nasals are allowed in codas. The exception is /ʈ/, which turns into [ɻ] in codas. All other consonants delete, as shown in (57).

(57) Lardil Non-coronal Deletion (Hale 1973:424,425)

		Underlying	*Nominative*	*Non-future*
/p/	→ ∅	/ʈipiʈipi/ 'rock cod sp.'	→ [ʈipiʈi]	cf [ʈipiʈipi-n]
/t̪/	→ ∅	/t̪aɾawut̪a/	→ [t̪aɾawu]	cf [t̪aɾawut̪a-n]
/t/	→ [t]	/jaɻputi/ 'snake'	→ [jaɻput]	cf [jaɻputi-n]
/ʈ/	→ [ɻ]	/kiɾuʈa/ 'booby'	→ [kiɾuɻ]	cf [kiɾuʈa-n]
/t̪/	→ ∅	/t̪aput̪i/ 'older brother'	→ [t̪apu]	cf [t̪aput̪i-n]
/k/	→ ∅	/ŋaluki/ 'story'	→ [ŋalu]	cf [ŋaluki-n]
/m/	→ ∅	/muɾkunima/ 'nullah'	→ [muɾkuni]	cf [muɾkuni-n]
/n/	→ [n]	/pirŋen/ 'woman'	→ [pirŋen]	cf [pirŋeni-n]
/ŋ/	→ ∅	/peɾeŋ/ 'vagina'	→ [peɾe]	cf [peɾeŋi-n]
/l/	→ [l]	/kentapali/ 'dugong'	→ [kentapal]	cf [kentapali-n]
/ɾ/	→ [ɾ]	/peːɾ/ 'ti-tree sp.'	→ [peːɾ]	cf [peːɾ-in]
/ʈ/	→ [ʈ]	/mijaʈi/ 'kind of spear'	→ [mijaʈ]	cf [mijaʈ-in]
/w/	→ ∅	/kurumpuwa/ 'tata-spear'	→ [kurumpu]	cf [kurumpuw-an]

The following analysis follows the one proposed by Prince & Smolensky (1993:98ff) in its essentials.

Deletion of non-coronals in Lardil can be produced by having (i) *{KP} outrank MAX and (ii) MAX outrank all markedness constraints that ban less marked elements (i.e. *{KPT}, *{KPTʔ}). Tableau (58) illustrates this ranking.

(58)   Lardil Deletion Ranking

/puʈuka/	*{KP}	MAX	*{KPT}
(a) puʈuk	* *!		* * *
☞ (b) puʈu	*	*	* *

Candidate (a) is ruled out by the *{KP} as it contains too many non-coronals compared with (a).

Other outcomes – epenthesis and neutralization – are blocked by ranking DEP and IDENT{KP} above MAX, as shown in tableau (59).

(59)   Lardil Deletion Ranking

/puʈuka/	*{KP}	IDENT{KP}	MAX
(a) puʈuki̱	* *!		
(b) puʈut		*!	
☞ (c) puʈu			*

After Prince & Smolensky, ONSET blocks deletion in onsets, as shown below.

(60)   Lardil Deletion Ranking

/puʈuka/	ONSET	*{KP}	MAX
(a) uʈu	*!		*
(b) puʈuk		*!	
☞ (c) puʈu			

The lamino-dental [t̪] and lamino-alveolar [t̺] are also banned in codas. Hamilton (1993) proposes that laminals have a feature [laminal], which is essentially the same as [+distributed] (T.Hall 1997:144). Thus, *[+distributed] ranked above MAX will achieve the right result here.

Since [ʔ] does not appear in Lardil, *-Δ_σ≥{glottal} can also outrank MAX.

More extreme cases include Capanahua (Loos 1969) and Yaminawa Pano (Loos 1999), where all word-final stops delete.

- *Gapping and Deletion*

Deletion in Lardil is possible because the result is a harmonically complete inventory. The present theory predicts that the gap in gapped inventories cannot come about through deletion.

As an example, the lack of [t] in the gapped inventory [k p ʔ] can only be due to neutralization. If /t/ were deleted, *{KPT} must outrank MAX. However, this ranking forces deletion of dorsals and labials as well. As discussed above, no constraint can

prevent deletion of K and P without also preserving T. In short, there can be no language that is just like Yamphu except that coda /t/'s delete rather than neutralize.

An interesting case of a gapped coda inventory that further illustrates this point is found in Siuslawan (Frachtenberg 1922:456-7, Trigo 1988:108). Before [n], coda [k] and [t] are banned, leaving just [p] and a glottal. /k/ is eliminated by deletion: /taak-nxan/→[tanxan] 'this one thou', *[tahnxan]. Therefore, *K must outrank MAX.

Since /p/ survives faithfully, MAX must outrank all markedness constraints that ban [p]: i.e. *{KP}, *{KPT}, *{KPTʔ}. Since MAX now outranks all markedness constraints that ban [t], /t/ cannot be eliminated through deletion. Indeed, it neutralizes to [h]: [waayũtnɛ]~[waayũhnɛ] 'he is told', *[waayũnɛ].[130]

Similar facts are found in child language. For example, Pater & Barlow (to appear) report the speech of child LP65 to delete velars when possible: *adult* [klin] 'clean' vs *LP65* [jin]; *adult* [kloʊðz] 'clothes' vs *LP65* [joʊː].[131] In contrast, there seem to be no cases where children delete labials but keep dorsals (Joe Pater p.c.).

To conclude this section, the conclusions about MAX could also be extended to other non-IDENT faithfulness constraints like UNIFORMITY, LINEARITY, and DEP (McCarthy & Prince 1995). Like MAX, these constraints may not have feature-specific versions. The empirical implications of this point deserve separate exploration, so they will not be discussed further here (see Howe & Pulleyblank 2001 for feature-specific DEP constraints).

6.4.3 Summary

To summarize, marked-IDENT constraints do not allow disharmonic inventories. Two factors are essential in producing this result.

One factor is Harmonic Ascent (Moreton 1999). Harmonic Ascent prevents unfaithful candidates that are more marked than the faithful candidate from winning. Thus, the least marked element cannot be altered since no other candidate is less marked (or more faithful). As an example, /ʔ/ cannot yield anything but [ʔ] in terms of the PoA constraints alone: [t], [p], and [k] are all less faithful, and more marked.

Glottal Elimination can interfere with this result to promote coronals to least marked status. In such cases, coronals cannot be eliminated, again for Harmonic Ascent reasons. Taking Glottal Elimination into consideration, then, every manner in every inventory is predicted to have a glottal, a coronal, or both.

The other factor relates to the form of the marked-faithfulness constraints themselves. None of the marked-faithfulness constraints used here favour preservation of marked elements over deletion. For example, IDENT{KP} is equally satisfied by deletion

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[130] Catalan presents an apparent counter-example (Mascaró 1976, Hualde 1992:404). Word-final /n/ deletes while /m/ and /ɲ/ do not: [plɛ] 'full' (cf [plɛn-ə]), cf [som] 'we are', [sɛɲ] 'sense'. However, /n/ is deleted under complex conditions: it must be underlyingly (i) in absolute final position (cf /plɛn/ → [plɛns], *[plɛs], /kuntent/ 'happy' → [kuntén], *[kunté], cf kuntént-ə]), (ii) preceded by a vowel: /karn/ → [karn], *[kar] 'meat', and (iii) in a stressed syllable (cf [pətéʃin] 'they may suffer'). These factors suggest that /n/-deletion is not simply driven by PoA markedness considerations, but by some other condition, perhaps on prosodic structure.

[131] Velar deletion is blocked by the constraint ONSET, but then velars are neutralized to coronals: e.g. *adult* [geɪt] 'gate' vs *LP65* [deɪː].

or faithful preservation of /k/ and /p/. The effect is that disharmonic inventories cannot be produced by deletion. A disharmonic inventory consisting of just /k p/, having deleted /t ʔ/, would have to have some faithfulness constraint that favours preservation of [k] and [p] over [t], [ʔ], and deletion – the IDENT constraints do not fit this profile. In contrast, a constraint like MAX{KP} does, showing that MAX constraints cannot be feature-specific.

The lack of MAX(feature) constraints places a strong restriction on deletion as an inventory-forming process in the present theory: deletion can only produce harmonically complete inventories. This predicts that there can be no language with a gapped inventory where the gap comes about through deletion: i.e. there can be no Yamphu-like language with a coda [k p ʔ] inventory where /t/ deletes.

This section concludes with the point that the results in this section only hold in a localized sense: the theory predicts that disharmonic inventories cannot come about solely through the action of the PoA-markedness and -faithfulness constraints proposed here. However, CON contains a number of other constraints. The next section shows how these can create apparently disharmonic PoA inventories.

As a final note on deletion, the claim that MAX does not refer to subsegmental features does not mean that subsegmental features cannot play a role in deletion. Lombardi (1995) has observed that constraints like *[+voice] can motivate deletion of voiced segments through the ranking || *[+voice], IDENT[+voice] » MAX ||. Wilson (2000) observes that feature-referring constraints like *{K} could influence which of a set of consonants will delete. For example, *{K} would favour deletion of /k/ in both /kp/ and /pk/. However, Lombardi (1995) observes that in fact conditions on voicing cannot force deletion, and Wilson (2000) argues that PoA-markedness constraints cannot determine which consonant deletes. Unfortunately, Lombardi (1995) and Wilson (2000) propose theories that cannot be discussed here without going far from the theme of this chapter (cf McCarthy 2002b). So, in the interests of thematic unity, I regrettably forego discussion of their proposals here.

6.5   Interaction with other scales and processes

PoA neutralization can interact with many other processes. These processes can influence the outcome of PoA neutralization, producing apparently disharmonic inventories. The aim of this section is to show that processes such as lenition and nasalization can produce apparently disharmonic inventories, but that such cases are never the result of PoA neutralization.

Section 6.5.1 identifies several types of 'manner neutralizations'. In many cases, the manner of articulation of a segment may be altered, as in lenition of /t/ to the flap [ɾ]. The result can be a disharmonic [k p] inventory. Similar processes include conversion of voiced stops to nasals, and coalescence of nasals and vowels. This section shows that in each case the PoA constraints are not responsible. Moreover, PoA of unmarked segments is never converted to something more marked in a different manner of articulation.

The other major influence on disharmonic inventories is Glottal Elimination. The result can be the inventory [k p t], which – strictly speaking – is disharmonic in terms of PoA. Section 6.5.2 presents two relatively independent arguments: (i) that Glottal

Elimination is different from PoA neutralization, and (ii) that it is caused by a condition on sonority.

Section 6.5.3 summarizes the results of this section.

6.5.1 Manner neutralization

A variety of processes is subsumed under the term 'manner neutralization' here. Manner neutralizations cause one or more segments to change their manner of articulation, as in lenition of /t/ to [ɾ], or nasalization of /d/ to [n].

Manner neutralizations can create disharmonic inventories, though in almost all cases they do so in a clearly transparent manner. A disharmonic inventory can come about through manner neutralization when segments less marked in terms of PoA undergo the neutralization while more marked ones do not. The case studies below show how this situation can come about. It will turn out that marked-faithfulness constraints will prove essential in accounting for the reported patterns.

Section 6.5.1.1 discusses a neutralization dubbed 'nasal conversion' here. This refers to a process that turns stops into nasals in codas. In Dakota, only /p/, /t/, and /tʃ/ undergo this process, /k/ does not. The result is a disharmonic stop inventory consisting of just a velar. This section shows that the reason that /k/ does not undergo nasal conversion is not due to a desire to form a disharmonic inventory, but rather because the target of such conversion – [ŋ] – is otherwise banned in the language.

Section 6.5.1.2 discusses lenition, focusing on flapping. In some languages, only coronals undergo lenition (e.g. English). The remaining unlenited stops can form a disharmonic stop inventory of [k p]. Again, it is argued that this pattern is not motivated by a desire to eliminate coronal stops; instead, /k p/ are prevented from flapping by a constraint that prevents them from losing their Place of Articulation.

Section 6.5.1.3 examines cases of vowel+nasal coalescence. In some languages, only [m] appears in codas – [n] does not. This section shows that the marked-faithfulness constraints are crucial in producing this type of system: they prevent the /m/ from coalescing with the preceding nasal to form a nasalized vowel, but they do not do the same for a coda /n/.

Section 6.5.1.4 examines cases where allophony produces apparently disharmonic inventories. For example, in Gujarati /w/ is banned word-initially, so it changes into the voiced fricative [v]. However, since there are no other voiced fricatives, this creates a disharmonic inventory. This section shows how the present theory produces such cases.

6.5.1.1 Nasal conversion

Stops can be forced to turn into nasals in codas (e.g. Dakota, Ecuador Quichua, Kashaya). For example, the voiced stops [b d] turn into their nasal counterparts in Kashaya codas: [cad-u] 'look!' cf [can' pʰi] 'if he sees'; [mahsad-un] 'while taking it away' cf [mahsan'-qʰ] (Buckley 1994:48).

Dakota presents a case where such nasalization produces a disharmonic voiceless stop inventory in codas. Word-final stops /p t/ and the affricate /tʃ/ are optionally

converted into the nasals [m n] in codas.[132] However, [k] never nasalizes in this position: it simply voices to [g] (Shaw 1980: 367, 374). The data in (61) is from Shaw (1980:367-374).

(61) Dakota Stop Nasalization
    (a) /p/→[m] in codas

/RED-pot-a/	→ [potpota] ~ [ponpota]	'worn out, spoiled'
/RED-top-a/	→ [toptopa] ~ [tomtopa]	'four'
/nap-kawi/	→ [napkawĩ] ~ [namkawĩ]	'beckon with the hand'
/xap/	→ [xam] (cf [xap-a])	'to be stripped'

    (b) /t/→[n] in codas

/RED-ʔot-a/	→ [ʔodʔota] ~ [ʔonʔota]	'be many'
/o-kʰat-jaɣu/	→ [okʰad-jaɣu] ~ [okʰan-jaɣu]	'to be scorched in'
/sdot-ja/	→ [sdod-ja] ~ [sdon-ja]	'to know'
/ʃot/	→ [ʃon]	'be smoky'

    (c) /tʃ/ → [n] in codas

/aki-RED-hetʃa/	→ [aki-hen-hetʃa]	'withered, nearly dead'
/ʃetʃ-ja/	→ [ʃen-ja]	'dry'
/ʃitʃ-ja/	→ [ʃin-ja]	'badly'
/o-ʃitʃ-xã-ka/	→ [oʃin xãka]	'to act wickedly'
/wa-nitʃ/	→ [wa-nin]	'be without, lack' (cf [wa-nitʃ-a])
/ja-zitʃ/	→ [ja-zin]	'elastic, flimsy' (cf [ja-zitʃ-a])

    (d) /k/→[g] in codas

/wãjak/	→ [wãjag]	'to see' (cf [wãjak-a])
/ʃok/	→ [ʃog]	'thick, solid' (cf [ʃok-a])
/tʃek/	→ [tʃeg]	'to stagger' (cf [tʃek-a])
/ka-kʰak/	→ [ka-kʰag]	'to make dull noise' (cf [ka-kʰak-a])
[ojate-kĩ]~[ojate-g]		'the people' (stylistic variation)

Nasal conversion results in a disharmonic coda stop inventory consisting of just the velar [g]. However, it is clear that the disharmonic inventory is an incidental result of a non-PoA neutralization process. The reason that [k] does not nasalize is because the corresponding nasal [ŋ] is banned in the language.[133]

Stop nasalization can be motivated by a ban on low sonority coda consonants: i.e. *Δ_μ≤{+vd stop} (cf Zec 1995). Assuming that codas are moraic in Dakota, *Δ_μ≤{+vd stop} will ban all stops in codas. This constraint outranks all faithfulness constraints that preserve the stop's nasality and voicing (i.e. IDENT[±nasal], IDENT[±voice]). The requirement that stops retain their value for [continuant] (i.e. IDENT[±continuant]) will ensure that stops turn into nasals rather than fricatives.

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[132] If the voiceless stops are not converted into nasals, they undergo voicing assimilation to the following segment.
[133] The only situation in which [ŋ] can appear is before a dorsal stop. This comes about through assimilation of the coronal nasal only.

(62)   Nasal Conversion in Dakota

/ʃot/	*$\Delta_\mu \leq$\{+vd stop\}	IDENT[±continuant]	IDENT[±voice]	IDENT[±nasal]
(a) ʃot	*!			
(b) ʃod	*!		*	
☞ (b) ʃon			*	*
(c) ʃos		*!		

To prevent /k/ from nasalizing, a constraint against [ŋ] must outrank *$\Delta_\mu \leq$\{+vd stop\}. The present theory provides such a constraint: *\{K\}/nasal, a manner-specific version of *\{K\}. *\{K\}/nasal must outrank *$\Delta_\mu \leq$\{+vd stop\} to block /k/→*[ŋ]. However, this is not enough: *$\Delta_\mu \leq$\{+vd stop\} could still be satisfied by both nasalizing /k/ and changing its PoA: e.g. /k/→*[n]. This indicates that a dorsal-preserving faithfulness constraint must outrank *$\Delta_\mu \leq$\{+vd stop\} as well (i.e. any PoA-faithfulness constraint). Since [ŋ] is banned generally in the language, assuming that /ŋ/ is eliminated through PoA neutralization, *\{K\}/nasal must outrank IDENT\{K\}.

(63)   Blocking velar nasal conversion

/ʃok/	*\{K\}/nasal	IDENT\{K\}	*$\Delta_\mu \leq$\{+vd stop\}
☞ (a) ʃog			*
(b) ʃon		*!	
(c) ʃoŋ	*!		

The fact that /k/ doesn't turn into [x] can be accounted for by ranking IDENT[±continuant] above *$\Delta_\mu \leq$\{+vd stop\}.

The final issue is why /k/ does not remain faithful – i.e. [k], rather than voice. This can be ascribed to the effect of the emergent coda sonority constraint *$\Delta_\mu \leq$\{-vd stop\}, which bans voiceless stops in codas. As long as *$\Delta_\mu \leq$\{+vd stop\} outranks IDENT[±voice], codas will voice.

(64)

/ʃok/	*$\Delta_\mu \leq$\{+vd stop\}	*$\Delta_\mu \leq$\{-vd stop\}	IDENT[±voice]
(a) ʃok	*	*!	
☞ (b) ʃog	*		*

In summary, Dakota's disharmonic coda stop inventory [g] is not due to PoA neutralization; it is the result of a ban on low sonority elements that is blocked for dorsals.

Exactly the same pattern is found in Ecuador Quichua (Orr 1962). Of the stops [p b t d ts dz tʃ dʒ k g] only [k g] are found in codas ([tʃ] can appear in medial codas). However, this correlates with the fact that Ecuador Quichua only has the nasals [m n ɲ]. Again, dorsal stops are blocked from nasalizing to [ŋ], producing an apparently disharmonic inventory on the surface.

6.5.1.2 Lenition and flapping

It is not uncommon for stop inventories in certain structural positions to be the disharmonic [k p] or [g b], lacking a coronal. In these cases, though, it is usually transparent that the coronal is not eliminated by PoA constraints, but by lenition: specifically, conversion to a flap [ɾ] (for an extensive survey, see Kirchner 1998:ch.4§1.2.1). The non-coronal segments are blocked from lenition, resulting in a disharmonic inventory.

For contrast, an example where all stops spirantize will be presented first. Timugon Murut's voiced stop inventory is [b d g] (Prentice 1971). However, after vocoids, voiced stops, glottal stop, and clause-finally, these segments are lenited to [β ɾ ɣ] respectively.

(65)   Lenition in Murut (Prentice 1971:17)
        /balaʔ/ 'inform'   [naka-βalaʔ] 'has informed'
                                cf [mam-balaʔ] 'will inform'
        /balojti/ 'cramped'   [toodʒo βalojti] 'really cramped'
                                cf [balojti] 'cramped'
        /di/ 'of'   [amaʔ ɾi] 'father of' cf [anak di] 'child of'
        /maŋudad/ 'will scrub' [maŋuɾaɾ]
        /giti/ 'here'   [moːnsoj ɣiti] 'it's good here'
                                cf [molondom giti] 'it's dark here'

The constraint LENITE will be used to stand for the markedness constraints that motivate lenition. Lenition is taken to be essentially an increase in sonority here, brought about by assimilation to the manner (or [sonority]) features of neighbouring vowels. Following Kirchner's proposals (1998), LENITE does not target specific places of articulation, but applies to all PoAs equally.

If LENITE outranks all faithfulness constraints that preserve manner of articulation (called IDENT[manner] for brevity here), stops will be converted into more sonorant counterparts. In Murut, LENITE forces all medial stops to turn into segments with as high a sonority as possible. There are two conditions on lenition: one is that the stops must retain their [–nasal] feature (IDENT[±nasal]), so preventing /b/ from turning into [m]. The other is that stops must retain their input PoA (IDENT{KPT}): so /b/ cannot turn into the coronal [ɾ].

(66)   Murut lenition

	/roɡop/	IDENT{KPT}	IDENT[±nasal]	LENITE	IDENT[manner]
	(a) roɡop			*!	
☞	(b) roɣop				*
	(c) roŋop		*!		*
	(d) roɾop	*!			*

One other factor is essential in producing lenition in Murut. The constraint LENITE must outrank all markedness constraints that ban voiced fricatives (e.g. *{KP}/+CONT), otherwise lenition will be blocked.

In contrast to Murut, only coronals lenite in Abau (Bailey 1975). [t] is in complementary distribution with [ɾ] (which is in free variation with [l]): [t] appears pre-consonantally, while [ɾ] appears in other positions. In contrast, /k/ and /p/ are realized faithfully in all positions, with the exception that all stops are voiced after nasals.

(67) Abau lenition
      (a) [t] and [ɾ] in in complementary distribution

[ɾwak]	'to be'	[wɒndɛs]	'snake sp.'
[sipɾi]	'pigeon'	[ɾɒwpwatɾɒwp]	'all'
[ɾutsanoɾ]	'to slip'	[ɛtpɒw]	'sweat fly'

      (b) /k/ and /p/ are realized faithfully in all positions

[juwap]	'rib of sago palm frond'		
[ɒmbɒw]	'bow'	[pɒkɒn]	'now, today'
[papo]	'past tense'	[kikjɛ]	'to put'
[siup]	'stomach'	[ampɒk]	'a room'
[kɒŋgon]	'lice'	[jɒk]	'plant shoot'

The ranking that sets Abau apart from Murut relates to *{KP}/+CONT; with this constraint outranking LENITE, labial and dorsal stops cannot lenite. This is shown in tableau (68).

(68)

/pɒkɒn/	*{KP}/+CONT	LENITE	IDENT[manner]
☞ (a) pɒkɒn		*	
(b) pɒɣɒn	*!		*

As above, IDENT{KPT} prevents /k/ from turning into the flap [ɾ]. In contrast, since /t/ turns into [ɾ], *{ɣ,β} will not block coronal lenition.

(69)

/sipti/	*{KP}/+CONT	LENITE	IDENT[manner]
(a) sipti		*!	
☞ (b) sipɾi			*

So, as with Dakota nasal conversion, the disharmonic [k p] inventory comes about because the output of lenition for non-coronals is banned. Again, PoA neutralization has nothing to do with the surface disharmonic inventory. However, PoA-faithfulness is crucial: because IDENT{KPT} outranks LENITE, non-coronals are not allowed to change their PoA, indirectly resulting in a disharmonic inventory.

Although voiceless stops have been the focus here, the same effects can be found for voiced stop inventories. There are several languages in which the only voiced stops are [b] and/or [g] – the coronal [d] is not present. However, in the majority of these languages it is transparently obvious that the lack of [d] is due to a general lenition process that converts voiced stops into resonants, usually the flap [ɾ]. The reason it is obvious is due to the limited environments in which lenition applies – often only intervocalically. For example, Sirionó, Ocaina, and Warao have just [b], or [g], or both, but [d] and [ɾ] are in free variation. Tigak, and Roro have gone a step further: they both have [b] and [g], but [d] has lenited in every position to [ɾ] (the same for Makurap, though this has a [g] and no [b]). In other words, the lack of [d] is not due to constraints against coronal place of articulation, but rather to a general process that does not target Place of Articulation.

In short, disharmonic stop inventories can occur, but only if some process affects coronals alone.

As a concluding note, the present theory's predictions are somewhat different for fricatives. Manner-changing lenition seems to apply to voiceless fricatives only rarely (Kirchner 1998).[134] So, if there is no independent process that eliminates /s/ without eliminating other voiceless fricatives, no language can be without an [s] or [h]. The survey of languages reported in Appendix A did not yield any language that lacked both [s] and [h], having just [x f].[135]

6.5.1.3 Vowel+nasal coalescence

This section deals with a process that can produce disharmonic nasal inventories in codas. When only coronal nasals coalesce with a preceding vowel, the result can be a surface nasal inventory consisting of only non-coronals.

A relevant case is found in Chickasaw (Munro & Ulrich 1985, Trigo 1988:111). On the surface, the coda inventory is disharmonic, consisting solely of [m]. This is because underlying /Vn/ surfaces as a nasalized vowel: /cholhkan-a-n/ → [cholhkanã] 'spider-object', cf [apa-ta-m] 'eat-question-past'.[136]

Such nasalization can be seen as arising from a general ban on codas (NOCODA). To motivate vowel-nasal coalescence, NOCODA must outrank UNIFORMITY – the anti-coalescence faithfulness constraint (for a full analysis of coalescence, see ch.8).

The reason that only /n/ coalesces can be related to the loss of consonantal place features. If /m/ coalesces with a vowel, the /m/'s labial PoA feature would be lost, fatally

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[134] /s/ did surface as /r/ in Latin between vowels (*hono_s_-hono_ris_*), but this type of change seems rare.
[135] The only exception is Cubeo. Morse & Maxwell (1999) report that Cubeo has [x] and no other fricatives (p.3). However, there seems to be a process of affrication whereby /s/ becomes [tʃ]: all stridents in Spanish loanwords are realized as [tʃ]. The fact that /x/ does not undergo affrication can be accounted for by a high-ranking ban on [kx]. Thus, affrication parallels the flapping process: /x/ alone of the fricatives survives because it is blocked from an otherwise general fricative-elimination process.
[136] Medial codas are placed under more stringent restrictions: both /m/ and /n/ end up as nasalization: [im-oka] 'his water', cf[ĩ:nita] 'his bear', [ĩ-ʃoloʃ] 'his shoe'. *{KPT}{KPT} may outrank IDENT{KP} here, banning medial labials. See ch.7 for details.

violating IDENT{KP}. In contrast, /Vn/ coalescence would only require unfaithfulness to the coronal PoA.[137]

(70)   Nasal Coalescence

	/ta₁n₂ka₃m₄/	IDENT{KP}	NOCODA	IDENT{KPT}	UNIFORMITY
	(a) ta₁n₂ka₃m₄		* *!		
☞	(b) tã₁,₂ka₃m₄		*	*	*
	(c) tã₁,₂kã₃,₄	*!		*	* *

Candidate (a) gratuitously violates NOCODA by retaining both nasals. In contrast, while candidate (c) satisfies NOCODA, it does so at the expense of losing the marked PoA feature 'labial'. The coalescence of /am/ to [ã] fatally violates IDENT{KP}. In contrast, coalescing /an/ to [ã] does not violation IDENT{KP} since the fusion only involves losing the unmarked coronal feature. As shown in the tableau, IDENT{KPT} must be ranked below NOCODA for /n/-coalescence to take place at all.

In short, although Chickasaw has a disharmonic nasal coda inventory, it does not come about through PoA neutralization.

Vowel-nasal coalescence is fairly common, and usually has the same result as Chickasaw. However, some cases do not show overt alternations. For example, in Chaoyang coda coronals are banned, resulting in a nasal inventory of [ŋ m] (Yip 1994). Since nasal vowels are in complementary distribution with [Vm] and [Vŋ] sequences (i.e. *[Ṽm], *[Ṽŋ]), it is likely that nasal vowels derive from underlying /Vn/ sequences. Again, it is arguable that /n/ coalesces with a preceding vowel while other nasals do not (cf Yip 1994§3.1).

- *Other nasal-eliminating processes*

Two other processes can produce apparently disharmonic nasal inventories. One is where nasals are apparently neutralized to [ŋ];§6.6.1 argues that this is actually neutralization to [N] – a harmonically complete inventory.

The other is conversion of nasals to laterals. For example, Lawton (1993:21) reports that [n] is in free variation with [l] in Kiriwina codas. This results in a coda nasal inventory that consists of [m] alone. As with lenition, this can be seen as a general process of nasal→liquid conversion, with /m/→[l] blocked by the PoA-faithfulness constraints since there is no labial liquid in the language.

6.5.1.4 Sonorant allophones

In the cases discussed so far, disharmonic inventories have come about when a highly marked segment has been blocked from undergoing an otherwise general

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[137] Hume (1991) and Clements & Hume (1995) have proposed that vowels and consonants share the same PoA features. This model of PoA features is not incompatible with the present proposal: the authors cited propose a difference between consonantal and vowel Place features. Coalescence of vowels and nasals can be seen as a loss of specifically C-Place features, in their terminology.

neutralization of manner. An analogous situation is found with certain cases of allophony. For example, [v] is the only voiced fricative to appear on the surface in Gujarati. However, it is in complementary distribution with the glide [w], and the two are demonstrably related in alternations. This section will show how allophonic processes can produce apparently disharmonic inventories.

A number of languages have the voiced fricative [v] but not the coronal [z] (e.g. Tahitian, Gujarati). In all such cases, there is evidence that (i) voiced fricatives are banned in general and (ii) [v] is related to an approximant [w] or [ʋ]. This section will focus on the Gujarati situation.

- *Description*
  Gujarati's consonant inventory is provided in Table 6.10 (Cardona 1965).

Table 6.10: Gujarati Consonants

	labial	dental	alveolar	palatal	retroflex	velar	glottal
-vd stops	p	t̪		tʃ	ʈ	k	
+vd stops	b	d̪		dʒ	ɖ	g	
fricatives		s̪ (z̪)		ʃ			
nasals	m	n̪		(ñ)	ɳ	(ŋ)	N
laterals			l		ɭ		
flap			ɾ				
glides	w~v			j			h

Generally speaking, voiced fricatives are banned. [z] only appears in loanwords and [ɣ] is banned. However, [v] does appear in certain environments: in mono-segmental onsets (e.g. [vat] 'manner'), and as the first member of bisegmental onsets (e.g. [vjas] {proper name}). Thus, in certain environments, there is a disharmonic voiced fricative inventory consisting of [v] alone.

The proposal advanced here is that this fact can be explained in much the same way as the cases discussed in previous sections. All voiced fricatives undergo a general neutralization process. However, neutralization of /v/ is blocked in specific environments (just as /k/→[ŋ] is blocked in Dakota, or /b/→[β] is blocked in Abau). The result is an apparently disharmonic voiced fricative inventory.

To provide a full account of this proposal, it is necessary to point out that [w] and [v] are in complementary distribution, as described in (71).

(71)   Gujarati [v]~[w] distribution
        (a) [v] appears in
                (i) monosegmental onsets
                        [vat] 'matter, story'
                        [səvar] 'morning')
                (ii) as the first member of complex onsets
                        [vjas] {proper name}
                        [vrət] 'a vow'
        (b) [w] appears in
                (i) codas
                        [bʰaw] 'price'
                        [kew.ɻo] 'how big?'
                (ii) the second member of onsets
                        [dwara] 'by means of'
                        [swikar] 'acceptance'

- *Eliminating /v/*

Since [v] and [w] are in complementary distribution, it is likely they are allophones. Therefore, /v/ and /w/ must neutralize to [v] in the environments in (71a), and to [w] in the environments in (71b).

The fact that /v/ neutralizes to [w] gives a clue as to the fate of other voiced fricatives – it is reasonable to assume that they turn into sonorants.[138] Thus, a constraint that bans voiced fricatives (*VDFRIC for short) must outrank both IDENT[±vocoid] and IDENT[±sonorant]. On all other features, [v] and [w] agree.

(72)

/bʰav/	*VDFRIC	IDENT[±sonorant]	IDENT[±vocoid]
(a) bʰav	*!		
☞ (b) bʰaw		*	*

All other options involve violating faithfulness to continuancy, voicing, and nasality, so IDENT[±continuant], IDENT[±voice], and IDENT[±nasal] outrank the IDENT constraints in (72).

- *Blocking* /v/→[w]

However, [v] surfaces faithfully when it appears as the first member of an onset: e.g. [vat], [vrət]. This can be ascribed to avoidance of high-sonority onsets – i.e. glides. Such bans are found elsewhere, as discussed in §6.5.2.2. The prohibition is implemented by the constraint *-Δ_μ≥{glide}, which bans all segments that are equally or more sonorous than glides in onset position. With *-Δ_μ≥{glide} outranking *VDFRIC, /v/→[w] is blocked in onset position.

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[138] More precisely, /v/→[w], /z/→[ɾ], and /ɣ/→[w]. For discussion of the PoA of [w] and its participation in allophony, see Ohala & Lorentz (1977) and Appendix A.

(73)

	/vat/	*-$\Delta_\mu \geq$\{glide\}	*VDFRIC
☞	(a) vat		*
	(b) wat	*!	

/v/ cannot neutralize with any other segment because the faithfulness constraints on continuancy, nasality, and voicing mentioned above block all other segments.

However, /v/ does surface as [w] when it is the second member of an onset: e.g. [dwara], *[dvara]. This indicates that yet another constraint bans [v] in just this position. A restriction on sonority-distance will achieve the right result: [d] and [v] are too close in sonority. More generally, only clusters where the second member is a sonorant are allowed in Gujarati. Thus, the constraint SONDIST must outrank *-$\Delta_\mu \geq$\{glide\} (for theories on the form of SONDIST see Baertsch 1998, Gouskova 2002 and references cited therein).

(74)

	/dwara/	SONDIST	*-$\Delta_\mu \geq$\{glide\}
☞	(a) dwara		*
	(b) dvara	*!	

The same type of alternation does not happen for other voiced fricatives like /z/. Neutralization of /z/ does not encounter the same problems as [v] (i.e. *-$\Delta_\mu \geq$\{glide\}) because /z/ can absolutely neutralize to the non-glide [ɾ] (analogous to Latin). Since [ɾ] is allowed in all positions, /z/→[ɾ] neutralization will never be blocked. Thus, for incidental reasons, of the voiced fricatives only /v/ will ever be realized faithfully.

- /w/→[v]

What makes Gujarati interesting is that there is a complementary process of /w/→[v] neutralization. Thus, /w/ neutralizes to [v] in onset-initial position: *[wat], *[wras]. The same constraints that were identified above can be used here. With *-$\Delta_\mu \geq$\{glide\} and SONDIST outranking all /w/-preserving constraints, /w/ will neutralize to [v] in onset-initial position.

(75)

	/wat/	*-$\Delta_\mu \geq$\{glide\}	IDENT[$\pm$sonorant]	IDENT[$\pm$vocoid]
	(a) wat	*!		
☞	(b) vat		*	*

/w/ neutralizes to [v] rather than some other segment because [v] is the most faithful available segment: it preserves all of /w/'s features (i.e. PoA, voice, continuancy) except for [+sonorant] and [+vocoid].

This point provides an account for why the palatal glide /j/ does not neutralize in onsets: although *-$\Delta_\mu \geq$\{glide\} assigns a violation to onsets with [j], /j/ cannot neutralize to

a less sonorous element: all other options are too unfaithful. Specifically, there is no segment that shares /j/'s PoA, continuancy, and voicing (as /w/→[v] does): [z] is not palatal, [ʃ] is not voiced, and [dʒ] is not a continuant (after Clements 1999). Formally, this can be modeled by having IDENT[±voice], IDENT[±continuant], and IDENT{KPT} outrank *-$\Delta_\mu \geq$ {glide}.

In summary, the Gujarati disharmonic voiced fricative inventory, consisting of just [v], comes about because (i) /v/→[w] is blocked in certain environments, and (ii) /w/→[v] is required in certain environments.

- *Generalizing the result*

Allophony and blocking of neutralization produces disharmonic inventories in a number of languages.

A number of languages take the Gujarati pattern further, neutralizing /w/ to [v] in all environments (e.g. Pāli – Geiger 1943, Fahs 1985; most Polynesian languages – Clark 1976:20; Russian – Lightner 1965). In all these cases, there is no surface [w], and [v] (by virtue of its derivation) acts like a surrogate glide. For example, [v] behaves just like its close relative Maori's [w] for several processes, including dissimilation (de Lacy 1997b). Pāli [v] acts like a glide in coalescence, a case described in detail in ch.8§8.5.[139] In a related example, the only voiced fricative in Huariapano is [β] (Parker 1994a). Parker notes that its realization "fluctuates between a stop, a fricative, and a glide articulation". Again, there is a correlation between the voiced fricative and glide.

An analogous situation can be ascribed to the relation between voiced stops and nasals in some languages.[140] This is arguably the case for Koasati [b] (Kimball 1991). The consonant inventory is as follows:

Table 6.11: Koasati consonant inventory

	labial	coronal	palatal	dorsal	glottal
stops	p	t	tʃ	k	ʔ
	b				
fricatives	ɸ	s	ʃ		h
nasals	m	n			
liquids		ɬ l			
glides	w		j		

Kimball's (1991) grammar of Koasati provides a detailed account of the phonetics and phonology of [b]. He notes that [b] has "a nasal quality" and that it "patterns more frequently with resonants than with stops" (p.20). Indeed, in terms of medial consonant clusters, [b] patterns with the nasal [m] in only allowing the low sonority [t k] and [h] to follow it. In contrast, [p] and [f] allow both low sonority [t k h] and high sonority [n] or [l]

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[139] In some cases, it is possible that the segment [v] has been misreported, and is actually the approximant [ʋ].
[140] The cases of disharmonic voiced stop inventories were found by searching UPSID. Several cases listed as lacking a [d] were found to in fact have one: Dakota, Kewa ([ᵐb ⁿd], Nasioi, Nenets (Tundra has [b d]), Paya ([b d g],o r perhaps [pː tː kː]), Seneca ([b] (and [m]) appear in three or so nicknames).

to follow them. So, it is possible that the segment realized as [b] is derived from an underlying sonorant, or is even phonologically specified as a sonorant. The same situation (i.e. [b] but no [d]) occurs in other Muskogean languages (Alabama, Muskogee, Koasati, Chickasaw, and Chocktaw).

Another relevant case is Mura-Pirahã, which is reported as having the consonants: [p t k ʔ b g s h][141] (Heinrichs 1964). Notably, there is no [d]. However, Dixon & Aikhenvald (1999b:354) point out that /b/ has allophones [m] and a bilabial trill. /g/ has a rather curious double-flap allophone ([ɾ ̮β]) (Everett 1982). Again, voiced stops are banned generally, but appear as allophones of sonorants.

In short, disharmonic inventories can come about through allophony as well as blocking of neutralization. The same pattern holds here as in the previous cases of manner neutralization: disharmonic inventories come about when – for incidental reasons – a neutralization that applies to all segments with a certain manner of articulation is blocked in a specific environment for only one of those segments.

6.5.2 Glottal Elimination

As mentioned in sections 6.2 and 6.3, languages may lack glottals. This section argues that the lack of glottals in those languages is not due to PoA neutralization. Instead, some other process is responsible for the elimination of glottals, just as flapping is responsible for the elimination of [t] in many languages, and nasal coalescence is responsible for the lack of coda [n].

There are two relatively independent parts to this section. The first (§6.5.2.1) argues that Glottal Elimination cannot be PoA neutralization. The arguments stem from facts relating to direction of neutralization and from asymmetric behavior in neutralization of non-glottal PoAs.

The second part (§6.5.2.2) proposes that Glottal Elimination derives from a ban on high sonority onsets. Glottals are argued to be highly sonorous elements. From this, Glottal Elimination is argued to be the elimination of highly sonorous segments in syllable margins, analogous to the elimination of glides in Gujarati.

6.5.2.1 Glottal Elimination is not place neutralization

In the present theory, the lack of glottals in some languages cannot be ascribed to the action of the PoA constraints. As shown in §6.4, since 'glottal' is the least marked PoA, it cannot be eliminated by the PoA constraints alone.

- *The subset relation*
There are empirical reasons to think that Glottal Elimination is not the same as PoA neutralization processes. A striking reason relates to the 'subset' relation between onsets and codas.

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[141] Everett (1982) reports that /hi/ → [k]. For women, /s/→[h]/_i and sometimes everywhere. So, the woman's register of Pirahã has only the phonemes /p t ʔ b g h/.

A number of authors have argued that there is a relation between PoA contrasts in onsets and codas: the PoA contrasts found in codas are always a subset of those found in onsets (Trubetzkoy 1939, Beckman 1998, Goldsmith 1990, and references cited therein).

If attention is restricted to non-glottal PoAs, this generalization is valid. More specifically, none of the languages listed in Appendix A have a dorsal in the coda without having one in the onset; the same is true for labials and coronals. For example, there is no language with [p t] in its onset but [k p t] in the coda.[142]

However, Parker (2001) shows that the same is not true for Glottal Elimination. If a language allows glottals in its coda, this does not necessarily mean that it also permits them in onsets. He points out that the Peruvian language Chamicuro allows the voiceless fricatives [s h] in codas but only [s] in onsets (also Parker 1994b, to appear). Parker cites further examples, including Macushi Carib, which allows only [s] in onsets, and only [h] in codas. For stops, §6.2 showed that Standard Malay allows [ʔ] in codas but not in onsets.

In contrast, some languages have glottals in onset position but not in codas. For example, Yuma has [k p t ʔ] in onsets but only [k p t] in codas. Similarly, Lamani allows [s h] in onsets, but only [s] in codas.

To summarize, elimination of non-glottal PoAs obeys the Subset generalization, while glottal elimination does not. This difference is summarized in the tables below.

Table 6.12: Glottals and the subset generalization

(a) *Glottal Distribution*			(b) *Non-Glottal Distribution*		
onsets	*codas*	*language*	*onsets*	*codas*	*language*
✓	✓	Apalai Carib	✓	✓	English [k p t]
✓	✗	Yuma [ʔ]	✓	✗	Kalantan Malay
✗	✓	Chamicuro [h]	✗	✓	-
✗	✗	Maori [ʔ]	✗	✗	Djapu (fricatives)

To explain, Table 6.12(a) shows that any configuration of glottals is permitted. There are languages that allow glottals in (i) both onsets and codas (Apalai Carib), (ii) onsets only (Yuma for [ʔ]), (iii) codas only (Chamicuro for [h]), and (iv) neither in onsets nor codas (Maori for [h]). Table 6.12(b) shows that the same is not true of any non-glottal PoA. There are languages that allow non-glottals in both onsets and codas (e.g. English), and there are languages that allow non-glottals in onsets but not codas (e.g. Kalantan Malay has [k p t] in onsets but just [ʔ] in codas). However, there is no language that allows a certain non-glottal PoA in codas but bans it in onsets: for example, such a language would allow [k] in codas but not in onsets.

There are also languages that ban all non-glottal fricatives in both codas and onsets. There is no analogous case for stops, but this is no doubt due to functional reasons (as discussed in §6.2.1, §6.3.1). Of course, there are languages that ban a *subset* of non-glottal stops in both onsets and codas (e.g. Ayutla Mixtec bans [p] in both positions).

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[142] The exception is nasal inventories: a language may have [ŋ] in the coda but not in the onset. In §6.6.3.1 I propose – extending Trigo's (1988) theory – that the [ŋ] in such cases is actually [N].

• *Theoretical Implications*

Beckman (1998) provides an explanation for the asymmetric nature of non-glottal PoA neutralization. Beckman shows that context-free markedness constraints coupled with onset-specific faithfulness constraints cannot produce a system with more contrasts in codas than in onsets. Tableau (76) shows why this is so. The markedness constraint *{K} bans dorsals, IDENT{K} preserves dorsals, and onset-IDENT{K} preserves dorsals in onset position. ☞ points to possible winners: i.e. winners under some ranking.

(76) The subset generalization in velar neutralization

/kak/	onset-IDENT{K}	IDENT{K}	*{K}
☞ (a) kak			* *
☞ (b) kaʔ		*	*
(c) ʔak	*	*	*
☞ (d) ʔaʔ	*	* *	

The tableau shows that the form [ʔak] cannot win under any ranking – this form neutralizes [k] in onsets but not in codas. It cannot win because it is collectively harmonically bounded (Samek-Lodovici & Prince 1999). If *{K} dominates, (c) will lose to (d); if IDENT{K} dominates, (c) will lose to (a); if onset-IDENT{K} dominates, (c) will lose to (b) or (a).

It is crucial, then, that no markedness constraint bans {K} in onsets alone: a constraint like *ONS/{K} would favour (c) over (a) and (b), and IDENT{K} would favour (c) over (d).

It is also crucial that there be no coda-specific faithfulness constraint: coda-IDENT{K} would favour (c) over (b) and (d), and *{K} would favour (c) over (a).

However, Glottal Elimination is not asymmetric. Therefore, one of the two options just identified must hold for glottals. Either there is a coda-specific faithfulness constraint that preserves glottals in codas: coda-IDENT{glottal}, or there is an onset-specific markedness constraint that bans glottals: *ONS/{glottal}.

Parker (2001) makes a proposal along the lines of the onset-markedness approach, so this approach will be examined here. The coda-faithfulness approach will not be considered here as it has not been proposed to this date.

From the point of view of the present theory, a constraint like *ONS/glottal presents a problem: it combines a subsegmental feature with a prosodic position. While this is a theory-internal concern, it does give pause: *ONS/{glottal} would be an anomaly as the only markedness constraint that referred to a prosodic position and a subsegmental feature.[143]

In contrast, the present theory does allow for the combination of prosodic scales and prosodic positions. This leads to the notion that glottals are banned in onsets not

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[143] Note that *ONS/{glottal} would be the only *markedness* constraint to combine glottals and prosodic conditions in the present theory. Faithfulness constraints – as generated by Positional Faithfulness theory – can refer to such positions. See ch.2§2.4.2.

because of their PoA, but because of some prosodic-scale related property. This proposal is developed in the next section.

6.5.2.2 Glottals and sonority

The previous section showed that a constraint banning glottals in onsets is necessary. The idea explored in this section is that such a constraint refers to the sonority hierarchy, not the PoA scale. More concretely, glottals are argued to be highly sonorous, so the constraints that motivate Glottal Elimination are those that ban highly sonorous elements in margins: $*\text{-}\Delta_\mu{\geq}\{\text{glottal}\}$ and $*\text{-}\Delta_\sigma{\geq}\{\text{glottal}\}$.

There are two parts to the argument in this section. The first part aims to show that highly sonorous elements are avoided in margins (Clements 1990, Prince & Smolensky 1993, Gnanadesikan 1995). The second part argues that glottals are more sonorous than their non-glottal counterparts.

- *High sonority syllable onsets are undesirable*

The Polynesian language Niuafo'ou bans high sonority onsets – glides – in stressed syllables (Tsukamoto 1988, de Lacy 2000b).[144] So, while the high vowels /i u/ turn into glides pre-vocalically, they will not do so if they end up in a stressed syllable:

(77)   Niuafo'ou Glide Restriction (Tsukamoto 1988)
      (a) Glide onsets in unstressed syllables

[ju.ní.t̥i̥]	'unit'	*[iunit̥i̥]
[wa.é.a]	'wire'	*[uaea]
[we.lì.ŋa.tó.n̥i̥]	'Wellington'	*[ueliŋaton̥i̥]

      (b) No glide-formation before stressed syllables

[i.á.te]	'yard'	*[já.te]
[u.á.f̥u̥]	'wharf'	*[wá.f̥u̥]
[u.í.p̥i̥]	'whip'	*[wí.p̥i̥]
[ku.á.ta]	'quarter'	*[kwá.ta]

In de Lacy (2000b), I argue that a constraint against highly sonorous onsets blocked glide formation in Niuafo'ou. Glide formation comes about when ONSET outranks constraints that preserve underlyingly moraic vowels (IDENT-μ).

(78)   Glide formation in Niuafo'ou

/iuniti/	ONSET	IDENT-μ
☞ (a) ju.ní.ti		*
(b) i.u.ní.ti	* *!	

---

[144] A number of other languages ban highly sonorous elements in onsets. For example, a number of languages ban liquids in this position (e.g. Golin – Bunn & Bunn 1970:4, Arabana-Wangkangurru – Hercus 1972, see Walsh Dickey 1997 for an extensive list). In Campidanian Sardinian, glides and rhotics are banned in word-initial onsets, but are allowed elsewhere (Bolognesi 1998). See de Lacy (2000b) for a more detailed survey and discussion.

The markedness constraint that bans glides in stressed syllable margins is *-$\Delta_\sigma \geq$\{glide\}. With this outranking ONSET, glide formation will be blocked when it would place a glide in a stressed syllable:

(79)   Blocking glide formation in stressed syllables

/iate/	*-$\Delta_\sigma\geq$\{glide\}	ONSET	IDENT-μ
☞ (a) i.á.te		* *	
(b) já.te	*!		*

The ranking || *-$\Delta_\sigma\geq$\{glide\} » IDENT-μ || also allows inputs such as /jate/ to surface as [iáte] – this form satisfies *-$\Delta_\sigma\geq$\{glide\}, while the faithful [játe] does not (see de Lacy 2000b for details).

An analogous case is found in the Australian language Alyawarra. In Alyawarra, main stress falls on the leftmost syllable with an onset, unless that onset is a glide (Yallop 1977:43).[145]

(80)   Alyawarra Stress
(a)   i.lí.pa   *axe*, *í.li.pa
(b)   rín.ha   {3[rd] person pronoun}
(c)   ju.kún.tʲa   *ashes*, *jú.kun. tʲa
(d)   walíjmparra   *pelican*, *wálijmparra

The constraint ALIGN-ǿ-L expresses the tendency for stress to appear at the left edge while the avoidance of onsetless syllables is prompted by the constraint ǿ/ONSET, requiring that stressed syllables have onsets.

(81)

/ilipa/	ǿ/ONSET	ALIGN-ǿ-L
í.li.pa	*!	
☞ i.lí.pa		*

(82)

/rinha/	ǿ/ONSET	ALIGN-ǿ-L
☞ rín.ha		
rin.há		*!

---

[145] Yallop (1997:43) proposes that word-initial glides form diphthongs with the following vowel, so they really form onsetless syllables. There is no independent evidence for this, though. One reason to think that glides are really onsets is the fact that they can appear in front of diphthongs: e.g. [al.kwij.la] *am/is/are eating* (p.42). The nucleus in this word would have to be [wij] – a triphthong, which is typologically marked, to say the least.

The final step is to explain why stress avoids syllables with glide onsets. Enter the constraint *-Δ_σ≥{glide}.

(83)

/ju.kun.tʲa/	IDENT-μ	*-Δ_σ≥{glide}	ALIGN-σ́-L
☞ ju.kún.tʲa			*
jú.kun.tʲa		*!	
í.u.kun.tʲa	*!		

In short, neutralization, glide-formation, and stress assignment shows that high sonority margins are undesirable.

Niuafo'ou and Alyawarra are not the only languages to avoid glide onsets in stressed syllables: Mabalay Atayal prevents glide-formation in stressed syllables too (Lambert 1999§3.3.2.3).

- *Glottals and sonority*[146]

The aim of this part is to show that glottals are more sonorous than their non-glottal counterparts: i.e. [ʔ] is more sonorous than [p t k] and [h] is more sonorous than [f s x]. A good deal of previous work supports this proposal (Pike 1954, Chomsky & Halle 1968:301, Pinker & Birdsong 1979, Levin 1985, Trigo 1988:46, Parker 1989, 2002, Churma & Shi 1995, Gnanadesikan 1995, 1997). The sonority status of glottals is far from uncontroversial, though. Clements (1990:322) suggests that glottals "behave arbitrarily in terms of the way they class with other sounds", effectively having no sonority value (also van der Hulst 1984, Boersma 1998). A number of authors have argued the opposite: that glottals have the same sonority as obstruents (Heffner 1950, Lass 1976, Dogil 1989, 1992, Zec 1988). The following paragraphs identify phonological evidence that glottals class with highly sonorous elements like glides and liquids.

Walker (2000, to appear) shows that the ability of segments to undergo nasal harmony follows the sonority scale, with more sonorous elements more susceptible to nasalization. Notably, the glottals are at the top of this list, classed with glides.[147] For example, nasality can only spread through glides, laryngeals, and nasals in a Malay dialect: [mẽwãh] 'prosperous', [mãjãt] 'corpse', [mãhãl] 'expensive', [mãʔãp] 'forgive' (Teoh 1988:60).

Another example relates to transparency in vowel copy. Vowel features can spread through intervening consonants. Gafos & Lombardi (1999) show that such spreading follows the sonority hierarchy, with glides more willing to allow spread than liquids, liquids more susceptible than nasals, and so on. Notably, glottals stand at the top of this hierarchy. For example, height and roundness features can spread leftward in Harar Oromo (Owens 1985), but only through glides, [h], and [ʔ], as shown in (84).

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[146] I am endebted to Steve Parker for a discussion of this issue. Parker (2002) provides an extensive survey of literature on sonority, on which the following discussion is based.

[147] See esp. Walker (1998:sec.2.2.3). Walker's arguments for the nasalization of glottals are based on her phonological analysis. See Walker (1998:56) for discussion of the relative nasalizability of glides and glottals.

(84)   Harar Oromo Height Assimilation (Owens 1985:21)

/tah-e/	→	[tehe]	'he became'
/tah-u/	→	[tohu]	'he becomes (dependent form)'
/dʒaʔ-e/	→	[dʒeʔe]	'he said'
/dʒaʔ-u/	→	[dʒoʔu]	'let him say {jussive}'
/d'agaj-e/	→	[d'ageje]	'he heard'

cf [barar-ne] 'we flew' *[barerne]; [dameː] 'branch'.

In sonority-distance restrictions, glottals usually act like highly sonorous elements; they rarely behave like other PoAs with the same manner of articulation. For example, Gujarati allows only glides, liquids, and [h] as the second member of onset clusters: [kjal] 'opinion', [krupa] 'kindness', [kleʃ] 'fatigue', [khərəc] 'cost' (Cardona 1965:31ff). In contrast, it is rare that [h] has the same opportunities as other fricatives: compare English [s̲lɪt] 'spit', [f̲lɪt] 'flit', *[h̲lɪt]. For a general discussion of glottals and syllabification, see Churma & Shi (1995).

Zec (1988, 1995) and Churma & Shi (1995:30) also observe that codas tend to house high sonority segments. They list several cases where only high sonority elements (glides, liquids, nasals) and glottals are permitted in coda position. For example, Cayapa only allows nasals, continuants, and [ʔ] to appear in codas.

Of course, to be fully convincing that glottals are highly sonorous, one would have to examine all the behaviours of glottals, especially the ones where (apparently) glottals do not act like highly sonorous elements. I will touch on one fact that can occasionally make glottals seem to behave like low sonority elements. Chapter 7 shows that less marked elements can undergo assimilation while more marked ones do not. Since glottals are the least marked in terms of PoA, this predicts that they should be very prone to assimilation. More generally, because glottals are the least marked elements in terms of PoA, they excite least faithfulness. So, the fact that glottals make such chequered appearances in inventories therefore could derive from the fact that they submit to so many processes because of their unmarked status.

- *The Constraints*

If glottals are indeed more sonorous than non-glottals, it follows that constraints on high sonority margins could eliminate glottals without also eliminating non-glottals. The present theory provides two relevant constraints: *-$\Delta_\mu \geq${glottal} and *-$\Delta_\sigma \geq${glottal}. The former applies to the non-DTEs of moras, and the latter to syllable non-DTEs (i.e. onsets, moraic codas, and non-moraic codas). The syllable structure in (85) identifies these elements.

(85)
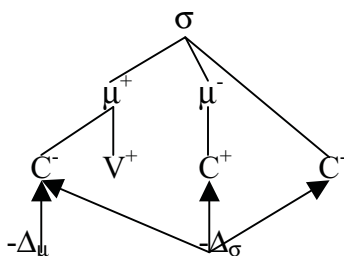
In traditional terms, the non-DTEs of moras are 'onset consonants' (see Hyman 1985, Zec 1988:7). The non-DTEs of syllables are syllable margins (onsets and codas). Table 6.13 identifies the typology needed for glottals.

Table 6.13: Glottal typology
(a) No glottals
$\parallel$ *-$\Delta_\sigma \geq$\{glottal\} » F(glottal) $\parallel$
(b) Glottals in onsets and codas
$\parallel$ F(glottal) » *-$\Delta_\sigma \geq$\{glottal\}, *-$\Delta_\mu \geq$\{glottal\} $\parallel$
(c) Glottals in codas and not onsets
$\parallel$ *-$\Delta_\mu \geq$\{glottal\} » onset-F(glottal), F(glottal) » *-$\Delta_\sigma \geq$\{glottal\} $\parallel$
(d) Glottals in onsets and not codas
$\parallel$ onset-F(glottal) » *-$\Delta_\sigma \geq$\{glottal\}, *-$\Delta_\mu \geq$\{glottal\} » F(glottal) $\parallel$

Illustrations of the use of the glottal constraints have been provided in §6.2.2.3 and §6.3.2.1.

This section concludes with the observation that the proposal that glottals are highly sonorous yet unmarked in terms of PoA is unlikely to provide an entire account of glottal behavior. For one, there are differences between [h] and [ʔ], with some languages allowing one but not the other (e.g. Japanese), and others allowing both, but in complementary positions. While much more clearly needs to be said about such cases, the proposals made so far are adequate for addressing the issues at hand.

6.5.2.3 Glottals are not placeless

To complete this discussion of glottals, this section discusses an alternative to the proposal above – that glottals lack place features entirely. A number of authors have argued for this idea (Clements 1985, Sagey 1986, Hayes 1986, Steriade 1987, Avery & Rice 1989, 1994, Rice 1995). Of course, this is not a theory of Glottal Elimination in itself – many authors have proposed a constraint that requires segments to have some PoA feature, thereby favouring K, P, and T over ʔ (Padgett 1994, 1995, Causley 1999:100, Parker to appear, Broselow 2001).

However, McCarthy (1994) shows that the 'Placeless Glottal' proposal encounters a number of problems. He observes that if glottals are placeless, OCP restrictions on PoA should be unable to eliminate them. This is not so: gutturals and glottals act as a class in

Arabic: no two elements from the set [χ ʁ ħ ʕ h ʔ] can appear in the same root (see also Hayward & Hayward 1989).

If glottals are placeless, they should also be unable to trigger assimilation. McCarthy (1994:207ff) shows that this is not the case for vowel-consonant assimilation involving glottals. He argues that vowels can assimilate to the PoA feature of glottals (and pharyngeals and uvulars), resulting in lowering. For example, the feminine /-e/ in Syrian Arabic lowers to [a] after glottals, pharyngeals, and uvulars:

(86)   Syrian Arabic Lowering (McCarthy 1994)
        [daraʒ-e]   'step'
        [waːʒh-a]   'display'
        [mniːħ-a]   'good'
        [dagːaːʁ-a]   'tanning'

Rose (1996) provides further examples.

Glottals can also trigger Place assimilation. For example, glottals require a preceding consonant to assimilate to their PoA in Yamphu (see ch.7§7.6.2.4): e.g. /mo-do<u>k</u>-<u>h</u>a/ → [modoʔha] 'like those', /læː<u>t</u>-<u>h</u>e-ma/ → [læːʔhema] 'to be able to do' (Rutgers 1998:48).

As Smolensky (1993) has shown, effects akin to placelessness can be derived by ranking constraints against the 'placeless' feature below all others; this dissertation and Prince (1997 et seq.) have shown that the same result follows from stringent constraints. These approaches have the advantages of the placeless proposal without the shortcomings, as shown in this chapter and for assimilation in ch.7§7.3.

• *Other placeless segments*

It is worth pointing out that the placelessness proposal has been applied to other segments, raising the same problems. A number of authors have argued that coronals are placeless, given the fact that they are often the product of neutralization and can undergo processes while other segments do not (Paradis & Prunet 1991 and references cited therein). However, McCarthy & Taub (1992) and Steriade (1995b) have identified several areas where the 'placeless coronal' proposal encounters problems (see also ch.7§3.3). If coronals are placeless, then [coronal] should not trigger or block processes. However, coronals both trigger and block assimilation. A full account is presented in chapter 7.

Schwa has also been argued to lack place features. Oostendorp (1995) proposes that the placelessness of schwa prevents it from bearing stress in Dutch. In other words, stressed syllables require their dependents to have place features – analogous to constraints that require dependents of onsets to have place features in order to ban glottals. The problem with this approach is that it fails to explain why other vowels can repel stress. For example, high vowels [i y u] in Nganasan avoid stress with the same alacrity as [ə] and [ɨ], but these vowels cannot all be placeless (ch.3§3.2).

- *Summary*

In summary, the proposal that glottals are placeless encounters the same problems as previous claims that coronals and schwa are placeless. Placelessness results in inertness and predicts unique behaviour. However, glottals – like schwa and coronals – are not phonologically impotent: they can undergo and trigger processes just like non-glottals. Glottals are also not unique. While they may fail to undergo a certain processes in some language, other non-glottal PoAs can fail to undergo that same process in other languages.

6.5.3 Summary

In conclusion, disharmonic inventories can arise through processes that are not related to PoA. Section 6.5.1 identified several neutralizations involving a change in manner of articulation. For example, lenition can target coronals alone, resulting in a disharmonic inventory consisting of just dorsals, just labials, or both. The same was shown to happen for coalescence of vowels and nasals, and for a variety of other processes.

Finally, Glottal Elimination was argued to not be a PoA-related process. It is unlike other PoA neutralizations in that glottals can be eliminated in onsets but not in codas. Evidence that glottals are highly sonorous led to the proposal that Glottal Elimination is triggered by a ban on high sonority margins.

The important point of this section is that disharmonic inventories are not produced by PoA neutralization. Accordingly, there is no need for any constraints apart from the markedness and faithfulness ones proposed herein.

6.6 Neutralization targets

Trubetzkoy (1939) claimed that segments could only neutralize to the least marked element available. Thus, the output target of neutralization is always the unmarked scale element: e.g. /t/→[ʔ] but never /t/→[k]. This section adopts Trubetzkoy's proposal. So, only the neutralizations in (87) are possible; examples are given in table (88).[148]

(87) | Input | | neutralizes to | | |
|---|---|---|---|---|
| /K/ | → | [ʔ] | or | [T] |
| /P/ | → | [ʔ] | or | [T] |
| /T/ | → | [ʔ] | | |
| /ʔ/ | → | [T] | | |

---

[148] This almost excludes the possibility of PoA-related chain shifts (i.e. /k/→[p], /p/→[t]), except perhaps for /p,k/→[t], /t/→[ʔ]. I have found no cases of PoA chain-shifts reported in the literature.

(88)   *Neutralization targets: examples*

UR	Surface	Example	Language
dorsal	glottal	/baik/ → [baiʔ] cf [kə-baik-an]	Malay codas (Lapoliwa 1981)
	coronal	/k'ak-RED/ → [lak-<u>k'it</u>]	Taiwanese secret language codas (Li 1985)
labial	glottal	[m-<u>rataʔ</u>-ratap]	Ulu Muar Malay reduplicant codas (Hendon 1966)
	coronal	/ɕap-RED/ → [lap-ɕit]	Cantonese secret language codas (Yip 1982)
coronal	glottal	/namːit/ → [namːiʔ] cf [namːid-æʔ]	Yamphu codas (Rutgers 1998)
glottal	coronal	/tʃoh-kʰo/ → [tʃoːtꜗ-kʰo] cf [tʃoːh-ɯni]	Korean codas (Kim-Renaud 1986)

As an example, /k/ can neutralize to [ʔ] since it is the least marked PoA. /k/ can also neutralize to [t] if [ʔ] is ruled out by Glottal Elimination. However, /k/ can never neutralize to [p] because every inventory contains a less marked element – either [t] or [ʔ].

Section 6.6.1 identifies the factors responsible for the neutralizations listed above. One relates to the form of the markedness constraints: since 'glottal' is a local harmonic bound for all other PoAs, glottals will always be favoured as outputs over other segments. Another reason relates to the form of the faithfulness constraints: the constraints assign the same violations to all unfaithful elements. Together, these two factors result in the least marked PoA emerging as the target of neutralization: the form of the faithfulness constraints ensures that markedness constraints will determine the output's form, and glottals harmonically bound all other PoAs, so the output of neutralization will typically be glottals.

Section 6.6.2 discusses the effect of Glottal Elimination on the output of neutralization. This section shows that Glottal Elimination can force neutralization to a coronal, even when a glottal is present in the language.

Section 6.6.3 discusses the relation of gapped inventories to possible outputs of neutralization. This section shows that only glottals can be the target of neutralization in a gapped inventory [k p ʔ]. More generally, it shows that dorsals and labials can never be the output of neutralization. An alternative proposal is also discussed – that velars are less marked than coronals in some grammars (Trigo 1988, Rice 2000a,b).

Section 6.6.4 discusses cases where glottals are neutralized, through Glottal Elimination.

Section 6.6.5 presents a summary.

6.6.1   The output of neutralization

It is common for glottals to be the output of neutralization (i.e. debuccalization), as discussed in §6.6.2 and §6.6.3. This section argues that this generalization follows from two facts: (i) the PoA-markedness constraints favour [ʔ] over all other PoAs, and (ii) marked-faithfulness constraints do not distinguish between different types of unfaithfulness.

6.6.1.1 The form of markedness constraints

The focus of discussion here will again be /k/-neutralization in Malay (§6.2). In that section, it was shown that the output of /k/-neutralization was [ʔ]: e.g. /baik/ → [baiʔ].

In terms of the PoA constraints, the output of /k/ neutralization cannot be anything but [ʔ]. Part of the reason for this is that the PoA constraints favour glottals over all other PoAs, as shown in the tableau for /baik/→[baiʔ]. As shown in §6.2, the ranking || *{K} » IDENT{KPT} || ensures that /k/ and no other PoAs neutralize. Tableau (89) shows that the remaining markedness constraints determine that the output of neutralization will be [ʔ], regardless of their ranking.

(89)

/baik/	*{K}	IDENT{K}	*{KP}	*{KPT}	*{KPTʔ}
(a) baik	*!				
(b) baip		*	*!	*	*
(c) bait		*		*!	*
☞ (d) baiʔ		*			*

The tableau shows that the ranking of the PoA-markedness constraints is irrelevant because [ʔ] is a local harmonic bound for both [t] and [p].[149]

So, the target of neutralization depends on the form of markedness constraints. Since /k/ neutralizes to [ʔ] and not [t] or [p] in Malay, there must be some constraint or constraints that favours [ʔ] over both [t] and [p] (*{KPT} here).

Similarly, since /k/ never neutralizes to [p] in any language, there cannot be any constraint that favours [p] over both [t] and [ʔ] (i.e. *{Tʔ} or *{T}).[150] The same is true for neutralization to [k]: since [k] is never the target of neutralization, constraints that favour [k] over both [t] and [ʔ] cannot exist in CON.

6.6.1.2 The form of faithfulness constraints

Faithfulness constraints also play a role in determining the target of neutralization. A crucial aspect of tableau (89) is that the faithfulness constraint conflates all unfaithful

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[149] As discussed in ch.5, an alternative theory with a fixed ranking of constraints || *K » *P » *T || would achieve the same results.
[150] Unless *{Tʔ} and *{T} were universally outranked by a constraint against [p], as in the fixed ranking theory || *K » *P » *T ||.

forms. In other words, IDENT{K} assigns the same violation to [p], [t], and [ʔ]. This fact allows markedness constraints to be solely responsible for the outcome of neutralization.

To clarify this point, suppose that faithfulness constraints assigned different violations based on the degree of difference along the scale; such faithfulness constraints will be called ✳IDENT, to distinguish them from the standard IDENT constraints. For example, [k] and [p] are only one step away on the PoA scale, so ✳IDENT{K} would assign one violation to the mapping /k/→[p]. Since [t] is two steps away from [k], /k/→[t] would incur two violations of ✳IDENT{K}, and /k/→[ʔ] would incur three violations. Faithfulness constraints that are somewhat similar to this type are proposed by Gnanadesikan (1995).

With this type of faithfulness constraint, neutralization could produce the next least marked element on a scale (as shown by Gnanadesikan 1995). Tableau (90) illustrates this situation.

(90)

/baik/	*{K}	✳IDENT{K}	*{KP}	*{KPT}	*{KPTʔ}
(a) baik	*!				
☞ (b) baip		*	*	*	*
(c) bait		* *!		*	*
(d) baiʔ		* * *!			*

The tableau shows that this type of faithfulness constraint, ranked above all markedness constraints, can prevent markedness from having any say in the output of neutralization. Since /k/→[p] neutralization is not attested, this type of

faithfulness constraint cannot exist.[151]

Not only does the lack of /k/→[p] ban the type of scalar-faithfulness just mentioned, it means that CON cannot contain any faithfulness constraint that favours /k/→[p] over /k/→[t] and /k/→[ʔ]. For example, suppose there were a faithfulness constraint IDENT[‑coronal]. This would not assign a violation to /k/→[p], but would assign one to /k/→[t]. In a language with Glottal Elimination, /k/ could therefore neutralize to [p]. Therefore, there is no constraint IDENT[‑coronal]. Generalizing, CON cannot contain faithfulness constraints that favour /m_1f/→[m_2f] over /m_1f/→[uf], where m_1f and m_2f are different marked elements on the same scale and uf is the unmarked scale element.[152] The problem with IDENT[‑coronal] is that it favours /k/→[p] (i.e. the

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[151] Gnanadesikan (1995:ch.3) argues that faithfulness constraints with a similar effect account for chain shifts: where /x/→[y] but /y/→[z]. Curiously enough, the consonant chain shifts discussed all involve increases in markedness, not neutralization to less marked elements (Gnanadesikan argues that the chain shifts are triggered by morphemes). Gnanadesikan's proposal also predicts neutralizations whereby /m/→[b] and /b/→[p] (e.g. in coda position). I have not found any cases fitting this description. For vowel height chain shifts, see the alternative proposal in Kirchner (1994).
[152] Elliott Moreton, cited in McCarthy (2000) dubs this property of faithfulness constraints 'retentiveness'. He concludes that OT must have retentive faithfulness constraints to produce chain shifts. The result produced here shows that at the very least PoA-faithfulness constraints cannot be retentive. It may be that

neutralization of a marked feature to another marked feature) over /k/→[t] (i.e. the neutralization of a marked feature to an unmarked feature).

In contrast, the PoA-faithfulness constraints proposed conflate unfaithful categories. From input /k/, the outputs [p], [t], and [ʔ] are all equally unfaithful – they all incur exactly the same violations of IDENT{K}, IDENT{KP}, IDENT{KPT}, and IDENT{KPTʔ}. This is illustrated in the violations of IDENT{K} in tableau (89). Because all unfaithful candidates are equally unfaithful, they allow the lower-ranked markedness constraints to make the crucial decision.

6.6.2   Coronal promotion

The output of PoA neutralization is not always a glottal: it can be a coronal. In these cases Glottal Elimination blocks glottals as outputs, either overtly or emergently. Glottal Elimination can favour coronals over glottals as the output because glottals are more marked than other PoAs in terms of sonority: i.e *-$\Delta_\sigma \geq$glottal.

In the trivial case, glottals are banned from an inventory, so the least marked PoA available is coronal. For example, /ŋ/ neutralizes to [n] in Yecuatla Misantla Totonac (MacKay 1994:33): this language has no placeless [N] (cf Caribbean Spanish – §6.6.3.1).

A more interesting case is where dorsals and/or labials neutralize to coronal PoA, but a glottal is available. In these cases, Glottal Elimination has an emergent effect. A relevant case is found in a Taiwanese secret language: dorsal and labial stops in reduplicants neutralize to [t] in codas, despite the fact that [ʔ] is available (Li 1985). This case is discussed in §6.6.2.1.

Section 6.6.2.2 discusses whether labials and dorsals can be 'promoted' in the same way as coronals. This section shows that this is not possible under the proposals about constraint form in this chapter.

6.6.2.1 Emergent Glottal Elimination

The Taiwanese secret language described by Li (1985) is very similar to the Cantonese one discussed in §6.3.2.1: (i) the reduplicant's vowel is neutralized to [i], (ii) its coda is neutralized to a coronal, and (iii) the base's initial consonant is replaced with [l] (or [n] if the following vowel is nasal). The differences are that /k/ neutralizes to [t] in the Taiwanese secret language (cf Cantonese), and the other is that Taiwanese allows coda [ʔ]. Relevant data is provided in (91); the reduplicant is underlined.

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more generally faithfulness constraints on the same scale cannot be retentive, though retentiveness may emerge through the interaction of faithfulness constraints on separate scales.

(91)   Taiwanese secret language (Li 1985:97,98)
         (a) Vowel-final roots
               /be ts'ai/   → [le-<u>bi</u> lai <u>ts'i</u>]   'buy food, go to the market'
               /e hiau/   → [le <u>i</u> liau <u>hi</u>]   'able'
         (b) Neutralization to coronals
               /tsap ap/   → [lap <u>tsit</u> lap <u>it</u>]   'ten boxes'
               /kam tsia/   → [lam <u>kin</u> lia <u>tsi</u>]   'sugarcane'
               /t'at/   → [lat <u>t'it</u>]   'to kick'
               /tsin t'iam/ → [lin <u>tsin</u> liam <u>t'in</u>] 'very tired'
               /pak k'ak/   → [lak <u>pit</u> lak <u>k'it</u>]   'to peel, to crack open'
               /p'ɔŋ hɔŋ/   → [lɔŋ <u>p'in</u>   lɔŋ <u>hin</u>] 'flatus ventritus'

In contrast, [ʔ]-final roots appear with the underlying [ʔ]: /piaʔ/ → [lia(ʔ) <u>piʔ</u>] 'wall'; /ho k'e/ → [lo <u>hi</u> le(ʔ) <u>kiʔ</u>].[153]

The issue raised by this case is why labials and dorsals do not neutralize to [ʔ], since it is available: for example, /pak/ could be realized as *[lak <u>piʔ</u>], analogous to reduplication in Ulu Muar Malay (§6.2.2.2). However, the result is [lak <u>pit</u>]. In short, although [ʔ] is allowed in Taiwanese, it is clearly not considered less marked than [t] for neutralization purposes.

- *Analysis: emergent Glottal Elimination*
      Glottals harmonically bound all other types of PoA in terms of the PoA markedness constraints. So the PoA-markedness constraints cannot be responsible for favouring neutralization to [t] rather than [ʔ]: there must be some other markedness constraint that blocks neutralization to glottals but not coronals. The obvious candidate is the Glottal Elimination constraint *-$\Delta_\sigma \geq$glottal. This constraint must outrank all constraints that favour glottals over coronals – i.e. *{KPT}, as shown in tableau (92).

(92)

	/pak-RED/	*{KP}	BR-IDENT{KPTʔ}	*-$\Delta_\sigma \geq$glottal	*{KPT}
	(a) lak-<u>pik</u>	*!			*
☞	(b) lak-<u>pit</u>		*		*
	(c) lak-<u>piʔ</u>		*	*!	

The constraint *{KP} bans dorsals and labials, eliminating (a). As in Malay reduplication, an onset-specific PoA faithfulness constraint prevents neutralization of onset [p].

Both (b) and (c) are equally unfaithful, so the decision is passed to lower-ranked markedness constraints. Since *-$\Delta_\sigma \geq$glottal favours non-glottals over glottals, candidate (c) is eliminated. This leaves the candidate with coronal PoA (b).

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[153] Glottals are usually eliminated before other consonants, but always appear in word/phrase-final codas. There has been some discussion about the status of coda glottals in Taiwanese (Roberts & Li 1963, Yip 1995:19).

In short, Glottal Elimination can have an emergent effect in the language, forcing neutralization to coronals.

As a final point, glottals are not neutralized to coronals in the ranking above: /piaʔ/ → [lia(ʔ) pi**ʔ**], *[lia(ʔ) pit]. This follows from the ranking ‖ BR-IDENT{KPTʔ} » *-Δ_σ≥{glottal} ‖ – this preserves glottals in reduplicants. The opposite ranking would produce an emergent Glottal Elimination, in which glottals were banned in reduplicants but allowed elsewhere.

6.6.2.2 Can labials and dorsals be promoted too?

The discussion above has shown that Glottal Elimination can emergently affect the outcome of neutralization, producing coronals even when glottals are available. The issue this raises is whether some other process can do the same for labials or dorsals: in other words, could some process(es) emergently eliminate both coronals and glottals so that labials (or dorsals) are effectively promoted to least marked status?

If such a process existed, [p] (or [k]) could be the output of neutralization. Since no such neutralizations exist, coronal- & glottal-eliminating processes must be banned.

The constraints proposed in this chapter do not allow such a process. To eliminate both coronals and glottals, a constraint (or constraints) is needed that favours labials and/or dorsals over coronals. As argued in §6.5, there is no such constraint.

For example, while lenition may only apply to coronals, the constraint that triggers lenition – LENITE – targets all PoAs equally; the fact that only coronals undergo lenition in some languages is due to the blocking effect of marked-faithfulness constraints. Thus, an emergent lenition process cannot be used to eliminate coronals in this case.

To expand on this point, suppose that glottals were banned in a language by Glottal Elimination and only /t/ lenites to [ɾ]. Tableau (93) repeats the coronal-only lenition ranking from §6.4.

(93)

	/abada/	IDENT{KP}	*{ɣ,β}	LENITE
☞	(a) abaɾa			*
	(b) abada			* *!
	(c) aβada		*!	*
	(d) aɾaɾa	*!		

Candidate (a), with lenition only of /d/, wins because it preserves non-coronal PoAs (unlike (d)), avoids the prohibited segment [β] (unlike (c)), and does not avoid lenition entirely (cf (b)).

However, suppose that [g] is banned in the output, and is forced to neutralize to some other segment. Since [d] is eliminated by lenition, could /g/ neutralize to [b]? The answer is no: /g/ must neutralize to [ɾ]. This result is illustrated in tableau (94).

(94)

/aga/	*{K}	LENITE	IDENT[manner]
(a) aga	*!	*	
(b) aba		*!	
(c) ada		*!	
☞ (d) aɾa			*

The faithful candidate (a) is eliminated because it contains a dorsal. This leaves the candidates with [b], [d], and [ɾ].

The problem with both candidates (b) and (c) is that they both have failed to lenite, equally violating LENITE. This means that the flapped candidate (d) wins. The only constraint that could thwart this result is IDENT[manner], which prevents /g/ from turning into the sonorant [ɾ]. However, IDENT[manner] must be ranked below LENITE in order for lenition to happen in the first place, so it can have no adverse effects.

More generally, the tableau shows that /g/ cannot neutralize to [b] because there is no constraint that favours labials over coronals. LENITE does not do so – it applies equally to all PoAs. In contrast, if there were a coronal-specific version of LENITE – i.e. LENITE(coronal) – then the result would be quite different: candidate (c) would fatally violate LENITE(coronal) and (d) would fatally violate IDENT[manner], leaving candidate (b). Therefore, there can be no constraint that specifically targets coronals in this way.

The treatment of lenition outlined above can be generalized to other processes. If all processes are like lenition in that they do not specifically target coronals, there can be no markedness constraint that favours labials over coronals. If there is no markedness constraint of this type, neutralization to coronals will always trump neutralization to labials. In short, labials or dorsals can never be the targets of neutralization. This point is discussed further in the next section.

6.6.3   Gapping and the output of neutralization

The issue raised in the last part of the previous section arises in gapped inventories: suppose that coronals are eliminated from an inventory, as in Yamphu and Hawaiian. Could Glottal Elimination not emergently prevent neutralization to glottals? In this case, /k/ could only neutralize to [p] since [p] is the least marked non-glottal available.

The answer is again no. The reason follows from the ranking needed to eliminate coronals. As shown in §6.3, coronals are eliminated when *{KPT} outranks IDENT{KPT} and IDENT{KPTʔ}. However, one further ranking is necessary: *-Δ≥{glottal} must be ranked below *{KPT}. Without this ranking, coronals cannot be neutralized to glottals. In fact, glottals would be eliminated from the inventory. This is illustrated in tableau (95).

(95)

/ta/	*{KPT}	*-Δ≥{glottal}	IDENT{KPT}
(a) ta	*!		
☞ (b) ʔa		*	*

Tableau (95) shows that if *-Δ≥{glottal} outranked *{KPT}, candidate (b) would be eliminated, thereby preventing coronals from being eliminated. This result follows from Harmonic Ascent: /t/ can only neutralize to a less marked element. The only element less marked than [t] is [ʔ]. Therefore, if [ʔ] is eliminated, /t/ can only surface as [t].

The ranking || *{KPT} » *-Δ≥{glottal} || has another effect: it ensures that glottals are less marked than labials and dorsals. Since *{KPT} favours glottals over dorsals and labials, this means that dorsals can only neutralize to glottals.

(96)

/ka/	*{K}	*{KPT}	*-Δ≥{glottal}	IDENT{KPT}
(a) ka	*!	*!		
(b) pa		*!		*
(c) ta		*!		*
☞ (d) ʔa			*	*

Therefore, if coronals are eliminated in a language, PoA neutralization can only produce glottals. This again follows from the fact that no markedness constraint favours labials and/or dorsals over coronals. If there were such a (freely rankable) constraint – *{T} – it would not only be an easy matter to create a gapped inventory where /k/ neutralized to [p], it would be an easy matter to have all non-labial segments neutralize to labials, as shown in the tableau below.

(97)

/ʔakata/	*{K}	*{T}	*-Δ≥{glottal}	IDENT{KPTʔ}	*{P}
(a) ʔakata	*	*	*		
(b) papapa				* * *	* * *

In short, there can be no constraint that favours labials above coronals. The same goes for dorsals and their relation to labials and coronals – if there were a constraint *{PTʔ}, all segments could neutralize to [k]. The lack of such a constraint in the present theory prevents this from happening.

6.6.3.1 The velar-unmarkedness hypothesis

Although this section is something of a digression from the preceding discussion, it is necessary to point out that some researchers have claimed that dorsals – or more particularly velars – can be the targets of neutralization (Trigo 1988, Causley & Rice 1998, Rice 2000a,b). This proposal has been extensively criticized in a series of papers by Paradis & Prunet (1990a,b, 1994). This section aims to discuss cases that Paradis & Prunet did not address. As in their work, this section concludes that there is no solid evidence for the 'velar-as-unmarked' hypothesis.

As a preliminary remark, I consider the following discussion overly brief for what is a proposal with broad implications; nevertheless, some comment must be given here as the proposal directly challenges some of the premises of the present theory.

- *The hypotheses*

Trigo (1988) proposes that coronals are least marked in onset position, but dorsals are least marked in coda position. Causley & Rice (1998) and Rice (2000a,b) propose that there are two scales relevant to PoA. One relates to structural complexity: on this scale, velars are less marked than coronals, labials, and other dorsals.[154] However, PoAs can also be evaluated in terms of structural completeness, in which case coronals, labials, and non-velar dorsals are less marked than both velars and glottals. In effect, then, depending on the ranking a grammar can chose whether coronals are less marked than velars, or vice-versa.

- *Dorsal obstruents are not targets of neutralization*

Both 'velar-as-unmarked' proposals predict that dorsals can be the target of neutralization in codas. However, of the languages listed in Appendix B, there are no convincing synchronic cases of neutralization to [k].[155]

The closest case is found in the Maracaibo dialect of Venezuelan Spanish. Guitart (1981) (cit Trigo 1988) reports that coda stops neutralize to [k] and fricatives to [x]: *obsekio* [oksekio], *este* [exte]. However, these forms are in free variation with neutralizations to [ʔ] and [h]: i.e. [oʔsekio], [ehte]. It is therefore unclear whether this constitutes evidence for neutralization to glottals, or dorsals.

To conclude, unlike synchronic cases, there are clear examples of diachronic change of *t to [k]. For example, Hawaiian [kanaka] 'man' is cognate with other Eastern Polynesian language's [taŋata] (e.g. Māori), as is [ke] {determiner} with other languages' [te]. The reconstructed forms for Proto-Eastern Polynesian have *t (Clark 1976). Haas (1968) and Rice (1978) show that *t has turned into [k] in two dialects of Chipewyan – Yellowknife and Fort Resolution respectively. In contrast, all the synchronic cases of /t/-elimination show neutralization to [ʔ] (e.g. Cockney English, Yamphu, Refugee Tibetan – see §6.3). It is not clear what to make of this disparity between diachronic and synchronic change. Since the present theory focuses solely on synchronic grammar, though, this issue is put aside here. In short, there are no synchronic cases of stop neutralization to [k].

For fricatives, I have found no cases where fricatives neutralize to the velar [x].[156]

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[154] Causley & Rice (1998) propose that glottals consist of a bare root node while velars consist of a root node and a Place node, but no place features. In contrast, coronals, labials, and non-velar dorsals have more complex structure: root nodes, Place nodes, and place features.

[155] Chen (1973) argues that the development of coda consonants in Chinese dialects involved development of coronals into velars, both for stops *t→k and nasals *n→ŋ (cf Zee 1985, who argued that *ŋ developed into [n]). The same development occurred in Proto-Eastern Polynesian to Hawaiian, and in Chipewyan dialects (§6.6.3.1). Despite the *t→k change, the dialects do not provide evidence against the present proposal. One of the dialects – Fuzhou – has both [ʔ] and [k] in codas (Yip 1982:646), an admissible inventory in the present theory (also see Wright 1983:26ff, Zhang 2000). Chen reports the Chaozhou dialect to have only [p k] in codas; however, this only applies to the literary language: the colloquial language has debuccalized all consonants to [ʔ]. In short, Chen's (1973) proposals do not conflict with the present theory.

- *Dorsal nasals are not targets of neutralization*

The final type of neutralization involves nasals. In contrast to stop and fricative neutralization, there are many reported cases of neutralization to [ŋ]. Languages with alternations (usually of /n/ to [ŋ]) include Huallaga Quechua, Seri[157], Yamphu (Rutgers 1988), Selayarese (Broselow 2001), Makassarese (Aronoff et al. 1987, Basri et al. 1998), Misantla Totonac (San Marcos dialect) (Mackay 1994:380), a number of Spanish dialects (Trigo 1988, Morris 2000), and the Carib languages Arekuna (Edwards 1978:226), Tiriyó (Peasgood 1972:39), and Wayana (Jackson 1972:47). Many other languages restrict nasals in codas to just [ŋ].

I adopt Trigo's (1988) theory that all these cases actually involve the 'glottal' nasal [N] rather than velar [ŋ] (for discussion, see ch.5§5.3.3.1). A variety of evidence supports this proposal. Yamphu will be used as a representative example here because its phonological system is already familiar from §6.2.

Yamphu has the nasals [m n ŋ]. In terms of distribution, neutralization, and assimilation, [ŋ] behaves like a glottal.

For distribution, [ŋ] is rare in word-initial position, and has a free variant [n]: e.g. [ŋa]~[na] 'fish', [ŋaːkma]~[naːkma] 'to request' (Rutgers 1998:33). This is fairly typical behaviour: [ŋ] is often banned word-initially but allowed elsewhere (e.g. English, Dutch).[158] There is a small amount of evidence that [ŋ] is avoided intervocalically in Yamphu. Rutgers (1998:24) notes that intervocalic [ŋ] is in free variation with [w̃] in a small number of words. A number of words with intervocalic [ŋ] have allomorphs with [ŋʔ] (e.g. [hoŋaja]~[hoŋʔaja] 'hole'). However, medial [ŋ] is tolerated in the majority of words (e.g. [kaːŋa] 'kind of cricket').

[ŋ]'s behaviour parallels the behavior of glottals: glottals are often banned in onsets, but permitted in codas. In contrast, it does not parallel the behavior of dorsals in other manners of articulation: none of the languages listed in Appendix B ban [k] or [x] in onsets, but allow them in codas.

[ŋ] also parallels [ʔ] in neutralization. As shown in §2, /t/ neutralizes to [ʔ] in codas. For the nasals, /n/ neutralizes to [ŋ]. This neutralization occurs word-finally;

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[156] Neutralization to a uvular has been reported for Carib (Hoff 1968, Gildea 1995:65). In codas, uvular [χ] appears before obstruents and [ʔ] appears before sonorants. Due to a process of apocope, consonants may end up in coda position. In this environment, they neutralize to [χ] before obstruents and to [ʔ] before sonorants: [enaːpɨ] 'eat', cf [enaːχ-potɨ] 'eat repeatedly', [enaʔ-nen] 'he ate' (Hoff 1968:58, Gildea 1995). It seems that the uvular [χ] is at least treated like a glottal in this situation, since it parallels [ʔ] in the neutralization pattern above. In fact, [χ] is in complementary distribution with [h], the latter appears in onsets while the former appears in codas. It is thus inviting to consider [χ] not a true uvular, but perhaps [h] with some secondary articulation. Without close phonetic analysis, further speculation is unwarranted. I can only conclude by noting that Gildea's (1995) survey of debuccalization in other Carib languages shows that the target of neutralization in all other cases is a glottal. In any case, Carib does not provide support for the velar-as-unmarked hypothesis.

[157] To be precise, /m/→[ŋ] before pause, but in an unstressed syllable: /koːtpam/→ [kóːtpaŋ] 'sardine', cf [sáːòm] 'he will beg' (Marlett 1981:20). Faithfulness to the stressed syllable blocks neutralization in this case (Beckman 1998).

[158] For arguments that the English [ŋ] is [N], see McCarthy (2001). Apart from being banned in onsets, [ŋ] counts as moraic while [n] and [m] do not. Thus, [ŋ] cannot appear after a long vowel: e.g. [diːn] *dean*, [diːm] *deem*, *[diːŋ].

medially /n/ assimilates (discussed below). The paradigm of the person pronoun /hæn/ shows the coda neutralization of [n].

(98)   Yamphu: neutralization of /ŋ/ to [n]
         /hæn/ 'you (sg.)' → [hæŋ]
                 cf   [hæn-æʔ] {ergative}
                        [hæn-iŋ] {plural}
                        [hæn-iŋ-æʔ] {pl.+ergative}

        Other morphemes that show this alternation include /-hon/ {logical consequence (LC)} (e.g. [asa-hoŋ] 'whoever'), /iman/ {interrogative}, and the elative suffix /-pan/ (e.g.[tuː-m-em-baŋ] 'be.3pl.fact.elative' – 278).
        A number of languages neutralize stops to [ʔ] and nasals to [ŋ]. It is common for languages to allow only [ʔ] and [ŋ] in codas. For example, Makassarese only allows [ʔ] and [ŋ] word-finally; notably, it does not allow word-final [k] (Aronoff et al. 1987, Basri et al. 1998, McCarthy & Prince 1994§5). Languages with the same restriction are Nantong Chinese (Ao 1993), Kelantan and Terengganu Malay (Teoh 1988), Selayarese, and Konjo (Broselow 2001). Similarly, Caribbean Spanish neutralize fricatives to [h] and nasals to [ŋ] (Trigo 1988:72ff). Other languages that allow only [h] and [ŋ] in codas include Wayana (Jackson 1972), and Macushi (Abbott 1991 – only [h ŋ]). Finally, several Chinese secret languages neutralize codas in reduplicants to just [ʔ] and [ŋ] (Yip 1982, 2000:27).
        In contrast, there is no language in which [ŋ] as the result of neutralization parallels [k]: i.e. there is no language in Appendix B that bans all but [k] and [ŋ] in codas.
        Assimilation in Yamphu also provides evidence that [ŋ] is really [N]. /n/ assimilates in PoA to a following obstruent. For example, /pen/ 'sit' is realized as follows: [mæm.bem.ba] 'without sitting', [pen.so.ben.ni] 'he doesn't even sit', [peŋ.go.ben.ni] 'he really won't sit'. Before /ʔ/ and /h/, /n/ is realized as [ŋ]: [peŋ.ʔi] 'he's sitting', /hen-heː-nd-u-æn-de/ → [heŋheːndwende] 'can you open it?' (p.44-5). Stops also assimilate before glottals, but to glottal PoA, not dorsal: /mo-dok-ha/ → [modoʔha] 'like those' (p.48). Again, [ŋ] parallels [ʔ].
        In summary, there is a variety of evidence that surface [ŋ] in Yamphu is in fact glottal [N]. In terms of surface restrictions, [ŋ] behaves like glottals: it can appear in codas but not in onsets, just like [ʔ] and [h] in many languages. In contrast, no language bans [k] and/or [x] in onsets but allows them in codas. Notably, assimilation of /n/'s PoA to a glottal [ʔ] or [h] results in [ŋ] in Yamphu, indicating that [ŋ] and [ʔ] share the same PoA.
        Finally, in languages with debuccalization of stops and/or fricatives, nasals often parallel these processes by neutralizing to [ŋ]. It is never the case that neutralization of nasals to [ŋ] is paralleled in other manners of articulation by neutralization to dorsals (i.e. stops to [k] or fricatives to [x]).

•   *No epenthesis of dorsal obstruents*
        Epenthesis is not neutralization, but still directly reflects relative markedness, as discussed in ch.5§5.3.3.3. Therefore, the 'velar-as-unmarked' hypothesis (or at least

Causley & Rice's version) predicts epenthesis of [k], [x], and [ŋ], paralleling epenthesis of [ʔ], [h], and [n].

Trigo (1988) argues that two languages show epenthesis of velars: [k] and [ŋ] in Uradhi (Hale 1976, Crowley 1983), and [g] in Murut (Prentice 1971). I have found two other relevant cases: Koḍava (Ebert 1996) and Seri (Marlett 1981). While these cases deserve more discussion that presented here, it is possible to cast doubt on their validity.

As Broselow (1982) and many others have shown, consonant epenthesis takes place to satisfy general phonotactic requirements such as bans on onsetless syllables (e.g. [h]-epenthesis in Slave – Rice 1989), or avoidance of adjacent identical consonants. However, none of the cases cited above are that straightforward. All involve 'epenthesis' of dorsals without a clear phonotactic motive for insertion.

The Dravidian language Koḍava will be discussed here since – in my opinion – it offers the clearest and most detailed evidence of putative [k]-insertion of the cases cited above.

Koḍava has the voiceless stops [p ṭ t tʃ k]. Syllable structure is CVX, where X is either a consonant or vowel; onsets are optional word-initially. Ebert (1996:9) reports that "euphonic [k] is inserted between roots ending in a vowel or [n] and a following [a]", with the additional proviso that [k] voices after nasals. Examples are given in (99).

(99)   <u>Koḍava euphonic [k] (Ebert 1996)</u>
        /kuḍi-a/   → [kuḍika]   'let's drink'   (cf [kuḍi] 'drink')
        /aḷa-ate/   → [aḷakate]   'without sitting down'
        /koḍɯ-ate/   → [koḍɯkate] 'do not give!'
        /tin-adɯ/   → [tiŋgadɯ]   'let him eat'
        /kan-a/   → [kaŋga]   'see you!'
        cf /ʌḷɯd-aṭe/ → [ʌḷɯdaṭe]   'don't write' (cf [ʌḷɯdɯ] 'write')[159]

The problem with treating [k] as epenthetic here relates to the environment that triggers its insertion. If [k] were truly epenthetic, it should be inserted for phonotactic reasons, such as a requirement that syllables have onsets. However, epenthesis after /n/-final roots is prosodically unnecessary: /kan-a/ could surface as *[ka.na], since this form satisfies ONSET. Instead, [g] is epenthesized (voiceless stops are banned after nasals): [kaŋ-g-a]. There is not only no prosodic motivation for dorsal epenthesis here, the epenthesis creates a prosodically undesirable syllable – i.e. one with a coda.

Moreover, euphonic [k] is severely restricted in its distribution. It can only appear between a verb root and suffix.[160] For example, /√kond-ɯn-avʌ̃/→[kondɯnavʌ̃], *[kondɯnkavʌ̃] 'one who killed'; /√ʌḷɯd-ɯn-ʌ/→[ʌḷɯdɯnʌ], *[ʌḷɯdɯnkʌ] 'I wrote'.

In short, [k] does not behave like epenthetic consonants in other languages. If anything, its distribution suggests that it has the status of a morpheme, much like the semantically contentless 'thematic' morphemes in Attic Greek (Lupas 1972).

The same point can be made for Seri, Murut, and Uradhi.

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[159] Koḍava epenthesizes [ɯ] after root-final consonants.
[160] It could be that /k/ is part of the root. Exact determination of the status of /k/ awaits a detailed analysis of Koḍava morphology.

In Seri, Marlett (1981:56) reports that [k] is epenthesized in a very specific morphological and phonological environment: $\emptyset \rightarrow$ [k] / $C^{coronal}\_C^{nasal}$+. In other words, [k] is epenthesized after [t] and before a nasal that is part of a prefix: e.g. /ʔa-tm-aɬχ/ → [ʔatkmaɬχ] '1pS-ABIL-go/pl', /ʔp-tm-kap/ → [ʔptkomkap] '1sS-ABIL-fly' (p.56); /m-t-m-aa/ → [imtkmaa] 'don't you know it?', /i-t-m-pi:/ → [itkompi:] 'didn't he taste it?' (p.72).

As in Koḍava, it is unclear what prosodic restriction motivates the 'epenthesis'. [k] is not epenthesized to avoid an ONSET or NOCODA violation. Moreover, it may be accompanied by [o]-epenthesis: [it<u>ko</u>mpi:] (see ch.4§4.4 for discussion). It is unclear in this case why the output is not simply [it<u>o</u>mpi:] – this solves the problem of [tm] adjacency and avoids creating marked syllables.

As in Koḍava, Seri [k]-'epenthesis' is limited to a very specific morphological environment – between prefixal elements (e.g. /i-t-√mis/ → [itmis], *[it<u>k</u>mis] 'OM-RL-resemble' (p.56)). In fact, it effectively only shows up after two different morphemes: /tm/ and between /t/ and /m/. In short, Seri [k] does not act like an epenthetic element; its distribution may reasonably be called idiosyncratic, much like a morpheme's.

Paradis & Prunet (1994) have already provided a detailed reanalysis of Uradhi; the reader is referred to their work for further details.

As for Murut, Trigo (1988:59ff) argues that a [ɣ] that appears with certain reduplicants in Murut is epenthetic. Data from Prentice (1971:121) includes /RED+aŋkup/ → [ga<u>ɣ</u>aŋkup]*no gloss*, /RED+insilot/ → [gi<u>ɣ</u>insilot] 'toothpick' (cf [bu-βulud] 'ridges in which tuberous crops are planted'). Notes that [ɣ] reduplicates as [g] – this is due to the fact that voiced stops and voiced fricatives are in complementary distribution – voiced stops are banned intervocalically (they spirantize, as described in §6.5.1.2).

However, the appearance of [ɣ] poses a number of puzzles if it is epenthetic. One is why a less marked segment like the voiceless stop [k] is not epenthesized: it is perfectly acceptable in stem-initial position and intervocalically (e.g [kabul] 'fan', [kutupus] 'bangs, explodes' (p.99); [naka-<u>β</u>alaʔ] 'has informed' (p.17)). The other issue is that [ɣ]'s appearance is unpredictable. It only occurs with some vowel-initial reduplicants. Others employ infixation: e.g. /RED+ulampoj/ → [u<u>l</u>alampoj] *no gloss,* /RED+indimo/ → [in<u>d</u>idimo] 'about five times'. If [ɣ] appears to satisfy some prosodic requirement, it is difficult to see why it should only appear for some roots and not others. Like the other cases cited above, [ɣ]'s distribution is idiosyncratic and unpredictable, more reminiscent of a morpheme than an epenthetic element.

To conclude, there are no convincing cases of dorsal epenthesis, and therefore no reason to posit a markedness constraint that favours dorsals over coronals.[161] The lack of such a constraint ensures that neutralization can never produce dorsals, only glottals and coronals.

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[161] Yip (1992) reports that [ŋ] is inserted to meet a prosodic weight requirement in Kaingang (cit Lombardi 1998). Again, this can be treated as the glottal nasal [N].

6.6.4 Glottal neutralization

The final issue that requires some comment is neutralization of glottals. As argued in previous sections, glottals can neutralize through Glottal Elimination: if *-Δ$_\sigma$≥{glottal} outranks both *{KPT} and IDENT{KPTʔ}, /ʔ/ and /h/ will be banned.

Evidence that glottals can neutralize to coronals is found in Korean.

Korean places many restrictions on its coda consonants. One is a ban on fricatives: [s] and [h] are not allowed to appear in codas. As shown in (100), both fricatives are neutralized to the stop [tˈ] (Kim-Renaud 1986:10,16, Iverson 1989:287, Lee 1998:146, Ahn 1998:40, 93).[162] "KR" refers to Kim-Renaud (1986), "I" refers to Iverson (1989), and "L" to Lee (1998).

(100) <u>Korean coda continuant neutralization</u>
    (a) /s/ → [t]
        /os/ 'clothes'   [osɨn] 'as for the clothes'   (KR10,L146)
                               [os-e] 'clothes+locative'
                               [otˈ-k'wa] 'clothes and'
        /pus/ 'swell up'   [pus-ə]   (L161)
                               [putˈ-k'o] 'swell up and'
        /is'/ 'exist, have' [is'-ə] 'I have it'   (KR10)
                               [itˈ-k'o] 'exist and'
        /nas/ 'sickle'   [nat] 'sickle'   (L151)
                               [natˈ-kwa] 'sickle and'
        cf /soki/ 'inside' [soki] {nominative}   (L146)
                               [sokˈ-t'o] 'inside also'
                               [sokˈ] {phrase-final form}
    (b) /h/ → [t]
        /tʃoːh/ 'good'   [tʃoːh-ɨni] 'as (it's) good' (I287)
                               [tʃoːtˈ-kʰo] 'good and'
                               [tʃoːtˈ-tʰa] 'good (decl.)'
        /suh/ 'male'   [sutˈ-pʰəm] 'male tiger'   (KR16)
        /nəh/ 'insert'   [nətˈ-tʰa] 'to insert'   (KR16)
        /nah/ 'bear'   [natˈ-kʰo] 'bear and'   (KR16)

Kim-Renaud (1986:16) reports that the pre-consonantal [h] appears in a "slow, bookish, emphatic pronunciation"; it is deleted in faster and colloquial speech. This is not true of word-final /h/, which always surfaces as [tˈ] (Ahn 1998:93).

- *Analysis*

The aspect of Korean coda neutralization that is of present interest is that the glottal /h/ neutralizes to the coronal [t].

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[162] Coda stops are unreleased.

The first step is to explain why fricatives are eliminated in Korean codas. The ranking ‖ onset-IDENT[±continuant] » *+continuant » IDENT[±continuant] ‖ will achieve this result, as shown in tableau (101).

(101)   /h/→[t] in Korean I

/suh/	onset-IDENT[±cont]	*+continuant	IDENT[±cont]
(a) suh		* *!	
☞ (b) sut		*	*
(c) tut	*!		* *

The issue of present interest is why /h/ neutralizes to the coronal [t] rather than any other stop. /h/ cannot neutralize to [ʔ] because glottal stops are banned in Korean (Ahn 1998:55). This can be formally implemented by the Glottal Elimination constraint *-Δ_σ≥{glottal}.[163] To prevent elimination of /h/ in onsets, onset-IDENT{KPTʔ} can outrank this constraint.

With *-Δ_σ≥{glottal} banning glottals, /h/ has no choice but to neutralize to one of [pˈ tˈ kˈ].[164] The reason /h/ neutralizes to [tˈ] rather than [pˈ] or [kˈ] is because [tˈ] has the least marked PoA, as shown in tableau (102).

(102)

/tʃoːh/	*[+continuant]	*-Δ_σ≥{glottal}	*{K}	*{KP}
(a) tʃoːh	*!			
(b) tʃoːʔ		*!		
☞ (c) tʃoːtˈ				
(d) tʃoːpˈ				*!
(e) tʃoːkˈ			*	*!

In short, neutralization of glottal /h/ to a coronal is emergence of the unmarked. As predicted by the present theory, if glottals are eliminated, coronals are promoted to least marked status. Therefore, glottals neutralize to coronals.

6.6.5   Consistency of neutralization target

As a concluding point, one further prediction that follows from this approach is that the output target of neutralization for an individual language will be the same for every element, holding all else equal. So, if /k/ neutralizes to [ʔ] in a language and /p/ also neutralizes, /p/ will neutralize to [ʔ] as well. There is no language in which /k/ neutralizes to [ʔ] in codas while /p/ neutralizes to [t]. In other words, the neutralization target within an individual language is consistent.

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[163]   This ranking does not mean that [ʔ] will also appear in onsets: /ʔ/ may neutralize to [h] in onsets.
[164]   Aspirated consonants, tense consonants, and palato-alveolars are banned in codas.

The within-language consistency of neutralization target follows from basic principles of markedness, and relies on certain properties of faithfulness constraints. Schematically, if /α/ neutralizes to [δ] and not [γ], then some markedness constraint M that favours [δ] over [γ] must outrank all markedness constraints that do the opposite. If that is so, then neutralization of /β/ in the same environment must also be to [δ] -- it cannot produce [γ] as M favours [δ] over [γ].

More concretely, if /k/ neutralizes to [ʔ], then *{KPT} outranks *MAR/glottal. So, /p/ can only neutralize to [ʔ] -- [t] is eliminated by *{KPT}.

The markedness side is only part of the story, though; this result depends heavily on the form of faithfulness constraints. Schematically, if some faithfulness constraint is not violated by /β/→[γ] but is violated by /β/→[δ], then /β/ could neutralize to [γ] while /α/ neutralizes to [δ]. For example, if there is a faithfulness constraint F that penalizes /k/→[ʔ] but is not violated by either /k/→[t] or /p/→[ʔ], the ranking || F » *{KPT} » *MAR/glottal || will produce a language where /k/ neutralizes to [t] but /p/ neutralizes to [ʔ]. As this does not take place, there can be no such faithfulness constraint.

More generally, within-language consistency of target for PoA requires that there is no faithfulness constraint that is violated by neutralization of PoA /x/ to glottal or coronal PoA without also being violated by PoA /z/→[y]. Thus, there can be no faithfulness constraint that is violated by /k/→[ʔ] but not /p/→[ʔ] or /t/→[ʔ]; the same holds for neutralizations to [t].

6.6.6 Summary

The aim of this section was to show that the form of the markedness and marked-faithfulness constraints permitted only certain values to be the output of neutralization.

Glottals can be the output of neutralization because they are harmonic bounds for all other PoAs in terms of the PoA scale. Neutralization can also produce coronals because they can be promoted to least marked status by Glottal Elimination. In contrast, no process eliminates both coronals and glottals alone, so dorsals and labials can never be the outcome of neutralization.

The form of faithfulness constraints is crucial to this result. Faithfulness constraints cannot favour mappings to a more marked element over a less marked one. For example, there can be no faithfulness constraint that penalizes the mapping /k/→[t] but not /k/→[p]. The marked-faithfulness constraints have this character. For example, IDENT{K} is violated equally by /k/→[p] and /k/→[t]. Accordingly, the marked-faithfulness constraints cannot determine the target of neutralization – this is left entirely to markedness constraints.

The results of this section also apply to non-PoA scales. Neutralization should always produce the least marked element available. So, for any scale S=| γ 〉 β 〉 α |, [α] will always be the output of neutralization of S elements. Similarly, for binary scales the least marked element should always be the target of neutralization. We should therefore expect neutralization of [+voice] to [−voice] in obstruents (e.g. German), but there is no way in the present theory to produce the opposite.

6.7   Summary

The aim of this chapter was to show that highly marked elements can be preserved while less marked elements are not. More formally, the aim was to show the need for faithfulness constraints that preserved marked elements only.

Such constraints were argued to be crucial in accounting for 'gapped' inventories – ones that contained highly marked elements but lacked less marked ones. For example, coronals are eliminated in Yamphu codas, but the more marked labials and dorsals are permitted: /soksæt/ → [soksæʔ], *[soʔsæt], *[soʔsæʔ]. The same inventory is found in onsets in Hawaiian (Kupui & Elbert 1979) and a number of other languages (§6.3.1).

Section §6.3.4 showed that an adequate account of gapped systems required a constraint that preserved marked elements alone. In the case of Yamphu, this was the constraint IDENT{KP}, which preserves input labial and dorsal specifications only. Tableau (103) shows how IDENT{KP} prevents /k/ from neutralizing to [ʔ], but allows the less marked /t/ to debuccalize. To simplify matters, only violations of stop PoA will be shown for *{KPT}.

(103)   Gapped Inventories

/soksæt/	IDENT{KP}	*{KPT}	IDENT{KPT}
(a) soʔsæʔ	*!		* *
☞ (b) soksæʔ		*	*
(c) soksæt		* *!	

Candidate (a) debuccalizes all stops in coda position. By doing so, it fatally violates IDENT{KP} because the dorsal PoA of input /k/ is not preserved in the output.

Both candidates (b) and (c) avoid violations of IDENT{KP} by preserving /k/. However, candidate (c) is over-zealous in its preservation – it fails to capitalize on the fact that nothing prevents /t/ from debuccalizing. In contrast, candidate (b) minimizes violations of *{KPT} by eliminating output [t]. The result is a gapped coda inventory.

The marked-faithfulness constraints can generate all possible gapped and harmonically complete inventories. However, they cannot generate 'disharmonic' ones: those that fail to have some least marked element ([ʔ] or [t]) (i.e. [K P], [K], [P]). Consequently, almost all gaps in table 6.14 are filled. For the languages cited, the first has the inventory in codas, and the second has it in onsets; see Appendix A for more examples. 'GE' stands for 'Glottal Elimination'.

Table 6.14: Voiceless stop inventories

		k	*p*	*t*	*ʔ*	*Languages*
Harmonically Complete		✓	✓	✓	✓	Chamicuro, Tongan
			✓	✓	✓	Standard Malay, Tahitian
				✓	✓	Menomini, Harar Oromo
					✓	Nantong Chinese, Nancowry reduplicants
	GE	✓	✓	✓		Yuma, Maori
			✓	✓		Kiowa (formal), Vanimo
				✓		Lardil
Gapped	3	✓	✓		✓	Yamphu, Hawaiian,
		✓		✓	✓	Nambiquara, Tlingit
	2		✓		✓	Nganasan
		✓			✓	Fuzhou
		✓		✓		Hixkaryana, Gilbertese
		✓	✓			*unattested (disharmonic)*
			✓			*unattested (disharmonic)*
		✓				*unattested (disharmonic)*

Disharmonic inventories like [k p] cannot be produced by the PoA constraints because they fail to contain the least marked PoA element; by Harmonic Ascent, the least marked element cannot be eliminated through any ranking.

However, other processes may interfere to produce disharmonic inventories. For example, glottals may be eliminated through a ban on high sonority margins and coronals may undergo flapping, leaving only the voiceless stops [k p] in certain environments.

- *Deletion vs Neutralization*

The theory proposed here predicts that deletion and neutralization have different effects as inventory-forming processes. While neutralization may produce both gapped and harmonically complete inventories, deletion can only produce harmonically complete inventories.

More concretely, the gap in the Yamphu coda inventory must come about through neutralization: /t/ must neutralize to [ʔ]. The present theory predicts that /t/ cannot delete in this case.

To explain, if /t/ is deleted, then *{KPT} must outrank MAX. However, since *{KPT} also bans dorsals and labials, it will be impossible to block their deletion as well. At this point, the form of the marked-faithfulness constraints is crucial. IDENT{KP} cannot prevent /k/ and /p/ from deleting: it is equally satisfied by both /k/→[k] and /k/→∅ (McCarthy & Prince 1995).

- *Direction of Neutralization*

The theory significantly restricts the output of neutralization. /x/ may only neutralize to [y] if [y] is less marked than [x] and there is no [z] that is less marked than [y]. This follows from Harmonic Ascent: for an unfaithful candidate to win, it must fare better that the fully faithful candidate on some markedness constraint. Since no markedness constraint favours a less marked element over a more marked one, all unfaithful winners must be less marked than the faithful form.

Together, this means that /T/ can only neutralize to [ʔ]. /K/ and /P/ must neutralize to [ʔ] or [T]. [ʔ] must neutralize to /T/.

- *Other Scales*

The generalizations identified for PoA extend to other scales. With binary scales, the results are somewhat more limited. In a binary scale | β 〉 α |, there can be only two inventories [β α] and [α]. Since [α] is least marked, it cannot be eliminated: the disharmonic inventory [β] is therefore banned. There is no equivalent to a gapped inventory for binary scales, for practical reasons.

For example, if we take a vowel nasalization scale, with | V^{nasal} 〉 V^{oral} |, two types of inventory are predicted: one with only oral vowels, and one with both oral and nasal vowels.

This does not mean that the results only apply to PoA, though. For example, they apply to the sonority scale to explain the typology of manners of articulation. To explain, the sonority scale is repeated in (104).

(104) | glides 〉 liquids 〉 nasals 〉 +vd frics 〉 -vd frics 〉 +vd stops 〉 -vd stops |

Languages can have contiguous parts of the sonority hierarchy in onsets. For example, Mura-Pirahã has voiceless stops, voiced stops, and voiceless fricatives in onsets: higher sonority elements (voiced fricatives, nasals, liquids, and glides) are not present (except as allophones in restricted environments). In contrast, Maori has a gapped inventory: it has voiceless stops, voiceless fricatives, nasals, and liquids, but lacks voiced stops and voiceless fricatives. The following table presents a fuller typology of gaps. The shaded boxes highlight the relevant gap in the inventory.

Table 6.15: Gapped non-DTE inventories

Language	glides	liquids	nasals	+vd frics	-vd frics	+vd stops	-vd stops
Aguaruna	✓		✓	✓	✓		✓
Cubeo	✓	✓			✓	✓	✓
Mundurukú	✓	✓	✓		✓	✓	✓
Djapu	✓	✓	✓			✓	✓
Gavião	✓	✓	✓	✓		✓	✓
Rarotongan		✓	✓	✓			✓
Awetí	✓	✓	✓	✓	✓		✓

These gaps can be accounted for by the same method as PoA gaps: some faithfulness constraint preserves the marked (high sonority) elements, while lesser-marked elements are eliminated.

As with PoA, Harmonic Ascent predicts that the least marked element – voiceless stops – cannot be eliminated. In all the languages listed in Appendix B, this prediction holds.[165]

- *Implications for Markedness Diagnostics*

This section concludes with a point mentioned in the introduction, relating to the implications of this chapter for the concept of 'markedness'. Given the existence of gapping, inventories can no longer be seen as diagnostics for markedness relations in scales. For example, the fact that [k] exists in Yamphu codas but not [t] does not imply that [k] is less marked than [t] in this – or any – grammar. In short, this chapter has all but eliminated inventory structure as a diagnostic for markedness.

The one exception relates to the least marked element. The present theory predicts that the least marked element of scale S can never be eliminated by S-referring constraints. To obscure the issue, nothing precludes another scale Z from having different markedness relations. Interaction of S- and Z-referring constraints can therefore confuse the surface picture. This chapter showed how PoA- and sonority-referring constraints did precisely this: while glottals are least marked in terms of PoA, the sonority constraints can eliminate them.

Even with the interference of sonority, though, the persistence of the least marked element comes through, embodied in the empirical claim that all manners in all inventories have a segment at either glottal or coronal PoA, or both.

In contrast, this chapter affirms that direction of neutralization and epenthesis both provide reliable diagnostics for markedness. Both direction of neutralization and epenthesis are free from the influence of faithfulness constraints, so they provide insight into the form of markedness constraints.

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[165] A number of Australian languages are reported as having no voiceless stop phonemes (e.g. Ngunggabuyu). However, in these cases voiceless stops occur word-initially; the lack of voiceless stops elsewhere can be explained by an interfering process of intervocalic and post-sonorant voicing. The Polynesian language Nukuoro has been cited as having voiced stops but no voiceless ones (Carroll 1965). It may be the case that this language (and other reported cases) has unaspirated voiceless stops (like all other Polynesian languages); this was my impression on hearing Nukuoro spoken, though I took no measurements. Languages relevant to this issue, cited in UPSID, are Jomang, Bandjalang, Yidiny, Dyirbal, Mbabaram.

CHAPTER 7

FAITHFULNESS TO THE MARKED II:

AVOIDING HETERORGANIC CLUSTERS

7.1   Introduction

The aim of this chapter is to provide further evidence for the proposal that more marked elements can be preserved while less marked ones are not, formally expressed as faithfulness constraints that preserve marked elements without preserving less marked ones: e.g. IDENT{K}, IDENT{KP}. A further aim is to show that there are no faithfulness constraints that preserve unmarked elements alone – e.g. IDENT{T}, IDENT{PT}.

As in chapter 6, the focus of this chapter is entirely on the proposal that marked elements are subject to greater faithfulness than unmarked ones. This chapter does not aim to show that faithfulness constraints must be formulated stringently; this is reserved for chapter 8.

The empirical focus of this chapter is heterorganicity-avoidance. A heterorganic consonant cluster is a sequence of consonants that disagrees in Place of Articulation: e.g. [ŋp ŋt mk mt nk np]. In contrast, homorganic clusters agree in PoA: e.g. [ŋk mp nt].

Languages can avoid heterorganic clusters like [mk] in a variety of ways: deletion [k] (§7.5.1), epenthesis [mik] (§7.3.1), coalescence [ŋ] (ch.8), neutralization [nk] (§7.6.1), metathesis [km] (§7.5. 3), and – most commonly – assimilation [ŋk] (§7.1-§7.3). As indicated by the section references, almost all of these heterorganicity-avoidance techniques are discussed in this chapter, though assimilation is the primary focus.

Heterorganicity-avoiding processes provide evidence for the marked-faithfulness constraints. As with neutralization (ch.6), the marked-faithfulness constraints can prevent marked elements alone from undergoing heterorganicity-eliminating processes.

- *The usefulness of marked-faithfulness*

For example, assimilation is used to eliminate certain heterorganic clusters in Catalan. However, only coronals undergo assimilation in Catalan; labials and dorsals are exempt (Mascaró 1976, 1986, Hualde 1992, Palmada 1994). A full description and analysis is provided in §7.2; (1) summarizes the data.

(1)   Catalan Coronal-Only Assimilation (in brief)
       (a) Coronals assimilate
              [son əmiks]   *son amics*   'they are friends'
              [som bɛus]   *son beus*   'they are voices'
              [soŋ kuzins]   *son cosins*   'they are cousins'

(b) Labials do not assimilate

[som əmiks]	*som amics*	'we are friends'
[som pɔks]	*som pocs*	'we are few'
[som dos]	*som dos*	'we are two'

(c) Dorsals do not assimilate

[tiŋ pa]	*tinc pa*	'I have bread'
[tiŋ presə]	*tinc pressa*	'I'm in a hurry'

In informal terms, /ŋ/ and /m/ do not assimilate in Catalan because they are highly marked, and their high markedness excites greater preservation. In contrast, the coronal /n/ is less marked, and – in Catalan – it is not marked enough to warrant preservation. So, /n/ undergoes assimilation while the more marked elements do not.

In formal terms, Catalan-type systems result from a ranking in which IDENT{KP}, which preserves dorsals and labials alone, outranks the markedness constraint that bans heterorganic clusters. In such a ranking, it is more harmonic to retain marked feature values – i.e. labial and dorsal specifications – than assimilate. In contrast, nothing prevents coronals from assimilating – faithfulness constraints that preserve coronals (IDENT{KPT}) are dominated by the anti-heterorganic markedness constraint. This analysis builds on previous OT analyses by Kiparsky (1994) and Jun (1995). Tableaux (2) and (3) illustrate this ranking; the constraint ASSIM bans heterorganic clusters.

(2)

/son bɛus/	IDENT{KP}	ASSIM	IDENT{KPT}
(a) son bɛus		* !	
☞ (b) som bɛus			*

(3)

/som dos/	IDENT{KP}	ASSIM	IDENT{KPT}
☞ (a) som dos		*	
(b) son dos	* !		*

Tableau (2a) shows that coronals undergo assimilation because ASSIM outranks all coronal-preserving faithfulness constraints. In contrast, tableau (2b) shows how the more marked labial and dorsal PoAs can be exempt from assimilation: IDENT{KP} prevents the input labial /m/ from being unfaithful, as regressive assimilation requires.

- *The need for marked-faithfulness*

Catalan shows how marked-faithfulness constraints can be useful, but it does not show that they are *necessary* – in other words, it does not rule out analyses without marked-faithfulness constraints. For example, Catalan could also be analyzed by invoking a constraint that just rules out coronal+non-coronal clusters, dubbed the 'Markedness-Reliant' approach here. In this type of analysis, only coronals would assimilate because no markedness constraint would ban non-coronals in heterorganic clusters.

Section 7.3 examines the Markedness-Reliant approach. It shows that it is both too restrictive and not restrictive enough.

Evidence that the Markedness-Reliant approach is too restrictive comes from systems that have more than one method of avoiding heterorganic clusters. For example, Ponapean avoids coronal+non-coronal heterorganic clusters by assimilation /np/→[mp], but eliminates other heterorganic clusters by epenthesis /mt/→[m<u>a</u>t] (Rehg & Sohl 1981, Goodman 1995). A theory without marked-faithfulness constraints is argued to predict that that the Ponapean system is impossible.

Evidence that the Markedness-Reliant approach is not restrictive enough comes from neutralization. A constraint that targets coronal+non-coronal heterorganic clusters alone can produce a type of neutralization whereby coda coronals become non-coronal: e.g. /anka/ → [amka]. As established in ch.6§6.6, this type of neutralization is unattested.

- *No need for unmarked-faithfulness*

The second half of this chapter (§7.4-§7.6) is devoted to showing why there is no need for 'unmarked'-faithfulness constraints – faithfulness constraints that only preserve unmarked elements, like IDENT{T} and IDENT{PT}. The theory proposed here denies that such constraints exist in CON.

On the surface, theories without unmarked-faithfulness constraints face a challenge in systems like Sri Lankan Portuguese Creole's (Smith 1978, Hume & Tserdanelis 1999). This language is the exact complement to Catalan: labials and dorsals assimilate while coronals do not (for analogous cases involving voice assimilation, see §7.4.4, Wetzels & Mascaró 2001). Selected data is given in (4), taken from both Smith (1978) and Hume & Tserdanelis (1999). See §7.4.2 for details.

(4)　　Sri Lankan Portuguese Creole marked-only assimilation (in brief)
　　　　(a) Coronals do not assimilate
　　　　　[kəkluːn+pə]　　　'turkey {dative sg.}'
　　　　　[siːn+ki]　　　　'bell {verbal noun}'
　　　　　[siːn kidaːj]　　　'the ringing of bells'
　　　　(b) Labials assimilate
　　　　　/maːm+su/　　→ [maːnsu]　　　　'hand+{genitive}'
　　　　　/pikiniːm kaːzə/　→ [pikiniːŋkaːzə]　'small house'
　　　　　/maːm+ki/　　→ [maːŋki]　　　　'hand {verbal noun}'
　　　　(c) Dorsals assimilate
　　　　　/miːtiŋ+pə/　　→ [miːtimpə]　　　'meeting {dative sg.}'
　　　　　/uŋ pæːzu/　　→ [um pæːzu]　　'one pound'
　　　　　/miːtiŋ+su/　　→ [miːtinsu]　　　'meeting {genitive}'

Section 7.4 will argue that faithfulness constraints are not responsible for the lack of coronals assimilation (cf Catalan). Instead, the SLP Creole system will be shown to follow from the proposal that heterorganic clusters differ in markedness. Specifically, heterorganic clusters without coronals are less marked than those with coronals. So,

coronal+C heterorganic clusters are exempt from assimilation in SLP Creole because they are already adequately unmarked.

This idea is implemented by combining all context-free PoA markedness constraints with themselves, forming constraints such as *{KP}{KPT}, which bans clusters consisting of either a dorsal or labial, followed by a dorsal, labial, or coronal. This theory differs from previous approaches in OT, which have typically treated all heterorganic clusters as being equally marked (e.g. Lombardi's 1995, 1999 AGREE theory).

In short, systems like SLP Creole's do not provide evidence that unmarked-faithfulness constraints are necessary.

- *Not all heterorganic clusters are equal*

Sections 7.5 and 7.6 present two pieces of evidence that anti-heterorganicity constraints like *{KP}{KPT} are independently necessary.

Section 7.5 discusses the triggers of heterorganicity-avoidance. For example, in Attic Greek only heterorganic clusters in which the second member is a non-coronal are avoided (Steriade 1982, Bubeník 1983). The net result of this restriction was that only (i) homorganic clusters and (ii) non-coronal+coronal clusters are allowed on the surface: e.g. /RED+peːt^h+k+a/ → [pepeːka] 'I have persuaded' (S217), cf /dioːk+teːn/ → [dioːkteːn] 'persecutor {acc.masc.sg.}'. This system and others like it are shown to fall out from the proposal that heterorganic clusters differ in markedness. In fact, the formal account employs a constraint that is the mirror image of the one used for SLP Creole (*{KP}{KPT}).

Section 7.6 discusses neutralization. Specifically, Kiowa (casual register) neutralizes PoA distinctions in medial codas but not final ones: /t^{h}ɔp-kɔ/→[t^{h}ɔʔkɔ] 'shoot {neg}', cf [tap] 'deer'. This neutralization pattern is shown to require a constraint that specifically targets certain types of heterorganic cluster without targeting others.

The relation between medial assimilation/neutralization and final neutralization is also discussed in this section.

In short, the constraints used for SLP Creole are shown to be independently necessary, again providing support for the proposal that unmarked-faithfulness constraints are unnecessary.

- *Empirical observations*

Apart from the theoretical points, this chapter makes novel empirical observations, and provides more evidence for some previous proposals relating to assimilation.

One observation is that there are no implicational relationships in relation to undergoers of assimilation (and heterorganicity-avoiding processes in general).[166] As Table 7.1 shows, any subset of {dorsal, labial, coronal} can undergo assimilation. For example, only dorsals are exempt from assimilation in Inuktitut, only labials are exempt in

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[166] This claim disagrees with a great deal of previous work that has held that if coronals undergo assimilation, so do non-coronals. For the most recent and extensive discussion, see Cho (1990), Mohanan (1993:76), and Jun (1995§2.2.2).

Harar Oromo, and only coronals are exempt in SLP Creole. See the sections cited for references to the language in the table.

Table 7.1: Undergoers of assimilation

K	P	T	*Language*
✓	✓	✓	Diola Fogny (J.Sapir 1965:16)
✓	✓		Sri Lankan Portuguese Creole (§7.4.1), Nunggubuyu (§7.4.4)
✓		✓	Harar Oromo (§7.4.3.2)
	✓	✓	NBA Inuktitut (§7.2.2), (Korean – §7.5.2)
		✓	Catalan (§7.2.1), Yamphu (§7.2.2)
	✓		Gunin/Kwini (§7.1)
✓			Chukchi, Uradhi (§7.4.3.1)
			Southern Sierra Miwok (§7.6.2.2)

In contrast, evidence is provided for Mohanan's (1993) (also see Jun 1995) observation regarding triggers of assimilation: if a less marked element triggers assimilation, so does a more marked one. In slightly different terms, if heterorganic clusters of the form C(onsonant)+coronal undergo assimilation, then so do clusters of the form C+labial and C+dorsal. This allows for languages where coronals do not trigger heterorganicity-avoidance (e.g. Attic Greek) and where neither coronals nor labials trigger assimilation (e.g. Korean), while excluding languages where coronals alone trigger assimilation.

Finally, this chapter identifies a number of predictions about the relations among medial assimilation, medial neutralization, and final neutralization (§7.6.2). As Table 7.2 shows, almost every possible combination is attested except for one in which there is final PoA neutralization and neither assimilation nor neutralization medially. See §7.6.2 for references to the languages cited.

Table 7.2: Medial-final PoA relations

medial codas	*word-final codas*	/amkam/[167]	*Language*
×	×	[amkam]	Southern Sierra Miwok
neutralize	×	[ankam]	Kiowa
assimilate	×	[aŋkam]	Harar Oromo, Diola Fogny
×	neutralize	[amkan]	*impossible*
neutralize	neutralize	[ankan]	Nganasan
assimilate	neutralize	[aŋkan]	Selayarese, Tzutujil

As a final comment, while this chapter is primarily concerned with the PoA scale, attention is also given to the (obstruent) voicing scale | +voice 〉 -voice |; all sections conclude by showing how the proposals for the PoA scale extend to the voicing scale.

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[167] The systems listed here apply to assimilations of both nasals and stops. So, the input /apkap/ is more appropriate for some of the systems listed (i.e. Kiowa – see §7.6.1, Nganasan – ch.6§6.3).

- *Organization*

§7.2   discusses the usefulness of marked-faithfulness constraints in accounting for systems in which only unmarked elements undergo assimilation.
Languages analyzed: Catalan, Inuktitut, Kiowa, Yamphu; Ukrainian

§7.3   shows that Markedness-Reliant approaches to Catalan-type systems are undesirable.
Language analyzed: Ponapean

§7.4   introduces the theory of anti-heterorganic cluster constraints, formally expressing the proposal that heterorganic clusters differ in markedness.
The theoretical aim of this section is to show that there is no need for faithfulness constraints that exclusively preserve unmarked feature values.
Languages analyzed: Sri Lankan Portuguese Creole, Chukchi, Harar Oromo, Mekkan Arabic

§7.5   shows that there is independent evidence for the markedness constraints proposed in §7.4. The evidence presented in this section relates to asymmetries in the elements that trigger assimilation.
Languages analyzed: Attic Greek, Korean, Kui.

§7.6   shows that there is independent evidence for the markedness constraints proposed in §7.4. The evidence in this section relates to cases of medial neutralization without final neutralization.
Language analyzed: Kiowa.

§7.7   discusses alternative approaches to the SLP Creole type of system. Specifically, Baković's (1999a,b) and McCarthy's (2002a) theories are compared to the one proposed here.

§7.8   summarizes the findings of this chapter.

7.2   Preserving the marked

The aim of this section is to show that the predictions of the marked-faithfulness theory are borne out. As discussed in chs.5 and 6, the marked-faithfulness constraints can prevent marked feature values from undergoing a process while unmarked values are not spared. Such a situation is formally implemented by having a marked-faithfulness constraint outrank the markedness constraints that motivate the process. This is schematized in a general way in the ranking in (5). IDENT{*marked*} preserves some

marked feature value alone. M motivates unfaithfulness; its ranking over IDENT{*marked,unmarked*} ensures that unmarked values undergo the process.[168]

(5)   Unmarked Undergoers Only
        || IDENT{*marked*} » M » IDENT{*marked,unmarked*} ||

The ranking in (5) can be easily extended to deal with scales with several steps; an example is given below for the 4-member PoA scale.

For processes that avoid heterorganic clusters, the ranking in (5) will prevent clusters with marked elements from being eliminated, but allow clusters with less marked elements to be dispensed with. As mentioned in §7.1, this type of system is found in Catalan, where only coronals undergo assimilation. Jun's (1995) and Cho's (1999) surveys of Place assimilation identify several other Catalan-type systems, including Brussels Flemish, German, Keley-i, Japanese, Lithuanian, Polish, Sanskrit, and Toba Batak. Meccan Arabic can be added to this list (Bakalla 1973:508-513).

At face value, the Catalan-type system conflicts with the predictions of markedness theory (at least the Prague School conception): an unmarked element is converted into something more marked (i.e. /n/→[m]/_p, /n/→[ŋ]/_k), while more marked elements are prevented from becoming less marked: e.g. /mt/ does not undergo assimilation to *[nt], even though the resulting [n] would have the less marked coronal PoA.

Section 7.2.1 shows that marked-faithfulness constraints provide a solution to this conundrum. Specifically, the constraint IDENT{KP} prevents marked elements from assimilating, but allows coronals to be affected. This analysis builds on previous work in OT, especially Kiparsky (1994) and Jun (1995). Underspecification approaches to the Catalan system are also discussed (Kiparsky 1982, Cho 1999). They are argued to be inadequate for reasons relating to the typology of undergoers in assimilation.

Section 7.2.2 identifies the further typological predictions of the theory.
Section 7.2.3 provides a summary.

7.2.1   Catalan

PoA assimilation in Catalan has been the subject of a number of descriptions and analyses (Mascaró 1976, 1986, Wheeler 1979, Kiparsky 1985, 1994, Recasens 1991, Hualde 1992, Palmada 1994). The analysis presented in this section owes much to this previous work, especially Kiparsky's (1994) OT analysis. The following sections recast

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[168] Unmarked feature values might *not* undergo the process triggered by the markedness constraint if there is no more harmonic candidate. This situation relates to Harmonic Ascent, and is discussed in detail in chapter 6. For assimilation, the issue does not arise since there is no heterorganic cluster that is less marked than a homorganic one. Under some rankings, though, certain heterorganic clusters may be *equally* as marked as homorganic ones. For example, the constraint *{K}{KPT} can motivate /ŋp/ to either be realized as homorganic [mp] or for the /ŋ/ to neutralize to [n] (i.e. [np]) – both outcomes satisfy the constraint. See §7.6 for discussion of relevant cases.

the analyses in terms of the present theory and consider a number of related facts about heterorganicity-avoidance in Catalan.[169]

Section 7.2.1.1 describes aspects of Catalan phonotactics relevant to assimilation, and the process of nasal assimilation itself. Section 7.2.1.2 presents an analysis. Section 7.2.1.3 discusses related processes in Catalan.

7.2.1.1 Description

Catalan has the consonants listed in Table 7.3 (adapted from Hualde 1992:367).[170] Segments in parentheses are marginal or differ from dialect to dialect.

Table 7.3: Catalan consonants

	labial	dental/alveolar	alveo-palatal	palatal	dorsal
stops	p	t̪			k
	b	d̪			g
affricates		(ts)	tʃ		
		(dz)	(dʒ)		
fricatives	f	s	ʃ		
		z	ʒ		
nasals	m	n		ɲ	ŋ
laterals		l		ʎ	
rhotics		ɾ r			
glides	w			j	

Syllables have the form (C)(C)V(C)(C). Singleton onsets can consist of any consonant except [ɾ], the affricates, [ŋ], and [w]. Codas can contain any segment except voiced obstruents, which demonstrably neutralize to their voiceless counterparts.

Onset clusters consist of a stop or [f] plus a coronal liquid [r l], with the exception of [tl] and [dl]. Examples are [prumɛtrə] 'promise', [blaw] 'blue', [kla] 'clear', [frɛt] 'cold' (Hualde 1992:380).

Almost the same facts hold for coda clusters, though the order of segments is reversed. Word-finally, liquid+stop clusters are admissible, with the exception of [lt].[171] In addition, the following clusters with [s] are admissible: [sp st sk ns ls].

- *Assimilation*

Many coda consonants assimilate to the PoA of a following onset. To be precise, certain stops, nasals, and laterals assimilate; the fricative [s] also alters in codas (see Hualde 1992).

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[169] My thanks to Eva Juarros for her native speaker intuitions regarding the data in this section and for help with the transcriptions and glosses.
[170] As Hualde (1992) points out, there are several dialects of Catalan, differing in a number of phonological features. The following generalizations refer (at least) to Eastern Catalan.
[171] Obstruent voicing neutralizes in codas, so /d/ → [t], hence coda [ld] clusters are ruled out independently.

Two types of PoA assimilation are distinguished here. One is assimilation of major PoA – i.e. labial, coronal, and dorsal specifications. The other is assimilation of minor PoA – i.e. distinctions within the major PoA categories, such as bilabial vs labio-dental for labials, and dental vs alveolar vs palatal in the coronal category. The focus of this section is major PoA assimilation; minor PoA will be discussed when relevant.

Only the alveolar nasal [n] exhibits major PoA assimilation in coda position; [m ɲ ŋ] remain unchanged. (6) provides data from Mascaró (1976), Hualde (1992:395), and Palmada (1994:83, 109).

(6)   Major PoA Assimilation in Catalan

	/son/ 'they are'	/som/ 'we are'	/aɲ/ 'year'
amics 'friends'	son əmiks	som əmiks	aɲ əmik
pocs 'few'	som pɔks	som pɔks	aɲ pətit[172]
beus 'voices	som bɛus	som bɛus	
felisus 'happy pl.'	soɱ fəlisus	soɱ fəlisus	aɲ fəlis
tontus 'stupid'	son tontus	som tontus	aɲ tontu
docils 'amenable'	son dɔsils	som dosils	
cinc 'five'	son siŋ	som siŋ	
ʃikɔts 'boys', *ʃop* 'wet'	son ʃikɔts	som ʃikɔts	aɲ ʃop
rossos 'blonde'	son rosəs	som rosəs	
lliures 'free pl.'	soɲ ʎiwrəs	soɱ ʎiwrəs	aɲ ʎiwrəs
cosins 'cousin pl.'	soɲ kuzins	som kuzins	
grans 'big pl.'	soŋ grans	som grans	aɲ gran

The forms [tiŋ presə] *tinc pressa* 'I'm in a hurry' and [tiŋ pa] *tinc pa* 'I have bread' show that the dorsal [ŋ] does not assimilate either (Palmada 1994:109, Mascaró 1976 resp.).

The same restrictions hold morpheme-internally. In other words, homorganic nasal+C clusters and heterorganic clusters consisting of a labial followed by a non-labial are permitted.

(7)   *Morpheme-internal NC clusters*
       (a) homorganic
               [kámbi] *canvi* 'change'
               [kəmpánə] *campana* 'bell'
               [kəmbɔ́dʒə] *Cambotja* 'Cambodia'
               [kəndó] *candor* 'candour'
               [kəŋgúr] *cangur* 'kangaroo'
               [kuŋkəriðó] *conqueridor* 'conquering'

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[172] From /aɲ/ + /pətit/ *any petit* 'short year'.

(b) heterorganic labial+C (Hualde 1992:373)

[kumtát] *comtat* 'country'
[əsúmtə] *assumpte* 'business'
[dəmná] *damnar* 'to damn'
[ímnə] *himne* 'hymn'
[prémsə] *premsa* 'press'

7.2.1.2 Analysis

PoA assimilation comes about when a constraint against heterorganic clusters outranks all relevant PoA-faithfulness constraints. The constraint that bans heterorganic clusters will be called *HETERORGANIC here. This constraint is formally identical to Lombardi's (1996, 1999) AGREE[Place] constraint (also see Baković 1999a,b). However, it will be replaced by a theory of anti-heterorganicity constraints presented in §7.4. This section explicity argues against the AGREE theory, so – to avoid the semblance that the AGREE theory is adopted here –the name *HETERORGANIC is employed instead.

For assimilation of coronals to take place, *HETERORGANIC must outrank all faithfulness constraints that preserve coronals: i.e. IDENT{KPT}, repeated in (8).

(8)   IDENT{KPT}   "If *x* is dorsal or labial or coronal,
              then *x′* has the same place of articulation as *x*,
              where *x′* is the correspondent of *x*."

To be even more precise, the relevant IDENT{KPT} in Catalan refers to the relation between inputs and output correspondents (i.e. IO-IDENT{KPT}). For discussion of this point, see §7.7.4. Unless otherwise stated, all IDENT constraints mentioned in this chapter refer to the Input→Output dimension. Tableau (9) shows the assimilation ranking at work.

(9)   Basic anti-heterorganicity ranking

/son kuzins/	*HETERORGANIC	IDENT{KPT}
(a) son kuzins	*!	
☞ (b) soŋ kuzins		*

The constraint *HETERORGANIC is violated by all heterorganic clusters. So, candidate (a)'s [nk] cluster incurs a violation, while (b)'s [ŋk] cluster does not. Candidate (a)'s violation is fatal, as shown above.

- *Blocking labial and dorsal assimilation*
    *HETERORGANIC assigns a violation to all heterorganic clusters, not just those with [n]. Section 7.3 will show that this is a necessary fact: there is no constraint that bans coronal+non-coronal clusters alone. However, *HETERORGANIC's generality raises the question of why labials, palatals, and dorsals do not assimilate in Catalan.

The relevant constraint in the marked-faithfulness theory is IDENT{KP}, which preserves input labial and dorsal specifications.[173]   With IDENT{KP} outranking *HETERORGANIC, the marked categories are prevented from assimilating. This approach follows Kiparsky's (1994) analysis.

(10)   Blocking assimilation of the marked

/som kuzins/	IDENT{KP}	* HETERORGANIC	IDENT{KPT}
☞ (a) som kuzins		*	
(b) soŋ kuzins	*!		*

Candidate (b) fatally violates IDENT{KP} because the input labial specification is lost in the output: /m/→[ŋ]. In other words, IDENT{KP} blocks assimilation, rendering the constraint *HETERORGANIC inactive.

The Catalan ranking therefore illustrates the blocking effect of marked-faithfulness constraints. The constraint IDENT{KP} specifically preserves marked PoA values, so blocking the markedness constraint that promotes unfaithfulness – *HETERORGANIC. However, the markedness constraint outranks all faithfulness constraints that preserve unmarked feature values – IDENT{KPT} – with the result that only unmarked values undergo assimilation.

As a side note, it is impossible to determine the ranking of IDENT{K} in this system (cf §7.2.2). Since IDENT{K} incurs a subset of IDENT{KP}'s violations, ranking it either above or below IDENT{KP} will have no effect in relation to the markedness constraints discussed so far.

- *Avoiding Other Outcomes*

Like standard OT markedness constraints, the anti-heterorganic markedness constraints only eliminate candidates; they do not specify which of the surviving candidates will win. Thus, *HETERORGANIC bans candidates with a heterorganic cluster like [ŋp], but does not specify which of the alternatives – deletion [p], epenthesis [ŋip], assimilation [mp], or coalescence [m] – will apply.

The choice of winner falls to other constraints. Since deletion and epenthesis are ruled out in Catalan, the anti-deletion constraint MAX and anti-epenthesis constraint DEP must both outrank *HETERORGANIC. Tableau (11) illustrates this ranking.

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[173]   I adopt the proposal that (true) palatals are a type of dorsal (corono-dorsals, or [−back] dorsals – Keating 1988, E.Pulleyblank 1989) (cf alveo-palatals, which are [−anterior] coronals). So, IDENT{KP} will prevent /ɲ/ from assimilating to [t] in [aɲ tontu], *[an tontu].

(11)   Blocking deletion and epenthesis

/som kuzins/	IDENT{KP}	MAX	DEP	*HETERORGANIC
☞ (a) somkuzins				*
(b) soŋkuzins	*!			
(c) sokuzins		*!		
(d) somikuzins			*!	

The competition between (a), (c), and (d) shows the need for the ranking || MAX, DEP » *HETERORGANIC ||. If *HETERORGANIC outranked either MAX or DEP, the /mk/ cluster would be resolved by deletion or epenthesis. This point is discussed in detail in §7.3, where epenthesis is used to avoid heterorganic clusters (in Ponapean), and §7.5 where deletion is employed (in Attic Greek).

Other outcomes are ruled out by other faithfulness constraints. For example, coalescence of /mk/ is blocked by the anti-coalescence constraint UNIFORMITY (McCarthy & Prince 1995). Neutralization and metathesis will not improve on *HETERORGANIC, so – by process of elimination – the only option available is assimilation.

- *Direction of Assimilation*
  One further comment is needed in relation to the faithful mapping /som tontus/→[som tontus].   Significantly, the coronal onset does not assimilate here: *[sompontus]. An onset-faithfulness constraint will be used to deal with this directionality effect, after Beckman (1998) and Lombardi (1995, 1999).

  As Lombardi (1995, 1999) shows, a faithfulness constraint that specifically preserves PoA values in onsets produces regressive assimilation. In the present instance, such a constraint blocks assimilation of onsets if it outranks *HETERORGANIC.

(12)

/som tontus/	IDENT{KP}	onset-IDENT{KPT}	*HETERORGANIC
☞ (a) som tontus			*
(b) som pontus		*!	

For further discussion of directionality, see §7.4.

- *Ranking summary*
  Figure 7.1 summarizes the ranking established above.

Figure 7.1: Catalan assimilation ranking

IDENT{KP}   MAX   DEP

*HETERORGANIC
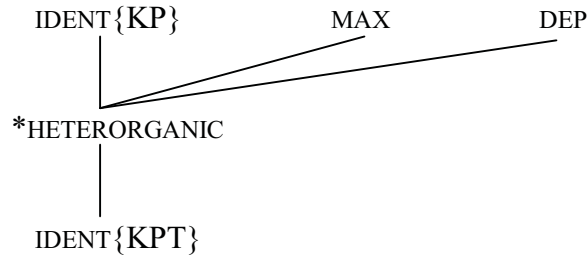
IDENT{KPT}

The diagram shows that the form of the marked-faithfulness constraint IDENT{KP} is crucial in blocking assimilation. If it preserved coronals as well, no assimilation would take place.

- *Alternatives*
This subsection concludes with a discussion of an alternative approach to Catalan. This approach appeals to the idea that /m/ does not assimilate because doing so would lose a grammatically significant contrast. In such an approach, /m/ fails to assimilate in [som tontus] because doing so – i.e. *[son tontus] – would fail to preserve the surface contrast between the 3rd and 1st person (cf [som tontus]) (or other relevant grammatical restrictions for other /m/~/n/ cases).   Such an approach has been formally implemented using MORPHREAL constraints, requiring morphemes to retain some vestige of their output correspondents. Łubowicz (in prep.) aims to provide another formal implementation. At the time of writing, though, I am unaware of any formal detailed theory of surface contrast preservation. Thus, the following remarks are somewhat general, and not directed at any particular theory.

A 'preserve contrast' approach has some hurdles to overcome in accounting for Catalan. For one, it fails to explain why /n/ can assimilate but /m/ can not. Preventing /m/ from assimilating does not effectively preserve the contrast in person on the surface: compare /son pɔks/ and /som pɔks/, which both surface as [som pɔks]. In a sense, the surface contrast between /m/ and /n/ is preserved before coronals and dorsals: /son dɔsils/ → [son dɔsils] cf [som dɔsils] and /son kuzins/ → [soŋ kuzins] cf [som kuzins]. However, this then raises the issue of why contrast is only selectively preserved, and conditioned by phonological environment in such a way. The same point can be made for the contrast between /n/ and /ŋ/ – it is neutralized before dorsals, so failing to preserve surface contrast in this environment.

Finally, /m/ is preserved (i.e. does not assimilate) even in environments which do not carry crucial grammatical information – i.e. morpheme-internally. The words [kumtát] *comtat* 'country', [əsúmtə] *assumpte* 'business', [ímne] *himne* 'hymn', and [prémsə] *premsa* 'press' all have a bilabial nasal before a non-labial; it is unclear why loss of the /m/ through assimilation here would result in a fatal loss of gramatical information.

7.2.1.3 Stop gemination

The PoA-faithfulness constraint IDENT{KP} has visible effects throughout Catalan's phonology, not just in major PoA assimilation. Another effect is found in stop gemination.

Coda coronal stops in Catalan geminate with a following onset consonant, but labials and dorsals geminate only if their input PoA specification would not be lost. The data in (13) is taken from Palmada (1994:82) and Hualde (1992:397).

(13) <u>Stop gemination</u>

	sɛt 'seven'	cap 'none'	pok 'few'
pɔbːləs 'villages'	sɛpːɔbːləs	capːɔbːlə	pokpɔbːlə
kamp 'field'	sɛkːamp	capkamp	pokːamp
bɔʒus 'fools', bo 'good'	sɛbːɔʒus	cabːo	pogbo
mal 'pain'	sɛmːals	camːal	pogmal
labials 'labials'	sɛlːabials	cablabial	poglabial
ʎiures 'free'	sɛʎːiures	cabʎiura	pogʎiuras

Gemination can be seen as 'total assimilation', and is a method of avoiding heterorganic clusters. Like assimilation, gemination is blocked only when it would force unfaithfulness to input dorsal or labial specifications.[174] So, /cap mal/→[camːal] is permissible because the input /p/'s labial feature is preserved in the output [m]. However, /pog mal/→*[pomːal] is prohibited because the input dorsal specification is lost. Similarly, /cap labial/→*[calːabial] is banned because the input /p/ loses its labial specification in the output.

Gemination can be motivated by constraints on syllable contact. As Venneman (1988) has argued, many languages require a sonority fall from coda to onset segments. Such a condition would rule out the level sonority heterorganic stop-stop clusters and rising sonority [t.l], [t.m], and [t.ʎ] clusters. Geminates avoid syllable contact violations because they have a single root node, so there is no sonority cline at all. As expected under a syllable-contact approach, nasal and lateral codas do not geminate (for fricatives, see below): e.g. [son tontus], *[sotːontus]; [sɔltontus], *[sɔtːontus]. This follows from the use of SYLLCON here – the clusters [n.t] and [l.t] have falling sonority.

For a recent theory of syllable contact set within Optimality Theory, see Gouskova (2002). The constraint SYLLCON will be used here (Davis 1998), with the caveat that it can no doubt be reduced to the interaction of several different constraints. In any case, the constraint *HETERORGANIC cannot be used instead of SYLLCON here. *HETERORGANIC only motivates PoA assimilation, predicting /sɛt labials/→*[setlabials]. Conversely, SYLLCON cannot take over *HETERORGANIC's role: SYLLCON cannot motivate nasal assimilation: /son pɔks/→*[sonpɔks] does not violate SYLLCON, and neither does [sompɔks].

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[174] Other assimilation requirements are at work in these alternations: voice assimilation is required (e.g. /po<u>k</u> labial/ → [po<u>g</u>labial]); for discussion of obstruent-sonorant voice assimilation, see Jun (1995). Some dialects require assimilation in nasality (Hualde 1992:397).

Again, IDENT{KP} outranks SYLLCON, preventing dorsals and labials from geminating.

(14)   Blocking Gemination of the Marked

/cap₁ k₂amp/	IDENT{KP}	SYLLCON	IDENT{KPT}
☞ (a) cap₁k₂amp		*	
(b) cakː₁,₂amp	*!		*

One assumption that underlies the analysis here is that consonants coalesce to form a geminate. This means that both /p/ and /k/ correspond to output [kː] in candidate (b) below. Because the labial /p/ corresponds to (b)'s dorsal [kː], IDENT{KP} is violated. Further discussion of coalescence is provided in chapter 8. Clearly, this approach differs from the traditional analysis that gemination involves an opaque process of coda deletion followed by compensatory lengthening. For relevant discussion, see chapter 8.

- *Liquid assimilation*

Finally, the ranking established above also accounts for liquid assimilation. For example, the non-palatal lateral [l] assimilates in patalality, but the palatal [ʎ] does not.

(15)   Lateral assimilation (Hualde 1992:396)
         (a) /l/ assimilation
                 /sɔl/   'sun'
                 [sɔl əmik]   'friendly sun'
                 [sɔl sɛk]   'dry sun'
                 [sɔʎ ɣərma]   'brother sun'
                 [sɔʎ ʎiwrə]   'free sun'
         (b) /ʎ/ non-assimilation
                 /eʎ/   'he'
                 [eʎ donə]   'he gives'
                 [eʎ sap]   'he knows'
                 [eʎ ʒaw]   'he lies'

Since palatals are specified as [‒back] dorsals, IDENT{KP} blocks /ʎ/ assimilation, as shown in tableau (16).

(16)

/eʎ donə/	IDENT{KP}	*HETERORGANIC
☞ (a) eʎ donə		*
(b) el donə	*!	

As with nasal assimilation, /l/ can assimilate to palatals without hindrance, due to the dominance of *HETERORGANIC over IDENT{KPT}.

As a concluding note, Rice & Avery (1991:116), citing J.Mascaró (p.c.), report that /l/ is realized as [lʷ] before labials and [ɫ] before dorsals. Other sources report velarization but not labialization (Wheeler 1979:301), and others that /l/ does neither (Hualde 1992:396). Dialects that block velarization and/or labialization can be accounted for by having constraints that ban these marked segments outranking the constraint that motivates place assimilation – i.e. || *ɫ, *lʷ » *{KPT}{KPT} ||.[175] The opposite ranking obtains in languages with velarization or labialization.

7.2.2 Typology of unmarked-undergoer systems

Catalan represents just one of several types of system in which only unmarked elements undergo assimilation. While Catalan employs IDENT{KP} to block assimilation, others use IDENT{K} or IDENT{KPT}. The result is the typology of unmarked-undergoer systems in Table 7.4.

To explain the notation used in the table, the columns K, P, T, ʔ indicate whether a certain PoA undergoes assimilation or not. An ✗ indicates that the PoA does not assimilate, and the ✓ indicates that it does assimilate. The grayed box under the ʔ column indicates that the language bans glottal PoA. For example, the Catalan entry indicates that both dorsals and labials do not undergo assimilation while coronals do; there is no glottal counterpart that is relevant, so the glottal box is grayed-out.

Table 7.4: Unmarked undergoer systems

K	P	T	ʔ	Language	Type
✓	✓	✓		Diola Fogny	nasal assimilation
✗	✓	✓	✓	-	
✗	✓	✓		NBA Inuktitut	stop clusters
✗	✗	✓	✓	Yamphu	stop assimilation
✗	✗	✓		Catalan	nasal assimilation
✗	✗	✗	✓	Gujarati	nasal assimilation
✗	✗	✗		Southern Sierra Miwok	nasal assimilation

The gap in the table is a language that (i) has a glottal element and (ii) assimilates all PoAs except dorsals. This is no doubt an accidental gap given that this system is so like NBA Inuktitut's.

All the cases listed in the table – apart from Catalan – are discussed in turn below.

- *Preservation of all PoAs*

At one extreme of preservation, IDENT{KPTʔ} outranks *HETERORGANIC. Such a language has no assimilation at all, as in Southern Sierra Miwok (Broadbent 1964).

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[175] The constraint on [ɫ] and [lʷ] might be considered a manner-specific instantiation of *{KP} – *{KP}/liquid.

(17)   Southern Sierra Miwok lack of assimilation
       [sympyː] 'close eyes'   [ponpuː] 'to get dusk'   [kaweŋpa] 'shout at s.o.'
       [ʔymtyː] 'to sing'   [tyntynːyː] 'to think'   [coɲtitaʔ] 'crooked'
       [homcupaʔ] 'barber'   [palancaʔ] 'flatiron'
       [momkoʔ] 'moccasins'   [tynkynːaː] 'to maim'   [ciŋkuʔ] 'seed basket'

At the other extreme, all PoAs assimilate, as in Diola Fogny (J.Sapir 1965:16).

(18)   Diola Fogny nasal assimilation
       /ni+RED+gam/ →   [nigaŋgam]   'I judge'
       /pan+ɟi+maɲɟ/ →   [paɲɟimaɲɟ]   'you (pl) will know'
       /ku+RED+bɔɲ/ →   [kubɔmbɔɲ]   'they sent'
       /na+RED+tiːŋ/ →   [natiːntiːŋ]   'he cut (it) through'

- *Dorsal preservation only*

The marked-faithfulness constraints also predict a language in which only dorsals are preserved in heterorganic clusters, since dorsals are the most marked elements. This system is found in Northern Baffin-Aiviluk Inuktitut (Dorais 1986): this language allows for the surface geminates [pː tː] and any cluster starting with a dorsal – either the velar [k] or uvular [q].

To generalize over the data, N.B.A.Inuktitut requires coda consonants to either be homorganic or dorsal. For concreteness, assimilation will be assumed to eliminate underlying heterorganic clusters.[176] Accordingly, *HETERORGANIC must outrank all faithfulness constraints that preserve coronals and labials – i.e. IDENT{KPT} and IDENT{KP}.

(19)   Coronal and Labial Undergoers

/tanka/	*HETERORGANIC	IDENT{KPT}
(a) tanka	*!	
☞ (b) taŋka		*

Since dorsals do not undergo assimilation, IDENT{K} must outrank the markedness constraint, as shown in tableau (20).

(20)

/taŋpati/	IDENT{K}	*HETERORGANIC	IDENT{K,P}
☞ (a) taŋpati		*	
(b) tampati	*!		*

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[176]   There are no alternations to support this assumption. However, by Richness of the Base (P&S 1993) underlying heterorganic clusters must be disposed of in some manner.

N.B.A.Inuktitut shows that faithfulness constraints must distinguish between dorsals and non-dorsals. In short, faithfulness constraints must not only distinguish coronals from non-coronals, but make distinctions among the non-coronals as well.

- *Non-glottal preservation*

As discussed in ch.5, 'glottal' is the least marked PoA in the present theory (also Lombardi 1998). Thus, glottals can pattern with coronals in unmarked-undergoer systems. For example, only glottals and coronals undergo assimilation in Yamphu – like Catalan, labials and dorsals are exempt (Rutgers 1998; also see ch.6).

In Yamphu, glottal and coronal stops assimilate to the PoA of a following obstruent while dorsals and labials do not. The data in (21) is from Rutgers (1998:43); for justification of underlying forms, see Rutgers (1998) and ch.6§6.3.

(21)   Yamphu assimilation
        (a) /ʔ + C/ → [Cː]
                /ham-beʔ-te/   → [hambetːe]   'where?'
                /hago-noʔ-so/   → [hagonosːo]   'even only now'
        (b) /t + C/ → [Cː]
                /piːt-kʰad-a/   → [piːkːʰada]   'it started boiling'
                /læːt-pe-ma/   → [læpːema]   'to do'
                /kit-si-ma/   → [kisːima]   'to feel fear'
        (c) /p + C/ → [pC]
                [optaŋ]   'head scarf'
                [kep-kʰad-i]   'Let's go sticking'
                [wapsa]   'chick'
        (d) /k + C/ → [kC]
                [kʰaːk-pa]   'scrape one's throat + perform act'
                [aktok]   'like that'
                [tsiktsiʔ]   'nasty, repugnant'
                [tsuksum]   'six days ago'

An alternation that shows /ʔ/-assimilation is found with the possessive suffix. The possessive is underlyingly /æʔæ/: e.g. [k-æʔæ] 'I+{possessive}', but before consonants the final vowel deletes: e.g. [jiːw-æʔ-mu] 'river-poss.-down'. Vowel-final deletion often creates a [ʔ]+obstruent cluster. As expected, the [ʔ] is eliminated through gemination: e.g. /hæŋguw-æʔæ-tw-e/ → (*deletion* [hæŋguæʔtwe] →) [hæŋguætːwe] 'of the one of Hæŋguwa' (p.65); /maguw-æʔæ-tu/ → [maguwætːu] 'of *Maguwa*'. It is also worth noting that [ʔ]s are not generally banned in codas – only before a following obstruent (cf [kiʔ.ma] 'to fear' – ch.6§3).

As in Catalan, dorsal and labial assimilation is blocked by IDENT{KP}. The following tableaux illustrate the ranking.

(22)

/ham-beʔ-te/	IDENT{KP}	*HETERORGANIC	IDENT{KPTʔ}	IDENT{KPT}
(a) hambeʔte		*!		
☞ (b) hambetːe			*	*

(23)

/aktok/	IDENT{KP}	*HETERORGANIC	IDENT{KPTʔ}
☞ (a) aktok		*	
(b) atːok	*!		*

Gujarati presents a case that is similar to Yamphu, but differs in that (i) only nasals assimilate and (ii) only the 'glottal' nasal assimilates (see ch.5 for discussion; Trigo 1988): e.g. /səN-tap/→[səntap] 'affliction', cf [dʒəm̲to] 'dining', [mən̲pətidʒ] 'soothing of mind', [kən̲bi] 'peasant' (Cardona 1965:27). In this language, IDENT{KPT} outranks *HETERORGANIC, preventing all but glottals from assimilating.

7.2.2.1 Underspecification and the typology of undergoers

It is important to point out that the present theory relies entirely on constraint ranking rather than representation or underspecification to produce the typology of unmarked-undergoer systems reported above. Following Prince & Smolensky (1993), feature values are assumed to be fully specified in the output. As discussed in ch5§5.3, the coronals – and even the glottals – bear a place feature (Lombardi 1998:6).[177]

In fact, the typology of undergoers in assimilation shows that an underspecification approach to unmarked-undergoer systems is unworkable.

The underspecification approach to a system like Catalan's is based on the assumption that segment *x* can (more readily) undergo assimilation if it lacks place features. For example, if coronal segments have no PoA features in Catalan, the specified PoA features [labial] and [dorsal] may spread into codas without hindrance (Kiparsky 1985:97, Avery & Rice 1989, Cho 1999 and references cited therein).

The typology of undergoers presents two major problems for this approach. One is that only one PoA feature value may be underspecified per language: if two segments both lacked PoA features, they would be phonologically indistinguishable for PoA. Problems therefore arise in a system like Yamphu's, in which both coronals and glottals undergo assimilation while dorsals and labials do not. The same problem arises for N.B.A. Inuktitut, where both coronals and labials assimilate. If ability to undergo assimilation equates with lack of PoA features, then two segment types must lack PoA features in both these languages, making them phonologically indistinguishable.

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[177] To clarify, full output specification does not imply that segments may lack features, but rather that features cannot be filled in at the end of the derivation (i.e. after candidate evaluation). The proposal that glottals have a place feature is therefore a separate issue.

Another problem is that there are languages in which the exact opposite to the Catalan situation holds: dorsals and labials undergo assimilation while coronals do not (see §7.5.1). If ability to undergo assimilation indicates lack of place features, dorsals and labials must lack PoA features in such languages, effectively reversing PoA markedness.

In short, proposing that certain segments lack PoA features offers no explanation of asymmetries in undergoers of assimilation once the full typology is considered. In contrast, the present theory has no need to appeal to underspecification – failure to assimilate is solely due to the interaction of constraints (also see Smolensky 1994, Lombardi 1995, 1998, Jun 1995:17ff).

For discussion on the shortcomings of underspecification theory in other areas, see ch.5§3, McCarthy & Taub (1992), Kaun (1993), Mohanan (1993), Prince & Smolensky (1993), and Steriade (1995b).

7.2.3 Summary

The aim of this section was to show that there are systems in which marked elements are exempt from processes that avoid heterorganic clusters. The theory not only predicts that unmarked-undergoer systems exist, but that for every possible set of marked feature values there can be a system in which only those values are exempt from assimilation (or some other anti-heterorganic process). With the PoA scale | dorsal 〉 labial 〉 coronal 〉 glottal |, then, there should be a system in which elements from the following sets are exempt from assimilation: {dorsal}, {dorsal, labial}, {dorsal, labial, coronal}.

North Baffin Aiviluk Inuktitut was shown to be of the first type, with only dorsals avoiding assimilation. Catalan and Yamphu are of the type where dorsals and labials, but not coronals (or glottals), are preserved. In Gujarati all but glottals avoid assimilation.

In all cases, the ranking has the same character: a faithfulness constraint that picked out marked feature values outranks the anti-heterorganic markedness constraints, which in turn outranked all faithfulness constraints that preserved the lesser marked feature values. Schematically, each system had the ranking || IDENT{*marked*} » M » IDENT{*marked,unmarked*} ||, where IDENT{*marked*} and IDENT{*marked,unmarked*}, in this instance, refer to the marked and unmarked values of the Major PoA scale.

7.2.3.1 Unmarked undergoers and the Voice scale

The marked-faithfulness theory applies to every scale, not just to PoA. Therefore, effects similar to those discussed above should be found in the assimilation of every scale/feature. This prediction is borne out for obstruent voicing: the marked [+voice] specification can be exempt from undergoing voice assimilation (Cho 1999:110, 123ff).

Standard Ukrainian provides a relevant case (Bethin 1987, Butska 1997). The marked voiced segments are exempt from voice assimilation.[178]

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[178] There is no word-final devoicing. See §7.5.2 for discussion of the relation of medial assimilation to final neutralization.

(24)   Ukrainian Voicing
(a) $C^{-vd} \rightarrow C^{+vd} / \_C^{+vd}$

/borot + ba/	→ [borodba]	'fight'
/pros' + ba/	→ [proz'ba]	'request'
/jak + ze/	→ [jagze]	'how'
/vok + zal/	→ [vogzal]	'station'
/os^j + de/	→ [oz^{j}de]	'here/there'

(b) C^{+vd} does not assimilate to [−voice]

[duʒka]	'handle'
[vezty]	'to drive'
[xobta]	'trunk (gen.sg.)'
[ridko]	'rarely'
[s'vbyd + ko]	'quick'
[v'id + pov'idajte]	'answer (imperative)'

The Ukrainian system can be generated using the same ranking schema identified above. For the voicing scale | +voice 〉 -voice |, there are two faithfulness constraints IDENT[+voice] and IDENT[±voice]. The ranking needed to produce Ukrainian is || IDENT[+voice] » *HETERO-voice » IDENT[±voice] ||, where *HETERO-voice bans clusters that disagree in voicing. Analogous to Catalan, onset-IDENT[±voice] forces assimilation to be regressive.

(25)

/borot + ba/	IDENT[+voice]	*HETERO-voice	IDENT[±voice]
(a) borotba		*!	
☞ (b) borodba			*

(26)

/ridko/	IDENT[+voice]	*HETERO-voice	IDENT[±voice]
☞ (a) ridko		*	
(b) ritko	*!	*	*

As a contrasting example, both voiceless and voiced stops undergo voicing assimilation in Serbo-Croatian: /rob + stavo/ → [ropstavo] 'slavery', /top + dz^{j}izja/ → [tobdz^{j}izja] 'gunner' (Partridge 1956, Grozdić 1969, Cho 1999:115ff).

As a closing note, only coda-onset assimilation has been discussed here. The existence of marked faithfulness constraints makes predictions for within-constituent assimilation as well. By having a ranking such as the one provided in ch.8§8.4 for Swedish, within-constituent assimilation can be to the unmarked value: e.g. /abt/ → [apt], /apd/ → [apt]. In contrast, by having IDENT[+voice] ranked appropriately, voice assimilation in coda constituents can be to the marked value: i.e. /abt/ → [abd], /apd/ → [abd]. The former of these cases is attested in a number of languages, as observed by

Baković (1999b). Baković claims that the latter type is not attested, though the empirical grounds for this assertion are not made clear. Future research will no doubt determine whether within-constituent assimilation can be to either marked or unmarked values, and if – like Catalan – marked elements can be exempt from assimilation.

7.3 The need for marked-faithfulness

The preceding section aimed to show that the marked-faithfulness constraints are desirable – they have attested empirical effects. The aim of this section is to go one step further, showing that the marked-faithfulness constraints are necessary, given certain standard assumptions about CON's contents.

To elaborate on this aim, the preceding section did not show that marked-faithfulness constraints offer the only solution to unmarked-undergoer systems (i.e. languages of the Catalan type). The alternative is a 'markedness-reliant' approach: one that relies on the form of anti-heterorganicity constraints to account for the asymmetric behaviour of undergoers.

For Catalan, a markedness-reliant approach would employ a markedness constraint that only bans coronal+non-coronal clusters, called *{T}{KP} here. *{T}{KP} assigns violations to [nk np], but not to [mk mt ŋp ŋt]. As the following tableaux show, *{T}{KP} can be used to produce the Catalan system without appealing to marked faithfulness constraints. The only faithfulness constraint used here is one that preserves all PoAs, called IDENT[Place] (Prince 1998).

(27)   The Markedness-Reliant approach to unmarked-undergoer systems

/son kosins/	*{T}{KP}	IDENT[Place]
(a) sonkosins	*!	
☞ (b) soŋkosins		*

(28)

/som kosins/	*{T}{KP}	IDENT[Place]
☞ (a) somkosins		
(b) soŋkosins		*!

In short, only coronals undergo assimilation in a markedness-reliant approach because only they are subject to active markedness constraints.

The aim of this section is to show that the Markedness-Reliant approach to unmarked-undergoer systems is both too restrictive and not restrictive enough. The marked-faithfulness theory will therefore be argued to offer the only account of unmarked-undergoer systems.

Section 7.3.1 shows that the markedness-reliant approach cannot produce every system that the marked-faithfulness ones can. Specifically, marked-faithfulness constraints can account for certain systems that employ more than one method of avoiding heterorganic clusters while markedness-reliant approaches cannot.

Section 7.3.2 shows that the markedness constraint needed in a markedness-reliant approach to Catalan – *{T}{KP} – predicts an unattested type of neutralization.

Section 7.3.3 summarizes the findings of this section.

7.3.1   Multiple methods for avoiding heterorganicity

There are several ways to avoid heterorganic consonant sequences. For example, the heterorganic cluster /np/ could be eliminated through assimilation [mp], deletion [p], epenthesis [nip], or coalescence [m]. In fact, it is possible for more than one method to be employed in the same language, as happens in Ponapean (Rehg & Sohl 1981, Ito 1986:120ff). The term 'multiple method system' will be used below to refer to such cases.

The aim of this section is to show that the Ponapean multiple-method system is amenable to an analysis with marked-faithfulness constraints and that no Markedness-Reliant account of Ponapean is possible, under standard assumptions.

Section 7.3.1.1 describes the Ponapean system. Section 7.3.1.2 provides an analysis using the marked-faithfulness constraints. Section 7.3.1.3 shows that a Markedness-reliant approach to Ponapean cannot work. Section 7.3.1.4 identifies predictions of the marked-faithfulness approach for systems that avoid heterorganic clusters in several ways.

7.3.1.1 Ponapean: Description

The following description is based on Rehg & Sohl (1981) and Goodman (1995). The consonants of Ponapean are given in Table 7.5.

Table 7.5: Ponapean consonant inventory

	labial	dental/alveolar	palatal	dorsal
stops	p pʷ	ṭ		k
affricates			tʃ	
fricatives		s		
nasals	m mʷ	ṇ		ŋ
liquids		ḷ r		

Ponapean has five vowels [i e a o u] (some dialects also have [ɔ]) and long counterparts. Syllables have the shape CV(X), where X is either lengthening of the vowel or a consonant. Onsets are optional in word-initial position only. Word-final position licenses a further consonant, allowing final syllables of the shape CVCC and CV:C in addition to the other types.

Heterorganic clusters are banned in the output. Only sonorant geminates and homorganic nasal+obstruent clusters are allowed, as illustrated in (29).

(29)　Ponapean Clusters
　　　(a) Medial Clusters
　　　　(i) Nasal+Obstruent
　　　　　　[manta] 'next day'　　　　　　[nanset] 'ocean'
　　　　　　[sampaː] 'world, earth'　　　　[naŋkɛp] 'inlet'
　　　　(ii) Sonorant Geminates
　　　　　　[komːɔl] 'to rest'　　　　　　　[ŋoŋːoŋ] 'to be barking'
　　　　　　[nalːeŋ] 'heaven'　　　　　　　[narːas] 'ground level of feasthouse'

　　　(b) Word-final clusters
　　　　　　[kens] 'yaws'　　　　　　　　[emp] 'coconut crab'
　　　　　　[malː] 'forest clearing'　　　　[lemːʷ] 'afraid of ghosts'

　　　(c) Word-initial clusters[179]
　　　　　　[mːetʃ] 'full'　　　　　　　　[mpek] 'to look for lice'
　　　　　　[nta] 'to say'　　　　　　　　[ŋkol] 'to make sennit'

　　　　The restriction to homorganic nasal+obstruent and geminate sonorant clusters can be actively seen in reduplication and certain compounds. For example, the reduplicated form of /pap/ is [pampap] 'to swim', not *[pappap] since obstruent geminates are not permitted.

- *Avoidance of heterorganic clusters I: prefix+root and classifier+noun*
　　　　The ban on heterorganic clusters is evident in a number of alternations. Relevant examples at the prefix+root boundary are given in (30). The set in (30a) show changes in the prefix /nan/ 'in' – the final /n/ assimilates in PoA to a following obstruent, and totally assimilates to a following sonorant. The data in (30b) show changes with the prefix /lim/ {numeral}. Again, heterorganic clusters are avoided, but in this case through epenthesis.[180]

(30)　Prefix+Root heterorganicity elimination
　　　(a) Coronal + Non-Coronal: Assimilation
　　　　　　[nan + imʷ] 'in that house'　　　　　[nal + lɛŋ] 'in heaven'
　　　　　　[nam + par] 'in trade wind season'　　[nar + rɛk] 'season of plenty'
　　　　　　[namʷ+pʷuŋara] 'between them'
　　　　　　[nan + sɛt] 'in the ocean'
　　　　　　[naŋ + kɛp] 'inlet'
　　　　　　[naŋ + kɛp] 'inlet'

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[179] A vowel is optionally epenthesized before word-initial NC clusters (Rehg & Sohl 1981:55).
[180] The featural content of the epenthetic vowel is determined by complex conditions, relating to the quality of nearby vowel (Goodman 1995:168, Rehg & Sohl 1981:92). An analysis of the form of the epenthetic vowel is tangential to the issue at hand; for discussion of copy epenthesis in general see Kitto & de Lacy (1999) and references cited therein.

(b) Labial + Non-Labial: Epenthesis

[lim + <u>a</u> + tip] 'slices, chips'   [lim + <u>a</u> + kap] 'sheaves'
[lim + <u>i</u> + sou] 'heaps, piles'   [lim + <u>a</u> + ka] 'rows, lines'
[lim + <u>e</u> + lep] 'oblong things'   [lim + <u>a</u> + kis] 'small pieces'
[lim + <u>a</u> + ra] 'branches

Epenthesis also takes place after dorsals: e.g. /ak-tei/ → [ak<u>e</u>tei] 'engage in a throwing contest' (Rehg & Sohl 1981:70).

Heterorganicity-avoidance also is in force across classifier-noun boundaries (Rehg & Sohl 1981:57, Goodman 1995: 160).

(31)   Classifier+noun coronal assimilation
/kisin pakas/   → [kisim pakas]   'small species of fish'
/kilin pᵂiːk/   → [kilimᵂ pᵂiːk]   'skin of a chicken'
/tiːn kidi/   → [tiːŋ kidi]   'bone of a dog'
/tiːn malek/   → [tiim malek]   'bone of a dog'
/paan ŋeteŋete/   → [paaŋ ŋeteŋete]   'roof of mouth'

Epenthesis only takes place to avoid underlying heterorganic clusters: it does not occur after every labial and dorsal coda, as shown in (32). As an example, /lim+pak/ is realized as [limpak], not *[lim<u>a</u>pak] 'times'.

(32)   No epenthesis after homorganic labials and dorsals
[lim+pitʃ]   'strip, strand'
[lim+pali]   'body extremities'
/RED+kik/   → [kiŋkik] 'kicking'
/tɔtɔːk+ki/   → [tɔtɔːŋki] 'to work'

• *Avoidance of heterorganic clusters II: root+suffix*
There is a difference in the methods of heterorganicity-avoidance at the root+suffix boundary: coronals do not assimilate; like labials and dorsals, coronal+non-coronal clusters are eliminated through epenthesis. Examples are given in (33).

(33)   Root+Suffix Coronal+C epenthesis
/liŋan + ki/ → [liŋan<u>i</u>ki] 'consider to have the property of prettiness'
/sapan + ki/ → [sapan<u>i</u>ki] 'consider to have the property of generosity'

To clarify, /sapan+ki/ is not realized as *[sapaŋki] with assimilation, but with epenthesis as [sapan<u>i</u>ki]; this form contrasts with the prefix+root cluster /nan+kɛpi/→[naŋkɛp], which assimilates.

To summarize, heterorganic clusters are eliminated by two different methods in Ponapean. At the prefix+root and classifier+noun boundaries, coronal+non-coronal heterorganic clusters are avoided by assimilation, while non-coronal heterorganic clusters

are eliminated by epenthesis. In contrast, at the root+suffix boundary, all heterorganic clusters are eliminated by epenthesis.

The following section provides an analysis of this system, starting with the processes employed at the prefix+root/classifier+noun boundaries. It concludes with an account of the differences at the root+suffix juncture.[181]

7.3.1.2 Ponapean: Analysis

There have been a number of analyses of Ponapean heterorganicity-avoidance or processes related to it (Ito 1986, 1989, Blevins & Garrett 1993, Goodman 1995). Goodman (1995) provides an in-depth OT analysis of the assimilation facts and of Ponapean phonotactics in general. The following analysis follows Goodman's in many respects, primarily differing in its use of the marked-faithfulness constraints and Correspondence Theory (McCarthy & Prince 1995).

For assimilation to eliminate coronal+non-coronal clusters, *HETERORGANIC must outrank all faithfulness constraints that preserve coronal PoA (IDENT{KPT}, IDENT{KPT?}).

As discussed in the Catalan analysis, further rankings are needed to ensure that assimilation takes place rather than some other phenomenon. To prevent both deletion and epenthesis, both MAX and DEP must outrank IDENT{KPT}. Tableau (34) illustrates the ranking for DEP.[182]

(34)

/nan-para/	*HETERORGANIC	DEP	IDENT{KPT}
(a) nanpar	*!		
☞ (b) nampar			*
(c) nanapar		*!	

Candidates (b) and (c) both satisfy *HETERORGANIC – neither has a heterorganic cluster. However, (c) is ruled out by DEP because it has epenthesis; candidate (b) incurs the least significant violation by being featurally unfaithful (i.e. violating IDENT{KPT}).

- *Blocking non-coronal assimilation*

Ponapean is like Catalan in that labials and dorsals do not assimilate. So, the Catalan solution can be invoked for Ponapean: IDENT{KP} must block assimilation.

However, Ponapean is unlike Catalan in that heterorganic clusters staring with a labial or dorsal are not tolerated on the surface: they are eliminated by epenthesis (e.g. /lim+tip/ → [limatip]. In constraint terms, [limatip] violates DEP but not IDENT{KP},

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[181] For discussion of changes in manner, such as coda stop nasalization, see Rehg & Sohl (1981:58ff) and Goodman's (1995) extensive analyses.
[182] There is word-final apocope in Ponapean, accounting for the loss of the final /a/ in /nan-para/. I leave analysis of this fact aside here (see Goodman 1995:100ff).

indicating that the latter outranks the former. Furthermore, to get epenthesis at all, *HETERORGANIC must outrank DEP. Tableau (34) illustrates these rankings.

(35)

/lim+tip/	*HETERORGANIC	IDENT{KP}	DEP	IDENT{KPT}
(a) limtip	*!			
(b) lintip		*!		*
☞ (c) limatip			*	

    The markedness constraint *HETERORGANIC eliminates the fully faithful candidate (a), leaving the assimilated form (b) and the form with epenthesis (c). *HETERORGANIC must outrank DEP otherwise no assimilation would take place in Ponapean at all (cf the Catalan ranking).

    The competition between (b) and (c) shows why IDENT{KP} must outrank DEP: (b) is fatally unfaithful to the input labial specification of /m/, so violating IDENT{KP}. In contrast, the candidate with epenthesis (c) only violates the relatively low-ranked DEP.

    The ranking established above will still allow coronals to assimilate: since IDENT{KP} does not apply to coronals, it will be inactive in competitions such as [nampar]~*[nanapar], allowing DEP to eliminate the unattested form, as in (34).

    Significantly, this analysis relies on the existence of the marked-faithfulness constraint IDENT{KP}. Without a faithfulness constraint that specifically preserves labials and dorsals, there would be no way to prevent non-coronals alone from assimilating rather than having epenthesis.

    To summarize, Ponapean is much like Catalan. In both languages, the marked PoAs labial and dorsal are preserved. The difference is that Ponapean does not tolerate heterorganic sequences at all, so an alternative non-feature-changing process is employed for non-coronal+C clusters. In ranking terms, the difference relates to the place of DEP. The constraint *HETERORGANIC only outranks IDENT{KPT} in Catalan; the other faithfulness constraints MAX and DEP outrank *HETERORGANIC, ensuring that neither deletion nor epenthesis could be employed as a secondary method of heterorganicity-avoidance. In Ponapean *HETERORGANIC outranks both DEP and IDENT{KPT}, so allowing both assimilation and epenthesis as methods of eliminating heterorganic clusters.

- *Root faithfulness and boundary differences*

    This analysis concludes with an account of the behaviour of coronals at the root+suffix boundary. While coronals assimilate at prefix+root and classifier+noun boundaries, they behave like labials and coronals at the root+suffix boundaries: e.g. /sapan + ki/ → [sapaniki], *[sapaŋki]. To account for this difference, the constraint Root-IDENT{KPT} is employed here; this constraint requires input PoA specifications of root segments to be preserved (after McCarthy & Prince 1995, Beckman 1998).

    Root-IDENT{KPT} functions like IDENT{KP} in Ponapean: it outranks DEP, so preserving coronals in roots, and therefore preventing assimilation. The result is illustrated in tableau (36).

(36)   <u>Root-Faithfulness</u>

/sapan+ki/	*HETERORGANIC	Root-IDENT{KPT}	DEP	IDENT{KPT}
(a) sapanki	*!			
(b) sapaŋki		*!		*
☞ (c) sapaniki			*	

The assimilation candidate (b) is ruled out because the input coronal /n/ is part of the root, and so its change to [ŋ] violates Root-IDENT{KPT}.   The only remaining candidate is (c), with epenthesis.

In contrast, Root-IDENT{KPT} will not prevent prefix-final consonants from assimilating. For example, the /n/ in /nan-para/ is not part of a root, so Root-IDENT{KPT} will not prevent it from assimilating to [nampar].

- *Ranking summary*
Figure 7.2 summarizes the rankings identified for Ponapean.

<u>Figure 7.2: Ponapean anti-heterorganicity ranking</u>

MAX   *HETERORGANIC   IDENT{KP}   Root-IDENT{KPT}

                              DEP
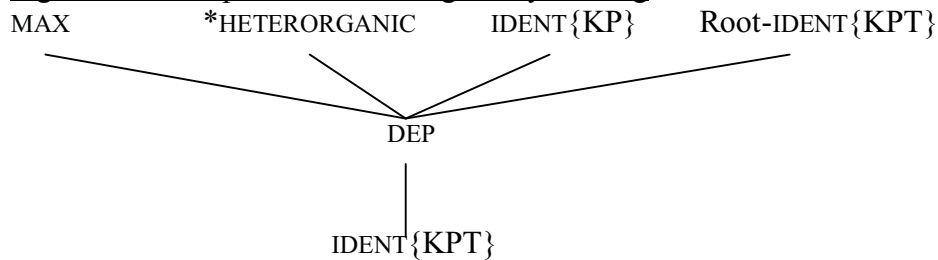
                        IDENT{KPT}

As in Catalan, the ranking of IDENT{K} is indeterminate, so it is not included in the diagram above.

7.3.1.3 The failure of Markedness-Reliant approaches
It is now possible to consider an alternative analysis of Ponapean – one in which there are no marked-faithfulness constraints (e.g. see Prince 1998). In other words, this section deals with a hypothetical CON that does not contain faithfulness constraints that preserve marked PoAs alone. This rules out constraints like IDENT{K}, IDENT{KP}, and IDENT{P}, but still allows hypothetical constraints like IDENT{KPʔ}, IDENT{PTʔ}, and IDENT{Tʔ}, none of which preserves marked elements exclusively. Conversely, this section aims to ask whether a theory without a faithfulness constraint that preserves just non-coronals – i.e. IDENT{KP} – can produce the Ponapean system.

- *The epenthesis ranking*

Epenthesis eliminates heterorganic clusters consisting of a non-coronal and another consonant in Ponapean: /lim-tip/→[lim<u>a</u>tip], *[lintip]. At least two rankings are needed to produce epenthesis. *HETERORGANIC must outrank DEP, in the familiar way.[183]

The other ranking needed to eliminate the candidate with assimilation – *[lintip]. To ban this form, some constraint C that favours [lim<u>a</u>tip] over *[lintip] must outrank DEP; the faithful form may or may not violate C – this violation is irrelevant because the faithful form is eliminated by *HETERORGANIC in any case. The ranking is therefore || *HETERORGANIC, C » DEP ||.

(37)

/lim-tip/	*HETERORGANIC	C	DEP
(a) limtip	*!	(*)	
(b) lintip		*!	
☞ (c) lim<u>a</u>tip			*

Of course, all constraints not mentioned in (37) that favour (b) over (c) must be ranked below *C*.

- *What is C?*

But what is the constraint *C*?

Suppose that *C* is a markedness constraint of the standard type – one that assigns a violation based on some output property. Then, *[lintip] must have some property p that [lim<u>a</u>tip] does not have, and *C* must assign a violation to p (i.e. C is *p). Furthermore, there is no other constraint *D* that outranks *C* and favours a candidate with property p over one without p; more concretely, *D* does not favour *[lintip] over [lim<u>a</u>tip].

However, *C*'s ranking poses a problem for forms with property p. *C* outranks DEP, and tableau (37) establishes that property p can be avoided through epenthesis. Therefore, since *C* outranks DEP, there should be no occurrence of p on the surface in Ponapean: all inputs with property p should be realized without p on the surface.[184]

Since *[lintip] contains property p, *[lintip] must contain some property that is never faithfully realized. In other words, some aspect of *[lintip] is absolutely ill-formed in Ponapean.

The problem is that nothing in *[lintip] is absolutely banned in the output: *[lintip] contains no feature value or prosodic structure that is not found in other attested forms. Of most relevance, [nt] sequences are found elsewhere: e.g. [manta] 'next day', so *C* cannot be a constraint like NOCODA, *COMPLEX, or the far more specific *[nt]. All of these

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[183] To be more precise, a markedness constraint *M* against non-coronal+C heterorganic clusters must outrank DEP. *M* need not assign a violation to coronal+non-coronal clusters, though if *M* does not do so, some other markedness constraint that does ban coronal+non-coronal clusters will have to be invoked to outrank IDENT{KPT}. This note makes no difference to the argument made below, so I adopt the simpler approach that *M* bans all heterorganic clusters.

[184] No other constraint ranked higher than *C* can be invoked to block across-the-board p-elimination. As pointed out above, such a constraint (i.e. *D*) cannot outrank *C* in this language.

constraints would trigger epenthesis since they outrank DEP. Therefore, paradoxically, *[lintip] cannot contain *p*.

This paradox shows that the premise was incorrect: *C* cannot be a markedness constraint.

- *Assimilation ranking*

Since *C* is not a markedness constraint, *C* must therefore be a faithfulness constraint. The only faithfulness difference between [lim<u>a</u>tip] and *[lintip] in [lim<u>a</u>tip]'s favour is that the loser fails to preserve the input labial specification. So, *C* must be a faithfulness constraint that requires preservation of input labial specifications.

In a theory with no marked-faithfulness constraints, though, *C* cannot preserve labial PoA alone; a constraint like IDENT{P} preserves a marked value without preserving a lesser marked one (i.e. T), and so is a marked-faithfulness constraint. Thus, *C* must at least require both labials and coronals to surface faithfully in the output: i.e. it is IDENT{PT} (or any other faithfulness constraint that preserves both labials and coronals).

In short, the ranking needed for epenthesis is ‖ *HETERORGANIC, IDENT{PT} » DEP ‖.

Unfortunately, this ranking incorrectly predicts that coronal+non-coronal clusters cannot be eliminated through assimilation. For example, there are two significant candidates from input /nan-par/: the form with assimilation [nampar] and the form with epenthesis *[nan<u>a</u>par]. The ranking ‖ IDENT{PT} » DEP ‖ will incorrectly favour the epenthesis candidate over the former since only *[nan<u>a</u>par] satisfies IDENT{PT}, by preserving the coronal PoA.

In short, a theory without marked-faithfulness constraints predicts that the Ponapean system is impossible. The only way around this problem is to employ a faithfulness constraint that preserves labials but not coronals: IDENT{KP}. This constraint correctly favours [lim<u>a</u>tip] over *[lintip], but does not favour *[nan<u>a</u>par] over [nampar].

The next section generalizes this result by identifying the types of 'multiple-method' systems – those in which heterorganic clusters are eliminated by two or more different methods – that can be produced using marked-faithfulness constraints.

7.3.1.4 Marked faithfulness and Multiple Method systems

Theories with only marked-faithfulness constraints, like the present one, make a prediction with regard to multiple-method systems like Ponapean's.[185]

(38) Multiple-method prediction within a marked-faithfulness theory
      If a language employs both assimilation and another non-PoA changing process (e.g. epenthesis, deletion) to eliminate heterorganic clusters, then the elements that assimilate will always be the least marked ones.

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[185] The prediction holds only if there are no MAX constraints that refer to marked features – see ch.6 for discussion.

In other words, there can be no language 'Anti-Ponapean' in which labials and dorsals assimilate (e.g. /am-ta/→[anta]) while coronal+C clusters undergo epenthesis (e.g. /an-pa/→[anapa]).

To produce epenthesis between coronal+non-coronal clusters /an-pa/ → [anapa], and not assimilation *[ampa], some IDENT constraint that preserves coronals – i.e. IDENT{KPT} – must outrank DEP. This way, IDENT{KPT} will eliminate *[ampa], leaving [anapa]. No faithfulness constraint other than IDENT{KPT} can be used here; crucially, since only marked faithfulness constraints are allowed, any constraint that preserves coronals must also preserve labials.

However, this ranking prevents /am-ta/ from assimilating. The assimilated form [anta] will be eliminated by IDENT{KPT}, meaning that the form with epenthesis *[amata] will win.

- *Generalizing the result*

This result follows from the nature of the different types of faithfulness constraint. IDENT constraints block candidates with assimilation, but not deletion or epenthesis. Because of the form of marked-IDENT constraints, if assimilation of *x* is blocked, then assimilation of all more marked values is also blocked. So, since assimilation of coronals is blocked in the putative case above, labials cannot assimilate either. Therefore, if assimilation takes place in a system at all, it must happen to the least marked element.

- *Comparison with free-reference theories*

This prediction not only sets the MRH apart from theories without marked-faithfulness constraints, but also apart from theories that allow both marked- and unmarked-faithfulness constraints. Because these theories can contain virtually any IDENT constraint, they will be called 'free-reference' theories.

A theory that allows unmarked-faithfulness constraints like IDENT{T} predicts that Anti-Ponapean could exist. Its ranking would be analogous to the one presented for Ponapean using the marked faithfulness theory: i.e. || *HETERORGANIC, IDENT{T} » DEP » {other IDENTs} ||. In this ranking, IDENT{T} blocks assimilation of coronals, forcing epenthesis; since DEP outranks all the other IDENT constraints, though, labials and dorsals assimilate.

In short, the present theory predicts that Anti-Ponapean systems cannot exist: in a multiple-method system, assimilation will always apply to the least marked elements.

As a final note, this section has shown that a theory without marked-faithfulness constraints cannot account for multiple-method systems in Ponapean. Therefore, a theory that relies on markedness constraints alone to produce Catalan-type systems is too restrictive: it predicts that systems like Ponapean's should not exist. The next section is devoted to showing that markedness-reliant approaches are not restrictive enough.

7.3.2 Neutralization and the Markedness-Reliant theory

As discussed in the introduction to this section, the markedness-reliant approach to Catalan relies on the existence of a markedness constraint that bans coronal+C clusters

alone – *{T}{KP}. However, this constraint has an undesirable side effect: it can motivate an unattested type of neutralization.

The unattested system is one in which word-medial coronal codas neutralize to labials: i.e. input /an-ka/ surfaces as ☠[amka] (the symbol ☠ marks a universally unattested output, given the input) (cf cases where medial codas neutralize to less marked PoAs – §7.6). This type of neutralization is easy to generate with the constraint *{T}{KP}, as shown in tableau (39).

(39)

	/anka/	*{T}{KP}	IDENT{KPT}	*{K}
	(a) anka	*!		*
☞	(b) amka		*	*
	(c) aŋka		*	* *!

The constraint *{T}{KP} rules out the candidate with a coronal+non-coronal sequence (a), leaving ☠[amka] and *[aŋka]. IDENT{KPT} is irrelevant in selecting the winner – its role is simply to ensure that dorsals are not neutralized in every position (by outranking *{K}).

The crucial constraint for choosing between [amka] and *[aŋka] is the context-free markedness constraint *{K}, which is violated for every instance of a dorsal in the output. As shown, *{K} favours [amka] over [aŋka], thus producing neutralization of /n/ to [m]. All constraints that favour [aŋka] over [ampa] are ranked below *{K} (e.g. *HETERORGANIC).

The neutralization of /n/ to [m] would only apply in heterorganic clusters. Homorganic codas remain faithful: /anta/ will surface as [anta] since *{T}{KP} is not violated by homorganic sequences. Furthermore, there is no constraint that *favours* [amta] over [anta] – such a constraint would have to be *{T}, with a variety of undesirable consequences detailed in ch.6.

In short, the constraint *{T}{KP} can produce a system in which coda /n/ neutralizes to [m] in heterorganic clusters. Such neutralization is unattested: it goes against the generalization that all 'horizontally context-free' neutralizations – i.e. those that are not influenced by neighbouring segments (as in assimilation, dissimilation) – result in a less marked segment (see chapters 8 and 9, Trubetzkoy 1939:81ff).[186]

This point is rather unsurprising, given that the context-free constraint *{T} has equally undesirable effects in neutralization: a constraint *{T} could cause coronals to neutralize to more marked elements, a point discussed in detail in ch.6§6.

In short, the markedness-reliant approach to Catalan necessarily invokes a markedness constraint that makes unattested typological predictions. Therefore, the only

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[186] To anticipate the constraints proposed in §7.4, the Cluster constraints cannot produce this unattested neutralization. No Cluster constraint favours [amka] over [anka]. Specifically, [nk] violates *{KPT}{K}, *{KPT}{KP}, and *{KPT}{KPT}. [mk] violates all of these constraints plus *{KP}{K}, *{KP}{KP}, *{KP}{KPT}. In short, [nk] is a local harmonic bound for [mk] in terms of the Cluster constraints. Therefore, /anka/ can never surface as ☠[amka] – [anka] will always win.

remaining option is a marked-faithfulness approach, so affirming the existence of marked-faithfulness constraints.

7.3.3   Summary

The aim of this section was to show that the marked-faithfulness constraints are a necessary part of CON. Two arguments for marked-faithfulness constraints were presented.

The first argument focused on multiple-method systems. It showed that the ranking ‖ IDENT{KP} » DEP » IDENT{KPT} ‖ is crucial in preventing non-coronals from assimilating, so allowing epenthesis to apply. Alternative analyses in which markedness constraints are responsible for the Ponapean system were shown to be impossible.

The second argument showed that a markedness account of Catalan relies on markedness constraints that ban coronal+non-coronal clusters. Such constraints predict unattested neutralizations, in which /n/ surfaces as [m] in heterorganic clusters, regardless of the PoA of the following consonant.

In short, only a marked-faithfulness analysis of unmarked-undergoer systems is viable; the alternatives are both too restrictive – failing to account for multiple-method systems like Ponapean's – and not restrictive enough, producing unattested neutralizations.

7.4   Eliminating faithfulness to the unmarked

The preceding sections aimed to show that marked faithfulness constraints exist in CON. The following sections deal with the second aim: to show that no other faithfulness constraints need exist.

In the present theory, if a faithfulness constraint preserves a feature value it also preserves all more marked values. This requirement rules out the PoA-faithfulness constraints in (40).

(40)   <u>Non-existing PoA-faithfulness constraints</u>
IDENT{ʔ}, IDENT{T}, IDENT{P}
IDENT{Tʔ}, IDENT{Pʔ}, IDENT{Kʔ}, IDENT{PT}, IDENT{KT}
IDENT{PTʔ}, IDENT{KTʔ}, IDENT{KPʔ}

This and the following section aim to show that heterorganicity-avoiding processes do not require any of the constraints in (40).

A challenge for this proposal is provided by languages in which only unmarked elements are exempt from assimilation. For example, in Sri Lankan Portuguese (SLP) Creole, only labials and dorsals assimilate – coronals do not: e.g. /maːm+ki/→[maːŋki] 'hand {verbal noun}', *[maːmki]; cf /siːn+ki/→[siːnki], *[siŋki] (Smith 1978, Hume & Tserdanelis 1999).

Such 'marked-undergoer' systems have two possible analyses. One invokes a faithfulness constraint that blocks coronals from assimilating. However, this faithfulness

constraint necessarily refers to coronals alone: ‖ IDENT{T} » *HETERORGANIC » IDENT{KPT} ‖. IDENT{T} is one of the constraints ruled out by the present theory.

The other possible analysis is a markedness-reliant one, and is the one proposed here. The markedness-reliant analysis maintains that coronals are exempt from assimilation in SLP Creole because they are already 'adequately unmarked'. In other words, SLP Creole tolerates coronal+non-coronal sequences because they are the least marked of all the heterorganic clusters.

Behind this proposal is the idea that not all heterorganic clusters are equally marked. A formal implementation of this idea is presented in §7.4.1. This section proposes a set of constraints that replaces the constraint *HETERORGANIC used above. The combined effect of these constraints is to favour clusters composed of less marked elements over those with more marked elements; they are accordingly called the 'Marked-Cluster' constraints.

Section 7.4.2 presents an analysis of the SLP Creole system in terms of the Marked-Cluster constraints, showing that an unmarked-faithfulness constraint like IDENT{T} is unnecessary.

The Marked-Cluster constraints predict other marked-undergoer systems, specifically ones in which only dorsals undergo assimilation, and one in which only dorsals and coronals – not labials – assimilate. Section 7.4.3 identifies and analyzes such systems, in Chukchi and Harar Oromo respectively. As for SLP Creole, the Marked-Cluster constraints are shown to eliminate need for non-marked-faithfulness constraints (specifically IDENT{PT} and IDENT{KT}).

Since the existence of marked-undergoer systems has been explicitly denied in previous work, §7.4.4 identifies other relevant cases, and extends the analysis to unmarked-undergoer systems in voicing assimilation.

As a side-note, Wetzels & Mascaró (2001) have identified systems of voicing assimilation that are analogous to SLP Creole's PoA assimilation (also see Baković 1999b). An analysis of such systems within the present theory is given in §7.4.4.

7.4.1 The Marked-Cluster constraints: Heterorganicity-avoidance

There are two leading ideas behind the form of the markedness constraints presented in this section. One is that all homorganic clusters are favoured over heterorganic ones. The other is that some heterorganic clusters are more marked than others. Specifically, those with highly marked components are more marked than those with lesser-marked components.[187] For example, [kp] is universally more marked than [pt].

The entire set of anti-heterorganic cluster constraints – called the 'Marked-Cluster' constraints – is given in (41); their definition is provided in schematic terms in (42). The

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[187] The earliest precursor to the present theory is Cairns & Feinstein's (1982) theory of onset cluster markedness (also see Morelli 1998). For recent approaches to cluster constraints in Optimality Theory, see Baertsch (1998) and Gouskova (2002).

Marked-Cluster constraints effectively combine the sets of PoA specifications allowed by the present theory.[188]

As above, K stands for 'dorsal', P for 'labial', T for 'coronal', and 'ʔ' for glottal; the constraints in (41) do not refer to a particular manner of articulation; though manner-specific instantiations may be possible (see below for discussion). The constraints are freely rankable.

(41)   The Marked-Cluster Constraints (anti-heterorganic markedness constraints)
        *{K}{K}   *{K}{KP}   *{K}{KPT}   *{K}{KPTʔ}
        *{KP}{K}   *{KP}{KP}   *{KP}{KPT}   *{KP}{KPTʔ}
        *{KPT}{K}   *{KPT}{KP}   *{KPT}{KPT}   *{KPT}{KPTʔ}
        *{KPTʔ}{K}   *{KPTʔ}{KP}   *{KPTʔ}{KPT}   *{KPTʔ}{KPTʔ}

(42)   Interpretation of the anti-heterorganic constraints
        *XY   "Assign a violation for every pair of adjacent segments such that
                (i) the first segment has a feature f_1 from set X
             and (ii) the second segment has a feature f_2 from set Y."

As an example, the constraint *{K}{KPT} assigns a violation to all clusters that consist of a dorsal followed by a labial or coronal: e.g. [ŋp], [ŋt].

Importantly, the constraint does not assign a violation to homorganic sequences – [ŋk]. This effectively adopts the autosegmental approach that a sequence of featurally identical elements – a geminate – has a single root node (Halle & Vergnaud 1980, Steriade 1982, Clements 1985, Hayes 1986, Sagey 1986, Schein & Steriade 1986).[189] Thus, the constraint *{K}{K} does not assign a violation to the geminate [kː]: *{K}{K} bans two adjacent segments with dorsal PoA, while [kː] is a single segment (i.e. consists of a single root node). Note that *{K}{K} will assign a violation to 'fake' geminates [k.k], consisting of two root nodes (a distinction needed in Tigrinya – Schein & Steriade 1986, also see Keer 1999 for discussion of fake geminates).

To provide further examples, *{KPTʔ}{KPTʔ} assigns a violation to every sequence with non-identical PoA specifications – i.e. all heterorganic clusters. In contrast, *{KP}{KPTʔ} only assigns violations to sequences where the first member is a non-coronal: e.g. [ŋp], [ŋt], [ŋʔ],[mp], [mt], [mʔ]. Similarly, *{KPT}{KP} is only violated by clusters where the second member is non-coronal: e.g. [pk], [tk], [kp], [tp].

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[188] One might enquire as to whether the constraints are formed through local conjunction (Smolensky 1993). They cannot be formed solely through local conjunction since *{KPT}&*{K} does not specify linear order (e.g. [ŋt] violates *{KPT}&*{K}, but not *{KPT}{K}) nor adjacency (e.g. [ŋat] violates *{KPT}&*{K} – see Alderete 1997 for relevant discussion). For present purposes, it is enough that the constraints favour homorganic clusters over heterorganic ones and establish a ranking between different types of heterorganic clusters.

[189] The constraints could be straightforwardly adapted to Selkirk's (1991) two-root theory, where geminates have two root nodes but still share features. If the constraints banned adjacent PoA features rather than segments with features, Selkirkian two-root geminates would not violate them. Selkirk's two-root theory was designed to deal with processes of geminate fission; for discussion of such cases using the single-root approach, see Keer (1999).

It is worth pointing out that the validity of the Marked-Cluster constraints does not stand or fall on the validity of the autosegmental representation of geminates. The central points here are that (i) there are constraints that assign violations to heterorganic clusters and that (ii) the constraints favour some types of heterorganic cluster (namely, those with highly marked components) over other types (i.e. those with less marked components). Even so, the structural description of the constraints is straightforwardly expressed assuming autosegmental representation, so it will be assumed throughout.

- *Undergoers*

It is useful to distinguish two general types of Marked-Cluster constraints. In one type, the leftmost set of elements is a subset of the rightmost one: e.g. *{K}{KPT}, *{KP}{KPT}. In the other type, the rightmost set of elements is a subset of the leftmost set: e.g. *{KPT}{K}, *{KPT}{KP}. The different types have distinct empirical effects.

Constraints of the first type, like *{K}{KPT}, affect undergoers. For example, *{K}{KPT} will ban clusters consisting of a dorsal+non-dorsal [ŋp ŋt], but will not militate against any other heterorganic cluster [mk mt nk np]. Thus, if *{K}{KPT} is the only active constraint in a grammar, only dorsal+non-dorsal clusters would be eliminated. This situation happens in Chukchi §7.4.1.3, where only dorsals assimilate.

The combined effect of the Marked-Cluster constraints is to favour clusters starting with a low-marked element over all those with a highly marked leftmost element. The result is that KC clusters, where C is any consonant that disagrees in PoA with the preceding segment, are local harmonic bounds for PC, TC, and ʔC clusters in terms of Marked-Cluster constraints with the form *{x}{KPT}; the same is true of PC as a local harmonic bound for TC and ʔC, and TC as a local harmonic bound for ʔC. Thus, the constraints can be used to avoid any contiguous set of these clusters. For example Sri Lankan Portuguese Creole (§7.4.2) avoids KC and PC heterorganic clusters, but allows TC clusters.

Importantly, the constraints do not present the same problem as the Markedness-Reliant approach discussed in sections 7.2-7.3. That discussion showed that a constraint like *{T}{KP} has undesirable consequences. In the theory of cluster markedness presented here, there is no constraint *{T}{KP}. Moreover, no ranking of the constraints can be used to ban coronal+non-coronal clusters. More concretely, coronal+non-coronal clusters violate the constraints *{KPT}{KP}, *{KPT}{KPT}, and *{KPT}{KPTʔ}. However, labial+non-labial and dorsal+non-dorsal clusters also violate all these constraints. Thus, the constraints could not be used to provide a markedness-reliant account of Catalan – i.e. an analysis without marked-faithfulness constraints.

- *Triggers*

Constraints of the second type – e.g. *{KPT}{K} – place restrictions on triggering elements. For example, *{KPT}{K} bans all heterorganic clusters with a dorsal second member: [mk nk], but no others [ŋp ŋt mt np]. If *{KPT}{K} were the only active constraint in a grammar that eliminated clusters through assimilation, it would effectively only force assimilation before dorsals. Such a case is found in Korean in §7.5.1.2 (with slightly more complexity).

Together, these 'triggering' constraints also impose relations between different types of cluster: CK clusters, where C is a heterorganic consonant, are local harmonic bounds for CP, CT, and CɁ clusters in terms of Marked-Cluster constraints with the form *{KPT}{*x*}. Similarly, CP is a local harmonic bound for CT and CɁ, and CT for CɁ. In short, clusters with a dorsal as the rightmost member are the worst kind in terms of triggering, followed by those with a labial as the second member, and so on. In effect, this means that there can be a language where only dorsals trigger assimilation (Korean), one in which only dorsals and labials trigger heterorganicity-avoidance (Attic Greek – §7.5.1.1), and one in which dorsals, labials, and coronals – but not glottals – trigger assimilation.

Of course, the constraints are not mutually exclusive. They can be intermingled to produce systems with restrictions on both undergoers and on triggers. The following sections will generally focus on grammars with conditions on one or the other. However, the analysis of Kui (§7.5.1.3) shows the need for constraints of the form *{K}{KP}, where coronals are neither undergoers nor triggers.

- *Elaborations*

As stated in (41), the constraints apply to any type of segment. Since there are often different conditions on heterorganic clusters of different manners of articulation, it is quite possible that there are specific instantiations of the constraints in (41) for certain manners of articulation.[190] Since the aim of this section is to determine the form of faithfulness constraints, little time will be devoted to developing this notion (see §7.6) – the exact form of the markedness constraints will be made clear for each of the case studies as they arise.

Similarly, the constraints in (41) do not refer to constituency, only linear order. So, the constraint *{KPTɁ}{KPTɁ} bans heterorganic clusters in any position, regardless of whether they consist of two onset segments, two coda segments, or a coda+onset sequence. While it is possible that further investigation will show the need for versions of these constraints that refer to constituency, the cases studies discussed below provide no relevant evidence (also see Steriade 1995a for relevant work that does not refer to constituency). Again, while this issue is worthy of future attention, it is tangential to the main point here and – more importantly – has no bearing on the claims about faithfulness constraints made in this section.

In fact, for the purposes of this chapter it is only essential that there are markedness constraints that (i) favour homorganic over heterorganic clusters and (ii) distinguish different types of heterorganic cluster, based on PoA markedness. The constraints in (41) are employed because they fulfill these two functions. Supporting evidence is provided in the following sections.[191]

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[190] I do not mean to imply that there should be a constraint for every possible combination of manner of articulation with PoA. Such an approach would fail to capture the implicational relations in manner of articulation for assimilation, as demonstrated by Padgett (1994) and Jun (1995). Clearly, the role of manner in place assimilation is significant and deserves careful formal development; unfortunately, this is beyond the scope of this chapter.

[191] For discussion of Lombardi's (1995 et seq.) AGREE[F] constraints, see §6.2.

As a final point, one may wonder whether constraints that mention glottals: e.g. *{KPTʔ}{KPTʔ} are necessary (cf Rice 2000a,b). Yamphu provides support for this proposal, from evidence that glottals can be both triggers and targets of assimilation (§7.5.1.4).

For discussion regarding direction of assimilation, see §7.7.1.1.

• *The Marked-Cluster theory: aims and evidence*

This section concludes with a comment about how the Marked-Cluster constraints figure in the following sections.

The aim of the following subsections is to show that the Marked-Cluster constraints eliminate the need for unmarked-faithfulness constraints (e.g. IDENT{T}). However, doing so only shows that the Marked-Cluster constraints are a viable alternative to the unmarked-faithfulness constraints.

So, §7.5 is devoted to showing why the Marked-Cluster constraints are independently necessary. Cases in which faithfulness cannot play a crucial role are discussed and argued to depend on the Marked-Cluster constraints.

As a final note, four previous proposals relating to assimilation are compared to the Marked-Cluster theory in the following sections. Sections 7.5 and 7.6 discuss theories that do not make distinctions between different types of heterorganic cluster (e.g. AGREE[Place], after Lombardi 1995), and those that seek to reduce assimilation to conditions on independent PoA in codas (Ito 1986, Cho 1999). Section 7.7 focuses on two recent theories that have been used to deal with marked-undergoer systems like SLP Creole's – Baković's (1999a,b) constraint conjunction approach and McCarthy's (2002a) Comparative Markedness theory.

7.4.2 Marked undergoers I: Sri Lankan Portuguese Creole

Sri Lankan Portuguese (SLP) Creole is the exact opposite to Catalan: only coronals are exempt from assimilation in the former while only coronals undergo assimilation in the latter (Smith 1978, Hume & Tserdanelis 1999). This section argues that the SLP Creole system – and all 'marked-undergoer' systems – comes about through a ban on highly marked clusters. For SLP Creole, this idea is implemented by the constraint *{KP}{KPT}, which only bans heterorganic clusters with a non-coronal as the leftmost element. In effect, then, coronals are already 'adequately unmarked' in SLP Creole – they do not assimilate because doing so will not sufficiently improve their markedness.

Section 7.4.2.1 describes relevant facts of SLP Creole phonology, and discusses the relevant assimilations. Section 7.4.2.2 presents an analysis in terms of the Marked-Cluster constraints, and compares it with an unmarked-faithfulness analysis (i.e. with a constraint like IDENT{T}).

7.4.2.1 Description

SLP Creole has the following consonant phonemes:

Table 7.6: Sri Lankan Portuguese Creole consonants

	labial	coronal	palatal	dorsal[192]
stops	p	t		k
	b	d		ɡ
affricates		tʃ		
fricatives	f	s		
		z		
nasals	m	n	ɲ	ŋ
laterals		l		
rhotics		ɾ		
glides	w		j	

The short vowels are [i e æ ə ɔ o u], with long counterparts [iː eː æː aː ɔː oː uː]. Syllables have the structure (C)(C)V(ː)(C). Complex onsets consist of (1) an obstruent+[ɾ] (excepting [sɾ]), and – rarely – (2) an obstruent+[l] or (3) [s] followed by a stop. Word-medial codas must be sonorants.

- *Assimilation*

There are also restrictions on heterorganicity. Labial and dorsal codas require the following obstruent to be homorganic, both within words and across word boundaries. This requirement can be seen in the alternations in (43); the annotation (xx#yy) refers to the page number and example number respectively in Smith (1978), whereas (H&T) refers to Hume & Tserdanelis (1999).

(43)   SLP Creole assimilation data
    (a) /m/+C *assimilation*

/pərim təsuwaː/	→ [pərintəsuwaː]	'I am sweating'	(100#739)
/maːm+su/	→ [maːnsu]	'hand+{genitive}'	(100#736)
/taːm nikərə/	→ [taːnːikərə]	'also won't'	(89#641)
/ɾezaːm lej/	→ [ɾezaːnlej]	'reasonably'	(100#740)
/boːm dʒentis/	→ [boːɲdʒentis]	'good people'	(100#738)
/pikiniːm kaːzə/	→ [pikiniːŋkaːzə]	'small house'	(100#737)
/maːm+ki/	→ [maːŋki]	'hand {verbal noun}'	(H&T)

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[192] I only distinguish Major PoA here. /t/ and /d/ are realized as dental [t̪ d̪] while other coronals are alveolar.

(b) /ŋ/+C *assimilation*

/miːtiŋ+pə/	→ [miːtimpə]	'meeting {dative sg.}'	(H&T)
/uŋ pæːzu/	→ [um pæːzu]	'one pound'	(102#758)[193]
/uŋ faːkə/	→ [um faːkə]	'one knife'	(102#757)
/uŋ maːm/	→ [um maːm]	'one hand'	(103#760)
/uŋ diːjəpə/	→ [un diːjəpə]	'for one day'	(102#758)
/miːtiŋ+su/	→ [miːtinsu]	'meeting {genitive}'	(H&T)
/əluŋ dʒeːntis/	→ [əluɲ dʒeːntis]	'some people'	(102#756)

In contrast, the nasal [n] allows consonants with any PoA to follow it, as shown in (44).[194]

(44) /n/+C = no assimilation

[kəkluːn+pə]	'turkey {dative sg.}'	(100#741)
[siːn+pə]	'bell {dative sg.}'	(H&T)
[grænpəpa]~[grænpə]	'grandfather'	(73#492)
[konwən]	'convent'	(102#753)
[siːn+ki]	'bell {verbal noun}'	(H&T)
[siːn kidaːj]	'the ringing of bells'	(67#465)

The same is true of the coronal codas [l ɾ].

(45) Liquid clusters
(a) [l]+C

[kúːlpə]	'guilt'		[áːltu]	'tall, high'
[əlkonsáː]	'consult'		[əlfáːdə]	'pillow'

(b) [ɾ]+C

[kóːɾpu]	'body'		[gáːɾfu]	'fork'
[koɾtáː]	'cut, slaughter'		[pəɾsə]	'see, appear'
[póːɾku]	'pig'			

In short, only labials and dorsals are undergoers in SLP Creole assimilation; coronals are exempt.

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[193] That 'one' is underlyingly /uŋ/ can be seen by its form before vowel-initial forms like [əluŋ ɔɾas] 'sometimes' (101#748, 749).
[194] I was unable to find relevant data for the palatal nasal [ɲ] because it does not occur word-finally. In addition [ɲ] does not occur word-initially, and in intervocalic position it optionally becomes a nasalized glide [j̃] (Smith p.92). This means that [ɲ] has a rather marginal phonemic status, only obligatorily occurring in medial codas before a palatal: [ɲtʃ] and [ɲdʒ]. It is therefore possible to treat [ɲ] as an allophone of /n/ here, assimilating to palatals (as in Catalan).

7.4.2.2 Analysis

The leading idea behind the following analysis of SLP Creole is that coronals do not assimilate because they are already 'adequately unmarked'. In other words, coronal+C clusters are less marked than non-coronal+C clusters, so allowing them to survive in SLP Creole.

The leading idea is formalized in the present theory through the structure of the anti-heterorganic markedness constraints. In terms of the Marked-Cluster constraints of the type *{x}{KPT}, coronal+C clusters incur a proper subset of the violations of other clusters. Specifically, while [n{p,k}] violates only *{KPT}{KPT}, [m{t,k}] violates *{KP}{KPT} as well, and [ŋ{p,t}] further violates *{K}{KPT}. Because of this local harmonic bounding relation there is a hierarchy of cluster types: | ŋ{t,p} 〉 m{k,t} 〉 n{p,k} |.

In effect, SLP Creole only aims to avoid the most marked clusters: it makes a cut above [n{p,k}] clusters, and bans all those that are more marked.

- *Avoiding marked clusters*

The Marked-Cluster constraint that is responsible for the SLP Creole system is *{KP}{KPT}. This constraint bans non-coronal+C clusters but not coronal+C ones. *{KP}{KPT} must outrank all PoA-faithfulness constraints that preserve dorsal or labial PoA – i.e. all faithfulness constraints (only IDENT{KPT} is given in the tableau below for the sake of brevity).

(46)

/mitiːŋ+pə/	*{KP}{KPT}	IDENT{KPT}
(a) mitiːŋpə	*!	
☞ (b) mitiːmpə		*

The ranking in tableau (46) cannot force coronal+non-coronal clusters to assimilate. For example, from /siːn-pə/, the faithful output [siːnpə] will not violate *{KP}{KPT} because it has a coronal as its first member. Thus, nothing favours the assimilated form *[siːmpə], and so the faithfulness constraint IDENT{KPT} makes the crucial decision, favouring the unassimilated [siːnpə].

(47)

/siːn-pə/	*{KP}{KPT}	IDENT{KPT}
☞ (a) siːnpə		
(b) siːmpə		*!

Further to this ranking, to ensure that coronals do not undergo assimilation some faithfulness constraint to coronals – i.e. IDENT{KPT} – must outrank all constraints that ban coronal+non-coronal clusters – i.e. *{KPT}{KPT} (and also *{KPT}{KP}, *{KPT}{K}).

(48)

/siːn+pə/	*{KP}{KPT}	IDENT{KPT}	*{KPT}{KPT}
☞ (a) siːnpə			*
(b) siːmpə		*!	

Again, onset-IDENT{KPT} ensures that assimilation is regressive.

- *Summary*

To summarize, systems in which unmarked elements are exempt (marked-undergoer systems) come about through the action of markedness constraints. In effect, unmarked elements are exempt in such systems because they are already 'unmarked enough'.

In general terms, the ranking needed for marked-only undergoer systems involves (i) a markedness constraint that targets marked elements alone outranking all faithfulness constraints that preserve those elements and (ii) faithfulness constraints that preserve unmarked elements outranking all markedness constraints that would eliminate those elements.

For example, in SLP Creole the constraint *{KP}{KPT} targets marked consonant clusters alone. This constraint outranked all PoA-faithfulness constraints. Since the unmarked coronals did not undergo assimilation, IDENT{KPT} had to outrank all markedness constraints that banned heterorganic coronal-initial clusters (e.g. *{KPT}{KPT}). This point is schematized in Figure 7.3, which shows the rankings identified above.

Figure 7.3: Sri Lankan Portuguese Creole assimilation ranking
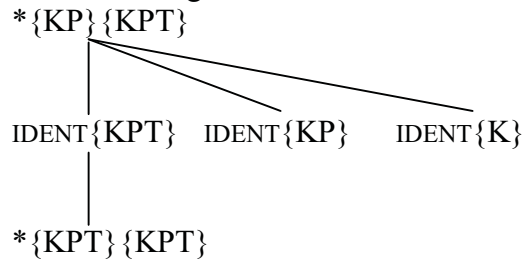
- *Alternatives: unmarked faithfulness*

The alternative to the analysis just provided relies on faithfulness to block coronal assimilation. One could appeal to a constraint that only preserves coronals (IDENT{T}) outranking all anti-heterorganicity constraints (analogous to the Catalan analysis). So, from /siːn-pə/, the assimilated candidate *[siːmpə] would be eliminated due to the fact that it is unfaithful to the input coronal specification, violating IDENT{T}. Crucially, from /maːm-ki/, the candidate [maːŋki] does not violate IDENT{T}, allowing the anti-heterorganic constraints to do their job.

While an analysis with the unmarked-faithfulness constraint IDENT{T} does in principle work for SLP Creole, §7.5 will show that it cannot replace the Marked-Cluster

constraints. In contrast, the Marked-Cluster constraints are needed for independent reasons, so unmarked-faithfulness constraints are redundant.

7.4.3 Marked undergoers II: Avoiding dorsals

The Marked-Cluster constraints not only predict a language like SLP Creole, where only labials and dorsals undergo assimilation; they can also generate a language in which only dorsals undergo assimilation. The aim of this section is to show that these predictions of the Marked-Cluster constraints for undergoers are borne out.

Section 7.4.3.1 presents an example of a dorsal-undergoer system – nasal assimilation in Chukchi.

Section 7.4.3.2 discusses a case where only labials undergo assimilation. This system is produced by having both Marked-Cluster constraints and marked-faithfulness constraints active in the same grammar.

7.4.3.1 Chukchi

The most marked cluster consists of a dorsal+C. Such a sequence violates all of the relevant markedness constraints: *{K}{KPT}, *{KP}{KPT}, and *{KPT}{KPT}. The constraint *{K}{KPT} sets dorsal+non-dorsal clusters apart from all other types, predicting a language that tolerates all heterorganic clusters except for this type: i.e. √[nt np nk], √[mp mt mk], *[ŋp ŋt], √[ŋk].

Chukchi provides a relevant system (Bogoras 1922, Krause 1980, Odden 1988). In this language, only /ŋ/ assimilates to the PoA of a following consonant; /m/ and /n/ remain unchanged. Chukchi consonants are provided in Table 7.7.

Table 7.7: Chukchi consonants

	labial	dental	palatal	velar	uvular	glottal
stops	p	t	tʃ	k	q	ʔ
fricatives		ɬ	ʃ	x		
				ɣ		
nasals	m	n		ŋ		
rhotics		r r̥				
glides	w w̥		j j̥			

The /ŋ/-assimilation examples below use the morpheme /teŋ/ (e.g. [teŋt-əʔ-ən] 'good').[195] The examples marked (O) below are from Odden (1988:12), those from Bogoras (1922) are marked (B), and those from Krause (1980) are marked K.

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[195] A process of vowel harmony is responsible for the alternations in the vowels (Bogoras 1922, Krause 1980).

(49)   Chukchi /ŋ/ assimilation
        (a) /ŋ/ assimilates
                [tam-pera-k]   'to look good'   (O)
                [tam-pera-e]   'he appeared well'   (B655)
                [pʔom-pʔoŋ]   'mushroom'   (K21)
                [tam-vairgin]   'good state of things' (B655)
                [tam-wa-rərɣ-ən]   'good life'   (K21)
                [tam-waŋeirgin]   'good work'   (B655)
                [tan-tʃai]   'good tea'   (B655)
                [tan-tʃottʃot]   'good pillow'   (K21)
                [tan-ʟəmŋəʟ]   'good story'   (O)
                [tʃenl-ət]   'drawers' (cf [tʃeŋəl]) (K21)
                [tan-leut]   'cleaver head'   (B655)
                [telen-remkin]   'ancient people'   (B655)
                [tan-ran]   'a good house'   (B655)
                [tan-rʔarqə]   'good breastband'   (O)
                [telen-jep]   'long time ago'   (B655)
                [ten-jəlqet-ək]   'to sleep well'   (K21)
        (b) /m/ and /n/ do not assimilate
                [valvimtilanaŋ]   'to Raven-Man'   (B667)
                [gumnin]   'my left hand'   (B659)
                [miml-ət]   'place near the water' (K41)
                [təmk-ən]   'hummock (abs.sg.)   (K40)
                [nə-mkə-kin]   'often'   (O)
                [ramkitʃin]   'people'   (B665)
                [tumɣ-ə-tum]   'comrade'   (K40)
                [mŋe-eŋeŋilin]   'sacrificing shaman'   (B660)
                [umqə]   'polar bear'   (K40)
                [n-i-np-u-qin]   'old one'   (B658)
                [ɣa-n-pera-w-ʟen]   'decorated'   (O)
                [mit-i-nmu-ut]   'we killed you(sg)'   (B659)
                [ningdlinin]   'hand'   (B658)
                [ŋinqej]   'boy (abs.sg.)   (K40)

The restriction identified above holds of all NC clusters: whether morpheme internal or across morpheme-boundaries, [m] and [n] can appear before any consonant, but [ŋ] can only appear before a velar (Bogoras 1922:652).

- *Glottal or velar?*

Given the distinction between glottal and velar nasals discussed in ch.5, one may ask whether the surface [ŋ] cited above is a glottal [N] rather than a velar (cf Trigo 1988). As discussed in ch.5, both glottal and velar nasals are realized with velar constriction, so are phonetically indistinguishable. Nevertheless, there is phonological evidence that the segment realized as [ŋ] is underlyingly a velar, not a glottal.

Velars alone undergo a process of spirantization before nasals. Krause (p.18) observes that the velar stop /k/ spirantizes to the velar [ɣ] before all consonants except for [k ɣ ŋ q ʔ], before which it remains faithful; /ʔ/ does not undergo any analogous change.[196] The examples in (50) are taken from Krause (p.18).

(50)   Chukchi /k/-lenition
        [ḵətəjɣat-ək] cf   [ɣa-ɣtəjɣat-len]   'the wind blew'
        [ḵərəŋew-ək] cf   [ɣe-ɣrəŋəw-lin]   'he grew up'
        [ḵəjəw-ək]   cf   [ɣe-ɣjəw-lin]   'he woke up'
        [t∫iḵ-ejmew-ək] cf   [t∫iɣ-mŋet-ək]   'to grow somewhat'
                              [t∫iɣ-nilɣin-nin]   'he raised slightly'

Notably, /ŋ/ behaves in a similar way. As shown in (49), /ŋ/ assimilates before almost every manner of articulation. However, assimilation is blocked before other nasals. In this environment, /ŋ/ spirantizes, as shown in (51) (from Krause 1980:20).

(51)   Chukchi pre-nasal /ŋ/-lenition
        [rat∫wəṇ-ək] cf   [mət-rat∫wəɣ-mək]   'we competed'
        [taraṇ-ək]   cf   [nə-taraɣ-more]   'let's build a place to live'
        [enawrəṇ-ək] cf   [enawrəɣ-nen]   'he presented him'
        [petʔiŋ]   cf   [petʔiɣ-ŋinqej]   'boy with a cold'

In contrast, /m/ and /n/ remain faithful before another nasal (e.g. [ɡumnin] 'my left hand', [mṇe-eŋeŋilin] 'sacrificing shaman', [mit-i-nmu-ut] 'we killed you (sg)' – Bogoras 1922).

There are two points to note here. One is that /ŋ/ behaves like the velar /k/ in the fact that it spirantizes, and unlike labials and coronals,. The other is that /ŋ/ lenites to a velar [ɣ] rather than a consonant with some other PoA (e.g. [ʔ]). Both of these facts suggest that /ŋ/ is phonologically a velar. If [ŋ] were a glottal nasal [N], its behaviour is more difficult to explain, especially considering that the glottal stop /ʔ/ does not behave analogously to /ŋ/ (i.e. /ʔ/ remains faithful before other consonants and undergoes several processes that /ŋ/ does not – Krause 1980:95ff). For these reasons, Chukchi will be treated as having a velar nasal rather than a glottal [N].

- *Analysis*
    In the present theory, only dorsal+non-dorsal clusters violate the constraint *{K}{KPT}. So, with this Marked-Cluster constraint outranking all faithfulness constraints, only dorsal+non-dorsal clusters will be eliminated. To prevent assimilation of labials and coronals, at least IDENT{KPT} must outrank all other cluster constraints (i.e. *{KP}{KPT}, *{KPT}{KPT}).

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[196] The exception is before /ŋ/, before which /k/ is realized as [ŋ]: e.g. cf [pleḵ-ət] cf [tə-pleṇ-ŋə-k] 'to sew footwear' (Krause 1980:18).

(52) Dorsals assimilate

/teŋ-pera-k/	*{K}{KPT}	IDENT{KPT}	*{KP}{KPT}	*{KPT}{KPT}
(a) teŋperak	*!		*	*
☞ (b) temperak		*		

(53) Labials and Coronals do not assimilate

/ɣa-n-pera-w-ʟen/	*{K}{KPT}	IDENT{KPT}	*{KP}{KPT}	*{KPT}{KPT}
☞ (a) ɣanperawʟen				*
(b) ɣamperawʟen		*!		

In summary, the typological predictions of the Marked-Cluster theory are borne out for marked-undergoer systems. For an analogous case, see Uradhi (Crowley 1983:321).

7.4.3.2 Harar Oromo

To complete the typological picture, the present theory predicts that a language could combine properties of Chukchi and Catalan. This section argues that such a case is found in Harar Oromo. Harar Oromo is like Catalan in that a marked PoA is exempt from assimilation (i.e. labials) but a less marked PoA (coronal) is not. However, Harar Oromo is also like SLP Creole in that a marked PoA (dorsal) undergoes assimilation while a less marked one (labial) does not. The net result is that only labials are exempt from assimilation.

- *Assimilation*
  Harar Oromo has the consonants in Table 7.8 (Owens 1985, Lloret 1992).

Table 7.8: Harar Oromo consonants

		labial	coronal	(alveo-) palatal	dorsal	glottal
stops	-vd		t	tʃ	(k)[197]	ʔ
	ejective	p'	t'	tʃ'	k'	
	+vd	b	d	dʒ	g	
	implosive		ɗ			
fricatives		f	s	ʃ	x	h
			z			
nasals		m	n	ɲ		
liquids			l	r		
glides		w		j		

Syllables have the form (C)V(ː)(C).

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[197] [k] only appears as a geminate or as the second consonant of a consonant cluster: [mukːeːni] 'trees, forest', [ark] 'see'.

The examples relevant to present concerns relate to stop assimilation. As shown in (54a), dorsal stops assimilate to form a geminate with a following consonant; [x] also optionally assimilates.[198] In contrast, labials do not (54b).

(54)   Harar Oromo Assimilation
        (a) Dorsal + C$_2$ → [C$_2$ː]

/hok' + ne/	→ [hojnne]	'we scratched'	(24)
/meːk' + te/	→ [meːtt'e]	'you turned'	(22)
/d'iːk' + na/	→ [d'iːjnna]	'we wash'	(23)
/fiːg + te/	→ [fiːjdde]	'you escaped'	(23)
/d'uːg + ne/	→ [d'uːjnne]	'we drank'	(23)
/beːx + ne/	→ [beːnne]	'we know' {optional}	(23)

        (b) Labial + [C$_2$] → No change

/tʃ'ap' + ti/	→ [tʃ'ap't'i]	'it (fem.) breaks'	(22)
/k'ab + ta/	→ [k'abda]	'you have'	(23)
/gub + tan/	→ [gubdan]	'you (pl) burn something'	(23)

There are no root+suffix alternations showing that coronals assimilate in PoA since all suffixes seem to only contain coronals. However, coronal nasals in prefixes assimilate to the PoA of a following stem consonant: /hin-waːdu/ → [hiwwaːdu] 'he doesn't bake', /hin-jaːdu/ → [hijjaːdu] 'he doesn't think', /hin-raftu/ → [hirraftu] 'you don't lie down'.

Coronals also assimilate in manner and voice: e.g. /d$^?$iːt$^?$+na/ → [d$^?$iːnna] 'we kick'; /did+ne/ → [dinne] 'we refused'; /haːd$^?$+tiː/ → [haːttiː] 'mother {nominative}' (p.24).[199]

The same assimilation pattern is also found in the Southern Oromo languages Boraana, Orma, and Waata for plain stop+coronal clusters (Lloret 1992:259ff). The Western Oromo languages differ in that only coronals assimilate (i.e. the Catalan system).

It is important to point out that input geminate labials surface faithfully in the language: e.g. [lapp'eː] 'heart', [gubbaː] 'on top' (p.14). So, the failure of labials to assimilate cannot be ascribed to a surface ban on labial geminates.

- *Analysis*

Since coronals undergo assimilation, the Marked-Cluster constraint *{KPT}{KPT} must outrank IDENT{KPT}. No other relevant Marked-Cluster constraint (i.e. *{K}{KPT} and *{KP}{KPT}) can be used because these do not ban coronal+non-coronal clusters.

(55)

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[198] Assimilation is accompanied by diphthongization, described by Owens (p.24) as "a strong palatalization in the vowel preceding the velar consonant": e.g. /hok'-ne/ → [hojnːe] 'we scratched'. The diphthong formed has almost the same status as underlying /Vj/ clusters, shown by the fact that a rule of raising (/aj/→[eː] – e.g. /d'agaj-sis/ → [d'ageːsis] 'make someone hear') can optionally apply to them: e.g. /lag-niː/ → [leːnːiː]~[lajnːiː] 'river+nom'. For further discussion, see Owens (1985:20, 23-4).
[199] Consonant clusters with [ʔ] as the first member are also banned. These are eliminated by assimilating the /ʔ/ to the preceding vowel: /deːbiʔ+ti/ → [deːbiːti], *[deːbitːi] 'she returns' (Owens 1985:20). Clusters with /tʃ/ as the first member are not reported by Owens.

/hin-waːdu/	*{KPT}{KPT}	IDENT{KPT}
(a) hinwaːdu	*!	
☞　(b) hiwwaːdu		*

- *Why Harar Oromo is like Catalan*

The Catalan-like aspect of Harar Oromo relates to labials. As in Catalan, labials are exempt from assimilation but the less marked coronals are not. As shown for Catalan, the only way to account for this fact is to have a marked-faithfulness constraint blocking assimilation of labials. In ranking terms, the constraint IDENT{KP} must outrank *{KPT}{KPT}, as shown in tableau (56).

(56)

/tʃap'+ti/	IDENT{KP}	*{KPT}{KPT}	IDENT{KPT}
☞　(a) tʃap'ti		*	
(b) tʃatt'i	*!		*

- *Why Harar Oromo is like Chukchi*

However, there is an important difference between Harar Oromo and Catalan. Neither labials nor dorsals assimilate in Catalan, but dorsals assimilate in Harar Oromo. In this respect, Harar Oromo is like Chukchi – dorsals assimilate while the less marked labials do not.

As in Chukchi, then, some constraint that bans dorsal+non-dorsal clusters must dominate all constraints that preserve dorsals – i.e. IDENT{KP}, IDENT{K}. This ranking is shown in tableau (57).

(57)

/meːk' + te/	*{K}{KPT}	IDENT{KP}
(a) meːk'te	*!	
☞　(b) meːtt'e		*

No other markedness constraint will work. For example, *{KP}{KPT} must be ranked below IDENT{KP}, otherwise labials would assimilate. Similarly, there is no faithfulness constraint that can force dorsals to assimilate. Figure 7.4 shows the full ranking of the constraints.

Figure 7.4: Harar Oromo assimilation ranking
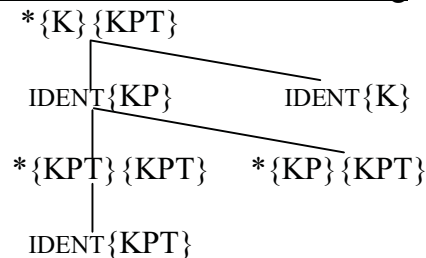
The diagram shows aspects of both the marked- and unmarked-undergoer rankings identified in §7.2 and §7.4.1. Having the marked-faithfulness constraint IDENT{KP} outrank the anti-heterorganic cluster constraint *{KPT}{KPT} blocks marked elements from assimilating, as in Catalan. Having the Marked-Cluster constraint *{K}{KPT} outrank the relevant faithfulness constraints IDENT{KP} and IDENT{K} forces marked elements alone to assimilate, as in SLP Creole and Chukchi.

In short, Harar Oromo shows that languages cannot be classed as having either 'marked undergoers' or 'unmarked undergoers'. As predicted by the free ranking of constraints, a language may have both aspects – in effect being a hybrid form of Catalan and Chukchi.

7.4.4 Exempting the unmarked elsewhere

Since it has been claimed that marked-undergoer systems do not exist (Mohanan 1993:63,76, Jun 1995:33,70ff), this section provides further evidence for this type of assimilation system.

The SLP Creole-type system is common among Australian languages. For example, Alyawarra allows both homorganic and coronal codas, but no other types: e.g. [inpima] 'get', [aranka] 'beard', [antira] 'fat', [ampa] 'child', [aŋka] 'child' (Yallop 1977). Other examples include Bardi (Metcalfe 1975), Kuuku Ya'u (Thompson 1988), Lardil (Hale 1973), Ngawun Mayi (Breen 1981), Ngiyambaa (Donaldson 1980), Nhanda (Blevins 2001), and Nunggubuyu (Heath 1984). Sources for several of the languages show alternations. For example, Nunggubuyu eliminates dorsals in heterorganic clusters in a variety of ways, but always retains coronals.

(58)   Nunggubuyu: marked-undergoers only
    (a) /ŋ/ assimilation and /g/ deletion

root	[gulmuŋ] 'belly'	[wulug] 'soft'
+pergressive	[ama-gulmum-baɟ]	[ama-wulu-baɟ]
+locative	[gulmun-duɟ]	[wulu-duɟ]
+relative	[ama-gulmuɲ-ɟinjuŋ]	[ama-wulu-ɟinjuŋ]

    (b) /n/ and /d/ preservation
     [man-bajama] '(group) to keep going'   [wadbar] 'grevillea'
     [a-muːn-baɟ] 'by foot'   [gudga] 'to prod'
     [dan-garu-gaji] 'to have a bellyache'

Outside Australia, the Uralic language Saami has the same restriction (Bye 2001:139).

The Dravidian language Tamil exhibits the same restriction in syllable-initial codas: dorsal and labial nasals undergo assimilation, and coronals do not (e.g. [tun.bã] 'sorrow', cf /maːm-taːn/ → [maːndã] 'tree (emphatic)' (Beckman 1998§2.4.4, Asher 1985, Christdas 1988).

The Hokan language Seri has a similar restriction: /m/ assimilates, but /n/ does not (Marlett 1981): /i-m-kaː/→[iŋkaː] 'who does not look for it' (cf [i-m-aː] 'who is not grinding') cf [soːme<u>n</u> <u>k</u>aʔa] 'he will winnow' (Marlett 1981:16-17).

Finally, Hamer (South Omotic) bans *{KP}{KPT} clusters as well, but resolves violations (for obstruent-obstruent clusters) through metathesis: /ep-sa/ → [es.pa] 'cause to cry', /wob-sa/ → [wospa] 'make bent', /ʊs-ka/ → [ʊksʌ] 'cause to spear' (Lydall 1976: 404, Zoll 1998). For a discussion of how the cluster constraints can produce metathesis, see §7.5.1.3.

- *Voicing assimilation*

Marked-undergoer systems are not a peculiarity of PoA assimilation. Wetzels & Mascaró (2001) have recently identified a number of such cases in voice assimilation. In these systems, only segments with the marked [+voice] feature assimilate; voiceless segments do not (Yorkshire English, Parisian French, and Yaːthê). Mekkan Arabic has the same type of system: voiced stops assimilate to voiceless stops, but not vice-versa (Abu-Mansour 1994, 1996, Bakalla 1973). In the data below, AM refers to Abu-Mansour (1994), and B to Bakalla (1973).

(59)   Mekkan Arabic[200]
        (a) Voiced → Voiceless

/ʔabtahal/	→ [ʔaptahal]	'he supplicated' (B521)
/ʔadˤfa/	→ [ʔatˤfa]	'added to' (AM)
/ʔadˤtarr/	→ [ʔatˤtˤarr]	'he compelled' (B522)
/ʔadʒtamaʕt/	→ [ʔaʃtamaʕt]	'met with' (B521)
/mudʒtahid/	→ [muʃtahid]	'diligent' (B522)
/maɡtuːl/	→ [maktuːl]	'killed' (B521)
/ʔaɡtabas/	→ [ʔaktabas]	'he learned' (B521)
/saːħabt/	→ [saːħapt]	'I dragged' (B521)
/ʔantadʒt/	→ [ʔantaʃt]	'I bore' (B522)
/miridˤt/	→ [miritˤtˤ]	'I was sick' (B522)
/ʔaɡsam/	→ [ʔaksam]	'he made an oath' (AM)
/mazkuur/	→ [maskuur]	'mentioned' (AM)
/ʔidʒtimaaʕ/	→ [ʔiʃtimaaʕ]	'meeting'

        (b) Voiceless stops = no assimilation

[ʔakbar] 'older', *[aɡbar]		AM
[matdʒar]	'shop'	AM
[xutˤbah]	'engagement'	AM

---

[200] Emphatic consonants are indicated with a superscript [ʁ].

(c) No voice neutralization in codas or word-finally

[ʔiʃtiha:d]	'effort'	(B521)
[madbaħa]	'massacre'	AM
[ʔabɡa]	'he made someone stay'	(B136)
[ʔadʒbar]	'he forced'	AM
[muru:dʒ]	'meadows'	AM

It is important to point out that codas are not devoiced in Mekkan (59c), so the fact that they appear voiceless in front of voiceless segments must be due to assimilation.

This pattern of assimilation can be accounted for by having cluster constraints for the voicing scale | +voice ⟩ -voice | analogous to the ones proposed for PoA above. This would produce four constraints, listed in (60).

(60)   Voicing-Cluster Constraints

*{±vd}{+vd}	bans voiceless+voiced clusters
*{±vd}{±vd}	bans voiceless+voiced and voiced+voiceless clusters
*{+vd}{+vd}	*vacuously satisfied*
*{+vd}{±vd}	bans voiced+voiceless clusters

As an example, *{+vd}{±vd} bans clusters of a voiced segment followed by a voiceless segment – as with the PoA cluster constraints, clusters that agree in voicing are not banned.

Mekkan Arabic can be produced by ranking a constraint that specifically targets voiced segments – i.e. *{+vd}{±vd} – over all faithfulness constraints, which in turn outrank the anti-heterorganic constraint against voiceless elements: i.e. *{±vd}{±vd}. The result is illustrated in the following two tableaux.

(61)

/ʔaɡtabas/	*{+vd}{±vd}	IDENT{±vd}	*{±vd}{±vd}
(a) ʔaɡtabas	*!		*
☞ (b) ʔaktabas		*	

(62)

/ʔakbar/	*{+vd}{±vd}	IDENT{±vd}	*{±vd}{±vd}
☞ (a) ʔakbar			*
(b) ʔaɡbar		*!	

In short, marked-undergoer systems are neither particularly rare nor confined to PoA assimilation.

To summarize, this section has argued that systems in which only unmarked elements undergo assimilation do not require faithfulness constraints that specifically preserve unmarked elements. The markedness constraints of the present theory provide an

adequate solution. The next section provides independent evidence for the Marked-Cluster constraints.

7.5   Triggering heterorganicity avoidance

The aim of the preceding section was to show that there is no need to appeal to unmarked-faithfulness constraints like IDENT{T} to account for systems in which only marked elements undergo assimilation. The argument presented was that such 'marked-undergoer' systems fall out from the proposal that heterorganic clusters differ in markedness, as formally expressed by the Marked-Cluster constraints.

The aim of this section and §7.6 is to show that the Marked-Cluster constraints are needed independently, for phenomena other than marked-undergoer systems. Since the Marked-Cluster constraints are necessary in any case, they not only pose an alternative to the unmarked-faithfulness constraints, but also render them redundant.

The rest of this section presents evidence for the Marked-Cluster constraints from 'triggers' of heterorganicity-avoidance. For example, only dorsal and labial onsets trigger deletion of preceding non-homorganic consonants in Attic Greek. For example, underlying /t/ is deleted before [k]: e.g. /RED+anut+k+a/ → [anuka], *[anutka] 'I have accomplished'. In contrast, stops are not deleted before [t]: e.g. /diɔːk+tɛːn/ → [diɔːktɛːn] 'persecutor {acc.masc.sg.}'. In other words, non-coronals trigger deletion of preceding heterorganic consonants, while coronals do not.

The following case studies affirm the typological generalization made by Mohanan (1993:75,6) that there is an implicational relationship between different PoA types in terms of triggering elements (also see Jun 1995:71,78). That is, if x triggers avoidance of heterorganic clusters, then all segments with a more marked PoA also trigger heterorganicity-avoidance.[201] For example, [p] in Attic Greek triggers heterorganicity-avoidance: it forces deletion of a preceding segment that disagrees in PoA. This implies that [k] will do the same, but does *not* imply that [t] will do so. In Korean (§7.5.1.2), dorsals require preceding elements to assimilate to them, but labials and coronals do not. In contrast, there is no language in which only coronals trigger assimilation (or deletion, or any other heterorganicity-avoiding process).

This asymmetry is shown to follow from the form of the Marked-Cluster constraints. The Marked-Cluster constraints favour clusters with a less marked rightmost element over those with a more marked rightmost element: | pk, tk ⟩ kp, tp ⟩ kt, pt |. From this, the following sections show that a language cannot both avoid clusters with a rightmost coronal and tolerate clusters with a more marked second member.

Section 7.5.1 discusses Attic Greek. This section provides evidence for the constraint *{KPT}{KP}.

Section 7.5.2 presents an analysis of assimilation in Korean, in which dorsals trigger assimilation in preceding elements, but labials and coronals do not (with the added

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[201]   To be accurate, Mohanan (1993) only refers to assimilation. I generalize the prediction here to all processes that are used to avoid heterorganic clusters (e.g. deletion, epenthesis, coalescence, metathesis).

complexity that coronals always undergo assimilation). This section is shown to provide evidence for the constraint *{KPT}{K}.

Section 7.5.3 fills out the typology by showing the need for the constraint *{K}{KP}, which accounts for interesting effects in Kui metathesis.

By showing that constraints of the sort *{KPT}{KP}, *{KPT}{K}, and *{K}{KP} exist, it is clear that different types of heterorganic clusters have different markedness. Having shown that these constraints are independently necessary, the SLP Creole system is argued to follow analogously. Section 7.5.4 presents this argument in detail.

Section 7.6 presents evidence for the Marked-Cluster constraints from neutralization. Section 7.7 discusses two recent theories that aim to account for marked-undergoer systems – Baković's (1999a,b) theory of markedness-faithfulness constraint conjunction, and McCarthy's (2002a) theory of Comparative Markedness.

7.5.1   Triggering deletion in Attic Greek

Yip (1991) observes that heterorganic clusters with a coronal member can be exempt from heterorganicity-eliminating processes. In this respect, such clusters are treated like homorganic ones. Yip terms the ban on heterorganic clusters without a coronal the 'Cluster Condition'. This section expresses the Cluster Condition in terms of the Marked-Cluster constraints, focusing on stop+stop clusters in Attic Greek.

This section shows that Attic Greek is the mirror image of SLP Creole. In SLP Creole, coronal+non-coronal clusters escape elimination (through assimilation) because they are the least marked cluster type (formally expressed by *{KP}{KPT}). In Attic Greek, non-coronal+coronal clusters escape elimination (through deletion) for the same reason, though a different constraint – *{KPT}{KP} – is responsible.

The striking aspect of the Attic Greek case (and the others reported in the following sections) is that the featural content of the second cluster element determines whether the cluster is eliminated; this contrasts with a language like Catalan where any consonant – labial, palatal, or dorsal – may trigger assimilation of a preceding coronal.

It is also worth pointing out that the Attic Greek restriction is not unique: a number of other Indo-European languages share this property. Apart from English, another striking example is Swedish. Just like Attic Greek, the permissible clusters (in both medial and word-final position) are (1) K{K,T}, (2) P{P,T}, and (3) TT: i.e. homorganic clusters and clusters with a coronal as the second member (Sigurd 1965).[202]

7.5.1.1 Description

Attic Greek consonant clusters have been described extensively by Lupas (1972), Sommerstein (1973), Steriade (1982) and Bubeník (1983). Stop clusters are the focus of this section; their relation to other cluster types is discussed at the end.

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[202]   The one exception is [mk], which is found medially (but not [mg]). More precisely, [nasal+C] clusters show this pattern, [stop+C] clusters also show this pattern, with the restriction that homorganic stop+stop clusters (i.e. geminates) are banned. Clusters of a moraic sonorant ([l r]) + C allow the C to have any PoA.

The consonants of Attic Greek are given in Table 7.9. There are three series of stops, contrasting in voicing and aspiration; each series contrasts three places of articulation.[203]

Table 7.9: Attic Greek consonants

	labial	coronal	palatal	dorsal	glottal
stops	p	t		k	
	pʰ	tʰ		kʰ	
	b	d		g	
fricatives		s			h
nasals	m	n			
liquids		l r			
glides	w		j		

In word-internal stop clusters the second consonant must be either coronal or homorganic to the preceding consonant: [pt kt bd gd pː tː pːʰ tːʰ kːʰ] are admissible, while *[tp tk pk kp db dg bg] are not (Steriade 1982, Bubeník 1983:89ff).[204]

(63) Attic Greek stop clusters
    (a) Word-initial Stop Clusters
        [ptyrɔː]   'I scare'
        [ktidzɔː]   'I call into existence'
        [bdeluktos]   'detestable'
        [kʰtʰes]   'yesterday'
        [pʰtʰeːrɔː]   'destroy'
    (b) Word-Medial Stop Clusters
        [piptɔː]   'I fall'   [papːos]   'grandfather'
        [diktuon]   'net'   [pratːɔː]   'to do'
        [hebdomas]   'week'   [apːʰus]   'daddy'
        [ekʰtʰros]   'hateful'   [titːʰos]   'breast'
        [hepʰtʰros]   'boiled'   [bakːʰos]   'Bacchus'

Alternations that show the stop-cluster restrictions in action are given in (64). The data in (a) shows elimination of [tk] clusters through deletion of the first member; (b) and (c) are provided for way of comparison. The annotation (Sxx) refers to page numbers in Steriade (1982).

(64) Attic Greek deletion
    (a) *tk

---

[203] [h] occurred only initially and [ŋ] only before dorsals. There are five short vowels [i y e a o] and accompanying long vowels (see ch.8§8.2 for further discussion).
[204] Obstruent clusters have to agree in voicing and aspiration, hence the absence of [pd kd bt gt pʰt kʰt]. [gd] is only attested medially.

/RED+anut+k+a/	→ [ɛ:nuka]	'I have accomplished' (S217)
/RED+pɛːtʰ+k+a/	→ [pepɛːka]	'I have persuaded' (S217)
/RED+erɛːd+k+a/	→ [ɛːrɛːka]	'I have propped' (S217)

(b) ✓pt

/grap+ton/	→ [grapton]	'written {acc.sg.neut.}'
/heps+to+s/	→ [hepʰtʰos]	'boiled' (S216)
/RED+grapʰ+stʰai/	→ [gegrapʰtʰai]	'to have been written' (S216)

(c) ✓kt

/diɔːk+tɛːn/	→ [diɔːktɛːn]	'persecutor {acc.masc.sg.}'

Several properties of the Attic Greek system set it apart from the cases discussed so far. One is that heterorganic clusters are eliminated through deletion, not assimilation or epenthesis.

The other difference relates to the 'triggering element', a term adopted from Jun (1995:76ff). The triggering element in heterorganicity-avoidance is the rightmost segment in a cluster – or more precisely the one that remains faithful in any anti-heterorganicity process. So, the triggering elements in Catalan are [p t k] since they all induce coronals to assimilate. In contrast, the only triggering elements in Attic Greek are [p k] since these alone cause deletion of a preceding segment. Attic Greek is therefore a 'marked-trigger' system: one in which marked elements alone motivate heterorganicity-avoidance.

7.5.1.2 Analysis

The leading idea behind the following analysis of Attic Greek is that non-coronal+coronal clusters escape deletion because they are already 'adequately unmarked'. This is formally expressed through the constraint *{KPT}{KP}, which bans heterorganic clusters with a non-coronal as the second member: i.e. [kp], [pk], [tp], [tk].

Since the response to heterorganic clusters in Attic Greek is deletion, two rankings are needed. One is that *{KPT}{KP} must outrank MAX (the anti-deletion constraint – McCarthy & Prince 1995), as shown in tableau (65).

(65)

/anut+k+a/	*{KPT}{KP}	MAX
(a) anutka	*!	
☞ (b) anuka		*

The other ranking ensures that deletion takes place rather than assimilation or epenthesis: i.e. ‖ DEP, IDENT{KPT} » MAX ‖. Tableau (66) illustrates this ranking.

(66)

/anut$_1$+k$_2$+a/	*{KPT}{KP}	DEP	IDENT{KPT}	MAX
(a) anut$_1$k$_2$a	*!			
(b) anut$_1$ek$_2$a		*!		
(c) anuk:$_{1,2}$a			*!	
☞ (d) anuk$_2$a				*

A separate issue is why the rightmost consonant of the cluster survives. The constraint σ-CONTIGUITY will be employed here, after Lamontagne & Rice (1995) (for an alternative see Wilson 2000, and McCarthy's 2002b critique). σ-CONTIGUITY requires every segment within a syllable to have contiguous correspondents in the input. So, [a.nu.ka] satisfies σ-CONTIGUITY because /nu/ are contiguous, as are /ka/. However, *[a.nu.ta] violates σ-CONTIGUITY because /t/ and /a/ are not contiguous.

σ-CONTIGUITY can almost be ranked in any position (analogous to the behaviour of onset-IDENT{KPT} in Catalan). At the very least, it must outrank *{K} and *{KP}, otherwise deletion will be sensitive to featural content (cf Wilson 2000).

• *Coronals*

The ranking established above does not eliminate clusters with a rightmost coronal member. Tableau (67) illustrates this point for /dioːk+teːn/, in which the /kt/ cluster surfaces faithfully: [dioːkteːn], *[dioːteːn].

(67)

/dioːk$_1$+t$_2$εːn/	*{KPT}{KP}	DEP	IDENT{KPT}	MAX
☞ (a) dioːk$_1$t$_2$εːn				
(b) dioːt$_2$εːn				*!
(c) dioːt:$_{1,2}$εːn			*!	
(d) dioːk$_1$et$_2$εːn		*!		

This tableau shows the crucial part of this analysis: *{KPT}{KP} does not assign a violation to [kt] clusters. There is no other motivation to avoid non-coronal+coronal clusters (ensured by ranking *{KPT}{KPT}, *{KP}{KPT}, *{K}{KPT} below MAX). So, the faithful candidate (a) wins.

The Attic Greek ranking is summarized in Figure 7.5. The following discussion of alternatives will refer to this ranking. Given that there is no crucial ranking involving σ-CONTIGUITY, it is not mentioned in the diagram.

Figure 7.5: Attic Greek deletion ranking

$$*\{KPT\}\{KP\} \qquad \text{DEP-IO} \qquad \text{IDENT}\{KPT\}$$

$$\text{MAX}$$

$$*\{KPT\}\{KPT\} \qquad *\{KP\}\{KPT\} \qquad *\{K\}\{KPT\}$$
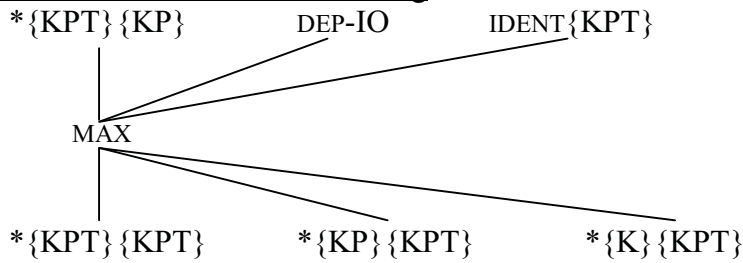
7.5.1.3 Alternatives: Faithfulness and AGREEment

Approaches to Attic Greek that rely on faithfulness constraints to obtain the right results face significant difficulties.

The problem with a faithfulness analysis is that there are no asymmetries in faithfulness in Attic Greek: every segment type can undergo deletion – dorsals delete in /kp/ clusters, labials delete in /pk/ clusters, and coronals delete in /tk/ and /tp/ clusters. So, a faithfulness constraint that preserves labials and/or dorsals will 'over-preserve', preventing deletion in [kp] and [pk] clusters.[205]

Unmarked-faithfulness constraints (like IDENT{T}) also cannot be used to deal with the Attic Greek system. In short, the empirical effects of Marked-Cluster constraints and unmarked-faithfulness constraints are distinct: Marked-Cluster constraints provide a solution to Attic Greek, while unmarked-faithfulness constraints do not.

As a final note, the only type of faithfulness approach that can be used in Attic Greek is one that invokes a context-sensitive faithfulness constraint: specifically, a constraint like MAX/_coronal, which bans deletion before a coronal. A more formal definition is given in (68).

(68) MAX/_coronal "For all *x* such that *x* precedes a coronal in the input, *x* has an output correspondent *x*'."

Similar 'pre-coronal' faithfulness constraints have been proposed in previous work – specifically Jun's (1995:129) IDENT constraints. However, they have undesirable typological effects. A set of faithfulness constraints of the form IDENT/_*x*, where *x* is a set of PoAs (after Jun 1995) effectively preserves PoA in word-medial codas.[206] Their existence in CON therefore predicts a language with more PoA contrasts in codas than in onsets. For example, the ranking || IDENT/_{KPT} » *{K} » onset-IDENT{K}, IDENT{K} ||

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[205] In any case, such an approach would require a MAX constraint. See ch.6 for discussion.

[206] Jun's (1995:129) proposal has two constraints in a fixed ranking: || PRESERVE-Place/_coronal » PRESERVE-Place/_non-coronal ||. If both of these constraints outrank *{KP}, which in turn outranks onset-IDENT-Place, there will be neutralization of non-coronals in onsets but not in codas. While this problem could be resolved by having onset-IDENT[Place] universally outrank the pre-coronal faithfulness constraints, the present theory avoids the need for both this arbitrary fixed ranking and such context-sensitive faithfulness constraints.

will eliminate dorsals in every position except word-medial codas, as shown in tableau (69).

(69)

/kakpa/	IDENT/_{KPT}	*{K}	onset-IDENT{K}	IDENT{K}
(a) kak.pa		* *!		
(b) kaʔ.pa	*!	*		*
☞ (c) ʔak.pa		*	*	*
(d) ʔaʔ.pa	*!		*	* *

The tableau shows that the ranking produces a language with [k] in codas but not in onsets. As observed in ch.6§6.5.2.1 and Beckman (1998), this type of language does not occur.

In short, the failure of dorsals and labials to delete before coronals in Attic Greek must be due to a markedness constraint. As shown above, the markedness constraint necessarily distinguishes between different types of heterorganic cluster, banning all but non-coronal+coronal clusters.

- *Markedness alternatives*
  The contention in this section is that the markedness constraint that triggers deletion in Attic Greek assigns distinct violations to different types of heterorganic cluster. This approach differs from theories that only make distinctions between homorganic and heterorganic clusters.

For example, the constraint AGREE[Place] assigns a violation to all heterorganic clusters (after Lombardi 1995, 1999 and Baković 1999a:4, see Baković & Wilson 2001 for this specific constraint). Thus, AGREE[Place] cannot be used to produce the Attic Greek system (or Korean and Kui, discussed in the following sections). The problem with AGREE[Place] is that it assigns the same violations to [kt] and *[tk]. With a CON that has only AGREE[Place] to regulate heterorganic clusters, the only recourse for Attic Greek is to turn to a faithfulness solution. However, as shown above, such a solution faces serious challenges.

Interestingly, a version of the AGREE theory that distinguishes different PoAs also will not work for Attic Greek, Korean, or Kui. For example, AGREE[dorsal] requires a consonant to agree in PoA with an adjacent dorsal. However, no constraint formulated in this 'symmetric' manner can deal with Attic Greek. The problem can again be illustrated with [kt] and *[tk] clusters. These clusters do not differ as to their lack of PoA agreement. Rather, they differ solely in that the former consists of a dorsal+coronal while the latter has the opposite order. A constraint like AGREE[dorsal], as defined above, will therefore assign both [kt] and *[tk] violations. The only type of markedness constraint that will work for Attic Greek is an 'asymmetric' one – one that treats coronal+dorsal clusters differently from dorsal+coronal ones.

In summary, analyses of Attic Greek that do not appeal to constraints that distinguish between different types of heterorganic cluster face significant challenges that – at least from the perspective of current constraints – seem insurmountable.

7.5.1.4 Relation to other processes and clusters

To round off the analysis of Attic Greek, this section examines the relation of the ranking above to the process of stop deletion. It concludes by discussing cooccurrence restrictions on clusters other than stop+stop ones.

- *Stop deletion*

Stops delete word-finally in Attic Greek, illustrated in (70) (Steriade 1982, Ito 1986:104).

(70)   /onomat/ → [onoma] 'name{nom.sg.}' cf [onomat-os] {gen.sg.}
        /brɔːmat/ → [brɔːma] 'solid food {nom.sg.}' cf [brɔːmat-os] {gen.sg.}
        /gunaik/ → [gunai] 'woman {voc.}' cf [gunaik-a] {acc.sg.}
        /galakt/ → [gala] 'milk {acc.sg.}' cf [galakt-os] {gen.sg.}

Word-final stop deletion is no doubt motivated by a different process than deletion in clusters (cf Ito 1986:104ff). Word-final stop deletion can be motivated by the constraint $*\Delta_\mu \leq$stop, which bans segments with equal or less sonority than a stop as mora DTEs (coda consonants are taken to be moraic here); this constraint is essentially the same as Ito's (1986:105) coda condition for Attic Greek. If $*\Delta_\mu \leq$stop outranks MAX, coda stops will be deleted.

To prevent $*\Delta_\mu \leq$stop from deleting medial stop codas, the constraint I-CONTIG can be employed (McCarthy & Prince 1995); I-CONTIG requires input segments to have contiguous outputs, so banning deletion internal to a string (also see Kenstowicz 1994b). In short, || I-CONTIG » $*\Delta_\mu \leq$stop » MAX ||.

The tableau below illustrates this ranking with the word /paraptɔːmat/ 'a false step' ([paraptɔːma] {nom.sg}, [paraptɔːmatos] {gen.sg.}).

(71)

	/paraptɔːmat/	I-CONTIG	$*\Delta_\mu \leq$stop	MAX
	(a) paraptɔːmat		* *!	
☞	(b) paraptɔːma		*	*
	(c) paratɔːma	*!		* *

The constraint I-CONTIG is violated by (c) because the output substring [at] is not a contiguous string in the input. This leaves candidates (a) and (b); (a) violates $*\Delta_\mu \leq$stop twice because it has two stop codas. So, (b) wins.

To complete the ranking, since medial coda stops are deleted when preceding a non-coronal, *{KPT}{KP} must outrank I-CONTIG. The result is illustrated in the tableau below.

(72)

/anut+k+a/	*{KPT}{KP}	I-CONTIG	*$\Delta_\mu \leq$stop	MAX
(a) anutka	*!		*	
☞ (b) anuka		*		*

- *Other Clusters*

To generalize over the following discussion, only clusters where both members have the same manner of articulation are (non-trivially) subject to the Cluster Condition.

Stop+{fricative, liquid} clusters trivially satisfy the Cluster Condition since all fricatives and liquids are coronals (except for /h/, which only appears word-initially). In [sC] clusters the C may have any PoA: e.g. [spaɔː] 'I draw', [stratos] 'army', [skaptɔː] 'I dig'. The Cluster Condition also does not hold of stop+nasal clusters: the nasal may be either [m] or [n] (excepting [pm] and [b{m,n}]).[207]

(73)   Stop+nasal clusters
[tmɛː:ma] 'slice'   [tʰnɛː:jskɔː] 'I die'
[dmɔːs] 'slave'   [dnopʰos] 'darkness'
[akmɛː:n] 'the point of a weapon'   [knɛː:n] 'scratching'
[praɡma] 'deed'   [haɡnos] 'holy'

In liquid+stop clusters the second consonant may also have any PoA: e.g. [orpʰne] 'darkness', [artʰron] 'joint', [arktos] 'a bear', [elpis] 'hope', [alkaia]. 'tail (esp.of lion)'

While stop+nasal and liquid+stop clusters are rather free in comparison to stop+stop clusters, nasal+obstruent clusters are more restricted: they must be homorganic [mp mb nt nd ŋk ŋɡ]. Notably, heterorganic nasal+coronal clusters are not allowed: *[mt md ŋt ŋd]. The only nasal+nasal cluster is [mn].

In short, the Cluster Condition only holds non-trivially of stop+stop clusters; it demonstrably does not hold of stop+nasal, nasal+stop, and liquid+stop clusters – i.e. any cluster with a sonorant. It also holds of nasal+nasal clusters. In short, the Cluster Condition holds of all clusters that agree in manner of articulation (see Padgett 1991, 1994 for discussion of this point).

The fact that there are differences between stop+stop sequences and other clusters is not surprising given Jun's (1995) survey. Jun showed that certain clusters are more likely to be subject to heterorganicity restrictions than others cross-linguistically. Jun's survey revealed that there is an implicational hierarchy of undergoers in terms of manner.

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[207] I note that word-initial stop+[m] clusters are extremely rare though: unattested for [km ɡm tʰm kʰm], and marginal for [dm tm] (Bubeník 1983:90). On top of that, a number of processes conspire to eliminate stop+[m] clusters (Steriade 1982:252ff), though some of these are limited to specific morphological environments.

Nasals are most likely to assimilate, followed by stops; fricatives and non-nasal sonorants are least likely to assimilate (p.69).

The difference can be dealt with in the present theory by employing separate anti-heterorganic constraints for different manners of articulation. Thus, there can be separate constraints for Stop+Stop sequences, Nasal+Stop clusters, and Liquid+Stop sequences. In Attic Greek, then, *{ŋ,m,n}{k,p,t} rules out all but homorganic nasal+stop clusters, while *{k,p,t}{k,p} deals with stop+stop clusters.

This extension to the theory will not be pursued further here, but merely note that it offers a way to distinguish between the behaviour of different clusters (see Jun 1995, and ch.5 for discussion).

7.5.1.5 Summary

In summary, the account of Attic Greek presented above crucially relies on the fact that a markedness constraint distinguishes different types of heterorganic cluster. Specifically, *{KPT}{KP} only bans heterorganic clusters with a non-coronal second member. The previous sections argued that alternative solutions without such a constraint face significant difficulties.

There are a number of similarities between the present theory and Yip's (1991) Cluster Condition. In effect, Yip's Cluster Condition draws a distinction between lesser-marked heterorganic clusters and more marked ones, just as the Marked-Cluster constraints do.[208] As with the Marked-Cluster constraints, the Cluster Condition has a potentially symmetric effect: it allows coronal+C or C+coronal heterorganic clusters to be the least marked type in a particular grammar, depending on other conditions in the language (i.e. Attic Greek cf SLP Creole).

One of the major differences between the Cluster Condition and the present theory is that the Marked-Cluster constraints distinguish several different degrees of heterorganic-cluster markedness, with coronal+C/C+coronal clusters simply the least marked. The next section shows that this difference is warranted: C+dorsal clusters are also distinct from all other types (also cf Chukchi and Harar Oromo, which treat dorsal+non-dorsal clusters as more marked than all other types).[209]

As a concluding note, the Attic Greek cluster restriction is found in a number of Indo-European languages (Yip 1991). For a recent discussion relating to its activity in English, see Lamontagne (1993).

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[208] Yip (1990:64) accounts for asymmetries in Attic Greek (i.e. *[tk] vs [kt]) by requiring the leftmost consonant to contain the marked (i.e. labial or dorsal) PoA. Thus, the Cluster Condition does not necessarily have a symmetric effect – i.e. it does not necessarily ban both non-coronal+C and C+non-coronal clusters in a language.

[209] The similarities between the present theory and the Cluster Condition mean that Jun's (1995:22) criticism of the Cluster Condition applies equally to the present theory. Jun points out that Yip's condition allows for a language with (1) homorganic clusters, (2) coronal+C clusters, and (3) C+coronal clusters; the only clusters banned would therefore be [kp pk]. The present theory predicts the same: || *{KP}{KP} » IDENT{KPT} ||. Jun observes that such a system is unknown. However, one possibility is Lamani (Trail 1970), which allows [pt], [kt], and [tk] codas (there is no mention of [tp]). I do not consider such a system to be impossible, just likely to be rare.

7.5.2 Korean: Assimilation to the marked

The aim of this section and §7.5.3 is to show that the typological predictions of the Marked-Cluster constraints are borne out. This is not only of typological interest; it will prove to be significant in distinguishing the Marked-Cluster theory from alternative theories proposed by Baković (1999a,b) and McCarthy (2002a).

Attic Greek shows the need for the constraint *{KPT}{KP}, in which only dorsals and labials trigger heterorganicity avoidance. Another relevant constraint in the present theory is *{KPT}{K}; this constraint can produce a system in which only dorsals trigger assimilation. Korean provides a relevant case, though with additional interesting complexities.

7.5.2.1 Description

Table 7.10 lists consonant contrasts found in Korean (Cho 1999:83, see Ahn 1998:37 for a full list of allophones).

Table 7.10: Korean consonants

		labial	coronal		dorsal	glottal
stops	plain	p	t	tʃ	k	
	aspirated	pʰ	tʰ	tʃʰ	kʰ	
	tense	p'	t'	tʃ'	k'	
fricatives			s s'			h
nasals		m	n		ŋ	
liquid			l			

Certain consonants in syllable codas undergo assimilation. Diagram (74) summarizes the assimilation pattern.

(74)   Korean coda assimilation (summary)

Input	Output	Assimilation?
/K + P/	→ [KP]	✗
/K + T/	→ [KT]	✗
/P + K/	→ [KK]	✓
/P + T/	→ [PT]	✗
/T + K/	→ [KK]	✓
/T + P/	→ [PP]	✓

To point out the generalizations in this pattern, labials assimilate to dorsals, but labials do not assimilate to coronals (Kim 1973, Kim-Renaud 1974, 1986, Iverson & Kim 1987, Jun 1995, Ahn 1998, Cho 1988, 1999).

(75)   Korean labial assimilation
        (a) /{p, m}/ + dorsal = assimilation
                /əp+ko/   → [əkko]   'bear on the back + conj.'
                /əp+ko/   → [əkko]   'bear on the back + conj.'
                /ip+ko/   → [ikko]   'wear and'
                /tʃip + kaps/   → [tʃikkap]   'price of a house' (Ahn 100)
                /kamki/   → [kaŋki]   'a cold/influenza'
                /namkɨk/   → [naŋkɨk]   'the South Pole'
        (b) /{p, m}/ + coronal = no assimilation
                /ip+ta/   → [ipta]   'wear+SE'
                /nap+nita/   → [namnita]   'sprout'
                /tʃip+to/   → [tʃipto]   'house as well' (Ahn 100)
                /sum+ta/   → [sumta]   'hide+SE'
                /kim + tʃʰi/   → [kimtʃʰi]   'kimchee' (Ahn 100)

        Dorsals in Korean do not assimilate at all.

(76)   dorsals + non-assimilation
        /tʃak + pʰa/   →   [tʃakpʰa]   'destruction'
        /kuk + pap/   →   [kukpap]   'rice in soup'   (Ahn 100)
        /ik + ta/   →   [ikta]   'ripe + SE'
        /kak + tʃa/   →   [kaktʃ'a]   'each'
        /kuk + mul/   →   [kuŋmul]   'soup + water'
        /paŋ + pota/   →   [paŋpota]   '(more) than room'
        /kaŋ + pota/   →   [kaŋpota]   'river + rather than'
        /paŋ + to/   →   [paŋto]   'room as well'   (Ahn 100)
        /kaŋ + mul/   →   [kaŋmul]   'river water'   (Ahn 100)

        In contrast, coronals assimilate to every PoA, not just to dorsals (Cho 1999:85ff;
Jun 1995:51-2, Ahn 1998:99ff).

(77)   Korean coronal (alveolars, alveo-palatals) assimilation
      (a)   /t,tʃ,n/ + labial → *assimilation*[210]

/kot + palo/	→ [koppalo]	'straight'	
/patʰ + pota/	→ [pappota]	'rather than field'	(Ahn 100)
/natʃ + pota/	→ [nappota]	'rather than daytime'	(Ahn 100)
/an + paŋ/	→ [ampaŋ]	'inner room'	
/sin + pal/	→ [simpal]	'shoes'	(Ahn 100)
/tʃinan+pam/	→ [tʃinampam]	'last night'	
/han + bən/	→ [hambən]	'once'	

      (b)   /t,tʃ,n/ + dorsal → *assimilation*

/pat + ko/	→ [pakko]	'receive and'	
/tat + ki/	→ [takki]	'closing'	(Ahn 100)
/tɨt + ko/	→ [tɨkko]	'hear and'	
/mit + ko/	→ [mikko]	'believe and'	
/kotʃ + kam/	→ [kokkam]	'dried persimmon'	(Ahn 100)
/han + kaŋ/	→ [haŋkaŋ]	'the Han river'	
/ton + kanpaŋ/	→ [toŋkapaŋ]	'money bag'	(Ahn 100)

7.5.2.2 Analysis

The following analysis pursues the idea that Korean is similar to Catalan. Thus, coronals undergo assimilation while (generally) non-coronals do not. The complexity is that dorsals trigger assimilation regardless of the preceding consonant.

Like Catalan, coronals undergo assimilation while labials and dorsals (generally) do not because the marked-faithfulness constraint IDENT{KP} preserves labials and dorsals. Tableau (78) shows that coronals undergo assimilation, while tableau (79) shows that labials and dorsals do not. These tableaux will not be discussed further here because the same ranking has been discussed in previous sections.

(78)   Coronal Undergoer

/an + paŋ/	IDENT{KP}	*{KPT}{KPT}	IDENT{KPT}
(a) anpaŋ		*!	
☞ (b) ampaŋ			*

(79)   Labial and Dorsals ≠ Undergoers

/sum + ta/	IDENT{KP}	*{KPT}{KPT}	IDENT{KPT}
☞ (a) sumta		*	
(b) sunta	*!		*

---

[210] There is also minor PoA assimilation: /kot + tʃo/→ [kotʃːo] 'let's uncover' (Ahn 1998:100). [tʃ] is a coronal here (cf true palatals, which are dorso-coronals [c] – cf §7.2).

- *Dorsals as triggers*

The next step is to explain why labials assimilate to dorsals, but dorsals do not assimilate to labials (or any other consonant). The ranking above does not account for this pattern: it predicts that /kam-ki/ should surface as *[kamki], due to IDENT{KP}.

The idea presented here is that dorsals trigger assimilation regardless of the preceding PoA. The constraint *{KPT}{K} requires assimilation to dorsals. With *{KPT}{K} outranking IDENT{KP}, labials will assimilate to dorsal PoA.

(80)   Labial + Dorsal

	/kamki/	*{KPT}{K}	IDENT{KP}	*{KPT}{KPT}	IDENT{KPT}
	(a) kamki	*!		*	
☞	(b) kaŋki		*		*

The labial /m/ assimilates to dorsal PoA in the tableau above because *{KPT}K compels assimilation to dorsals. However, labials do not assimilate to every PoA in this ranking; *{KPT}{K} does not compel assimilation to coronals, so labials will remain faithful in this environment.

(81)   Labial + Coronal

	/sumta/	*{KPT}{K}	IDENT{KP}	*{KPT}{KPT}	IDENT{KPT}
☞	(a) sumta			*	
	(b) sunta		*!		*

In short, the Korean ranking can be seen as a combination of the Attic Greek and Catalan rankings. Like Attic Greek, it is selective about triggers: only dorsals trigger assimilation in all environments. Like Catalan, it is selective about undergoers: only coronals assimilate in every situation.

Figure 7.6: Korean assimilation ranking

```
          *{KPT}{K}
              |
          IDENT{KP}
              |
  *{KPT}{KPT}, *{KPT}{KP}
              |
          IDENT{KPT}
```
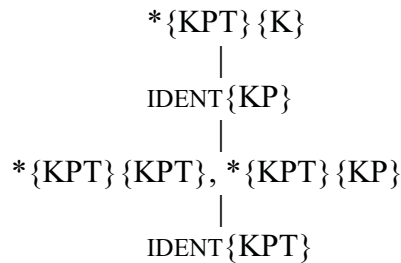
In short, the present theory's prediction of a system with dorsal triggers is borne out in Korean.

7.5.3 Metathesis, triggers, and undergoers

To complete the typology, a remaining type of system is one that has limits on both triggers and undergoers: essentially a combination of Attic Greek for triggers and Chukchi for undergoers. This type of system is revealed in a remarkable way in Kui, a Dravidian language (Winfield 1928, 1929; Hume 1997, 1998, 2001). Kui has a process of metathesis that reverses the order of dorsal-labial stop clusters: /kp/→[pk]. The process can be clearly seen in the second and fourth conjugations of verbs. The examples below are from the second conjugation, showing the combination of a C-final root with the future /i/, past tense /te/, the present participle /pi/, and the infinitive /pa/. The examples below are taken from Winfield (1928, 1929) and Hume (1997); the description and analysis given here owes much to Hume (1997).

(82)   Kui metathesis (Winfield 1928, 1929; Hume 1997, 2001)

Root	Fut. /i/	Past /te/	Part. /pi/	Infinitive /pa/	Gloss
/bluk/	bluki	blukte	blupki	blupka	fall
/kok/	koki	kokte	kopki	kopka	sit down
/mlik/	mliki	mlikte	mlipki	mlipka	turn over
/poːk/	poːki	poːkte	poːpki	poːpka	announce
/lek/	leki	lekte	lepki	lepka	break
/aɡ/	aɡde	aɡde	abɡi	abɡa	be fitting
/noɡ/	noɡde	noɡde	nobɡi	nobɡa	wash
/ɡeɡ/	ɡeɡde	ɡeɡde	ɡebɡi	ɡebɡa	associate with
/saːp/	saːpi	saːpte	saːppi	saːppa	kill
/lup/				luppa	extinguish
/uʈ/	uʈi	uʈte	uʈpi	uʈpa	give to drink
/ɡas/	ɡasi	ɡaste	ɡaspi	ɡaspa	hang oneself
/kos/				kospa	beat
/mil/	mili	milte	milpi	milpa	turn over
/maɻ/				maɻpa	bind up load

To complete the table above, /coronal + dorsal/ clusters do not undergo metathesis, as shown by the combination of root+/ka/ 'plural': [ut-ka] 'kneel+pl', [uʈ-ka] 'accuse+pl.', [ruːs-ka] 'crush+pl.', [maːr-ka] 'give birth+pl'.

From the forms with the suffix /-te/, it is clear that there is no general ban on coda /k/. Instead, as Hume (1997) argues, the ban specifically targets [dorsal+labial] clusters.[211] In the present theory, such a ban comes about through the constraint *{K}{KP}. This constraint targets dorsal+labial clusters without banning any other sequence: i.e. labial+dorsal, dorsal+coronal, coronal+labial, coronal+dorsal.

After Hume (1997), the constraint *{K}{KP} must outrank the metathesis-banning constraint LINEARITY (McCarthy & Prince 1995).

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[211] While Hume's constraint against labial+dorsal clusters is superficially similar to the one proposed here, it is motivated on entirely different grounds. See Hume (1997, 1998, 2001) for discussion.

(83)   LINEARITY   If *x* precedes *y*, then *y*' does not precede *x*'.

The interaction of the constraints is illustrated in tableau (84).

(84)   <u>Metathesis in Kui</u>

/kok-pa/	*{K}{KP}	LINEARITY
(a) kokpa	*!	
☞ (b) kopka		*

Crucially, *{K}{KP} targets dorsal+labial sequences alone. It does not ban labial+dorsal clusters, otherwise (b) would be equally as harmonic as (a) (compare to *{KP}{KP}). Similarly, it does not target any cluster consisting of a coronal. All such clusters emerge faithfully, showing that LINEARITY outranks all other cluster constraints:

(85)   <u>No Metathesis of coronals</u>

/kok-te/	*{K}{KP}	LINEARITY	*{K}{KPT}
☞ (a) kokte			*
(b) kotke		*!	

To complete the ranking picture, since metathesis is preferred over deletion or epenthesis, MAX and DEP must also outrank LINEARITY.

In effect, Kui is a combination of Attic Greek in terms of triggers and Chukchi in terms of undergoers. Like Inuktitut, only dorsals are undergoers: only [{k,g}C] clusters are banned; and like Attic Greek only dorsals and labials are triggers: i.e. only [{k,g}p] is banned, [{k,g}t] is admissible.

To summarize, Kui represents a language which exhibits restrictions on both undergoers and triggers. As a parting note, a system of metathesis identical to Kui's is found in Mokilese (Harrison 1976, Hume 1997:13).

7.5.4   Theoretical implications

The existence of the Attic Greek, Korean, and Kui systems provides support for the proposal that heterorganic clusters differ in markedness, formally expressed by the Marked-Cluster constraints. The systems provide support, albeit slightly indirect, for the analyses of SLP Creole, Chukchi, and Harar Oromo in §7.4.

The argument presented in §7.4 was that marked-undergoer systems are not produced through the action of faithfulness constraints – specifically faithfulness constraints that preserve unmarked elements. Instead, they fall out from the proposal that different types of heterorganic cluster differ in markedness.

Attic Greek, Korean, and Kui provide support for this claim: in these systems, certain heterorganic sequences are less harmonic than others. Moreover, these systems were shown to not be amenable to any analysis except for one that employs a markedness constraint that distinguishes certain types of heterorganic cluster from others. Thus, the

systems provide independent support for the principle behind the Marked-Cluster constraints.

- *Typology*
  Table 7.11 summarizes the typological findings of this section.

Table 7.11: Typology of triggering elements

K	P	T	Language	Section
✓			Korean, Kui	§7.5.2, §7.5.4
✓	✓		Attic Greek	§7.5.1
✓	✓	✓	Catalan	§7.2

The table expresses the claim that there is an implicational relationship between triggers (Mohanan 1993). In general terms, if coronals trigger heterorganicity-avoidance in a language, so will the more marked labials and dorsals. If labials are triggers, dorsals are sure to be so, but coronals may not (e.g. Attic Greek). If dorsals are triggers, then labials and coronals may not be (e.g. Korean, Kui).

To be more precise, the implicational relations relate specifically to the element that undergoes assimilation. Recall that the present theory does *not* predict that if x forces y to assimilate x will also force every other segment to assimilate. For example, dorsals force preceding labials to assimilate in SLP Creole (/amka/ → [aŋka]), but dorsals do not force preceding coronals to assimilate (/anka/ → [anka], *[aŋka]). Therefore, assimilation-triggering can only be discussed in relation to particular preceding elements. Generalization (86) states the Triggering Implication more carefully.

(86) *The Trigger Implication*
       If x triggers assimilation of y, then
       for all z s.t. z is more marked than x,
       z triggers assimilation of y.

So, if /amta/ → [anta], then /amka/ → [aŋka]. However, if /amta/→[anta], then it is not necessarily the case that /anta/ → [anta]. Moreover, if /amka/ → [aŋka], it is not necessarily the case that /amta/ → [anta].

I have found no language in which the generalizations just stated are false.[212] For example, there is no language that is the mirror image of Attic Greek in terms of triggers,

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[212] Nasal PoA assimilation in some dialects of English (e.g. Received Pronunciation) behaves in a way that on the surface suggests that labials trigger assimilation while dorsals do not: e.g. /ɪn-pɒsɪbl/ → [ɪmpɒsɪbl] 'impossible', cf /ɪn-kəmplit/ → [ɪnkəmplit], *[ɪŋkəmplit] 'incomplete'. However, I suggest that this case reduces to the fact that dorsal nasals are banned in prefixes (for relevant discussion about the behaviour and featural content of English [ŋ], see McCarthy 2001a; see Oostendorp 1999 for related comments on Dutch; further complexities relate to English *con-* and its realization under stress, which I put aside here). Under this view, the failure of /n/ to assimilate to [k] is due to structure-preservation: doing so would create a segment that is not otherwise permitted. Notably, there is no ban on [ŋ] in roots; this explains why there are no *[nk ng] clusters in roots: structure-preservation does not block input /nk ng/ from assimilating outside prefixes. My thanks to John McCarthy and Joe Pater for discussing this case with me.

where /akta/ → [ata] and /apta/ → [ata], but all other clusters surface faithfully ([kp pk tp tk]).

The typology in Table 7.11 is supported by child language. Pater (1997) and Pater & Werle (2001) identify a number of cases where dorsals trigger assimilation (or more precisely, consonant harmony) in child speech. In these systems, only dorsals trigger assimilation, not labials or coronals. In contrast, there are no reports of systems in which only labials trigger consonant harmony (Joe Pater p.c.). This fits in exactly with the typology above.

This typological generalization falls out from the form of the Marked-Cluster constraints. If *x* is a trigger in a grammar, then a Marked-Cluster constraint that mentions *x* as its rightmost member is active. However, if *x* is mentioned, then all more marked elements are also mentioned. For example, *{KPT}{KP} mentions labials as one of its rightmost members, so it also mentions the more marked dorsals. There is no Cluster-Markedness constraint that mentions labials in this way without also mentioning dorsals (i.e. no *{KPT}{P}). This asymmetry implements the hierarchy of triggers. If *x* triggers heterorganicity avoidance involving a preceding segment *y*, then all elements that have more marked PoA specifications than *x* will also trigger heterorganicity-avoidance involving *y*.

As a final comment on the typology, glottals as triggers are not mentioned in the table above because they are rarely in a position to trigger assimilation. However, they can do so, as shown in Yamphu. In Yamphu, stops assimilate to /ʔ/ and /h/. Before /h/, stops are realized as [ʔ]: /mo-dok-ha/ → [modoʔha] 'like those', /læːt-he-ma/ → [læːʔhema] 'to be able to do' (Rutgers 1998:48). [ʔh] clusters optionally simplify to [ʔ]. Before /ʔ/, stops are also banned; a /stop+ʔ/ cluster emerges as a single glottal stop [ʔ], presumably because geminate [ʔː] is banned: e.g. /læːt-ʔa-ma/ → [læːʔama] 'to go and do', /kʰik-ʔiʔi/ → [kʰiʔiʔi] 'it's bitter'. The fact that glottals trigger assimilation shows that an assimilation constraint that mentions glottals is necessary: i.e. *{KPT}{KPTʔ}.

7.6   Neutralization and cluster markedness

The aim of this section is to show that the Marked-Cluster constraints are needed for reasons that are entirely independent of the ones given in §7.4. The empirical focus here is cases with neutralization medially but not finally. As a reminder, the term 'neutralization' is used as in ch.6: it refers to non-assimilative, non-dissimilative neutralizations – i.e. those feature changes that are not influenced by nearby segments. This section argues that such cases show the need for constraints that (i) refer to heterorganic clusters and (ii) distinguish between types of heterorganic clusters. More directly, this section shows that the constraint used in the analysis of SLP Creole – *{KP}{KPT} – is needed to explain certain neutralization patterns.

The point of showing that Marked-Cluster constraints exist is to demonstrate that the unmarked-faithfulness analysis of SLP Creole is redundant, so showing that a theory with only marked-faithfulness constraints is empirically adequate.

Section 7.6.1 discusses medial neutralization in Kiowa. In this language, medial codas debuccalize while final ones do not. This section argues that an adequate analysis of this system requires Marked-Cluster constraints.

To provide support for the argument made in §7.6.1, a typology of the relation between final neutralization and medial assimilation and neutralization is presented in §7.6.2.

7.6.1 Medial neutralization in Kiowa

This section focuses on PoA neutralization in medial codas in Kiowa (Watkins 1984). Section 7.6.1.1 describes the relevant facts. Section 7.6.1.2 presents an analysis that makes crucial use of the constraint marked-cluster constraint *{KPT}{KPT?}.

7.6.1.1 Description

Kiowa has the consonants listed in Table 7.12 (Watkins 1984:7).

Table 7.12: Kiowa consonants

		labial	coronal	palatal	dorsal	glottal
stops	-vd	p	t	c	k	ʔ
	ejective	p'	t'	c'	k'	
	aspirated	pʰ	tʰ		kʰ	
	+vd	b	d		g	
fricatives			s			h
			z			
nasals		m	n			
laterals			l			
glides				j		

Syllables have the shape (C)V(:)(C). Dorsals are only found in onsets.

Codas can contain the sonorants [m n l j] and voiceless stops. Exactly which voiceless stops are permitted depends on the speech style. In both careful and casual speech, the singletons [p t ʔ] are permitted in word-final codas. In word-medial codas, though, there is a difference in register: while [p t ʔ] are allowed in careful speech, only [ʔ] is allowed the casual register.

(87)   Kiowa coda stops
          (a) Word-final codas
               [sep] 'descend, sew' (p.8)   [set] 'bear' (p.8)
               [tap] 'deer' (p.12)   [kɔbɔt] 'bullboat' (p.21)
               [tʰɔ̃cep] 'flood' (p.21)   [t'opʰot] 'shade, breeze' (p.21)
               [kitʰap] 'dried meat' (p.23)   [pʰikut] 'design' (p.21)
          (b) Medial codas

Careful	*Casual*	
[tʰopkjæj]	[tʰoʔkjæj]	'pierce through'
[tʰɔpkɔ]	[tʰɔʔkɔ]	'shoot {neg}'
[t'atkjɛ]	[t'aʔkjɛ]	'sever {sg.detr.}'
[batpɔ]	[baʔpɔ]	'eat {imp.2sg}'

To summarize, PoA neutralizes to [ʔ] only in medial codas in casual Kiowa speech; word-final codas do not neutralize. [213]

There is good evidence that word-final consonants are codas, and not extra-prosodic or onsets to degenerate syllables. One reason relates to shortening of long vowels in closed syllables: e.g. [tʰɔː] 'beyond' cf [tʰɔ-p] 'away beyond', [tʰɔː-dekʰi] 'next day'. As is clear from [tʰɔ-p], word-final consonants induce shortening, showing that they are part of the final syllable.

Apart from the specific PoA neutralization discussed above, medial codas and final consonants act in exactly the same way. Both positions ban dorsals, for example. Similarly, both word-final and medial codas undergo voice neutralization /caːd/→[caːt] 'doorway', cf [caːdɔ] 'doorway at'.

Thus, the difference between medial and final codas cannot be ascribed to a difference in prosodic structure (for further reasons, see §7.6.2).

7.6.1.2 Analysis

The following analysis treats the Casual Kiowa neutralization pattern as being similar in kind to SLP Creole's. There is a ban on marked heterorganic clusters: [pk tk tp pt]. The difference in Kiowa is that this language employs neutralization to resolve the problem rather than assimilation, deletion, epenthesis, or metathesis. By converting the coda into a [ʔ], the medial cluster becomes adequately unmarked: [ʔC] clusters are the least marked type of heterorganic cluster in the present theory.

- *General neutralization: eliminating dorsal codas*

Dorsals are banned in both medial and final codas in Kiowa. Coda neutralization comes about through two rankings, as shown in detail in chapter 6, following Beckman (1998) and Lombardi (1999). One ranking has a context-free markedness constraint – *{K} in this case – outrank all relevant faithfulness constraints: IDENT{KPTʔ}, IDENT{KPT}, IDENT{KP}, IDENT{K}. This will ensure that dorsals neutralize. To prevent them from being eliminated in onsets, an onset-specific faithfulness constraint must outrank *{K}. The ranking is illustrated in tableau (88).

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[213] The examples cited only contain underlying stop+stop clusters. Nevertheless, Watkins (1984:15) clearly states that "glottal stop also alternates predictably with syllable-final stops /p,t/ preceding another consonant."

(88)

/kik/	onset-IDENT{K}	*{K}	IDENT{K}
☞ (a) kiʔ		*	*
(b) kik		* *!	
(c) ʔiʔ	*!		* *

For further discussion of this type of analysis, see ch.6.

- *Medial neutralization only: Marked-Cluster constraints*

Neutralization of medial codas in the Casual register is quite different from dorsal neutralization in a formal sense. The ranking used for dorsal neutralization cannot be used for medial PoA neutralization. If the context-free constraint *{KPT} was used to motivate labial and coronal neutralization, it would incorrectly predict that these contrasts should be eliminated in final codas as well. In short, the ranking with the context-free constraint can only produce neutralization in all codas.

The Marked-Cluster constraints provide a solution to this problem. The constraint *{KPT}{KPTʔ} militates against all medial clusters consisting of a non-glottal followed by another consonant. With *{KPT}{KPTʔ} outranking IDENT{KPT}, medial coda consonants can neutralize, as shown in tableau (89).

(89)

/batpɔ/	*{KPT}{KPTʔ}	IDENT{KPT}
(a) batpɔ	*!	
☞ (b) baʔpɔ		*

This analysis formally expresses the idea that medial neutralization in Casual Kiowa is really a method of avoiding marked heterorganic clusters. By neutralizing codas to [ʔ], medial clusters become the least marked type possible. All other clusters are relatively more marked.

- *The competition*

An important competing candidate for [baʔpɔ] is *[bapːɔ], with a fully assimilated coda. Since *{KPT}{KPTʔ} does not ban homorganic clusters, it does not eliminate *[bapːɔ]. In other words, some other constraint must favour [baʔpɔ] over *[bapːɔ]. The deciding constraint is UNIFORMITY, a constraint that bans coalescence (McCarthy & Prince 1995, see ch.8 for discussion). By fully assimilating into a geminate, the two underlying root nodes /tp/ coalesce into a single one.[214] So, UNIFORMITY will favour [baʔpːɔ] over *[bapːɔ]. Tableau (90) illustrates this ranking.

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[214] This analysis relies on the proposal that geminates have a single root node. Nevertheless, Selkirk's (1991) two-root theory of geminates can be accommodated here: instead of violating UNIFORMITY, two-root geminates would violate the OCP, which bans adjacent identical elements (Goldsmith 1976).

(90)

/bat₁p₂ɔ/	*{KPT}{KPTʔ}	UNIFORMITY	IDENT{KPT}
(a) bat₁p₂ɔ	*!		
☞ (b) baʔ₁p₂ɔ			*
(c) bapː₁,₂ɔ		*!	

So, it is crucial that UNIFORMITY outrank all Marked-Cluster constraints that ban glottal+non-glottal clusters: i.e. *{KPTʔ}{KPTʔ}. The opposite ranking would favour *[bapːɔ] over [baʔpɔ]. UNIFORMITY is essential because the Marked-Cluster constraints do not ban homorganic clusters. So, *[bapːɔ] cannot be ruled out by a Marked-Cluster constraint, or perhaps any markedness constraint in CON that would also rule out [baʔpɔ]. Furthermore, the Marked-Cluster constraint *{KPTʔ}{KPTʔ} must be ranked below UNIFORMITY in Kiowa as this constraint favours [pː] over [ʔp].

In short, UNIFORMITY plays a crucial role in ensuring that [ʔp] is the result of medial neutralization and not *[pː]. Section 7.6.1.3 will return to this point, using it to account for the lack of "medial neutralization without final neutralization" cases generally.

As a final note, UNIFORMITY does not eliminate underlying geminates, as in /etːɔ/ → [etːɔ] 'big {sg. inv.}' (p.13). The faithfulness constraint UNIFORMITY only militates against geminate-formation, so allowing underlying geminates to be preserved faithfully.

- *Medial clusters*

It is essential that the markedness constraint that motivates medial neutralization in Kiowa favours unmarked heterorganic clusters [ʔC] over marked ones [pC tC] otherwise there would be no medial neutralization at all.

For example, the input /tʰɔpkɔ/ would surface as *[tʰɔkːɔ] with a constraint like AGREE[Place], not [tʰɔʔkɔ]. The following tableau illustrates this point; the constraint AGREE[Place] is violated by all heterorganic sequences equally (after Lombardi 1995, 1999).

(91)

/tʰɔpkɔ/	AGREE[Place]	IDENT{KPTʔ}
(a) tʰɔpkɔ	*!	
(b) tʰɔʔkɔ	*!	*
●※ (c) tʰɔkːɔ		*

The tableau above shows that without a constraint that favours [ʔk] over [pk], [tʰɔʔkɔ] could never win: both *[tʰɔpkɔ] and *[tʰɔkːɔ] are harmonic bounds for [tʰɔʔkɔ]. Even if a constraint that ruled out *[tʰɔkːɔ] were introduced, it would still be impossible to rule out *[tʰɔpkɔ] without appealing to a markedness constraint that favoured [ʔk] over [pk].

- *Alternatives*

The Casual Kiowa system shows why assimilation cannot be motivated by constraints that ban independent PoA in codas (Ito 1986). A ban on independent PoA specifications in codas could motivate assimilation in Kiowa, but it incorrectly predicts that neutralization should also take place in final codas. In contrast, the Marked-Cluster constraints can be used to apply specifically to medial clusters, accounting for the lack of an implicational relation between the two positions.

As a final note, a positional-faithfulness constraint cannot be invoked to preserve word-final codas. Word-final position is not prominent – it is not always stressed (Watkins, p.38). Stress placement depends on a variety of factors, including moraic content and tone. Of present interest is that codas debuccalize in [kʰópdɔ]~[kʰóʔdɔ] even though it is in a stressed syllable (compare [batpɔ́]~[baʔpɔ́]).

Secondly, a constraint that specifically preserves word-final codas would have adverse typological effects: it would allow a language that has neutralization of voice distinctions medially but not finally – §7.6.2 shows that such a system is unattested.

In short, medial neutralization in Casual Kiowa requires a markedness constraint that favours unmarked clusters over marked ones – i.e. *{KPT}{KPTʔ}.

- *Typology*

As a comment on the typological applicability of this proposal, another system of medial PoA neutralization without final neutralization is found in Menomini (Bloomfield 1962, Yip 1991:64ff). Menomini has the obstruents [p t tʃ k ʔ s h]. All the consonants can appear in onsets and word-final codas (e.g. [napoːp] 'broth', [apetʃ] 'to that degree', [mɛʔtek] 'tree'). However, only the coronals [tʃ s] and glottals [ʔ h] appear as the first member of clusters, both medially and finally: [mɛʔtek] 'tree', [koːʔtʃ] 'fearing to', [namɛːʔs] 'fish'.

Menomini is like Kiowa: it bans marked clusters. The only difference is that it employs the constraint *{KP}{KPTʔ} rather than *{KPT}{KPTʔ}; this allows coronal+non-coronal [tʃ+C] and [s+C] clusters to survive.

- *Summary*

To summarize, Kiowa provides support for two proposals embodied in the Marked-Cluster constraints. One is that assimilation is driven by constraints on heterorganic clusters rather than by a ban on independent PoA in codas (cf Ito 1986). Kiowa provides evidence for this by having medial neutralization without final neutralization.

The other point made by Kiowa is that some heterorganic clusters are more marked than others. Specifically, [ʔ]+C heterorganic clusters are the least marked of all, so allowing other heterorganic clusters to neutralize to them, as in /batpɔ/→[baʔpɔ]. The proposal that [ʔ]+C heterorganic clusters are the least marked type is also supported by the facts of Kagoshima Japanese: Kaneko & Kawahara (2002) report that the only stop codas allowed in this language are either homorganic to a following consonant or [ʔ]: e.g. [kiʔne] 'fox', [maʔnoʔ] 'pine tree', [nanːa] 'tear', [natːa] 'became', [ʃinzo] 'heart'. Like Casual Kiowa, the only heterorganic clusters permitted are [ʔ]+C ones

7.6.1.3 Conditions on medial neutralization

As pointed out in the analysis of Kiowa above, the Marked-Cluster constraint *{KPT}{KPTʔ} does not rule out a candidate with a homorganic cluster: i.e. from /batpɔ/, *[bapːɔ]. In fact, if the choice was left up to the Marked-Cluster constraints, *[bapːɔ] would win: it beats [baʔpɔ] in terms of *{KPTʔ}{KPTʔ}, and no Marked-Cluster constraint favours [ʔC] over [pː]. In fact, *[bapːɔ] only loses in Kiowa because its creation results in an incidental faithfulness violation – of UNIFORMITY. Thus, neutralization only comes about 'incidentally'.

In other words, UNIFORMITY is crucial in producing medial neutralization rather than medial assimilation. If UNIFORMITY did not block geminate formation, the result would have been /batpɔ/ → [bapːɔ].

This analysis makes significant implications for cases where the competing candidate is not a geminate. For example, is it possible for the input /mk/ to be avoided by neutralization to [nk] rather than assimilation [ŋk]? Unlike gemination, [ŋk] does not violate any faithfulness constraints that [nk] does not also violate – both violate IDENT{KP(T)}. Most significantly, [ŋk] does not violate UNIFORMITY: this constraint is only violated when segments coalesce, not when they assimilate. Because [ŋk] does not fare worse than [nk] on faithfulness and the homorganic [ŋk] fares better on the Marked-Cluster constraints than the heterorganic [nk], [ŋk] will always win. In other words, medial codas alone cannot neutralize if an assimilation alternative is not blocked for faithfulness reasons. So, there should be no language in which nasals neutralize to [n] before stops medially, while no neutralization happens finally.

Medial voice neutralization without final neutralization

To put this point in more concrete terms, Wetzels & Mascaró (2001) have observed that there is no language that has medial voice neutralization without also having neutralization finally. For example, in no language does underlying /abdab/ surface as ☠[apdab].

The reason such a system is impossible relates to the immediately preceding discussion. The Cluster constraints provide no way to eliminate sequences that agree in a feature: no Cluster-Voicing constraint of the ones given in (60) (§7.4.4) bans clusters that agree in voicing. So, there is no motivation for /abdab/ to change to ☠[apdab] because its faithful competitor [abdab] will not violate any cluster markedness constraints. Moreover, [abdab] will fare better on faithfulness constraints than ☠[apdab]. In short, the only way that such a system could be produced in the present theory is if there was some independent constraint that banned clusters that agreed in [+voice].

A typology of the relation between medial and final processes is discussed in §7.6.2.

• *Theoretical implications*

The points just made have significant theoretical implications for the analysis of Kiowa. They show that the Casual Kiowa neutralization pattern cannot be produced by invoking a faithfulness constraint that targets word-final codas. If there were a constraint

_#IDENT{KPT}, preserving PoA in word-final position, a system with medial neutralization but no final neutralization would be straightforward to generate: || _#IDENT{KPT}, onset-IDENT{KPT} » *{KPT} » IDENT{KPT} ||.

However, the word-final faithfulness approach makes different predictions from the Marked-Cluster theory. The Marked-Cluster constraints can be used to produce medial neutralization without final neutralization, but only if the competing homorganic candidate is ruled out for some incidental reason (e.g. faithfulness in Kiowa). This makes it perhaps impossible to produce a system in which /mk/ neutralizes to [nk] medially but not finally, since the competing form [ŋk] violates fewer markedness constraints overall and violates the same faithfulness constraints (i.e. from input /mk/, [ŋk] is a harmonic bound for [nk]).

In contrast, the word-final faithfulness approach predicts that no special conditions need to obtain to produce medial neutralization alone. It is an easy matter to produce the /mk/→[nk] pattern.

Moreover, if word-final faithfulness can apply to every feature, it incorrectly predicts a pattern in which only word-medial codas neutralize: || _#IDENT{+voice}, onset-IDENT{+voice} » *{+voice} » IDENT{+voice} ||.

In short, the typology of systems with medial neutralization and no final neutralization shows that a faithfulness approach makes broader predictions than are warranted. In contrast, the Marked-Cluster theory produces the right results, allowing for a restricted type of medial-only neutralization for PoA, and none for voicing.

7.6.1.4 Summary

To summarize, systems with medial (but not final) PoA neutralization require Marked-Cluster constraints that ban some heterorganic clusters but not others. Kiowa required the constraint *{KPT}{KPTʔ}, which banned all medial clusters except for those that start with a glottal stop; Menomini requires the constraint *{KP}{KPTʔ}, which bans all clusters except for those that start with a coronal or glottal.

These constraints are the same as those invoked to deal with the marked-undergoer systems in §7.4. As shown in that section, a constraint like *{KP}{KPTʔ} can trigger assimilation of marked segments alone.

In short, the Cluster-Markedness constraints are needed for reasons quite independent of marked-undergoer systems. Since they are necessary in any case, unmarked-faithfulness constraints are therefore redundant.

7.6.2   Final-medial relations

The aim of this section is to provide support for the typological claims made in the §7.6.1. Typologies of the relation between medial and final processes for both Place of Articulation and voice are presented. The gaps in each typology are shown to follow from the Marked-Cluster theory.

Section 7.6.2.1 summarizes the typological findings. The major observation is that – for both voice and PoA neutralization – lack of medial assimilation or neutralization implies lack of final neutralization.

Section 7.6.2.2 shows how the medial-final implications are produced in the present theory.

7.6.2.1 Typology

This section discusses the relation between medial and final positions for processes that affect voice and PoA. The voice typology will be presented first since it has received most attention in the literature. It also provides a useful contrast to the PoA typology.

Lombardi (1999) and Wetzels & Mascaró (2001) present a typological survey of the relation between final and medial codas for [voice] contrasts. The following table is adapted from Wetzels & Mascaró (2001). The '×' symbol indicates that neither neutralization nor assimilation takes place in that position.

Table 7.13: Medial-final voicing relations

medial codas	word-final codas	/abtabdab/	*Language*
×	×	[abtabdab]	Berber
neutralize	×	[aptapdab]	-
assimilate	×	[aptabdab]	Yiddish, Ukrainian
×	neutralize	[abtabdap]	-
neutralize	neutralize	[aptapdap]	German
assimilate	neutralize	[aptabdap]	Walloon, Catalan

As an example, medial codas in Yiddish assimilate in voicing and final codas do not neutralize.

There are two gaps. One is where neutralization takes place medially but not finally. The other is where final codas neutralize but medial codas neither assimilate nor neutralize. I consider both gaps theoretically significant.[215]

- *Place of articulation typology*

The facts for PoA are similar to those for voicing, but not identical. The following table is compiled from my own research (for a list of languages consulted, see Appendix B). Cases where word-final consonants assimilate to the initial consonant of the following word are not considered. The examples given below neutralize to coronals rather than glottals (i.e. /m/→[n], /p/→[t]). This was an arbitrary choice, made for consistency and ease of exposition. Whenever 'neutralization' is mentioned, it refers to neutralization to any PoA – i.e. coronals or glottals.

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[215] Wetzels and Mascaró (2001:225,226) suggest that the type with neutralization finally but neither neutralization nor assimilation medially is an accidental gap. The present theory predicts that it is not.

Table 7.14: Medial-final Place of Articulation relations

medial codas	*word-final codas*	/amkam/[216]	*Language*
✗	✗	[amkam]	Southern Sierra Miwok
neutralize	✗	[ankam]	Kiowa
assimilate	✗	[aŋkam]	Harar Oromo, Diola Fogny
✗	neutralize	[amkan]	-
neutralize	neutralize	[ankan]	Nganasan
assimilate	neutralize	[aŋkan]	Selayarese[217], Tzutujil

I found no cases in which PoA is neutralized finally, but medial codas neither assimilate nor neutralize. In other words, there is no language in which only coronals are allowed word-finally while medial codas are fully preserved: e.g. /akpak/ → ☠[akpat].

In short, if something happens finally, something must also happen medially, but not vice-versa. The difference between the PoA and voicing typology is that a system with medial neutralization but not final neutralization is attested for PoA. This type of system was examined in detail in the previous section, so will not be discussed here. To recall from §7.6.1.4, the difference in behaviour was argued to follow from incidental factors: in almost all cases of this type, medial assimilation beats medial neutralization; only when an incidental factor (like faithfulness) intervenes does medial assimilation win. PoA presents such an opportunity; [voice] does not.

The following section shows why systems with final neutralization but no change medially – found in both typologies – fall out from the Marked-Cluster constraints.

7.6.2.2 Rankings

Both typologies cannot produce a system with final neutralization but no change medially – neither assimilation nor neutralization. For voice, this means that there is no language in which input /abdab/ surfaces as [abdap] and input /abtab/ surfaces as [abtap]. For PoA, this means that there is no language in which input /amkam/ surfaces as ☠[amkan].

Such systems cannot be produced by the Marked-Cluster or marked-faithfulness constraints. This follows because no constraint specifically targets final codas. To produce final PoA neutralization, a context-free PoA constraint like *{KP} must outrank IDENT{KPT} (as shown in ch.6). However, this ranking will produce neutralization in medial codas as well as final ones.

- *Medial assimilation + final neutralization*
There are only two potential ways a medial coda could be prevented from neutralizing. One way is to employ a markedness constraint *m* that only targets medial

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[216] The systems listed here apply to assimilations of both nasals and stops. So, the input /apkap/ is more appropriate for some of the systems listed (e.g. Kiowa – see §7.6.1, Nganasan – ch.6§6.3).
[217] Medially, Selayarese has geminates and homorganic nasals: e.g. [lampa] 'to go'. Finally, though, it has only glottals – [ʔ] and the placeless [N]: [toboʔ] 'stab', [bataN] 'driftwood' (Piggott 1999).

codas. If *m* prevents /m/ from neutralizing to [n] medially but not finally, then medial neutralization would be blocked.

The only constraints that can do this in the present theory are the Marked-Faithfulness ones. A constraint like *{KPT}{KPT}, for example, will eliminate the candidate [ankam] from input /amkam/. However, *{KPT}{KPT} does not simply block medial neutralization, it requires medial assimilation: it favours [aŋkam] over the final-neutralization candidate ☠[amkam]. In short, attempting to block medial neutralization by a Marked-Cluster constraint will result in a system with medial assimilation and final neutralization, as attested in Selayarese and Tzutujil for PoA, and Walloon and Catalan for voice.

The ranking for a system with medial assimilation and final neutralization is given in (92). *m*f is the marked value(s) of feature f, and *u*f is the unmarked value(s). The constraint *{*m*f,*u*f}{*m*f,*u*f} is a Marked-Cluster constraint for feature *f*.

(92)   Medial assimilation + final neutralization ranking schema
        || onset-IDENT{*m*f(,*u*f)}, *{*m*f,*u*f}{*m*f,*u*f} » *{*m*f} » IDENT{f} ||

The ranking || onset-IDENT{*m*f} » *{*m*f} » IDENT{f} || is needed to produce final neutralization, after Beckman (1998) and Lombardi (1999). By ranking the Marked-Cluster constraint *{*m*f,*u*f}{*m*f,*u*f} over *{*m*f}, assimilation takes place medially rather than neutralization. For example, from /amkam/, *{KPT}{KPT} eliminates the medial-neutralization candidate [ankan], favouring the assimilation candidate [aŋkan].

- *The role of marked-faithfulness*
     Returning to the issue of systems with final neutralization and no change medially, the only other potential way for medial neutralization to be blocked is through the action of a faithfulness constraint. For example, if there were a faithfulness constraint that only preserves medial codas, it could block medial neutralization but allow it finally; medial assimilation could also be blocked in this grammar by ranking the Marked-Cluster constraints below all relevant faithfulness constraints.

As discussed for Attic Greek in §7.5.1.3, there is good reason to believe that there is no such medial-faithfulness constraint.

It is worth noting, though, that the same statement does not hold in regard to deletion: there are languages with final coda deletion but no medial deletion. This is because there is a faithfulness constraint that specifically preserves medial elements – CONTIGUITY (McCarthy & Prince 1995). For discussion of this ranking, see §7.5.1.4.

In short, neither markedness nor faithfulness constraints can block medial deletion without also producing assimilation. So, the lack of (1) a markedness constraint that specifically promotes neutralization in final position and (2) a faithfulness constraint that preserves in non-final positions only ensures that no language neutralizes finally without something – either neutralization or assimilation – happening medially.

- *Preservation in medial and final position*
  To fill out the typological picture, the present rankings do predict systems in which there is neither final neutralization nor any action medially. This situation is found in Southern Sierra Miwok (Broadbent 1964:26ff).

(93)   Southern Sierra Miwok
        (a) No final PoA neutralization
            [cuʔpam] 'middle'
            [hasːyn] 'abalone shell'
            [kanyŋ] 'my'
        (b) No assimilation or neutralization
            [sympyː] 'close eyes'   [ponpuː] 'to get dusk'   [kaweŋpa] 'shout at s.o.'
            [ʔymtyː] 'to sing'   [tyntynːyː] 'to think'   [coɲtitaʔ] 'crooked'
            [homcupaʔ] 'barber'   [palancaʔ] 'flatiron'
            [momkoʔ] 'moccasins'   [tynkynːaː] 'to maim'   [ciŋkuʔ] 'seed basket'

This type of system is one in which all Marked-Cluster and context-free markedness constraints are outranked by all the relevant faithfulness constraints, as schematized in (94).

(94)   Medial inaction + final inaction ranking schema
        || onset-IDENT{f}, IDENT{f} » *{*m*f,*u*f}{*m*f,*u*f}, *{*m*f} ||

- *Medial neutralization + final neutralization*
  Systems with neutralization in both positions can be produced by the ranking in (95).

(95)   Medial neutralization + final neutralization ranking schema
        || onset-IDENT{f} » *{*m*f} » *{*m*f,*u*f}{*m*f,*u*f}, IDENT{f} ||

There are two crucial parts to this ranking. The ranking || onset-IDENT{f} » *{*m*f} » IDENT{f} || is Beckman's (1998) coda-neutralization ranking, as illustrated above. However, this is not enough to ensure that medial codas will neutralize. By ranking *{*m*f} over the Marked-Cluster constraint, the assimilated candidate will be eliminated. For example, from input /amkam/, *{KP} will favour [ankan] over [aŋkan] – the latter incurs two violations of *{KP} while the latter only has one.

- *Medial assimilation + final neutralization*
  As discussed in §7.4.3.2, Harar Oromo has assimilation medially, but final codas do not neutralize. For example, /hok' + ne/ assimilates to [hojnne], but the words [ark] 'see', [bak'] 'melt', [beːx] 'know', and [delag] 'work' show that final velars are not banned.
  To produce medial assimilation, a Cluster-Markedness constraint must outrank all relevant IDENT constraints. For Harar Oromo, this involved ranking *{K}{KPT} over all

IDENT constraints (because all IDENT constraints preserve dorsals). To prevent neutralization, all context-free markedness constraints (*{K}, *{KP}, *{KPT}) are ranked below a faithfulness constraint.

(96)

	/bak'/	*{K}{KPT}	IDENT{KPT}	*{K}
☞	(a) bak'			*
	(b) bat		*!	

(97)

	/meːk'+te/	*{K}{KPT}	IDENT{KPT}	*{K}
	(a) meːk'te	*!		*
☞	(b) meːtt'e		*	

Similar facts hold for voicing assimilation. Lombardi (1995) and Wetzels & Mascaró (2001:216ff) identify Yiddish as a relevant case; there is no word-final devoicing ([briv] 'letter', [vog] 'weight'), but medial obstruent codas assimilate in voicing to a following obstruent ([brif+tregər] 'mailman', [vok+ʃol] 'scale'). The analysis of such a system proceeds as for Harar Oromo: i.e. || *{+vd}{±vd} » IDENT{+vd} » *+vd ||.

(98)   Medial assimilation + final inaction ranking schema
       || onset-IDENT{f} » *{*m*f,*u*f}{*m*f,*u*f} » IDENT{f} » *{*m*f} ||

This type of system is significant in evaluating alternative theories of the triggers of assimilation. In autosegmental theories, assimilation was conceived as a process of neutralization/delinking of coda PoA followed by regressive spreading from the following onset (Cho 1999 and references cited therein). However, if coda neutralization were a necessary prelude to assimilation, it would be impossible to produce a language like Harar Oromo with medial assimilation and final inaction. The first step in the assimilation process is to delink PoA in all codas, so producing neutralization. Therefore, it is impossible to get to assimilation without neutralizing finally.

A similar problem arises with theories that trigger assimilation by banning independent PoA specifications in codas (e.g. Ito 1986). In other words, such theories propose that codas are unable to support (or 'license') their own PoA, so must share that of an onset. In such theories, a constraint against independent coda PoA outranks faithfulness constraints to produce assimilation (called *CODAPoA here). To produce assimilation, *CODAPoA must outrank all relevant faithfulness constraints (i.e. IDENT{KPT}, etc.). However, this ranking not only applies to medial codas, but to final codas as well. Thus, final neutralization cannot be blocked without also blocking medial assimilation with such a constraint.[218]

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[218]   Pre-OT theories avoided this problem by invoking extrametricality – if the word-final consonant is extrametrical, it will avoid violating *CODAPoA. However, extrametricality – or any device that exempts

In short, the only way to produce a "medial assimilation+final inaction" system is with a markedness constraint that specifically targets clusters (or medial codas), like the Marked-Cluster constraints.[219]

- *Summary*

Table 7.15 summarizes the rankings identified in this section. All the rankings assume that onset-IDENT{f} is undominated, so preventing neutralization in onsets.

Table 7.15: Typology of rankings for medial-final relations

Ranking			Medial	Final
IDENT{f} »	*{*m*f} »	M-C	✗	✗
IDENT{f} »	M-C »	*{*m*f}		
*{*m*f} »	IDENT{f} »	M-C	neutralize	neutralize
*{*m*f} »	M-C »	IDENT{f}		
M-C »	IDENT{f} »	*{*m*f}	assimilate	✗
M-C »	*{*m*f} »	IDENT{f}	assimilate	neutralize

As discussed in §7.6.1, the ranking || M-C » IDENT{f} » *{mf} || can also be used to produce neutralization medially and inaction finally under restricted circumstances.

Therefore, the only system that cannot be produced is one with medial inaction and final neutralization.

7.6.3 Summary

To summarize the findings of this section, the Marked-Cluster constraints are needed to produce systems with medial neutralization but no final neutralization. Specifically, *{KPT}{KPTʔ} forces medial coda consonants to neutralize to [ʔ] in Kiowa, but allows final codas to remain faithful. The crucial part of this analysis is that the constraint *{KPT}{KPTʔ} favours certain heterorganic clusters over others: specifically, clusters with an initial [ʔ] are more harmonic than those that begin with a more marked PoA.

The constraint *{KP}{KPTʔ} was shown to have a similar effect in Menomini.

The theoretical import of these cases is that Marked-Cluster constraints are necessary, quite independently of their use in marked-undergoer systems like SLP Creole's (§7.4).

So, because Marked-Cluster constraints are necessary in any case, they cannot be excluded as providing a solution for marked-undergoer systems. This effectively renders unmarked-faithfulness constraints redundant – while they can provide an account of SLP

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word-final consonants from neutralizing – raises a typological problem. There are no languages where word-final codas neutralize in voicing but medial ones do (i.e. /abdab/ → [apdap]). Such languages are easy to produce with extrametricality, though.

[219] Cho (1999) proposes a process of medial coda neutralization ('cluster devoicing') to deal with this problem for the voicing typology. However, such a process would produce the unattested system with medial neutralization and no final neutralization.

Creole, they can do nothing that the Marked-Cluster constraints cannot also do in regard to marked-undergoer systems. Because the Marked-Cluster constraints have a wide variety of independent support, there is therefore no evidence that unmarked-faithfulness constraints exist, as predicted by the marked-faithfulness theory.

7.7   Typology and Issues

This section discusses the typological implications of the present theory and compares it with alternatives.

Section 7.7.1 discusses the systems of surface heterorganic clusters predicted by the Marked-Cluster and marked-faithfulness constraints. Of 64 possible systems, the present theory predicts that 27 are possible. For direction of assimilation, the present theory is shown to allow both regressive and bi-directional coda-onset assimilation, but not allow systems with uniformly regressive assimilation.

Section 7.7.2 discusses an alternative approach to marked-undergoer systems: Baković's (1999a,b) and McCarthy's (2002) 'Relative Markedness' theories. This section argues that the present theory is more typological adequate than the alternatives.

Section 7.7.3 discusses the predictions of the present theory for assimilations involving three or more elements. As Lombardi (1996, 1999) and Baković (1999a,b) have observed, constraints of the sort proposed here produce 'Majority Rule' effects, where the output's feature value is the same as the value of the majority of input segments.

Section 7.7.4 deals with the dimension over which IDENT constraints may apply. After Pater (1995, 1999), the 'asymmetric' nature of the present constraints is discussed: where IDENT constraints can assign a violation to $/\alpha F/\rightarrow[\beta F]$ but not necessarily $/\beta F/\rightarrow[\alpha F]$. Fully symmetric IDENT theories (McCarthy & Prince 1995, Baković 1999c) are rejected, and the empirical effects of Output→Input IDENT constraints are examined.

7.7.1   Typology of assimilation effects

The aim of this subsection is to identify the predictions of the Marked-Cluster constraints and marked-faithfulness constraints for the typology of assimilation effects.

Section 7.7.1.1 discusses direction of assimilation. It shows that the cluster constraints allow certain types of progressive and bi-directional assimilation but cannot produce uniformly progressive assimilation.

As shown in preceding sections, not all elements in a language need undergo assimilation, and not all elements necessarily trigger assimilation. Section 7.7.1.2 identifiers the possible arrangements of undergoers and triggers predicted by the present theory.

7.7.1.1 Direction

"Direction" of assimilation refers to the element that assimilates. In regressive assimilation, /x/ takes on a following /y/'s features in an /xy/ cluster to produce [yy]; in progressive assimilation, /xy/ → [xx]. For bi-directional assimilation, the assimilating

element is not consistently the leftmost or rightmost in a cluster – some other factor determines which element assimilates.

To some extent, the Marked-Cluster constraints are irrelevant to direction of assimilation. This follows from the fact that the constraints only ban a surface structure; they do not specify how to eliminate heterorganic clusters. For example, the constraint *{K}{KP} bans the cluster /ŋp/, but does not specify whether regressive or progressive assimilation should apply: both [ŋk] and [mp] satisfy *{K}{KP}. Therefore, for the majority of cases, direction of assimilation must be determined by faithfulness in the present theory. After Lombardi (1995, 1996, 1999) and Beckman (1998), positional faithfulness constraints provide an account for this fact. A constraint such as ONSET-IDENT{KPT} preserves PoA features in onsets, with the result that coda features must change to satisfy the Marked-Cluster constraints. This is a desirable result – the majority of assimilations are regressive, and progressive assimilation often seems to be conditioned by non-phonological factors (Lombardi 1996).

Nevertheless, the present theory does allow for bi-directional assimilation.

- *Bi-directional systems*

The marked-faithfulness constraints can produce bi-directional assimilation. For example, if IDENT{K} outranked all onset-IDENT constraints, segments would assimilate to dorsals regardless of whether they are in codas or onsets: i.e. /ŋt/ → [ŋk], /nk/→[ŋk]. Tableau (99) illustrates this situation.

(99)   *Direction driven by preservation of the marked element*

/aŋtanka/	*{KPT}{KPT}	IDENT{K}	ONSET-IDENT{KPT}
(a) aŋtanka	* *!		
(b) antaŋka		*!	
(c) aŋkanta		*!	* *
☞ (d) aŋkaŋka			*
(e) antanta		*!	*

Candidate (a) has heterorganic clusters, so is eliminated by the cluster constraint *{KPT}{KPT}; all remaining candidates have homorganic clusters. Candidates (b) and (c) have uniformly regressive and progressive assimilation respectively; by doing so they both violate IDENT{K} because they do not preserve the underlying dorsals. In contrast, (d) manages to retain the dorsals by having progressive assimilation in the first cluster and regressive assimilation in the second. In effect, the need to retain the marked dorsal feature determines the direction of assimilation. This is a 'bi-directional marked' assimilation system – where assimilation can be regressive or progressive, depending on the nature of the cluster involved. Candidate (e) also employs bi-directional assimilation, but fatally preserves the unmarked element (cf ch.8§8.3).

No bi-directional marked systems have yet been reported, as Lombardi (1995) has observed for voicing assimilation. Whether there are no bi-directional marked systems at all is an issue that awaits a far more detailed typological investigation than has been carried

out here, though recent work in child language is suggestive (see below). In contrast, a bi-directional *unmarked* system has received a good deal of discussion– voicing assimilation in Swedish (see ch.8§8.3.1 for detailed references).

In short, if there are no bi-directional marked systems then there is a fault with the present theory (though see Baković 1998a,b for discussion on how to rectify it).

However, it is important to point out that the marked faithfulness constraints cannot force uniformly progressive coda-onset assimilation. While they constraints allow for bi-directional systems – both marked (as shown above) and unmarked (ch.8§8.3.1) – and can interact with positional faithfulness constraints to produce uniformly regressive assimilation, neither constraint type permits a system in which assimilation is always progressive (unless some other non-phonological factor intervenes – Lombardi 1996). This follows from the nature of the constraints: the marked-faithfulness constraints simply preserve marked elements, regardless of their position; so they cannot be used to uniformly force assimilation in a particular direction.

- *Trigger-restricted bi-directional assimilation and progressive assimilation*

With the present constraints it is possible to get the surface effect of progressive assimilation, though only when the sole trigger of assimilation is the most marked element. Such systems, though, are identical to bi-directional marked systems that allow only marked triggers.

Pater & Werle (2001) identify the ranking for a system of this kind. Their constraints are identical to a subset of the Marked-Cluster constraints, namely *{K}{KPT} and *{KPT}{K}.

Pater & Werle (2001:126) show that if *{K}{KPT} outranks IDENT{KPT} non-dorsals will assimilate to a preceding dorsal (e.g. /akda/→[akga]). However, non-dorsals will not assimilate to a following dorsal (e.g. , /adka/ → [adka], *[agka], *[adta]). Tableau (100) summarizes the argument.

(100)

/akda/	*{K}{KPT}	IDENT{K}	ONSET-IDENT{KPT}
(a) akda	*!		
☞ (b) akga			*
(c) atda		*!	

In contrast, /adka/ will surface as [adka] – this form does not violate *{K}{KPT}, so there is no motivation to assimilate to *[agka].

The net result of this ranking is progressive assimilation to dorsals. However, there is a restriction: such a system can only occur when the only triggering element is the most marked one. For example, a minimally different constraint system is one with *{KP}{KPT} highest-ranked. However, this constraint will produce bi-directional assimilation of P to K: i.e. /abka/ → [agka] and /akba/ → [akga], as both satisfy *{KP}{KPT} and IDENT{K} the most. This minor change shows that the system in (100) is formally a bi-directional marked assimilation system with a limitation on triggers.

It is important to note that Pater & Werle (2001) provide empirical evidence that such 'bi-directional systems with restricted triggers' exist. In one case they report, non-dorsals assimilate to a following dorsal (e.g. [kʌg] 'plug', *[pʌb]). However, non-dorsals do not assimilate to a preceding dorsal (e.g. [gɛːd] 'good', [gɛːg]). Their argument is summarized in the following tableaux.

(101)

/p(l)ʌg/ 'plug'	*{KPT}{K}	IDENT{KPT}	IDENT{K}
(a) pʌg	*!		
☞ (b) kʌg		*	
(c) pʌb		*	*!

(102)

/gɛːd/ 'good'	*{KPT}{K}	IDENT{KPT}	IDENT{K}
☞ (a) gɛːd			
(b) gɛːg		*!	
(c) dɛːd		*!	*

Importantly, positional faithfulness constraints cannot be used to produce the directional effect here – a constraint like ONSET-IDENT{KPT} would incorrectly result in progressive assimilation in /pʌg/, producing [pʌb]. For further discussion of this pattern and others like it, see Pater & Werle (2001) and Pater (2002, to appear).

For voicing, the prediction is that there can be uniformly progressive assimilation to the marked value, using the constraints *{+vd}{±vd} and IDENT[+vd]. /abka/ surfaces as [abga] to satisfy *{+vd}{±vd}, while /apga/ surfaces faithfully. However, there can be no progressive assimilation from voiceless (i.e. unmarked) segments: /apga/ must surface as [apga] – the assimilated *[apka] does not violate *{+vd}{±vd}.

In summary, cases like those reported by Pater & Werle (2001) follow from the present theory – they are bi-directional systems in which only marked elements trigger assimilation. The fact that the Marked-Cluster constraints can produce the effects discussed above is clearly desirable – it accounts for the child language pattern. However, no analogous cases have been found in adult language. As Lombardi (1996) argues, adult language assimilation is overwhelmingly regressive; progressive assimilation only happens under duress, when regressive assimilation is impossible. The theoretical import of this difference between adult and child language deserves more discussion than can be afforded here; I merely note the typological implications here.

7.7.1.2 A typology of surface assimilated clusters

As shown in sections 7.2 and 7.4, languages differ in terms of the elements that undergo and trigger assimilation. For example, only coronals assimilate in Catalan, while only dorsals force labials to assimilate in Korean. From a more surface-oriented perspective, languages differ in terms of the surface heterorganic clusters they allow.

Catalan permits [KP KT PK PT] and not [TP TK], while Korean allows [KP KT PT] but not [PK]. For heterorganic clusters involving K, P, and T, there are 64 possible surface systems (i.e. the subsets of {KP, KT, PK, PT, TK, TP}. This section aims to identify the subsets that are predicted to exist by the marked-cluster and marked-faithfulness constraints. It concludes that 27 systems are possible. The 37 that are banned violate one or more of the implicational relations in (103).

(103) *Surface heterorganic cluster implicational relations*
    (a) If [TK] is permitted, then [TP] is permitted
    (b) If [PK] is permitted, then [PT] is permitted
    (c) If [KP] is permitted, then [KT] is permitted
    • Assume that K, P, and T are permitted generally in the language.

The aim of this section is to generalize over the results of the previous sections for undergoers and triggers of assimilation, to determine the implicational universals in assimilation systems that are predicted by the present theory. This section takes a slightly different approach to typology than the previous discussion. Instead of focusing on the relation between inputs and outputs, it focuses on the distribution of surface clusters, asking whether the existence of cluster c_1 in a language implies the presence of cluster c_2.

•   *Voicing and surface clusters*
    The discussion will start with the typology of voice assimilation. As pointed out in previous discussion, the Marked-Cluster constraints do not allow for every possible assimilation system. Most obviously, they do not allow systems that contain clusters that disagree in feature *f* while banning all clusters that agree in feature *f*. For example, there can be no language that allows clusters that disagree in voicing ([pd], [bt]), but bans clusters that agree in [voice] (i.e. *[pt], *[bd]). This follows from the fact that the former are local harmonic bounds for the latter in terms of the Marked-Cluster constraints: no Marked-Cluster constraint favours clusters that disagree in voicing over those that agree. In short, if a language allows clusters that disagree in some feature *f*, then it also allows clusters that agree in *f* (barring incidental restrictions like a general ban on voiced stops).
    Apart from this general prohibition, the Marked-Cluster constraints produce no implicational relations for clusters in terms of voicing. Table (104) illustrates this point. A ✓ indicates that the cluster is permitted on the surface.

(104) *Typology of surface clusters for voicing*

[+vd][-vd]	[-vd][+vd]	Description	Language
✓	✓	No assimilation	Berber
✗	✓	Assimilation of [+vd] only	Mekkan Arabic
✓	✗	Assimilation to [+vd] only *or* assimilation of [-vd] only	Ukrainian
✗	✗	Assimilation of/to [±vd]	Serbo-Croatian

Systems that allow all types of surface cluster – and therefore no assimilation – have faithfulness constraints outranking all relevant Marked-Cluster constraints. The opposite ranking produces languages that lack clusters that disagree in voicing.

Languages that ban *[+vd][-vd] clusters like *[bt] but allow [pd] come about through the action of an asymmetrically formulated Marked-Cluster constraint: *[+vd][±vd] in this case. With faithfulness constraints outranking *[±vd][±vd], /pd/ will surface faithfully while /bt/ will not (see §7.4.4).

Languages that ban [-vd][+vd] clusters like *[pd] but allow [bt] can do so by two different methods. In one method, only marked elements trigger assimilation, effected by the constraint *[±vd][+vd]. The other method is for marked elements to be exempt from assimilation, due to IDENT[+vd]. It is impossible to determine which analysis is appropriate on the basis of surface clusters alone in these cases; other processes must be brought to bear to determine the ranking of IDENT[+vd].

- *PoA surface clusters: Marked-Cluster predictions*

The typology of surface clusters that differ in terms of Place of Articulation is more complex than for voicing. The complexity arises from the greater number of PoA distinctions – K vs P vs T vs ʔ. The first step will be to focus on the predictions for surface clusters that follow solely from the Marked-Cluster constraints. In other words, the discussion immediately below will effectively assume that there is only one faithfulness constraint for PoA – i.e. IDENT{KPT}. In addition, due to the rarity of heterorganic clusters with glottals, only clusters consisting of K, P, or T will be considered.

Quasi-tableau (105) shows the local harmonic bounding relations between heterorganic clusters in terms of the Marked-Cluster PoA constraints. The results are summarized in lattice (106). The arrows $c_2 \rightarrow c_1$ indicate that cluster c_1 is a local harmonic bound for c_2 in terms of the Marked-Cluster constraints, or that the presence of c_2 implies the presence of c_1.

(105)

	*{KPT}{KPT}	*{KP}{KPT}	*{KPT}{KP}	*{K}{KPT}	*{KP}{KP}	*{KPT}{K}	*{KP}{K}	*{K}{KP}
KP	*	*	*	*	*			*
KT	*	*		*				
PK	*	*	*		*	*	*	
PT	*	*						
TK	*		*			*		
TP	*		*					

(106) *Local harmonic bounds: Marked-Cluster constraints*
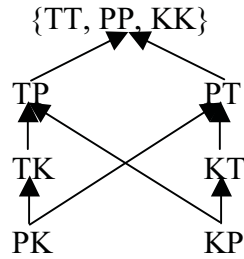
Lattice (106) indicates that [TP] is a harmonic bound for [TK] in terms of the Marked-Cluster constraints. In other words, if the Marked-Cluster constraints were the only ones relevant in a language (i.e. if interfering constraints like the Marked-Faithfulness ones were ranked appropriately low), the presence of [TK] would imply the presence of [TP]. Of course, the homorganic clusters [TT], [PP], [KK] do not violate any of the Marked-Cluster constraints, so they are guaranteed to be in every system (unless a particular feature is banned entirely).

The net result is that the Marked-Cluster constraints predict the existence of 14 patterns of surface heterorganic clusters; the patterns with all heterorganic clusters (i.e. no assimilation) and no heterorganic clusters (i.e. total assimilation) are omitted in table (107).

(107) *Heterorganic cluster typology due to marked-cluster constraints*

KT	KP	PK	PT	TP	TK	Language
				✓		
			✓			
			✓	✓		
				✓	✓	SLP Creole – §7.4.2
✓			✓			Attic Greek – §7.5.1
			✓	✓	✓	
✓			✓	✓		
✓			✓	✓	✓	
		✓	✓	✓	✓	Chukchi – §7.4.3
✓	✓		✓	✓		(~Korean) – §7.5.2
✓		✓	✓	✓	✓	Kui – §7.5.3
✓	✓		✓	✓	✓	

The Marked-Cluster constraints have been used in two ways in previous sections: (1) to account for marked-undergoer systems, where clusters with unmarked elements are the only ones tolerated (e.g. SLP Creole), and (2) to account for marked-trigger systems, where only marked elements trigger assimilation (e.g. Korean, Harar Oromo). Thus, all the systems listed in table (107) have some marked-undergoer and/or marked-trigger aspect to them.

For example, the language with surface clusters [TP TK PK PT] is one in which only dorsals undergo assimilation (e.g. Chukchi). In contrast, the [TP PT KT KP] system is one in which only dorsals trigger assimilation (similar to Korean, except that coronal+non-coronal clusters are also banned). Similarly, the [TP TK] and [PT KT] systems are marked-undergoer and marked-trigger ones respectively, where both dorsals and labials are the relevant feature values.

All other systems are more complex, having both a marked-undergoer and marked-trigger aspect to them. For example, the system with all heterorganic clusters except [KP] is one in which only K undergoes and only P and K trigger (i.e. *{K}{KP} is the only active constraint). This system is found in Kui, as discussed in §7.5.3. In effect, it is a mixture of Korean and Attic Greek.

An even more complex system is one in which the only heterorganic cluster is [TP]. This system is produced when only *{KP}{KPT} and *{KPT}{K} are active. In effect, P and K are forced to assimilate to every other PoA, but T only assimilates to dorsals – this system is a mixture of Korean and SLP Creole.

One point that table (107) raises is that the Marked-Cluster constraints place no implicational restrictions between undergoers and triggers. For example, if both labials undergo assimilation, there is no requirement that it must also trigger it (cf Kui).

Of course, there are many gaps in table (107). Pending a more detailed and careful typological survey of assimilation patterns, it would be rash to claim that the gaps are fatal or even significant to the present theory; it would be equally rash to claim that the present theory is empirical adequate. However, some observations can be made about the missing systems. The systems that are more easy to observe are listed; these systems are ones in which either all elements are triggers or all elements are undergoers. Systems that have both a proper subset of undergoers and a proper subset of triggers – like Kui's – are more difficult to discover for practical reasons: existence of every possible heterorganic cluster must be examined carefully (a task often made difficult by inadequate source material). In addition, marked-undergoer systems and marked-trigger systems are rare (or at least less discussed) compared with unmarked-undergoer systems (e.g. Catalan's).

In short, the gaps in table (107) may be due to a lack of data. In any case, the cases that are available – reported in this chapter – show that constraints that limit both undergoers and triggers are necessary. Only future research can determine whether the Marked-Cluster constraints overpredict.

- *Deletion*

The present theory predicts that table (107) lists all the possible surface clusters for languages that resolve their heterorganic clusters through deletion. This follows from the fact that there are no MAX-F constraints in the present theory, as discussed in ch.6. However, if a language eliminates heterorganic clusters through assimilation, IDENT constraints may interfere with the surface inventory.

- *Marked-faithfulness*

The marked-faithfulness constraints are the other important factor for the typology of surface heterorganic clusters. If there were no Marked-Cluster constraints – only one against heterorganic clusters in general (e.g. AGREE[Place]) – the marked-faithfulness constraints would predict four types of language, given in table (108).

(108)   *Marked-faithfulness typology (regressive assimilation only)*

Surface Heterorganic Clusters	Language
	Diola Fogny – §7.2.2
KP KT	Inuktitut – §7.2.2
KP KT PK PT	Catalan – §7.2.1
KP KT PK PT TK TP	Sierra Miwok – §7.6.2.2

As established in previous sections, if a marked-faithfulness constraint like IDENT{KP} outranks all assimilation-inducing constraints, all heterorganic clusters except those containing both dorsals and labials will be eliminated (i.e. *[KT PT TP TK]). Other factors may intervene to limit the attrition: in Catalan, ONSET-IDENT{KPT} saves the clusters [KT PT], with the result that only [TP TK] are banned on the surface. The remaining task is to show how the marked-faithfulness and marked-cluster constraints interact.

- *The interaction of marked-faithfulness and Marked-Cluster constraints*

The following discussion will focus on languages that resolve heterorganic clusters through regressive assimilation. A graphical representation of the interaction of the marked faithfulness constraints IDENT{K} and IDENT{KP} is given in (109).

(109)   *Marked-Cluster + marked-faithfulness constraints*
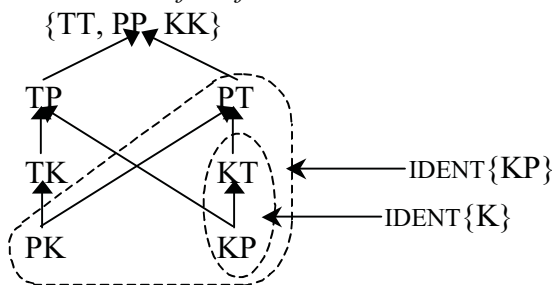
The dotted lines enclose clusters that IDENT{KP} and IDENT{K} can save from elimination by regressive assimilation. For example, IDENT{K} preserves the K in KT and KP. With IDENT{K} active, the implicational restrictions imposed by the marked-cluster constraints are somewhat curtailed. For example, while it is true that the marked-cluster constraints on their own cannot produce a [KP KT TP] system, combination of IDENT{K} and the marked-cluster constraints can.

Diagram (109) provides a representation of the possible surface cluster inventories, if read with the guidelines in (110).

(110) *Interpretation of Diagram (109)*

(a) Select one of the sets of elements enclosed by dotted lines (i.e. [KT KP] or [KT KP PT PK]).

(b) Remove or add clusters under the following conditions:

(i) If cluster c_1 is removed, then remove all clusters that are more marked than c_1 (e.g. if KT is removed, also remove KP)

(ii) If cluster c_1 is added, then add all clusters that are less marked than c_1 (e.g. if TK is added, then also add TP).

Algorithm (110) produces the possible systems in table (111). Systems identical to those in table (107) are greyed out.

(111)

KT	KP	PK	PT	TP	TK	Language
		✓	✓			Harar Oromo
✓						
✓			✓			
✓	✓					NBA Inuktitut
		✓	✓	✓		
✓				✓	✓	
✓			✓	✓		
✓		✓	✓			
✓	✓			✓		
✓	✓		✓			Korean
		✓	✓	✓	✓	
✓			✓	✓	✓	
✓		✓	✓	✓		
✓	✓	✓	✓			Catalan
✓	✓			✓	✓	Gunin
✓	✓		✓	✓		
✓	✓		✓	✓	✓	
✓		✓	✓	✓	✓	
✓	✓	✓	✓	✓		
✓	✓	✓	✓	✓	✓	

If only clusters inside the dotted circles of (109) are taken, they form systems with [KT KP] and [KP KP PK PT] as the only heterorganic clusters (e.g. Inuktitut and Catalan resp.). These systems have the ranking || {IDENT{K}, IDENT{KP}} » *{KPT}{KPT} » IDENT{KPT} || with all marked-cluster constraints below IDENT{KPT}. As another example, if the clusters inside the smaller circle (produced by IDENT{K}) are taken [KT

KP] along with the clusters TK and TP, the result is a system that lacks the clusters [PK PT] (i.e. where only labials assimilate, as in Gunin).

Some Cluster-Markedness constraints may outrank marked-faithfulness constraints, which in turn may outrank other marked faithfulness constraints. This is the case for Harar Oromo, where IDENT{KP} outranks all but *{K}{KPT}, with the result that both dorsal+C and coronal+C clusters are eliminated, while labials are preserved intact.

As with table (107), there are many gaps. Again, these gaps may not be empirically significant, but rather follow from the limitations of the typological survey reported here. Again, the 'easiest' systems are identified above – those that pose little complexity. For example, the [TP KT KP] system is one in which only labials undergo assimilation (as in Gunin), and dorsals trigger assimilation (as in Korean). The rarity of systems with limitations on both triggers and undergoers means that the lack of such a system is unsurprising.

- *What doesn't exist*

While the Marked-Faithfulness and Marked-Cluster constraints can produce a wide variety of different cluster types, they do not allow every possible system. Table (112) summarizes the restrictions on surface clusters imposed by the present theory.

(112) *Surface heterorganic cluster implicational relations*
 (a) If [TK] is permitted, then [TP] is permitted
 (b) If [PK] is permitted, then [PT] is permitted
 (c) If [KP] is permitted, then [KT] is permitted
 • Assume that K, P, and T are permitted generally in the language.

In other words, if a language permits a TK cluster on the surface and resolves heterorganic clusters through regressive assimilation, it also allows TP (assuming that P is permitted in the language, of course). If PK is permitted, then so is PT; the same holds for KP and KT. These restrictions rule out 37 possible systems.

The relations in (112) hold because of the nature of the Marked-Cluster and Marked-faithfulness constraints. On the markedness side, TP is a harmonic bound for TK, as is PT for PK, and KT for KP. Therefore, the Cluster-Markedness constraints cannot be used to produce systems with TK and not TP, and so on. Therefore, such systems could only come about through faithfulness constraints.

However, faithfulness constraints cannot preserve TP from regressive assimilation without also preserving TK. To prevent T from assimilating to P in TP (i.e. /TP/→[TT]), the constraint IDENT{KPT} must be employed. However, this constraint will also preserve the T in /TK/. In short, faithfulness constraints cannot distinguish the TP and TK for regressive assimilation: unfaithfulness to T in either cluster incurs the same faithfulness violations.

So, because faithfulness constraints cannot distinguish the two types of cluster and markedness constraints universally favour TP over TK, every inventory with TK must also contain TP. The same holds for the other implicational relationships.

This result relates to the discussion of possible triggers in §7.5.4. It was claimed that if *x* triggered assimilation, then all elements more marked than *x* would also trigger assimilation. So, there can be no language in which labials force a segment *y* to assimilate without dorsals also doing so. In such a language, /TP/ would be eliminated (i.e. to [TT]) but /TK/ would remain faithful; in other words, the surface clusters would include [TK] but not [TP]. In short, the discussion above accords with the Trigger Implication in (86).

7.7.2 Relative Markedness theories

The preceding sections have presented a particular view of 'marked undergoer' systems – i.e. systems in which only marked values undergo assimilation. To return to the example of SLP Creole, only coronals fail to undergo assimilation in this language: e.g. /mːitiŋ-pə/→[mitiːmpə], /maːm-su/→[maːnsu], cf /siːn-pə/→[siːnpə], *[siːmpə].

The leading idea behind the present theory is that unmarked elements do not undergo assimilation in marked undergoer systems because they are already 'adequately unmarked'. In SLP Creole, coronals are the least marked type of element, so there is no pressure on them to assimilate. This is formally expressed in the theory as a markedness constraint that bans non-coronal+C heterorganic clusters *{KP}{KPT} – this constraint puts no pressure on coronals to assimilate.

However, there is a class of theory that offers a potential alternative to systems like SLP Creole's. Such theories would see SLP Creole as a case where coronals do not undergo assimilation because the outcome is relatively more marked. In other words, they ban assimilations that result in an increase in markedness. For example, if /n/ assimilates to [p] or [k], the output increases in markedness relative to /n/ – the process will turn a coronal element into something more marked – a labial [mp] or a dorsal [ŋk]. Theories based on this leading idea will be called 'Relative Markedness (RM) theories' here.

The aim of this section is to compare two recently proposed Relative Markedness (RM) theories to the current approach. They are Baković's (1999, 2000) theory of faithfulness-markedness conjunction (building on Łubowicz 2002[1998]), and McCarthy's (2002a) theory of Comparative Markedness.

This section aims to show that RM theories and the Marked-Cluster theory differ in their predictions regarding the typology of assimilation. The conclusion will be that – for the typology of assimilation – the Marked-Cluster constraints are needed regardless of RM theories.

It is important to point out that the aim of this section is not to show that either Baković's (1999, 2000) nor McCarthy's (2002a) theories are flawed. The aim is to show that they cannot provide a complete account of the attested cases of assimilation, thus showing that the leading idea behind the Marked Cluster theory is correct. Baković's and McCarthy's theories deal with many issues apart from assimilation, including derived environment effects, opacity, and the 'Majority Rule' problem (Lombardi 1996, 1999). The Marked-Cluster approach solely focuses on dealing with asymmetries in assimilation, and as such has nothing to say about these other phenomena.

In any case, the RM theories discussed in this section do not offer an alternative to the main point of this chapter – i.e. that marked-faithfulness constraints are necessary. The

issue discussed here relates solely to the Marked-Cluster constraints and the particular issue of languages in which only marked elements undergo assimilation. Languages with unmarked undergoer systems – like Catalan – still stand as evidence for marked-faithfulness constraints regardless of RM theories.[220]

7.7.2.1 Behind the theories

A marked undergoer system like SLP Creole's can be informally characterized in a number of ways. The leading idea behind the present theory is that "coronals do not assimilate because they are already adequately unmarked." In other words, assimilation is considered a markedness-reducing operation: elements undergo assimilation to produce a less marked structure – i.e. a homorganic cluster. However, if a segment already has marked features, it may have nothing to gain by assimilating. Coronals, for example, are the least marked of PoA features, so they are exempt from assimilation in SLP Creole.

To cast this intuitive characterization a little more precisely, coronals are considered adequately unmarked in SLP Creole so that no pressure is placed on them to assimilate. The present theory formally expresses this intuition by having a markedness constraint that specifically bans non-coronal+C heterorganic clusters: i.e. *{KP}{KPT}. In grammars where *{KP}{KPT} is the only active markedness constraint, there is no pressure on coronals to assimilate to non-coronals, so they are exempt from undergoing assimilation.

There is another informal way to characterize the SLP Creole system: "Coronals do not assimilate because doing so would create something too marked." For example, if /siːn-pə/ were realized as [siːmpə], the unmarked coronal /n/ would end up with a marked PoA: labial [m]. In short, the leading idea behind this approach is that a process can be blocked if it creates something more marked out of something less marked. This informal characterization lies behind analyses of marked undergoer systems proposed by Baković (1999a,b) and McCarthy (2002a). Both theories employ constraints that militate against elements that become more marked, though they do so in significantly different ways.

The following section shows how the theories approach a system like SLP Creole's. The result will be that both an RM theory and the present approach can deal with marked undergoer systems of precisely SLP Creole's type. However, they diverge in their predictions for other marked undergoer systems; RM theories predict a type that is unattested and ban attested types, while the present approach predicts the opposite.

7.7.2.2 RM theories and SLP Creole

Baković (1999a,b) has presented the earliest RM theory, which also has the distinction of being the first theory applicable to marked undergoer systems (for voice

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[220] To expand on this point, RM theories cannot deal with unmarked-undergoer systems where only unmarked elements undergo assimilation. Since RM theories ban an increase in markedness, they cannot provide an account of systems in which the only assimilations that take place create more marked outputs (as in Catalan, where only coronals assimilate, producing more marked elements).

assimilation). Baković's proposal is that a markedness and faithfulness constraint can be conjoined to block creation of a marked element. For example, *[+voice]&IDENT[±voice] prevents a segment from becoming more marked – i.e. voiced (e.g. /p/→[b]), but does not block a segment from becoming less marked (e.g. /b/→[p]). This theory will be called the 'Relative Markedness Conjunction Theory' here (RMCT).

Baković (1999a,b) shows that locally conjoined constraints, along with a restriction on its ranking, is able to deal with the 'Majority Rule' effect of Lombardi (1996, 1999) and provide insight into the analysis of certain Dominant-Recessive vowel harmony systems. Both of these issues are beyond the scope of this section. Instead, the following discussion will focus on the ability of RMCT to explain unmarked-undergoer systems of assimilation.

To give a brief explanation of why RMCT offers some possibility for analysis of unmarked-undergoer systems, consider the case of Mekkan Arabic voicing assimilation from §7.4.4 (for an analogous case, see Baković 1999b). In this language, voiced sounds assimilate to voiceless ones: e.g. /magtu:l/ → [maktu:l] 'killed'. However, voiceless sounds do not assimilate to voiced ones: e.g. [ʔakbar], *[ʔagbar] 'older'. RMCT offers an explanation for why voiceless segments do not assimilate to voiced ones. If a voiceless sound did assimilate to a voiced one, it would be both unfaithful to its input [voice] specification – i.e. violate IDENT[±voice] – *and* it would violate *[+voice]. Thus, from input /ʔakbar/, the candidate *[ʔagbar] is eliminated by the conjunction *[+voice]&IDENT[±voice]. In contrast, voiced sounds can assimilate to voiceless ones; although /g/ in /magtu:l/ is unfaithful in [maktu:l], it does not violate *[+voice]. In other short, the RMCT conception of Mekkan Arabic is that it avoids creation of marked elements.

However, I suggest that the RMCT approach to unmarked-undergoer assimilation works for incidental reasons relating to binary scales, and does not cut to the heart of the problem posed by unmarked-undergoer systems. PoA assimilation in SLP Creole provides support for this contention.

As a reminder, dorsals and labials undergo assimilation in SLP Creole, but coronals do not. So, the relevant conjoined constraint would be *{KP}&IDENT{KPT}. The effect of this conjoined constraint is "Don't both have a marked PoA (i.e. dorsal or labial) and be unfaithful". So, the conjoined constraint would block a mapping where a coronal becomes more marked – i.e. a labial or a dorsal. In such a case, the output would violate IDENT{KPT} because it is unfaithful and *{KP} because it is a non-coronal, thus incurring a violation of the conjunction of the two.

Tableau (113) illustrates *{KP}&IDENT{KPT}'s application. The constraint ASSIM bans heterorganic clusters.[221]

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[221] It is argued below that the Marked-Cluster constraints provide an alternative to an RM account of assimilation. Therefore, only RM theories that do not employ Marked-Cluster constraints will be considered here. The constraint ASSIM is a cover term for assimilation-motivating constraints in such theories.

(113)   RMCT Analysis I: SLP Creole

/siːn-pə/	*{KP}&IDENT{KPT}	ASSIM
☞ (a) siːnpə		*
(b) siːmpə	*!	

The assimilated candidate (b) violates *{KP}&IDENT{KPT} because [m] violates *{KP} (because it is a labial) and is unfaithful to the underlying PoA feature of /n/. This violation blocks the influence of ASSIM, allowing the unassimilated candidate to win.

In contrast, the ranking does not (entirely) ban assimilation of dorsals and labials. If ASSIM outranks all dorsal- and labial-preserving constraints (i.e. IDENT{K}, IDENT{KP}, IDENT{KPT}), labials and dorsals will assimilate to coronals without hindrance, as shown in tableau (114).

(114)   RMCT Analysis II

/maːm-su/	*{KP}&IDENT{KPT}	ASSIM	IDENT{KPT}
(a) maːmsu		*!	
☞ (b) maːnsu			*

The assimilated candidate (b) does not violate *{KP}&IDENT{KPT}: while output [n] is unfaithful to input /m/ (thereby violating IDENT{KPT}), it crucially does not violate *{KP}. This allows ASSIM to assign the crucial violation, favouring the assimilated candidate (b) over (a).

However, there is an empirical problem with the RMCT analysis. As shown above, the ranking || *{KP}&IDENT{KPT} » ASSIM || is necessary, but predicts that /uŋ pæːzu/ will not assimilate to [umpæːzu]. The faithful candidate *[uŋpæːzu] is predicted to win under this ranking because [umpæːzu] violates *{KP}&IDENT{KPT}: [m] is both unfaithful and violates *{KP}. In contrast, [uŋpæːzu] violates only *{KP}, so does not incur a violation of the conjoined constraint:

(115)   The Problem

/uŋ pæːzu/	*{KP}&IDENT{KPT}	ASSIM	IDENT{KPT}
💣 (a) uŋpæːzu		*	
(b) umpæːzu	*!		*

There is no way to avoid this problem in RMCT. If the conjoined constraint only banned unfaithfulness and labials (i.e. IDENT{KPT}&*{P}), then /siːn-ki/ should assimilate to *[siːŋki]. The only other option is to employ a faithfulness constraint that preserves coronals only: i.e. *{KP}&IDENT{T}, but this defeats the purpose entirely: with IDENT{T}, the SLP Creole analysis has no need of a conjoined constraint.

To give an informal characterization of the problem, the RMCT approach sets a markedness threshold on unfaithful elements. The constraint *{KP}&IDENT{KPT} requires unfaithful elements to not be highly marked (i.e. K or P). However, this is not precisely what happens in SLP Creole: rather, the process is that "unfaithful elements must

not become *more* marked." Thus, /uŋ pæːzu/→[umpæːzu] is permitted because /ŋ/ has not become relatively more marked by turning into [m].

    While RMCT does face an empirical problem, the problem is not a general property of RM theories as shown by the fact that another Relative Markedness approach – McCarthy's (2002a) Comparative Markedness theory – can successfully deal with SLP Creole.

- *Comparative Markedness: McCarthy (2002a)*

    McCarthy (2002a) proposes a new type of markedness constraint that can be used to deal with marked undergoer systems. The theory is called 'Comparative Markedness' (CM), a term that characterizes the constraints proposed.

    CM constraints are violated when two conditions are met: (i) the output form meets the constraint's structural description and (ii) the violation is 'new'. A violation is 'new' if it has no analogue in the fully faithful form. For example, the CM constraint $_N$*{KP} is only violated by candidates that have a dorsal or labial that is not present in the input/fully faithful form.

    For example, the fully faithful candidate from input /siːn-pə/ is [siːnpə]. This has one violation of the standard *{KP} constraint – i.e. in [p]. However, [siːnpə] has no violations of $_N$*{KP} – compared to the fully faithful form (i.e. itself), [siːnpə] does not have any different violations of *{KP}.[222]

    In contrast, the output form [siːmpə] violates *{KP} twice and $_N$*{KP} once. It violates *{KP} twice for obvious reasons – there are two labials in the output. It violates $_N$*{KP} once because there is a violation of *{KP} that is present in [siːmpə] but not in the fully faithful form [siːnpə]. Importantly, $_N$*{KP} is not violated twice by [siːmpə]: [p] does not register a violation because it is not a 'new' violation – it has an analogue in the fully faithful form. In effect, then, $_N$*{KP} is penalizing [siːmpə] for *introducing* a more marked element.

    In short, CM captures the RM theory intuition in a rather straightforward manner. $_N$*{KP} is (essentially) violated when an input coronal turns into something more marked. Hence, $_N$*{KP} provides a straightforward account of SLP Creole. The use of $_N$*{KP} to account for SLP Creole follows McCarthy's (2002a) analysis.[223]

(116)   Comparative Markedness I

/siːn-pə/	$_N$*{KP}	ASSIM	*{KP}
☞ (a) siːnpə		*	*
(b) siːmpə	*!		* *

    Candidate (a) is the fully faithful form. It incurs one violation of *{KP} – i.e. by means of [p]. In contrast, *[siːmpə] incurs two violations of *{KP} – one for [m] and one

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[222] This is casting the theory in a much simpler way than it really is. However, for present purposes it is accurate enough; the reader should consult McCarthy (2002a) for in-depth discussion.
[223] See McCarthy (2002a:9 and fn.9) for a circular chain shift of attribution.

for [p]. Importantly, one of these violations (caused by [m]) is 'new' – i.e. it has no analogue in the fully faithful form. This causes a violation of $_N*\{KP\}$, dooming *[siːmpə].

Significantly, the Comparative Markedness approach avoids the problem of a markedness threshold. Comparative Markedness constraints do not set a markedness threshold on unfaithful elements; instead, they are inherently comparative, assigning a violation only if it increases markedness. So, /uŋ pæːzu/→[umpæːzu] does not incur any violations of $_N*\{KP\}$. This is because the fully faithful form *[uŋpæːzu] incurs two violations of *{KP}, and [umpæːzu] also incurs two; in other words, [umpæːzu] is no less marked than *[uŋpæːzu] in terms of *{KP}. This allows ASSIM to rule out the unassimilated candidate, as shown in tableau (117).

(117)   <u>Comparative Markedness II</u>

/uŋ pæːzu/	$_N*\{KP\}$	ASSIM	*{KP}
(a) uŋpæːzu		*!	* * *
☞ (b) umpæːzu			* * *

Interestingly, the stringent form of the markedness constraint $_N*\{KP\}$ is essential to the success of this analysis. If there were two non-stringent constraints $_N*\{K\}$ and $_N*\{P\}$, the analysis would prevent assimilation of non-coronals to other non-coronals. For example, /ŋp/→[mp] would fatally violate $_N*\{P\}$ and /mk/→[ŋk] would fatally violate $_N*\{K\}$.

In short, Comparative Markedness can successfully produce an unmarked undergoer system. The leading idea behind the theory is significantly different from the one behind the present approach, though: for Comparative Markedness, coronals do not assimilate to non-coronals because the output would be too marked when compared with the input. In the present theory, coronals do not assimilate because they are already unmarked enough, so nothing motivates them to assimilate.

The focus of the following discussion will henceforward be on Comparative Markedness.

7.7.2.3 Differences and predictions

While both an RM theory (i.e. CM) and the present approach can deal with the marked undergoer system found in SLP Creole, the two approaches differ significantly in their predictions about other types of assimilation systems.

Three different predictions are identified here. The first type relates to another marked undergoer system that differs minimally from SLP Creole's: one in which only the most marked elements (i.e. dorsals) undergo assimilation. The present theory can produce this type of system, while CM cannot.

The second issue relates to a type of system that also differs minimally from SLP Creole: one in which a segment cannot assimilate to something more marked. CM predicts such a system to exist, while the present theory does not.

Finally, asymmetries in triggering elements are discussed. The cluster-markedness constraints are argued to be necessary regardless of whether CM constraints exist or not.

- *A Dorsal-Undergoer Language*

CM and the present theory differ in regard to predictions about a system in which only the most marked PoA – dorsals – undergoes assimilation while coronals and labials do not. Chukchi was argued to be such a system in §7.4.3.1; Harar Oromo is also a relevant system: dorsals assimilate while labials do not (§7.4.3.2). A dorsal-undergoer system is illustrated schematically in (118).

(118)   Dorsal-Undergoer System
　　　　(a) Dorsals assimilate
　　　　　　/aŋpa/ → [ampa]
　　　　　　/aŋta/ → [anta]
　　　　(b) Labials do not assimilate
　　　　　　/amka/ → [amka], *[aŋka]
　　　　　　/amta/ → [amta], *[anta]
　　　　(c) Coronals do not assimilate
　　　　　　/anka/ → [anka], *[aŋka]
　　　　　　/anpa/ → [anpa], *[ampa]

This type of system presents a difficulty for CM in that dorsals assimilate while the less marked labials do not. The problem involves transitivity of ranking. The fact that dorsals assimilate shows that the assimilation-inducing markedness constraint must outrank all faithfulness constraints against dorsals: i.e. ‖ ASSIM » IDENT{K}, IDENT{KP}, IDENT{KPT} ‖.

However, if ASSIM outranks all faithfulness constraints, what prevents coronals and labials from assimilating? CM provides a partial answer in the form of the comparative markedness constraints: $_N$*{KP} will block assimilation of coronals to something more marked, as shown for SLP Creole.

However, labials present a significant difficulty. While the mapping /amka/→*[aŋka] can be blocked by a CM constraint $_N$*{K}, no constraint can block /amta/→*[anta]. There is no faithfulness constraint available that can favour [amta] over [anta] (because both are equally unfaithful – see ch.6§6), nor can any comparative markedness constraint ban /mt/→[nt] since the output is *less* marked than the fully faithful form.

This conundrum is a general problem for RM theories. Since RM theories rely on the idea that change to a more marked element is banned, there is no RM-based way to prevent a change from a more to a less marked element.

The only way around the problem is to propose significantly different faithfulness constraints and then appeal to a Catalan-style analysis. If there were a constraint IDENT{P}, for example, then IDENT{P} would outrank ASSIM, preventing assimilation. Crucially, the faithfulness constraint cannot preserve dorsals as well, otherwise dorsals would fail to assimilate. However, proposing a separate IDENT{P} has a problematic ripple

effect throughout the theory of scale-referring faithfulness constraints. To retain stringent faithfulness constraints, all constraints would have to mention P: i.e. IDENT{P}, IDENT{PK}, IDENT{PKT}. This implies that labials are more marked than dorsals. Proposing an IDENT{P} constraint then turns into a 'local' solution, good only for Chukchi. The IDENT{P} approach then faces the exact same problem with systems in which labials are the only undergoers (Gunin/Kwini – §7.1) – such systems are predicted to not exist in a CM theory with IDENT{P} for the same reasons that Chukchi is predicted not to exist with a CM theory with IDENT{K}.

In contrast, the present theory can account for dorsal-undergoer systems, as shown in §7.4.3.1. The crucial part of the analysis provided there was that there is some markedness constraint that specifically bans dorsal+non-dorsal clusters. This analysis captures the intuition behind the present approach: labials do not assimilate because they are already unmarked enough. Formally, there is no active markedness constraint that bans labial+C heterorganic clusters, so labials are never under pressure to assimilate in Chukchi.

The implication is that the markedness constraint *{K}{KPT} is necessary regardless of whether CM constraints exist or not. If this is the case, it is a small step to assume that there is a constraint *{KP}{KPT}. However, if this is so, then there is no need for a CM analysis of SLP Creole, as shown in §7.4.2.

In short, RM theories are too restrictive, banning an attested type of assimilation.

- *Progressive Blocking*

RM theories also predict a type of system that is as yet unknown; the present theory does not. The system is one in which assimilation is blocked only when it would create a more marked segment. This type of system is called a 'progressive blocking' system since it bans outputs that are progressively more marked. The system is illustrated in (119).

(119) Progressive Blocking (PB) Language
    (a) Dorsals assimilate to coronals and labials
        /aŋ-pa/ →   [ampə]
        /aŋ-ta/ →   [anta]
    (b) Labials assimilate to coronals, but not dorsals.
        /am-ka/ →   [amka]
        /am-ta/ →   [anta]
    (c) Coronals do not assimilate at all.
        /an-ka/ →   [anka]
        /an-pa/ →   [anpa]

In other words, from the scale | dorsal 〉 labial 〉 coronal |, assimilation only takes place if the output contains a strictly less marked sound: i.e. /m/→[n], but not to [ŋ]. This system differs from SLP Creole: in SLP Creole, only coronals were prevented from assimilating; labials could assimilate to the more marked dorsals, and dorsals to labials.

This type of system can be produced in the CM theory with the ranking || N*{K}, N*{KP} » ASSIM ||. The input /am-ka/ cannot emerge as *[aŋka] because this form introduces a new violation of *{K} (cf fully faithful [amka]), thus fatally violating N*{K}.

As with SLP Creole, this ranking does not block the assimilation of labials and dorsals to coronals, or dorsals to non-dorsals. Tableau (120) illustrates this point.

(120)

/amkamta/	ₙ*K	ASSIM	*K
(a) amkamta		* *!	*
☞ (b) amkanta		*	*
(c) aŋkanta	*!	*	* *

In contrast, the present theory cannot produce a Progressive Blocking system. The reason can best explained by returning to the intuition behind the theory: "a segment may be exempt from assimilation if it is already adequately unmarked". Coronals are very unmarked, so they can be exempt from assimilation. However, when it comes to labials, the theory gives one of two choices: either they assimilate or they don't. So, if the answer to the question "Are labials adequately unmarked?" is positive, then labials cannot assimilate at all; if it is negative, then labials will assimilate to both dorsals and labials.

To give a formal account of the problem posed by labials, consider the ranking needed for assimilation of /am-ta/ to [anta]. Some markedness constraint that bans [labial+coronal] clusters (i.e. *{KP}{KPT}) must outrank all faithfulness constraints that preserve labials (IDENT{KP}, IDENT{KPT}).

However, with this ranking nothing prevents labials from assimilating to dorsals. To ban labial→dorsal assimilation, some faithfulness constraint that preserves labials (i.e. IDENT{KP} or IDENT{KPT}) must outrank all markedness constraints that ban labial+dorsal clusters – i.e. *{KP}{x}, *{KPT}{x}, where *x* is any set of elements. This ranking directly contradicts the one needed for labial→coronal assimilation. This result relates to a general prediction made by the present theory (discussed in §6.3): if *x* assimilates to *y*, then *x* assimilates to *z*, where *z* is more marked than *y*.

In contrast, the present theory can produce the SLP Creole system because it is not a progressive markedness system: all segments that fail to assimilate before some other segment do not assimilate at all (i.e. /n/).

So far, no progressive blocking system has been reported. This fact does not weigh in favour of either theory at this point, though, since very few marked-undergoer systems have been identified at all (cf Baković 1999b, Wetzels & Mascaró 2001, and most extensively in this chapter). However, it is notable that the predictions of RM and the present theory are different, and thus will ultimately provide a way to tell which is more empirically adequate.

- *Triggering*

CM and the present theory make significantly different predictions regarding the elements that trigger assimilation. Specifically, with only a markedness constraint like ASSIM, CM predicts that there is no system that is the exact opposite of Progressive Blocking: where a segment will only assimilate to something *more* marked. Interestingly

enough, such a system has already been identified in Korean (sec.7.5.2), repeated briefly in (121).

(121)   Korean: A progressively more marked system
        (a) coronals assimilates to labials and dorsals
                /an paŋ/   →[ampaŋ]
                /han kaŋ/   → [haŋkaŋ]
        (b) labials assimilate to dorsals but not coronals
                /kamki/   → [kaŋki]
                /sum-ta/   → [sumta], *[sunta]
        (c) dorsals do not assimilate
                /paŋ pota/   → [paŋpota], *[pampota]
                /ik ta/   → [ikta], *[itta]

Without any other markedness constraint, CM constraints cannot produce the Korean system. In fact, it runs exactly counter to what is expected under CM: elements only assimilate if they become *more* marked, not *less*.

Section 7.5.2 showed that the present theory can account for Korean. However, it crucially relied on an 'asymmetric' assimilation constraint *{KPT}{K}. This constraint requires assimilation to dorsals, and is based on the idea that more marked elements promote greater assimilation.

Given the necessity of *{KPT}{K}, a 'plausibility' argument for the current theory will be made here. If even the CM theory needs asymmetric assimilation constraints like *{KPT}{K} to deal with Korean, then there is no a priori objection to a constraint such as *{K}{KPT} for Chukchi (or *{KP}{KPT} for SLP Creole). If this is the case, then there is then no need for CM constraints to produce marked undergoer systems.

7.7.2.4 Conclusions

To conclude, RM theories do not provide a full account of undergoer systems in assimilation. While RM theories can potentially deal with certain types of marked undergoer system (i.e. one in which the least marked element of a scale fails to undergo assimilation – Mekkan Arabic, SLP Creole), they cannot account for other attested types (i.e. where only the most marked element of a >2-step scale is an undergoer). Moreover, they predict the existence of an otherwise unattested system in which only assimilation to a more strictly marked element is blocked. Finally, the Comparative Markedness theory does not account for asymmetries in triggering effects, as found in Korean.

In contrast, the Marked-Cluster theory accounts for all attested marked assimilation patterns as well as triggering. It also predicts that the unattested 'Progressive Marked' type of system cannot exist.

So, the asymmetric assimilation constraints are needed independently of RM theories. Currently known cases of asymmetries in undergoers therefore provide no evidence that exclusively supports Comparative Markedness constraints.

This result supports the intuition behind the present theory's approach to SLP Creole: coronals do not undergo assimilation because they are already adequately unmarked; there is no evidence that the difference between input and output markedness is taken into account in PoA assimilation.

As a concluding note, both Baković's and McCarthy's theories have more uses that just accounting for asymmetries in undergoer systems. The formalism behind Baković's theory was first proposed by Łubowicz (1998) to deal with derived environment effects (cf Inkelas 1999, McCarthy 2002a). Moreover, Baković's theory provides a solution to Majority Rule effects, discussed in §7.7.3.

McCarthy argues that Comparative Markedness can also be used to deal with types of opacity, derived environment effects, non-iterating processes, and non-structure-preserving coalescence. While RM theories may have application in other domains, the argument presented here is simply that they cannot adequately deal with the range of attested assimilation patterns, and that the Marked-Cluster constraints are necessary regardless of RM constraints.

7.7.3   Majority Rule

Lombardi (1996, 1999) identified a problem that is relevant to the faithfulness proposals raised here. IDENT[±voice] can ensure that the voicing value that is prevalent in the input is preserved in assimilation. In such a system, because there are two [+voice] segments in /ɡbt/ and only one [-voice] one, the output will be [ɡbd]; in contrast, there are more [-voice] in /ɡpt/ than [+voice] ones, so the output cluster will be [−voice]: [kpt]. In other words, whichever input feature value is in the majority appears in the output, hence the term 'Majority Rule' (Baković 1999a:3).

Lombardi (1999a,b) and Baković (1999a,b) claim that Majority Rules do not exist – there is no attested assimilation pattern like the one just described. Therefore, the Majority Rule issue is significant for the proposals here. As one of the consequences of the proposals in this Part is that there are faithfulness constraints that preserve more than one value of a feature, and such constraints produce Majority Rule effects, it is necessary to make some comment on the present theory's proposals and Majority Rules.

The following discussion owes a significant debt to Baković's (1999a,b) work on the Majority Rule problem. I conclude that (a) there is little empirical support for the claim that Majority Rules do not exist, and (b) the Majority Rule problem – if it does exist – must be solved without rejecting the existence of faithfulness constraints that preserve two or more feature values.

Section 7.7.3.1 discusses the Majority Rule problem in more detail, and generalizes it to coalescence as well. Section 7.7.3.2 identifies the rankings for Majority Rule effects, and section 7.7.3.2 discusses some solutions.

7.7.3.1 The empirical generalization

Before discussing the ranking that produces the Majority Rule effects, it is necessary to discuss whether Majority Rule effects ever have the opportunity to arise. I can add little to Baković's (1999b§4) discussion of this point so I quote the relevant passage here.

(122) "In order to garner any evidence from actual alternations, a language must at least have obstruent-final items, suffixes consisting of nothing other than an obstruent (or obstruents), and the ability to tolerate the resulting tautosyllabic obstruent cluster — each a taller order than the last. Indeed, even when such a language is in evidence, as in the case of Yiddish, there are insufficient data to truly see the full range of possibilities. I have no doubt that Lombardi is right in her suspicion that no language could have the equivalent of 'majority rule,' but it would seem that this is not really possible to know for sure.

Other assimilation processes do not seem to offer any solace."
Baković (1999b§4)

However, Baković then goes on to argue that non-local assimilation – i.e. harmony – does provide relevant situations. For example, if all vowels in a word must agree in [ATR], then a Majority Rule for ATR harmony would require a word with more +ATR input vowels than −ATR ones to surface with all +ATR vowels, while the opposite input situation would produce an entirely −ATR output. One issue this proposal raises is whether local assimilation and harmony are similar enough, formally speaking, so that the Majority Rule problem for harmony systems is not mitigated by incidental factors, such as the form of the markedness constraints that trigger the process. Baković (1999a,b) assumes that AGREE constraints trigger both local assimilation and harmony, so the Majority Rule arises in the same way for both processes in this system. It is imaginable, though, that the form of harmony-triggering markedness constraints may reduce the Majority Rule problem, though pursuing this ill-defined thought would be tangential to this discussion.

In any case, the Majority Rule problem also potentially arises outside of assimilation – in coalescence. In the following discussion, I will assume that the reader has examined chapter 8, so as to avoid duplication of material here.

In coalescence, input elements fuse into a single output segment. In formal terms, two or more input segments may correspond to a single output one. So, $/k_1d_2/$ may coalesce to form $[g_{1,2}]$. The Majority rule problem can arise in cases where three or more elements coalesce. In a Majority Rule-controlled coalescence, $/g_1b'_2t_3/$ would coalesce to $[d'_{1,2,3}]$, preserving the [+voice] specification because more input elements are [+voice]. In contrast, $/g_1p'_2t_3/$ would surface as $[t'_{1,2,3}]$. Again, the constraint IDENT[±voice] would be responsible for this outcome.

However, clear cases of coalescence are hard to find, and cases involving three separate segments are even rarer. Nevertheless, Pāli – discussed in ch.8§8.5.2.4 – presents the right context for a Majority Rule coalescence to occur: it coalesces three elements into

one (e.g. /sak$_1$-ʃ$_2$-t$_3$i/ → [sakː^h$_{1,2,3}$i] 'be able+aorist+3p.sg.'. In this particular case, though, the marked dorsal feature always survives – there is no Majority Rule effect. So, while it is possible for coalescence to provide the opportunity for a Majority Rule to occur, finding enough relevant cases to determine whether Majority Rules do or do not exist in coalescence will prove to be a significant challenge.

To summarize, it is not obvious that Majority Rule effects are impossible. While there is some intuitive validity to such a claim, a much wider range of appropriate data is needed before any claim can be made about the existence of Majority Rules. Even so, the following sections will assume that Majority Rules cannot exist, and determine their relevance to the present theory.

7.7.3.2 Rankings

The Majority Rule ranking is provided in (123); it is based on Lombardi (1996, 1999) and Baković (1999a,b). For consistency, I use constraints introduced in this chapter rather than those in the works cited.

(123)

/ɡbt/	*{±vd±vd}	IDENT[±vd]	ONSET-IDENT[±vd]	*[+vd]
(a) ɡb.t	*!			* *
☞　(b) ɡb.d		*	*	* * *
(c) kp.t		* *!		

Candidate (a) is eliminated because the cluster [bt] disagrees in voicing. Of the two remaining candidates, (b) wins because it preserves the most input values. The tableau shows that ONSET-IDENT[±vd] must be dominated by IDENT[±vd], otherwise the underlying voicing of the onset consonant will determine the outcome. Similarly, IDENT[±vd] must outrank the markedness constraint *[+vd], otherwise the voiceless candidate will always win, regardless of the outcome (see ch.8§8.3.1 for an example of the opposite ranking).

One further ranking not shown in the tableau above relates to IDENT[+vd] – this must be dominated by IDENT[±vd] otherwise the output will always be voiced (i.e. even /kpd/ would surface as [ɡbd]).

To complete the picture, tableau (124) shows how the ranking produces /ɡpt/ → [kpt] rather than *[ɡbd].

(124)

/ɡpt/	*{±vd±vd}	IDENT[±vd]	ONSET-IDENT[±vd]	*[+vd]
(a) ɡp.t	*!			* *
(b) ɡb.d		* *!	*	* * *
☞　(c) kp.t		*		

Lombardi (1996, 1999) and Baković (1999a§3.3.1) identify the source of the Majority rule problem as the constraint IDENT[±vd]. This constraint penalizes unfaithfulness in a gradient fashion: the more unfaithful segments, the more violations. This gradience effectively favours candidates that differ as little from the input, so favouring assimilations that cause the least number of changes.

Another crucial property is that this constraint preserves more than one feature value – i.e. both + and −. If it only preserved one value (e.g. IDENT[+vd]), there would be no Majority Rule effect – the output would always preserve the value specified. In other words, for Majority Rule effects to exist, it is crucial that some faithfulness constraint conflates two or more values of a feature in terms of faithfulness – i.e. unfaithfulness to either feature value incurs equal violations.

Of course, Majority Rules could in principle exist for all features, including Place of Articulation, nasality, vowel features, and so on. For example, the faithfulness constraint IDENT{KP} could result in a PoA assimilation that makes /akbka/ → [akgka] and /apgpa/ → [apbpa], where the output cluster's PoA is the same as the majority of the input segments (although such a PoA assimilation seems unlikely to exist).

To generalize over the preceding discussion, existence of IDENT constraints that preserve more than one value of a feature result in Majority Rule effects. Therefore, Majority Rules pose a problem for the present theory (with the empirical caveats discussed in the preceding section).

7.7.3.3 Solutions

The aim of this subsection is to identify some methods of avoiding the Majority Rule problem, and discuss their effectiveness and relation to the present theory. Baković (1998b§2) discusses two solutions, suggested by Lombardi (1999); one involves redefining IDENT constraints so that they are evaluated non-gradiently in relevant environments, and another relies on MAX-feature constraints. Baković shows that neither of these results is satisfactory; for discussion of the MAX-feature solution, see ch.6§6.4.2. Other solutions will be discussed here.

- *Privativity*

Since IDENT[±voice] is the problem, one obvious step would be to eliminate it. Two different theories provide this result. One is the notion that features are privative. If [voice] is a privative feature, there can be no faithfulness to [-voice], so there can be no constraint that preserves both values of [voice] equally. The problem with this approach is that faithfulness to [-voice] is demonstrably necessary in some cases. For example, Lombardi (1999) shows that [-voice] is explicitly preserved in Swedish assimilation (also see ch.8§8.3.1 and Wetzels & Mascaró 2001). Chapter 8 also provides examples where [-voice] survives in coalescence. Moreover, this type of solution only works for binary scales and features. For PoA, there must be faithfulness constraints that explicitly preserve both dorsal and labial values because coronal (or glottal) is the unmarked (i.e. unspecified) value (see ch.6). However, a constraint like IDENT{KP} also results in Majority Rule effects, as discussed above.

- *Single-value IDENT*

Another alternative follows from proposals by Pater (1996, 1999) and McCarthy & Prince (1995, 1997): there are two different constraints IDENT[+voice] and IDENT[-voice]. Neither constraint preserves *both* values of [voice] at the same time. However, there is evidence that this type of theory is not rich enough – constraints that preserve both (or several) values of the same feature are necessary. This same point is made by Lombardi (1996, 1999) for Swedish voice assimilation (also ch.8§8.3.1); Baković (1998b§4) makes a similar point for ATR harmony systems and the equivalent constraint IDENT[±ATR]. More generally, chapter 8 is devoted to showing that types of coalescence in which the unmarked value survives require faithfulness constraints that preserve different values equally, for voicing, PoA, and other features.

- *Baković's solution*

The conclusion that the discussion above comes to, and in Baković (1998a,b), is that faithfulness constraints that preserve more than one value of a feature are necessary. However, such constraints produce Majority Rule effects. This requires any solution to the Majority Rule problem to not derive from the form of faithfulness constraints.

Baković's (1999a,b) provides just such a solution, discussed in §7.7.2. It involves the local conjunction of a faithfulness and markedness constraint, which universally outranks their conjuncts. For the voicing assimilation case, *[+voice]&IDENT[±voice] outranks *[+voice] and IDENT[±voice], so ensuring that assimilation will never produce more marked segments (unless onset-specific faithfulness interferes). The tableau below shows how the conjoined constraint blocks voicing assimilation of /gpd/ to [gbd]:

(125)

/gpd/	*[+voice]&IDENT[±voice]	IDENT[±voice]	*[+voice]
(a) gbd	*!		* * *
☞ (b) kpt		* *	

The constraint *[+voice]&IDENT[±voice] penalizes candidate (a) because /p/ is unfaithful to its input [voice] specification in [b] and is the marked value [+voice]. In contrast, no segment in (b) is both unfaithful and marked: /g/ and /d/ are the unmarked [-voice]. In short, this solution allows faithfulness constraints to preserve multiple values of a single feature, while eliminating Majority Rules.

Unfortunately, the Bakovićian solution is not entirely compatible with the present theory, and perhaps with scales that have three or more values. For example, the present theory's constraints in locally conjoined terms would allow *{KP}&IDENT{KPT}, penalizing segments that are both unfaithful and are highly marked. Unfortunately, in clusters consisting solely of dorsals and labials, the Majority rule problem again appears for PoA: e.g. /mgp/ → [mbp] and /ŋpg/ → [ŋkg].

(126)

/mɡp/	*{KPT}{KPT}	*{KP}&IDENT{KPT}
(a) mɡp	*!	
☞ (b) mbp		*
(c) ŋɡk		* *!

(127)

/ŋbk/	*{KPT}{KPT}	*{KP}&IDENT{KPT}
(a) ŋbk	*!	
(b) mbp		* *!
☞ (c) ŋɡk		*

The problem is that *{KP}&IDENT{KPT} effectively preserves more than one feature (or, rather, equally penalizes unfaithfulness to two different feature values). However, without *{KP}&IDENT{KPT} there would be no way – in the present theory – to prevent Majority Rule problems involving coronals and non-coronals.

In short, a number of aspects of the Majority Rule problem – and whether there even is such a problem – seem unresolved. The empirical extent of the Majority Rule problem is not clear, and the most successful solution – Baković's (1999a,b) – is not entirely compatible with the present theory in regard to multi-valued features/scales.

7.7.4   Symmetric and Asymmetric IDENT

For the most part, the IDENT constraints used in this Part have referred to the Input→Output dimension. In this sense, they are 'asymmetric', a term introduced by Pater (1996, 1999): IO-IDENT{K} assigns a violation to /k/→[t] but not to /t/→[k]. In contrast, McCarthy & Prince (1995) and Baković (1999c) have proposed that IDENT constraints should be symmetric, at least along the Input and Output dimensions. So, IDENT{K} would assign a violation both to /k/→[t] and /t/→[k].

This section discusses the relation of the present theory to symmetricity. It concludes that the present theory is 'weakly asymmetric', having both symmetric and asymmetric constraints.

- *Weak and strong asymmetricity*

The debate between asymmetric and symmetric IDENT constraints relates to the values to which the constraints refer. For example, there is no practical difference between IO-IDENT and OI-IDENT constraints if they preserve all values of a feature. More concretely, the constraints IO-IDENT[±voice] and OI-IDENT[±voice] are formally different: the former requires input [voice] features to be preserved in the output, while the latter requires output [voice] features to be the same in the input. However, both constraints assign the same violations: i.e. to /b/→[p] and /p/→[b]. For IDENT constraints that preserve to all values of a certain feature, then, the debate over symmetric and asymmetric formulation is irrelevant.

However, there is a significant difference between asymmetric and symmetric IDENT constraints that preserve only a subset of a feature's values. For example, the asymmetric constraints IO-IDENT[+voice] and OI-IDENT[+voice] assign distinct violations. IO-IDENT[+voice] assigns a violation to /b/→[p], but not to /p/→[b]. While OI-IDENT[+voice] assigns a violation to /p/→[b], but not to /b/→[p]. A symmetric IDENT constraint would assign a violation to both /b/→[p] and /p/→[b].

In terms of the labels 'symmetric' and 'asymmetric' for IDENT constraints, two types of asymmetric theory may be identified. One type is 'strongly' asymmetric: there is no pair of IDENT constraints IO-IDENT and OI-IDENT that assign exactly the same violations. This type of theory would therefore admit constraints like IDENT[+voice] and IDENT[-voice], but ban constraints like IDENT[±voice].

A weakly asymmetric theory allows (some) some asymmetric constraints (e.g. IDENT[+voice], but does not ban constraints with a symmetric effect (e.g. IDENT[±voice]). The present 'marked-faithfulness' theory is therefore weakly asymmetric. For every feature *f*, it allows 'asymmetric' IDENT constraints IDENT[*mf*], where *m* is a marked value of *f*, and the 'symmetric' constraint IDENT[{*m,u*}f], where {*m,u*} range over all marked and unmarked values of *f*.

- *The need for asymmetric IDENT*
  Pater (1996, 1999) argues that asymmetric IDENT constraints are necessary; specifically IO-IDENT[+nasal] is used to prevent denasalization (/nt/→[tt]), while OI-IDENT[+nasal] prevents nasal substitution (i.e. /n₁t₂/ → [nn]/[n₁,₂]).

  The cases in this chapter provide further evidence that asymmetric IDENT constraints are necessary. As shown in section 7.2, Catalan prevents dorsals and labials from assimilating: i.e. /mt/ → [mt], *[nt]; /ŋt/ → [ŋt], *[nt]. However, it does not prevent coronals from becoming labial or dorsal: /np/ → [mp], /nk/ → [ŋk]. These facts follow straightforwardly by using the asymmetric IO-IDENT{KP}: this constraint prevents input dorsals and labials from being unfaithful in the output (i.e. */mt/ → [nt]), but does not prevent output dorsals and labials from having unfaithful input correspondents (i.e. ✓/nt/ → [mt]).

  In contrast, a symmetric IDENT constraint would both prevent dorsals and labials from undergoing assimilation, and prevent other segments from becoming dorsals and labials. More generally, a symmetric IDENT theory predicts that if *x* is prevented from assimilating, no *y* can assimilate to *x*. For example, if dorsals cannot assimilate, then no segment can become a dorsal through assimilation. As the studies in this chapter show, this prediction is too strong.

- *Symmetric constraints*
  On the other hand, Catalan-type systems do not show that IDENT constraints must be strongly asymmetric. Nothing prevents a constraint like IO-IDENT{KPTʔ} from existing, which is identical in its function to OI-IDENT{KPTʔ}. In fact, ch.8 provides evidence that such constraints are necessary, crucially allowing faithfulness 'conflation'. Furthermore, Baković (1999c) argues that symmetrically formulated IDENT constraints provide a more adequate explanation of [ɹ]~∅ alternations in Eastern Massachusetts

English. These proposals support the idea that an IDENT theory must be weakly asymmetric.

- *OI-IDENT*

The bifurcation of IDENT constraints into Input→Output and Output→Input versions raises an important issue: if OI-IDENT constraints do exist, do they pose any threat to the empirical generalizations made in this and the other chapters in this Part?

The answer is "no", and follows primarily from the fact that faithfulness constraints can only refer to marked feature values in the present theory. A constraint such as OI-IDENT[αf] effectively prevents an input segment's *f*-value from becoming α. Since α is always a marked value in the present theory, OI-IDENT constraints will always militate against features taking on a marked value. For example, OI-IDENT{K} prevents segments from becoming dorsals: it blocks /anka/ → [anka] (but not /anta/→[anta]). So, OI-IDENT constraints in the present theory effectively prevent outputs from becoming more marked, playing a similar role to markedness constraints.

Importantly, the present theory does not allow IDENT constraints that refer to unmarked values. For example, there can be no constraint OI-IDENT{T}. This constraint effectively prevents segments from taking on the less marked coronal feature: e.g. /anta/ → *[anta]; cf /anka/ → [anka]. The constraint OI-IDENT{T} has undesirable effects for both neutralization and assimilation. For example, it can produce neutralization to more marked elements, as shown in tableau (128).

(128)

/ak/	OI-IDENT{T}	*{K}	IO-IDENT{K}
(a) ak		*!	
☞ (b) ap			*
(c) at	*!		*

OI-IDENT{T} effectively prevents neutralization to the least marked element [t], forcing segments to neutralize to the next least marked segment – [p]. As discussed in ch.6§6.6.1, this type of neutralization is unattested.

In contrast, a constraint like OI-IDENT{K} has no pathological effects. It can prevent neutralization to more marked segments (i.e. /ap/→[ak]) – a result which is highly desirable.

While OI-IDENT constraints are not clearly undesirable, the need for their existence is still controversial. Pater (1996, 1999) and Gnanadesikan (1997) provide relevant arguments.

However, there is some reason to be cautious: OI-IDENT constraints predict effects that run counter to the predictions for triggering elements identified in §7.5.4. These effects follow from the fact that OI constraints can set a threshold on the markedness produced by assimilation (much like RM theories – see §7.7.2). For example, OI-IDENT{K} can prevent assimilation to dorsals: /anka/ → [anka] is violated by this constraint. In a language where OI-IDENT{K} outranks all marked-cluster constraints,

then, assimilation will only take place if the result produces labials or coronals. In other words, only labials and coronals will trigger assimilation.

(129)

/ankanpa/	OI-IDENT{K}	*{KPT}{KPT}
(a) ankanpa		* *!
(b) aŋkampa	*!	
☞ (c) ankampa		*

If OI-IDENT{KP} were ranked in the same position, it would prevent segments from assimilating to labials and dorsals.

The problem with these results is that there seems to be an implicational relationship in assimilation triggers: if *x* forces *y* to assimilate, then all *z* that are more marked than *x* also force *y* to assimilate (see (86)). So, if labials force preceding segments to assimilate, then so do dorsals. With OI-IDENT{K} ranked appropriately high, this generalization is reversed: labials trigger assimilation in this language while dorsals do not.

Therefore, the existence of marked-OI-faithfulness constraints may introduce undesirable effects into the typology of assimilation patterns. Further typological research into triggering effects will reveal whether this is a well-founded concern. For the moment, I merely identify it as a point of concern.

7.8   Summary and empirical implications

This chapter had two aims. One was to show that constraints that preserve only marked elements – marked-faithfulness constraints – are necessary. The other was to show that all other faithfulness constraints are unnecessary. Sections 7.2-7.3 were devoted to the first aim, and sections 7.4-7.7 argued for the second proposal.

- *The need for marked-faithfulness*

Evidence that marked-faithfulness constraints are essential was provided by systems in which only unmarked elements undergo assimilation. For example, only coronals undergo assimilation in Catalan: /son bɛus/→[som bɛus], cf [som docils], [tiŋ pa].

This pattern was argued to result from the blocking effect of the marked-faithfulness constraints. Because marked-faithfulness constraints can preserve more marked elements without preserving less marked ones, they can prevent the marked dorsals and labials from assimilating. The ranking is provided for the hypothetical form /ankamka/ in tableau (130).

(130)

/ankamka/	IDENT{KP}	*{KPT}{KPT}	IDENT{KPT}
(a) ankamka		* *!	
☞ (b) aŋkamka		*	*
(c) aŋkaŋka	*!		* *

The faithful candidate (a) has too many heterorganic clusters [nk mk] – so violating *{KPT}{KPT} twice – compared with the winning form (b). In contrast, the fully assimilated candidate (c) is fatally unfaithful to an underlying labial specification: /m/ is converted into [n] on the surface. In this way, IDENT{KP} blocks assimilation of marked elements, but places no restrictions on less marked elements so allowing candidate (b), with assimilation of the coronal, to win.

Section 7.3 was devoted to showing why no alternative analyses of 'unmarked-undergoer' systems could work.

- *No need for other faithfulness constraints*

Sections 7.4-7.6 were devoted to showing that only marked-faithfulness constraints are necessary. Specifically, there is no need for constraints like IDENT{T} or IDENT{PT}; these both preserve less marked elements without preserving more marked ones.

A challenge for this proposal appears in systems in which only marked elements undergo assimilation: the opposite of Catalan. For example, /n/ fails to assimilate in Sri Lankan Portuguese Creole (/siːn-pə/ → [siːnpə], *[siːmpə]), while labials and dorsals do (e.g. /maːm-ki/ → [maːŋki], /miːtiŋ-su/ → [miːtinsu]).

The sections argued that the failure of coronals to assimilate in SLP Creole is not due to the fact that they are preserved above all other elements; such an analysis would require the *un*marked-faithfulness constraint IDENT{T}. Instead, coronals do not undergo assimilation in SLP Creole because they are already adequately unmarked. This idea was formally expressed in a set of constraints that militate against heterorganic clusters. The most important characteristic of this constraint is that they assigned different types of cluster different violations. The net result is that clusters with more marked components are more marked than those with less marked components. This was used to explain why labials and dorsals undergo assimilation in SLP Creole: the faithful clusters [mk] and [ŋs] are too marked, violating the constraint *{KP}{KPT}. In contrast, the heterorganic cluster [np] is relatively less marked – it does not violate *{KP}{KPT}.

At this point, the Marked-Cluster constraints had been shown to provide an alternative to the unmarked-faithfulness constraints, but no reason had been given that one approach was necessarily more desirable than the other.

Accordingly, sections 7.5 and 7.6 were devoted to showing why the Marked-Cluster constraints are independently necessary. Section 7.5 dealt with systems in which only a subset of elements triggers heterorganicity-avoidance. Section 7.6 focused on languages with medial PoA neutralization and no final neutralization. The Marked-Cluster constraints were argued to be essential in accounting for these cases.

So, sections 7.5 and 7.6 showed that the Marked-Cluster constraints are independently necessary. There is therefore no need for the unmarked-faithfulness constraints, a conclusion also made in chapter 6.

- *Eliminating unmarked-faithfulness*

It would be ideal if unmarked-faithfulness constraints could be shown to make undesirable typological predictions, rather than simply be redundant. However, there are

few effects that are not subsumed by markedness constraints. Of the cases considered so far, one difference identified relates to multiple-method systems.   With a constraint IDENT{T}, there could be a system in which coronal+C clusters are eliminated by epenthesis, while non-coronals assimilate: i.e. /am+ka/ → [aŋka], /an+ka/ → [anaka]; this system is the opposite to Ponapean's.   In this system, IDENT{T} would prevent coronals from assimilating, so forcing the less desirable method of epenthesis to apply. Without a constraint that specifically preserves coronals, there is no way to produce such a system. More generally, in all multiple-method systems in which assimilation is employed, the present theory predicts that the least marked undergoers should assimilate; this prediction only holds if there are no unmarked-faithfulness constraints.

Unfortunately, the rarity of multiple-method systems precludes any conclusion about the validity of the prediction made by the present theory. Pending future discoveries in this area (or lack of them), it can be provisionally concluded that unmarked-faithfulness constraints are unnecessary, and that they should therefore be eliminated from the theory.

7.8.1   Implications for markedness

At first glance, the typological results of this chapter may seem to render any notion of markedness irrelevant to assimilation. After all, almost every imaginable set of PoAs can be undergoers of assimilation (or heterorganicity-avoidance in general), as shown in Table 7.16. For the sake of brevity only two languages at most are given for each language type. The sections indicated contain other examples.

Table 7.16: Typology of undergoers of assimilaton

K	P	T	Language
✓	✓	✓	Diola Fogny (J.Sapir 1965)
✓	✓		Sri Lankan Portuguese Creole (§7.4.1), Nunggubuyu (§7.4.4)
✓		✓	Harar Oromo (§7.4.3.2)
	✓	✓	NBA Inuktitut (§7.2.2), (Korean – §7.5.2)
		✓	Catalan (§7.2.1), Yamphu (§7.2.2)
	✓		Gunin/Kwini (see below)
✓			Chukchi, Uradhi (§7.4.3.1)
			Southern Sierra Miwok (§7.6.2.2),

A check ✓ in a column indicates that segments with the underlying PoA indicated (K=dorsal, P=labial, T=coronal) undergo assimilation.   Shaded boxes indicate that segments with the underlying PoA indicated do not assimilate.

As shown, every possible system is attested. Glottals were left out of the table because they are rarely available for assimilation (for incidental reasons – they are often excluded in the relevant positions – see ch.6). Section §7.2.2 provides relevant discussion.

The only system in the typology not discussed in the text is Gunin (McGregor 1993). In this language, both coronals and dorsals can appear in heterorganic clusters [nb nd ng ŋb], but labials cannot: [*md mg]. This system is a combination of NBA Inuktitut,

with IDENT{K} preserving dorsals, and SLP Creole, where *{KP}{KPT} only motivates assimilation of marked categories.

Although it seems that undergoers tell us nothing about markedness – since every imaginable system is attested – the preceding sections have argued that there are two distinct types of language in the table. One comes about by having marked-faithfulness constraints outrank all anti-heterorganic constraints (e.g. Catalan, N.B.A.Inuktitut). The other type owes its existence to the form of the cluster-markedness constraints (e.g. SLP Creole and Chukchi). Languages such as Harar Oromo and Gunin owe their structure to a mixture of both conditions. In short, although every option in the table above is filled, the formal apparatus for the different types of language is far from unified – some systems depend on marked-faithfulness constraints while others rely on the form of the cluster-markedness constraints.

- *Triggers*

In contrast to the undergoer typology, the theory proposed in this chapter predicts that only marked elements can trigger heterorganicity-avoidance, agreeing with observations by Mohanan (1993:75,76) and Jun (1995:71,78). For example, only labials and dorsals trigger deletion in heterorganic clusters in Attic Greek, and only dorsals trigger assimilation in Korean. I have found no language in which only coronals are triggers (i.e. /apta/ → [ata], /apka/ → [apka]). This prediction follows from the nature of the markedness constraints: the cluster-constraints all favour clusters with less marked elements over clusters with more marked elements. For example, [kp] harmonically bounds [pt] in terms of the cluster constraints, as does [tk] for [tp]. Since only the most marked clusters can be avoided through markedness constraints, there is no system in which only [Ct] clusters are avoided – such a system would require a markedness constraint that only targeted coronals.

The present theory also predicts that there is no relation between which elements trigger assimilation and which ones undergo it. The languages examined in previous sections indicate that this prediction is borne out. Coronals undergo deletion in Attic Greek, but they do not trigger it; dorsals trigger assimilation in Catalan, but they do not undergo it. The lack of a relation between undergoers and triggers ultimately derives from the form of the cluster-constraints. One can conceive of the markedness constraints as essentially having the form *{*undergoers*}{*triggers*}, given systems in which the leftmost element undergoes the process and the rightmost one triggers it. The independence of the two sets follows from the fact that there is a constraint for every combination of possible PoA sets. In short, undergoers are affected by both markedness and faithfulness, while triggers are only affected by markedness. Therein lie the differences in their markedness behaviour.

- *Voice*

While the focus of this section has been on place of articulation, the present theory extends to other scales as well (e.g. the obstruent voicing scale – sec.3.1.3, 5.3). The prediction of the present theory is that blocking effects analogous to those found with PoA assimilation should be found with other scales. For the voice scale this is borne out: the

marked [+voice] value does not assimilate in some languages (sec.3.1.3).[224] There are also cases of voice assimilation in which only [+voice] assimilates, analogous to SLP Creole's assimilation of dorsals and labials only (sec.5.3). This fact suggests that the markedness approach to PoA assimilation presented in §2 can and should be generalized to other scales.

7.8.2   Extending the theory: Where to go from here

The primary aim of this chapter was to provide evidence for marked faithfulness constraints. So, constraints were only proposed and examined insofar as they were relevant to this goal. The most significant of these were the constraints proposed for dealing with heterorganic consonant clusters – the Marked-Cluster constraints. These constraints raise questions that are outside the scope of this chapter's aims. Several major ones will be discussed here.

The marked-Cluster constraints used in this chapter do not mention constituency. So, *{KPT}{KPT} bans heterorganic clusters in all positions, whether they be heterosyllabic or tautosyllabic. Since this issue was not particularly relevant to the point of this chapter, it was not addressed above. I also did not discuss differences depending on manner of articulation: in some languages heterorganic stop clusters are tolerated, while nasals must be homorganic (Jun 1995:77) (but see sec.6.2.1)

It is possible that the Marked-Cluster constraints need to be enhanced or increased to deal with these issues. However, an alternative is that the form of markedness constraints is adequate, and that constituency-related effects result from the form of faithfulness constraints. If faithfulness constraints require preservation of onset elements, for example, they could block assimilation in onsets while allowing codas to assimilate. Thus, heterosyllabic clusters would not assimilate while tautosyllabic ones would, obviating the need for separate hetero- and tautosyllabic versions of the markedness constraints. This issue is left to further research. The only concern of this chapter is that there are markedness constraints that favour certain heterorganic clusters over others.

7.8.3   Harmony and marked-faithfulness

The focus of this chapter has been on PoA assimilation, with frequent mention of voice assimilation. Only brief mention of the predictions of the present theory for other types of assimilation and harmony systems is given here (for recent work on harmony within OT, see Kaun 1997, Baković 1999a, Walker 2000).

The marked-faithfulness constraints predict that marked elements may be exempt from processes that harmonize other features (e.g. [nasal], [ATR], [round], [back]). For

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[224] Lombardi (1995) proposes that there are differences between PoA and voice in terms of possible methods of avoidance,   deriving the differences partly from representational distinctions and partly from faithfulness constraint differences. In her approach, there is no feature [−voice], and MAX constraints apply to voicing while IDENT applies to PoA. While the too-many-methods problem is certainly significant, it may be the case that there are other non-representational solutions. For example, Wilson (2000) has presented a proposal that restricts possible methods of avoiding violations without appealing to representational differences.

example, one may expect to find a system with rounding harmony in which the marked [+round] vowels are exempt from harmonizing with [‒round] vowels, but the unmarked [‒round] vowels must harmonize with the [+round] vowels. For example, /poti/ would surface as [potu], but /pito/ would surface as [pito], not *[pite]. The net effect of such a system is that the marked [+round] feature seems to be the only one that harmonizes. Such 'marked only' harmony systems are common – even more common perhaps than systems in which both feature values harmonize (nasal harmony – Walker 2000, rounding harmony – Kaun 1997 and references cited therein, ATR harmony – Casali 2002 and references cited therein). For binary scales, such as | +round ⟩ -round |, systems in which marked elements are exempt from harmony are effectively the same as those in which only marked feature values propagate. This prediction follows from the present theory –from the fact that faithfulness constraints always preserve the marked elements.

The present theory makes no direct predictions about systems in which only unmarked values are exempt from harmony, or – similarly – in which only unmarked feature values propagate. In the present theory, such systems must be produced through the action of markedness constraints: faithfulness constraints cannot be used to exempt unmarked values alone. For example, I have argued that the SLP Creole system – in which only dorsals and labials undergo assimilation – comes about because the anti-heterorganic constraints specifically target marked elements; faithfulness constraints have nothing to do with the fact that coronals fail to assimilate.

So, since unmarked-undergoer systems do exist in voice and PoA assimilation, should we expect them to appear for other harmony systems? For example, should there be rounding harmony systems in which only [+round] vowels harmonize, while [‒round] ones are exempt? In such a system, /poti/ would surface unchanged as [poti], while /pito/ would surface as [pite].

The marked-faithfulness theory makes no predictions either way about the existence of such systems. In the marked-faithfulness theory, such systems do not come about through the action of faithfulness constraints, but through markedness constraints. Since the theory is about faithfulness constraints, then, predictions about such systems rests on a theory of harmony-triggering markedness constraints – a theory that is not within the scope of this chapter's aims.

Nevertheless, two relevant sets of markedness constraints have been proposed in this chapter – one for PoA and one for [voice]. The form of the constraints allows for systems in which only unmarked elements are exempt from agreement. However, this does not imply that the form of all harmony/assimilation-triggering constraints should be the same. For example, there may be no constraint *{±round}{+round}, so precluding the existence of rounding harmony systems in which only marked elements agree in rounding. Certainly, such systems are at least rare, and perhaps unattested – but accounting for this fact is not the aim of the present approach.

In short, the marked faithfulness theory predicts that for *all* scales – and therefore all assimilation and harmony systems – there may be systems in which only unmarked elements are undergoers. This chapter has shown the prediction to be borne out in PoA and voice assimilation; there are relevant cases for ATR, [round], and [nasal] harmony as well.

The faithfulness theory does not make any direct predictions about the existence of systems in which only marked elements undergo assimilation/harmony. The only prediction is that if such systems do exist for a feature, they come about through the action of markedness constraints. It is conceivable, then, that one may find variation depending on the feature – while PoA and voice assimilation evidently have such systems, it is not then necessary that rounding harmony, or harmony of any other feature, should also have systems in which only the marked value is an undergoer.

In contrast, any theory with unmarked faithfulness constraints predicts that systems in which only marked elements are undergoers exist for all assimilations and harmonies. With a constraint IDENT[uf], where u is the unmarked value of feature f, the unmarked value can be preserved while the marked one undergoes it.

Thus the two theories make different predictions with regard to marked-undergoer systems. Theories with unmarked faithfulness constraints predict that there should be systems in which only marked elements undergo assimilation/harmony for all features and scales. In contrast, the marked-faithfulness theory only predicts that all assimilations/harmonies should allow for a system in which only unmarked elements are undergoers; the existence of marked-undergoer systems depends on the form of faithfulness constraints.

Therefore, if it were proven that there are no marked-undergoer systems for some feature harmony/assimilation, this would strike a blow against theories with unmarked-faithfulness constraints, but not against the marked-faithfulness theory.

CHAPTER 8

FAITHFULNESS AND CONFLATION:

COALESCENCE

8.1 Introduction

As discussed in chapter 5, the faithfulness constraints proposed in this Part have two core properties. One has been discussed at length in the preceding two chapters: the constraints can preserve marked features without preserving less marked ones. The other core property is the focus of this chapter: the faithfulness constraints' stringent form.

As an example, the PoA faithfulness constraints are IDENT{K}, IDENT{KP}, IDENT{KPT}, and IDENT{KPTʔ}. They are in a stringency relation because every constraint preserves either a subset or superset of the feature values that every other constraint preserves. Quasi-tableau (1) graphically illustrates this point.

(1)   Stringent form of faithfulness constraints

	IDENT{K}	IDENT{KP}	IDENT{KPT}	IDENT{KPTʔ}
/k/ → [p] or [t] or [ʔ]	*	*	*	*
/p/ → [k] or [t] or [ʔ]		*	*	*
/t/ → [k] or [p] or [ʔ]			*	*
/ʔ/ → [k] or [p] or [t]				*

A stringent theory of faithfulness contrasts with one in which constraints refer to individual points on a scale: e.g. ‖ IDENT{K} » IDENT{P} » IDENT{T} » IDENT{ʔ} ‖.

Chapter 3 showed that evidence for stringent markedness constraints is found in a phenomenon called 'category conflation' – where a grammar ignores markedness distinctions between categories for the purposes of some process. This chapter identifies an analogous phenomenon for faithfulness: 'faithfulness conflation' is when unfaithfulness to two different scale categories is treated in the same way. To clarify, the previous chapters have shown that some languages assign greater importance to marked categories in terms of faithfulness: this explains why labials are exempt assimilation in Catalan, while coronals are not (ch.7§7.2). In contrast, this chapter shows that faithfulness distinctions can be collapsed, with languages treating unfaithfulness to labials and coronals as equally significant.

- *Coalescence*

The empirical focus of this chapter is coalescence. 'Coalescence' refers to the situation where two or more input segments fuse to form a single output segment; in the most transparent type of coalescence, the output preserves features of both input segments.

An example is consonant coalescence in the Indic language Pāli: e.g. /lab^h-tabːa/ → [lad$ː^h$abːa] 'take {gerund}' (§8.4, Fahs 1985). The input consonants /b^h-t/ fuse to form a geminate in the output: [d$ː^h$]. That coalescence has taken place rather than deletion is shown by the featural content of the output: [d$ː^h$] retains the voicing and aspiration of the input /b^h/, but has the Place of Articulation (PoA) of the input /t/.

In Optimality Theory, coalescence describes a situation where two or more input segments correspond to a single output segment (McCarthy 1995, 2000b, Lamontagne & Rice 1995, Pater 1996, 1999, Gnanadesikian 1995). In other words, both /b^h/ and /t/ of /lab^h-tabːa/ correspond to [d$ː^h$] in [lad$ː^h$abːa]. This type of multiple correspondence violates the constraint UNIFORMITY, given in (2) (McCarthy & Prince 1995).

(2)   UNIFORMITY   For all output segments *x*, *x* has only one input correspondent.

Coalescence in Pāli is motivated by a ban on certain types of coda consonant, called CODACOND here (see §8.4 for details). To produce coalescence, CODACOND must outrank UNIFORMITY, as shown in (3). The subscript numerals indicate correspondence relations.

(3)

/lab$^h_1$-t$_2$abːa/	CODACOND	UNIFORMITY
(a) lab$^h_1$t$_2$abːa	*!	
☞ (b) lad$ː^h_{1,2}$abːa		*

Coalescence of featurally distinct segments inevitably results in featural unfaithfulness. For example, /b^h/ is specified as a labial while /t/ is a coronal. Because a surface segment cannot be both labial and coronal at the same time, Pāli is forced to choose whether the coalesced output is one or the other. Whichever option it chooses – whether /b^h-t/ coalesce to form [d$ː^h$] or *[b$ː^h$] – PoA-unfaithfulness is inevitable. In constraint terms, the coalescence of /b^h-t/ will inevitably result in a violation of IDENT{KPT}.[226]

- *The marked survivor*

The 'inevitable violation' issue raises two questions for Pāli. One is why the marked value of [voice] – i.e. [+voice] – survives in the output: i.e. /b^h-t/ → [d$ː^h$], *[t$ː^h$].

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[226] Because IDENT is inevitably violated by coalescence of featurally non-identical elements, IDENT can block coalescence of all but featurally identical elements. See de Lacy (1998) and Keer (1999) for discussion and applications.

Another is why the unmarked PoA value 'coronal' survives: i.e. /bʰ-t/ → [dːʰ], *[bːʰ]. Both issues will be discussed in turn.

Preservation of the marked value of [voice] receives the same account as in previous chapters: [+voice] survives because marked values excite greater preservation. Thus, the output [dːʰ] is as faithful as possible to its input in terms of the feature [voice].

Tableau (4) illustrates the formal implementation of this point. IDENT[+voice] is crucial: it favours the candidate that preserves the marked [+voice] value.

(4)   Preservation of the marked

/labʰ₁-t₂abːa/	CODACOND	IDENT[+voice]	*[+voice]	UNIFORMITY
(a) labʰ₁t₂abːa	*!		* *	
(b) latːʰ₁,₂abːa		*!	*	*
☞ (c) ladːʰ₁,₂abːa			* *	*

The tableau shows that the marked [+voice] value is retained because the marked-faithfulness constraint IDENT[+voice] preserves marked elements alone. Candidate (b) fails to retain the [+voice] value of its input correspondent /bʰ/, so violating IDENT[+voice].

The tableau also identifies a conflict between the faithfulness constraint IDENT[+voice] and the markedness constraint *[+voice]. It is therefore crucial that IDENT[+voice] outrank *[+voice]: the opposite ranking would favour the candidate with a voiceless output segment. The nature of this conflict will prove to be crucial in accounting for the appearance of the unmarked PoA value.

- *The unmarked survivor*

In contrast to [voice] preservation, the unmarked PoA value [coronal] survives in Pāli coalescence: /labʰ-tabːa/ → [ladːʰabːa], *[labːʰabːa]. The fact that the unmarked PoA value (i.e. coronal) survives in coalescence cannot be ascribed to faithfulness. As shown for [voice], faithfulness constraints prefer preservation of the marked value, so a ranking of the PoA faithfulness constraints analogous to the ranking in (4) would produce an output that preserves the marked labial specification.

Instead, markedness constraints must be responsible for the survival of [coronal]. In terms of the PoA-markedness constraints, the constraint *{KP} favours [ladːʰabːa] over *[labːʰabːa]. *{KP} must outrank all faithfulness constraints that preserve labials without also preserving coronals. Tableau (5) illustrates this point.

(5)   Unmarked survivor ranking I

/labʰ₁-t₂abːa/	CODACOND	*{KP}	IDENT{KP}
(a) labʰ₁t₂abːa	*!	* *	
(b) labːʰ₁,₂abːa		* *!	
☞ (c) ladːʰ₁,₂abːa		*	*

The conflation aspect of the Pāli system appears in considering the extent of *{KP}'s influence. While *{KP} is clearly crucial in choosing between candidates with coalescence, it does not otherwise exert any influence over Pāli's surface phonology. In other words, *{KP} does not force a general elimination of labials and dorsals. More concretely, it cannot force the second /bː/ in /lab$^h_1$-t$_2$ab̠ːa/ to neutralize to [dː], producing *[ladː^{h}ad̠ːa].

To prevent *{KP} from causing a general neutralization of non-coronals, a faithfulness constraint must outrank it, blocking its effect. Tableau (6) shows that the constraint IDENT{KPT} does this job effectively.

(6)   <u>Unmarked survivor ranking II</u>

/lab$^h_1$-t$_2$abːa/	IDENT{KPT}	*{KP}	IDENT{KP}
☞ (a) ladː$^h_{1,2}$abːa	*	*	*
(b) ladː$^h_{1,2}$adːa	* *!		* *

IDENT{KPT} assigns two violations to candidate (b) – one for the loss of /b^h/'s input labial specification and one for the loss of /bː/'s input labial specification. Candidate (a) only incurs one violation – for the unfaithfulness of [dː^h] to /b^h/.

It is crucial that IDENT{KPT} is formulated as it is. IDENT{KPT} must assign the same violation to different types of faithfulness in order for the coalescence to take place correctly. Specifically, IDENT{KPT} must assign equal violations to /b^h-t/ → [dː^h] as it does to /b^h-t/ → *[bː^h]. This is shown in tableau (7).

(7)   <u>Unmarked survivor ranking II</u>

/lab$^h_1$-t$_2$abːa/	IDENT{KPT}	*{KP}	IDENT{KP}
(a) labː$^h_{1,2}$abːa	*	* * *!	
☞ (b) ladː$^h_{1,2}$-abːa	*	*	*
(c) ladː$^h_{1,2}$-adːa	* *!		* *

It is essential that both candidates (a) and (b) violate IDENT{KPT} equally. Because they are equally faithful at this point, the markedness constraint *{KP} can emerge to assign the crucial violation.

In other words, the mappings /b^h-t/→[dː^h] and /b^h-t/→*[bː^h] are *conflated* by IDENT{KPT} – they are treated the same, so allowing a lower-ranked constraint to make the crucial determination. The stringent form of the faithfulness constraints is crucial to producing this conflation. A set of non-stringent constraints is unable to produce this result, predicting that the marked value will always win in coalescence; this point is discussed in detail in §8.2.3.

-   *Organization*

Three basic types of coalescence are predicted by employing stringent constraints. The sections of this chapter are arranged around these three types.

In one type, the marked feature value survives. Section 8.2 presents an analysis of a relevant case in Attic Greek, where vowel coalescence retains the marked [+round] feature (Sommerstein 1973:55, Lejeune 1972:260-3, de Haas 1988). This section also introduces the ranking needed for coalescence.

The type that is of most interest here – because it illustrates faithfulness conflation – is one in which the unmarked feature survives. Sections 8.3 and 8.4 provide analyses of cases of this type. Section 8.3 focuses on consonantal features, namely [‑voice] and [‑continuant] in Chipewyan (Li 1946, Causley 1997). The other case is Swedish (Hellberg 1974, Sigurd 1965, and Lombardi 1999). Swedish does not involve coalescence, but rather bi-directional voice assimilation, in which [‑voice] always survives. The ranking needed for Swedish is akin to the one needed for coalescence, and so it also demonstrates the need for stringent faithfulness constraints.

The third type is a mixture of the other two types. Such 'hybrid' systems emerge with multi-valued scales. For example, a full analysis of Pāli shows that the unmarked value survives in the competition between a labial and coronal, but the marked value wins in the competition between a dorsal and a coronal. Sections 8.4 and 8.5 discuss hybrid cases, both found in Pāli. Section 8.4 examines the preservation of Place of Articulation while section 8.5 focuses on the fate of sonority in Pāli coalescence (Hankamer & Aissen 1974, Fahs 1985).

Section 8.7 presents a summary of the findings of this chapter.

8.2   The marked survivor: Attic Greek

This section has two aims. One is to introduce the ranking needed to produce coalescence (after McCarthy 1995, 2000b, Lamontagne & Rice 1995, Pater 1996, and others). The other aim is to show how faithfulness constraints can be used to preserve the marked value in coalescence, so accounting for one of the three types of coalescence (i.e. 'marked-coalescence') identified in the introduction.

The following sections provide an analysis of a case of marked-coalescence in Attic Greek. Famously, vowel hiatus is avoided through coalescence in this language: e.g. /mistʰo-ɛːte/ → [mistʰɔːte] 'hire out + subjunctive 2pl' (Allen 1974, Bubeník 1983:67ff, Lejeune 1972:260-3, Lupas 1972, Sommerstein 1973, Wetzels 1986, de Haas 1988). The output of coalescence always retains the marked [+round] feature. The following sections provide an account for this fact.

Section 8.2.1 describes the relevant facts.

An analysis is provided in §8.2.2.

Section 8.2.3 discusses alternatives. In particular, theories that do not make distinctions between PoA values in faithfulness constraints are examined.

Section 8.2.4 discusses the typological predictions of the theory for other scales.

A summary is provided in §8.2.5.

8.2.1 Description

The following discussion focuses on vowel coalescence in Attic Greek, so only phonological facts relating to the vowels and syllable structure will be discussed here; for a discussion of consonants, see ch.7§7.5.1. Table 8.1 lists the Attic Greek vowels (de Haas 1988:95ff, Bubeník 1983:ch.2); feature specifications for height and [ATR] are included as they will be relevant in the following analysis.[227] For an extensive discussion and analysis of Attic Greek vowel phonology, see de Haas (1988).

Table 8.1: Attic Greek vowels

		Short Vowels		Long Vowels	
high	+ATR	i	u	iː	uː
mid		e	o	eː	oː
	-ATR			ɛː	ɔː
low			a		aː

Syllable nuclei contain either a single vowel, a long vowel, or a diphthong. Diphthongs consist of a sequence V_1V_2 where V_2 is a high vowel and V_1 is a non-high vowel (i.e. [oi ai eu au ɛːi aːi ɔːi]).[228]

- *Coalescence: facts*

Coalescence is employed to avoid violating the restrictions on vowel clusters described in the preceding paragraph. More specifically, coalescence takes place when vowels cannot be incorporated into the same syllable: i.e. in V_1+V_2 sequences where V_1 and V_2 are not identical and V_2 was not high. Other clusters – i.e. long vowels and VV^{+high} clusters – do not coalesce because they form acceptable nuclei.

The generalizations in (8) hold of the output of Attic Greek vowel coalescence (adapted from Sommerstein 1973:55; see Lejeune 1972:260-3 for a more traditional statement).

(8)   Output of Attic Vowel Coalescence
        The output vowel is
                (a) long
                (b) round if and only if one of the input vowels is round
                (c) [-ATR] if and only if one of the input vowels is [-ATR]

Table 8.2 gives some content to (8) (compiled from Bubeník 1983:70, de Haas 1988). Grayed-out cells indicate incomplete data. For example, I did not find stems that clearly terminated in /eː/ and /oː/, nor suffixes that began with /aː/.

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[227] Orthographic equivalents: [i, iː]=ι, [e]=ε, [a, aː]=α, [o]=o, [u, uː]=υ, [eː]=ει, [oː]=ου, [ɛː]=η, [ɔː]=ω.
[228] Bubeník (1983:39) also includes [ei] and [ui], which occur only before vowels. I consider these 'false' diphthongs, consisting of [ej] and [uj] sequences.

Table 8.2: Attic Greek vowel coalescence

V₁+V₂	e	a	o	eː	ɛː	aː	oː	ɔː
e	eː	ɛː/aː²²⁹	oː	eː	ɛː		oː	ɔː
a	aː	aː	ɔː	aː	aː		ɔː	ɔː
o	oː	ɔː	oː	oː	ɔː		oː	ɔː
eː								
ɛː	ɛː		ɔː	ɛː	ɛː		ɔː	ɔː
aː	ɛː		ɔː	aː	ɛː		ɔː	ɔː
oː								
ɔː	ɔː	ɔː		ɔː	ɔː	ɔː	ɔː	ɔː

Supporting data is provided in tables (10) and (11) (compiled from Liddell & Scott 1996). The roots listed in the leftmost column combine with the suffixes in (9).

(9)   Suffixes
/-e-te/   2pl.present active indicative
/-o-men/   1pl present active indicative
/-eːn/   infinitive
/-ɛː-te/   2pl present subjunctive
/-oːsa/   present participle
/-ɔː-men/   1pl present subjunctive

Evidence that the suffixes have the form stated in (9) comes from verbs with consonant-final stems or high-vowel final stems. These do not undergo contractions in morpheme concatenation: e.g. /krin/ 'judge': [krinete], [krinomen], [krineːn], [krinɛːte], [krinoːsa] and [krinɔːmen].

(10)   Attic Greek: V + unround vowels

Root	/-e-te/	/-eːn/	/-ɛː-te/
/pʰile/ 'love'	pʰileːte	pʰileːn	pʰilɛːte
/tiːma/ 'honour'	tiːmaːte	tiːmaːn	tiːmaːte
/mistʰo/ 'hire out'	mistʰoːte	mistʰoːn	mistʰoːte
/zdɛː/ 'live'	zdɛːte	zdɛːn	zdɛːte
/peːnaː/ 'be hungry'	peːnɛːte	peːnaːn	peːnɛːte
/rʰiːgɔː/ 'be cold'	rʰiːgɔːte	rʰiːgɔːn	rʰiːgɔːte

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²²⁹ de Haas (1988:115ff) observes that an active process in Attic fronts [aː] to [ɛː] except after [r], [i], or [e]. This explains why /aː+e/, /a+ɛː/, and some /e+a/ are realized as [ɛː] rather than [aː]. However, all other combinations are realized as [aː]: i.e. /a+{e,eː,ɛː}/→[aː] and /aː+eː/→[aː], as well as some /e+a/ (e.g. /hugie-a/→[hugiaː], *[hugieː]). de Haas (1988:130ff) provides an account of the /e+a/→[ɛː] fact. Since it does not directly relate to roundness preservation, it is put aside here.

(11)   <u>Attic Greek: V + round vowels</u>

Root	/-o-men/	/-oːsa/	/-ɔː-men/
/pʰile/ 'love'	pʰiloːmen	pʰiloːsa	pʰilɔːmen
/tiːma/ 'honour'	tiːmɔːmen	tiːmɔːsa	tiːmɔːmen
/mistʰo/ 'hire out'	mistʰoːmen	mistʰoːsa	mistʰɔːmen
/zdɛː/ 'live'	zdɔːmen	zdɔːsa	zdɔːmen
/peːnaː/ 'be hungry'	peːnɔːmen	peːnɔːsa	peːnɛːte
/rʰiːgɔː/ 'be cold'	rʰiːgɔːmen	rʰigoːsa	rʰiːgɔːmen

Data relevant for V+a combinations is /gera+a/→[geraː] 'prize', and /aido+a/→[aidɔː] 'shame {acc.sg.}'.

- *Why coalescence?*

The majority of vowel-cluster simplifications show that Attic Greek vowel-cluster simplification involves coalescence rather than deletion. For example, /aː+o/ results in the output [ɔː] (e.g. /peːnaː+omen/ → [peːnɔːmen] 'we are hungry'); the output retains the roundness of the input /o/ but the ATR value of the input /aː/. The same can be seen in the combinations /o+a/→[ɔː], /o+ɛː/→[ɔː], /ɛː+o(ː)/→[ɔː], and /aː+e/→[ɛː].

The examples also show that 'direction' does not matter: the output is always [+round] and low regardless of whether the leftmost or rightmost consonant has the relevant value in the input. For example, both /a+o/ and /o+a/ coalesce to form [ɔː]: e.g. /tiːma+omen/ → [tiːmɔːmen], /aido+a/→[aidɔː].

- *Deletion and coalescence*

An important point must be made about the difference between the traditional notion of coalescence and its use here, using the formalism of Correspondence theory (McCarthy & Prince 1995). A number of the vowel-cluster simplifications are not coalescence in the traditional sense: e.g. /aː+eː/ → [aː]. The output [aː] does not retain any vestiges of /eː/, so – strictly speaking – is not coalescence in the traditional sense.

However, /aː+eː/→[aː] is still coalescence in terms of the formal apparatus used here. The reason that there is no vestige of /eː/ in the output is because the two vowels differ only in one feature – [ATR]. The coalesced output always chooses [-ATR] over [+ATR], as shown by /aː+oː/ → [ɔː]. So, the output of /aː+eː/ coalescence will be [-ATR] – i.e. [aː]. In short, /eː/'s features are entirely obscured in the output – a seemingly 'vacuous' coalescence. Even so, they are obscured for obvious reasons, and there is no reason to think that /aː$_1$/ and /eː$_2$/ do not fuse into a single output element: [aː$_{1,2}$].

This point raises a general issue, though: how do we know that /aː+eː/→[aː] – and all such cases where one of the input segments is entirely obscured in the output – does not simply involve deletion?

A preliminary point is that nothing in Correspondence theory bans coalescence of /aː$_1$+eː$_2$/ to [aː$_{1,2}$]. More specifically, no constraint forces deletion just when the coalesced output would be vacuous. Thus, vacuous coalescence is formally possible.

Furthermore, in some situations vacuous coalescence may be required by the constraint ranking. For example, because /aː+oː/→[ɔː] clearly involves coalescence, MAX must outrank UNIFORMITY (see the following analysis for discussion). Because coalescence is preferred over deletion in this competition, /aː+eː/ → [aː] may necessarily involve coalescence as well.

Whether /aː+eː/ does indeed involve coalescence depends on the blocking effect of higher-ranked constraints. If a constraint incidentally prevents coalescence in the /aː+eː/ situation, a candidate with deletion may win instead. For example, if coalescence of /aː+eː/ to [aː] would result in a loss of some feature [αf], IDENT[αf] could block coalescence, allowing deletion instead (see de Lacy 1999b, Keer 1999 for discussion of IDENT's blocking effect in coalescence). However, IDENT[f] must not block coalescence of /aː+oː/→[ɔː].

In this particular case, it is difficult to see what feature f is: the only feature /eː/ loses in /aː$_1$+eː$_2$/→[aː$_{1,2}$] is [+ATR], and this is also lost in /aː$_1$+oː$_2$/→[ɔː$_{1,2}$] coalescence. Thus – in this particular case – the constraints and ranking may dictate that /aː+eː/→[aː] is formally coalescence rather than deletion. More generally, once the || MAX » UNIFORMITY || ranking is established – i.e once *one* case can be shown to be coalescence – deletion cannot simply be assumed to take place in analogous vacuous coalescences in the same grammar.

A final caveat is that the cases in this chapter are considered coalescence rather than the result of an opaque process of assimilation followed by deletion. For example, the Attic Greek coalescence could be argued to involve the steps: (i) roundness assimilation: /aː+o/ → [ɔːo] followed by (ii) deletion [ɔː]. Evidence that an opaque analysis produces the wrong results or is irrelevant to the points made will be given for each case where appropriate.

- *Other dialects*

Attic is far from unique among Greek dialects. Lupas (1972), Lejeune (1972:260ff), and Bubeník (1983:67ff) discuss a number of other dialects with the same or similar restrictions (see Kaisse 1977 for Modern Greek). In contrast Aetolian, Boeotian, and Cretan have no or less coalescence (Bubeník 1983:67ff).

- *The markedness of [+round]*

The analysis presented in the following section focuses on the feature [+round]. The feature [+round] is the marked value of [round], so Attic Greek vowel coalescence is a case where the marked value survives – i.e. 'marked coalescence'.

Evidence that [+round] is marked independent of its context comes from vowel inventories. Some languages lack round vowels (e.g. Kabardian – Choi 1992a; Marshallese – Bender 1968, Choi 1992b; Margi – Maddieson 1987).[230] As shown in ch.6, the least marked element can never be eliminated in a binary scale. The fact that no

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[230] These systems do have round vowels, but only through assimilation. In non-assimilating contexts, round vowels are banned.

language lacks [‑round] vowels therefore shows that [‑round] is the less marked of the two roundness values (see ch.4§4.4.1.4).

The point could be raised that the markedness of roundness depends on backness: [+round] is preferred with back vowels, but [‑round] with front or central vowels. However, the markedness of [+round] can be seen in back vowel inventories as well: while there are languages with back round vowels and no back unround vowels (e.g. Maori), there are also languages with back unround vowels [ɯ] and no back round vowels of the same height (e.g. Koḍava – Ebert 1996, and many other Dravidian languages). In contrast, if a language has a front round vowel, it also has a front unround vowel of the same height: i.e. no language has [y] without [i].

These facts follow if (i) [+round] is generally more marked than [‑round] and (ii) there is a markedness constraint that bans unround back vowels: *[+back,+round]. If *[+back,+round] outranks *+round, the language will contain round back vowels and unround front vowels. The opposite ranking will produce a language with unround front and back vowels. No ranking will produce a ranking with only round front vowels. In short, the proposal is that [+round] is more marked than [‑round], with a contextual markedness constraint *[+back,+round] obscuring this fact for back vowels.

8.2.2   Analysis

For the roundness scale | +round 〉 ‑round |, the present theory predicts that there are two roundness-referring faithfulness constraints, listed in (12).

(12)   IDENT[+round]   If *x* is [+round] then *x*' is [+round]
       IDENT[±round]   If *x* is [αround] then *x*' is [αround]

One constraint preserves only the marked [+round] feature; the other preserves both values of [round]. As explained in ch.5-7, the theory does not allow a constraint that preserves only the unmarked feature – i.e. IDENT[‑round].

The scale also produces two markedness constraints: *[+round] and *[±round]. The former bans round vowels, and the latter is violated by both round and unround vowels. Given full specification, all vowels will violate *[±round].[231]

The following sections will show how the roundness constraints affect the result of coalescence in Attic Greek. The first two sections identify the ranking needed to motivate coalescence and avoid other outcomes. Section 8.2.2.3 shows how the marked value is preserved. Section 8.2.2.4 discusses preservation of other features. §8.2.2.5 discusses lack of a directional effect. §8.2.2.6 summarizes the ranking.

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[231] Despite the fact that *[±round] is violated by all vowels, this does not necessarily mean that *[±round] will be unnecessary or redundant (or more precisely, that *[±round] makes no division in the candidate set). *[±round] is effectively a general ban on vowels.

8.2.2.1 Motivating coalescence

The aim of this and the following section is to present the ranking responsible for coalescence. The coalescence ranking has previously been identified in McCarthy (1995, 2000b), Lamontagne & Rice (1994, 1995), Pater (1995), Gnanadesikan (1995), and developed further in later work (de Lacy 1999b, Keer 1999, Struijke 2001).

Avoidance of vowel clusters in Attic Greek is motivated by ONSET. This constraint penalizes heterosyllabic vowel clusters because the second vowel appears in an onsetless syllable. For example, ONSET is violated by *[tiː.ma.o.men], so forcing coalescence of the /ao/ cluster.

ONSET conflicts with the constraint UNIFORMITY, defined in (2). This constraint bans output segments with more than one input correspondent, which effectively bans coalescence (McCarthy & Prince 1995). Tableau (13) shows that ONSET must outrank UNIFORMITY.

(13)   Attic Greek I: Triggering coalescence

/tiːma$_1$+o$_2$men/	ONSET	UNIFORMITY
(a) tiː.ma$_1$.o$_2$.men	*!	
☞ (b) tiː.mɔː$_{1,2}$.men		*

As shown in the tableau, coalescence in (b) avoids the onsetless syllable that dooms (a).

The next step is to show why other outcomes – deletion, epenthesis, and resyllabification – are not employed instead of coalescence.

8.2.2.2 Avoiding deletion, epenthesis, and neutralization

The hiatus in *[tiː.ma.o.men] is not avoided by deletion or epenthesis; MAX and DEP must therefore (at least) outrank UNIFORMITY.

(14)   Attic Greek II: Avoiding other outcomes

/tiːma$_1$+o$_2$men/	ONSET	MAX	DEP	UNIFORMITY
(a) tiː.ma$_1$.o$_2$.men	*!			
(b) tiː.ma$_1$.men		*!		
(c) tiː.ma$_1$.to$_2$.men			*!	
☞ (d) tiː.mɔː$_{1,2}$.men				*

In fact, a further ranking can be established based on data such as [a.gɔː] 'to lead', and [e.pi.or.kos] 'perjured'. In these cases, onsetless syllables are tolerated – they are not eliminated through deletion or epenthesis, so MAX and DEP must outrank ONSET. Why [i.o] in [e.pi.or.kos] is not eliminated through coalescence will be discussed presently.

The onsetless syllable in *[tiː.ma.o.men] could be avoided by syllabifying the [a] and [o] into the same nucleus: i.e. *[tiː.mao.men]. However, this method of hiatus-

avoidance is blocked in Attic Greek because only high vowels are allowed as the second member of diphthongs: e.g. [poi.oin.tai] 'make {pres.middle indicative 3 pl}', [pneu.ma] 'spirit {nom.sg}'.

The second member of a diphthong is a non-DTE of a syllable. So, the Attic Greek restriction – as in many other languages – can be ascribed to a ban on high-sonority non-DTEs (see ch.4). The relevant constraint is therefore $*\text{-}\Delta_\sigma{\geq}\{e,o\}$, banning all segments more sonorous than high vowels in as syllable non-DTEs of syllables.[232]

The $*\text{-}\Delta_\sigma{\geq}\{e,o\}$ constraint is not enough on its own. Vowels must also be blocked from raising: i.e. /tiːma.o.men/ must be prevented from surfacing as *[tiːmau.men], where the /o/ has raised to [u] in order to form an acceptable diphthong. To block raising, the constraint IDENT[±high] is employed here (also see ch.4§4.3). These constraints must also outrank UNIFORMITY.

(15)   <u>Attic Greek III: Avoiding neutralization</u>

/tiːma$_1$+o$_2$men/	ONSET	$*\text{-}\Delta_\sigma{\geq}\{e,o\}$	IDENT[±high]	UNIFORMITY
(a) tiː.ma$_1$.o$_2$.men	*!			
(b) tiː.ma$_1$o$_2$.men		*!		
(c) tiː.ma$_1$u$_2$.men			*!	
☞ (d) tiː.mɔː$_{1,2}$.men				*

As with MAX and DEP, there is evidence that IDENT[±high] outranks ONSET. Hiatus is permitted with sequences of high vowels + non-high vowels: e.g. [e.pi.or.kos] 'perjured'. ONSET does not force lowering of [i] in this position – i.e. [e.poːr.kos] – because IDENT[±high] would be violated in the process.

As a final note, the ranking above correctly tolerates (i) diphthongs that terminate in a high vowel and (ii) long vowel nuclei: e.g. /kainos/ 'new' → [kai.nos], *[ka.i.nos]; /hista-aːsi/ 'set' → [histaːsi], *[hista.aːsi]. This point is illustrated in tableau (16). Again, ONSET can be seen to be active, favouring [kai.nos] over [ka.i.nos].

(16)

/ka$_1$i$_2$nos/	ONSET	$*\text{-}\Delta_\sigma{\geq}\{e,o\}$	IDENT[±high]	UNIFORMITY
(a) ka$_1$.i$_2$.nos	*!			
☞ (b) ka$_1$i$_2$.nos				
(c) kaː$_{1,2}$nos			*!	*
(d) kiː$_{1,2}$nos			*!	*

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[232] Importantly, this constraint does not ban long vowels like [aː ɛː ɔː eː oː]. This is because a long vowel does not contain a root-non-DTE of a syllable. From the definition in ch.4, a non-DTE of a syllable is a root node that is (i) dominated by a σ node and (ii) is not a σ-DTE. Long vowels consist of a single root node which is a Δ_σ. No root node in a long vowel is a non-DTE. Therefore, $*\text{-}\Delta_\sigma{\geq}\{e,o\}$ does not apply to long vowels.

In summary, every alternative in Attic Greek is blocked – deletion, epenthesis, neutralization, and diphthong formation. The least costly way to resolve hiatus is therefore coalescence.

8.2.2.3 Preserving the marked value

All cases of hiatus involving a round vowel result in a round vowel in the output; the only time a non-round vowel appears is when neither of the input segments are round (e.g. /peːnaː-ete/ → [peːnɛːte]).

Since [+round] is more marked than [‑round], it is impossible to appeal to a markedness constraint to prefer round coalesced vowels over unround vowels. Therefore, some faithfulness constraint that preserves roundness must be active. The marked-faithfulness theory provides the constraint IDENT[+round] – this constraint requires that input round vowels remain round in the output; it makes no demands on unround vowels.

IDENT[+round] must outrank all markedness constraints that favour [‑round] vowels over [+round] ones – i.e. *[+round]. Tableau (17) illustrates this point.

(17)   Attic Greek IV: Preserving the marked value

/tiːma$_1$+o$_2$men/	IDENT[+round]	*+round
(a) tiːmaː$_{1,2}$men	*!	
☞ (b) tiːmɔː$_{1,2}$men		*

Candidates (a) and (b) both avoid an ONSET violation by coalescing the vowels. However, (a) fails to retain the input [+round] specification of /o/, so fatally violating IDENT[+round]. The tableau shows that the ranking ‖ IDENT[+round] » *+round ‖ is essential – the opposite ranking would favour (a) over (b).

The ranking of the markedness constraint *[±round] is also indeterminable. Since *[±round] does not favour [‑round] vowels over [+round] ones, it is not crucially ranked with respect to IDENT[+round] in Attic coalescence.[233]

- *Generalization*

In short, the crucial ranking for preserving the marked feature in Attic Greek is that IDENT[+round] outranks all markedness constraints that ban round vowels. Generally speaking, to preserve a marked value *m*F rather than an unmarked value *u*F in coalescence, some faithfulness constraint that preserves *m*F but not *u*F must outrank all markedness constraints that favour *u*F over *m*F.

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[233] Because *[±round] is violated by all vowels, MAX must outrank it otherwise all vowels would be deleted.

8.2.2.4 IDENT[f] as a blocking constraint

Now that the ranking for IDENT[+round] has been established, the ranking for IDENT[±round] can be identified.

At first glance, it may seem that there is no way to determine the ranking of IDENT[±round]. IDENT[±round] is equally violated by both output candidates in coalescence. For example, from /tiːma$_1$-o$_2$men/, both *[tiːmaː$_{1,2}$men] and [tiːmɔ$_{1,2}$men] incur equal violations of IDENT[±round]: the latter for the loss of [‒round] in /o/→[aː] and the former for the loss of [+round] in /a/→[ɔː]. This equal violation seems to make the constraint inactive.

However, IDENT[±round] does have a significant effect: it is violated by candidates with coalescence. IDENT[±round] is not violated by candidates with epenthesis *[tiːma$_1$to$_2$men], deletion *[tiːma$_1$men], neutralization *[tiː.ma$_1$u$_2$.men], and inaction *[tiː.ma$_1$.o$_2$.men] – all of these candidates preserve the [round] specifications of the /a/ and /o/.

In being violated by coalesced forms, IDENT[±round] is like UNIFORMITY. More precisely, IDENT[±round] is violated by candidates that are unavoidably unfaithful through coalescence.

For further discussion of this point, see Pater (1995). This property of IDENT constraints has been used to block coalescence of non-identical elements, by de Lacy (1999b) for morphological haplology, and by Keer (1999) for geminates.

To prevent IDENT[±round] from blocking coalescence, it must be dominated by MAX, DEP, ONSET, and IDENT[‒high], as shown in tableau (18).

(18)   Attic Greek V: IDENT can block coalescence

/tiːma$_1$+o$_2$men/	ONSET	MAX	DEP	IDENT[±high]	IDENT[±round]
(a) tiː.ma$_1$.o$_2$.men	*!				
(b) tiː.ma$_1$.men		*!			
(c) tiː.ma$_1$.to$_2$.men			*!		
(d) tiː.ma$_1$u$_2$.men				*!	
☞ (e) tiː.mɔː$_{1,2}$.men					*

The ranking needed for IDENT[±round] is also needed for every feature for which the coalesced output is unavoidably unfaithful. For example, [tiːmɔːmen] is also unavoidably unfaithful to ATR: it does not preserve /o/'s [+ATR] feature; its competitor *[tiːmoːmen] does not preserve /a/'s [‒ATR] feature. The same is true for [low]: [tiːmɔːmen] is unfaithful to /a/'s [+low] specification. Therefore, IDENT[±ATR] and IDENT[±low] must be ranked in the same way as IDENT[±round]. This point will be raised in the other cases discussed in this chapter, since it is an essential part of the coalescence ranking. The most extensive – and complex – discussion in this chapter can be found in §8.3.2.5, for coalescence in Chipewyan. Note that IDENT[±high] was used in this way in tableau (16) to block coalescence of a high and non-high vowel.

8.2.2.5 Preserving other features: ATR, height, and length

This section discusses height, quantity, and their effect on the output of Attic Greek coalescence.

- *height and [ATR]*

The traditional description of coalescence is that if either of the input vowels is low, the output vowel is also low. Following the analysis of similar cases by Casali (1997a,b), the relevant phonological feature is [ATR]: [ɛ ɔ a] are [−ATR] while [e o i u] are all [+ATR].

Preservation of [−ATR] is shown by /tima + omen/ → [timɔːmen], where the input vowels are [−ATR] and [+ATR] respectively, but the output vowel is [ɔː] is [−ATR]. The form /pʰile + ɔː/ → [pʰilɔː] 'I love' shows that there is no directional effect – the input vowels are [+ATR] and [−ATR] respectively, but the output is still [−ATR].

The retention of the [−ATR] specification receives the same treatment as preservation of [+round]. If a constraint that preserves [−ATR] outranks all markedness constraints against low vowels, the winning form will have a low vowel.[234]

(19) Attic Greek VI: Preserving [−ATR]

/tiːma$_1$+o$_2$men/	ONSET	IDENT[+round]	IDENT[−ATR]	*-ATR
(a) tiːma$_1$.o$_2$men	*!			*
(b) tiːmaː$_{1,2}$men		*!		*
(c) tiːmo$_{1,2}$ men			*!	
☞ (d) tiːmɔː$_{1,2}$ men				*

This is not quite the end of the story for height preservation, though. Coalescence of /a(ː)/ with an unround vowel produces [aː]: /tiːma-ɛːte/ → [tiːmaːte]. The ranking established so far will not decide between the competitors [tiːmaːte] and *[tiːmɛːte] since both contain low vowels.

There are two ways to achieve the right result. A faithfulness constraint like IDENT[+low] can favour [aː] over [ɛː] ([ɛː] is taken to be [−high, −low, −ATR]). A markedness constraint can also be used to favour [aː] over [ɛː]. As in ch.3, a constraint banning low sonority syllable heads can be invoked – *Δ$_σ$≤{ɛ,ɔ}. The choice of analysis is immaterial to the main point here, so the ramifications of the two approaches will not be explored here. However, it is important that – whatever constraint is employed – it must

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[234] This analysis assumes that [−ATR] vowels are marked. There are no clear implications as to which ATR value is preserved in coalescence (cf de Haas 1988:81, Casali 1997a,b). In Attic Greek, the lowest height possible wins (restricted by the requirement that the vowel be [+round]); the same is true in Modern Greek, Rotuman, Korean, Japanese, and Tunica. In contrast, in Tsishaath Nootka the highest height wins: a combination of a high vowel and /a/ yields a (+ATR) high vowel (Stonham 1999: 64); the same is true of Dakota (/tʃʰã i-tʃoɣ/ → [tʃʰĩ tʃoɣ], *[tʃʰãtʃoɣ]) and Mohawk (Hopkins 1987). In contrast, Sanskrit chooses a compromise height: /a(ː)+i/ → [eː], /a(ː)+u/ → [oː].

be ranked below IDENT[+round]. The opposite ranking would favour *[tiːmaːmen] over [tiːmɔːmen] (a ranking found in Modern Greek – Kaisse 1977).

- *Length*

The other input property retained in Attic Greek is vowel length. Even identical vowels do not coalesce into a single output vowel; they end up as a long vowel: /pʰile + ete/ → [pʰileːte], *[pʰilete]. An account of this fact refers to the constraint MAX-μ, which requires input moras to be retained in the output (McCarthy 1995, 2000b; Morén 1999).[235] With MAX-μ outranking constraints against complex nuclei, input moraic content will be retained.

However, there is one further crucial ranking involving MAX-μ. The form /tima+ɔː/ → [timɔː] 'estimate {1sg}' shows that ONSET outranks MAX-μ; the opposite ranking would block coalescence:

(20)   Attic Greek VII: Preserving moraic content

/tiᵘmaᵘ + ɔːᵘᵘ/	ONSET	MAX-μ
(a) tima.ɔː	*!	
☞ (b) timɔː		*
(c) timɔ		* *!

Both ONSET-satisfying candidates (b) and (c) violate MAX-μ: there are three moras in the input, but only two in (b) and one in (c). Since (b) incurs fewer violations than (c), it wins. However, if MAX-μ outranked ONSET, coalescence would be blocked and the faithful form (a) would win.[236]

8.2.2.6 Lack of direction

The final ranking issue to be addressed in this analysis relates to the fact that direction and morphological affiliation are irrelevant to roundness preservation in Attic. Regardless of whether the round vowel is first or second in the input, or whether it is in a root or affix, the output vowel is always round: compare /mistʰo+ete/→[mistoːte] and /pʰile+omen/→[pʰiloːmen]. Therefore, any constraint that favours the [round] value of segments depending on input position or morphological affiliation must be dominated by IDENT[+round].

[235] Coalescence of moras must also be banned. Cases like this one raise issues about Richness of the Base: since we cannot guarantee that input vowels will have moras, how can we use MAX-μ to ensure a long vowel in the output? One way is to ensure that only vowels with moras are retained in the output. If the constraint DEP-μ – banning insertion of moras – outranks MAX, moraless input vowels will be deleted in the output. Thus, only candidates with vowels that had input moras will be relevant. An alternative is an opaque analysis: all vowels are assigned moras, then coalescence takes place.
[236] All moras could be preserved by coalescing to form a trimoraic segment (i.e. *[ti.mɔːː]). However, tri-moraic syllables are banned in the language generally.

In the present instance, the most relevant constraint is root-IDENT[±round], which preserves the roundness of input root segments (after McCarthy & Prince 1994, Beckman 1998). The relevant ranking is provided in (21).

(21)   Attic Greek VIII: Eliminating directional effects

/p^{h}ile$_1$ + o$_2$men/	IDENT[+round]	root-IDENT[±round]
(a) p^{h}ile:$_{1,2}$ntas	*!	
☞ (b) p^{h}ilo:$_{1,2}$ntas		*

As the tableau shows, it is crucial that IDENT[+round] dominate root-IDENT[±round], otherwise the roundness value of the root segment will always win.

8.2.2.7 Ranking summary

The essential parts of the Attic Greek ranking are represented in Figure 8.1.

Figure 8.1: Attic Greek vowel coalescence ranking
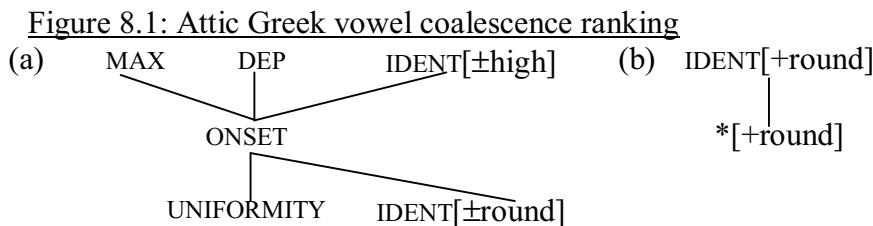
The diagram shows that the ranking that motivates coalescence (a) and the ones that determine the output quality (b) are relatively independent. IDENT[+round] could almost be ranked above or below any of the constraints in (a) and have the same effect. The only condition is that no markedness constraint that favours [‑round] vowels over [+round] ones outrank IDENT[+round].

The ranking in (a) expresses the fact that all constraints that ban coalescence – UNIFORMITY and IDENT[±round] (also IDENT[±ATR] and IDENT[±low]) – are rendered inactive by constraints that (i) ban some surface configuration (ONSET), and (ii) block every other possible outcome (MAX, DEP, IDENT[±high]).

- *Other cases*

This subsection concludes by identifying other cases that are similar to the one found in Attic Greek. The same pattern of [+round] preservation is found in several other cases of vowel coalescence. Languages in which [+round] is preserved include Tsishiaath Nootka (Stonham 1999), Rotuman (Churchward 1940), Korean (Sohn 1987), Sanskrit (Whitney 1889), Pali (Geiger 1943), and Tunica (Haas 1946).

However, it is worth pointing out that [+round] does not always take precedence in vowel coalescence, nor is it predicted to do so. In Modern Greek, for example, preservation of [+low] overrules faithfulness to [round] (Koutsoudas 1962, Sanders 1974, Kaisse 1977).

While any non-low vowel [i e o u] plus a round vowel yields a round vowel, any vowel combination with the [+low] vowel [a] produces [a]. In this case, IDENT[+low] outranks IDENT[+round], producing the [+low, -round] vowel [a]; the language bans [+low, +round] vowels (i.e. [ɶ œ ɔ]). Furthermore, §8.4 will discuss cases where the coalesced output retains the [-round] specification.

8.2.3   Alternatives

The facts of coalescence in Attic Greek rule out a number of alternative theories of faithfulness constraints. In particular, theories that either have no faithfulness constraint that specifically preserves marked elements (IDENT[+round] in the present case), or rank all faithfulness constraints that preserve unmarked values above all those that preserve marked values (i.e. ‖ IDENT[-round] » IDENT[+round] ‖) cannot account for the Attic Greek system.

Pater (1995) shows that it is impossible to retain the marked value in coalescence without a faithfulness constraint that preserves only marked values. Since no markedness constraint favours the marked feature value over the unmarked one, and no faithfulness specifically preserves the marked value, the coalesced output with the unmarked value will harmonically ban the competitor with the marked value.

To illustrate, consider a theory that has only one faithfulness constraint; the constraint preserves both values of [round] – IDENT[±round] (cf Prince 1998 for Place of Articulation). No faithfulness constraint will favour the mapping $/o_1e_2/\rightarrow[o_{1,2}]$ over $/o_1e_2/\rightarrow[e_{1,2}]$ – IDENT[±round] assigns the same violations to both. No markedness constraint favours [o] over [e]: neither *[+round] nor *[±round] favours [o] over [e], and *+round favours [e] over [o]. Since no constraint favours $/o_1e_2/\rightarrow[o_{1,2}]$ over $/o_1e_2/\rightarrow[e_{1,2}]$, the coalesced unround vowel $[e_{1,2}]$ is a therefore a harmonic bound for the coalesced $[o_{1,2}]$.

(22)   Failed Theory I: no marked-faithfulness constraint

/pʰile₁ + o₂n/	IDENT[±round]	*[+round]	*[±round]
☀ (a) pʰileː₁,₂n	*		*
(b) pʰiloː₁,₂n	*	*!	*

This result not only rules out theories that have only one faithfulness constraint IDENT[±round], but theories in which faithfulness to the unmarked is always dominant: e.g. in the fixed ranking ‖ IDENT[-round] » IDENT[+round] ‖, and with the stringent constraints IDENT[-round], IDENT[±round]. With both these theories, there is no ranking in which $/o_1e_2/\rightarrow[o_{1,2}]$ is favoured over $/o_1e_2/\rightarrow[e_{1,2}]$: no faithfulness constraint favours the former mapping, and no markedness constraint favours [o] over [e]. Of course, these theories have already been shown to be inadequate for neutralization in ch.6 and assimilation in ch.7; this case drives another nail into the coffin.

- *Opaque analyses*

The other alternative approach that must be considered for Attic Greek is one with opacity. In such an approach, Attic Greek vowel coalescence is a two-step process (e.g. de Haas 1988). It starts with assimilation of roundness, then the [+ATR] vowel deletes, followed by compensatory lengthening to form a long vowel.

(23)   Opaque analysis of coalescence
     Input   /tiːma-omen/
     round assimilation   [tiːmɔomen]
     +ATR deletion   [tiːmɔmen]
     compensatory lengthening   [tiːmɔːmen]

An interesting point is that whether an opaque analysis is employed instead of a coalescence one for the cases in this chapter, the core proposal still stands. In order to explain why [+round] always wins in roundness assimilation, regardless of the direction, a constraint like IDENT[+round] is indispensable. Without a constraint that favours preservation of [+round] over [−round], all vowels should end up as [−round], since this is the least marked feature value. A relevant case of such a 'bi-directional' assimilation system is given in §8.3.1.

Even so, there is still reason to think that coalescence – at least in the cases discussed in this chapter – is a one-step process. The reason relates to the fact that there is no evidence for roundness assimilation outside coalescence. High vowels do not assimilate in roundness: e.g. [poi̯.ɔː] 'I make', *[pou.ɔː]; [eu̯.a.res.tɔːs] 'acceptably', *[ei.a.res.tɔːs]. In short, in an opaque analysis of roundness assimilation must be restricted to elements that will coalesce.

The same point can be made for [+ATR] deletion (or [−ATR] assimilation, depending on the details of the analysis).

This problem does not arise in the present analysis because coalescence does not depend on an independent assimilation process. More concretely, the analysis presented above did not employ any assimilation-triggering constraints.

This same criticism can be raised for all the cases discussed in this chapter. An opaque analysis of the cases appeals to processes that have no general applicability in the language.

As a final note, this observation does not mean that there cannot be an independent assimilation process that mimics the effect of an opaque analysis of outputs. For example, there could be a language just like Attic Greek that also contains a process of roundness assimilation. This makes no difference to the present point, though: opaque analyses of coalescence predict that coalescence is always accompanied by an independent process of assimilation of the relevant feature. As shown by Attic Greek, this is not the case (also see §8.2.3.6).

8.2.4   Marked survivors elsewhere

The aim of this section is typological: it identifies cases that are analogous to Attic Greek's coalescence, but differ in terms of the marked feature they preserve, showing that the analysis presented above generalizes to other scales.

- *Nasality*

Dakota is akin to Attic Greek in that the [+round] specification of coalesced vowels persists in coalescence (Shaw 1980:34, 82). In addition, the marked feature [+nasal] also survives.[237]

(24)   Dakota coalescence: [+nasal] preservation
　　　/tʃʰã i-tʃoɣ/　　→ [tʃʰ ĩtʃoɣ] 'drift log'
　　　/xʔã o-tʔa/　　→ [xʔũtʔa] 'be tired out from working'
　　　/ptã ehã/　　　→ [ptĩha] 'last fall'
　　　c.f.　　/tʰa-isto/　　　→ [tʰisto] 'ruminant's foreleg'
　　　　　　/wa-o-waʃte/ → [wowaʃte] 'goodness'
　　　　　　/ka-eja/　　　→ [keja] 'to say that'

That the feature [+nasal] is marked for vowels is clear from inventory facts: all languages with nasal vowels have oral vowels, but not vice-versa.

In Dakota, then, IDENT[+nasal] must outrank all constraints against nasal vowels: i.e. *[+nasal]/V. The result is preservation of nasality. Tableau (25) illustrates this ranking and its effect.

(25)   Dakota [+nasal] preservation

/tʃʰã₁ i₂-tʃoɣ/	ONSET	IDENT[+NASAL]	*+NASAL/V
(a) tʃʰã₁i₂tʃoɣ	*!		*
(b) tʃʰi₁,₂tʃoɣ		*!	
☞　(c) tʃʰĩ₁,₂tʃoɣ			*

As a side-note, discussed further below, Dakota contrasts with Attic Greek in preserving [‑low] rather than [+low]. For example, /ãi/ is realized as [ĩ], not [ã].

A similar fact is seen in coalescence of nasal consonants with obstruents. In Indonesian, for example, coalescence of a prefix nasal and a voiceless stop results in retention of all features of the root consonant, except for the [+nasal] feature of the prefix consonant: /məN + pilih/ → [məmilih], *[məpilih]; /məN+kasih/ → [məŋasih] 'to give' (Lapoliwa 1981:110, see Pater 1995 for an analysis).

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[237] The fact that /ã/ and mid vowels surface to form a nasalized high vowel follows from a general ban on nasalized mid vowels in the language. The height preserved in Dakota is [‑low].

- [−anterior]

Hualde (1992:400) reports that fricative clusters in Catalan coalesce. If one of the input consonants is alveo-palatal [ʃ ʒ tʃ dʒ], the output is also alveo-palatal. For example, /baʃ zɛru/ is realized as [baʒɛru] *baix zero* 'low zero', where the [ʒ] preserves the [−anterior] feature of the /ʃ/ and voicing of the /z/. Similarly, /midʒ sak/ is realized as [mitʃak] 'half a bag', where the output [tʃ] preserves the [−anterior] feature of /dʒ/ and voicing of the /s/.

Again, [−anterior] is a marked feature: all inventories with [−anterior] segments also have [+anterior] ones: e.g. no language has [tʃ] without also having [t]. Thus, preservation of [−anterior] in this case is produced by the marked-coalescence ranking identified above: IDENT[−anterior] outranks *[−anterior]. This case contrasts with Pāli's treatment of (alveo-)palatals in coalescence (§8.5.1).

- *Sonority*

In Harar Oromo, a syllable contact restriction bans adjacent sonorants [j w r l n] (Owens 1985:22). Adjacent sonorants in the input coalesce to form a geminate in the output. The most sonorous input segment wins.

(26)   Gemination in Harar Oromo
　　　(a) /{r,l} + n/ → [rː,lː]
　　　　　/laːl+ne/　　　→ [laːlːe] 'we watched'
　　　　　/barar+ne/　　→ [bararːe] 'we flew'
　　　　　/moːr+niː/　　→ [moːrːiː] 'fat-nom'
　　　(b) /n + {r,l,j,w}/ → [rː,lː,jː,wː]
　　　　　/hin+raftu/　　→ [hirːaftu] 'you don't lie down'
　　　　　/hin+laːlːu/　　→ [hilːaːlːu] 'we don't observe'
　　　　　/hin+waːdu/　　→ [hiwːaːdu] 'he doesn't bake'
　　　　　/hin+jaːdu/　　→ [hijːaːdu] 'he doesn't think'
　　　(c) /l + r/ → [rː]
　　　　　/ol+rafe/　　　→ [orːafe] 'he slept up'

Gemination in Harar Oromo is a case of coalescence rather than deletion. Other geminations show retention of elements of both input segments: e.g. /meːk'+te/ → [meːtː'e] 'you turned' (p.22).

The output in Harar Oromo can be ascribed to the action of faithfulness constraints: it is most harmonic to preserve the most sonorous – and highly marked – element. This result is achieved by ranking all relevant faithfulness constraints over all markedness ones. The constraint IDENT≥liquid is relevant here.

(27)   IDENT≥{liquid}　　　"If *x* is equally or more sonorous than a liquid,
　　　　　　　　　　　　　then *x'* has the same sonority value as *x*,
　　　　　　　　　　　　　where *x'* is the correspondent of *x*."

IDENT≥{liquid} must outrank all markedness constraints that favour non-liquids over liquids.

(28)   High sonority preservation in Harar Oromo

/barar+ne/	SONDIST	IDENT≥liquid	*-Δ$_\sigma$≥liquid
(a) bararne	*!		* *
☞ (b) bararːe			* *
(c) baranːe		*!	*
(d) baratːe		*!	*

The tableau shows that faithfulness constraints will favour the most marked element. It is crucial that the faithfulness constraint outranks its markedness counterpart *-Δ$_\mu$≥liquid   otherwise liquids will be penalized in favour of nasals, producing (c) as the output.

It is impossible to determine the influence of faithfulness constraints on glides in this language; no relevant examples are provided. The fact that /r/ wins over /l/ in /ol+rafe/ → [orːafe] may not indicate a sonority difference, but rather defaulting to the [r]; there is no corresponding /r+l/ case to decide the issue.

A similar case is found in the Australian language Bardi (Metcalfe 1975, Bowern 2001). Harar Oromo contrasts with Pāli, discussed in §8.4.

•   *Summary*

In summary, the marked-coalescence pattern is found for many different scales, not just for roundness. The following section summarizes the rankings identified in this section.

8.2.5   Summary

This section has shown that a theory with marked-faithfulness constraints correctly predicts that the most marked features may be retained in coalescence. The most marked value *m*f will emerge in coalescence if the faithfulness constraint that exclusively preserves *m*f (i.e. IDENT{*m*f}) outranks all markedness constraints that ban *m*f (*{*m*f}). The following tableau schematizes this ranking, with [*m*f] the marked value of feature f and [*u*f] the unmarked value.

(29)   Marked-Coalescence Ranking

/*m*f+*u*f/	IDENT{*m*f}	*{*m*f}		IDENT{*m*f, *u*f}	*{*m*f, *u*f}
☞ (a) *m*f		*		*	*
(b) *u*f	*!			*	*

Candidate (b) violates IDENT{*m*f} because it fails to keep the underlying marked feature specification; this leaves candidate (a). The constraints IDENT{*m*f, *u*f} – which preserves both marked and unmarked values of *f* – and *{*m*f, *u*f} – which bans both marked and unmarked values of *f* – are included to show that their ranking is irrelevant in this type of coalescence. Since IDENT{*m*f, *u*f} preserves both feature specifications equally it cannot distinguish between the two candidates. Similarly, a markedness constraint like *{*m*f, *u*f} is irrelevant – such a constraint does not favour one feature value over the other, so has no effect on the outcome.

More concretely, the analysis of Attic Greek showed that the ranking ‖ IDENT[+round] » *[+round] ‖ resulted in preservation of roundness. The ranking of IDENT[±round] and *[±round] was indeterminate in relation to these other constraints.

As illustrated in §8.2.4, the same principle applies to many other scales: nasality in Dakota, [anterior] in Catalan, and the sonority scale in Harar Oromo. Further examples will appear in the following case studies.

8.3   The unmarked survivor

The aim of this section is to demonstrate the need for stringently formulated faithfulness constraints. The empirical focus is the voicing scale | +voice ⟩ -voice |. Cases in which the unmarked [‑voice] feature survive are shown to require faithfulness constraints that preserve both values of [voice] equally, hence in a stringency relation with the marked-faithfulness constraint IDENT[+voice] (from ch.7).

Section 8.3.1 presents an analysis of bi-directional [‑voice] assimilation in Swedish, based on data from Sigurd (1965) and Hellberg (1974). The analysis owes a significant debt to Lombardi’s (1999) analysis and Baković’s (1999a) insights, though it is cast in terms of the present theory. The claim made in this analysis – and in all analyses in ‘unmarked coalescence’ cases – is that the unmarked value wins due to the action of markedness constraints against the marked value – i.e. *[+voice] in this case. It is then argued that only a faithfulness constraint that preserves both values of [voice] – IDENT[±voice] – must outrank *[+voice] in order to prevent voice neutralization generally.

Section 8.3.2 presents an analysis of coalescence in the Athapaskan language Chipewyan (Fort Chipewyan dialect – Li 1946). Chipewyan has several coalescence patterns, one of which is the famous Athapaskan *d*-effect. As in Swedish, the unmarked [‑voice] value survives in coalescence, as does the feature [‑continuant].

This same argument is provided for vowel features in §8.4.

8.3.1   Bi-directional assimilation in Swedish

This section shows that bi-directional assimilation poses the same issues as coalescence. In bi-directional assimilation, the featural content of the output is not determined by the rightmost or leftmost element. Instead, a single value dominates. In Swedish, the value is [‑voice]: underlying clusters with an underlying voiceless segment surface as voiceless. This pattern differs from Attic Greek’s in that the unmarked value

survives. This fact is shown to require voice-referring faithfulness constraints in a stringency relation.

Section 8.3.1.1 describes the relevant facts, followed by an analysis in §8.3.1.2. Section 8.3.1.3 discusses the central point of this analysis: that the unmarked feature value can only survive in bi-directional assimilation and coalescence if there is faithfulness conflation. Faithfulness conflation is argued to require stringently formulated constraints. Section 8.3.1.4 discusses alternative theories.

8.3.1.1 Description

Table 8.3 lists the consonant contrasts found in Swedish (Sigurd 1965:19).

Table 8.3: Swedish consonants

	labial	alveolar	(alveo-)palatal	velar	glottal
stops	p	t	tʃ	k	
	b	d	dʒ	g	
fricatives	f	s	ʃ		h
	v				
nasals	m	n		ŋ	
liquids		l r			

The Swedish syllable has optional onsets and codas; both constituents may contain between one and three consonants. There is no voicing neutralization in codas; both voiced and voiceless obstruents can appear in this position: e.g. *tub* 'tube', *kap* 'cape'; *hed* 'heath', *bit* 'piece'; *tyg* 'cloth', *bak* 'back'; *räv* 'fox', *kuf* 'odd'.

- *Voice assimilation*

Swedish obstruent voicing assimilation has received a great deal of descriptive and theoretical attention (Sigurd 1965, Hellberg 1974, Anderson 1974, Cho 1999:134ff, Lombardi 1999, Baković 1999a:58, Wilson 2000:132ff). The output of Swedish voice assimilation is always a pair of voiceless segments, as shown in (30); the data is from Hellberg (1974), Sigurd (1965), and Lombardi (1999).

(30)   Swedish obstruent voice assimilation
        (a) +vd → -vd / _-vd

Root	Gloss	Assimilated	Gloss
[tʊb]	*tub* 'tube'	[tup-s]	*tub-s* 'tube + genitive'
[røːd]	*röd* 'red'	[røt-t]	*röd-t* 'red (neuter)'
[ɡud]	*gud* 'good'	[ɡut-s]	*gud-s* 'good (genitive)'
[sprøːd]	*spröd* 'brittle'	[sprøt-t]	*spröd-t* 'brittle (neuter)'
[tiːd]	*tid* 'time'	[tit-s]	*tid-s* 'time+genitive'
[klædə]	*kläda* 'to dress'	[klɛt-səl]	*klädsel* 'dressing'
[fœdə]	*föda* 'feed'	[fœt-səl]	*fötsel* 'food'
[skuːɡ]	*skog* 'forest'	[skuk-s]	*skogs* 'forest (genitive)'
		[skʊks foːɡəl]	*skogsfågel* 'forest bird'
[hœːɡ]	*hög* 'high'	[hœkː tiːd]	*hög tid* 'festival'
		[hœkː fæːdig]	*hög färdig* 'festival'
		[hœk-st]	*högst*
[viɡə]	*viga* 'to marry'	[vik-səl]	*vigsel* 'marriage'
[daːɡ]	*dag* 'day'	[dak-sljʊːs]	*dagsljus* 'daylight'
[styɡ]	*stygg* 'naughty'	[styk-t]	*styggt* 'naughty (neuter)'
[byɡ]	*bygg* 'build'	[byk-t]	'build {supine}'
[hav]	*hav* 'sea'	[haf-s]	*hav-s* 'sea+adv. suffix'
[ræv]	*räv* 'fox'	[raf-s]	*räv-s* 'fox + genitive'
[stræv]	*sträv* 'rough'	[stræf-t]	*strävt* 'rough (neuter)'

        (b) +vd → -vd / -vd_

[kœp]	*köp* 'purchase'	/kœp-d/→ [kœpt] {pt part.}	
[brand]	*brand* 'fire'	[skukːs-praːnd]	*skogsbrand* 'forest fire'
[daːɡ]	*dag* 'day'	[tisː-ta]	*Tisdag* 'Tuesday'
[də]	*-de* {preterite}	[syl-də]	*syl-de* 'covered'
		[læs-tə]	*läs-te* 'read'
		[stɛk-tə]	*stek-te* 'fried'

        (c) +vd +vd

[hanːd-buːk]	*hand-bok* 'handbook'		
[syːd-vesːt]	*sydväst* 'south-west'		
[æɡə]	*äga* 'to own'	[æɡ-də]	*äg-de* 'owned'
[vævə]	*väve* 'to weave'	[væv-də]	*väv-de* 'weaved'
[byɡ]	*bygg* 'build'	[byɡ-d]	*bygg-d* 'build {pt part.}'

As shown by the pair /læs-də/→[læstə] and /vig-səl/→[viksəl] the output of assimilation is not directionally conditioned: in other words, neither the rightmost nor the leftmost segment consistently determines the voicing of the output.

The pair /tid+s/→[tits] and /kœp-d/→ [kœpt] provide evidence that morphological affiliation does not matter: the voicing of the affix segment persists in [tits], while the root's value wins in [kœpt]. In general, then if one of the input segments is [‑voice], the output will be voiceless.

There is little controversy that [‑voice] is the unmarked voicing feature for obstruents. This point is discussed in chapter 7. Therefore, the issue that arises in Swedish voice assimilation is why the unmarked [‑voice] value emerges while the marked [+voice] value is eliminated.

8.3.1.2 Analysis

The following analysis will show that the constraint IDENT[±voice] is needed to adequately account for Swedish bi-directional voicing assimilation. The crucial aspect of this constraint is that it 'conflates' unfaithfulness: it assigns the same violations to /+voice/→[‑voice] as to /‑voice/→[+voice] mappings.

Swedish voice assimilation has been analyzed in Optimality Theory by Lombardi (1999), Baković (1999a:58ff, 1999b), and Wilson (2000:132ff). The following analysis owes a great deal to Lombardi's proposals, and for the most part is a straightforward recasting of the analysis in Lombardi (1999) in terms of the present theory. The differences will be commented on where necessary.

Baković (1999a,b) presents a significantly different approach to the issue presented here; this theory is discussed in ch.7§7.7, so it will not be discussed further here. For a critique of the proposals in Wilson (2000), see McCarthy (2002b).

- *Motivating assimilation*

In obstruent voicing, [+voice] segments are more marked than [‑voice] ones. Therefore, the present theory provides two faithfulness constraints. One exclusively preserves the marked value – IDENT[+voice], and the other preserves both values – IDENT[±voice].

A full theory of the markedness constraints that trigger assimilation has been presented in chapter 7§7.2.3.1; the relevant assimilation-inducing constraints will be called ASSIM[voice] here to save the reader the trouble of referring back to that chapter.

In order for ASSIM[voice] to motivate assimilation of voiced segments, ASSIM[voice] must outrank all constraints that preserve voiced segments – i.e. IDENT[±voice] and IDENT[+voice]; the opposite ranking would prevent voiced segments from undergoing assimilation. This general ranking was established in ch.7.

(31)   <u>Swedish I: assimilation</u>

/fœd-səl/	ASSIM[voice]	IDENT[±voice]	IDENT[+voice]
(a) fœdsəl	*!		
☞ (b) fœtsəl		*	*

- *The unmarked survivor*

Swedish contrasts with Attic Greek in that the marked input feature is not preserved in assimilation. Therefore, the opposite ranking must hold: whereas a faithfulness constraint that preserved only marked elements (i.e. [+round]) outranked all markedness

constraints against that feature (*[+round]) in Attic, the relevant markedness constraint in Swedish (*[+voice]) must outrank all faithfulness constraints that preserve that feature (IDENT[+voice]).

Tableau (32) illustrates this ranking.

(32)   Swedish II: Elimination of the marked

/fœd-səl/	ASSIM[voice]	*[+voice]	IDENT[+voice]
(a) fœdsəl	*!	*	
☞ (b) fœtsəl			*
(c) fœdzəl		* *!	

The crucial competition is between (b) and (c): (c) loses because it contains more voiced segments than (b).[238]   Thus, *[+voice] must outrank IDENT[+voice]; the opposite ranking would favour preservation of the marked value, with the undesirable result that (c) would win.

Tableau (33) is an elaboration on the ranking in (32).   It shows that onset-faithfulness constraints must also be ranked below *[+voice].

(33)   Swedish IIa: onset-faithfulness

/stɛk-də/	ASSIM[voice]	*[+voice]	onset-IDENT[+voice]	onset-IDENT[±voice]
(a) stɛk.də	*!			
(b) stɛɡ.də		* *!		
☞ (c) stɛk.tə			*	*

- *Faithfulness conflation*

A further ranking is needed.   Some faithfulness constraint that preserves [+voice] must outrank *[+voice], otherwise [+voice] would be eliminated in all contexts: e.g. /æg-də/ would emerge as *[æktə].

The only faithfulness constraint left in the present theory is IDENT[±voice]; its effect is shown in the following tableau.   A ranking analogous to ‖ IDENT[±voice] » *[+voice] ‖ was proposed by Lombardi (1999:285ff).[239]

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[238]   *[+voice] assigns a separate violation for each voiced segment here. If one adopts an autosegmental approach – that the two voiced segments share a single [+voice] feature – the approach will still work: candidate (b) will still incur fewer violations of *[+voice].

[239]   The difference between the present approach and Lombardi's (1999) is that Lombardi has only one faithfulness constraint IDENT[Lar(yngeal)], which is equivalent in effect to IDENT[±voice].   The present theory has both IDENT[±voice] and IDENT[+voice].

(34)   Swedish III: avoidance of neutralization

	/æg-də/	IDENT[±voice]	*[+voice]	IDENT[+voice]
☞	(a) ægdə		* *	
	(b) æktə	* *!		* *

The constraint IDENT[±voice] plays a crucial part. It prevents gratuitous elimination of [+voice], as in candidate (b). The opposite ranking would produce a language with wholesale elimination of [+voice].

Notably, no faithfulness constraint except for IDENT[±voice] can be brought to the aid of [ægdə] here. As Lombardi (1999) shows, all constraints that favour a directional bias must be ranked below *[+voice]. This was demonstrated in tableau (33) for onset-faithfulness constraints. Tableau (35) makes the same point for root-controlled faithfulness constraints.

(35)   Swedish IV: irrelevance of root-faithfulness

	/stræv-t/	ASSIM[voice]	*[+voice]	root-IDENT[+voice]	root-IDENT[±voice]
	(a) strævt	*!	*		
☞	(b) stræft			*	*
	(c) strævd		* *!		

So, the resulting ranking for Swedish voice constraints is anti-Paninian (Prince 1997 et seq.). The ranking has a general faithfulness constraint outranking a more specific one: i.e. || IDENT[±voice] » *+voice » IDENT[+voice] ||. The form of the constraint IDENT[±voice] is crucial in this analysis as it allows faithfulness conflation while maintaining contrast. This point will be fully developed in the next section.

8.3.1.3 Faithfulness conflation

The Swedish facts can be produced by the present theory because the marked-faithfulness constraints allow faithfulness conflation. The following tableau will be used to elucidate this point.

(36)   Swedish V: Faithfulness conflation

	/vig-səl/	ASSIM[voice]	IDENT[±voice]	*[+voice]	IDENT[+voice]
	(a) vig-səl	*!		*	
☞	(b) vik-səl		*		*
	(c) vig-zəl		*	* *!	

The reason that the markedness constraint *[+voice] emerges to make the crucial decision between (b) and (c) is because the mappings /vig-səl/→[viksəl] and /vig-səl/→*[vigzəl] are conflated in faithfulness terms. Unfaithfulness to an input [‑voice]

specification incurs the same violations of active constraints as unfaithfulness to an input [+voice] specification. More concretely, the mappings incur equal violations of all relevant active faithfulness constraints – i.e. IDENT[±voice].

Because the active faithfulness constraint fails to distinguish the two different mappings, the lower-ranked markedness constraint can emerge to make the crucial decision. This is analogous to markedness conflation, discussed in chapters 3 and 4: two markedness categories are conflated if they incur the same violations of active markedness constraints.

To elucidate this point, suppose that IDENT[+voice] outranked *[+voice]. This ranking would fail to produce Swedish: it would favour candidate (c) over candidate (b). A key point is that IDENT[±voice] *must* be active: if it were ranked below *[+voice], all voicing contrasts would be eliminated.

Therefore, there are two requirements on all active voice-faithfulness constraints in Swedish: (i) they must preserve the voicing contrast and (ii) they must allow faithfulness conflation. The only way to deal with both these conditions is to have a faithfulness constraint that preserves both values of [voice] at once, thereby assigning equal violations to candidates that differ in either value of [voice]. In short, the constraint IDENT[±voice] is indispensable.

8.3.1.4 Alternatives: Non-stringent theories

This section considers theories with non-stringent faithfulness constraints: constraints that refer to a single feature value.

Suppose that there were a set of non-stringent faithfulness constraints in a fixed ranking: || IDENT{*m*f} » IDENT{*u*f} ||. This approach cannot deal with the Swedish facts: it offers no way to both preserve the voicing contrast and allow [‑voice] to survive. Retention of the voicing contrast requires the ranking || IDENT[+voice] » *[+voice] ||. However, emergence of [‑voice] requires the ranking || *[+voice] » IDENT[+voice] ||. Thus, the fixed ranking approach produces a ranking paradox.

To explore non-stringent solutions further, one could propose that the ranking || IDENT[‑voice] » IDENT[+voice] || held in Swedish. While this would account for the facts in this case, it predicts that unmarked features may be the specific focus of preservation; chapter 7 shows this proposal to be problematic.

A final non-stringent approach – that IDENT[±voice] is the *only* voice-faithfulness constraint – has already been shown to be inadequate (ch.7§7.2.3.1).

A final comment about the Swedish facts is that it shows that faithfulness constraints must be able to mention unmarked features. With only a constraint IDENT[+voice], [+voice] is predicted to always win in assimilation and coalescence (see chapter 7§7.5 and Wetzels & Mascaró 2001:214ff for discussion).

8.3.2 Voicing and continuancy in Chipewyan[240]

The aim of this section is to show that the ranking for Swedish bi-directional assimilation can produce the same result for coalescence, with the result that the unmarked [‑voice] value survives. Moreover, the language discussed here – Chipewyan – also shows that the unmarked value for [continuant] can also survive.

The difference between this example and Swedish is primarily in complexity. Many different features are in conflict in Chipewyan coalescence: [voice], [continuant], [strident], [anterior], [lateral], [distributed], and major Place of Articulation. So, Chipewyan's complexity provides a good test for the approach to coalescence and feature preservation advocated here.

A number of Athapaskan languages employ coalescence to eliminate certain consonant clusters. The most famous coalescence case involves the classifier /t/ – the famous Athapaskan *d*-effect (e.g. Navajo: McDonough 1990, Sekani: Hargus 1988:97ff, Slave: Rice 1987, 1989; general: Howren 1971, Rice 1987, Lamontagne & Rice 1994, 1995).

This section focuses on two types of coalescence in the Athapaskan language Chipewyan, one of which is the *d*-effect; the other relates to coalescence of laterals (Li 1946). This section presents a unified analysis of both coalescence types, showing how both preserve the unmarked feature in the output.

Two generalizations hold of all the coalescence outputs: (i) if either of the inputs is [‑voice], the output is [‑voice] and (ii) if either of the inputs is a stop, the output will be a stop or affricate. The following table summarizes relevant data from Li (1946). More complete data is provided in the following sections.

(37) Chipewyan coalescence in brief
    (a) voiceless + voiced → voiceless
        /hɛ-u<u>h-l</u>-ze/   → [huɬzɛ]   'start to hunt 2 dual' (p.414)
        /ðɛ-<u>θ-l</u>-ɣĩ/   → [ðɛɬɣĩ]   'he is exhausted' (415)
        /nĩ-na-n-s-<u>t-ʒ</u>a/ → [nĩnanɛstʃa]   'I came back' (412)
    (b) voiced + voiceless → voiceless
        /-tsa<u>ʒ-ɬ</u>/   → [-tsaɬ]   'to handle grain-like
                                                object+progressive' (409)
        /-ði<u>r-ɬ</u>/   → [ðɛɬ]   'to be, act, do' (409)
        /-te<u>l-ɬ</u>/   → [-tɛɬ]   'several persons go' (409)
    (c) stop + C → stop/affricate
        /tsʔ-nɛ-i<u>t-ð</u>ir/ → [tsʔɛnit<u>θ</u>ɛr] 'we (dual) have woken up' (414)
        /tʃ-<u>it-t-t</u>ʰĩ/   → [tʃit<u>ʰ</u>ĩ]   'you (dual) eat' (413)

The majority of the data in (37) shows that Chipewyan cluster simplification involves coalescence rather than deletion. For example, coalescence of /θl/ produces an

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output that retains the voicing of the /θ/ and laterality of the /l/: i.e. [ɬ] (37a). Similarly, coalescence of a stop and fricative results in an affricate (as in /tʒ/→[tʃ] and /tð/→[tθ]). The reported simplification /t+ɣ/ produces [k], a segment which preserves the manner of articulation of the /t/ and place of articulation of the /ɣ/.

This section shows that Chipewyan requires the same type of ranking as Swedish: in other words, a general faithfulness constraint must outrank a more specific one. The difference is that the case involves both [voice] and [continuant].

Section 8.3.2.1 presents background facts on Chipewyan phonology and a description of the coalescence data. Sections 8.3.2.2 presents an analysis of lateral coalescence, and §8.3.2.3 provides an analysis of /t/-coalescence (i.e. the *d*-effect).

8.3.2.1 Description

Table 8.4 lists the consonants found in Chipewyan. Several facts prove to be important in consonant coalescence: (i) there are three types of stop: unaspirated, aspirated, and glottalized, (ii) there are a variety of affricates, including interdental [tθ], dental [ts], prepalatal [tʃ], and lateral [tɬ], and (iii) there is a voiceless lateral fricative [ɬ], which will prove to be significant in the alternations discussed below.[241]

Table 8.4: Chipewyan Consonants

	labial	coronal					dorsal		glottal
stops	p	tθ	t	ts	tʃ	tɬ	k	kʷ	ʔ
&		tθʰ	tʰ	tsʰ	tʃʰ	tɬʰ	kʰ	kʷʰ	
affricates		tθ'	t'	ts'	tʃ'	tɬ'	k'	kʷ'	
fricatives		θ	s		ʃ	ɬ	x	xʷ	h
		ð	z		ʒ		ɣ	ɣʷ	
nasals	m		n						
liquids			r			l			

Chipewyan syllables have the shape (C)V(ː)(C). Codas cannot be stops or affricates. They are also restricted to coronal or glottal PoA, with the exception of [ɣ]. In other words, coda consonants are one of [θ ð s z ʒ ɣ ɬ n h l r] (Li 1946:401).

Of largely incidental relevance is the fact that stem-initial fricatives are not contrastive in voicing. They are voiceless word-initially and after voiceless fricatives, but voiced elsewhere. By Richness of the Base, both voiced and voiceless stem-initial fricatives must be considered in input forms. Unless directly relevant, the data below has input voiced stem-initial fricatives.

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[241] Jakobson & Waugh (1979:141-2) observe that Chipewyan [tʰ] is produced with strong velarization. This fact will be ignored here. Some support for their observation is that pre-Chipewyan *t has become [k] in certain modern Chipewyan dialects (see ch.6§6.3.1).

- *Coalescence*

Coalescence most often takes place in the set of prefixes that precedes the verb root. The closest set of prefixes, which Li (p.410) calls the 'conjunctive prefixes', has the order [modals + aspectuals + pronominal subject + classifiers + verb root]. The consonants of these prefixes coalesce when their preservation would violate the syllable restrictions identified above.

Coalescence happens often because many of the conjunctive prefixes consist of a single consonant or terminate in a consonant. For example, the classifiers are /t/, /l/, and /ɬ/, and the pronominal subject morphemes are /s/ {1sg}, /n/ {2sg}, /it/ {1non-sg}, and /uh/ {2non-sg.} (Li 1946: 411-2); one of the aspect prefixes is /θ/; other aspect prefixes end in a vowel. All modal prefixes end in a vowel. Epenthesis is used to eliminate consonant clusters in other positions, as discussed in ch.4.

A unified analysis of all the consonant coalescences in Chipewyan will be presented in the following sections. However, it will prove useful to classify them into two types for descriptive purposes. All coalescences involve one of the classifiers /t/, /l/, and /ɬ/. So, 'lateral coalescence' will be used to refer to coalescence involving the lateral classifiers /l/ and /ɬ/. The term 'stop coalescence' will be used to refer to coalescence involving the classifier /t/, called the '*d*-effect' after the orthographic symbol used for this consonant.

- *Lateral coalescence*

The outputs of lateral coalescence are summarized in Table 8.5 and of stop coalescence in Table 8.6. Supporting data is provided at the end of this section (i.e. §8.3.2.1).

The top row in Table 8.5 lists all possible coda consonants (/θ ð s z ʒ ɬ n h l r/) except for /ð z/ which did not appear in the data, and /n/, which coalesces with the preceding vowel (e.g. /θɛ-n-ɬ-tsĩ/ → [θĩɬtsĩ] 'to make it (1pl.)'). Gaps indicate combinations for which there is no mention in Li (1946). The top row in Table 8.6 lists all stem-initial consonants for which there is data. The category 'stop$_i$/affricate$_i$' refers to all stops and affricates; the result of their coalescence with /t/ is the same stop or affricate.

Table 8.5: Lateral coalescence in Chipewyan

⇒+⇓	θ	s	ʒ	ɬ	l	r	h
ɬ	ɬ	s	ɬ	ɬ	ɬ	ɬ	ɬ
l	ɬ	s			l	(l)	ɬ

Table 8.6: /t/ coalescence in Chipewyan

/t/ +	ʔ	θ/ð	s/z	ʃ/ʒ	x/ɣ	n	ɬ,l	stop$_i$/affricate$_i$
output:	tʔ	tθ	ts	tʃ	k	t	tɬ	stop$_i$/affricate$_i$

That these cases involve coalescence rather than deletion is evinced by the pairs /θ+l/→[ɬ], /h+l/→[ɬ], and virtually all of the stop coalescence cases, where /t/ plus another

consonant fuse to form an affricate, or – in the case of /t+x/ – a stop that preserves the marked PoA.

Several generalizations hold of the output of both lateral and stop coalescence. They are summarized in (38).

(38)   The output of Chipewyan stop coalescence
         (a) If an input segment is [‑voice], the output is [‑voice]
         (b) If an input segment is [‑continuant], the output is [‑continuant]
         (c) Preserve aspiration and glottalization
         (d) Preserve marked (labial, dorsal) places of articulation.
         (e) Preserve the following features in order of importance:
                  [+strident] > [+lateral] > [‑anterior], [+distributed]

The primary focus of the following analysis is (38a) and (38b).

As an example of (38a), coalescence of /θ+l/ produces the voiceless [ɬ]:e.g. /ðɛ-θ̲-l̲-ɣĩ/ → [ðɛɬɣĩ] 'he is exhausted' (p.415). Similarly, coalescence of /h+l/ produces voiceless [ɬ]: e.g. /hɛ-uh̲-l̲-ze/ → [huɬzɛ] 'we started to hunt' (p.414). Finally, coalescence of /t+l/ produces the voiceless affricate [tɬ].

(38b) states that coalescence involving a stop will produce a stop. This is clearest in the coalescence /t+ɣ/, which produces [k]. In this case, the output preserves the [‑continuant] feature of the input /t/. After Clements' (1999) proposal that affricates are strident stops, combinations of /t/ and fricatives also show that [‑continuant] survives since the output is an affricate – i.e. [‑continuant].

To allow us to proceed to the analysis without further ado, (38c) and (38d) will be discussed when they become relevant.

- *Data*

The data in (39) and (40) is from Li (1946); numbers in brackets refer to page numbers in this work. All coalescences reported above are described by Li, though there are some missing combinations, noted below.

(39) <u>Lateral coalescence data</u>[242] (relevant clusters are underlined)

(a) /C+ɬ/

/θ+ɬ/→[ɬ]	/ʒɛ-<u>θ-ɬ</u>-tsĩ/	→ [ʒɛ̠ɬtsĩ] 'to make it {perf.3sg}' (414)
/s+ɬ/→[s]	/hɛ-<u>s-ɬ</u>-tsi/	→ [hɛ̠stsi] 'make it 1sg' (414)
	/ʔa-<u>s-ɬ</u>-ʔĩ/	→ [ʔa̠sʔĩ] 'I am doing so' (418)
/ʒ+ɬ/→[ɬ]	/-tsa<u>ʒ-ɬ</u>/	→ [-tsa̠ɬ] 'be handling grain-like object' (409)
/ɬ+ɬ/→[ɬ]	/-tɛ<u>ɬ-ɬ</u>/	→ [-tɛ̠ɬ] 'several persons go+progressive' (409)
/l+ɬ/→[ɬ]	/-te<u>l-ɬ</u>/	→ [-tɛ̠ɬ] 'several persons go' (409)
/r+ɬ/→[ɬ]	/-ði<u>r-ɬ</u>/	→ [-ðɛ̠ɬ] 'to be, act, do' (409)
/h+ɬ/→[ɬ]	/hɛ-u<u>h-ɬ</u>-tsi/	→ [hu̠ɬtsi] 'start to hunt'
	/ta-hɛ-u<u>h-ɬ</u>-tsi/	→ [dahu̠ɬtsi] 'you (pl.) all make it' (417)

(b) /C+l/

/θ+l/→[ɬ]	/ʒɛ-kʔo-tɛ-nɛ-<u>θ-l</u>-ʃa/	→ [ʒɛkʔotɛnɛ̠ɬʒa] 'he has learnt it' (400)
	/ðɛ-<u>θ-l</u>-ɣĩ/	→ [ðɛ̠ɬɣĩ] 'he is exhausted' (415)
/s+l/→[s]	/hɛ<u>s-l</u>-zɛ/	→ [hɛ̠szɛ] 'start to hunt 1sg.' (414)
	/ɬɛɣa-ʔɛdɛ-nɛ-<u>s-l</u>-ðer/	→ [ɬɛɣadɛnɛ̠sðer] 'I killed myself' (416)
/l+l/→[l]	/hĩ-<u>l-l</u>aɬ/	→ [hĩlaɬ] 'go to sleep!' (409)
/h+l/→[ɬ]	/u<u>h-l</u>-ze/	→ [hu̠ɬze] 'start to hunt 2 dual' (414)

(40) <u>Stop coalescence data</u>

/t+ʔ/→[t']	/nɛ-ɣɛ-<u>t-ʔ</u>a/	→ [nɛɣɛ̠t̚ʔa]	'I fooled him' (411)
/t+ð/→[tθ]	/tsʔ-nɛ-i<u>t-ð</u>ir/	→ [tsʔɛni̠tθɛr]	'we (dual) have woken up' (414)
/t+z/→[ts]	/na-hɛ-s<u>t-z</u>us/	→ [nahɛ̠stsus]	'I slide down repeatedly' (411)
	/xa-da-na-ʔɛ-s<u>t-z</u>is/	→ [xadanaʔɛ̠stsis]	'I sip out of it (cust.)' (417)
/t+ʒ/→[tʃ]	/ʔã-hɛ-θ<u>t-ʒ</u>a/	→[ʔãhɛ̠θtʃa]	'he went home' (419)
/t+x/→[k]	*no data*[243]		
/t+n/→[t]	/tu-n<u>t-n</u>ĩ/	→[tunɛ̠tĩ]	'to be drowned {imperf.3sg.}' (414)
/t+ɬ/→[tɬ]	*no data*		
/t+l/→[tɬ]	*no data*		

/t+{stop, affricate}/ → [stop, affricate]	/xa-na-ɣɛ-s<u>t-t</u>uð/	→[xanaɣɛ̠stuð]	'I have crawled out again' (418)
	/tʃ-i<u>t-t</u>ʰĩ/	→[tʃi̠tʰĩ]	'you (dual) eat' (413)
	/xa-ta-tɛ-θ<u>t-k</u>ai/	→[xatarɛ̠θkai]	'it is white spotted' (417)
	/ɣɛ-i<u>t-ts</u>aɣ/	→[ɣi̠tsaɣ]	'we cry' (413)

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[242] Evidence that the *l-* and *ɬ-* morphemes are underlyingly [l] and [ɬ] comes from forms without contraction: e.g. /n-ɬ-tsi/ → [nɛɬtsi] 'to make it {imperf. 3sg}', /θ-i-l-tsi/ → [θiltsi] 'to make it {1pl perf.}' (414).

[243] Compare with Hare /le-ʒe-<u>t-x</u>e/ → [leʒe̠ke] 'it is cut', /tah-te-i-<u>t-ɬ</u>eh/ → [ta.ʔe.te.ti.tɬeh] 's/he hangs him/herself'.

8.3.2.2 Lateral coalescence: Survival of [−voice]

Lateral coalescence is triggered by a ban on complex margins: *COMPLEX. As shown for Attic Greek, coalescence comes about when *COMPLEX outranks UNIFORMITY; deletion and epenthesis are blocked by MAX and DEP respectively. The example in tableau (41) is /ðɛ-θ-l-ɣĩ/ → [ðɛɬɣĩ] 'he is exhausted'.

(41)   Chipewyan I: basic coalescence ranking

/ðɛ-θ₁-l₂-ɣĩ/	*COMPLEX	MAX	DEP	UNIFORMITY
(a) ðɛθ₁l₂.ɣĩ	*!			
(b) ðɛθ₁ɣĩ/		*!		
(c) ðɛθɛlɣĩ			*!	
☞ (d) ðɛɬ₁,₂ɣĩ/				*

Input tri-consonantal clusters in which the middle element is a lateral [l ɬ] are resolved by coalescing the first two consonants in the output. For example, /ðɛ-θ-l-ɣĩ/ is realized as [ðɛɬɣĩ], with the leftmost input consonants /θl/ coalescing to produce [ɬ]; the rightmost two consonants do not coalesce: *[ðɛθɣĩ]/*[ðɛθlĩ].

To account for the fact that the first two consonants coalesce rather than the second two, a constraint that bans coalescence in onsets is employed. This constraint is a straightforward extension of Beckman's (1998) theory of positional faithfulness:

(42)   onset-UNIFORMITY   If *x* is in an onset, *x* has only one input correspondent.

The constraint onset-UNIFORMITY places a stronger requirement on onsets than other elements: onset consonants cannot be coalesced segments. With onset-UNIFORMITY, the only viable coalesced output from a tri-consonantal input is one in which the coalesced output segment is in the coda. Tableau (43) illustrates this point.

(43)   Chipewyan II: Avoidance of onset coalescence

/ðɛ-θ₁-l₂-ɣ₃ĩ/	*COMPLEX	onset-UNIFORMITY
(a) ðɛθ₁l₂ɣ₃ĩ	*!	
(b) ðɛθ₁.ɣ₂,₃ĩ		*!
☞ (c) ðɛɬ₁,₂.ɣ₃ĩ		

The analysis of stop coalescence below will show that *COMPLEX outranks onset-UNIFORMITY.

Tri-consonantal clusters with stops as the medial consonant behave differently – the stop coalesces with the following consonant. An explanation for this difference will be provided in the next section.[244]

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[244] Causley (1997) proposes that two coalescences take place in the derivation /hɛ-uh-l-ze/ → [huɬzɛ]: the lateral feature of /l/ coalesces with /h/ to produce [ɬ], and the [+voice] feature of the /l/ coalesces with the

- *Survival of [−voice]*

The analysis of voicelessness preservation presented here is much the same as given for Swedish. The fact that [−voice] persists in the output cannot be ascribed to faithfulness constraints because they favour preservation of the marked feature value. Instead, the markedness constraint *[+voice] must be responsible; it must outrank IDENT[+voice], as shown in (44).

(44) Chipewyan IIIa: Unmarked coalescence ranking, part I

/uh$_1$-l$_2$-ze/	*[+voice]	IDENT[+voice]
(a) hul$_{1,2}$ze	* *!	
☞ (b) huɬ$_{1,2}$ze	*	*

As in Swedish, though, some faithfulness constraint must prevent elimination of [+voice] generally. More specifically, some faithfulness constraint must prevent the /l/s in /hĩ-l-laɬ/ from turning into [ɬ]: [hĩlaɬ], *[hĩɬaɬ].

The only constraint available is IDENT[±voice]. With this constraint outranking *[+voice], gratuitous devoicing of /l/ to [ɬ] is blocked. However, IDENT[±voice] does not have the unfortunate side effect of favouring the coalesced candidate that preserves the marked [+voice] value, as shown in tableau (45).

(45) Chipewyan IIIb: Unmarked coalescence ranking, part II

/uh$_1$-l$_2$-ze/	IDENT[±voice]	*[+voice]	IDENT[+voice]
(a) hul$_{1,2}$ze	*	* *!	
☞ (b) huɬ$_{1,2}$ze	*	*	*
(c) huɬ$_{1,2}$se	* *!	*	*

The constraint IDENT[±voice] prevents neutralization of [+voice], so blocking the /z/ to [s] change in candidate (c). Equally as important is the fact that IDENT[±voice] assigns the same violations to candidates (a) and (b). This allows the effect of the lower-

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stem-initial fricative to form [z]. Causley's proposal is based on the claim that (at least some) stem-initial fricatives are underlyingly unspecified for voice: so the UR is /hɛ-uh-l-se/, and the surface [+voice] [z] in [huɬzɛ] comes about through coalescence of /l/ and /s/. In contrast, I maintain that there is no coalescence of the stem-initial fricative in such tri-consonantal clusters. Firstly, the voicing of stem-initial fricatives is not contrastive: stem-initial fricatives are always voiceless word-initially and after voiceless fricatives, and voiced elsewhere. Since voicing is completely predictable, by Richness of the Base inputs with both voiceless and voiced initial fricatives must be accounted for. This does pose a potential problem, since the stem-initial fricative [z] in [huɬzɛ] follows a voiceless fricative on the surface, and therefore should be voiceless. Causley suggests that the voicing of the fricative comes from the [+voice] feature of the underlying /l/. However, I suggest that there is a more opaque explanation: in just this combination, the affix *l* sets up a boundary that makes the initial fricative insensitive to its presence. This proposal is supported by the fact that a coalesced /l/ also blocks *s-ʃ* coalescence. /s/ coalesces before [ʃ ʒ]: /hu-s-ɬ-ʃɛ/ → [huʃɛ]. However, the coalescence does not take place if /s/ coalesces with underlying /l/: /pɛ-k'ɛ-ho-dɛ-s-l-ʒã/ → [pɛk'ɛhodɛsʒã] (412). Again, /l/ blocks an otherwise automatic process.

ranked markedness constraint *[+voice] to emerge, favouring the candidate with the unmarked [−voice] feature over the one with [+voice].

- *Preservation of* [lateral] *and* [strident]

The preservation of [lateral] and [strident] contrasts with [voice] in that the marked values of these latter features are retained. Almost all coalescences involving a lateral result in a lateral: e.g. /uh-l-ze/ → [huɫze], *[huhze]; /ðɛ-θ-l-ɣĩ/ → [ðɛɫɣĩ], *[ðɛθɣĩ].

The ranking responsible for retention of [+lateral] is schematically the same as that used for [+round] preservation in Attic Greek: IDENT[+lateral] dominates *[+lateral]. Through this ranking, the marked feature will be preserved, as shown in tableau (46).

(46)   Chipewyan IV: Lateral preservation

/ðɛ-θ$_1$-l$_2$-ɣĩ/	IDENT[+lateral]	*[+lateral]
(a) ðɛθ$_{1,2}$ɣĩ	*!	
☞ (b) ðɛɫ$_{1,2}$ɣĩ		*

An interesting point relates to stridency. In combinations of the strident /s/ and lateral, the output is strident: e.g. /ʔa-s-ɫ-ʔĩ/ → [ʔasʔĩ] 'I am doing so' (p. 418), /s-l-ze/ → [hɛsze] 'start to hunt 1sg.' (p.414). It is clear that preservation of stridency takes preference over preservation of [+lateral]. This can be formally expressed by having IDENT[+strident] outrank IDENT[+lateral], as in tableau (47).

(47)   Chipewyan V: Strident preservation

/s$_1$-l$_2$-zɛ/	IDENT[+strident]	IDENT[+lateral]
☞ (a) hɛɫ$_{1,2}$zɛ		*
(b) hɛs$_{1,2}$zɛ	*!	

Preservation of stridency will also play a role in stop coalescence, to which we now turn.

8.3.2.3 Stop coalescence: Survival of [−continuant]

Stops are banned in Chipewyan codas, so all /t+C/ clusters must be eliminated in the output form.[245] An interesting aspect of stop coalescence is that /t/ always coalesces with the following consonant in tri-consonantal clusters, rather than with the preceding one: e.g. /ʔã-hɛ-θ-t-ʒa/ → [ʔãhɛθtʃa], *[ʔãhɛθʒa]. This contrasts with lateral coalescence, in which the lateral coalesces with the preceding consonant.

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[245] Evidence that the classifier is /t/ comes from combinations with /ʔ/, where the result is [tʔ]. Rice (1987) has proposed that the /t/ classifier consists of the feature [−continuant] alone, with its other features being filled in as defaults. However, under present assumptions (i.e. that glottals are less marked than coronals), nothing would prevent the output from being just [ʔ], which is also [−continuant].

- *Survival of* [–continuant]

The account proposed for this fact relates to another fact: [–continuant] is always preserved in stop coalescence. For example, in the coalescence /t+{x,ɣ}/, the output is the stop [k], not a continuant. Similarly, coalescence of /t/ and a fricative produces an affricate, which – following Clements (1999) – is a [+strident] stop: /ʔã-hɛ-θ-<u>t-ʒ</u>a/ → [ʔãhɛθtʃa] 'he went home' (419).

Like [–voice], [–continuant] is an unmarked value (for obstruents at least): languages may lack fricatives (e.g. Djapu), but no language lacks stops. As established for [voice], then preservation of [–continuant] must involve the ranking in (48).

(48)   <u>Chipewyan VI: Survival of non-continuancy</u>

/ʔã-hɛ-θ-t₁ʒ₂a/	IDENT[±continuant]	*[+continuant]	IDENT[+continuant]
☞ (a) ʔã.hɛθ.tʃ₁,₂a	*	* *	*
(b) ʔã.hɛθ.ʃ₁,₂a	*	* * *!	
(c) ʔã.ʔɛn.tʃ₁,₂a	* * *!		* * *

Candidate (c) shows that IDENT[±continuant] blocks neutralization of [+continuant]. Crucially, candidates (a) and (b) violate IDENT[±continuant] equally, allowing the markedness constraint *[+continuant] to make the crucial decision. It favours candidate (a) because it only contains two continuants [h θ] as opposed to (b)'s three [h θ ʃ].

- *Direction of coalescence*

A side effect of the preservation of [–continuant] is that it forces /t/ to coalesce with the following consonant rather than the preceding one. The reason relates to the ban on stops in codas. If /t/ coalesced with the preceding consonant, the output would be unable to preserve the [–continuant] feature. For example, if the /θt/ coalesce in /ʔã-hɛ-θ-t-ʒa/, the outcome cannot be *[ʔãhɛt.ʒa] (or *[ʔãhɛtθ.ʒa]) as these outputs are banned by the ban on stops in codas. Therefore, the only way to preserve [–continuant] is for the /t/ to coalesce with the following consonant: i.e. *[ʔãhɛθ.tʃa].

This proposal is formally implemented by two rankings. One is that *[+continuant] outranks onset-UNIFORMITY. As discussed in the preceding section, onset-UNIFORMITY prevents coalescence of the rightmost two elements; *[+continuant] ensures that onset-UNIFORMITY will be ignored when the alternative fails to preserve [–continuant].

The second ranking relates to the constraint that motivates stop coalescence: the ban on stops in codas. This constraint will be called CODACOND here. Tableau (49) shows how the ranking of these constraints produces coalescence of the rightmost segments.

(49)   Chipewyan VII: directional effects in stop coalescence

/ʔã-hɛ-θ$_1$-t$_2$ʒ$_3$a/	CODACOND	*[+continuant]	onset-UNIFORMITY
(a) ʔã.hɛtθ$_{1,2}$.ʒ$_3$a	*!	* *	
(b) ʔã.hɛθ$_{1,2}$.ʒ$_3$a		* * * *!	
☞ (c) ʔã.hɛθ$_1$.tʃ$_{2,3}$a		* *	*

Candidate (a) coalesces the leftmost segment to form a [−continuant] affricate: /θ+t/→[tθ]. While doing so minimizes violations of *[+continuant], it fatally violates the ban on stops and affricates in codas.

Candidate (b) avoids violating the coda condition by failing to preserve /t/'s [−continuant] feature. However, doing so results in three continuants on the surface [h θ ʒ]. In contrast, candidate (c) minimizes continuants by coalescing the stop with the following consonant and preserving the [−continuant] feature.

8.3.2.4 The other features

This section focuses on the other features preserved in Chipewyan coalescence: minor and major place of articulation, stridency, and secondary articulations. For these features, the marked value is always preserved.

- *Minor PoA*

Coalescence of the alveolar /t/ and interdental /θ/ results in an interdental fricative [tθ], not an alveolar affricate [ts] or plain alveolar stop [t]. Similarly, coalescence of /t/ with an alveo-palatal /ʒ/ produces an alveo-palatal [tʃ], not an alveolar [ts] or [t].

These facts follow in much the same way as preservation of [+lateral] – by a ranking that preserves the marked values [+distributed] (for /θ ð/) and [−anterior] (for /ʃ ʒ/). If IDENT[+distributed] and IDENT[−anterior] outrank *[+distributed] and *[−anterior], both values will be preserved, so blocking the plain [ts] and [t].

Importantly, both these constraints must be ranked below IDENT[+lateral]. This can be seen in the coalescence /θ+{l,ɬ}/, which results in a lateral [ɬ], not an interdental *[θ], and /ʃ+ɬ/, which also results in the voiceless lateral.

Finally, /t+{s,z}/ results in the affricate [ts], not a plain stop. This can be explained by invoking IDENT[+strident], which preserves the stridency of /s z/, resulting in a strident stop – i.e. an affricate, after Clements (1999).

To summarize, several marked feature values are preserved in Chipewyan coalescence. The interesting fact is that there is an order of preference: [+strident] is preserved over all other features, then [+lateral], and finally – if possible – [+anterior] and [−distributed].

- *Aspiration and glottalization*

A similar point can be made for the secondary articulations of aspiration and glottalization. In combinations of /t/ with glottalized or aspirated stops and affricates, the
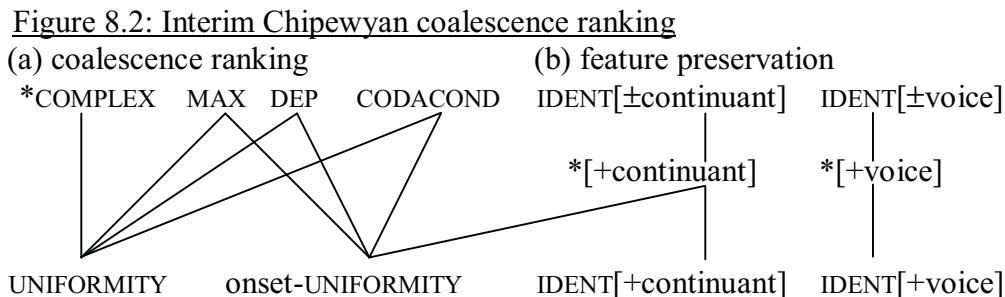
output is always glottalized or aspirated. This also shows up in the coalescence of /t+ʔ/, which results in a glottalized [t']. Assuming that [ʔ] is inherently glottalized, this result is expected. Thus, as for the marked features above, a faithfulness constraint that preserves [spread glottis] and [constricted glottis] can be invoked.

- *Major PoA*

    Finally, coalescence of /t/ with /x ɣ/ yields a [k]. The fact that /t+x/ does not result in a *[t] or *[ts] shows that Chipewyan preserves the marked PoA in coalescence. This generalization is supported by the fact that coalescence with any non-coronal stop or affricate results in the same stop or affricate: e.g. /xa-ta-tɛ-θ-t-kai/ → [xatarɛθkai] 'it is white spotted' (417). In this coalescence, the dorsal PoA of the /k/ survives, obscuring any vestige of the underlying /t/. Again, a faithfulness constraint that preserves marked feature values – IDENT{KP} – can be invoked; this constraint must outrank all antagonistic markedness constraints (i.e. *{K}, *{KP}).

8.3.2.5 Putting the rankings together

So far, two sets of rankings have been developed independently. One set produces coalescence. The other determines which features are preserved in the output. To help clarify, the rankings in (Figure 8.2:a) trigger coalescence and those in (Figure 8.2:b) result in the survival of the [‑continuant] and [‑voice] features. There is also another set of rankings, involving stridency, [lateral], [anterior], [distributed], and major PoA; these will be discussed below.

Figure 8.2: Interim Chipewyan coalescence ranking
(a) coalescence ranking   (b) feature preservation
*COMPLEX   MAX   DEP   CODACOND   IDENT[±continuant]   IDENT[±voice]

*[+continuant]   *[+voice]

UNIFORMITY   onset-UNIFORMITY   IDENT[+continuant]   IDENT[+voice]

So far, only one link between the two rankings has been shown: the ranking ‖ *[+continuant] » onset-UNIFORMITY ‖ ensures that stops will coalesce with the following segment rather than the preceding one.

- IDENT *blocks coalescence I*

    Further links must also be established. These links relate to the fact that faithfulness constraints like IDENT[±voice] can block coalescence. For example, from input /ðɛ-θ₁-l₂-ɣĩ/, IDENT[±voice] is inevitably violated by any of the coalescence candidates: i.e. [ðɛɬ₁,₂ɣĩ] or *[ðɛl₁,₂ɣĩ]. In contrast, the candidates with deletion,

epenthesis and full preservation do not violate IDENT[±voice]. In ranking terms, this means that *COMPLEX, MAX, and DEP must all outrank IDENT[±voice]. Tableau (50) illustrates this point.

(50)   Chipewyan VIII

/ðɛ-θ$_1$-l$_2$-ɣĩ/	*COMPLEX	MAX	DEP	IDENT[±voice]
(a) ðɛθ$_1$l$_2$.ɣĩ	*!			
(b) ðɛθ$_1$ɣĩ/		*!		
(c) ðɛθɛ̲lɣĩ			*!	
☞ (d) ðɛɬ$_{1,2}$ɣĩ/				*

The same point can be made for IDENT[±continuant] – this is violated by all forms where /t/ and a continuant coalesce, so it must also be outranked by CODACOND, MAX, and DEP.

The general point here is that coalescence of segments that disagree in some feature *f* results in unavoidable unfaithfulness to *f* (Pater 1995). Therefore, coalescence can be blocked by IDENT constraints that refer to this feature. For extensive discussion of this point and its relation to gemination, see Keer (1999); the same point is made for morphological haplology in de Lacy (1999b).

In Chipewyan, a further ranking can be established for IDENT[±voice], relating to onset-UNIFORMITY. Input /ðɛ-θ$_1$-l$_2$-ɣ$_3$ĩ/ can be coalesced so as to avoid violations of IDENT[±voice] altogether: i.e. *[ðɛθ$_1$ɣ$_{2,3}$ĩ]. By coalescing the /l/ and /ɣ/, the [+voice] of the /l/ is not lost. This satisfies IDENT[±voice], unlike the actual winner [ðɛɬ$_{1,2}$ɣ$_3$ĩ]. The problem with the losing form is that it violates onset-UNIFORMITY, as shown in tableau (51).

(51)   Chipewyan IX

/ðɛ-θ$_1$-l$_2$-ɣ$_3$ĩ/	onset-UNIFORMITY	IDENT[±voice]
☞ (a) ðɛɬ$_{1,2}$ɣ$_3$ĩ		*
(b) ðɛθ$_1$ɣ$_{2,3}$ĩ	*!	

The same problem does not arise for the relation between IDENT[±continuant] and onset-UNIFORMITY. Problems could only arise in a tri-consonantal cluster consisting of a stop+/t/+a continuant. In this case, /t/ would coalesce with the preceding stop rather than the following fricative to minimize violations of IDENT[±continuant]. However, no stops are permitted in Chipewyan codas. The only [–continuant] element is /n/, which coalesces with a preceding vowel: e.g. /θɛ-n-ɬ-tsi/ → [θĩɬ.tsi] 'you made it' (p.414). Therefore, the previously established ranking ‖ IDENT[±continuant] » onset-UNIFORMITY ‖ has no undesirable effects.

- IDENT *blocks coalescence II*

The point about IDENT constraints blocking coalescence also holds for the faithfulness constraints that relate to stridency, [lateral], [distributed], [anterior], and so on. To summarize the preceding sections, these constraints are arrayed in the ranking in Figure 8.3.

Figure 8.3: The role of IDENT in Chipewyan

```
        IDENT[+strident]
           /        \
  *[+strident]    IDENT[+lateral]
                   /        \
            *[+lateral]   IDENT[+distrib]   IDENT[−anterior]
                              |                   |
                         *[+distrib]         *[−anterior]
```
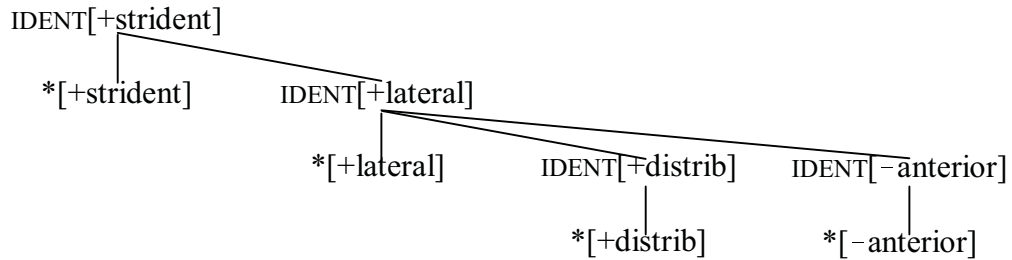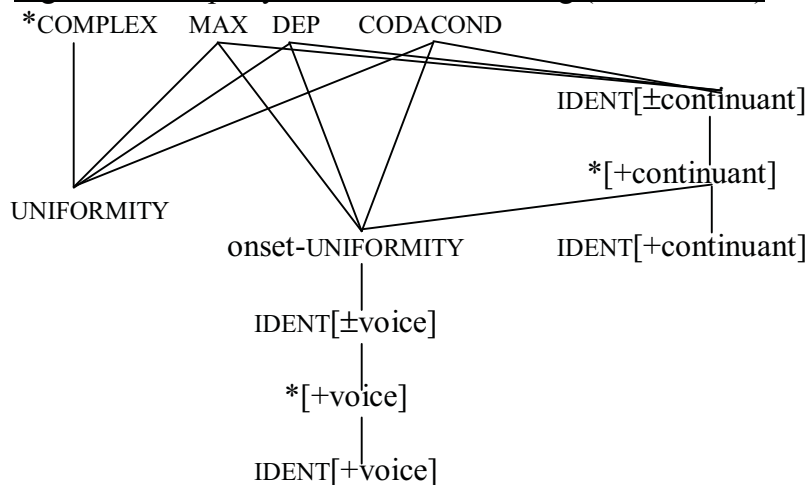
At least IDENT[+lateral] must be dominated by MAX, DEP, and the markedness constraints CODACOND and *COMPLEX. In any other ranking, competitions between a strident and lateral will be resolved by preserving both rather than coalescing them. For example, in /hεs$_1$-l$_2$-z$_3$ε/, the outputs *[hεs$_1$.z$_3$ε] (deletion), *[hεs$_1$.l$_2$ε̱.z$_3$ε] (epenthesis), and *[hεs$_1$l$_2$.zε] (complex margin) all preserve both [+strident] and [+lateral]. In contrast, the winning form [hεs$_{1,2}$.z$_3$ε] is unfaithful to the /l/'s [+lateral] specification.

- *Chipewyan Ranking*

The diagram in Figure 8.4 is provided primarily to assure the reader that all the rankings proposed so far are compatible. The rankings in Figure 8.3 are left aside; as explained above, they are incorporated into Figure 8.4 by having the *COMPLEX, CODACOND, MAX, and DEP all outrank IDENT[+lateral].

Figure 8.4: Chipewyan coalescence ranking (final version)

```
 *COMPLEX   MAX  DEP   CODACOND
                                    IDENT[±continuant]
                                           |
                                      *[+continuant]
  UNIFORMITY                               |
                                      IDENT[+continuant]
         onset-UNIFORMITY
                |
          IDENT[±voice]
                |
            *[+voice]
                |
          IDENT[+voice]
```

Despite its apparent complexity, Figure 8.4 is merely an elaboration on (i) the ranking needed for coalescence and (ii) the ranking needed for the unmarked value to survive. The coalescence ranking involves all constraints that prevent coalescence – UNIFORMITY, onset-UNIFORMITY, and the IDENT constraints – being outranked by relevant markedness constraints (*COMPLEX, CODACOND) and faithfulness constraints that block other outcomes (MAX, DEP).

8.3.2.6 Alternatives

This section considers an alternative analysis: that coalescence in Chipewyan involves a complex set of opaque processes.

In a rule-based analysis, underlying /θ+l/ would first undergo voicing assimilation: →[θɬ], followed by deletion → [ɬ]. Thus, there is no 'real' coalescence in Chipewyan: only an opaque assimilation process.

As pointed out for Attic Greek, the problem with an opaque approach is that opaque processes necessarily have transparent surface effects as well. By invoking voice assimilation for /θl/→[θɬ], one predicts that voice assimilation should occur in non-opaque contexts, too.

To some small extent, this is true: there is progressive voicing assimilation from segments to fricatives: e.g. [θi-ɣar] 'I shake it' cf [θuh-xar] 'you (pl.) shake it'; [hilzaih] 'it is being hooked' cf [hiɬsaih] 'hook it!' (411). This fits in with the proposed opaque process whereby /l/ becomes voiceless after the voiceless fricative /θ/.

However, the putative opaque assimilation is not the same as the progressive voicing otherwise seen in Chipewyan. The opaque assimilation is not progressive: it is bi-directional [‑voice] assimilation. This can be seen from the pair /ʒ+ɬ/→[ɬ]. Unlike non-opaque cases, the [ɬ] does not voice after the /ʒ/, cf /hɛ-ɣwa-l-sɛ/→[hulzɛ] 'he started to hunt' (414). In short, the opaque assimilation process is not the same that is seen elsewhere in the language: the opaque assimilation would have to be a bi-directional [‑voice] assimilation (like Swedish). Since bi-directional assimilation is not seen in transparent environments, the putative opaque process cannot exist.

8.3.3   Unmarked vowel features

The preceding two cases have focused on the features [voice] and [continuant]. §8.4 and §8.4 present cases of unmarked coalescence involving Place of Articulation, sonority, and [anterior]. This section shows that the unmarked value of vowel-related features can also survive in coalescence, standing in contrast to Attic Greek.

The case discussed here involves preservation of the feature [‑back] in the informal register of Japanese men's speech.[246]

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[246] I thank Makoto Kadowaki, Takahito Shinya, and Mariko Sugahara for their native speaker judgments. The generalizations presented here are from my own work. See Newman (1997) for a more limited

- *Description*

Certain vowel clusters are avoided in the variety of Japanese spoken by men in informal situations, called 'Japanese men's informal register' (JMIR) here. This pattern has been discussed and analyzed in previous work by Newman (1997), Rice & Causley (1998), and Causley (1999b). This section presents further data, considers all vowel combinations, and provides an alternative analysis.

Table 8.7 shows the full array of formal speech vowel clusters [i e a o ɯ] and their JMIR counterparts. Only the clusters /ai ei oi ae oe/ coalesce; all others are faithfully preserved. The shaded cells show coalescence.

Table 8.7: Japanese men's informal register vowel coalescence

V₁+V₂	i	e	a	o	ɯ
i	iː		ija	io	
e	**eː**	eː	ea	eo	eɯ
a	**eː**	eː	aː	ao	aɯ
o	**eː**	eː	oa	oː	oɯ
ɯ	ɯi	ɯe	ɯa	ɯo	ɯː

Supporting data is provided in (52).

(52) Japanese men's informal register data
  - Forms on the left are the formal (standard) register. Those on the right are JMIR forms.
  - Data is from my consultants and Newman (1997:103).
  (a) /oi/ → [eː]
      [osoi]   [oseː]   'slow, late'
      [toroi]   [toreː]   'slow, stupid'
      [aoi]   [aeː]   'bluey (adj.)'
  (b) /oe/ → [eː]
      [omoe]   [omeː]   'heavy (adj.)'
  (c) /ai/ → [eː]
      [amai]   [ameː]   'sweet'
      [miai]   [mieː]   'arranged meeting'
      [nigai]   [nigeː]   'bitter'
      [kurai]   [kureː]   'dark'
      [nai]   [neː]   'there is not'
      [wakai]   [wakeː]   'young'

---

description (of the [oi]~[eː] alternation). Also see Rice & Causley (1998) and Causley (1999b:139-140) for alternative analyses.

449

(d) /ei/ → [eː]

        /tokei/   [tokeː]

(e) Faithful clusters

[mi̠okɯrɯ]	'farewell'	[a̠ɯ]	'meet'
[me̠ataɾaʃi]	'new'	[jo̠ake]	'dawn/sunrise'
[se̠oɯ]	'carry on back'	[omo̠ɯ]	'think'
[me̠ɯtsɯɾi]	'be indecisive'	[nemɯ̠i]	'sleepy'
[ae̠ɾɯ]	'mix'	[ɯe̠ɾɯ]	'plant'
[a̠o]	'blue'	[mɯ̠atsɯ]	'kind of blanket'
		[ikɯ̠o]	{boy's name}

That the vowel cluster simplifications involve coalescence and not deletion is seen in /oso̠i/ → [ose̠ː], where the output [eː] retains the [‑back, ‑round] values of the /i/ and height of the /o/.

The result of the coalescences seen in [o{e,i}]→[eː] contrasts markedly with coalescence in Attic Greek. Neither the marked [+round] nor [+back] feature of input /o/ are retained – instead, the unmarked [‑round, ‑back] features of the input /i/ and /e/ are preserved in the output.

- *Motivating coalescence*

The coalescing clusters all consist of a high sonority segment [a o e] followed by a front vowel [e i]. All such clusters – if realized faithfully – would form a diphthong, while all clusters do not.[247] So, coalescence in JMIR can be seen as motivated by the desire to avoid diphthongs; heterosyllabic clusters therefore avoid coalescence.

- [‑back] *survival*

In the coalescence /oso₁i₂/ → [ose̠ː₁,₂], /i/'s [‑back] feature survives while /o/'s [+back] feature does not. Like [‑round], [‑back] is the unmarked value of [back]. This is therefore a case of unmarked coalescence.

For [‑back] to survive, *[+back] must outrank IDENT[+back], as shown in tableau (53).

(53)   JMIR I: unmarked coalescence ranking, part 1

/oso₁i₂/	*[+back]	IDENT[+back]
(a) osoː₁,₂	* *!	
☞ (b) oseː₁,₂	*	*

By retaining the marked [+back] value in coalescence, (a) fatally violates *[+back]: it incurs two violations to (b)'s one.

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[247] Other languages that only allow diphthongs consisting of a non-high vowel followed by a front vowel are Dumi (van Driem 1993), Urdu (Beg 1988:18), and Wari' (Everett & Kern 1997).

The second part to the ranking involves IDENT[±back]. This constraint must outrank *[+back], otherwise /o/ would neutralize to a front vowel in all environments.

(54)   JMIR II: unmarked coalescence ranking, part 2

/oso₁i₂/	IDENT[±back]	*[+back]	IDENT[+back]
☞ (a) ose:₁,₂	*	*	*
(b) ese:₁,₂	* *!		* *

Tableau (54) shows that IDENT[±back] is crucial: it prevents the word-initial /o/ from neutralizing to [e].

- *Roundness*

Unlike Attic Greek, [+round] does not survive in JMIR coalescence. There are two possible analyses of this fact for JMIR. One is that this is again an example of unmarked coalescence: the unmarked [−round] feature emerges through the ranking ‖ IDENT[±round] » *[+round] » IDENT[+round] ‖.

The other alternative is that JMIR coalescence is structure-preserving. To explain, if /oi/ coalesce to form a [−back] vowel but retain the [+round] feature, the output would be [ø] – a vowel that is banned in the language generally. To formally implement this approach, *[+back] must outrank IDENT[+round], as shown in tableau (55).

(55)   JMIR III: structure preservation

/oso₁i₂/	*ø	*[+back]	IDENT[+round]
☞ (a) ose:₁,₂		*	*
(b) oso:₁,₂		* *!	
(c) osø:₁,₂	*!	*	

Candidate (c) minimally violates *[+back] and preserves IDENT[+round]. However, it does so at the expense of creating a segment that is banned in the language – i.e. it is non-structure-preserving (Kiparsky 1982). In contrast, candidates (a) and (b) are structure-preserving, having only vowels that are allowed elsewhere in the language. Candidate (a) minimizes back vowels, and so wins.

- *Summary*

In short, coalescence in Japanese men's informal register is a case where the unmarked value of a vowel-related feature – [back] – survives. This contrasts with the preservation of the marked [+round] in Attic Greek.

The [‒back] type of marked coalescence has also been reported for Korean (Ahn 1998:80ff, Kim 1976, Lee 1979) and Rotuman (Churchward 1940, Biggs 1959, 1965, Cairns 1976, McCarthy 1986, 1989, 1995, 2000b, Besnier 1987, Blevins 1994).[248]

8.3.4 Summary

The case studies in this section have illustrated the ranking schema that allows unmarked features to emerge in coalescence. With the constraint ranking that causes coalescence, the schema in (56) is essential in ensuring that the unmarked value of feature f – i.e. uf – survives in the coalesced output.

(56) Unmarked survival ranking
$\|\ \exists \text{IDENT}\{m\text{f}, u\text{f}\} \gg \exists^*m\text{f} \gg \forall \text{IDENT}\{m\text{f}\}\ \|$

Again, mf is the marked feature value in relation to uf, as in the oppositions [+voice] to [‒voice], [dorsal] to [coronal], [dorsal] to [labial], and so on. The schema states that some markedness constraint that favours the unmarked value over the marked one (i.e. $^*m$f) must outrank all faithfulness constraints that preserve the marked value without preserving the unmarked one (i.e. IDENT$\{m$f$\}$). As tableau (57) shows, the result is that the unmarked feature uf survives.

(57) Unmarked survival, schematically

/mf$_1$ uf$_2$/	IDENT$\{m$f, uf$\}$	$^*\{m$f$\}$	IDENT$\{m$f$\}$
(a) mf$_{1,2}$	*	*!	
☞ (b) uf$_{1,2}$	*		*

Two crucial properties allow the result above. One is that there is a faithfulness constraint that preserves the least marked element: uf. If there were no such constraint – i.e. if there were only IDENT$\{m$f$\}$ – it would be impossible for the unmarked feature to emerge in coalescence and bi-directional assimilation. In such a system, IDENT$\{m$f$\}$ would have to outrank $^*m$f otherwise mf would be neutralized in all positions. However, if IDENT$\{m$f$\}$ were so ranked, the marked feature would always be favoured in coalescence.

The second property is that there is a faithfulness constraint that preserves both the marked and unmarked feature. Excluding the non-stringent theory that $\|$ IDENT$\{u$f$\}$ $\gg$ IDENT$\{m$f$\}$ $\|$ (see ch.7), the only way to give both (a) and (b) equal violations of active faithfulness constraints is if the active faithfulness constraint preserved both mf and uf equally. The result is that the faithfulness constraints are in a subset-superset relation: IDENT$\{m$f,uf$\}$ incurs a subset of the violations that IDENT$\{m$f$\}$ does.

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[248] The difference between Japanese, Korean, and Rotuman is that the latter two cases are non-structure-preserving. In other words, coalescence produces vowels that are not otherwise allowed: e.g. Korean /po-i/ → [pø], *[pe], Rotuman /hoti/ → [høt], *[het], (cf Japanese /osoi/ → [oseː], *[osøː]). The issue of structure-preservation in coalescence is not directly relevant to the aims of this chapter, so I will not discuss it further here. See McCarthy (1995, 2000b) for a relevant discussion of Rotuman coalescence.

8.4 Hybrid systems I: Place of Articulation in Pāli

The previous sections have focused on cases that show either unmarked- or marked-coalescence. This and the following section discuss 'hybrid' coalescence systems, where a marked scale element survives in competition with a lesser-marked element, and a different lesser-marked element survives in competition with a more marked element.

Hybrid systems can only come about with ternary scales or larger for practical reasons. To schematize the type of case discussed here, take a three-member scale $| \gamma \rangle \beta \rangle \alpha |$. In the coalescence /$\gamma\alpha$/, the output retains the most marked segment [γ] – this is 'marked-coalescence'. However, in the coalescence /$\beta\alpha$/, the output is the least marked element [α] – this is unmarked coalescence.

This section represents the first half of an analysis of coalescence in the Indic language Pāli. Morphological concatenation in Pāli produces many underlying consonant clusters. However, almost all tautosyllabic clusters are banned on the surface. In such cases, the consonants coalesce to (usually) form a geminate, as in /lab^h-tabːa/ $\rightarrow$ [ladːʰabːa] 'take {gerund}'.

The output of Pāli coalescence raises two main issues. Most famously, Hankamer & Aissen (1974) have argued that the coalesced output segment has the same sonority of the lowest sonority input segment. This issue will be taken up in §8.5.

The other issue relates to the place of articulation of the output. In terms of PoA, Pāli is a 'hybrid' system for coalescence: it preserves the marked dorsal PoA in competition between a dorsal and coronal, but the unmarked coronal specification survives in competition between a labial and a coronal.

This section shows that the proposals advanced in §8.2-4 can account for such hybrid systems.

Section 8.4.1 describes the basic fact of Pāli phonology relevant for coalescence. Section 8.4.2 presents an analysis. §8.4.3 summarizes the findings and comments on other relevant cases.

8.4.1 Description

Table 8.8 lists the consonant contrasts found in Pāli, from Fahs (1985).

Table 8.8 : Pāli Consonants

		labial	coronal	palatal	retroflex	dorsal	glottal
stops	-vd	p	t	c	ʈ	k	
	aspirated	pʰ	tʰ	cʰ	ʈʰ	kʰ	
	+vd	b	d	ɟ	ɖ	g	
	aspirated	bʰ	dʰ	ɟʰ	ɖʰ	gʰ	
fricatives			s				h
nasals		m	n	ɲ	ɳ	ŋ	
liquids			l ɻ				
glides		w/v		j			

Syllables can be onsetless word-initially, but medial onsetless syllables do not seem to occur. Rimes can contain (i) a long vowel, (ii) a short vowel+consonant, or (iii) a nasalized vowel. Word-final consonants are banned. Onset clusters can have two members if (i) the first member is [s] or (ii) the second member is a glide.

Heterosyllabic consonant clusters must be either geminates or homorganic nasal+stop clusters. Clusters of sonorants + [h] also occur; these are considered aspirated sonorants here. Examples of the latter three types are given in (58); examples of geminates are presented in the following sections. Examples marked (G*xx*) are from Geiger (1943), with *xx* as page numbers.

(58)   Consonant clusters in Pāli
        (a) [nasal+stop] clusters
                [vambʰeti] 'shames' (G103)
                [rundʰati] 'encloses' (G103)
                [anaṇtʃa] 'infinity' (G101)
                [kaŋkʰaː] 'doubt' (G101)
        (b) [{nasal, glide} + h]
                [amhanaː] 'with the stone' (G93)
                [paɲha] 'question' (G92)
                [puːbaɲha] 'forenoon' (G92)
                [saɟha] 'that which is to be endured' (G92)

Of the geminates, only [vː] cannot occur; when it would come about through assimilation, it appears as [bː] (Geiger p.94). More generally, [v] is classed as a glide here because its behaviour is distinctly glide-like. Not only does it behave as highly sonorous in assimilation, it classes with liquids and glides for other processes (Geiger p.60).

• *Coalescence*
        The following description and analysis is only concerned with synchronic alternations; unlike most previous analyses, the diachronic change from Sanskrit to Pāli will not be discussed, although it follows (approximately) the same lines as the synchronic

alternations. The generalizations proposed in this section are from my analysis of alternations reported in Fahs (1985).

Pāli's syllable restrictions force many input consonant clusters to simplify. The usual method of cluster-avoidance is coalescence to form a geminate: e.g. /k^{h}an$_1$+j$_2$a+ti/ → [k^{h}aɲː$_{1,2}$ati] 'dig'. However, if gemination would create an illicit output sequence, there is simply coalescence: e.g. /saɭ$_1$+t$_2$vaː/ → [sit$_{1,2}$vaː] 'go', *[sitːva]. The cases discussed below clearly involve coalescence. For example, /nj/ coalesces to form [ɲː], an output that preserves the nasality of the /n/ and PoA of the /j/. Similarly, /b^h-t/ coalesces to form [dːʰ], a form that preserve the voicing and aspiration of the /b^h/ and the PoA of the /t/.

This section focuses solely on the PoA of the output of coalescence. For discussion of other features, see §8.5.

Coalescence takes place between a stem-final consonant and a following suffix's consonant, or between adjacent suffix consonants. For example, the root-final /b^h/ coalesces with the alveo-palatal /ʃ/ and alveolar /t/ to form an aspirated geminate palatal [cːʰ] in /lab^h-ʃ-ti/ → [lacːʰim]. There are restrictions on possible consonants in Pāli suffixes: in effect, only coronals [t c s ṣ ʃ n] are found in a position where coalescence takes place. After T.Hall (1997) and a number of others, I adopt the view that [c] and [ɟ] are coronals.

- *Generalizations*
  Generalizations about the PoA of the output of coalescence are identified in (59).

(59) The PoA of Pāli coalescence
  (a) if the inputs are dorsal and coronal, the output is dorsal (see (60)).
  (b) if the inputs are labial and coronal, the output is coronal (see (61)).
  (c) if the inputs are (alveo-)palatal and alveolar, the output is alveolar (see (62)).

In other words, there is a precedence scale of | dorsal > alveolar > (alveo-)palatal > labial |, with the highest element on the scale surviving in any competition.

The PoA preferences in coalescence do not refer to 'direction' or morphological affiliation. The PoA of the rightmost (or leftmost) input consonant does not win in all situations: compare /lag-ʃ-ti/ → [lagːi], *[lacːʰi] with /lab^h-ʃ-ti/ → [ladːʰi]. Nor is it the case that the PoA of the root consonant wins in all situations (as shown by the same two examples.

Further generalizations about the persistence of aspiration and retroflexion are made in §8.5.

(60)   Pāli PoA coalescence I: /Dorsal + Coronal/ → [Dorsal]

/lag-na/   → [lagːa]   'bore through {participle}'
/lag-ʃ-ti/   → [lagːi]   'bore through {aorist+3p.sg}'
/likʰ-ʃ-ti/   → [likːʰi]   'write {aorist+3p.sg.}'
/rakːʰ-ʃ-ti/   → [rakːʰi]   'dirty {aorist+3p.sg}'
/sak-ʃːa-ti/   → [sakːʰati]   'be able to {future + 3p.sg.}'
/sak-ʃ-ti/   → [sakːʰi]   'be able to {aorist+3p.sg.}'
/saŋk-ʃ-ti/   → [saŋki]   'doubt {aorist+3p.sg}'
/vig-na/   → [vigːa]   'be excited {participle}'

(61)   Pāli PoA coalescence I: /Labial + Coronal/ → [Coronal]
(a) /Labial + alveolar/ → [alveolar]

/kʰip-ta/   → [kʰitːa]   'throw {participle}'
/labʰ-ta/   → [ladːʰa]   'take {participle}'
/labʰ-tabːa/   → [ladːʰabːa]   'take {gerund}'
/labʰ-tum/   → [ladːʰum]   'take {infinitive}'
/labʰ-tvaː/   → [ladːʰaː]   'take {absolutive}'
/lubʰ-ta/   → [ludːʰa]   'long for {participle}'
/sup-tum/   → [sotːum]   'sleep {participle}'
/tap-ta/   → [tatːa]   'burn {participle}'
/vap-ta/   → [vatːa]   'sow {participle}'

(b) /Labial + (alveo-)palatal/ → [(alveo-)palatal]

/gam-cːa/   → [gacːa]   'go {absolutive}'
/labʰ-ʃːa-ti/   → [lacːʰati]   'take {future + 3p.sg.}'
/labʰ-ʃ-im/   → [lacːʰim]   'take {1p.sg. aorist}

(62)   Pāli PoA coalescence I: /Coronal + Coronal/ → [Coronal]
(a) /Alveolar + alveolar/ → [alveolar]

/bandʰ-ta/   → [badːʰa]   'tie {participle}'
/budʰ-tum/   → [bodːʰum]   'wake {infinitive}'
/cʰid-tum/   → [cʰetːum]   'crack {infinitive}'
/daʂ-tabːa/   → [daʈːʰabːa]   'see {gerund}'
/har-tvaː/   → [hatvaː]   'take {absolutive}'
/man-tabːa/   → [mantabːa]   'think {gerund}'
/radʰ-ta/   → [radːʰa]   'be successful {participle}'

(b) /(alveo-)palatal + alveolar/ → [alveolar]

/bʰuɟ-tum/   → [bʰotːum]   'enjoy {infinitive}'
/muc-tvaː/   → [mutvaː]   'loose'
/saɟʰ-tum/   → [satːʰum]   'send {infinitive}'
/vac-tabːa/   → [vatːabːa]   'speak'
/vaʃ-tabːa/   → [vatːʰabba]   'live {gerund}'
/vaʃ-tum/   → [vatːʰum]   'live {infinitive}'

(c) /alveolar + (alveo-)palatal/ → [alveolar]

/kas-ja-ti/	→ [kasːati]	'plough'
/das-ja-ti/	→ [disːati]	'see'
/saːs-ja-ti/	→ [sisːati]	'read'
/a-kar-ʃ-i/	→ [akaːsi]	'do'
/tʰar-ʃ-i/	→ [tʰaːsi]	'litter'
/har-ʃ-i/	→ [haːsi]	'take'

8.4.2 Analysis

The following analysis starts by identifying the basic ranking needed for coalescence in Pāli. Section 8.4.2.2 shows how the marked element can be preserved, while sections 8.4.2.3-8.4.2.4 show how unmarked values can be preserved in the same grammar.

8.4.2.1 Motivating coalescence

Two conditions motivate gemination in Pāli. One bans heterorganic clusters. The other condition is that singleton codas can only contain nasals, so allowing homorganic NC clusters; geminates escape this prohibition (after Ito 1986). For discussion of how to effect these prohibitions, see ch.7. For present purposes, the effect of these conditions will be referred to as the constraint CODACOND.

In the standard way, CODACOND, MAX, and DEP, must outrank UNIFORMITY to produce coalescence.

(63)   Pāli I: basic coalescence ranking

/labʰ-ta/	CODACOND	MAX	DEP	UNIFORMITY
(a) labʰ₁t₂a	*!			
(b) lat₂a		*!		
(c) labʰ₁it₂a			*!	
☞ (d) ladːʰ₁,₂a				*

In addition, as explained in previous sections, all IDENT constraints that preserve features that are unavoidable eliminated in coalescence must be ranked below CODACOND, MAX, and DEP as well. These IDENT constraints preserve [voice], [sonority], and all PoAs except for dorsal (which always survives). For example, IDENT[±voice], IDENT{KP}, and IDENT{KPT} must be ranked at the same level as UNIFORMITY above, otherwise the output [ladːʰa], which is unfaithful to /t/'s [−voice] and /bʰ/'s labial specification, would be eliminated by the IDENT constraints just mentioned. Since PoA is the focus of this section, rankings involving these IDENT constraints will only be discussed when directly relevant.

8.4.2.2 Preserving the marked

In terms of coalescence of a dorsal and coronal, Pāli is a 'marked coalescence' system: the marked value dorsal survives. This fact can be explained by the method used for Attic Greek: some faithfulness constraint that preserves dorsals but not coronals (IDENT{K}, IDENT{KP}) must outrank all markedness constraints that favour coronals over dorsals (*{K}, *{KP}). The faithfulness constraint IDENT{K} is chosen here, for reasons that will become apparent in the next subsection.

(64)   Pāli II: marked preservation

	/sak$_1$-ʃ$_2$-t$_3$i/	IDENT{K}	*{K}	*{KP}
☞	(a) sakːʰ$_{1,2,3}$i		*	*
	(b) satːʰ$_{1,2,3}$i	*!		

Candidate (a) wins because – unlike (b) – it preserves the marked feature [dorsal].
As a side-note, coalescence with underlying stridents [s ṣ ʃ] produces an aspirated output. For an account of this fact, see §8.5.

8.4.2.3 Preserving the unmarked I: Coronals

In contrast with dorsal+coronal coalescence, the unmarked value emerges in coalescence of a labial and coronal: e.g. /labʰ-ta/ → [ladːʰa] 'take {participle}'. Analogous to Swedish and Chipewyan, no faithfulness constraint favours preservation of coronals over labials – quite the opposite in fact. Therefore, markedness constraints must be responsible for favouring the output [ladːʰa] over *[labːʰa]. Specifically, the constraint *{KP} favours the former over the latter.

*{KP} must outrank all faithfulness constraints that preserve labials without preserving coronals – i.e. IDENT{KP}. This ranking is shown in tableau (65).

(65)   Pāli IIIa: unmarked survival, part 1

	/labʰ$_1$-t$_2$a/	*{KP}	IDENT{KP}
	(a) labːʰ$_{1,2}$a	*!	
☞	(b) ladːʰ$_{1,2}$a		*

However, some constraint must prevent labials from neutralizing in all positions. More concretely, some faithfulness constraint must prevent /b/ from neutralizing to [d] in [badːʰa] 'tie {participle}' (i.e. *[dadːʰa]). Moreover, the faithfulness constraint cannot favour preservation of labials over coronals, otherwise the result in (65) would be undone. The only faithfulness constraint that can do this job, then is one that preserves labials and coronals equally – i.e. IDENT{KPT}. This is illustrated with /labʰ-tabːa/→[ladːʰabːa].

(66)   Pāli IIIb: unmarked survival, part 2

/lab$^h_1$-t$_2$abːa/	IDENT{KPT}	*{KP}	IDENT{KP}
(a) labː$^h_{1,2}$abːa	*	* *!	
☞ (b) ladː$^h_{1,2}$abːa	*	*	*
(c) ladː$^h_{1,2}$adːa	* *!		* *

Candidate (c) is eliminated by IDENT{KPT} because it eliminates labials altogether, even when coalescence is not at issue: the candidate incurs one violation of this constraint for [dː^h]'s unfaithfulness to /b^h/'s labial specification and one for [dː]'s unfaithfulness to [bː]'s labial specification.

It is crucial that candidates (a) and (b) are assigned the same violations of IDENT{KPT}. Candidate (a) incurs one for [bː^h]'s unfaithfulness to /t/'s PoA, and (b) for [dː^h]'s unfaithfulness to /b^h/'s PoA. So, IDENT{KPT} conflates the two different types of unfaithfulness: both unfaithfulness to input labials and unfaithfulness to input coronals incur the same violations.

Conflation renders IDENT{KPT} irrelevant in the competition between (a) and (b). So, the lower-ranked *{KP} makes the crucial decision, favouring the less marked candidate, (b).

As a concluding comment, IDENT{KPT} must be ranked below MAX, DEP, and CODACOND otherwise coalescence would not take place.

- *Fixed Ranking theories*
  Figure 8.5 summarizes the rankings of PoA constraints determined so far.

Figure 8.5: Major Place of Articulation in Pāli coalescence: Ranking
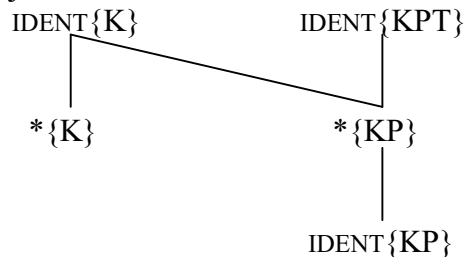
The ranking shows how both marked and unmarked features can survive in the same grammar. By ranking IDENT{K} over all markedness constraints, dorsals are ensured survival. By ranking *{KP} over all constraints that preserve labials without preserving coronals, coronals are assured survival when dorsals are not available.

This system shows why faithfulness theories with a universally fixed ranking – even those with stringent constraints – are inadequate. A theory with a fixed ranking such as ‖ IDENT{K} » IDENT{P} » IDENT{T} ‖ ensures that the most marked feature will always survive in coalescence. However, this is only partially true for Pāli. In coalescence of labials with coronals, the theory will incorrectly favour labials by the action of IDENT{P}.

Markedness constraints that favour coronals over labials cannot be invoked: if *{P} or *{KP} outranked IDENT{P}, the result would be neutralization of labials in every position.

A theory with the opposite fixed ranking || IDENT{T} » IDENT{P} » IDENT{K} || faces the reverse problem: it predicts that the unmarked feature will always survive. Because preservation of dorsals is less faithful than preservation of coronals, and no markedness constraint favours dorsals over coronals, the competition between dorsals and coronals can only produce labials.

It is not just Fixed Ranking theories with non-stringent constraints that fail to account for Pāli. Theories with stringent constraints in a fixed ranking do equally badly. For example, a theory with the fixed ranking || IDENT{K} » IDENT{KP} » IDENT{KPT} || still cannot deal with the output of labial+coronal coalescence. Because coronals survive in this case, some markedness constraint that bans labials must outrank IDENT{KP}, as established above. However, no higher-ranked faithfulness constraint preserves labials, resulting in labial neutralization in every position.

The opposite problem arises for a fixed ranking || IDENT{KPT} » IDENT{KP} » IDENT{K} ||. Because dorsals survive in competition with coronals, some faithfulness constraint that preserves dorsals and not coronals – IDENT{K}, IDENT{KP} – must outrank *{K} and *{KP}. This results in a problem for labial+coronal coalescence because the labial-eliminating constraint – *{KP} – is already ranked below all faithfulness constraints that preserve labials, so predicting that labials will win.

As a final note, the Pāli system does not rule out a theory with freely rankable non-stringent constraints. In such a system, the ranking || IDENT{K} » IDENT{T} » IDENT{P} || would produce the right results. See ch.5§5.3 for arguments against such a theory.

- *A comment on direction*

One might point out that the examples of labial+coronal coalescence all involve the order /labial+coronal/, never /coronal+labial/. Sequences of /coronal+labial/ never occur in Pāli because there are no labial-initial affixes.[249]

Therefore, one alternative is that this coalescence simply involves survival of the onset's PoA feature, rather than survival of the least marked feature.

Evidence against this proposal is found in a small class of roots that coalesce to form a singleton, not a geminate. For example, /ha$\mathfrak{t}_1$-t$_2$a/ coalesces to form /ha$\mathfrak{t}_{1,2}$a/ 'take' (170), not [ha$\mathfrak{t}_1$$\mathfrak{t}_2$a]. Notably, /jam$_1$-t$_2$a/ 'hold back' forms [jat$_{1,2}$a], not *[jap$_{1,2}$a] (also /d^{h}ov-ta/ 'clean' → [d^{h}ota], *[d^{h}opa]). Appealing to preservation of the onset's PoA does not resolve the tie between [jat$_{1,2}$a], and *[jap$_{1,2}$a] – both are equally unfaithful since [t$_{1,2}$] fails to preserve the PoA of the input /m/ while *[jap$_{1,2}$a] fails to preserve the PoA of the

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[249] Exceptions are the first person [m] for verbs, and the accusative [m]. However, the 1st person [m] is always separated from the root by a vowel, so coalescence never takes place. Some C-final nouns with accusative [m] coalesce to form an [m] (e.g. /sotas-m/ → [sotam]), but it seems that in such cases the overriding goal is to realize the accusative morpheme (i.e. *[sotas]).

input /t/. Thus, one would have to appeal to a markedness constraint to resolve the tie in favour of the coronal in any case.

Finally, in coalescence of /dorsal+coronal/, the leftmost PoA wins, not the rightmost. Thus, although direct evidence that /coronal+labial/ clusters would coalesce to form a [coronal] is lacking for incidental reasons, viable alternatives to the claim that labial+coronal coalescence aims to yield the least marked value are not at all obvious.

8.4.2.4 Preserving the unmarked II: Alveolars

The final PoA-related issue is competition between alveo-palatals and coronals. The proposal that [c] and [ɟ] are non-strident alveo-palatals is adopted here (Clements 1976, 1999, Halle & Stevens 1979, Hume 1992, T.Hall 1997). After Clements (1999), [c ɟ] are [−anterior, +distributed, −strident], compared with [tʃ dʒ] which are [−anterior, +distributed, +strident]. In short, the issue discussed in this section is the preservation of [anterior] values.

Coalescence of a [+anterior] segment with a [−anterior] one results in a [+anterior]: e.g. /vac-taːbːa/ → [vatːaːbːa], *[vacːabːa]; /saɟʰ-tum/ → [satːʰum].[250]

There is no doubt that of the two features, [+anterior] is the less marked. Every language in the ones listed in ch.6 that has a [−anterior] coronal also has a [+anterior] coronal, regardless of the manner of articulation. For example, there is no language with a [c] but no [t] (or [t̪]).

Therefore, survival of [−anterior] must be implemented by the same ranking as survival of coronal PoA: ‖ IDENT[±anterior] » *[−anterior] » IDENT[−anterior] ‖.

(67)   P̄ali IV: Unmarked survival of [anterior]

/saɟʰ₁-t₂um/	IDENT[±anterior]	*[−anterior]	IDENT[−anterior]
(a) sacːʰ₁,₂um	*	*!	
☞ (b) satːʰ₁,₂um	*		*

Tableau (67) shows how the candidate with [+anterior] [t̪ːʰ] comes to be the output: it beats candidate (a) in markedness, by minimizing [−anterior] segments.

The ranking of ‖ IDENT[±anterior] » *[−anterior] ‖ is essential for the same reasons as identified for ‖ IDENT{KPT} » *{KP} ‖ above – it prevents contrast in [anterior] from being neutralized in all environments. It also prevents the output of labial+alveo-palatal coalescence from being an alveolar, as shown in tableau (68).

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[250] The behaviour of true palatals in coalescence differs from alveo-palatals'. For example, /kʰaːd-ja-ti/ → [kʰaɟːati] 'eat {pass-3p.sg}', /kʰan-ja-ti/ → [kʰaɲːati] 'dig {pass-3p.sg.}'. /j/ is palatal, as opposed to the alveo-palatals [c ɟ]. The output of /d-j/ is the alveo-palatal [ɟ] because this is the sound that is most like a true palatal.

(68)   P̄āli V

/labʰ₁-ʃːₐ₂ati/	IDENT[±anterior]	*[−anterior]	IDENT[−anterior]
☞ (a) lacːʰ₁,₂ati		*	
(b) latːʰ₁,₂ati	*!		*

It is worth pointing out that this ranking contrasts with the one needed for Chipewyan. In §8.3.2.4, it was noted that [−anterior] survived in coalescence with a [+anterior]: i.e. /t+ʒ/ → [tʃ],*[ts] (e.g. /ʔ̃ã-hɛ-θ-t̲-ʒa/ →[ʔ̃ãhɛθt̲ʃa] 'he went home' (Li 1946: 419). The same is true of coalescence in Catalan (§8.2.4): /baʃ zɛru/ → [baʒɛru] *baix zero* 'low zero', *[bazɛru]. In these cases, the ranking ‖ IDENT[−anterior] » *[−anterior] ‖ holds.

- *Apparent exceptions*

This section concludes by noting that there are some exceptions to the claim that coalescence of alveolars and alveo-palatals yield alveo-palatals.

However, one class of these cases involve combinations of a nasal plus a palatal: e.g. /han-cːa/ → [hacːa] 'kill {absolutive}, /kʰan-ja-ti/ → [kʰaɲːati] 'he was killed'. In some situations, the nasal assimilates to the following alveo-palatal, rather than geminates: /han-ʃːa-ti/ → [haɲcʰati] 'kill {future-3p.sg.}'. The behaviour of /n/ may relate to the fact that nasals assimilate far more freely than other segments; this may be formally implemented by having nasal PoA features subject to less preservation than obstruents', accounting for the fact that the obstruent's PoA wins in coalescence.

The other class of exceptions relates to combinations of /d/ and an alveo-palatal, which typically result in an alveo-palatal: e.g. /bʰid-ʃːa-ti/ → [bʰeɟːati] 'crack {future-3p.sg.}', /cud-ja-ti/ → [cuɟːati] 'push'. However, /d/ is generally the least robust of all consonants in P̄āli, not only for PoA preservation, but for sonority preservation as well. The exceptional behaviour of /d/ is discussed further in §8.5.

8.4.3   Summary

In summary, P̄āli presents a hybrid system: where a marked scale value survives in one particular case of coalescence, but the least marked value survives otherwise. The analysis showed that the P̄āli facts can be produced by amalgamating the schemas for marked and unmarked coalescence identified in the analysis of Attic Greek, Swedish, and Chipewyan.

- *Other hybrid systems*

The present theory predicts a number of other hybrid systems for PoA. A number of these predictions are borne out in recent work on coalescence in child language. For example, Gnanadesikan's (1995) analysis of her child Gitanjali's speech shows a hybrid system in terms of PoA preservation. Relevant data is presented in (69). The data in the left column is the adult form, the rightmost column is Gitanjali's form.

(69)   Gitanjali's coalescence
        (a) /Labial + Coronal/ → [Labial]
                [smɛl]   *smell*   [fɛw]
                [swɛtə]   *sweater*   [fɛɾə]
                [twɪŋkl]   *twinkle*   [pɪkəw]
                [tri]   *tree*   [pi]
        (b) /Dorsal + Coronal/ → [Dorsal]
                [skaj]   *sky*   [ɡaj]
                [skɪn]   *skin*   [ɡɪn]
                [klin]   *clean*   [kin]
        (c) /Dorsal + Labial/ → [Labial]
                [kwajt]   *quite*   [pajt]
                [skwiz]   *squeeze*   [biz]

This is coalescence rather than deletion, as shown by forms like [fɛw] *smell*: the [f] retains the continuancy of /s/ and PoA of the /m/.

The data may seem to show a case of marked-coalescence: in competition with coronals, the marked PoA (dorsal, labial) wins, in contrast to Pāli. However, as argued in ch.7, dorsals are more marked than labials. Therefore, the fact that labial+dorsal coalescence yields a labial is a case where the least marked element survives: e.g. /kwajt/ → [pajt], *[kajt]. A similar pattern is reported by Pater & Barlow (2002).[251]

This hybrid system can be analyzed in the same way as Pāli. Preservation of the marked values dorsal and labial in coalescence with coronals is implemented by ranking IDENT{KP} over both *{K} and *{KP}. Preservation of the less marked labial in combination with the more marked dorsal is implemented by the ranking || IDENT{KP} » *{K} » IDENT{K} ||. For /kwajt/→[pajt], this ranking conflates the mappings /kw/→*[k] and /kw/→[p] – both incur equal violations of IDENT{KP}, so allowing *{K} to decisively favour [p] over [k].

(70)   Gitanjali I

/k₁w₂ajt/	IDENT{KP}	*{K}	IDENT{K}
(a) k₁,₂ajt	*	*!	
☞ (b) p₁,₂ajt	*		*

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[251] One might point out that this could be a marked coalescence system if it were assumed that labials are more marked than dorsals. However, there are several reasons to think this is not the case in child language (and adult language – see ch.6, ch.7). For example, dorsals can trigger consonant harmony in child language without labials also doing so, but the opposite situation – with labial triggers and not dorsal triggers – has not been reported. Similarly, some children delete dorsals without deleting labials, but there is no reported system in which labials are deleted without dorsals also being eliminated. For relevant work, see Pater (1997), Pater & Werle (2001), Pater & Barlow (2002, to appear).

(71)   Gitanjali II

/$k_1l_2$in/	IDENT{KP}	*{K}	IDENT{K}
☞ (a) $k_{1,2}$in		*	
(b) $t_{1,2}$in	*!		*

- *Limitations on hybrid systems*

    The present theory does not allow for all imaginable hybrid systems. Hybrid systems must be internally consistent in terms of the markedness relations they set up. The following quasi-Pāli system cannot be produced by the present theory.

(72)   'Impossible Pāli'
        (a) /Dorsal + Labial/ → [Dorsal]   /ak_1-p_2a/   →   [$ak_{1,2}$a]
        (b) /Dorsal + Coronal/ → [Coronal]   /ak_1-t_2a/   →   [$at_{1,2}$a]
        (c) /Coronal + Labial/ → [Labial]   /at_1-p_2a/   →   [$ap_{1,2}$a]

    The coalescence of /dorsal+labial/→[dorsal] indicates that IDENT{K} outranks *{K}.

    The coalescence /dorsal+coronal/ produces a coronal, so an 'unmarked coalescence' ranking is needed. Some coronal-favouring markedness constraint (either *{KP} or *{K}) must therefore outrank all dorsal-favouring faithfulness constraints (IDENT{KP}, IDENT{K}). The only markedness constraint available is *{KP} – recall that *{K} is outranked by IDENT{K}. So ‖ IDENT{KPT} » *{KP} » IDENT{K}, IDENT{KP} ‖.

    It is now impossible for /coronal+labial/ coalescence to produce labials. To do so, IDENT{KP} would have to outrank *{KP} – this contradicts the ranking established so far.

    The problem with the system just discussed is that it is inconsistent in its markedness relations. For example, (72a) sets up the markedness relation | dorsal > labial |. (72b) sets up the relation | coronal > dorsal |. Putting (72a) and (72b) together, the ranking is | coronal > dorsal > labial |. This predicts that a combination of coronal and labial should yield coronal, but it does not.

    Possible markedness relations for a 3-member scale | γ 〉 β 〉 α | can be represented as in Figure 8.6.

Figure 8.6: Transitively consistent markedness relations for a 3-member scale

(a) γ	(b) γ	(c) β	(d) β	(e) α	(f) α
|	|	|	|	|	|
β	α	γ	α	γ	β
|	|	|	|	|	|
α	β	α	γ	β	γ

    Figure 8.6 shows all *transitively consistent* markedness arrangements. In other words, for all of the arrangements in Figure 8.6 if *x>y* and *y>z*, then *x>z*. Due to the

transitive nature of ranking and the form of the constraints in the present theory, only transitively consistent systems can be produced.

8.5 Hybrid systems II: Sonority in Pāli

This section completes the analysis of Pāli coalescence started in §8.4. Like PoA in Pāli, sonority preservation is a hybrid system: in the majority of coalescences, the least marked sonority value survives, but in a few competitions, the most marked wins. This system is of interest primarily for its complexity, as for Chipewyan, Pāli sonority preservation provides a good testing ground for the adequacy of the stringency theory.

Pāli gemination has been the subject of many descriptions and analyses (Geiger 1943, Hankamer & Aissen 1974, Murray 1982, Wetzels & Hermans 1985, Cho 1999). As discussed in §8.4, syllable structure requirements eliminate many types of input clusters. Usually the method of elimination is gemination, as in /daʂ-tabːa/→ [daʈːʰabːa] 'see+{gerund}'. The focus of the previous section was preservation of Place of Articulation. The concern of this section is sonority.

Hankamer & Aissen (1974) propose that the coalesced segment's sonority is the same as that of the lowest sonority input segment. For example, since stops are less sonorous than fricatives, the result of /ʂ-t/ coalescence is the stop [ʈːʰ] rather than a fricative [sː].

The description presented below both extends and (largely) validates Hankamer & Aissen's proposal. However, exceptions to the sonority generalization are identified. Most notably, coalescence of a voiced stop and a voiceless stop yield the more sonorous voiced stops: e.g. /labʰ-tabːa/ → [ladːʰabːa] 'take', *[latːʰabːa]. This fact makes Pāli's system a 'hybrid' coalescence one, rather than one in which the unmarked value always survives.

For a discussion of the basic phonology of Pāli, see §8.4.1.

Section 8.5.1 describes the sonority of coalesced outputs.

Section 8.5.2 provides an analysis of sonority preservation.

Section 8.5.3 completes the analysis of Pāli by examining preservation of other features, including aspiration and retroflexion, and showing how they relate to preservation of sonority and PoA.

Section 8.5.4 discusses alternative approaches.

Section 8.5.5 presents a summary.

8.5.1 Description

Table 8.9 summarizes the outcome of coalescence in terms of sonority.

The leftmost column lists the first member of the input cluster, and the top row the second member. Due to restrictions on affixes, the second member is always a coronal, so the actual segments that occur are listed rather than their feature classes.

Grayed-out cells are not attested in the data. Superscript [h] stands for aspiration. The generalizations in the table are based on my analysis of alternations reported by Geiger (1943:95,96) and Fahs (1985). Supporting data is provided at the end of this subsection.

Table 8.9: Pāli Coalescence: The sonority of the output

/C_1+C_2/	[t, c]	[s]	[n]	[j]
-vd stops	-vd stop	-vd stop	-vd stop	-vd stop
+vd stops	+vd stop	stop	nasal, -vd stop	-vd stop
fricatives [s]	-vd stop[h]	fricative	s+nasal	fricative
nasals [m n]	-vd stop, nas+stop		nasal	nasal
liquids [l,ɭ,r]	-vd stop	fricative	nasal	j+{r,ɭ}
glides[j,v]	-vd stop			
h	-vd stop[h]			glide+h

The table shows that in almost all cases where the consonants coalesce, the output element has the same sonority as the least sonorous input element. The relevant parts of the consonant sonority scale are provided in (73), from ch.3 and ch.4.

(73)   Consonant sonority scale
        | glottal 〉 glide 〉 liquid 〉 nasal 〉 fricative 〉 voiced stop 〉 voiceless stop |

The most important exception to the generalization above is the coalescence of voiced and voiceless stops. The outcome of this coalescence is the more sonorous voiced stop, contrary to the expected outcome: e.g. /lub[h]-ta/ → [ludːʰa], *[lutːʰa]. This difference shows that Pāli coalescence is a hybrid system in terms of coalescence.

The table indicates that not all consonant clusters are eliminated through coalescence. Input clusters consisting of an /h/ or liquid followed by a glide are eliminated through metathesis: e.g. /kar-ja-ti/ → [kijrati] 'make+{passive+3p.sg.pres.}'.   This outcome will be discussed in §8.5.3.

The other exception involves clusters that can surface faithfully without violating syllable restrictions. For example, clusters consisting of [s]+nasal are acceptable on the surface, so underlying clusters of this type do not coalesce: /as-mi/ → [asmi], *[asːi] 'I am'. The same is true for certain combinations of nasals and stops.

- *Data*
A great deal of data is needed to provide adequate support for table 8.9's generalizations. So, for ease of exposition, the data has been placed at the end of this section, in §8.5.5. The following analysis will discuss relevant data when appropriate.

8.5.2 Analysis

There have been several formal analyses of Pāli coalescence (Hankamer & Aissen 1974, Murray 1982, Wetzels & Hermans 1985, Cho 1999). The analysis presented above has followed Hankamer & Aissen in invoking the sonority scale as the guiding factor behind the preservation of the output. One difference between previous analysis and the present one will be that the account of gemination here will not rely on opacity. However, the primary aim of the following analysis is to provide an account for why the least marked sonority level survives in coalescence in the majority of cases, but why one particular fusion – involving voiced stops and voiceless stops – results in the most marked sonority value surviving.

The motivation for coalescence in Pāli has already been discussed in detail in §8.4.2.1. The relevant tableau is repeated here. The constraint CODACOND stands for the set of constraints that bans all but homorganic nasals and the first half of geminates in codas. The tableau shows the coalescence /vas-tum/ → [vat:^{h}um] 'to live'. Note that coalescence of stops and fricatives produces an aspirated stop.

(74)   <u>Pāli VI: basic coalescence</u>

/vas$_1$-t$_2$um/	CODACOND	MAX	DEP	UNIFORMITY
(a) vas$_1$.t$_2$um	*!			
(b) vat$_2$um		*!		
(c) vas$_1$it$_2$um			*!	
☞ (d) vat:$_{1,2}$um				*

Section 8.5.2.1 discusses why the lowest sonority value is preserved in coalescence: i.e. why /vas$_1$-t$_2$um/ produces [vat:$^h_{1,2}$um] rather than *[vas:$_{1,2}$um].

Section 8.5.2.2 deals with coalescence involving voiced stops.

Section 8.5.2.3 discusses the survival of other features.

8.5.2.1 The unmarked survivor: Stops

As established in ch.3 (also see ch.8, Prince & Smolensky 1993), low sonority is less marked than high sonority in margins. Therefore, Pāli presents a case where the less marked value emerges in coalescence (cf Harar Oromo – section 8.2.4).[252] To account for the emergence of the least marked element, the 'unmarked coalescence' schema will be employed: || IDENT{*uf, mf*} » *{*mf*} » IDENT{*mf*} ||.

To take one pair of segments, /stop+fricative/ and /fricative+stop/ clusters produce a coalesced output with the sonority of a stop: e.g. /da<u>s</u>-tab:a/ → [dat:^{h}ab:a], /sak-ʃ-ti/ → [sak:^{h}i] 'be able to {aorist+3p.sg.}'.

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[252] It could be pointed out that high sonority is desirable in codas, and that preservation of low sonority may therefore be preservation of the marked value in codas. However, this will not account for cases where segments coalesce but do not form a geminate. See §8.5.2.4 for discussion.

In the present instance, *m*f is the sonority value 'fricative', and *u*f is the sonority value 'stop'. For stops to survive in coalescence, a markedness constraint that favours them over fricatives – i.e. *-$\Delta_\sigma\geq$\{fricative\} – must outrank all faithfulness constraints that preserve fricatives: i.e. IDENT$\geq$\{fricative\} here. As a reminder, the constraint *-$\Delta_\sigma\geq$\{fricative\} bans all segments that are equally or more sonorous than a fricative in syllable margins (i.e. the non-DTE of syllables).

(75) Pāli VIIa: The least sonorous wins, part 1

	/da$\underline{s}_1$-t$_2$abːa/	*-$\Delta_\sigma\geq$\{fricative\}	IDENT$\geq$\{fricative\}
☞	(a) daʈːʰ$_{1,2}$abːa		*
	(b) dasː$_{1,2}$abːa	*!	

Candidate (b) violates *-$\Delta_\sigma\geq$\{fricative\} because it has a fricative [sː] in a syllable margin. Candidate (a) violates IDENT$\geq$\{fricative\} because it fails to retain the sonority value of the /ʂ/ in the coalesced output /ʈːʰ/.

- *Faithfulness conflation*
The second ranking needed for unmarked coalescence involves a faithfulness constraint that preserves both stops and fricatives, so allowing conflation of the mappings. In the present competition, this constraint is IDENT$\geq$\{stop\}. IDENT$\geq$\{stop\} must outrank *-$\Delta_\sigma\geq$\{fricative\} otherwise (at least) fricatives will be neutralized in margins. This ranking is illustrated in (76).

(76) Pāli VIIb: The least sonorous wins, part 2

	/sak$_1$-ʃ$_2$a-ti/	IDENT$\geq$stop	*-$\Delta_\sigma\geq$fricative	IDENT$\geq$fricative
	(a) sasː$_{1,2}$ati	*	* *!	
☞	(b) sakːʰ$_{1,2}$ati	*	*	*
	(c) tʰakːʰ$_{1,2}$ati	* *!		* *

The need for the ranking ‖ *-$\Delta_\sigma\geq$fricative » IDENT$\geq$fricative ‖ is shown by the competition between (b) and (c). Candidate (b) fatally violates the markedness constraint *-$\Delta_\sigma\geq$fricative; since all faithfulness constraints that would save the fricative are ranked lower than the markedness constraint, they are inactive in this competition. So, (c) wins because it fares better on markedness.

The competition between (c) and (d) shows why IDENT$\geq$stop must outrank *-$\Delta_\sigma\geq$fricative. Without this constraint, there would be wholesale neutralization to stops: /s/ would emerge as the stop [tʰ] in all environments, not just in coalescence. So, candidate (d) fails because the initial /s/ gratuitously neutralizes to [tʰ], so incurring an extra violation of IDENT$\geq$stop.

As discussed for Attic Greek and Chipewyan, CODACOND, MAX, and DEP must all outrank IDENT$\geq$\{stop\} otherwise coalescence would be blocked.

As a final comment on this competition, the fact that /fricative+stop/ and /stop+fricative/ clusters yield the same result – a stop – shows that all faithfulness constraints that impose a directional bias on the outcome are ranked below *-Δ_σ≥fricative. The following tableau illustrates this point with the constraint ROOT-IDENT≥fricative – this constraint preserves input fricatives (and more sonorous elements) if they are affiliated to a root.

The ranking identified above only accounts for one of the results of coalescence. The next section deals with all the other types of coalescence in Pāli.

8.5.2.2 The other unmarked survivors

The ranking identified above deals with the outcome of the coalescence stops and fricatives. Because almost all other coalescences are resolved in the same way – through preservation of the least sonorous element – they are all amenable to the same explanation.

The ranking identified for stops and fricatives is ‖ IDENT≥{stop} » *-Δ_σ≥{fricative} » IDENT≥{fricative} ‖. This ranking can be generalized to every pair of sonority levels. The result is the ranking in Figure 8.7.

Figure 8.7: Pāli Ranking I: IDENT constraints
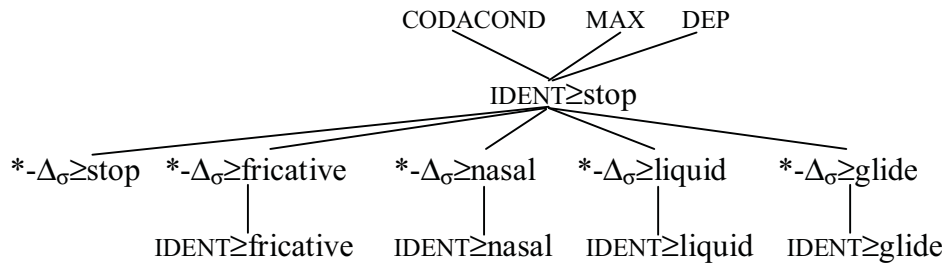
IDENT≥stop must outrank *-Δ_σ≥stop otherwise all segments would be neutralized to stops.

The need for the rankings above relates to the schema for unmarked coalescence: ‖ IDENT{*m*f, *u*f} » ∃*-*m*f » ∀IDENT{*m*f} ‖. The novelty with Pāli is that it refers to a multi-valued scale rather than a binary scale. However, the schema can be equally applied to multi-valued scales.

Starting with the competition between stops and other consonants, the output form in Pāli always has the sonority of a stop. In terms of the schema, then, *u*f refers to the 'stop' category, and *m*f refers to a more sonorous category: i.e. one of {fricative, nasal, liquid, glide}. Therefore, the schema dictates that: (1) some faithfulness constraint that preserves all sonorities be topmost (i.e. IDENT≥stop), (2) for every non-stop category *c*, there is a markedness constraint M that favours stops over *c* and (3) M outranks all faithfulness constraints that favour preservation of *c* without preserving stops.

For the competition between stops and fricatives, then, *-Δ_σ≥fricative must outrank IDENT≥fricative. *-Δ_σ≥fricative is the only markedness constraint that favours stops over

fricatives, and IDENT≥fricative is the only relevant faithfulness constraint that preserves fricatives without preserving stops.

Analogously, for the competition fricatives and nasals, *-Δ_σ≥nasal must outrank IDENT≥nasal. Again, *-Δ_σ≥nasal is the only markedness constraint that favours fricatives over nasals, and IDENT≥nasal is the only relevant faithfulness constraint that preserves nasals without preserving fricatives.

For nasals and liquid, the ranking is || *-Δ_σ≥liquid » IDENT≥liquid ||, and for liquids vs glides || *-Δ_σ≥glide » IDENT≥glide ||.

No other rankings are necessary. As an example, since the competition between stops and liquids yields stops, some markedness constraint against liquids must outrank all faithfulness constraints that preserve them to the exclusion of stops; conversely, there can be no faithfulness constraint F that favours liquids over stops such that F outranks all markedness constraints that favour stops over liquids. With the rankings so far established, there is no such ranking. F can be any of IDENT≥fricative, IDENT≥nasal, and IDENT≥liquid, but in each case, the faithfulness constraint is outranked by a markedness constraint that favours stops over liquids: i.e. *-Δ_σ≥fricative, *-Δ_σ≥nasal, *-Δ_σ≥liquid. Therefore, the liquid will never emerge from a /stop+liquid/ input cluster.

However, one pair does not fit into the general ranking above: coalescence of voiced and voiceless stops yields the more sonorous voiced stops, contrary to the other outcomes.

8.5.2.3 Voiced stops

Most /voiced stop+voiceless stop/ input clusters coalesce to form voiced stops: e.g. /rad^h-ta/ → [rad:^{h}a] 'be successful'; /lub^h-ta/ → [lud:^{h}a]. This outcome is the reverse of all other coalescences in sonority terms: the more sonorous element wins.

The marked coalescence ranking identified for Attic Greek must be employed to deal with the competition between voiced and voiceless stops. This ranking requires some faithfulness constraint that preserves voiced stops but not voiceless ones (IDENT≥{+vd stop}) to outrank all markedness constraints that favour voiceless stops over voiced ones (*-Δ_σ≥{+vd stop}). Tableau (77) shows how this ranking produces the right result.

(77) Pāli VIII: the marked wins

/lub$^h_1$-t$_2$a/	IDENT≥{+vd stop}	*-Δ_σ≥{+vd stop}
(a) lut:$^h_{1,2}$a	*!	
☞ (b) lud:$^h_{1,2}$a		*

Candidate (b) beats (a) because (a) fails to preserve the sonority value 'voiced stop' of the input /b^h/.

- *Relation to other rankings*
  The ranking in (77) will not contradict any of the other rankings established so far.

The most relevant ranking relates to the competition between voiceless stops and fricatives: $/sak_1$-$\int$:$_2$a-ti/ $\rightarrow$ [sak:$^h_{1,2}$ati]. This coalescence shows that *-$\Delta_\sigma \geq$fricative outranks all constraints that preserve fricatives without also preserving stops. The only two constraints that do this are IDENT$\geq$\{fricative\} and IDENT$\geq$\{voiced stop\}. This in no way contradicts the ranking in (77): since *-$\Delta_\sigma \geq$\{fricative\} does not favour *[lut:$^h_{1,2}$a] over [lud:$^h_{1,2}$a], it can outrank IDENT$\geq$\{+vd stop\}. This ranking is shown in tableau (78).
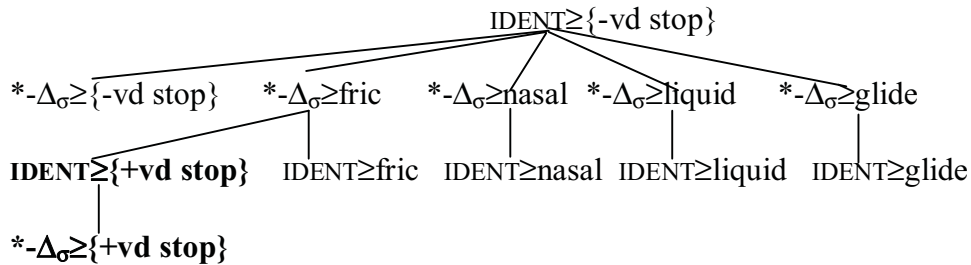
(78) Pāli IX: integrated rankings

$/sak_1$-$\int_2$-i/	*-$\Delta_\sigma \geq$\{fricative\}	IDENT$\geq$\{fricative\}	IDENT$\geq$\{+vd stop\}
(a) sas:$_{1,2}$i	*!		
☞ (b) sak:$^h_{1,2}$i		*	*

- *Ranking summary*

The rankings identified in (77) and (78) can be straightforwardly amalgamated into the constraint hierarchy, as shown in Figure 8.8.

Figure 8.8: Pāli Ranking II

The summary shows that the majority of coalesces in Pāli are of the 'unmarked sort'. By having markedness constraints dominate their correspondent faithfulness constraints, the output will always chose the candidate with the least marked (i.e. lowest) sonority value. The difference is with voiced stops, for which the ranking is reversed. As shown in bold, the faithfulness constraint for voiced stops and greater outranks the corresponding markedness constraint. This ensures that the marked value will survive in just this competition.

- *A note on exceptions*

The generalization above holds of all voiced stops except for the plain coronal /d/: e.g. /c^{h}id-tum/ $\rightarrow$ [c^{h}et:um] 'crack'.[253] This contrasts with the behaviour of aspirated /d^h/: e.g. /bud^h-tum/ $\rightarrow$ [bod:^{h}um], *[bot:^{h}um], /bad^h-ta/ $\rightarrow$ [bad:^{h}a].

/d/ not only acts as exceptional with voiceless stops. Coalescence of /d+n/ unexpectedly yields the more sonorous output [n:]: e.g. /nud-na/ $\rightarrow$ [nun:a] 'knock',

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[253] There is also one example involving /ɟ/: /b^{h}uɟ-tum/ $\rightarrow$ [b^{h}ot:um] 'drink'. A lack of further examples makes it impossible to determine whether this is a pattern.

[nudːa]; /tud-na/ → [tunːa] 'blow' (cf [tudati]).[254] This contrasts with other voiced stops: e.g. /bʰaɟ-na/ → [bʰaɟːa] 'break', /lag-na/ → [lagːa] 'hang up', /randʰ+na/ → [randʰa] 'be powerful'.

Finally, while most combinations of post-alveolars and alveolars yield alveolars, combinations of /d/ and post-alveolars yield post-alveolars: e.g. /aᵘ-cʰid-ʃ-i/ → [acːʰecːʰi] (see §8.4.2.4).

At this point, I have no explanation for why /d/ is so exceptional in its behaviour, especially given the contrast with its aspirated counterpart /dʰ/. It could be that /d/ undergoes an assimilation that only targets coronals (as in Catalan). This may opaquely precede coalescence, so obscuring the fact that there is an underlying /d/.

For present purposes, I only note that /d/ is exceptional in Pali. Whether its exceptionality is formally explained through opacity or by some other mechanism, the main point is that the majority of the sonority class 'voiced stop' wins in coalescence.

8.5.2.4 The survival of other features

The aim of this section is to provide an account of the other features that persist in Pāli coalescence – aspiration and retroflexion, and to explain why metathesis takes place in limited environments rather than coalescence

- *Aspiration*

If one of the input segments is an aspirated stop, /s/, /ʂ/, /ʃ/ or /h/, the output is also aspirated. This point is illustrated in (79).

(79) Aspiration Preservation in Pāli
    (a) stopʰ+C
        /labʰ-tum/   → [ladːʰum]   'take+infin.' (191)
        /radʰ-ta/   → [radːʰa]   'resut+participle' (170)
    (b) {s, ʂ}+C
        /vasː-ta/   → [vutːʰa]   'live+participle' (170)
        /sis-ta/   → [sitːʰa]   'leave+participle' (17)
        /iʂ-ta/   → [iʈːʰa]   'wish+participle' (170)
    (c) C+ʃ
        /sak-ʃ-ti/   → [sakːʰi]   'be able+aorist+3p.sg.' (158)
        /labʰ-ʃ-im/   → [lacːʰim]   'take+aorist+1p.sg.' (158)
        /cʰid-ʃːa-ti/   → [cʰecːʰati]   'crack+future+3p.sg.' (148)
    (d) h+C
        /duh-ta/   → [dudːʰa]   'milk+participle' (170)
        /snih-ta/   → [sinidːʰa]   'love+participle' (170)

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[254] Other roots with this pattern are /cʰad/ 'cover', /pad/ 'go', and /sid/ 'cook'.

The same analysis for aspiration preservation as used in Chipewyan is given here (§8.3.2.4): a faithfulness constraint that preserves [+spread glottis] outranks all markedness constraints that favour plain stops over aspirates. The proposal that voiceless fricatives are specified as [+spread glottis] is adopted here (Kingston 1990, Vaux 1998), so accounting for the fact that their coalescence yields an aspirated stop.

(80) <u>Pāli X: aspiration preservation</u>

/vas$_1$-t$_2$um/	IDENT[+spread glottis]	*[+spread glottis]
(a) vatː$_{1,2}$um	*!	
☞ (b) vatː$^h_{1,2}$um		*

It is impossible to tell whether sonority-preservation or aspiration-preservation is more important in Pāli. Data that would determine this issue would involve an input cluster consisting of an aspirate and a consonant that is (i) less sonorous and (ii) unable to bear aspiration. However, for purely incidental reasons such clusters never arise. There is no consonant that is less sonorous than an aspirated stop, so all /stop^h+C/ clusters are irrelevant. The only consonants less sonorous than fricatives are stops, and all stops have an aspirated counterpart, so /s+C/ clusters are irrelevant.

The only remaining relevant cluster is /h+C/, where C is a glide, liquid, or nasal. Since there are no aspirated counterparts of glides, liquids, or nasals, the result ought to show whether sonority or aspiration is more important. For example, if /h+n/→[nː], then preservation of sonority trumps aspiration; if aspiration-preservation is more significant, the result should be [h]. Unfortunately, there are very few such clusters. There are no /h+l/ clusters due to the lack of suffixes starting with /l/. Input /h+glide/ clusters usually surface as [glide+h]. There are one or two exceptions. For example, /kaɻ-ha-mi/ → [kahaːmi] 'make+fut+1p.sg' and /haɻ-hi-ti/ → [haːhiti] 'name-fut-3p.sg.'. However, the /h/ here is a marginal alternant of /sːa/, so it may be that the /sː/ has debuccalized to [h] opaquely. This leaves /h+nasal/ clusters. Unfortunately, I have been unable to find any systematic examples of such clusters – /h/-final verbs seem to be defective for the most part, and the crucial morphological contexts are missing.

- *Retroflexion*
  Input clusters of a retroflex consonant plus a stop always produce a retroflex consonant on the surface. Representative examples are given in (81).

(81) <u>Preservation of retroflexion</u>
      /daʂ-tabːa/   → [datːʰabːa]   'see {gerund}'
                      cf /vas-tabːa/ → [vatːʰabːa]   'live {gerund}'
      /daɻʂ-tvaː/   → [ditːʰaː]   'see {absolutive}'
      /kiɻ-na/   → [kiɳːa]   'scatter'
      /iʂ-ta/   → [itːʰa]   'wish'

Since Pāli does not allow retroflex fricatives or liquids on the surface, /daṣ/ and /kiɻ/ are realized with non-retroflex consonants in other environments: e.g. /daṣ-ja-ti/ → [disːati] 'see {causative}', /a-daṣ-ʃ-am/ → [adːasam] {aorist 1p.sg.}; /kiɻ-asi/ → [kirasi] {2p.sg.pres.indic}.

Since retroflexion is a marked feature, the 'marked coalescence' ranking must be used here: a retroflexion-preserving faithfulness constraint must outrank all markedness constraints against retroflex stops. The interesting difference in this ranking is that constraints against retroflex continuants (i.e. *ɻ, *ṣ) must outrank all retroflex-preserving faithfulness constraints, otherwise they would survive in the output. Tableau (82) shows the ranking for retroflex-preservation in coalescence; tableau (83) shows how retroflexion in continuants is otherwise neutralized. The relevant retroflexion feature is taken to be [+back] here (after Chomsky & Halle 1968, E.Pulleyblank 1989).

(82)   Pāli XIa: preservation of retroflexion

/daṣ₁-t₂abːa/	*ṣ, *ɻ	IDENT[+back]	*ʈ,ɖ
(c) datːʰ₁,₂abːa		*!	
☞ (d) daʈːʰ₁,₂abːa			*

(83)   Pāli XIb: retroflexion again

/daṣ-ja-ti/	*ṣ, *ɻ	IDENT[+back]	*ʈ,ɖ
(a) diṣːati	*!		
☞ (b) disːati		*	

Tableaux (82) and (83) also give some indication as to the relative ranking of the retroflex-preserving faithfulness constraint and the sonority faithfulness constraints. Underlying segments do not change their sonority in the output in order to preserve retroflexion. For example, /daṣ-ja-ti/ does not surface as [daʈːʰati] even though doing so would preserve the input retroflex feature. So, it is clear that sonority preservation requirements outweigh retroflex-preservation. In terms of the constraints discussed, this means that IDENT≥fricative must outrank IDENT[retroflex].

(84)   Pāli XII: Sonority beats retroflexion

/daṣ-ja-ti/	IDENT≥{fricative}	*ṣ, *ɻ	IDENT[retroflex]
(a) diṣːati		*!	
(b) diʈːati	*!		
☞ (c) disːati			*

There is no way to determine the relative ranking of the PoA-faithfulness constraints and retroflex-faithfulness constraints. The crucial data would involve a /k+retroflex/ input cluster. Unfortunately, no suffixes begin with a retroflex consonant.

- *Metathesis and faithfulness*

In all the cases where coalescence does not take place – i.e. the cluster surfaces faithfully – the cluster does not violate any syllable restriction. For example, since [s+C] onsets are permitted, /s+nasal/ clusters are realized faithfully: /as-mi/ → [asmi] 'be+1p.sg.', *[asːi] (139). Codas permit geminates and nasals homorganic to a following stop, so underlying nasal+stop clusters surface faithfully: /kʰan+tum/ → [kʰan.tum] 'dig+infin.', *[kʰatːum] (191); /gam-tvaː/ → [gan.tvaː] 'go+absolutive' (183).

Another situation where adjacent consonants do not coalesce is with [h+glide] clusters; /h+glide/ clusters metathesize to form an acceptable output sequence: e.g. /dah-ja-ti/ → [dajhati] 'burn+passive+3p.sg.' (201). Metathesis is also used with /{liquid,glide}+j/ clusters. Input /{glide,liquid}+j/ clusters surface as a [j+glide] output sequence, with [j] often realized as lengthening of the preceding vowel: e.g. /bʰaɹ-ja-ti/ → [bʰijɹati]/[bʰiːɹati] 'carry+passive+3p.sg.' (201). Metathesis is only allowed with glides and /h/, though. Other sequences do not allow metathesis: so /stop+nasal/ clusters are realized as stops, not *[nasal+stop] (e.g. /lag+na/ → [lagːa] 'hang up+participle', *[laŋga] (167).

Restricting metathesis to high sonority elements is expected. In a number of languages, only high sonority elements undergo metathesis (Hume 1997, Carpenter 2001, Blevins & Garrett 2001). After Carpenter (2001), there is more faithfulness to adjacency relations between low-sonority elements: LINEARITY≤{nasal} specifically preserves linear precedence relations between elements that are less sonorous than liquids. This constraint is in a stringency relation with the more general LINEARITY (from McCarthy & Prince 1995, slightly adapted below).

(85) (a) LINEARITY≤nasal If *x* or *y* are equally or less sonorous than a nasal,
         and *x* precedes *y*,
         then it is not the case that *y*' precedes *x*'.
         (*x*', *y*' are the correspondents of *x,y* resp.)

      (b) LINEARITY   If *x* precedes *y*,
         then it is not the case that *y*' precedes *x*'

Since all outcomes except metathesis are blocked – including deletion, epenthesis, and coalescence, the constraints MAX, DEP, and UNIFORMITY must outrank LINEARITY, as shown in tableau (86).

(86)   Pāli XIVa: Metathesis

/kar₁-j₂a-ti/	CODACOND	UNIF	MAX	DEP	LINEARITY
(a) kar₁.j₂a.ti	*!				
(b) kirː₁,₂a.ti		*!			
(c) ki.j₂a.ti			*!		
(d) ki.r₁i.j₂ati				*!	
☞ (e) kij₂.r₁a.ti					*

To ensure that coalescence takes place in every other combination, though, LINEARITY≤nasal must outrank UNIFORMITY.

(87) Pāli XIVb: Metathesis, part 2

/bʰaɟ₁-n₂a/	CODACOND	LIN≤nasal	UNIFORMITY	LINEARITY
(a) bʰaɟ₁.n₂a	*!			
(b) bʰaɲ₂ɟ̍₁a		*!		*
☞ (c) bʰaɟ̍₁₂a			*	

Candidate (b) violates LINEARITY≤nasal because a segment with the same or less sonority than a nasal – i.e. /n/ – metathesizes in the output. In contrast, /r+j/→[jr] does not violate LINEARITY≤nasal – neither segment has the same or less sonority than a nasal, so the constraint does not apply.

Notably, the coalesced candidate (c) does not violate LINEARITY. LINEARITY is only violated when there is a reversal of precedence relations, so /x₁y₂/→[z₁,₂] does not violate the constraint. So, the correct output in tableau (9) wins.

As shown in previous studies, the further ranking ‖ MAX, DEP » UNIFORMITY ‖ is needed to produce coalescence in /bʰaɟ-na/→[bʰaɟːa]. This leaves us with the triggering ranking: ‖ CODACOND, MAX, DEP » LINEARITY≤nasal » UNIFORMITY » LINEARITY ‖.

8.5.3 Summary

This section has presented a rather complex case of a hybrid coalescence system. For the most part, the unmarked value of sonority survives in Pāli coalescence. However, in one competition – between voiced and voiceless stops – the marked value is preserved.

The Pāli pattern is not unique. Child language provides a number of similar systems. For example, Pater (2001) provides a detailed analysis of a child's (Julia) coalescence patterns. To summarize, a consonant cluster will be generally reduced to the least sonorous of the two: i.e. /stop+liquid/ → [stop], /fricative+stop/→[stop], /fricative+liquid/→[fricative], and so on. However, there is one difference: /s+nasal/ clusters are realized as nasals, not as [s]. This contrasts with a similar pattern reported by Gnanadesikan (1995), where /sn/ is realized as [s] in Gitanjali's speech.

Julia's pattern is akin to Pāli's: although the majority of coalescence outputs preserve the least marked sonority value, there is a reversal in one case. The Pāli ranking can therefore be straightforwardly adapted to account for Julia's pattern: IDENT≥nasal must outrank *-Δ_σ≥{nasal}.

8.5.4 Data

The data given below is based on my construal of Pāli morphology and phonology, as determined from alternations presented by Fahs (1985), and from analysis by Geiger

(1943). Accordingly, this section starts by laying out the reasons for the claims about the underlying forms made below.

- /s/, /ʃ/, and /ʂ/

Coalescence facts provide a good deal of evidence for segments that otherwise undergo absolute neutralization in output forms. For example, Pāli only allows surface [s], not [ʂ] or [ʃ]. However, there is clear evidence that some forms that have [s] on the surface are underlyingly /ʂ/ or /ʃ/. One near minimal pair is [sis] 'leave' and [is] 'wish'; the former must be underlyingly /sis/ and the latter /iʂ/ to explain why *sis+ta* is realized as [sitːʰa] with a plain stop [tːʰ], while *is+ta* is realized as [iʈːʰa] with a retroflex.

There is also an underlying /s/-/ʃ/ distinction, neutralized on the surface to [s]. The aorist -*s* is underlyingly /ʃ/ and the future -*ssa* is underlyingly /ʃːa/, again shown by coalescence: /labʰ-ʃːa-ti/ → [lacːʰati] 'he will take'; /a-cʰid-ʃ-i/ → [acːʰecːʰi] 'split'. In both these cases, the output consonant is palatal despite the fact that – on the surface – the future and aorist otherwise show up as [s]: e.g. /har-ʃːa-ti/ → [hasːati] 'name {3p.sg.fut.}'.

- /r/ *and* /ɻ/

The same is true for an underlying /r/-/ɻ/ contrast neutralized to [r]. Two relevant roots are *har* 'name' and *dʰar* 'keep': the former produces a retroflex in combination with /ta/ {participle}, while the latter does not: [haʈa] cf [dʰata]; therefore *har* is /haɻ/ while *dʰar* is /dʰar/.

- *The ghost segment*

A more extreme case of underlying contrast is that roots differ as to whether they have a final underlying mora (or 'ghost segment'). This difference emerges in combination with suffixes, as shown in the following pairs: /ɡup+ta/→[ɡutːa] 'watch' (170) cf /kupᵘ+ta/→[kupita] 'be excited' (173); /haɻ+ʃːa+ti/→[hasːati] 'name 3p.sg.' (147) cf /sarᵘ+ʃːa+ti/→[sarisːati] 'go' (148). As shown by the examples, the underlying μ of μ-final roots emerges as the default vowel [i] on the surface. In contrast, the final consonant of C-final roots like /ɡup/ coalesces with the suffix's consonant.

Support for this proposal – that there is an underlying distinction between μ- and C-final roots – comes from several facts. One is that every suffix has a C-initial and an [i]-initial allomorph: [tabːa]~[itabːa], absolutive [tvaː]~[itvaː], infinitive [tum]~[itum], passive [ja]~[ija], and future [sːa]~[isːa]. In the present approach, this fact follows from the difference in underlying roots: the [i]-initial form shows up with μ-final roots, and the C-initial form appears with C-final roots. Finally, and most importantly, roots are (largely) consistent as to whether they take V-initial suffixes or C-final ones. For example /var/ 'live' takes all V-initial affixes, while /kar/ 'make' takes all C-initial suffixes. This goes to show that it is a property of the root as to whether an [i] intervenes between the root-final C and initial consonant of the suffix.

- *The data*

The underlying forms in the data below are based on the comments above. Evidence for the underlying final consonants in C-final forms come from V-initial suffixes. Output forms are from Fahs (1985). For ease of reference, the table of Pāli consonants is repeated from §8.4.1. Absolutely neutralized consonants are include as well – they are in lightly shaded cells. [v] is classed as a glide rather than a fricative – see ch.6 for discussion.

Table 8.10: Pāli underlying consonants

		labial	coronal	retroflex	palatal	dorsal	glottal	
stops	-vd	p	t	ṭ	c	k		
	aspirated	pʰ	tʰ	ṭʰ	cʰ	kʰ		
	+vd	b	d	ḍ	ɟ	g		
	aspirated	bʰ	dʰ	ḍʰ	ɟʰ	gʰ		
fricatives			s	ṣ	ʃ		h	ɦ
nasals		m	n	ṇ	ɲ	ŋ		
liquids			l r	ɭ				
glides		v		j				

(88) /X+Glide/
- the following examples use /ja/ {passive} + /ti/ {3pers.sg.}[255]

/hj/	→ [jh]	/ḍah-ja-ti/	→ [ḍajhati]	'burn'[256]
/rj/	→ [jr]	/kar-ja-ti/	→ [kijrati]/[kiːrati]	'make'
(/lj/	→ [jː]	/dal-ja-ti/	→ [diːjati]	'split' [only one example])
/nj/	→ [ɲː]	/kʰan-ja-ti/	→ [kʰaɲːati]	'graben'
/ṣj/	→ [sː]	/daṣ-ja-ti/	→ [disːati]	'see'
/pj/	→ [pː]	/tap-ja-ti/	→ [tapːati]	'burn'
/bʰj/	→ [bːʰ]	/labʰ-ja-ti/	→ [labːʰati]	'take'
/dj/	→ [ɟː]	/kʰaːd-ja-ti/	→ [kʰaɟːati]	'eat'
/dʰj/	→ [ɟːʰ]	/rudʰ-ja-ti/	→ [ruɟːʰati]	'check'
/cj/	→ [cː]	/ric-ja-ti/	→ [ricːati]	'leave'
/ɟj/	→ [ɟː]	/jaɟ-ja-ti/	→ [iɟːati]	'sacrifice'

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[255] Evidence that the passive is underlyingly /ja/ comes from vowel-final roots: e.g. /kʰaː-ja-ti/ → [kʰaːjati] 'proclaim' (201).
[256] Proof for the form of the root: /ḍah+a+ti/ → [ḍahati] {present indicative 3p.sg.}. All other underlying roots listed below have similar justification; their underlying form can also be seen by comparing their behaviour in different coalescence patterns.

(89) /Glide+X/
  /vt/ → [t] /dʰov-ta/ → [dʰota] ~ [dʰovita] 'clean {infin.}'
  /jt/ → [t] /ɟʰaːj-tva/ → [ɟʰaːtva] 'burn {absolutive}'
      /ɟʰaːj-ta/ → /ɟʰaːtːa] 'burn {infin.}'

(90) /X+nasal/
  • most of the following examples use /na/ {participle}
  /ɻn/ → [ɳː] /kiɻ-na/ → [kiɳːa] 'scatter'
  /rn/ → [tʰ] /satːʰar-nam/ → [satːʰanam] 'doctrine+{gen.}'
  /ndn/ → [nː] /sand-na/ → [sanːa] 'demolish'
  /sm/ → [sm] /as-mi/ → [asmi] 'be+1p.sg.'
  /dn/ → [nː] /tud-na/ → [tunːa] 'knock'
  /ɟn/ → [ɟː] /bʰaɟ-na/ → [bʰaɟːa] 'break'
  /gn/ → [gː] /lag-na/ → [lagːa] 'join'

(91) /nasal+X/
  /nj/ → [ɲː] /ɟan-ja-ti/ → [ɟaɲːati] 'generate'
  /nʃ/ → [ɲcʰ] /han-ʃːa-ti/ → [haɲcʰati] 'kill'
  /ns/ → [s] /puman-smaː/ → [pumasmaː] 'man'
  /nt/ → [nt] /kʰan-tabːa/ → [kʰantabːa] 'dig'
  /nc/ → [cː] /han-cca/ → [hacːa] 'kill'
  /mt/ → [nt] /gam-tum/ → [gantum] 'go'
  /mc/ → [cː] /gam-cca/ → [gacːa] 'go'

(92) /X+fricative/
  • most of the following examples use /ʃːa/ {future} or /ʃ/ {aorist}
  /rʃː/ → [sː] /har-ʃːa-ti/ → [hasːati] 'name'
  /ns/ → [s] /puman-smaː/ → [pumasmaː] 'man'
  /ʃʃː/ → [cːʰ] /vaʃ-ʃːa-ti/ → [vacːʰati] 'speak'
  /bʰʃː/ → [cːʰ] /labʰ-ʃːa-ti/ → [lacːʰati] 'take'
  /tːʃ/ → [tːʰ] /vatː-ʃ-ti/ → [vatːʰi] 'turn'
  /dʃː/ → [cːʰ] /cʰid-ʃːa-ti/ → [cʰecːʰati] 'crack'
  /cʃ/ → [kːʰ] /vac-ʃːa-ti/ → [vakːʰati] 'speak'
  /ɟʃː/ → [kːʰ] /bʰuɟ-ʃːa-ti/ → [bʰokːʰati] 'enjoy'
  /kʃː/ → [kːʰ] /sak-ʃːa-ti/ → [sakːʰati] 'be able to'
  /kʃ/ → [kːʰ] /sak-ʃ-ti/ → [sakːʰi] 'be able to'

(93) /fricative+X/
  /sj/ → [sː] /kas-ja-ti/ → [kasːati] 'plough'
  /sm/ → [sm] /as-mi/ → [asmi] 'be+1p.sg.' [1]
  /sʃː/ → [cːʰ] /sus-ʃːa-ti/ → [sucːʰati] 'dry'
  /ʂt/ → [ʈːʰ] /kiliʂ-ta/ → [kiliʈːʰa] 'be dirty'

(94)　/X+stop/
　　　• the examples use /ta/ {participle}, /tabːa/ {gerund},
　　　and /tum/ {infinitive}, /tvaː/ {absolutive}

/ɕt/	→ [dːʰ]	/duɕi-ta/	→ [dudːʰa]	'milk'
		/naɕi-ta/	→ [nadːʰa]	'tie'
/vt/	→ [t]	/dʰov-ta/	→ [dʰota] ~ [dʰovita]	'clean'
/rt/	→ [tː]	/kar-tabːa/	→ [katːabːa]	'make'
		/kar-tvaː/	→ [katvaː]	'make'
/rc/	→ [cː]	/kar-cca/	→ [kacːa]	'make'
/lt/	→ [lː]	/pʰal-ta/	→ [pʰulːa]	'burst'
/nt/	→ [nt]	/kʰan-tabːa/	→ [kʰantabːa]	'dig'
/nc/	→ [cː]	/han-cːa/	→ [hacːa]	'kill'
/mt/	→ [nt]	/gam-tum/	→ [gantum]	'go'
		/gam-tvaː/	→ [gantvaː]	'go'
/mc/	→ [cː]	/gam-cca/	→ [gacːa]	'go'
/ʂt/	→ [tːʰ]	/daʂ-tabːa/	→ [daʈːʰabba]	'see'
		/daʂ-tvaː/	→ [diʈːʰaː]	'see'
/st/	→ [tːʰ]	/vas-tabːa/	→ [vatːʰabba]	'live'
		/vas-tum/	→ [vatːʰum]	'live'
		/vas-ta/	→ [vutːʰa]	'live'
/pt/	→ [tː]	/sup-tum/	→ [sotːum]	'sleep'
		/kʰip-ta/	→ [kʰitːa]	'throw'
/bʰt/	→ [dːʰ]	/labʰ-tabːa/	→ [ladːʰabːa]	'take'
		/labʰ-ta/	→ [ladːʰa]	'take'
/dt/	→ [tː]	/cʰid-tum/	→ [cʰetːum]	'crack'
		/cʰid-tvaː/	→ [cʰetva]	'crack'
/dʰt/	→ [dːʰ]	/budʰ-tum/	→ [bodːʰum]	'wake'
		/vjadʰ-tvaː/	→ [vidːʰaː]	'bore through'
/ct/	→ [tː]	/vac-tabːa/	→ [vatːabːa]	'speak'
/ɟt/	→ [tː]	/bʰuɟ-tum/	→ [bʰotːum]	'enjoy'

(95)　/voiceless stop+X/

/pj/	→ [pː]	/lip-ja-ti/	→ [lipːati]	'scrawl'
/cj/	→ [cː]	/sic-ja-ti/	→ [sicːati]	'marry'
/kʃ/	→ [kːʰ]	/sak-ʃ-ti/	→ [sakːʰi]	'be able'
/tːʃ/	→ [tːʰ]	/vatː-ʃ-ti/	→ [vatːʰi]	'turn'
/pt/	→ [tː]	/kʰip-ta/	→ [kʰitːa]	'throw'
/ct/	→ [tː]	/vac-tabːa/	→ [vatːabːa]	'speak'
		/muc-tvaː/	→ [mutvaː]	'free'

(96) <u>/voiced stop+X/</u>
(a) /{d, ɟ}+X/

/dj/	→ [ɟː]	/cud-ja-ti/	→ [cuɟːati]	'press'
/dn/	→ [nː]	/pad-na/	→ [panːa]	'walk'
/dʃ/	→ [cːʰ]	/a-cʰid-ʃ-i/	→ [accʰecːʰi]	'crack'
		/rud-ʃːa-ti/	→ [rucːʰati]	'cry'
/dt/	→ [tː]	/cʰid-tum/	→ [cʰetːum]	'crack'
		/cʰid-tvaː/	→ [cʰetva]	'crack'
		/cʰid-tvaː/	→ [cʰitvaː]	'crack'
		/bʰid-tvaː/	→ [bʰetvaː]	'break'
/ɟt/	→ [tː]	/bʰuɟ-tum/	→ [bʰotːum]	'drink'
		/saɟ-tum/	→ [satːʰum]	'send'

(b) /{b, bʰ, dʰ, g, gʰ} + X/

/dʰj/	→ [ɟːʰ]	/rudʰ-ja-ti/	→ [ruɟːʰati]	'hemmen'
		/vjadʰ-ja-ti/	→ [vjaɟːʰati]	'durchbohren'
/ɟj/	→ [ɟː]	/bʰaɟ-ja-ti/	→ [bʰaɟːati]	'break'
/ndʰ/	→ [ndʰ]	/randʰ+na/	→ [randʰa]	'be powerful'
/ɟn/	→ [ɟː]	/bʰaɟ-na/	→ [bʰaɟːa]	'break'
/gn/	→ [gː]	/lag-na/	→ [lagːa]	'hang up'
		/vig-na/	→ [vigːa]	'be excited'
/bʰt/	→ [dːʰ]	/lubʰ-ta/	→ [ludːʰa]	'see onself'
		/labʰ-tum/	→ [ladːʰum]	'take'
		/labʰ-tabːa/	→ [ladːʰabːa]	'take'
		/labʰ-tvaː/	→ [ladːʰaː]	'take'
/dʰt/	→ [dːʰ]	/budʰ-tum/	→ [bodːʰum]	'wake'
		/radʰ-ta/	→ [radːʰa]	'be successful'
		/vjadʰ-tvaː/	→ [vidːʰaː]	'cut through'

8.6   Summary

The aim of this chapter was to show that stringently formulated faithfulness constraints are necessary. In other words, for every pair of faithfulness constraints F_1, F_2 that refer to the same scale, F_1 preserves a subset of the elements that F_2 preserves or vice-versa. With the additional proviso that the marked element is always preserved, for a (part of a) scale $| \alpha \rangle \beta |$ there are therefore two faithfulness constraints IDENT$\{\alpha\}$ and IDENT$\{\alpha,\beta\}$; there can be no faithfulness constraint IDENT$\{\beta\}$.

- *Faithfulness conflation*

These proposals predict that 'faithfulness conflation' may occur. In other words, two mappings from the same input may incur the same violations of active faithfulness constraints. This fact turns out to be crucial in accounting for certain cases in which

featural unfaithfulness is forced, or more precisely where an IDENT constraint for some feature is inevitably violated by the winning form. This occurs in both coalescence and bi-directional assimilation. For example, coalescence of /b^h+t/ in Pāli (§8.4) inevitably results in unfaithfulness to Place of Articulation: the output [dː^h] ignores /b^h/'s labial specification, and output [bː^h] ignores /t/'s coronal value.

To generalize, for a mapping /x$_1$y$_2$/ → [z$_{1,2}$], where *x* and *y* have different values for some feature *f*, the present theory predicts two possible outcomes. The examples focus on Place of Articulation. *m*f refers to a marked value of feature f, and *u*f refers to a relatively less marked value.

(97) Outcomes of coalescence
(a) The marked feature survives (e.g. /b+d^h/ → [b^h])
      || IDENT{*m*f} » *{*m*f} ||
(b) The unmarked feature survives (e.g. /b^h+d/ → [d^h])
      || IDENT{*m*f, *u*f} » *{*m*f} » IDENT{*m*f} ||

Cases where the unmarked value survives in the output of coalescence show the need for stringent faithfulness constraints. If the unmarked value of a feature *f* appears in the output, some markedness constraint against the marked value **m*f must outrank all faithfulness constraints that preserve marked values. For the coalescence /b^h+t/→[dː^h], where the unmarked coronal PoA survives, this means that *{KP} must outrank IDENT{KP}.

However, in order for *m*f to contrast with *u*f, some faithfulness constraint F must outrank **m*f. So, to prevent elimination of labials in every environment, IDENT{KPT} must outrank *[labial]. Therefore, F must both preserve *m*f yet not favour *m*f over *u*f. The only way to satisfy these requirements is if F preserves both *m*f and *u*f equally, as shown in the tableau below.

(98)

/*m*f$_1$ *u*f$_2$/	IDENT{*m*f, *u*f}	*mf	IDENT{*m*f}
(a) *m*f$_{1,2}$	*	*!	
☞ (b) *u*f$_{1,2}$	*		*

In short, the faithfulness constraints are in a subset-superset relation, so allowing the unmarked value to emerge.

Finally, the constraints predict systems in which a marked scale value survives in coalescence with a less marked value (e.g. /b+t/ → [d]), but a more marked value is preserved in coalescence with a less marked one (e.g. /k+d/ → [g]). These hybrid systems were shown to result from the fact that the rankings needed for marked and unmarked coalescence are compatible. Even so, certain types of hybrid system were shown to be impossible (§8.4.3).

- *Typology*

Table 8.11 summarizes the cases discussed in this chapter. As indicated, both marked and unmarked coalescence takes place.

Table 8.11: Coalescence typology

Feature	Marked Wins	Unmarked Wins
[‑anterior]	Catalan (8.2.4)	Pāli (8.4.2.4)
[back]		Rotuman, Korean (8.3.3)
[constr glottis]	Chipewyan (8.3.2.4)	Taos (Trager 1946)
[nasal]	Dakota, Indonesian (8.2.4)	
[round]	Greek (8.2.1)	Japanese men's speech (8.3.3)
[sonority]	Harar Oromo (8.2.4)	Pāli (8.5)
[spread glottis]	Chipewyan (8.3), Pāli (8.5)	
[voice]	Aka, Nuer (Akinlabi 1996)	Chipewyan, Swedish (8.3)
Major PoA	Pāli(dorsal>coronal) (8.4)	Pāli (coronal>labial) (8.4)

As the table shows, there are some gaps in the typology. I have found no clear case where [+back] wins in coalescence. This gap may be because [back] and [round] are so closely associated, so it is often difficult to tell whether the output preserves the input's [back] or [round] feature. However, cases like Korean and the analogous Rotuman (Churchward 1940, McCarthy 1995, 2000b) show that the two features are separable. Another gap relates to nasality: a clear case where the unmarked [‑nasal] value persisted would involve a coalescence such as /i + ð/ → [e], or /m+p/ → [b].

CHAPTER 9

SUMMARY AND IMPLICATIONS

9.1 Introduction

This chapter has two goals. The first is to discuss how the aims of this dissertation have been met (§9.2). The second is to re-evaluate the notion of markedness in the light of the results of the preceding chapters (§9.3).

9.2 Aims

This dissertation started with an informal statement of two leading ideas, repeated in (1).

(1) Leading Ideas
   (a) Markedness relations between categories may be ignored, but never reversed.
   (b) The more marked an element is, the greater the pressure to preserve it.

Evidence for (1a) was shown to come from systems in which different sonority categories are treated the same for stress purposes (ch.3, ch.4). For example, stress placement in Gujarati is sensitive to sonority distinctions: stress deviates from its default penult position if doing so will allow it to fall on a highly sonorous low vowel: e.g. [tádʒetəɾ] 'recently', [sinemá] 'movie theatre' (ch.3§3.2). However, while stress favours low vowels over all other types, it treats mid and high vowels in exactly the same way: stress does not avoid a penult high vowel for a mid vowel (e.g. [tʃʰokɾío] 'girls', *[tʃʰókɾio]), or avoid a mid vowel for a high vowel (e.g. [tʃumːóteɾ] '74', *[tʃúmːoteɾ]). In other words, the sonority categories 'mid peripheral vowel' and 'high peripheral vowel' are conflated for stress purposes in Gujarati. This contrasts with a stress system like Nganasan's, where stress avoids the default penult position if it contains a high vowel: ([kóntuɟa] 'carries', *[kontúɟa], cf Gujarati [tʃʰokɾío]).

Evidence for (1b) was shown to come from processes for which marked elements are exempt. For example, chapter 6 provided examples from neutralization in languages like Yamphu (Rutgers 1998). In Yamphu, a general process of Place of Articulation neutralization in syllable codas forces /t/ to surface as a glottal stop: /namːit/ → [namːiʔ] 'daughter-in-law', cf [namːid-æʔ] {instrumental}, /sitː-ma/ → [siʔma] 'to hit', cf [sitː-a] 'hit+past'. However, the more marked PoA values 'labial' and 'dorsal' are exempt from this attrition: e.g. [kʰap] 'language', *[kʰaʔ], [kep-ma] 'to stick'; [æʔlik] 'bendy', [kʰaːk-pa] 'scrape one's throat'. In other words, greater preservation is afforded to the marked PoA values in Yamphu, preventing them from undergoing an otherwise general process.

Further evidence for (1b) comes from assimilation (ch.7). While coronals assimilate in Catalan, labials and dorsals do not: /son pɔks/ → [som pɔks] 'they are few', cf /som dos/ → [som dos] 'we are two', [aɲ tontu] 'stupid year', [tiŋ presə] 'I am in a hurry'. Again, the marked elements are preserved, exempting them from an otherwise general process.

Evidence for both (1a) and (1b) was argued to be found in coalescence (ch.8). In Pāli, for example, adjacent consonants had to fuse to form geminates. When dorsals and coronals fused, the output element retained the more marked dorsal feature: /sak-ʃ-ti/ → [sak̲ːʰi], *[sat̲ːʰi], *[sac̲ːʰi] 'be able to {aorist+3p.sg.}. This shows that there is greater pressure to preserve the marked element in this competition, so providing evidence for (1b).

In contrast, the fusing of labials and coronals in Pāli produces a segment with the less marked coronal Place of Articulation: e.g. /lubʰ-ta/ → [lud̲ːʰa] 'long for {participle}', *[lub̲ːʰa]. Chapter 8 argued that the coronal PoA survives because labials and coronals are equally important in terms of preservation in Pāli. So, unlike dorsals, the output of /bʰ-t/ could be either a labial *[bːʰ] or coronal [dːʰ] and the preservation requirements of the language would be met. In this sense, the mappings /bʰ-t/ → *[bːʰ] and /bʰ-t/ → [dːʰ] are conflated: they are treated in exactly the same way in Pāli. Because survival of either the labial or coronal PoA is countenanced, the choice between the two falls to markedness constraints; accordingly, the least marked (coronal) PoA is favoured.

Now that evidence for the leading ideas has been reviewed informally, I will turn to a discussion of how the leading ideas are formally implemented. Since a detailed summary of the theoretical proposals has been provided at the end of each previous chapter, the aim of the following subsections is to provide a brief synopsis of the theoretical proposals as they relate to the leading ideas in (1). See the cross-references provided below for more detailed discussion.

9.2.1   Markedness constraints

Scale-referring markedness constraints have two tasks: (i) to formally encode hierarchical relations between scale elements and (ii) to allow category conflation. Chapter 3 argued that both (i) and (ii) could be achieved if constraints refer stringently to sets of elements and are freely rankable. An example of the type of constraints advocated here is provided in (3); the constraints refer to the partial vowel sonority scale in (2). The element Δ_{Ft} refers to the head of a foot.

(2)   (Partial) vowel sonority scale
         | ə ⟩ i, u ⟩ e, o ⟩ a |

(3)   *Δ_{Ft}/{ə}, *Δ_{Ft}/{ə,i/u}, *Δ_{Ft}/{ə,i/u, e/o}, *Δ_{Ft}/{ə, i/u, e/o, a}

As an example, the constraint *Δ_{Ft}/{ə,i/u,e/o} is violated by a stressed syllable that contains a vowel of equal or less sonority than the mid vowels [e o]. For example, [pítkə̀] incurs two violations of this constraint.

The constraints implement the hierarchy expressed by the scale in (2). More precisely, the constraints prevent reversal of the scale in (2). For example, low vowels are more desirable than mid vowels for stress purposes in Gujarati, as discussed above. This was implemented by ranking the constraint $*\Delta_{Ft}/\{ə,i/u,e/o\}$ above the constraint that requires penult stress (ALIGNFTR) in ch.3.

(4)

/tadʒetəɾ/	$*\Delta_{Ft}/\{ə,i/u,e/o\}$	ALIGNFTR
(a) ta(dʒétəɾ)	*!	
☞ (b) (tádʒe)təɾ)		*

However, mid vowels can never attract stress away from low vowels. For this to happen, there would have to be some constraint that assigned a violation to stressed low vowels but not to stressed mid vowels. As shown in quasi-tableau (5), there is no such constraint. While there is a constraint that favours [á] over [é] (i.e. $*\Delta_{Ft}/\{ə,i/u,e/o\}$), there is no constraint that does the opposite.

(5)

	$*\Delta_{Ft}/\{ə\}$	$*\Delta_{Ft}/\{ə,i/u\}$	$*\Delta_{Ft}/\{ə,i/u,e/o\}$	$*\Delta_{Ft}/\{ə,i/u,e/o,a\}$
(a) ə́	*	*	*	*
(b) í		*	*	*
(c) é			*	*
(d) á				*

Because [é] incurs a proper subset of the violations of [á], the ranking of the constraints will make no difference to the relative markedness of [é] and [á] – the former can never be preferred over the latter in terms of these constraints.

However, there are constraints that treat the two categories – i.e. mid and low vowels – in the same way. This is crucial for the competition between mid and high vowels in Gujarati. As discussed above, the two categories are conflated for stress purposes. This follows if all constraints that distinguish the two – i.e. $*\Delta_{Ft}/\{ə,i/u\}$ – are 'inactive' for stress, which in this case means 'ranked below ALIGNFTR'. This situation is illustrated in tableau (6).

(6)

/tʃʰokɾio/	$*\Delta_{Ft}/\{ə,i/u,e/o\}$	ALIGNFTR	$*\Delta_{Ft}/\{ə,i/u\}$
(a) (tʃʰókɾi)o	*	*!	
☞ (b) tʃʰok(ɾío)	*		*

The only constraint that favours stressed mid vowels over stressed high vowels is $*\Delta_{Ft}/\{ə,i/u\}$. Because it is ranked below ALIGNFTR, its violations are inconsequential in determining the winner for stress.

In this ranking, it is crucial that $*\Delta_{Ft}/\{ə,i/u,e/o\}$ assigns exactly the same violations to both (a) and (b). This is how conflation is formally implemented – through the assignment of equal violations. By doing so, $*\Delta_{Ft}/\{ə,i/u,e/o\}$ makes no decision between the two candidates; this allows ALIGNFTR to make the crucial decision, favouring the candidate with stress in the default position. Chapter 3 provided an in-depth discussion of why stringent form is crucial in producing conflation.

- *Structural elements*

The other major markedness-related theoretical proposal is that certain scales can combine with structural elements to form constraints. For example, the constraints in (3) are combined with the structural element 'stressed syllable'. This was argued to be only one of many possible structural elements. In fact, scales like the sonority hierarchy were argued to combine with both heads and non-heads of all prosodic levels.

Detailed arguments for this proposal were provided in chapter 4.

9.2.2 Faithfulness constraints

Faithfulness constraints must (i) encode the proposal that more marked elements can be subject to greater preservation and (ii) allow for faithfulness conflation. Chapters 6-8 argued that both (i) and (ii) could be achieved if faithfulness constraints referred to contiguous sets of scale elements and always preserved the most marked element. For example, the faithfulness constraints for the Place of Articulation scale in (7) are provided in (8).

(7)   Place of Articulation scale
       | dorsal ⟩ labial ⟩ coronal ⟩ glottal |
(8)   Place of Articulation (PoA) faithfulness constraints
       • *x* corresponds to *x*'
       IDENT{dorsal}   If *x* is dorsal, then *x*' has the same PoA as *x*.
       IDENT{dors,lab}   If *x* is dorsal or labial, then *x*' has the same PoA as *x*.
       IDENT{dors,lab,cor} If *x* is dorsal, labial, or coronal, then *x*' has the same PoA as *x*.
       IDENT{dors,lab,cor,gl} If *x* has any PoA, then *x*' has the same PoA as *x*.

The example of Pāli coalescence mentioned in the previous section will be used to illustrate the two major properties of the 'marked-faithfulness' constraints in (8).

- *Marked-faithfulness*

When dorsals and coronals coalesce in Pāli, the result is a dorsal: e.g. /sak-ʃ-ti/ → [sak:ʰi], *[sat:ʰi]. This illustrates the proposal that more marked elements can be subject to greater preservation. In constraint terms, the dorsal+coronal coalescence shows that there is a faithfulness constraint that preserves dorsals but not coronals, as shown in tableau (9).

(9)

	/sak$_1$-ʃ$_2$-t$_3$i/	IDENT{dorsal}	*{dorsal}
☞	(a) sakː$^h_{1,2,3}$i		*
	(b) satː$^h_{1,2,3}$i	*!	

The tableau shows that the input segments /k-ʃ-t/ coalesce into a single output segment. Because the input segments differ in PoA specifications, some unfaithfulness is inevitable: (a) is unfaithful to the input coronal specifications of /t/ and /ʃ/, while (b) is unfaithful to the input dorsal specification of /k/.

It is clear that markedness constraints cannot be responsible for favouring [kː^h] over [tː^h] since the latter contains a more marked PoA specification. Therefore, faithfulness constraints must be wholly responsible for the preservation of the dorsal PoA. Moreover, the faithfulness constraint must favour preservation of the more marked dorsal element over the less marked one: i.e. IDENT{dorsal}.

The need for a faithfulness constraint that favours preservation of dorsals over coronals can be seen in a theory that favours preservation of all PoAs equally. The constraint IDENT{Place} assigns the same violations to all PoA-unfaithfulness, regardless of the input feature value. So, IDENT{Place} assigns the same violations to /k-ʃ/ → [kː^h] and /k-ʃ/ → [cː^h]. This predicts that the unmarked value should always survive in coalescence, as shown in tableau (10).

(10)

	/sak$_1$-ʃː$_2$ati/	IDENT{Place}	*{dorsal}
	(a) sakː$^h_{1,2,3}$ati	*	*!
☞	(b) sacː$^h_{1,2,3}$ati	*	

Candidates (a) and (b) are both unfaithful to input PoA specifications: (a) is unfaithful to the input alveo-palatal specification of /ʃ/ and (b) is unfaithful to the input dorsal specification of /k/. However, since IDENT{Place} treats both types of unfaithfulness as equally important, it cannot decide between the two candidates. The choice inevitably falls to the markedness constraints, which always favour the least marked element.

- *Faithfulness conflation*
  However, there is a way for the least marked element to survive. A relevant case is the competition between labial and coronal PoA in Pāli, as in /lub^h-tabːa/ → [ludː^{h}abːa], *[lubː^{h}abːa]; in this case, the least marked PoA feature survives.

The reason that the output is coronal relates to faithfulness conflation. In effect, the marked-faithfulness constraints allow different types of unfaithfulness to be assigned equal importance. In Pāli, unfaithfulness to a labial is accorded the same status as unfaithfulness to a coronal. This allows markedness constraints to make the crucial decision.

The constraint IDENT{dors,lab,cor} allows unfaithfulness to labials and coronals to be conflated. This constraint must outrank *{dors,lab} in order to prevent wholesale

neutralization of labials in the output (i.e. /lub^h-tab:a/ → *[lud:^{h}ad:a]). Yet because IDENT{dors,lab,cor} treats the candidates' unfaithfulness as being equally severe, it allows the lower-ranked markedness constraints to determine the output of coalescence.

(11)

/lub$^h_1$-t$_2$ab:a/	IDENT{dors,lab,cor}	*{dors,lab}	IDENT{dors,lab}
(a) lub:$^h_{1,2}$ab:a	*	* *!	
☞ (b) lud:$^h_{1,2}$ab:a	*	*	*
(c) lud:$^h_{1,2}$ad:a	* *!	*	* *

The competition between (a) and (b) shows that it is crucial for both candidates to incur the same violations of IDENT{dors,lab,cor} – doing so allows the lower-ranked markedness constraint *{dors,lab} to favour the candidate with a coronal coalesced segment over the one (a) with the more marked labial segment.

The competition between (b) and (c) shows that the ranking of IDENT{dors,lab,cor} with respect to *{dors,lab} is crucial; the opposite ranking would result in neutralization of labials in all positions.

Finally, the ranking shows that it is crucial that all constraints that preserve labials and not coronals (IDENT{dors,lab}) must be inactive. If IDENT{dors,lab} outranked *{dors,lab}, candidate (a) would win.

In short, it is crucial that some faithfulness constraint preserve marked elements without preserving unmarked ones, but it is also crucial that there are faithfulness constraints that preserve all elements equally.

This concludes the synopsis of the theoretical proposals in this dissertation. I now move on to considering the implications of this dissertation for the notion of markedness.

9.3   The status of markedness

The preceding chapters have shown that certain diagnostics that have been standardly used to determine markedness relations are invalid.

For example, since the Prague School theorists it has been standard to use inclusion in segmental inventories to determine relative markedness: if *x* is in some inventory but *y* is not, then *y* is more marked than *x*. However, chapter 6 showed that this diagnostic gives almost no insight into markedness relations because almost all possible gaps in inventories are attested. This point is illustrated for voiceless stops in Table 9.1, repeated from ch.6§6.7.

Table 9.1: Voiceless stop inventories

		k	*p*	*t*	*ʔ*	*coda inventories*	*onset inventories*
Harmonically Complete		✓	✓	✓	✓	Chamicuro	Tongan
			✓	✓	✓	Standard Malay	Tahitian
				✓	✓	Menomini	Harar Oromo
					✓	Nantong Chinese	Nancowry reduplicants
	GE	✓	✓	✓		Yuma	Maori
			✓	✓		Kiowa (formal)	Vanimo
				✓		Lardil	
Gapped	3	✓	✓		✓	Yamphu	Hawaiian
		✓		✓	✓	Nambiquara	Tlingit
			✓		✓	Nganasan	
	2	✓			✓	Fuzhou	
		✓		✓		Hixkaryana	Gilbertese

The same point was made for undergoers of assimilation. While it has been claimed that only marked elements can be exempt from assimilation (Mohanan 1993, Jun 1995), only coronals do not undergo assimilation in Sri Lankan Portuguese Creole: /siːn-pə/ → [siːnpə], 'bell {dative sg.}, *[siːmpə]; cf /maːm-ki/ → [maːŋki] 'hand {verbal noun}' (ch.7§7.4.2.1). Chapter 7 showed that any set of segments could be exempt from undergoing PoA assimilation.

Similarly, chapter 8 showed that any feature value – marked or unmarked – can survive in coalescence. Chapter 4§4.4 showed that epenthetic vowels can have any sonority (i.e. [ɨ ə i e ɛ a]).

At this point, one may wonder whether the notion of markedness has any validity at all, considering that these traditional diagnostics have been shown to be uninformative. The following subsections discuss this concern. Section 9.3.1 discusses why the phenomena mentioned above do not show surface asymmetries. Section 9.3.2 identifies phenomena that still exhibit asymmetric behaviour, so providing valid diagnostics for markedness relations.

9.3.1   Covert asymmetry

While there are no surface asymmetries in terms of inventories, undergoers of assimilation, and the output of coalescence, this dissertation has argued that this fact is an incidental result of the proposal that marked values can be exempt from undergoing certain processes. To put this in slightly different terms, there *are* asymmetries in the grammar, but none in the superficial observations about phenomena.

As an example, chapter 6 distinguished between harmonically complete and gapped inventories. Harmonically complete inventories are those that have a contiguous set of elements including the least marked type: i.e. for PoA in voiceless stops, [p t ʔ], [t ʔ], and [ʔ]. Gapped inventories are those that contain a marked element but lack a less marked

one: i.e. [k t ʔ], [k p ʔ], [k ʔ], [p ʔ]. When the results of these two inventory types are combined, almost every imaginable inventory is attested. However, I have argued that the two types are produced through entirely different ways.

Harmonically complete inventories are produced by the effect of markedness constraints. Markedness constraints militate against highly marked elements, so may effectively eliminate all but the less marked segments in an inventory.

In contrast, gapped inventories are primarily produced through the effect of marked-faithfulness constraints. For example, a gapped inventory like [k p ʔ] occurs because a constraint that prevents marked elements from being eliminated – IDENT{KP} – prevents these elements from undergoing an otherwise general neutralization process.

So, there is an asymmetry in terms of inventories, but it is 'covert' – i.e. not obvious on the surface. The asymmetry relates to how the different types of inventory come about, one primarily through the influence of markedness constraints, and the other through the blocking effect of marked-faithfulness constraints.

In short, the lack of asymmetry in inventories is a coincidental result of the proposal that marked elements can be subject to greater preservation than unmarked ones. This proposal allows gapped inventories to exist, with the surface effect that almost any inventory is attested.

- *Coalescence and assimilation undergoers*

The same 'covert asymmetry' explains the lack of surface asymmetries for coalescence and the undergoers of assimilation.

As discussed in chapter 8, coalescence systems can be broadly divided into two types: those in which the unmarked feature survives (as in Pāli /bʰ-t/ → [dːʰ]) and those in which the marked value survives (as in /k-ʃ-t/ → [kːʰ], *[tːʰ]). The former type is produced primarily by the influence of markedness constraints – markedness constraints favour less marked elements over more marked ones, so ensuring that the least marked feature survives. The type in which the marked feature survives relies on the influence of marked-faithfulness constraints, which demand that marked features persist in the output.

An analogous 'covert asymmetry' accounts for the different types of assimilation systems, discussed in chapter 7. Those like Sri Lankan Portuguese Creole, where only marked elements assimilate, come about through the action of markedness constraints: the markedness constraints seek to eliminate highly marked clusters, but allow less marked ones (i.e. those with coronals, in this case) to survive. In contrast, systems like Catalan's, where marked elements are exempt from assimilation, rely on the existence of marked-faithfulness constraints: the greater preservation afforded to marked elements prevents them from assimilating in this language.

So, although there is no overt difference between inventory types, coalescence patterns, and assimilation systems, an asymmetry lurks beneath the surface: some systems come about through minimization of markedness, while others come about through preservation of marked elements.

For arguments that covert asymmetries exist, see the chapters cited.

9.3.2   Overt asymmetry

The previous section has argued that lack of surface asymmetry for some phenomena comes about through the preservation of marked elements. This proposal predicts that surface asymmetries should be visible in phenomena for which preservation is irrelevant.

- *Sonority-driven stress*

For example, faithfulness is irrelevant to sonority-driven stress. More concretely, in the candidates from input /pita/, [píta] and [pitá], both incur the same faithfulness violations; therefore, markedness alone is relevant in determining the winner. So, a phenomenon like this is predicted to behave asymmetrically – since markedness constraints determine the output, processes can only promote unmarked elements. Accordingly, there are systems in which less marked (i.e. more sonorous) stressed vowels are preferred over more marked (=less sonorous) ones, but there are none in which more marked stressed vowels are preferred over less marked ones. Concretely, while there are languages in which highly sonorous vowels attract stress away from lower sonority ones, there is no language where the opposite is true, where high vowels attract stress away from [a], for example.

- *Epenthetic PoA*

Faithfulness is also irrelevant in determining the PoA of epenthetic elements. Epenthetic segments do not have corresponding input elements, so the proposal that marked values are subject to greater preservation will have no effect on their form. So, the PoA of epenthetic elements can only reflect markedness concerns. As shown in ch.5§5.3, the result is that epenthetic consonants can only have the unmarked PoA values 'glottal' or 'coronal'; they are never labials or dorsals (also see ch.6§6.6, ch.4§4.4).

- *Output of neutralization*

The same is true for the output of neutralization. For example, [k] is banned in Standard Malay codas (ch.6§6.2). It can therefore neutralize to [p], [t], or [ʔ]. Importantly, faithfulness is irrelevant to the choice of output: [p], [t], and [ʔ] are all equally unfaithful to /k/. Therefore, only markedness constraints are relevant in choosing the winning form. As argued in ch.6, only [ʔ] and [t] are ever produced by neutralization. Again, this asymmetry follows from the fact that the marked-faithfulness constraints are irrelevant in this situation.

- *Output of Deletion*

An analogous point holds for deletion, in a subtler way. The proposal that more marked elements can be subject to greater preservation than less marked ones only applies to feature-changing processes, not segment-deleting ones. More concretely, the constraint IDENT{KP} cannot prevent /k/ and /p/ from deleting. As shown in ch.6§6.4.2, this means that the marked-faithfulness constraints are effectively irrelevant in determining which elements undergo deletion. The net result is that if an element *x* undergoes deletion, then

all more marked elements also delete. Again, because marked-faithfulness is irrelevant, deletion provides a clear indication of markedness asymmetries.

- *Triggers of assimilation*

The final major markedness diagnostic discussed here again relates to assimilation, but this time to the elements that trigger it. For example, dorsals in Korean force the preceding element to assimilate to them: /kamki/ → [kaŋki], /han-kaŋ/ → [haŋkaŋ]. In contrast, the less marked labials and coronals do not trigger assimilation: e.g. [paŋpota], *[pampota], [sumta], *[sunta].

Again, faithfulness has no relevance for assimilation triggers. This can be seen by comparing the candidates from /kam-ki/ → *[kamki], [kaŋki] and those from /sumta/ – [sumta] and *[sunta]. The only faithfulness difference between the candidates relates to the element that (potentially) undergoes assimilation – the coda nasal /m/. The triggering element – /k/ and /t/ respectively – do not undergo any featural change, so faithfulness is irrelevant for them. Accordingly, markedness constraints alone can determine which elements trigger assimilation. As argued in ch.6, the overall aim is to eliminate heterorganic clusters with highly marked elements, explaining why the most marked element – dorsal – triggers assimilation while the less marked elements do not. Since markedness is the sole factor that determines which elements trigger assimilation, the present theory predicts that if *x* triggers assimilation, so will all elements that are more marked than *x* (also see Mohanan 1993). For a detailed discussion of this point, see ch.7§7.5.

9.4   Summary

To summarize, the proposals in this dissertation in no way eliminate the need for a concept of markedness. However, they do offer a significantly different perspective on where markedness asymmetries may be found. For a number of phenomena, asymmetries will not be evident on the surface. Even so, all phenomena are predicted to at least show 'covert asymmetries', whereby some systems are produced through markedness reduction, while others are due to the preservation of marked elements. Finally, phenomena for which faithfulness is irrelevant are predicted to exhibit overt markedness asymmetries.

9.5   Closing remarks

I wish to conclude this dissertation by identifying (i) a few areas to which the proposals herein could potentially apply and (ii) issues that were not addressed.

While the entire focus of this dissertation has been on phonological scales, the proposals and results discussed herein could (and should) apply to morphological and syntactic scales. For example, one could expect to find a syntactic equivalent of conflation for phenomena involving the Person/Animacy hierarchy (Silverstein 1976, Dixon 1979, Aissen 1999, Woolford 1999). In fact, there is a hint that syntactic-scale conflation exists: some work recognizes a distinction between 1st and 2nd person in the Person hierarchy, while others group the two categories together (calling it 'local' – see Aissen 1999 for

relevant discussion). It is less easy to see how the faithfulness proposals – 'marked preservation' and stringent form – will apply to syntactic scales given the few feature-changing operations in syntactic phenomena (cf neutralization and assimilation in phonology). In short, the parallels with syntax are issues that require careful attention.

Some scale-related issues were not addressed in this dissertation. One is the combination of scales with other scales. For example, is it possible for two scales like those for PoA and voice to combine, forming constraints such as *{+vd}/{dorsal{, *{+vd}/{dorsal,labial}, and so on? Some attention has already been given to this issue from the viewpoint of local conjunction (Smolensky 1993). However, local conjunction alone predicts a vast number of scale-scale combinations; such combinations – if necessary – may be more limited.

Another unaddressed issue relates to 'distance' constraints, especially for sonority. Certain phenomena seem to refer to the degree of difference in the sonority of adjacent elements, as in syllable-contact restrictions (Hooper 1976, Murray & Vennemann 1983, Vennemann 1988, Gouskova 2002) and onset cluster conditions (Selkirk 1984 and many others). Some of these conditions may be explained solely by the constraints proposed here – i.e. by constraints that do not mention degree of difference.[257] However, it is likely that some constraints must explicitly refer to clusters of elements, as proposed in Baertsch (1998), Morelli (1999), Davis (1998), and Gouskova (2002). Exactly how conflation applies for such 'distance' effects is an issue that remains to be explicitly explored.

In conclusion, by no means has this dissertation provided solutions for every aspect of scale-reference. While it has presented proposals for many of the core aspects of scale-reference, a number of issues remain to be explored or re-evaluated in light of the issues raised herein.

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[257] I have argued this point for a case that involves apparent reference to degree of difference in tone height of different syllables elsewhere (de Lacy 2002b).

Appendix A: Coda and Onset Inventories

The following tables summarize the results of a survey of PoA inventories. This survey was the basis for the typological claims made in this chapter.[1]

The aim of the survey was to find two examples of each type, one for coda inventories and one for onset inventories. On occasion, more than one case is cited.

References for each of the languages cited are given in Appendix 2.

The tables list Major Place of Articulation only. I considered a language to have a coronal if it has a dental or alveolar segment of the appropriate manner of articulation; 'labial' covers bilabial and labiodental, 'dorsal' refers to velar or uvular, and 'laryngeal' is one of [ʔ h ɦ N]. Palatals [c ɟ ç ʝ ɲ] were disregarded because their phonological status is controversial (see T.Hall 1997§1.2.3 for discussion).

Languages may have several minor PoAs of the same major PoA. In such cases, a language's inventory is given in full.

The aim for coda inventories was to provide examples that had a full or at least fuller set of contrasts in onset position. For example, Chiracahua Apache has [ʔ] in codas, but the full complement of PoA contrasts [k p t ʔ] in onset position. For coda cases, the onset PoAs are listed next to the language. For example, "Nunggubuyu [k p t]" is listed under the entry for coda inventories consisting of [t] alone; this means that Nunggubuyu has [k p t] in onsets and [t] in codas.

In coda cases with minor PoA distinctions, both the coda and onset inventories are given in full. For example, "Yuma [q k p t]~[qʷ q kʷ k p t ʔ]ᴼᴺˢ" means that Yuma has [q k p t] in codas and [qʷ q kʷ k p t ʔ] in onsets.

A language was considered to have the coda inventory cited if (a) the inventory was reported for word-final consonants and (b) if the inventory appeared in medial codas (typically pre-consonantally). In some cases, an assimilation process blocked medial neutralization. In those cases, word-final consonants were taken to be representative of coda neutralization in the language.

Coda inventories are only given for voiceless stops, voiceless fricatives, and nasals. There was a strong tendency to eliminate voiced stops and voiced fricatives in codas in the languages examined; this prevented compilation of a clear typology of coda inventories for these manners of articulation.

As a final note, the languages cited with [N] in their codas are based on their behavior relative to other glottals in the language. As explained above and in ch.5, the relative recency of the [N]-theory (Trigo 1988) has limited the number of clear cases of [N] identified in inventories.

The tables contain several gaps. In most cases, gaps for one manner of articulation are present in another manner of articulation.

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[1] The survey was compiled primarily through a search of grammars and journals. Maddieson (1992) (UPSID) was also used as an initial search tool; all UPSID citations were checked against the original source(s).

Comments on specific inventory types are given in Appendices 3-5. Appendix 3 deals with harmonically complete inventories, Appendix 4 with gapped inventories, and Appendix 5 with disharmonic ones.

Only harmonically complete and gapped inventories are listed here. Disharmonic inventories (i.e. [K P], [K], [P]) are discussed in Appendix 5.

- *Liquids and glides*

Liquids are unrevealing due to the extreme rarity of non-coronal liquids (Walsh Dickey 1997). Consequently, if a language has a liquid, it always has a coronal. The same can be said for affricates: [p͜f] and [k͜x] are extremely rare, while their voiced counterparts are even rarer. In contrast, the coronal affricates [ts] and [tʃ] are common, so much so that I have found no language with affricates that does not have a coronal [ts] or [tʃ]. While this generalization supports the current hypothesis, it is again unrevealing given the lack of a reasonable sample of non-coronal affricates.

Glides present a rather unique situation in that the glide [w] classes with both the labials and dorsals in the same language and cross-linguistically (Ohala & Lorentz 1977).[2] Moreover, there is no true alveolar coronal: [j] always acts like a palatal (T.Hall 1997:21). Nevertheless, there are languages with only contrastive [j] and with both contrastive [j] and [w]. Nunggubuyu only allows [j] in codas, but both [w] and [j] in onsets (Heath 1984:19).

(1)   *Voiceless stops: Harmonically complete inventories without Glottal Elimination*

k	p	t	ʔ	Coda Inventory	Onset Inventory
			✓	Chiracahua Apache[k p t ʔ]^{ONS} Kiowa (Casual) [k p t ʔ]^{ONS} Apalai Carib [k p t ʔ]^{ONS} Fore [k p t ʔ]^{ONS} Kashaya [q k p t c ʔ]^{ONS} Kalantan Malay Nantong Chinese [k p t ʔ]^{ONS} Gadsup	Nancowry reduplicants Tübatulabal reduplicants
		✓	✓	Menomini [tʃ ʔ]~[k p t tʃ ʔ]^{ONS} Chickasaw	Harar Oromo (plain stops)
	✓	✓	✓	Standard Malay [k p t]^{ONS} Arekuna Carib [k p t]^{ONS}	Tahitian
✓	✓	✓	✓	Chamicuro [k p t]^{ONS} Pendau [k p t ʔ]^{ONS}	Nhanda Tongan Tsishaath Nootka [q k p t ʔ]

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[2] A rather remarkable case that attests to [w]'s dual nature is found in Ngubbuyu (Heath 1984). In this language there are two types of underlying /w/. One lenites to [b] in stem-initial position, and the other to [g] (p.14ff).

(2)   *Voiceless stops: Harmonically complete inventories with Glottal Elimination*

k	p	t	ʔ	Coda Inventory	Onset Inventory
		✓		Nunggubuyu [k p t] Taiwanese secret language reduplicants Uradhi	-
	✓	✓		Kiowa (Formal) [k p t ʔ]^{ONS}	Vanimo Berber (Imdlawn Tashlhiyt) [q qʷ k kʷ t]
✓	✓	✓		Yuma [q k p t]~[q qʷ kʷ k p t ʔ]^{ONS}	Nunggubuyu Walmatjari Maori

(3)   *Voiceless stops: Gapped inventories*

k	p	t	ʔ	Coda Inventory	Onset Inventory
✓	✓		✓	Cockney English [k p t (ʔ)] Yamphu [k p t ʔ] Refugee Tibetan [k p t ʔ] Chaoyang [k p t]^{ONS}	Hawaiian Yellowknife Chipewyan Apache
✓		✓	✓	Nambiquara [k p t ʔ] Nganasan codas [k t (ʔ)]^{onset}	Eyak Wichita [kʷ k tʃ t ʔ] Tlingit Cacaloxtepec Mixtec (Huajuapan) Ayutla Mixtec Kwara'ae
	✓		✓	Nganasan [p t k ʔ b d g]^{ONS}	-
✓			✓	Fuzhou	-
✓		✓		Mordvin (Erza) [k p t]^{ONS} Cantonese secret language Hixkaryana [p t tʃ k]^{ONS} Nunggubuyu [kptt̠]³	Gilbertese [k t] Nganasan [k t tʲ (ʔ)] [p] in recent loans Karajá [k tʃ] Chiricahua Apache (aspirated series) Japanese (Yamato & Sino-Japanese strata)

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3 Heath uses 'b', 'd', 'g' to stand for voiceless unaspirated stops [p t k]. All are allowed in onsets. [p] is only allowed in codas in a small number of interjections.

(4)   *Voiced stops: Harmonically complete inventories*

g	b	d	Onset Inventory
		✓	Diyari Nambiquara
	✓	✓	Sioux Valley (Santee) Xavanté Macro-Jê Juruna Lue Efik
✓	✓	✓	Nhanda Catalan Harar Oromo Kewa

(5)   *Voiced stops: Gapped inventories*

g	b	d	Onset Inventory
✓		✓	Cherokee Wapishana Ayutla Mixtec

(6)   *Voiced fricatives: Harmonically complete inventories without Glottal Elimination*

x	f	s	h	Coda Inventory	Onset Inventory
			✓	Peninsular Sp. dialects [x f s h] Fox [h]~[s h]^{ons}	Rapanui [h] Kapingamarangi [h] Bororó Macro-Je
		✓	✓	Chiracahua Apache [s ∫ h]~[s ʒ x h]^{ONS} Chipewyan [θsɬh]~[θsɬxh]^{ons} Chamicuro [s]^{ONS} Cayapa [f s h]^{ONS}	Stoney [ħ θ s h] Gujarati [s ∫ h] Attic Greek [s h] Tunica [s ∫ h] Sikaiana Kipeá Macro-Je Kashaya [s ∫ h] Abau
	✓	✓	✓	Florentine Italian Spirants Maltese [f s ∫ h]	Yâte Macro-Je [f s ∫ h] Yanomam [f s ∫ h] Finnish
✓	✓	✓	✓	Egyptian Arabic [χ f ∫ s h]	Harar Oromo [x f s h] Breton German Somali Karok

(7)   *Voiceless fricatives: Harmonically complete inventories with Glottal Elimination*

x	f	s	h	Coda Inventory	Onset Inventory
		✓		Lamani [s h]ONS Apatani [x s h]ONS	South Greenlandic Nambiquara [f in loans] Fore Juruna
	✓	✓		English [f s ʃ]~[f s ʃ (h)]ONS4	Catalan [f s ʃ] East Futuna [f s] Asmat [f s] Samoan [f s] Boazi [f s]
✓	✓	✓		Seri [χχ^w x f ɬ s ʃ]	Mordvin (Erzya) [x f ʃ s^j s]

(8)

x	f	s	h	Coda Inventory	Onset Inventory
Voiceless fricatives: Gapped inventories

x	f	s	h	Coda Inventory	Onset Inventory
✓	✓		✓	Peninsular Spanish (Coria) [x f s h]	Lakkia [x f θ h]
✓		✓	✓	-	Tsishaath Nootka [ħ χ x s ʃ h] Teton [x s ʃ h] Sentani [x s h] Yokuts (Yawelmani) Masset Haida Mongor Sui Mataco-Noctenes [x^w s h] Apatani
	✓		✓	-	Maori East Uvea Tokelau Guató Macro-Je Sentani
✓			✓	-	-
✓		✓		Tshishaath Nootka [ħχxsʃ]~[ħhχxsʃ] Mataco-Noctenes [x^w s h]ons	Yuma [x^w x s ʃ] Mansi [x s s^j] Khalka Atayal Kwaio Fuzhou Khanty [x s s^j]

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[4]   [h] appears PrWd-initially (e.g. [ri{h̲əbíləteit}] 'rehabilitate') and in stressed syllable onsets ([vihíkjələ 'vehicular'), but not elsewhere (cf [viəkl] 'vehicle').

(9)   *Voiced fricatives*

γ	v/β	z	Onset Inventory
		✓	Catalan Harar Oromo Gujarati ('innovating' dialects) Kiowa Yâte
	✓	✓	Majorcan Catalan Yuma [v ð] Hungarian [v z ʒ] Carijona Carib [β z]
✓	✓	✓	Greek [γ v z] Breton [γ v z] Kurdish [γ v z̦] Mari [γ β z ʒ] Ogbia [γ v z]
✓		✓	Sioux Valley (Santee) [ɣ z ʒ] Stoney [ʕ ð z] Chiracahua Apache [ɣ z ʒ] Aghem Savosavo Hare [ɣ z ʒ]

(10)　*Nasals: Harmonically complete inventories without Glottal Elimination*

ŋ	m	n	N	Coda Inventory	Onset Inventory
			✓	Pichis Asheninca Japanese [N]~[n m]ONS5 Cuban Spanish Nantong Chinese [N]~[m n N]ONS Pipil [N]~[m n]ons Kagoshima Japanese [N]~[m n ɲ]	[6]
		✓	✓	Seri [n N]~[m n]ons7	
	✓	✓	✓	Gujarati [m n ɳ N]~[m n]	Arabela [m n ħ] Piro [m n ħ]
✓	✓	✓	✓	[8]	

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[5] Coda [m n] are permitted before a homorganic consonant. e.g. [jonda].

[6] Avoidance of onset glottals could account for the lack of relevant examples. The only cases listed here have [ħ], not [ŋ] as their only onsets.

[7] Marlett (1981:20) reports that /m/→[ŋ] word-finally in unstressed syllables of younger speakers: /ko:tpam/ → [ko:tpaŋ] 'sardine'. I interpret [ŋ] as [N] here. /n/ remains faithul: [ʔesen] 'ironwood'.

[8] The fact that [N] and [ŋ] have the same phonetic realization makes it difficult to determine cases where they contrast phonologically.

(11)   *Nasals: Harmonically complete inventories with Glottal Elimination*

ŋ	m	n	N	Coda Inventory	Onset Inventory
		✓		Tzutujil [m n] Lardil [n or homorg]~[ŋ m n] Castilian Spanish [ŋ m n] Uradhi [ŋ m ɲ ṇ n]^ONS Ngawun Mayi [n ɲ ŋ]~[m ŋ ṇ]	Nambiquara [m in loans] Konkani
	✓	✓		-[9]	Harar Oromo [m n ɲ] Tsishaath Nootka [m n] Gujarati [m n] (cod=[m n ɳ N]) Jununa Tupí Sikaiana Fore
✓	✓	✓		NZ English [m n]^ONS Tol (Jicaque) [m n]^ONS	Nunggubuyu Nhanda Walmatjari Maori

(12)   *Nasals: Gapped inventories*

ŋ	m	n	N	Coda Inventory	Onset Inventory
✓	✓		✓	{See entry for [ŋ m n N]}	
✓		✓	✓	{See entry for [ŋ m n N]}	
	✓		✓	Caribbean Spanish	
✓			✓	{See entry for [ŋ m n N]}	
✓		✓		Nunggubuyu [ŋ m n ɲ] Cayapa [ŋ m n ɲ]^ons10 Cantonese secret language	

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[9] The rarity of onset [ŋ] is probably responsible for the lack of examples with onset [ŋ m n] and coda [m n].

[10] Word-initial [ŋ] is banned, but can appear in medial onsets.

(13)   *Glides: inventories*
       Note: [G] is the velar glide

G	w	j	Coda Inventory	Onset Inventory
		✓	Nunggubuyu [w j]$^{\text{ONS}}$	Mordvin (Erza)
	✓	✓		Nunggubuyu Tenango Otomi
✓	✓	✓	Mansi [j w]$^{\text{ONS}}$	Aguaruna Axininca Campa
✓		✓	-	-
	✓		-	Maori Karajá

Appendix B: Language References

Name	Subgroup	Reference
Apache	Athapaskan	Haas 1968, Rice 1978
Apache, Chiricahua	Athapaskan	Hoijer 1946
Apatani	Tibeto-Burman	Abraham 1985
Arabela	Zaparoan(Peru)	Rich 1963
Arabic, Egyptian	Semitic	Broselow 1976, Gadalla 2000
Arawakan	Arawakan	Aikhenvald 1999
Asmat	Central and South New Guinea	Voorhoeve 1965, Foley 1986:60
Attic Greek	Indo-European	Bubeník 1983:78
Ayutla	Mixtecan	Pankratz & Pike 1967
Beijing Chinese	Sino-Tibetan	Meredith 1990
Berber (Imdlawn Tashlhiyt)	Berber	Dell & Elmedlaoui 1988
Boazi	Trans-New Guinea	Foley 1986:61
Bora	Witotoan	Thiesen 1996
Cacaloxtepec	Mixtecan	Pike & Cowan 1967
Cantonese (secret language)	Sino-Tibetan	Yip 1982, Trigo 1988:54
Carib	Arawakan	Hoff 1968, Peasgood 1972
Carib (Arekuna)	Arawakan	Edwards 1978
Carijona Carib	Arawakan	Derbyshire 1999
Catalan	Romance	Hualde 1992
Cayapa	Barbacoan	Lindkoog & Brend 1962
Chamicuro	Arawakan	Parker 1994b, to appear
Chickasaw	Muskogean	Munro & Ulrich 1985
Chipewyan (Yellowknife)	Athapaskan	Haas 1968, Rice 1978
Chiricahua Apache	Athapaskan	Hoijer 1944
Coatzospan	Mixtec	Gerfen 1999
Diyari	Pama-Nyungan	Austin 1981
Ecuador Quichua	Quechuan	Orr 1962
Eyak	Na-Dene	Krauss 1965
Florentine Italian	Romance	Giannelli & Savoia 1979, Kirchner 1998:ch.7
Fore	Trans-New Guinea	Foley 1986:55

Fuzhou	Sino-Tibetan	Yip 1982:646
Gadsup	Trans-New Guinea	Foley 1986:61
Gilbertese	Oceanic	Blevins & Harrison 1994
Golin	Trans-New Guinea	Bunn & Bunn 1970
Gujarati	Indo-Iranian	Cardona 1965, Mistry 1997
Haida	Na-Dene	Sapir 1923
Harar Oromo	Ethiopic	Owens 1985
Hawaiian	Polynesian	Pukui & Elbert 1979
Hixkaryana	Carib	Derbyshire 1985
Hopi (Toreva)	Uto-Aztecan	Whorf 1946
Hullaga Quechua	Quechuan	Weber 1989:459
Hungarian	Uralic	Abondolo 1998b
Japanese, Kagoshima	-	Kaneko & Kawahara 2002
Jicarilla	Athapasakan	Haas 1968
Kannada	Dravidian	Sridhar 1990
Kashaya	Hokan	Buckley 1994
Khanty	Uralic	Abondolo 1998c
Kiowa	Athapaskan	Watkins 1984
Kiowa-Apache	Athapaskan	Haas 1968
Kwara'ae		Sohn 1980
Kui		Winfield 1928
Koḍava	Dravidian	Ebert 1996
Lipan	Athapaskan	Haas 1968
Luanguia	Polynesian	Salmond 1974
Macro-Je	Trans-New Guinea	Rodrigues 1999b
Makassarese	Malayo-Polynesian	Aronoff et al. 1987
Malay (Kalantan)	Malayo-Polynesian	Teoh 1988, Trigo 1988
Malay (Standard)	Malayo-Polynesian	Lapoliwa 1981, Teoh 1988, Trigo 1988
Maltese	Semitic	Borg & Azzopardi-Alexander 1997
Mansi	Uralic	Keresztes 1998
Maori	Polynesian	Bauer 1993
Masset Haida	Na-Dene	Enrico 1991
Mayu	Nilo-Saharan	Breen 1981
Menomini	Algonquian	Bloomfield 1962
Misantla Totonac	Totonacan	MacKay 1994, 1999
Makurap		Rodrigues 1999a:112ff

Mataco-Noctenes		Claesson 1994
Mordvin	Uralic	Zaicz 1998
Nambiquara	Nambiquaran	Kroeker 1972
Nancowry reduplicants	Mon-Khmer	Rhadakrishnan 1981, Alderete et al. 1999
Nantong Chinese	Sino-Tibetan	Ao 1993
Nganasan	Uralic	Helimski 1998, Olga Vaysman (p.c.)
Nhanda	Pama-Nyungan	Blevins 2001
Nunggubuyu	Gunwingguan	Heath 1984:17ff
Pendau	Indonesian	Quick 2000§2.4.1
Peninsular Spanish	Romance	Morris 2000
Pichis Asheninca	Arawakan	J.Payne 1990
Piro	Arawakan	Matteson 1965
Samoan	Polynesian	Mosel & Hovdhaugen 1992
Sentani	Trans-New Guinea	Foley 1986:59, Hargus 1988
Seri	Hokan	Marlett 1981
Sioux Valley (Santee)	Siouan	Shaw 1980:17
Slave (Hare)	Athapaskan	Rice 1989
South Greenlandic	Eskimo	Swadesh 1946
Stoney	Siouan	Shaw 1980:21
Tahitian	Polynesian	Coppenrath & Prevost 1974
Taiwanese (secret language)	Sino-Tibetan	Li 1985
Tamil	Dravidian	Vasanthakumari 1989
Tenango Otomo	Aztecan	Blight & Pike 1976
Teton	Siouan	Shaw 1980:16
Tigre	Semitic	Raz 1983
Tiriyó (Trio)	Carib	Parker 2001
Tongan	Polynesian	Churchward 1954
Tshishaath Nootka	Wakashan	Stonham 1999
Tübatulabal reduplicants	Uto-Aztecan	Voegelin 1935, Alderete et al. 1999
Tunica	-	Haas 1946
Tupí	Tupi	Rodrigues 1999b
Tzutujil	Mayan	Dayley 1985:38
Uradhi	Pama-Nyungan	Hale 1976, Crowley 1983
Vanimo	Sko	Ross 1980:78ff
Walmatjari	Pama-Nyungan	Hudson 1978
Wayana	Carib	Jackson 1972
Wichita	Caddoan	Garvin 1950
Yamphu	Tibeto-Burman	Rutgers 1998

Yanomam	-	Aikhenvald & Dixon 1999
Yokuts (Yawelmani)	Penutian	Newman 1944, 1946
Yucatec Mayan	Mayan	Lombardi 1991
Yuma	Hokan	Halpern 1946

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